

# **The Effect of Educational Attainment on Social, Economic, Political, and Environmental Indicators**

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## **Abstract**

The paper investigates the effect of educational attainment on social, economic, environmental, and political indicators across using regression analysis. Across 205 countries, the findings show that higher education attainment is positively associated with GDP per capita growth, political stability, government effectiveness, gross savings, life expectancy, rule of law, R&D expenditures, and literacy rate. These results support the idea that an educated population enhances economic growth, innovation, institutional equality, human capital, and healthcare. Conversely, educational attainment is negatively associated with climate risk, suggesting that an educated population may have greater climate awareness. We have also observed an unexpected negative relationship between educational attainment and voice and accountability, which may reflect the fact that improvements in education don't immediately translate into improvements in accountability. The findings show that educational attainment is a fundamental driver of positive socioeconomic outcomes, institutional equality, and sustainability. Therefore, policymakers should focus on maximizing educational attainment.

**Keywords:** education attainment, economic indicators, political indicators, social indicators, environmental indicators

## **Introduction**

Education is widely recognized as a critical investment in human capital, capable of generating long-term returns in increased productivity while also promoting greater innovation. Additionally, it can lead to better governance and improved health, thereby increasing overall quality of life.

This issue is important because it helps us better understand the implications of educational attainment for society. Most studies focus on the effects of educational attainment on only one aspect of society. However, this paper examines the effects of education through social, environmental, political, and economic lenses. Specifically, this paper uses regression analysis to empirically investigate the effect of educational attainment on a comprehensive range of socioeconomic, governance, and environmental indicators across 205 countries. The results show a positive association, where higher education attainment is linked to higher levels of economic growth, better governance, and improved welfare. Specifically, there is a positive and significant relationship between educational attainment and GDP per capita growth, gross savings, R&D expenditure, political stability, government effectiveness, rule of law, life expectancy, and

literacy rate. Conversely, there is a significantly negative relationship between educational attainment and voice and accountability, as well as climate risk. Finally, there is no statistically significant relationship between educational attainment and either male or female labor force participation rate.

This study offers several contributions to the understanding of the role of education in development. Unlike many existing studies, which typically focus on a single indicator or country, this paper examines the effect of educational attainment globally across a broad range of indicators. This study examines the effects from several different lenses, such as social, environmental, political, and economic, which allows for a clearer understanding of education's multidimensional impact. Furthermore, we used the most recent and comprehensive data set to provide more robust, relevant empirical evidence. This paper proceeds as follows: Section 2 provides background information on the existing literature; Section 3 highlights the empirical evidence; and Section 4 concludes the paper.

## **Literature Review**

Various methodologies have been used and employed to investigate the effect of education attainment on social, environmental, political, and economic indicators such as Panel Data Regression (Barro, 2013; Wang et al., 2022; Striessnig et al., 2013), VAR (Bambi, 2024), Cointegration Test (Okoli et al., 2024), Descriptive Analysis and Correlation (Smith-Greenaway, 2016; Falzone, 2017; Li and Sun, 2022), GEE (Nguyen et al., 2017), Multinomial Logit Models (Assaad et al., 2020), ARDL (Singh and Shastri, 2020), WLS (Mooi-Reci et al., 2019), KLD (Sasson, 2016), Causality Analysis (Rogoz et al., 2022), LASSO (Diakodimitriou et al., 2025), GMM (Sena and Higon, 2012; Garcia-Sanchez et al., 2013), Gravity Model (Arif, 2022), and Regression Analysis (Wadood, 2024).

Many studies have focused on various countries and regions, such as central Europe (Bambi, 2024), China (Wang et al., 2022; Li and Sun, 2022), Islamabad (Wadood, 2024), the UK (Sena and Higon, 2012), European Countries (Diakodimitriou et al., 2025), the USA (Sasson, 2016; Falzone, 2017; Nguyen et al., 2017), the Netherlands (Mooi-Reci et al., 2019), India (Singh & Shastri, 2020), MENA Countries (Assaad et al., 2020), Nigeria (Okoli et al., 2024), South Korea (Bambi, 2024).

The variables used in the literature as a driver of education attainment often varied such as GDP per Growth (Barro, 2013), Research and Development Expenditures (Bambi, 2024), Unemployment Rate (Okoli et al., 2024), Female Literacy Rate (Smith-Greenaway, 2016), Literacy Rate (Nguyen et al., 2016), Labor Force Participation Rate (Falzone, 2017), Marital Status (Assaad et al., 2020), Public Expenditure on Education (Singh & Shastri, 2020), Parents' Educational Attainment (Mooi-Reci et al., 2019), Life Expectancy (Sasson, 2016), Technological Development (Rogoz et al., 2022), Worker Productivity (Sena & Higon, 2012), Income Gap

(Arif, 2022), Government Effectiveness (Garcia-Sanchez et al., 2017), Rule of Law (Li & Sun, 2022), Financial Literacy (Wadood, 2024), Gross Savings (Wang et al., 2022), Climate Risk (Striessnig et al., 2013).

Barro (2013), utilizing Panel Data Regression across 100 countries, emphasizes that economic growth is driven significantly by education. These findings align closely with Bambi (2024), Rogoz et al. (2022). Recent studies by Bambi (2024) and Diakodimitriou et al. (2025) emphasize that educational attainment is the key determinant for research and development and innovation. Sena and Higon (2012) further argue that regions with a more educated workforce had higher worker productivity and gained more from R&D spillovers. The relationship between education and the government is another important area, for example, Garcia-Sanchez et al. (2017) and Li and Sun (2022) show a positive correlation between educational attainment and rule of law. This suggests that as the population becomes more educated, they are more likely to demand accountability. Arif (2022) found that more educated migrants are more likely to move to countries with less corruption, suggesting that controlling corruption can attract a more educated population. The literature consistently links education to improved health outcomes. For example, Sasson (2016) and Rogoz et al. (2022) report a strong positive relationship between educational attainment and life expectancy, finding that higher education promotes healthier lifestyles, better decisions, and improved access to healthcare. Conversely, the relationship between education and labor market outcomes appears more complex. While Okoli et al. (2024) demonstrated that higher education significantly reduces unemployment, Falzone (2017) found that decreased labor participation rates have been driven by population changes and shifting work behavior, suggesting that education alone is not the only factor.

**Table 1.** An extensive review of literature on the effect of educational attainment on social, environmental, political, and economic indicators.

| Authors          | Year | Key variables                                                               | Country                        | Methodology                       | Key Findings                                                                                                 | Data period |
|------------------|------|-----------------------------------------------------------------------------|--------------------------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------|-------------|
| Barro            | 2013 | GDP per capita growth, trade openness, rule of law                          | Global                         | Panel regression                  | Economic growth is driven more by the quality of education than by years of schooling.                       | 1960-1990   |
| Bambi            | 2024 | R&D, GDP growth, technological innovation                                   | Central Europe and South Korea | VAR                               | Education and human capital drive innovation, causing greater investment in research and education.          | 1996-2022   |
| Okoli et al.     | 2024 | Unemployment, graduation rate, inflation.                                   | Nigeria                        | Cointegration                     | Higher educational attainment and expenditures significantly reduced unemployment.                           | 1990-2020   |
| Smith-Green away | 2016 | Female literacy rate                                                        | Global                         | Descriptive analysis, correlation | Schooling doesn't always reflect true literacy for women.                                                    | 2000-2012   |
| Nguyen et al.    | 2017 | Demographic variables, literacy rate                                        | USA                            | GEE                               | Education improves mental health via literacy.                                                               | 1992-2010   |
| Falzone          | 2017 | Labor force, population                                                     | USA                            | Descriptive analysis              | Education alone can't reverse the decline in the U.S. labor force participation rate.                        | 1994-2014   |
| Assaad et al.    | 2020 | Working age population, marital status, age, region, household of children. | MENA                           | Multinomial Logit Models          | The decline in public-sector employment among educated women is associated with an increase in unemployment. | 2000-2017   |
| Singh & Shastri  | 2020 | Unemployment, public expenditure on education,                              | India                          | ARDL                              | Educational attainment negatively affects the unemployment rate.                                             | 1987–2017   |
| Mooi-Reci et     | 2019 | Unemployment, parents'                                                      | The                            | WLS                               | Fathers' unemployment reduces children's income and                                                          | 1985-2010   |

|                       |      |                                                                              |                      |                                 |                                                                                                                                                       |           |
|-----------------------|------|------------------------------------------------------------------------------|----------------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| al.                   |      | work ethic, presence of siblings                                             | Netherlands          |                                 | learning quality, while mothers' positive work attitudes can improve educational outcomes.                                                            |           |
| Sasson                | 2016 | Life expectancy                                                              | USA                  | KLD                             | Less-educated individuals face shorter, more uncertain lifespans, while college-educated individuals live longer with less variation in age at death. | 1990-2010 |
| Rogoz et al.          | 2022 | Economic freedom, fiscal policies, living standards, healthcare quality      | New EU member states | Causality, Cointegration tests  | Higher education promotes healthier lifestyles, better decision-making, and improved access to healthcare, thereby increasing life expectancy.        | 2000-2019 |
| Diakodimitriou et al. | 2025 | R&D expenditures, public expenditures                                        | European countries   | LASSO, 3SLS model               | Education spending drives economic growth by boosting R&D.                                                                                            | 1996-2019 |
| Sena & Higon          | 2012 | R&D expenditure, worker productivity                                         | UK                   | GMM                             | Plants in regions with a more educated workforce gain more from R&D spillovers and are more productive.                                               | 1997–2002 |
| Arif                  | 2022 | Corruption, Income gap, Democracy gap, Contiguity, Diplomatic representation | Global               | Panel data analysis             | Controlling corruption can attract educated workers and promote brain gain.                                                                           | 1990-2000 |
| Garcia-Sanchez et al. | 2013 | Government effectiveness                                                     | Global               | GMM                             | Education improves government effectiveness.                                                                                                          | 2002-2008 |
| Li & Sun              | 2022 | Rule of law, thinking skills                                                 | China                | Correlation, frequency analysis | There is a strong positive link between critical thinking and respect for legal principles.                                                           | 2019-2020 |
| Wadood                | 2024 | Savings, financial literacy, gender, age,                                    | Islamabad            | Regression                      | Education is strongly negatively associated with saving behavior.                                                                                     | 2024      |
| Wang et al.           | 2022 | GNI, unemployment, gender                                                    | China                | Panel data regression,          | Higher education lowers national savings by reducing job insecurity and precautionary savings.                                                        | 1991-2019 |

|                   |      |                                                     |        |                  |                                                               |           |
|-------------------|------|-----------------------------------------------------|--------|------------------|---------------------------------------------------------------|-----------|
|                   |      |                                                     |        | GMM              |                                                               |           |
| Striessnig et al. | 2013 | Climate risk, polity score, population density, HDI | Global | Panel regression | Investing in education greatly reduces climate vulnerability. | 1980-2013 |

Data and Methods

Scatterplot Graphics

**Figure 1.** Scatterplot Graph between GDP Per Growth, Government Effectiveness, Political Stability, Government Effectiveness, and Education Expenditure

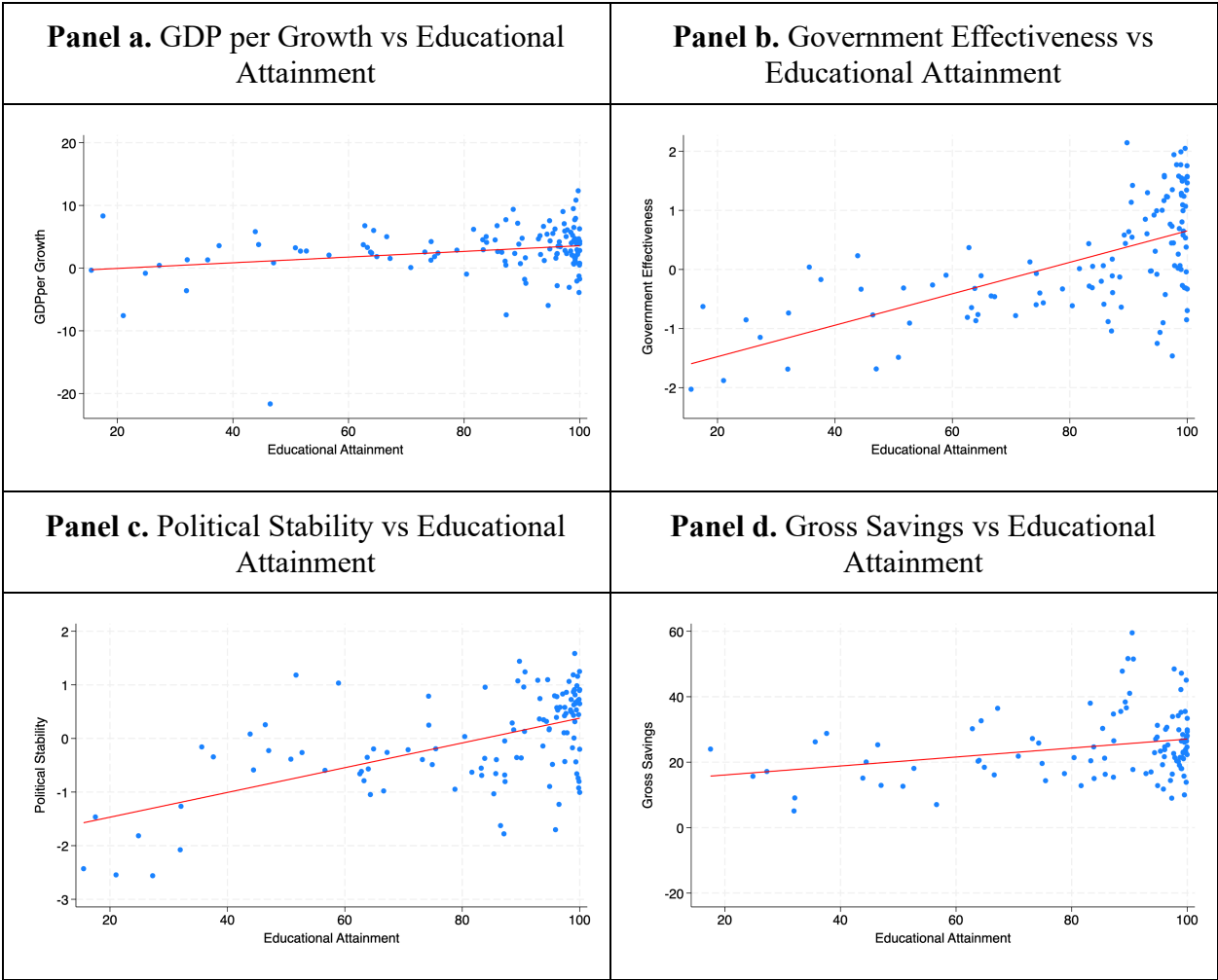


Figure 1 presents a series of scatterplots that illustrate the relationship between educational attainment and key economic and government indicators across countries. Panel a shows the association between GDP per capita growth and educational attainment. The slightly positive slope suggests that countries with higher levels of educational attainment tend to experience higher GDP growth rates. This supports that education contributes to productivity and economic development. Panel b examines the link between educational attainment and government effectiveness. The strong positive slope suggests that countries with a more educated population are likely to have more efficient, accountable governments. This supports that education

enhances institutional quality. Panel c shows the relationship between political stability and educational attainment. The scatterplot indicates a moderate positive relationship, suggesting that countries with higher educational attainment tend to have more stable governments. This supports economic stability. Panel d shows the correlation between educational attainment and gross savings. A positive correlation is observed, suggesting that higher educational attainment may lead to greater savings behavior, which increases the country's income levels.

**Figure 2.** Scatterplot Graph between Labor Force Male, Labor Force Female, Life Expectancy, Rule of Law, and Education Expenditure

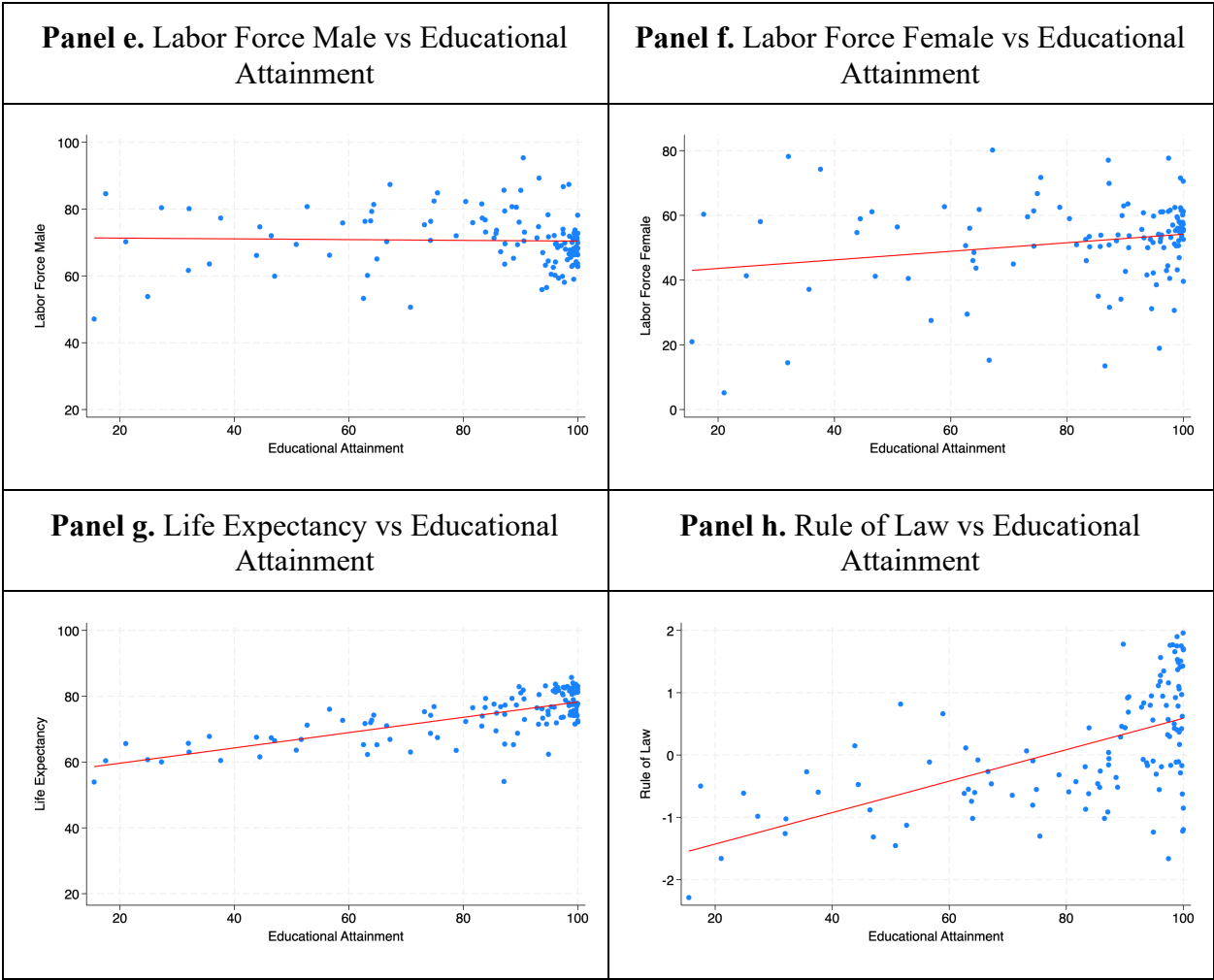


Figure 2 illustrates the relationship between educational attainment and four key social and labor market indicators. Panel e shows the association between male labor force participation and educational attainment. The relationship appears relatively flat and weak, indicating that male labor force participation rate may not vary significantly with different educational levels across countries. Panel f shows the relationship between female labor force participation and educational attainment. The scatterplot suggests a positive correlation, implying that higher

educational attainment levels are associated with higher female participation in the labor force. In panel g, a strong positive relationship is observed between life expectancy and educational attainment. Countries with higher levels of education tend to exhibit longer life expectancies. It is obvious that education contributes to improved living standards. Panel h examines the link between rule of law and educational attainment. The positive trend suggests that higher educational attainment is linked to stronger rule of law. It is clear that an educated population is more likely to demand accountability and respect legal norms.

**Figure 3.** Scatterplot Graph between GDP Per Growth, Government Effectiveness, Political Stability, Government Effectiveness, and Education Expenditure

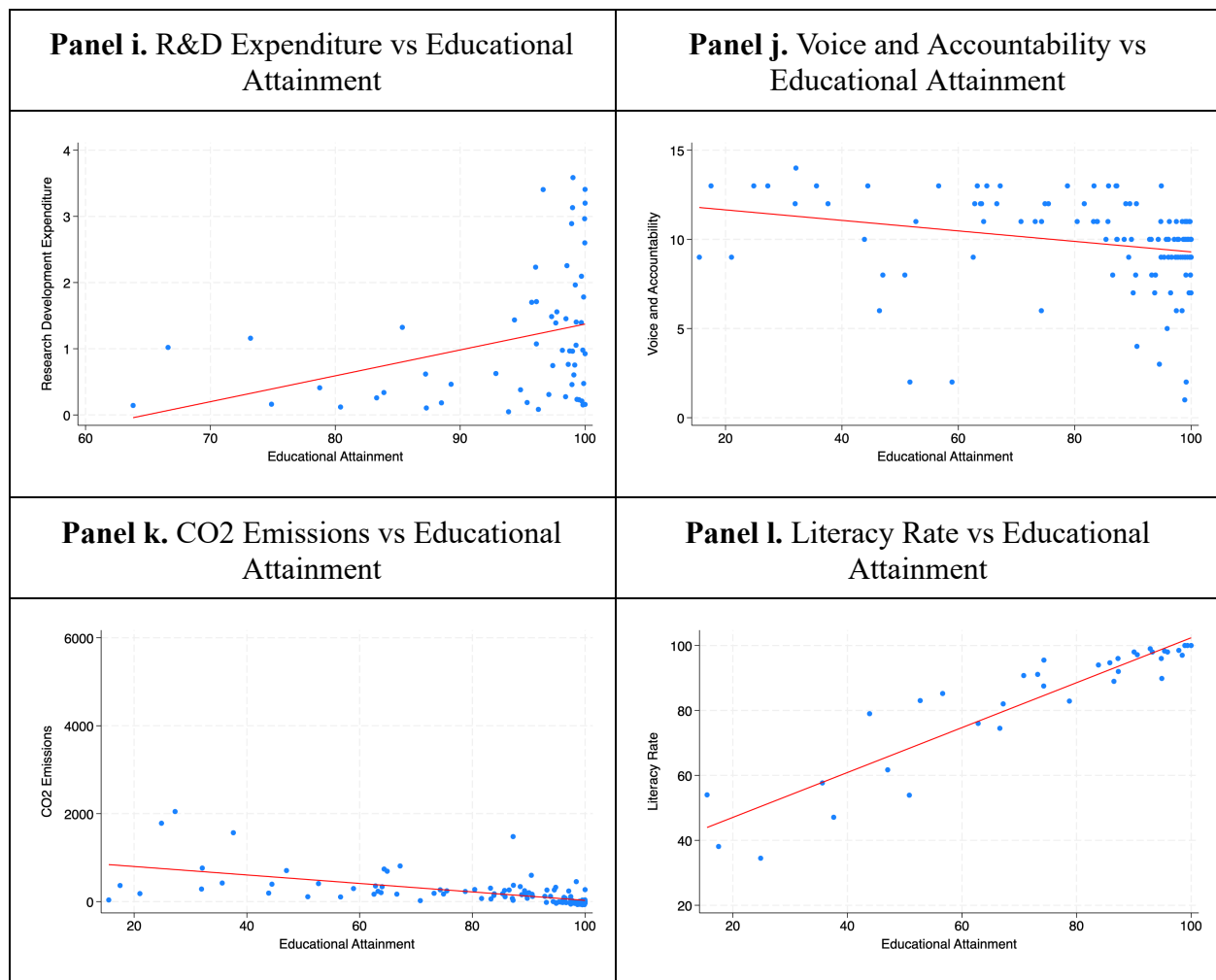


Figure 3 presents 4 scatterplot graphics examining the relationships between educational attainment and R&D expenditure, voice and accountability, CO2 emissions, and literacy rate. Panel i shows a positive correlation between educational attainment and R&D expenditure. Countries with a higher level of educational attainment tend to invest a larger proportion of their GDP in research and development activities. This finding suggests that an educated population

fosters innovation. Panel j indicates a slightly negative association between educational attainment and voice and accountability. That is interesting, but it may be because improvements in education don't immediately translate into improvements in accountability. Panel k shows a negative relationship between educational attainment and carbon dioxide emissions, suggesting that more educated societies may have lower climate risk. This panel suggests that education could play an important role in environmental awareness. Panel l displays a strong positive relationship between educational attainment and literacy rate, suggesting that education plays a critical role in human capital development.

## Data

Appendix 1 presents various indicators sourced from the World Bank World Development Indicators. The variables include educational attainment as a percentage of population ages 25 and above (Edu\_attainment), GDP per capita as a percentage of annual growth (GDPper\_growth), consumer price index as a proxy of inflation (Inf), political stability (Pol\_stability), literacy rate as a percentage of people ages 15 and above (Literacy), labor force participation rate as a percentage of male population ages 15+ (Lforce\_male), labor force participation rate as a percentage of female population ages 15+ (Lforce\_female), unemployment as a percentage of total labor force (Unemp), life expectancy (Life\_exp), research and development expenditure as a percentage of GDP (R&D), control of corruption (Corruption), government effectiveness (Gov\_effect), rule of law (Rule of Law), voice and accountability (Accountability), gross savings as a percentage of GNI (GNI), gini index (Gini), carbon intensity of GDP (Climate Risk).

## Descriptive Statistics

**Table 1.** Descriptive Statistics

| Variable       | Obs | Mean   | Std. Dev. | Min     | Max    |
|----------------|-----|--------|-----------|---------|--------|
| Edu_attainment | 121 | 83.091 | 21.809    | 15.5    | 100    |
| GDPper_growth  | 256 | 3.31   | 6.042     | -22.746 | 62.111 |
| Gov_effect     | 205 | -.039  | .995      | -2.391  | 2.144  |
| Pol_stability  | 205 | -.035  | .999      | -2.777  | 1.661  |
| GNI            | 198 | 24.675 | 10.815    | -21.882 | 59.525 |
| Lforce_male    | 234 | 70.453 | 8.791     | 24.098  | 95.365 |

|                |     |         |          |        |           |
|----------------|-----|---------|----------|--------|-----------|
| Lforce_female  | 234 | 50.314  | 14.75    | 4.977  | 82.575    |
| Life_exp       | 265 | 72.796  | 7.648    | 18.818 | 85.746    |
| Rule of Law    | 205 | -.023   | 1.001    | -2.287 | 1.958     |
| R&D            | 96  | 1.392   | 1.222    | .035   | 6.019     |
| Accountability | 203 | 8.798   | 3.443    | 1      | 14        |
| Climate Risk   | 246 | 667.546 | 4308.181 | -82.39 | 52245.455 |
| Literacy       | 95  | 81.356  | 16.122   | 27.28  | 100       |

Table 1 provides descriptive statistics for educational attainment and various social, economic, environmental, and political indicators. The Edu\_attainment has 121 observations with a mean of 83.091 and a standard deviation of 21.809, ranging from a minimum of 15.5 to a maximum of 100. GDPper\_growth has 256 observations with a mean of 3.31 and a standard deviation of 6.042, ranging from a minimum of -22.746 to a maximum of 62.111. Gov effect has 205 observations with a mean of -.039 and a standard deviation of .995, ranging from a minimum of -2.391 to a maximum of 2.144. Pol\_stability has 205 observations with a mean of -0.035 and a standard deviation of 0.999, ranging from a minimum of -2.777 to a maximum of 1.661. GNI has 198 observations with a mean of 24.675 and a standard deviation of 10.815, ranging from a minimum of -21.882 to a maximum of 59.525. Lforce\_male has 234 observations with a mean of 70.453 and a standard deviation of 8.791, ranging from a minimum of 24.098 to a maximum of 95.365. Lforce\_female has 234 observations with a mean of 50.314 and a standard deviation of 14.75, ranging from a minimum of 4.977 to a maximum of 82.575. Life\_exp has 265 observations with a mean of 72.796 and a standard deviation of 7.648, ranging from a minimum of 18.818 to a maximum of 85.746. Rule of Law has 205 observations with a mean of -0.023 and a standard deviation of 0.966, ranging from a minimum of -2.069 to a maximum of 1.958. R&D has 79 observations with a mean of 1.123 and a standard deviation of 1.019, ranging from a minimum of 0.035 to a maximum of 3.586. Accountability has 71 observations with a mean of 9.704 and a standard deviation of 1.87, ranging from a minimum of 1 to a maximum of 13. Climate Risk has 79 observations with a mean of 51.452 and a standard deviation of 135.39, ranging from a minimum of -70.277 to a maximum of 630.812. Literacy has 15 observations with a mean of 94.403 and a standard deviation of 7.701, ranging from a minimum of 74.5 to a maximum of 100.

## Model

$$Y_i = a_0 + b_1 X_i + e_i$$

Where  $Y_i$  is the dependent variable for observation  $i$ , which refers to GDPper\_growth, Pol\_stability, Gov\_effect, GNI, Lforce\_male, Lforce\_female, Life\_exp, Rule of Law, R&D, Climate Risk, Accountability, Literacy.  $a_0$  is the constant term, representing the expected value of the dependent variable when the independent variable is zero.  $b_1$  is the coefficient for the independent variable, which is Edu\_attainment. The coefficient shows how much the dependent variable changes when the independent variable changes by one unit.  $e_i$  is the error term, which represents the difference between the actual value and the predicted value from the model. We estimated 12 different models to investigate the effect of Edu\_attainment on social, economic, environmental, and political indicators. The estimated models are presented below.

$Edu\_attainment_i = a_0 + b_1 GDPper\_growth_i + e_i$  (model 1)

$Edu\_attainment_i = a_0 + b_1 Pol\_stability_i + e_i$  (model 2)

$Edu\_attainment_i = a_0 + b_1 Gov\_effect_i + e_i$  (model 3)

$Edu\_attainment_i = a_0 + b_1 GNI_i + e_i$  (model 4)

$Edu\_attainment_i = a_0 + b_1 Lforce\_male_i + e_i$  (model 5)

$Edu\_attainment_i = a_0 + b_1 Lforce\_female_i + e_i$  (model 6)

$Edu\_attainment_i = a_0 + b_1 Life\_exp_i + e_i$  (model 7)

$Edu\_attainment_i = a_0 + b_1 RuleofLaw_i + e_i$  (model 8)

$Edu\_attainment_i = a_0 + b_1 R\&D_i + e_i$  (model 9)

$Edu\_attainment_i = a_0 + b_1 Climate\_Risk_i + e_i$  (model 10)

$Edu\_attainment_i = a_0 + b_1 Accountability_i + e_i$  (model 11)

$Edu\_attainment_i = a_0 + b_1 Literacy_i + e_i$  (model 12)

## Analysis and Discussion

**Table 1a. Regression Analysis**

|                | ( model 1)        | (model 2)          | (model 3)          | (model 4)          |
|----------------|-------------------|--------------------|--------------------|--------------------|
| VARIABLES      | GDPper_g<br>rowth | Pol_stabili<br>ty  | Gov_effec<br>t     | GNI                |
| Edu_attainment | 0.05**<br>(0.02)  | 0.02***<br>(0.00)  | 0.03***<br>(0.00)  | 0.14***<br>(0.04)  |
| Constant       | -0.95<br>(2.01)   | -2.01***<br>(0.28) | -2.05***<br>(0.24) | 13.35***<br>(3.13) |
| Observations   | 119               | 118                | 118                | 106                |
| R-squared      | 0.06              | 0.35               | 0.39               | 0.08               |

Robust standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1a presents the results in four different regression models where the dependent variables are GDP per capita growth (GDPper\_growth), Political Stability (Pol\_stability), Government Effectiveness (Gov\_effect), and Gross Savings (GNI). Each column corresponds to a distinct model with an explanatory variable as Educational Attainment (Edu\_attainment). If the results are statistically significant at one percentage level, we indicate it by (\*\*\*), the five percentage level (\*\*), and the ten percentage level (\*). The coefficient for educational attainment is positive and statistically significant for all of the models, indicating that higher educational attainment is associated with higher levels of GDP per capita growth, greater political stability, more effective governance, and higher levels of gross savings. This suggests that countries with higher levels of educational attainment contribute to labor productivity and innovation, which enhances national output. Furthermore, the results also suggest that a more educated population is more likely to support a more effective and stable government. Higher educational attainment can also lead to greater savings behavior, thereby increasing the country's income levels.

**Table 1b. Regression Analysis**

|                | (model 5)          | (model 6)          | (model 7)          | (model 8)          |
|----------------|--------------------|--------------------|--------------------|--------------------|
| VARIABLES      | Lforce_male        | Lforce_female      | Life_exp           | Rule of Law        |
| Edu_attainment | -0.01<br>(0.05)    | 0.12<br>(0.08)     | 0.23***<br>(0.02)  | 0.03***<br>(0.00)  |
| Constant       | 71.34***<br>(4.27) | 41.73***<br>(7.48) | 55.13***<br>(1.35) | -2.00***<br>(0.24) |
| Observations   | 117                | 117                | 117                | 116                |
| R-squared      | 0.00               | 0.04               | 0.52               | 0.34               |

Robust standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1b presents four different regression results examining the relationship between educational attainment (Edu\_attainment) and male labor force participation rate (Lforce\_male), female labor force participation rate (Lforce\_female), life expectancy (Life\_exp), and rule of law (Rule of Law). Models 5 and 6 show that the relationship between educational attainment and male and female labor force participation rates is statistically insignificant. Models 7 and 8 show a positive and statistically significant relationship between educational attainment and life expectancy and rule of law, respectively, suggesting that countries with higher educational attainment tend to have healthier lives and greater respect for laws and institutions.

**Table 1c. Regression Analysis**

|                | (model 9)         | (model 10)            | (model 11)         | (model 12)         |
|----------------|-------------------|-----------------------|--------------------|--------------------|
| VARIABLES      | R&D               | Climate Risk          | Accountability     | Literacy           |
| Edu_attainment | 0.04***<br>(0.01) | -8.88***<br>(1.50)    | -0.09***<br>(0.01) | 0.65***<br>(0.15)  |
| Constant       | -2.57**<br>(1.02) | 882.09***<br>(144.01) | 18.10***<br>(1.33) | 35.76**<br>(13.98) |
| Observations   | 59                | 59                    | 59                 | 9                  |
| R-squared      | 0.11              | 0.38                  | 0.30               | 0.82               |

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1c displays the results of four different regressions examining the relationship between educational attainment and research and development expenditures (R&D), carbon dioxide emissions (Climate Risk), voice and accountability (accountability), and literacy rate (literacy). Models 9 and 12 show a positive and statistically significant relationship between educational attainment (Edu\_attainment) and research and development expenditures (R&D), and between educational attainment (Edu\_attainment) and the literacy rate (Literacy), suggesting that countries with higher education levels tend to invest more in research and innovation and have a greater literacy rate, indicating a more qualified human capital. In contrast, models 10 and 11 show negative, statistically significant relationships between educational attainment (Edu\_attainment) and carbon dioxide emissions (Climate Risk), and between educational attainment (Edu\_attainment) and voice and accountability (Accountability). This suggests that improvements in education may not immediately translate into greater accountability, and that a more educated population may foster greater climate awareness and reduce climate risk.

## Conclusion

This paper used linear regression to investigate the impact of educational attainment on a broad range of social, economic, political, and environmental indicators. Educational attainment in this study is defined as the percentage of the population aged 25 and over who have completed primary education. The results show a positive association between education attainment and GDP per capita growth, gross savings, R&D expenditures, political stability, government effectiveness, rule of law, life expectancy, and literacy rate, while also showing a negative association between climate risk and voice and accountability. Future studies should employ more complex methodologies, such as GMM and VAR, to see the effect of time variation. Furthermore, future studies should include other factors such as freedom, democracy, healthcare, and technology. Future research should use individual-level or household-level data.

## Appendix

### Appendix 1. Data Definition

| Indicator Symbol | Variable                                                                                         | Definition                                                                                                                                                                                                   | Source         |
|------------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Edu_ attainment  | Educational attainment, at least completed primary, population 25+ years, total (%) (cumulative) | The percentage of population ages 25 and over that attained or completed primary education.                                                                                                                  | WDI World Bank |
| GDPper_growth    | GDP per capita (annual % growth)                                                                 | This indicator represents the percentage change in GDP per capita from the previous year, expressed in constant prices (base year: 2015) in United States dollars.                                           | WDI World Bank |
| Inf              | Consumer price index (2010 = 100)                                                                | Index of the prices of consumption goods and services, as compared to a certain reference period (2010=100).                                                                                                 | WDI World Bank |
| Pol_stability    | Political Stability and Absence of Violence/Terrorism: Estimate                                  | Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism, ranging from -2.5 to 2.5." | WDI World Bank |
| Literacy         | Literacy rate, adult total (% of people ages 15 and above)                                       | Adult literacy rate is the percentage of people ages 15 and above who can both                                                                                                                               | WDI World Bank |

|               |                                                                                                 |                                                                                                                                                                                                                   |                |
|---------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|               |                                                                                                 | read and write with understanding a short simple statement about their everyday life.                                                                                                                             |                |
| Lforce_male   | Labor force participation rate, male (% of male population ages 15+) (modeled ILO estimate)     | Labor force participation rate is the proportion of the population ages 15 and older that is economically active: all people who supply labor for the production of goods and services during a specified period. | WDI World Bank |
| Lforce_female | Labor force participation rate, female (% of female population ages 15+) (modeled ILO estimate) | The labor force participation rate is the labor force as a percent of the population ages 15 and older. The labor force is the sum of all persons of working age who are employed and those who are unemployed.   | WDI World Bank |
| Unemp         | Unemployment, total (% of total labor force) (modeled ILO estimate)                             | Unemployment refers to the share of the labor force that is without work but available for and seeking employment.                                                                                                | WDI World Bank |
| Life_exp      | Life expectancy at birth, total (years)                                                         | Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.                        | WDI World Bank |

|             |                                                 |                                                                                                                                                                                                                                                                                                                                               |                |
|-------------|-------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| R&D         | Research and development expenditure (% of GDP) | Gross domestic expenditures on research and development, expressed as a percent of GDP.                                                                                                                                                                                                                                                       | WDI World Bank |
| Corruption  | Control of Corruption: Estimate                 | Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as ""capture"" of the state by elites and private interests, ranging from -2.5 to 2.5.                                                                              | WDI World Bank |
| Gov_effect  | Government Effectiveness: Estimate              | Government Effectiveness captures perceptions and views of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies, ranging from -2.5 to 2.5. | WDI World Bank |
| Rule of Law | Rule of Law: Estimate                           | Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of                                                                                                                                                                                                                                   | WDI World Bank |

|                |                                                |                                                                                                                                                                                                                                                                                          |                |
|----------------|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|                |                                                | society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence, ranging from -2.5 to 2.5.                                                                                                  |                |
| Accountability | Voice and Accountability:<br>Number of Sources | Voice and Accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.                                                             | WDI World Bank |
| GNI            | Gross savings (% of GNI)                       | Gross savings are calculated as gross national income less total consumption, plus net transfers. This indicator is expressed as a percentage of Gross National Income (GNI) which is the total income earned by all residents within an economic territory during an accounting period. | WDI World Bank |
| Gini           | Gini index                                     | Gini index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among                                                                                                                                                                    | WDI World Bank |

|              |                                                                                           |                                                                                                                                                                                                                                                                        |                |
|--------------|-------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|              |                                                                                           | individuals or households within an economy deviates from a perfectly equal distribution.                                                                                                                                                                              |                |
| Climate Risk | Carbon dioxide (CO <sub>2</sub> ) emissions (total) excluding LULUCF (% change from 1990) | Change of emissions (as %) of current year with respect to emissions in baseline year 1990 emissions of carbon dioxide (CO <sub>2</sub> ), one of the six Kyoto greenhouse gases (GHG), from the agriculture, energy, waste, and industrial sectors, excluding LULUCF. | WDI World Bank |

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## **Referee Report for The Effect of Educational Attainment on Social, Economic, Political, and Environmental Indicators**

This paper studies the relationship between educational attainment and a broad set of economic, political, social, and environmental indicators across countries. The topic is worthwhile and ambitious, especially for a student paper. One of the strengths of the manuscript is that it tries to show the multidimensional relevance of education rather than limiting itself to a single outcome. The paper is also clearly motivated and the author has made a serious effort to connect the analysis to existing literature. The overall message of the paper is understandable and potentially suitable for a high school journal.

At the same time, the current version needs revision before publication. My main concern is that the empirical strategy is not yet described consistently. In the model section, the general equation says that  $Y$  is the dependent variable and education is the independent variable, which fits the paper's stated goal. However, the twelve equations listed immediately below reverse that relationship and place educational attainment on the left-hand side as the dependent variable. This is a major presentation problem because it creates confusion about what is actually being estimated. The regression tables later suggest that the intended specification is indeed outcome on education, so the model section should be corrected to match the tables and the discussion.

A second issue is that the paper sometimes makes causal claims that go beyond what the analysis can support. The data appear to be cross sectional and the regressions are bivariate. Under those conditions, the results show association, not causal effect. This matters because the wording in several places suggests that education drives growth, stability, government effectiveness, and environmental improvement. That may be true, but the present design cannot establish it. I would recommend changing the language throughout from effect or driver to association or relationship unless the author adds a more sophisticated identification strategy.

Third, the manuscript needs much more care in variable definition and consistency. There are several places where the terminology shifts. For example, climate risk is described in the text as if it were a general risk measure, but in the appendix it is defined as change in carbon dioxide emissions. Those are not the same thing. Similarly, GNI is used in the regression tables to refer to gross savings as a percentage of GNI, which could easily confuse readers. The paper should standardize variable names and use the exact indicator names throughout.

Fourth, the descriptive statistics and regression sections appear to contain inconsistencies in sample sizes. For example, some variables have one number of observations in the descriptive table and a different number in the text that follows. Literacy is one example where the counts are especially small, which should make the author cautious about strong conclusions. This does not make the exercise invalid, but the paper should explain that the effective sample differs across models because of missing data. The current version reads as if all variables are measured for all countries, which is not the case.

I also think the literature review can be tightened. Right now it is broad but somewhat list-like. Instead of naming many methods and countries in sequence, the review would be stronger if it were organized by theme. For instance, one paragraph on economic outcomes, one on

governance and institutions, one on social outcomes, and one on environmental outcomes. That would make it easier for the reader to see how the present paper fits into the literature.

Finally, the writing is generally readable, but the manuscript would benefit from a careful edit for grammar, repetition, and figure labeling. Figure titles repeat some labels, and a few interpretations are stated too strongly relative to the evidence. The negative result on voice and accountability is interesting, but it currently feels underexplained. The author should either discuss more possible reasons for it or present it more cautiously as an unexpected correlation.

Recommendation: Revise and resubmit.

Main revisions requested:

1. Correct the model section so the equations match the regressions actually estimated.
2. Replace causal language with associative language unless stronger methods are introduced.
3. Standardize variable definitions and names across text, tables, and appendix.
4. Explain differing sample sizes and missing data across models.
5. Reorganize the literature review by substantive theme rather than as a long list.
6. Tone down overinterpretation, especially for unexpected findings.
- 7.

## Report

I enjoyed reading this paper. The author takes on a very large question and does so with energy and curiosity. For a high school submission, the scope is impressive. The paper also has a clear practical message, namely that education is connected to many dimensions of national development. That is a valuable starting point, and I think readers of a student journal would find the topic engaging.

My recommendation is positive overall, but I would like to see some revisions before acceptance.

The biggest improvement needed is analytical humility. The paper often presents the results as if they prove that education improves governance, growth, health, savings, innovation, and environmental outcomes. The regressions do not really allow that conclusion. The models use only one explanatory variable at a time, which means many other factors are left out. Richer countries, for example, may have both higher education and better institutions for reasons not captured here. This does not ruin the paper, but it means the conclusions should be framed more carefully. The author should explicitly acknowledge omitted variables and possible reverse causality. More educated societies may become richer, but richer societies may also be able to invest more in education.

A second concern is that some of the presentation choices make the paper harder to trust than it needs to be. The descriptive statistics section and the regression tables do not always line up neatly. The number of observations changes quite a bit, especially for R&D, accountability, climate risk, and literacy. That should be explained clearly in one sentence in the methods section and perhaps again in the table notes. Otherwise, readers may wonder whether the analysis is using the same sample throughout.

I also encourage the author to rethink how the figures are used. The scatterplots are helpful visually, but at present the discussion sometimes repeats what is already obvious from the fitted line without adding much interpretation. In a few cases the text may also overstate the visual pattern. A more effective use of the figures would be to point out where the relationship looks strong, where it looks weak, and where there may be outliers or substantial dispersion. That would make the paper feel more analytical and less descriptive.

Another point concerns the literature review. There is evidence that the author read widely, which is commendable. Still, the review tries to cover too many papers too quickly. As a result, the section becomes a catalog of methods and countries rather than a discussion of what is known and what remains unclear. I would advise trimming it and focusing on the studies most relevant to the paper's own dependent variables and empirical approach. That would also create more room to explain what is new here. Right now the contribution is described in general terms, but it would help to say more directly that the novelty lies in bringing multiple development indicators together in one cross country framework.

I have one additional substantive comment about measurement. The paper refers at times to climate risk, but the appendix indicates that the variable is actually change in carbon dioxide emissions excluding land use and forestry. That is a much narrower measure. The author should call it what it is and avoid broader wording. The same issue appears with accountability, where

the appendix suggests a specific World Bank measure. Precision matters here because the paper is comparing many indicators and readers need to know exactly what each one captures.

On style, the paper is in generally good shape, but I would recommend one more round of proofreading. There are a few awkward phrases, some repetition, and some minor labeling issues in the tables and figures. None of this is serious, but cleaning it up would make the final version much stronger.

In summary, I think this is a promising student paper with a strong topic and a commendable amount of work behind it. My suggested revisions are mostly about tightening the logic, clarifying the method, and moderating the claims. With those improvements, the paper could make a nice contribution to a high school journal.

This paper examines the relationship between educational attainment and a broad set of economic, political, social, and environmental indicators across countries. The topic is important and well-motivated, and the author demonstrates commendable ambition in assembling a wide range of outcomes into a single empirical framework. The use of publicly available cross-country data is appropriate, and the paper has the potential to make a meaningful contribution at the undergraduate level.

At the same time, the current version would benefit from more careful attention to empirical design, internal consistency, and interpretation. My recommendation is to **revise and resubmit**, with the expectation that the paper could become publishable after substantial but completely feasible revisions:

1. The central limitation of the paper is that all results are based on bivariate cross-sectional regressions, which do not allow for strong conclusions about the role of education. Many of the reported relationships, such as those with GDP growth, institutional quality, and life expectancy, are likely driven by broader differences in development across countries. To improve the credibility of the analysis, I strongly recommend introducing a small set of control variables. Even a limited specification including variables such as GDP per capita, regional indicators, or income group classifications would significantly strengthen the analysis and help distinguish the role of education from general development patterns.
2. The paper should consistently describe the results as *associations* rather than claim causality. Statements that education “drives,” “enhances,” or “contributes to” outcomes should be revised unless supported by a stronger identification strategy. The current empirical design does not permit causal interpretation, and so the language should reflect this clearly throughout the manuscript.
3. There is a major inconsistency between the general model equation and the list of estimated regressions. The general equation correctly specifies outcomes as dependent variables and education as the independent variable, but the twelve equations that follow reverse this relationship, placing educational attainment on the left-hand side. The model section should be carefully revised so that all equations, tables, and discussions are fully consistent.
4. The paper uses different numbers of observations across variables, sometimes quite dramatically (e.g., literacy and R&D). This variation is not clearly explained, and the descriptive statistics, regression tables, and text do not always align.
  - Clearly state that each regression uses a different effective sample due to missing data.
  - Provide a concise explanation of how samples differ.You may also consider including a summary table listing the number of observations for each model.
5. Results based on very small samples (e.g., literacy) should be interpreted with caution or potentially omitted.
6. The paper presents a series of separate regressions without clearly organizing them. The analysis would be significantly stronger if the outcomes were grouped into

categories (e.g., economic, governance, social, environmental) and discussed systematically, which would help the reader understand the broader argument and avoid the impression that the paper is a collection of loosely related results.

7. The literature review demonstrates a breadth of readings, but is currently organized as a list of methods and country applications. This makes it difficult to identify the key insights from the literature and how the present paper contributes. Similar to my comments on the regression analyses, I recommend reorganizing this section thematically (e.g., economic outcomes, governance, health, environment) and focusing on synthesizing findings rather than cataloging studies. The paper's contribution should then be stated more precisely in relation to these themes.
8. The conclusion currently makes strong policy recommendations based on the results. Given the limitations of the empirical design, these claims should be moderated. It would be more appropriate to frame the findings as suggesting broad associations and emphasize the need for more rigorous causal analysis in future work.

The paper addresses an important topic and shows strong effort and potential. With improvements to empirical design, consistency, and interpretation, it could become a solid contribution in *Convergence Journal*.

# The Relationship Between Educational Attainment and Social, Economic, Political, and Environmental Indicators



## Abstract

The paper investigates the relationship between educational attainment and various social, economic, environmental, and political indicators across countries using regression analysis. Using cross-sectional data from up to 205 countries, the findings show that higher education attainment is positively associated with GDP per capita growth, political stability, government effectiveness, gross savings, life expectancy, rule of law, research and development (R&D) expenditures, and literacy rates. These findings suggest that more educated populations tend to exhibit stronger economic performance, higher levels of innovation, improved institutional quality, and better social outcomes. Conversely, educational attainment is negatively associated with changes in CO2 emissions, which may reflect greater environmental awareness in more educated societies. The analysis also identifies an unexpected negative relationship between educational attainment and voice and accountability, although this result should be interpreted with caution due to the limitations of the empirical design. Overall, the findings suggest that educational attainment is closely linked to multiple indicators of development, highlighting the potential importance of education in broader socioeconomic outcomes.

**Keywords:** education attainment, economic indicators, political indicators, social indicators, environmental indicators

## Introduction

Education is widely recognized as a critical investment in human capital, capable of generating long-term returns in increased productivity while also promoting greater innovation. Additionally, it may be associated with better governance and improved health, thereby increasing overall quality of life.

This issue is important because it helps us better understand the implications of educational attainment for society. Most studies focus on the effects of educational attainment on only one aspect of society. However, this paper examines the effects of education through social, environmental, political, and economic lenses. Specifically, this paper uses regression analysis to empirically investigate the effect of educational attainment on a comprehensive range of socioeconomic, governance, and environmental indicators across 205 countries. The results show a positive association, where higher education attainment is linked to higher levels of economic growth, better governance, and improved welfare. Specifically, there is a positive and significant relationship between educational attainment and GDP per capita growth, gross savings, R&D

expenditure, political stability, government effectiveness, rule of law, life expectancy, and literacy rate. Conversely, there is a significant negative relationship between educational attainment and both voice and accountability, as well as changes in CO2 emissions. Finally, there is no statistically significant relationship between educational attainment and either male or female labor force participation rate.

This study offers several contributions to the understanding of the role of education in development. Unlike many existing studies, which typically focus on a single indicator or country, this paper examines the effect of educational attainment globally across a broad range of indicators. This study examines the effects from several different lenses, such as social, environmental, political, and economic, which allows for a clearer understanding of education's multidimensional impact. Furthermore, we used the most recent and comprehensive data set to provide more robust, relevant empirical evidence. This paper proceeds as follows: Section 2 provides background information on the existing literature; Section 3 highlights the empirical evidence; and Section 4 concludes the paper.

## **Literature Review**

### **Economic Outcomes**

A large body of literature has examined the relationship between educational attainment and economic performance. Many studies find that higher levels of education are positively associated with economic growth, innovation, and productivity. For example, Barro (2013), using panel regression analysis across multiple countries, found that the quality of education plays a significant role in promoting long-term economic growth. Similarly, Bambi (2024) and Diakodimitriou et al. (2025) argue that education and human capital contribute substantially to technological innovation and research and development (R&D) expenditures. Sena and Higon (2012) further demonstrate that regions with more educated workforces benefit more from R&D spillovers and exhibit higher productivity levels.

The relationship between education and savings behavior, however, appears more mixed. Wang et al. (2022) found that higher educational attainment may reduce national savings by lowering precautionary savings associated with job insecurity. Likewise, Wadood (2024) reports a negative association between education and individual saving behavior. These findings suggest that while education is generally associated with stronger economic performance, its relationship with financial behavior may be more complex and context-dependent.

### **Social Outcomes**

The literature consistently links educational attainment to improved social outcomes, particularly in health and literacy. Sasson (2016) found that individuals with higher levels of education tend to experience longer and less uncertain lifespans. Similarly, Rogoz et al. (2022) argue that

education promotes healthier lifestyles, better decision-making, and improved access to healthcare, all of which contribute to higher life expectancy. Nguyen et al. (2017) also emphasize the importance of literacy, showing that education may improve mental health outcomes through increased literacy skills.

Research on labor market outcomes presents more mixed findings. Okoli et al. (2024) and Singh and Shastri (2020) found that higher educational attainment is associated with lower unemployment rates. However, Falzone (2017) argues that education alone cannot fully explain labor force participation trends, suggesting that demographic and structural factors also play important roles. Assaad et al. (2020) similarly demonstrate that labor market outcomes may vary significantly across regions and demographic groups, particularly among women in MENA countries.

### **Governance and Political Institutions**

Existing literature also suggests a strong relationship between educational attainment and institutional quality. Garcia-Sanchez et al. (2013) found that education is positively associated with government effectiveness, while Li and Sun (2022) report a strong relationship between Education, critical thinking skills, and respect for legal principles. Similarly, Arif (2022) argues that lower corruption and stronger institutions help attract more educated individuals, highlighting the close connection between governance and educational outcomes.

More broadly, researchers suggest that educated populations may be more likely to support accountable institutions and political stability. However, much of the existing literature focuses on individual institutional indicators separately rather than examining multiple dimensions of governance simultaneously.

### **Environmental Outcomes**

Researchers have also explored the relationship between education and environmental sustainability. Striessnig et al. (2013) found that greater investment in education is associated with lower climate vulnerability, suggesting that education may improve environmental awareness and adaptive capacity. These findings indicate that education may play an important role not only in economic and social development, but also in sustainability and environmental outcomes.

### **Research Gap and Contribution**

Although the existing literature provides substantial evidence linking education to individual economic, social, political, and environmental outcomes, most studies focus on a single indicator, country, or region. In contrast, this paper examines the relationship between educational attainment and a broad range of development indicators simultaneously using cross-country data. By analyzing economic, governance, social, and environmental indicators

within one empirical framework, this study provides a more comprehensive understanding of the multidimensional relationship between education and development outcomes.

**Table 1.** An extensive review of the literature on the relationship between educational attainment and social, environmental, political, and economic indicators.

| Authors         | Year | Key variables                                                               | Country                        | Methodology              | Key Findings                                                                                                                                          | Data period |
|-----------------|------|-----------------------------------------------------------------------------|--------------------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Barro           | 2013 | GDP per capita growth, trade openness, rule of law                          | Global                         | Panel regression         | Economic growth is driven more by the quality of education than by years of schooling.                                                                | 1960-1990   |
| Bambi           | 2024 | R&D, GDP growth, technological innovation                                   | Central Europe and South Korea | VAR                      | Education and human capital drive innovation, causing greater investment in research and education.                                                   | 1996-2022   |
| Okoli et al.    | 2024 | Unemployment, graduation rate, inflation.                                   | Nigeria                        | Cointegration            | Higher educational attainment and expenditures significantly reduced unemployment.                                                                    | 1990-2020   |
| Nguyen et al.   | 2017 | Demographic variables, literacy rate                                        | USA                            | GEE                      | Education improves mental health via literacy.                                                                                                        | 1992-2010   |
| Falzone         | 2017 | Labor force, population                                                     | USA                            | Descriptive analysis     | Education alone can't reverse the decline in the U.S. labor force participation rate.                                                                 | 1994-2014   |
| Assaad et al.   | 2020 | Working age population, marital status, age, region, household of children. | MENA                           | Multinomial Logit Models | The decline in public-sector employment among educated women is associated with an increase in unemployment.                                          | 2000-2017   |
| Singh & Shastri | 2020 | Unemployment, public expenditure on education,                              | India                          | ARDL                     | Educational attainment negatively affects the unemployment rate.                                                                                      | 1987–2017   |
| Sasson          | 2016 | Life expectancy                                                             | USA                            | KLD                      | Less-educated individuals face shorter, more uncertain lifespans, while college-educated individuals live longer with less variation in age at death. | 1990-2010   |

|                       |      |                                                                              |                      |                                 |                                                                                                                                                |           |
|-----------------------|------|------------------------------------------------------------------------------|----------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Rogoz et al.          | 2022 | Economic freedom, fiscal policies, living standards, healthcare quality      | New EU member states | Causality, Cointegration tests  | Higher education promotes healthier lifestyles, better decision-making, and improved access to healthcare, thereby increasing life expectancy. | 2000-2019 |
| Diakodimitriou et al. | 2025 | R&D expenditures, public expenditures                                        | European countries   | LASSO, 3SLS model               | Education spending drives economic growth by boosting R&D.                                                                                     | 1996-2019 |
| Sena & Higon          | 2012 | R&D expenditure, worker productivity                                         | UK                   | GMM                             | Plants in regions with a more educated workforce gain more from R&D spillovers and are more productive.                                        | 1997–2002 |
| Arif                  | 2022 | Corruption, Income gap, Democracy gap, Contiguity, Diplomatic representation | Global               | Panel data analysis             | Controlling corruption can attract educated workers and promote brain gain.                                                                    | 1990-2000 |
| Garcia-Sanchez et al. | 2013 | Government effectiveness                                                     | Global               | GMM                             | Education improves government effectiveness.                                                                                                   | 2002-2008 |
| Li & Sun              | 2022 | Rule of law, thinking skills                                                 | China                | Correlation, frequency analysis | There is a strong positive link between critical thinking and respect for legal principles.                                                    | 2019-2020 |
| Wadood                | 2024 | Savings, financial literacy, gender, age                                     | Islamabad            | Regression                      | Education is strongly negatively associated with saving behavior.                                                                              | 2024      |
| Wang et al.           | 2022 | GNI, unemployment, gender                                                    | China                | Panel data regression, GMM      | Higher education lowers national savings by reducing job insecurity and precautionary savings.                                                 | 1991-2019 |
| Striessnig et al.     | 2013 | Climate risk, polity score, population density, HDI                          | Global               | Panel regression                | Investing in education greatly reduces climate vulnerability.                                                                                  | 1980-2013 |

Data and Methods

Scatterplot Graphics

**Figure 1.** Scatterplot Graph between GDP per Capita Growth, Government Effectiveness, Political Stability, and Educational Attainment

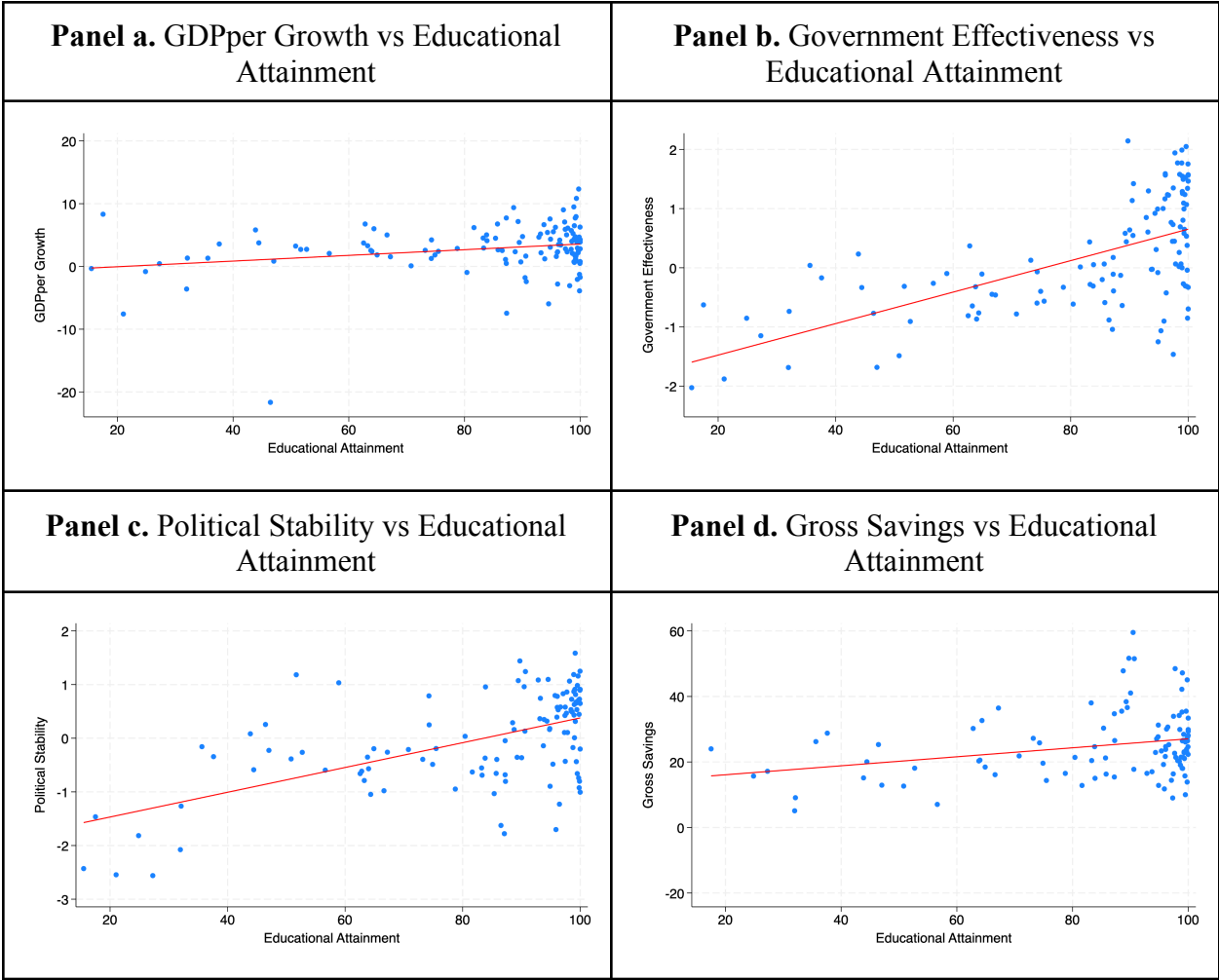


Figure 1 presents a series of scatterplots illustrating the relationship between educational attainment and key economic and governance indicators across countries. Panel a displays the association between GDP per capita growth and educational attainment. The upward trend suggests a modest positive relationship, although the data points remain widely dispersed. Though there is a slight positive correlation between GDP per capita growth and educational attainment, several countries with similar levels of education also exhibit substantially different growth rates, suggesting that other factors likely play important roles. Panel b examines the relationship between educational attainment and government effectiveness. Compared to the other indicators, the relationship appears relatively strong and more tightly clustered around the

fitted line, suggesting that countries with higher educational attainment tend to exhibit more effective governance. Although the association is not necessarily causal, the pattern may indicate that more educated populations are associated with stronger institutional quality and public administration. Panel c illustrates the relationship between educational attainment and political stability. The scatterplot shows a moderate positive relationship, although there is still noticeable variation across observations. While countries with higher educational attainment generally appear more politically stable, the dispersion in the data suggests that political stability is also influenced by historical, institutional, and regional factors beyond education alone. Panel d presents the correlation between educational attainment and gross savings. A positive correlation is observed; however, the relationship appears weaker than those for government effectiveness and life expectancy. The scatterplot also contains several outliers, suggesting that savings behavior may depend on broader macroeconomic conditions, income levels, and financial systems in addition to educational attainment.

**Figure 2.** Scatterplot Graph between Labor Force Male, Labor Force Female, Life Expectancy, Rule of Law, and Educational Attainment

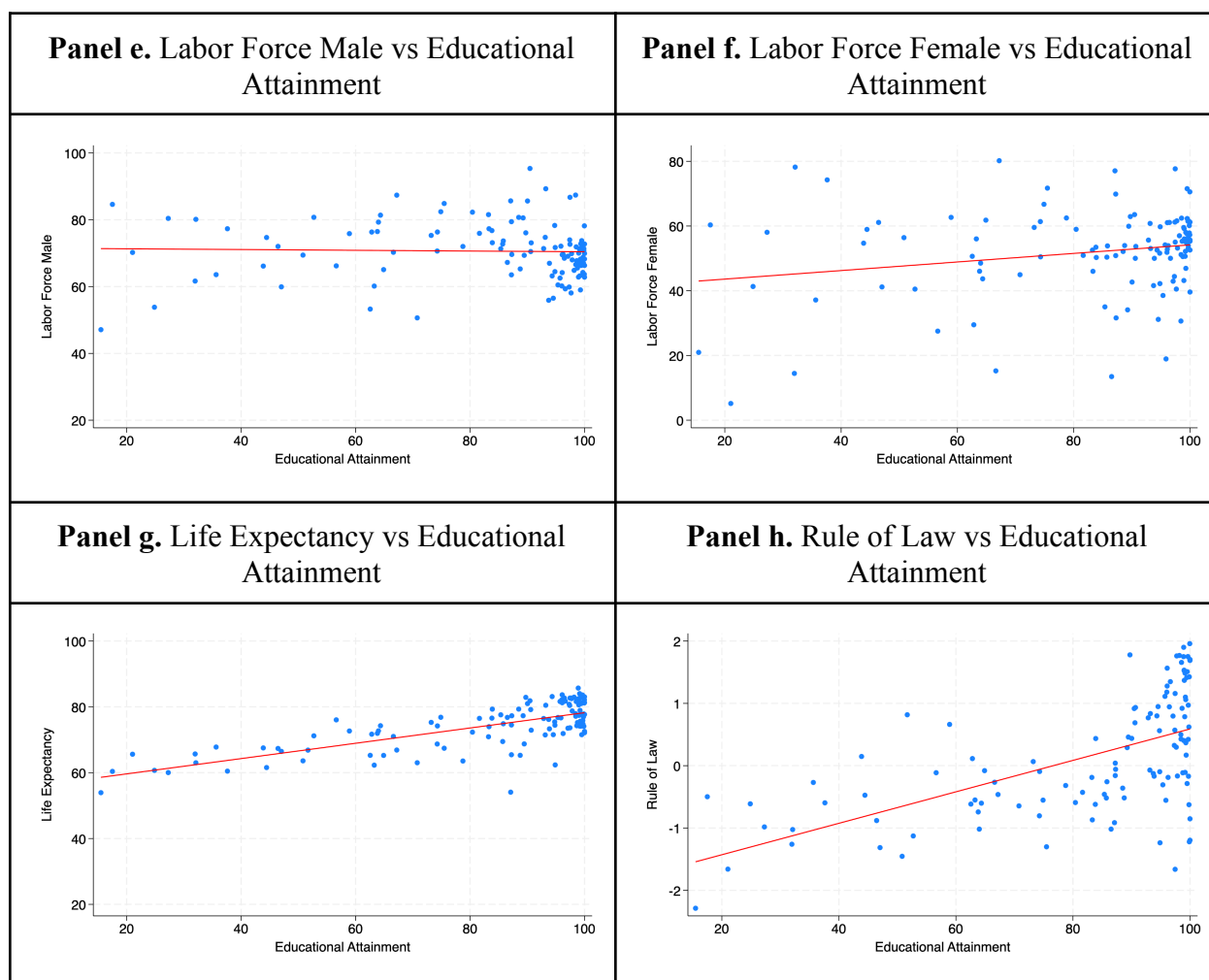
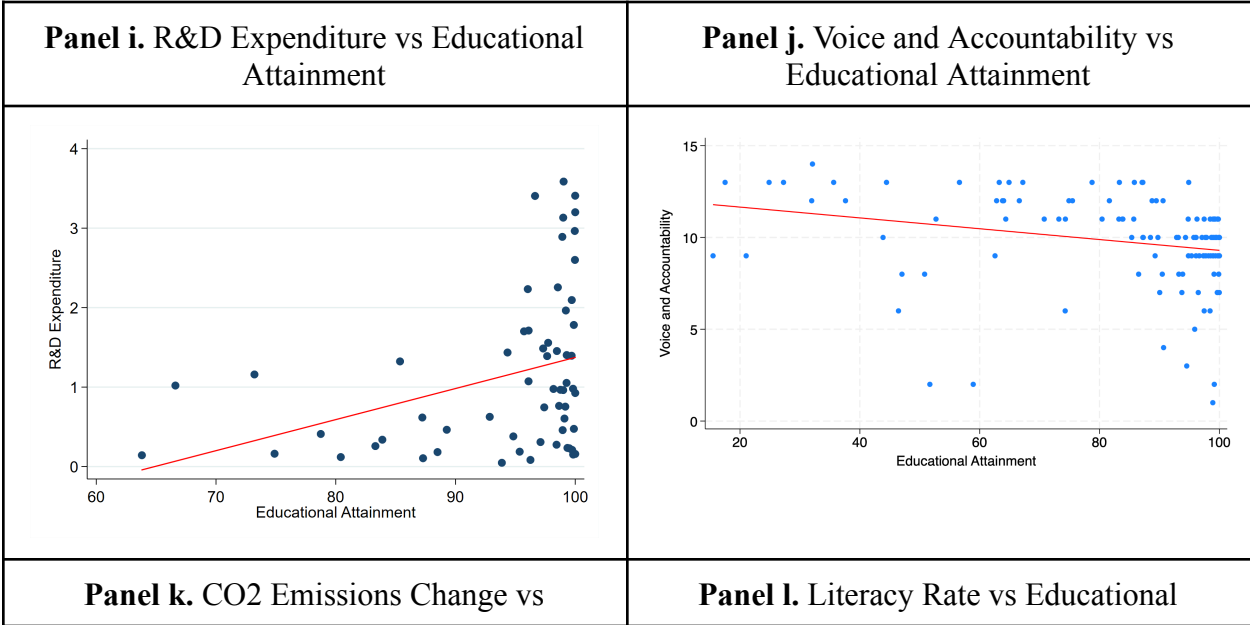


Figure 2 illustrates the relationship between educational attainment and four social and labor market indicators. Panel e shows the association between male labor force participation and educational attainment. The relationship appears relatively weak and nearly flat, indicating little clear relationship between the two variables across countries. The substantial dispersion of observations suggests that male labor force participation is likely more strongly influenced by labor market structure and economic conditions than by educational attainment alone. Panel f shows the relationship between female labor force participation and educational attainment. The upward trend suggests a moderate positive relationship, although the data remains fairly dispersed. This pattern may indicate that higher educational attainment is associated with greater female labor force participation, potentially through increased employment opportunities and human capital development. However, regional, cultural, and institutional differences may also substantially influence female labor force participation rates. Panel g displays the correlation between life expectancy and educational attainment. Countries with higher levels of education generally tend to exhibit longer life expectancies. This association may reflect broader relationships between education, healthcare access, health literacy, and living standards. Panel h presents the relationship between educational attainment and rule of law. A clear positive trend is observed, suggesting that countries with more educated populations tend to demonstrate stronger legal institutions and greater respect for legal norms. Nevertheless, some variation remains across countries, indicating that institutional quality may depend on other political and historical factors in addition to education.

**Figure 3.** Scatterplot Graph between R&D Expenditure, Voice and Accountability, CO2 Emissions Change, Literacy Rate, and Educational Attainment



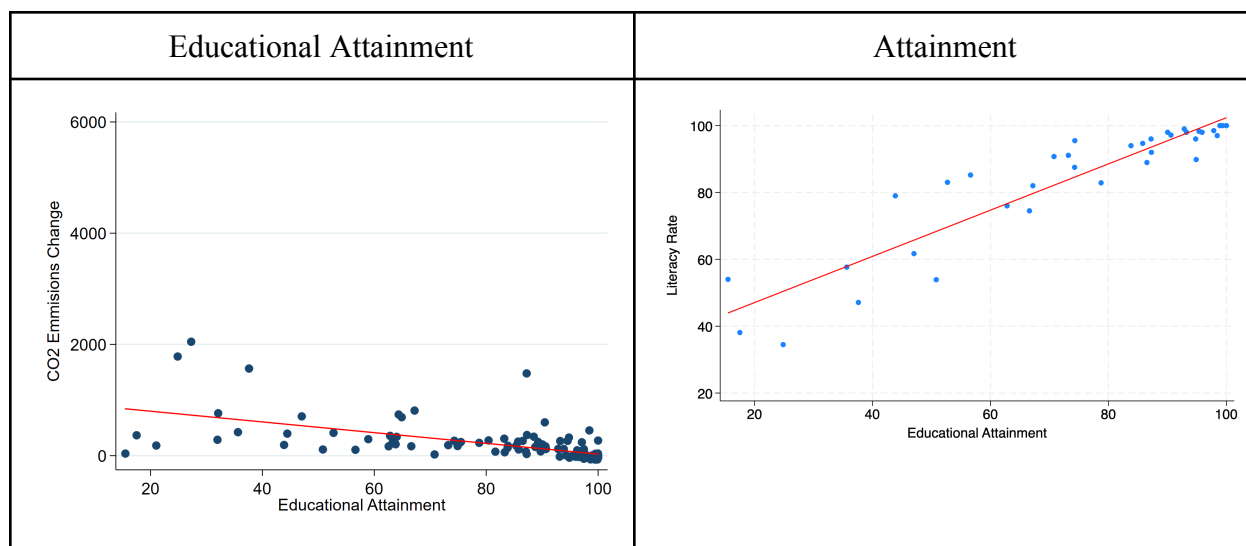


Figure 3 presents scatterplots examining the relationships between educational attainment and R&D expenditure, voice and accountability, CO2 emissions change, and literacy rate. Panel i shows a positive correlation between educational attainment and R&D expenditure. Although the number of observations is lower than in several other figures, the upward trend suggests that countries with higher educational attainment tend to invest more heavily in research and innovation. This pattern is broadly consistent with existing literature linking education to technological development and productivity growth. Panel j illustrates a slightly negative association between educational attainment and voice and accountability. This result appears somewhat unexpected and should therefore be interpreted cautiously. The relationship itself is relatively weak, and the observations are fairly dispersed. One possible explanation is that improvements in educational attainment may not immediately translate into greater political participation or accountability. Additionally, institutional structures, political systems, censorship, and historical conditions may influence accountability independently of education levels. Furthermore, the relatively small sample size may also limit the reliability of this result. Panel k shows a negative relationship between educational attainment and changes in CO2 emissions. Countries with higher educational attainment generally appear to experience lower changes in CO2 emissions. Although the relationship is not especially strong and includes several outliers, the pattern may suggest that more educated societies are associated with greater environmental awareness, stronger environmental policies, or more sustainable technologies. Finally, panel l demonstrates a strong positive relationship between educational attainment and literacy rate. Though this indicator has fewer observations than other figures, the observations are closely clustered around the fitted line, indicating a relatively strong association between the two variables. This finding is expected, as higher educational attainment is generally associated with improved literacy and human capital development across countries.

## Data

Appendix 1 presents various indicators sourced from the World Bank World Development Indicators. The variables include educational attainment as a percentage of population ages 25 and above (Edu\_attainment), GDP per capita as a percentage of annual growth (GDPper\_growth), consumer price index as a proxy of inflation (Inf), political stability (Pol\_stability), literacy rate as a percentage of people ages 15 and above (Literacy), labor force participation rate as a percentage of male population ages 15+ (Lforce\_male), labor force participation rate as a percentage of female population ages 15+ (Lforce\_female), unemployment as a percentage of total labor force (Unemp), life expectancy (Life\_exp), research and development expenditure as a percentage of GDP (R&D), control of corruption (Corruption), government effectiveness (Gov\_effect), rule of law (Rule of Law), voice and accountability (Voice and Accountability), gross savings as a percentage of GNI (Gross\_savings), carbon dioxide emissions change(CO2 emission change).

## Descriptive Statistics

**Table 1.** Descriptive Statistics

| <b>Variable</b>             | <b>Obs</b> | <b>Mean</b> | <b>Std. Dev.</b> | <b>Min</b> | <b>Max</b> |
|-----------------------------|------------|-------------|------------------|------------|------------|
| Edu_attainment              | 121        | 83.091      | 21.809           | 15.5       | 100        |
| GDPper_growth               | 256        | 3.31        | 6.042            | -22.746    | 62.111     |
| Gov_effect                  | 205        | -.039       | .995             | -2.391     | 2.144      |
| Pol_stability               | 205        | -.035       | .999             | -2.777     | 1.661      |
| Gross_savings               | 198        | 24.675      | 10.815           | -21.882    | 59.525     |
| Lforce_male                 | 234        | 70.453      | 8.791            | 24.098     | 95.365     |
| Lforce_female               | 234        | 50.314      | 14.75            | 4.977      | 82.575     |
| Life_exp                    | 265        | 72.796      | 7.648            | 18.818     | 85.746     |
| Rule of Law                 | 205        | -.023       | 1.001            | -2.287     | 1.958      |
| R&D                         | 96         | 1.392       | 1.222            | .035       | 6.019      |
| Voice and<br>Accountability | 203        | 8.798       | 3.443            | 1          | 14         |

|                     |     |         |          |        |           |
|---------------------|-----|---------|----------|--------|-----------|
| CO2 emission change | 246 | 667.546 | 4308.181 | -82.39 | 52245.455 |
| Literacy            | 95  | 81.356  | 16.122   | 27.28  | 100       |

Table 1 provides descriptive statistics for educational attainment and various social, economic, environmental, and political indicators. The Edu\_attainment has 121 observations with a mean of 83.091 and a standard deviation of 21.809, ranging from a minimum of 15.5 to a maximum of 100. GDPper\_growth has 256 observations with a mean of 3.31 and a standard deviation of 6.042, ranging from a minimum of -22.746 to a maximum of 62.111. Gov effect has 205 observations with a mean of -.039 and a standard deviation of .995, ranging from a minimum of -2.391 to a maximum of 2.144. Pol\_stability has 205 observations with a mean of -0.035 and a standard deviation of 0.999, ranging from a minimum of -2.777 to a maximum of 1.661. Gross\_savings has 198 observations with a mean of 24.675 and a standard deviation of 10.815, ranging from a minimum of -21.882 to a maximum of 59.525. Lforce\_male has 234 observations with a mean of 70.453 and a standard deviation of 8.791, ranging from a minimum of 24.098 to a maximum of 95.365. Lforce\_female has 234 observations with a mean of 50.314 and a standard deviation of 14.75, ranging from a minimum of 4.977 to a maximum of 82.575. Life\_exp has 265 observations with a mean of 72.796 and a standard deviation of 7.648, ranging from a minimum of 18.818 to a maximum of 85.746. Rule of Law has 205 observations with a mean of -0.023 and a standard deviation of 1.001, ranging from a minimum of -2.287 to a maximum of 1.958. R&D has 96 observations with a mean of 1.392 and a standard deviation of 1.222, ranging from a minimum of 0.035 to a maximum of 6.019. Voice and Accountability has 203 observations with a mean of 8.798 and a standard deviation of 3.443, ranging from a minimum of 1 to a maximum of 14. CO2 emission change has 246 observations with a mean of 667.546 and a standard deviation of 4308.181, ranging from a minimum of -82.39 to a maximum of 52245.455. Literacy has 95 observations with a mean of 81.356 and a standard deviation of 16.122, ranging from a minimum of 27.28 to a maximum of 100.

## Model

$$Y_i = a_0 + b_1 X_i + e_i$$

Where  $Y_i$  is the dependent variable for observation  $i$ , referring to GDP per capita growth (GDPper\_growth), political stability (Pol\_stability), (government effectiveness) Gov\_effect, gross savings (Gross\_savings), male labor force participation rate (Lforce\_male), female labor force participation rate (Lforce\_female), life expectancy (Life\_exp), rule of law (Rule of Law), research and development expenditure (R&D), CO2 emission change (CO2 emissions change), voice and accountability (Voice and Accountability), and literacy rate (Literacy).

$a_0$  is the constant term, representing the expected value of the dependent variable when the independent variable equals zero.  $b_1$  is the coefficient for the independent variable, Educational Attainment (Edu\_attainment). The coefficient indicates how much the dependent variable changes when educational attainment changes by one unit.  $e_i$  is the error term, representing the difference between the observed and the model's predicted values.

We estimated 12 different models to examine the relationship between educational attainment and various social, economic, environmental, and political indicators. The estimated models are presented below.

$GDPper\_growth_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 1)  
 $Pol\_stability_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 2)  
 $Gov\_effect_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 3)  
 $Gross\_savings_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 4)  
 $Lforce\_male_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 5)  
 $Lforce\_female_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 6)  
 $Life\_exp_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 7)  
 $RuleofLaw_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 8)  
 $R\&D_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 9)  
 $CO2\ emission\ change_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 10)  
 $Voice\ and\ Accountability\ _i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 11)  
 $Literacy_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 12)

While the regression analysis provides useful insight into the relationship between educational attainment and various development indicators, several limitations should be acknowledged. First, the analysis is based on cross-sectional data and bivariate regressions, which do not permit causal inference. The estimated relationships should therefore be understood as associations rather than direct effects. In addition, omitted variable bias may exist because many other factors, such as income levels, institutional quality, regional characteristics, and healthcare systems, may influence both educational attainment and the outcome variables. Reverse causality may also be present, as wealthier or more institutionally developed countries may have a greater capacity to invest in education. As a result, the findings should be interpreted with caution and treated as preliminary evidence of broader relationships between education and development outcomes.

## Analysis and Discussion

**Table 1a.** Regression Analysis

|           | ( model 1) | (model 2)   | (model 3) | (model 4)  |
|-----------|------------|-------------|-----------|------------|
| VARIABLES | GDPper g   | Pol stabili | Gov effe  | Gross savi |

|                | rowth  | ty       | ct       | ngs      |
|----------------|--------|----------|----------|----------|
| Edu attainment | 0.05** | 0.02***  | 0.03***  | 0.14***  |
|                | (0.02) | (0.00)   | (0.00)   | (0.04)   |
| Constant       | -0.95  | -2.01*** | -2.05*** | 13.35*** |
|                | (2.01) | (0.28)   | (0.24)   | (3.13)   |
| Observations   | 119    | 118      | 118      | 106      |
| R-squared      | 0.06   | 0.35     | 0.39     | 0.08     |

Robust standard errors in parentheses. The number of observations differs across regressions because some indicators contain missing data for certain countries

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1a portrays the results of four regression models, with the dependent variables being GDP per capita growth (GDPper\_growth), Political Stability (Pol\_stability), Government Effectiveness (Gov\_effect), and Gross Savings as a percentage of GNI (Gross\_savings). Each column corresponds to a distinct model, with the explanatory variable being Educational Attainment (Edu\_attainment). If the results are statistically significant at the 1% level, we indicate this with (\*\*\*), at the 5% level with (\*\*), and at the 10% level with (\*). The coefficient on educational attainment is positive and statistically significant across all models, indicating that higher educational attainment is associated with higher GDP per capita growth, greater political stability, more effective governance, and higher gross savings. This suggests that countries with higher levels of educational attainment contribute to labor productivity and innovation, which enhances national output. Furthermore, the results also suggest that a more educated population is more likely to support a more effective and stable government. Higher educational attainment may also be correlated with greater savings behavior, thereby increasing the country's income levels.

**Table 1b. Regression Analysis**

|                | (model 5)   | (model 6)     | (model 7) | (model 8)   |
|----------------|-------------|---------------|-----------|-------------|
| VARIABLES      | Lforce_male | Lforce_female | Life_exp  | Rule of Law |
| Edu attainment | -0.01       | 0.12          | 0.23***   | 0.03***     |
|                | (0.05)      | (0.08)        | (0.02)    | (0.00)      |
| Constant       | 71.34***    | 41.73***      | 55.13***  | -2.00***    |
|                | (4.27)      | (7.48)        | (1.35)    | (0.24)      |
| Observations   | 117         | 117           | 117       | 116         |
| R-squared      | 0.00        | 0.04          | 0.52      | 0.34        |

Robust standard errors in parentheses. The number of observations differs across regressions because some indicators contain missing data for certain countries

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1b presents four regression results examining the relationship between educational attainment (Edu\_attainment) and the male labor force participation rate (Lforce\_male), female labor force participation rate (Lforce\_female), life expectancy (Life\_exp), and rule of law (Rule of Law). Models 5 and 6 show that the relationship between educational attainment and male and female labor force participation rates is statistically insignificant. Models 7 and 8 show positive and statistically significant relationships between educational attainment and life expectancy and rule of law, respectively, suggesting that countries with higher educational attainment tend to have healthier lives and greater respect for laws and institutions.

**Table 1c. Regression Analysis**

|                | (model 9)         | (model 10)                 | (model 11)                      | (model 12)         |
|----------------|-------------------|----------------------------|---------------------------------|--------------------|
| VARIABLES      | R&D               | CO2<br>emissions<br>change | Voice and<br>Accountabil<br>ity | Literacy           |
| Edu attainment | 0.04***<br>(0.01) | -9.63***<br>(2.49)         | -0.03***<br>(0.0003)            | 0.69***<br>(0.06)  |
| Constant       | -2.57**<br>(1.02) | 992.25***<br>(228.49)      | 0.0605***<br>(0.02)             | 33.22***<br>(5.50) |
| Observations   | 59                | 113                        | 120                             | 36                 |
| R-squared      | 0.11              | 0.35                       | 0.06                            | 0.95               |

Robust standard errors in parentheses. The number of observations differs across regressions because some indicators contain missing data for certain countries.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1c displays the results of four regressions examining the relationship between educational attainment and research and development expenditures (R&D), change in carbon dioxide emissions (CO2 emissions change), voice and accountability (Voice and Accountability), and literacy rate (Literacy). Models 9 and 12 show a positive and statistically significant relationship between educational attainment (Edu\_attainment) and research and development expenditures (R&D), and between educational attainment (Edu\_attainment) and the literacy rate (Literacy), suggesting that countries with higher education levels tend to invest more in research and innovation and have a greater literacy rate, indicating a more qualified human capital. In contrast, models 10 and 11 show negative, statistically significant relationships between educational attainment (Edu\_attainment) and carbon dioxide emissions (CO2 emission change),

and between educational attainment (Edu\_attainment) and voice and accountability (Voice and Accountability). This suggests that improvements in education may not immediately translate into greater accountability, and that a more educated population may foster greater climate awareness and reduce carbon dioxide emissions.

### Robustness Check

To verify the reliability and stability of our main findings, we conducted a robustness check by introducing additional control variables and reestimating all regression models. Specifically, we included control variables such as inflation, GDP per capita growth, and voice and accountability where appropriate, to account for other factors that might affect the relationship between educational attainment and selected social, economic, political, and environmental indicators. After controlling for these additional variables, all models were reestimated and compared to the original results. Overall, the results remained consistent with the main findings, suggesting that the relationship between educational attainment and outcome variables is not driven by other variables. Therefore, the robustness check supports the reliability of the empirical findings.

**Table 2a.** Regression Analysis

| VARIABLES                | (model 1)<br>GDPper<br>growth | (model 2)<br>Pol_stability | (model 3)<br>Gov_effect | (model 4)<br>Gross_savin<br>gs |
|--------------------------|-------------------------------|----------------------------|-------------------------|--------------------------------|
| Edu_attainment           | 0.062*<br>(0.034)             | 0.023***<br>(0.004)        | 0.025***<br>(0.003)     | 0.114***<br>(0.039)            |
| Inflation                | -0.109***<br>(0.033)          | -0.033***<br>(0.012)       | -0.031*<br>(0.017)      | -0.457***<br>(0.101)           |
| GDPper growth            |                               | -0.004<br>(0.023)          | -0.001<br>(0.014)       | -0.174<br>(0.207)              |
| Voice and Accountability | 0.485<br>(0.341)              |                            |                         |                                |
| Constant                 | -7.163<br>(6.151)             | -1.881***<br>(0.307)       | -1.808***<br>(0.250)    | 16.131***<br>(3.115)           |
| Observations             | 112                           | 113                        | 113                     | 103                            |
| R-squared                | 0.121                         | 0.362                      | 0.372                   | 0.098                          |

**Table 1b.** Regression Analysis

| VARIABLES      | (model 5)<br>Lforce_male | (model6)<br>Lforce_fema<br>le | (model7)<br>Life_exp | (model8)<br>Rule of Law |
|----------------|--------------------------|-------------------------------|----------------------|-------------------------|
| Edu_attainment | -0.077*                  | 0.054                         | 0.223***             | 0.025***                |

|               |           |           |           |           |
|---------------|-----------|-----------|-----------|-----------|
|               | (0.041)   | (0.083)   | (0.018)   | (0.003)   |
| Inflation     | -0.293*** | -0.818*** | -0.045    | -0.020    |
|               | (0.076)   | (0.196)   | (0.153)   | (0.018)   |
| GDPper growth | 0.138     | 0.109     | 0.010     | -0.004    |
|               | (0.129)   | (0.327)   | (0.082)   | (0.017)   |
| Constant      | 77.240*** | 47.812*** | 55.916*** | -1.849*** |
|               | (3.695)   | (7.881)   | (1.503)   | (0.255)   |
| Observations  | 112       | 112       | 113       | 113       |
| R-squared     | 0.053     | 0.077     | 0.492     | 0.347     |

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table 1c. Regression Analysis**

| VARIABLES      | (model 9)<br>R&D    | (model 10)<br>CO2 emissions<br>change | (model 11)<br>Voice and<br>Accountabili<br>ty | (model 12)<br>Literacy |
|----------------|---------------------|---------------------------------------|-----------------------------------------------|------------------------|
| Edu_attainment | 0.041***<br>(0.013) | -11.289***<br>(2.712)                 | -0.038***<br>(0.011)                          | 0.733***<br>(0.070)    |
| Inflation      | -2.992**<br>(1.407) | -12.864***<br>(4.575)                 | 0.030<br>(0.036)                              | -0.917***<br>(0.100)   |
| GDPper growth  | -0.048<br>(0.038)   | -1.560<br>(8.709)                     | 0.030<br>(0.109)                              | 0.037<br>(0.266)       |
| Constant       | -1.912<br>(1.153)   | 1,151.884***<br>(261.257)             | 13.053***<br>(0.941)                          | 30.038***<br>(6.400)   |
| Observations   | 61                  | 107                                   | 113                                           | 33                     |
| R-squared      | 0.147               | 0.415                                 | 0.120                                         | 0.858                  |

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## Conclusion

This paper used linear regression to examine the relationship between educational attainment and a broad range of social, economic, political, and environmental indicators across countries. In this study, educational attainment is defined as the percentage of the population aged 25 and above who have completed primary education. The findings show that higher educational attainment is positively associated with GDP per capita growth, gross savings, research and development expenditures, political stability, government effectiveness, rule of law, life

expectancy, and literacy rate. In contrast, educational attainment is negatively associated with changes in CO2 emissions and with voice and accountability.

Overall, the results suggest that educational attainment is closely linked to multiple dimensions of development and institutional quality. However, because the analysis is based on cross-sectional bivariate regressions, the findings should be interpreted as associations rather than causal relationships. Other factors, including income levels, institutional conditions, healthcare systems, regional characteristics, and economic development, may also influence the observed relationships. Future research should employ more advanced methodologies, such as panel data analysis, GMM, VAR models, instrumental variable approaches, or longitudinal analysis, to better examine causal relationships and changes over time. In addition, future studies could incorporate additional explanatory variables related to democracy, healthcare, technology, and institutional quality. Future research using individual-level or household-level data may also provide a more detailed understanding of how educational attainment relates to broader development outcomes.

## Appendix

### Appendix 1. Data Definition

| Indicator Symbol | Variable                                                                                         | Definition                                                                                                                                                         | Source         |
|------------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Edu_attainment   | Educational attainment, at least completed primary, population 25+ years, total (%) (cumulative) | The percentage of the population ages 25 and over who have attained or completed primary education.                                                                | WDI World Bank |
| GDPper_growth    | GDP per capita (annual % growth)                                                                 | This indicator represents the percentage change in GDP per capita from the previous year, expressed in constant prices (base year: 2015) in United States dollars. | WDI World Bank |
| Inf              | Consumer price index (2010 = 100)                                                                | Index of the prices of consumption goods and services, as compared to a certain                                                                                    | WDI World Bank |

|               |                                                                                                                |                                                                                                                                                                                                                                                     |                |
|---------------|----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|               |                                                                                                                | reference period<br>(2010=100).                                                                                                                                                                                                                     |                |
| Pol_stability | Political Stability and<br>Absence of<br>Violence/Terrorism:<br>Estimate                                       | Political Stability and<br>Absence of<br>Violence/Terrorism<br>measures perceptions<br>of the likelihood of<br>political instability<br>and/or<br>politically-motivated<br>violence, including<br>terrorism, ranging<br>from -2.5 to 2.5."          | WDI World Bank |
| Literacy      | Literacy rate, adult<br>total (% of people<br>ages 15 and above)                                               | Adult literacy rate is<br>the percentage of<br>people ages 15 and<br>above who can both<br>read and write with<br>understanding a short,<br>simple statement<br>about their everyday<br>life.                                                       | WDI World Bank |
| Lforce_male   | Labor force<br>participation rate,<br>male (% of male<br>population ages 15+)<br>(modeled ILO<br>estimate)     | The labor force<br>participation rate is<br>the proportion of the<br>population ages 15<br>and older that is<br>economically active:<br>all people who supply<br>labor for the<br>production of goods<br>and services during a<br>specified period. | WDI World Bank |
| Lforce_female | Labor force<br>participation rate,<br>female (% of female<br>population ages 15+)<br>(modeled ILO<br>estimate) | The labor force<br>participation rate is<br>the labor force as a<br>percent of the<br>population ages 15<br>and older. The labor<br>force is the sum of all<br>persons of working<br>age who are                                                    | WDI World Bank |

|            |                                                                     |                                                                                                                                                                                                                                                                |                |
|------------|---------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|            |                                                                     | employed and those who are unemployed.                                                                                                                                                                                                                         |                |
| Unemp      | Unemployment, total (% of total labor force) (modeled ILO estimate) | Unemployment refers to the share of the labor force that is without work but available for and seeking employment.                                                                                                                                             | WDI World Bank |
| Life_exp   | Life expectancy at birth, total (years)                             | Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.                                                                     | WDI World Bank |
| R&D        | Research and development expenditure (% of GDP)                     | Gross domestic expenditures on research and development, expressed as a percent of GDP.                                                                                                                                                                        | WDI World Bank |
| Corruption | Control of Corruption: Estimate                                     | Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests, ranging from -2.5 to 2.5. | WDI World Bank |
| Gov_effect | Government Effectiveness: Estimate                                  | Government Effectiveness captures perceptions and views of the quality of public services, the quality                                                                                                                                                         | WDI World Bank |

|                          |                                                |                                                                                                                                                                                                                                                                                                |                |
|--------------------------|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|                          |                                                | of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies, ranging from -2.5 to 2.5.                                                         |                |
| Rule of Law              | Rule of Law:<br>Estimate                       | Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, particularly the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence, ranging from -2.5 to 2.5. | WDI World Bank |
| Voice and Accountability | Voice and Accountability:<br>Number of Sources | Voice and Accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.                                                                   | WDI World Bank |
| Gross_Savings            | Gross savings (% of GNI)                       | Gross savings are calculated as gross national income less total consumption,                                                                                                                                                                                                                  | WDI World Bank |

|                      |                                                                              |                                                                                                                                                                                                                                                                   |                |
|----------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|                      |                                                                              | plus net transfers. This indicator is expressed as a percentage of Gross National Income (GNI), which is the total income earned by all residents within an economic territory during an accounting period.                                                       |                |
| CO2 emissions change | Carbon dioxide (CO2) emissions (total) excluding LULUCF (% change from 1990) | Change of emissions (as %) of the current year with respect to emissions in the baseline year 1990 emissions of carbon dioxide (CO2), one of the six Kyoto greenhouse gases (GHG), from the agriculture, energy, waste, and industrial sectors, excluding LULUCF. | WDI World Bank |

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# The Relationship Between Effect of Educational Attainment and on Social, Economic, Political, and Environmental Indicators



## Abstract

The paper investigates the relationship effect between of educational attainment and various on social, economic, environmental, and political indicators across countries using regression analysis. Using cross-sectional data from up to Across 205 countries, the findings show that higher education attainment is positively associated with GDP per capita growth, political stability, government effectiveness, gross savings, life expectancy, rule of law, research and development (R&D) expenditures, and literacy rates. These findings suggest that more educated populations tend to exhibit stronger economic performance, higher levels of innovation, improved institutional quality, and better social outcomes. These findings sure results support the idea that an educated population enhances economic growth, innovation, institutional equality, human capital, and healthcare. Conversely, educational attainment is negatively associated with changes in CO2 emissions, which may reflect greater environmental awareness in more educated societies. We have The analysis also identifies an unexpected negative relationship between educational attainment and voice and accountability, although this result should be interpreted with caution due to the limitations of the empirical design. which may reflect the fact that improvements in education don't immediately translate into improvements in accountability. Overall, The findings suggest show that educational attainment is closely linked to multiple indicators of development, highlighting the potential importance of education in broader socioeconomic outcomes. a fundamental driver of positive socioeconomic outcomes, institutional equality, and sustainability. Therefore, policymakers should focus on maximizing educational attainment.¶

**Keywords:** education attainment, economic indicators, political indicators, social indicators, environmental indicators

## Introduction

Education is widely recognized as a critical investment in human capital, capable of generating long-term returns in increased productivity while also promoting greater innovation. Additionally, it may be associated with can lead to better governance and improved health, thereby increasing overall quality of life.

This issue is important because it helps us better understand the implications of educational attainment for society. Most studies focus on the effects of educational attainment on only one aspect of society. However, this paper examines the effects of education through social,

environmental, political, and economic lenses. Specifically, this paper uses regression analysis to empirically investigate the effect of educational attainment on a comprehensive range of socioeconomic, governance, and environmental indicators across 205 countries. The results show a positive association, where higher education attainment is linked to higher levels of economic growth, better governance, and improved welfare. Specifically, there is a positive and significant relationship between educational attainment and GDP per capita growth, gross savings, R&D expenditure, political stability, government effectiveness, rule of law, life expectancy, and literacy rate. Conversely, there is a significant negative relationship between educational attainment and voice and accountability, as well as **changes in CO2 emissions**~~climate risk~~. Finally, there is no statistically significant relationship between educational attainment and either male or female labor force participation rate.

This study offers several contributions to the understanding of the role of education in development. Unlike many existing studies, which typically focus on a single indicator or country, this paper examines the effect of educational attainment globally across a broad range of indicators. This study examines the effects from several different lenses, such as social, environmental, political, and economic, which allows for a clearer understanding of education's multidimensional impact. Furthermore, we used the most recent and comprehensive data set to provide more robust, relevant empirical evidence. This paper proceeds as follows: Section 2 provides background information on the existing literature; Section 3 highlights the empirical evidence; and Section 4 concludes the paper.

## Literature Review

~~Various methodologies have been used and employed to investigate the effect of education attainment on development indicators, such as social, environmental, political, and economic indicators such as Panel Data Regression (Barro, 2013; Wang et al., 2022; Striessnig et al., 2013), VAR (Bambi, 2024), Cointegration Test (Okoli et al., 2024), Descriptive Analysis and Correlation (Smith-Greenaway, 2016; Falzone, 2017; Li and Sun, 2022), GEE (Nguyen et al., 2017), Multinomial Logit Models (Assaad et al., 2020), ARDL (Singh and Shastri, 2020), WLS (Mooi-Reci et al., 2019), KLD (Sasson, 2016), Causality Analysis (Rogoz et al., 2022), LASSO (Diakodimitriou et al., 2025), GMM (Sena and Higon, 2012; Garcia-Sanchez et al., 2013), Gravity Model (Arif, 2022), and Regression Analysis (Wadood, 2024).~~

## Economic Outcomes

A large body of literature has examined the relationship between educational attainment and economic performance. Many studies find that higher levels of education are positively associated with economic growth, innovation, and productivity. For example, Barro (2013), using panel regression analysis across multiple countries, found that the quality of education plays a significant role in promoting long-term economic growth. Similarly, Bambi (2024) and

Diakodimitriou et al. (2025) argue that education and human capital contribute substantially to technological innovation and research and development (R&D) expenditures. Sena and Higon (2012) further demonstrate that regions with more educated workforces benefit more from R&D spillovers and exhibit higher productivity levels.

The relationship between education and savings behavior, however, appears more mixed. Wang et al. (2022) found that higher educational attainment may reduce national savings by lowering precautionary savings associated with job insecurity. Likewise, Wadood (2024) reports a negative association between education and individual saving behavior. These findings suggest that while education is generally associated with stronger economic performance, its relationship with financial behavior may be more complex and context-dependent.

### **Social Outcomes**

The literature consistently links educational attainment to improved social outcomes, particularly in health and literacy. Sasson (2016) found that individuals with higher levels of education tend to experience longer and less uncertain lifespans. Similarly, Rogoz et al. (2022) argue that education promotes healthier lifestyles, better decision-making, and improved access to healthcare, all of which contribute to higher life expectancy. Nguyen et al. (2017) also emphasize the importance of literacy, showing that education may improve mental health outcomes through increased literacy skills.

Research on labor market outcomes presents more mixed findings. Okoli et al. (2024) and Singh and Shastri (2020) found that higher educational attainment is associated with lower unemployment rates. However, Falzone (2017) argues that education alone cannot fully explain labor force participation trends, suggesting that demographic and structural factors also play important roles. Assaad et al. (2020) similarly demonstrate that labor market outcomes may vary significantly across regions and demographic groups, particularly among women in MENA countries.

### **Governance and Political Institutions**

Existing literature also suggests a strong relationship between educational attainment and institutional quality. Garcia-Sanchez et al. (2013) found that education is positively associated with government effectiveness, while Li and Sun (2022) report a strong relationship between Education, critical thinking skills, and respect for legal principles. Similarly, Arif (2022) argues that lower corruption and stronger institutions help attract more educated individuals, highlighting the close connection between governance and educational outcomes.

More broadly, researchers suggest that educated populations may be more likely to support accountable institutions and political stability. However, much of the existing literature focuses

on individual institutional indicators separately rather than examining multiple dimensions of governance simultaneously.

### **Environmental Outcomes**

Researchers have also explored the relationship between education and environmental sustainability. Striessnig et al. (2013) found that greater investment in education is associated with lower climate vulnerability, suggesting that education may improve environmental awareness and adaptive capacity. These findings indicate that education may play an important role not only in economic and social development, but also in sustainability and environmental outcomes.

### **Research Gap and Contribution**

Although the existing literature provides substantial evidence linking education to individual economic, social, political, and environmental outcomes, most studies focus on a single indicator, country, or region. In contrast, this paper examines the relationship between educational attainment and a broad range of development indicators simultaneously using cross-country data. By analyzing economic, governance, social, and environmental indicators within one empirical framework, this study provides a more comprehensive understanding of the multidimensional relationship between education and development outcomes.



~~Many studies have focused on various countries and regions, such as central Europe (Bambi, 2024), China (Wang et al., 2022; Li and Sun, 2022), Islamabad (Wadood, 2024), the UK (Sena and Higon, 2012), European Countries (Diakodimitriou et al., 2025), the USA (Sasson, 2016; Falzone, 2017; Nguyen et al., 2017), the Netherlands (Mooi-Reei et al., 2019), India (Singh & Shastri, 2020), MENA Countries (Assaad et al., 2020), Nigeria (Okoli et al., 2024), South Korea (Bambi, 2024).~~



~~The variables used in the literature as a driver of education attainment often varied such as GDP per Growth (Barro, 2013), Research and Development Expenditures (Bambi, 2024), Unemployment Rate (Okoli et al., 2024), Female Literacy Rate (Smith-Greenaway, 2016), Literacy Rate (Nguyen et al., 2016), Labor Force Participation Rate (Falzone, 2017), Marital Status (Assaad et al., 2020), Public Expenditure on Education (Singh & Shastri, 2020), Parents' Educational Attainment (Mooi-Reei et al., 2019), Life Expectancy (Sasson, 2016), Technological Development (Rogoz et al., 2022), Worker Productivity (Sena & Higon, 2012), Income Gap (Arif, 2022), Government Effectiveness (Garcia-Sanchez et al., 2017), Rule of Law (Li & Sun, 2022), Financial Literacy (Wadood, 2024), Gross Savings (Wang et al., 2022), Climate Risk (Striessnig et al., 2013).~~



~~Barro (2013), utilizing Panel Data Regression across 100 countries, emphasizes that economic growth is driven significantly by education. These findings align closely with Bambi (2024),~~

Rogoz et al. (2022). Recent studies by Bambi (2024) and Diakodimitriou et al. (2025) emphasize that educational attainment is the key determinant for research and development and innovation. Sena and Higon (2012) further argue that regions with a more educated workforce had higher worker productivity and gained more from R&D spillovers. The relationship between education and the government is another important area, for example, Garcia-Sanchez et al. (2017) and Li and Sun (2022) show a positive correlation between educational attainment and rule of law. This suggests that as the population becomes more educated, they are more likely to demand accountability. Arif (2022) found that more educated migrants are more likely to move to countries with less corruption, suggesting that controlling corruption can attract a more educated population. The literature consistently links education to improved health outcomes. For example, Sasson (2016) and Rogoz et al. (2022) report a strong positive relationship between educational attainment and life expectancy, finding that higher education promotes healthier lifestyles, better decisions, and improved access to healthcare. Conversely, the relationship between education and labor market outcomes appears more complex. While Okoli et al. (2024) demonstrated that higher education significantly reduces unemployment, Falzone (2017) found that decreased labor participation rates have been driven by population changes and shifting work behavior, suggesting that education alone is not the only factor.

**Table 1.** An extensive review of the literature on the relationship between educational attainment and social, environmental, political, and economic indicators.

| Authors                    | Year            | Key variables                                                               | Country                        | Methodology                                  | Key Findings                                                                                                 | Data period          |
|----------------------------|-----------------|-----------------------------------------------------------------------------|--------------------------------|----------------------------------------------|--------------------------------------------------------------------------------------------------------------|----------------------|
| Barro                      | 2013            | GDP per capita growth, trade openness, rule of law                          | Global                         | Panel regression                             | Economic growth is driven more by the quality of education than by years of schooling.                       | 1960-1990            |
| Bambi                      | 2024            | R&D, GDP growth, technological innovation                                   | Central Europe and South Korea | VAR                                          | Education and human capital drive innovation, causing greater investment in research and education.          | 1996-2022            |
| Okoli et al.               | 2024            | Unemployment, graduation rate, inflation.                                   | Nigeria                        | Cointegration                                | Higher educational attainment and expenditures significantly reduced unemployment.                           | 1990-2020            |
| <del>Smith-Greenaway</del> | <del>2016</del> | <del>Female literacy rate</del>                                             | <del>Global</del>              | <del>Descriptive analysis, correlation</del> | <del>Schooling doesn't always reflect true literacy for women.</del>                                         | <del>2000-2012</del> |
| Nguyen et al.              | 2017            | Demographic variables, literacy rate                                        | USA                            | GEE                                          | Education improves mental health via literacy.                                                               | 1992-2010            |
| Falzone                    | 2017            | Labor force, population                                                     | USA                            | Descriptive analysis                         | Education alone can't reverse the decline in the U.S. labor force participation rate.                        | 1994-2014            |
| Assaad et al.              | 2020            | Working age population, marital status, age, region, household of children. | MENA                           | Multinomial Logit Models                     | The decline in public-sector employment among educated women is associated with an increase in unemployment. | 2000-2017            |
| Singh & Shastri            | 2020            | Unemployment, public expenditure on education,                              | India                          | ARDL                                         | Educational attainment negatively affects the unemployment rate.                                             | 1987-2017            |
| <del>Mooi-Reci et</del>    | <del>2019</del> | <del>Unemployment, parents'</del>                                           | <del>The</del>                 | <del>WLS</del>                               | <del>Fathers' unemployment reduces children's income and</del>                                               | <del>1985-2010</del> |

|                       |      |                                                                              |                        |                                 |                                                                                                                                                       |           |
|-----------------------|------|------------------------------------------------------------------------------|------------------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| al.                   |      | <del>work ethic, presence of siblings</del>                                  | <del>Netherlands</del> |                                 | <del>learning quality, while mothers' positive work attitudes can improve educational outcomes.</del>                                                 |           |
| Sasson                | 2016 | Life expectancy                                                              | USA                    | KLD                             | Less-educated individuals face shorter, more uncertain lifespans, while college-educated individuals live longer with less variation in age at death. | 1990-2010 |
| Rogoz et al.          | 2022 | Economic freedom, fiscal policies, living standards, healthcare quality      | New EU member states   | Causality, Cointegration tests  | Higher education promotes healthier lifestyles, better decision-making, and improved access to healthcare, thereby increasing life expectancy.        | 2000-2019 |
| Diakodimitriou et al. | 2025 | R&D expenditures, public expenditures                                        | European countries     | LASSO, 3SLS model               | Education spending drives economic growth by boosting R&D.                                                                                            | 1996-2019 |
| Sena & Higon          | 2012 | R&D expenditure, worker productivity                                         | UK                     | GMM                             | Plants in regions with a more educated workforce gain more from R&D spillovers and are more productive.                                               | 1997–2002 |
| Arif                  | 2022 | Corruption, Income gap, Democracy gap, Contiguity, Diplomatic representation | Global                 | Panel data analysis             | Controlling corruption can attract educated workers and promote brain gain.                                                                           | 1990-2000 |
| Garcia-Sanchez et al. | 2013 | Government effectiveness                                                     | Global                 | GMM                             | Education improves government effectiveness.                                                                                                          | 2002-2008 |
| Li & Sun              | 2022 | Rule of law, thinking skills                                                 | China                  | Correlation, frequency analysis | There is a strong positive link between critical thinking and respect for legal principles.                                                           | 2019-2020 |
| Wadood                | 2024 | Savings, financial literacy, gender, age,                                    | Islamabad              | Regression                      | Education is strongly negatively associated with saving behavior.                                                                                     | 2024      |
| Wang et al.           | 2022 | GNI, unemployment, gender                                                    | China                  | Panel data regression,          | Higher education lowers national savings by reducing job insecurity and precautionary savings.                                                        | 1991-2019 |

|                   |      |                                                     |        |                  |                                                               |           |
|-------------------|------|-----------------------------------------------------|--------|------------------|---------------------------------------------------------------|-----------|
|                   |      |                                                     |        | GMM              |                                                               |           |
| Striessnig et al. | 2013 | Climate risk, polity score, population density, HDI | Global | Panel regression | Investing in education greatly reduces climate vulnerability. | 1980-2013 |

Data and Methods

Scatterplot Graphics

**Figure 1.** Scatterplot Graph between GDP per GDP pPer Capita Growth, Government Effectiveness, Political Stability, Government Effectiveness, and Educational Attainment-Expenditure

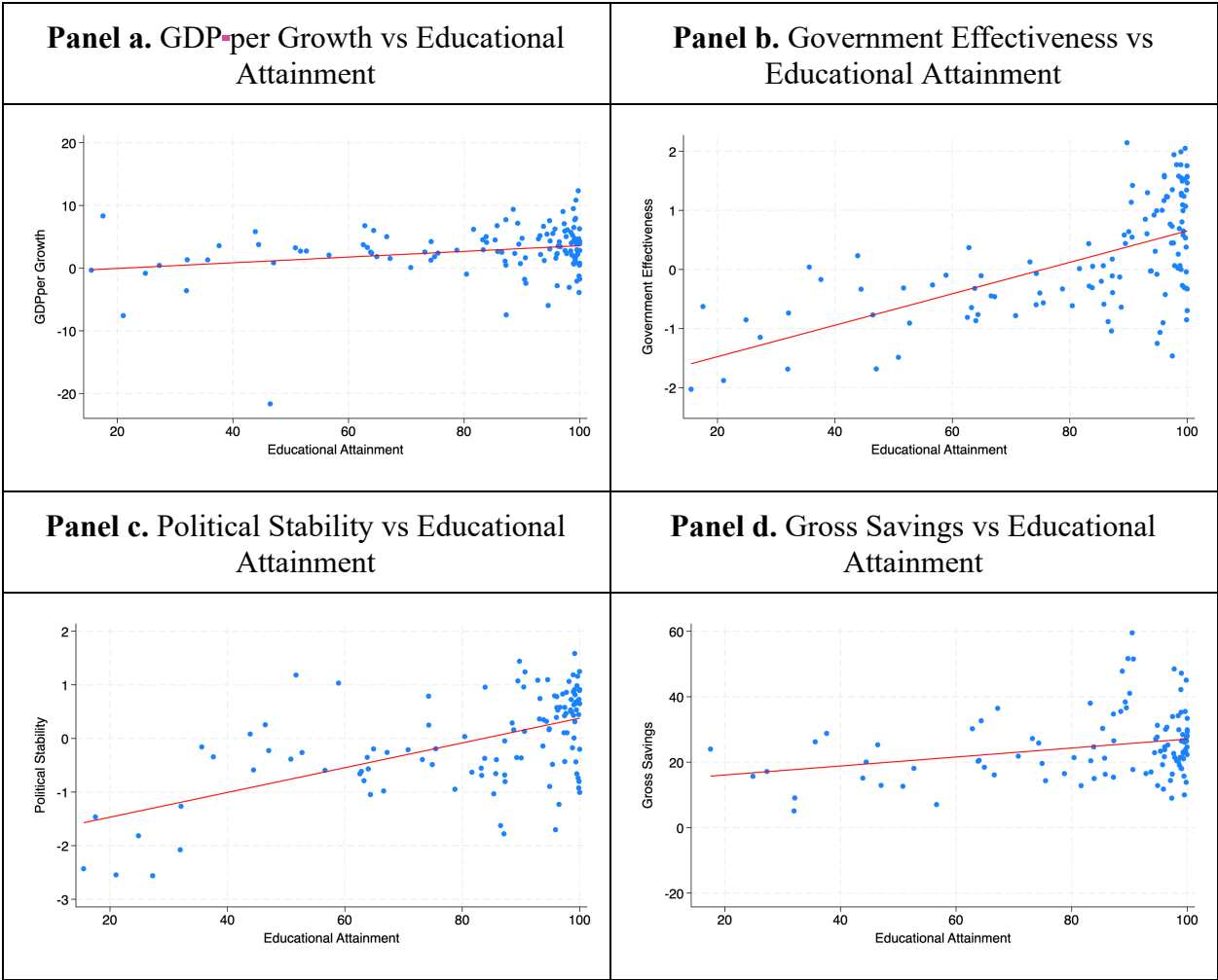
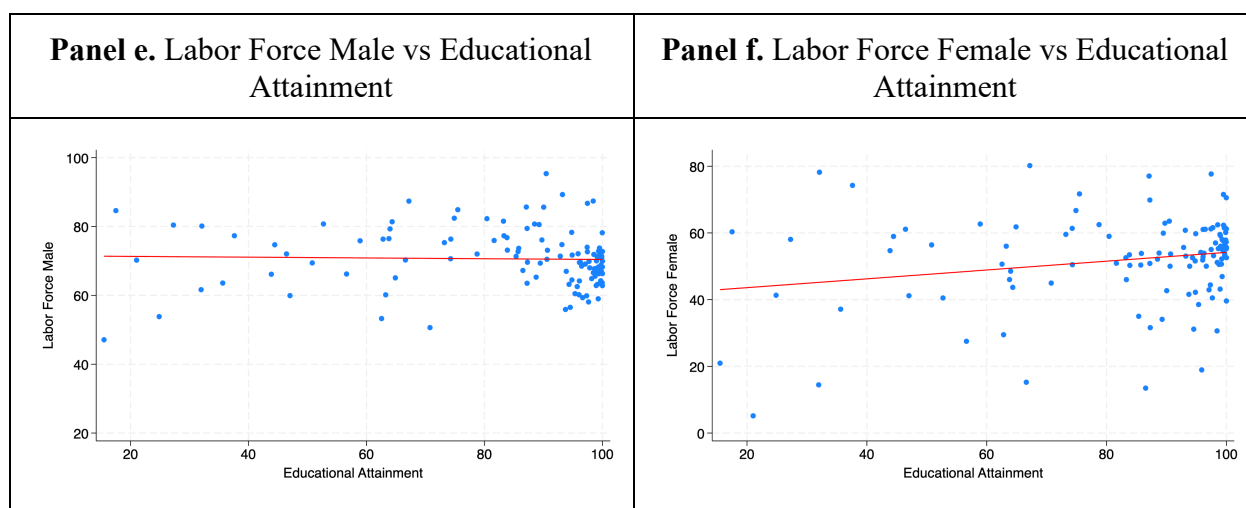


Figure 1 presents a series of scatterplots that illustrating the relationship between educational attainment and key economic and governance government indicators across countries. Panel a displays shows the association between GDP per capita growth and educational attainment. The upward trend suggests a modest positive relationship, although the data points remain widely dispersed. Though there is a slight positive correlation between GDP per capita growth and educational attainment, several countries with similar levels of education also exhibit substantially different growth rates, suggesting that other factors likely play important roles. The

slightly positive slope suggests that countries with higher levels of educational attainment tend to experience higher GDP growth rates. This supports that education contributes to productivity and economic development. Panel b examines the relationship between educational attainment and government effectiveness. Compared to the other indicators, the relationship appears relatively strong and more tightly clustered around the fitted line, suggesting that countries with higher educational attainment tend to exhibit more effective governance. Although the association is not necessarily causal, the pattern may indicate that more educated populations are associated with stronger institutional quality and public administration. The strong positive slope suggests that countries with a more educated population are likely to have more efficient, accountable governments. This supports that education enhances institutional quality. Panel c illustrates the relationship between educational attainment and political stability. The scatterplot shows a moderate positive relationship, although there is still noticeable variation across observations. While countries with higher educational attainment generally appear more politically stable, the dispersion in the data suggests that political stability is also influenced by historical, institutional, and regional factors beyond education alone. suggesting that countries with higher educational attainment tend to have more stable governments. This supports economic stability. Panel d presents the correlation between educational attainment and gross savings. A positive correlation is observed; however, the relationship appears weaker than those for government effectiveness and life expectancy. The scatterplot also contains several outliers, suggesting that savings behavior may depend on broader macroeconomic conditions, income levels, and financial systems in addition to educational attainment. higher educational attainment may be positively associated with lead to greater savings behavior, which increases the country's income levels. ¶

**Figure 2.** Scatterplot Graph between Labor Force Male, Labor Force Female, Life Expectancy, Rule of Law, and Educational Attainment-Expenditure



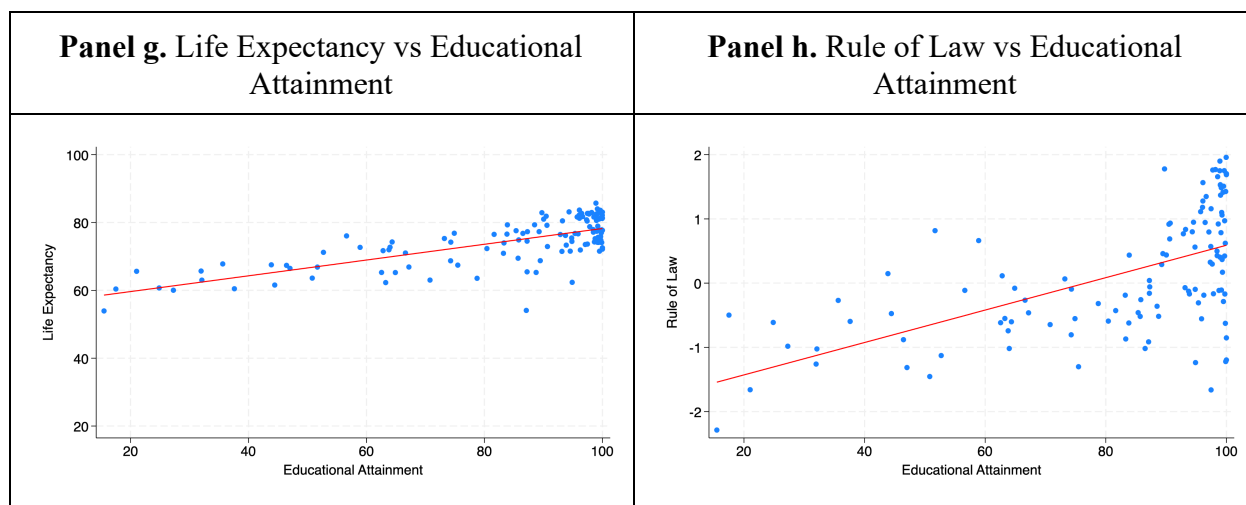
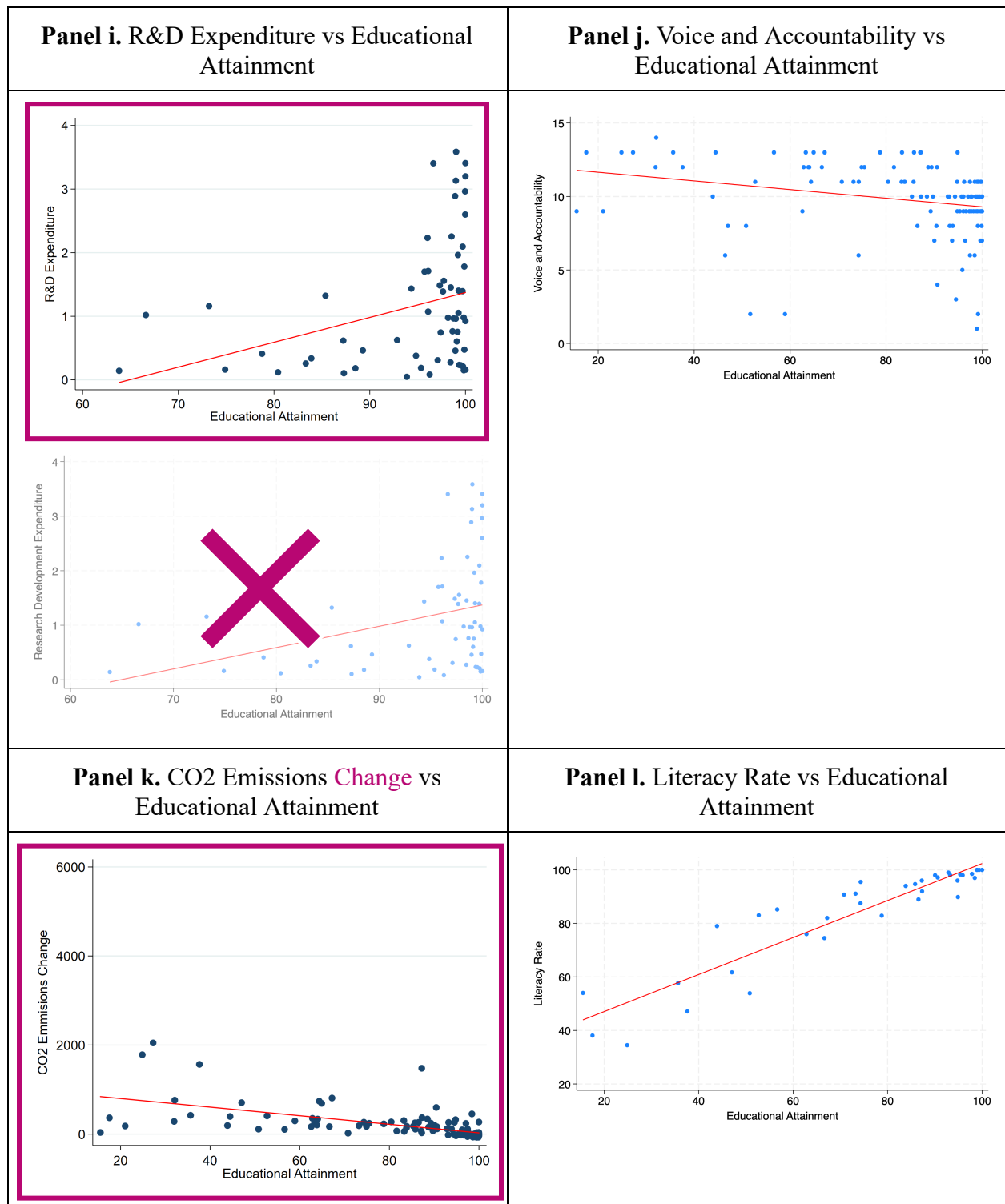


Figure 2 illustrates the relationship between educational attainment and four key social and labor market indicators. Panel e shows the association between male labor force participation and educational attainment. The relationship appears relatively flat and weak, indicating little clear relationship between the two variables across countries. ~~that male labor force participation rate may not vary significantly with different educational levels across countries.~~ The substantial dispersion of observations suggests that male labor force participation is likely more strongly influenced by labor market structure and economic conditions than by educational attainment alone. Panel f shows the relationship between female labor force participation and educational attainment. The upward trend suggests a moderate positive relationship, although the data remains fairly dispersed. This pattern may indicate that higher educational attainment is associated with greater female labor force participation, potentially through increased employment opportunities and human capital development. However, regional, cultural, and institutional differences may also substantially influence female labor force participation rates. ~~The scatterplot suggests a positive correlation, implying that higher educational attainment levels are associated with higher female participation in the labor force.~~ In panel g displays the correlation, a strong positive relationship is observed between life expectancy and educational attainment. Countries with higher levels of education generally tend to exhibit longer life expectancies. This association may reflect broader relationships between education, healthcare access, health literacy, and living standards. ~~This asso It is obvious that education can contribute to improved living standards.~~ Panel h presents the relationship between rule of law and educational attainment. ~~The A clear positive trend is observed, suggesting that countries with more educated populations tend to demonstrate stronger legal institutions and greater respect for legal norms. Nevertheless, some variation remains across countries, indicating that institutional quality may depend on other political and historical factors in addition to education.~~

~~higher educational attainment is linked to stronger rule of law. This shows that It is clear that an educated population may be more likely to demand accountability and respect legal norms.~~

**Figure 3.** Scatterplot Graph between ~~R&D Expenditure, Voice and Accountability, CO2 Emissions Change, Literacy Rate, GDP Per Growth, Government Effectiveness, Political Stability, Government Effectiveness, and Educational Attainment~~ Expenditure



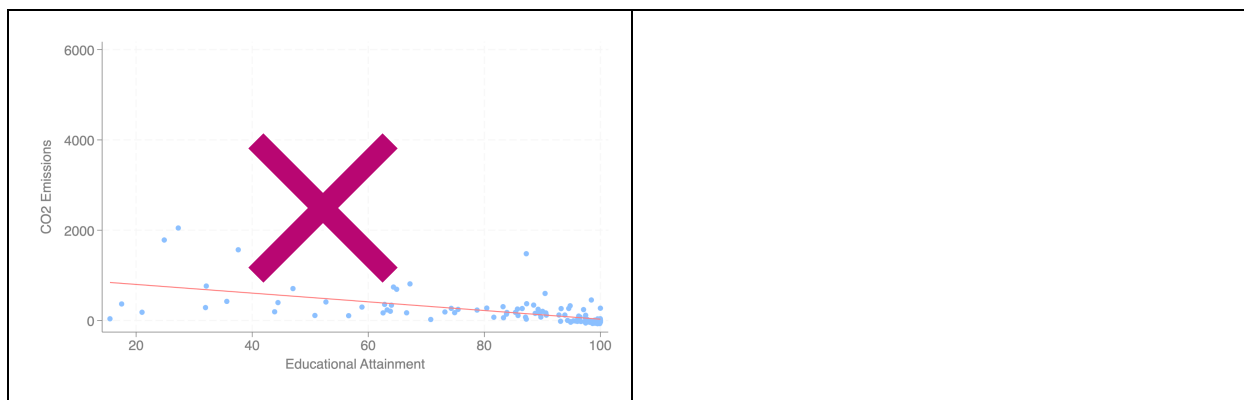


Figure 3 presents 4 scatterplot-graphics examining the relationships between educational attainment and R&D expenditure, voice and accountability, CO2 emissions change, and literacy rate. Panel i shows a positive correlation between educational attainment and R&D expenditure. Although the number of observations is lower than in several other figures, the upward trend suggests that countries with higher educational attainment tend to invest more heavily in research and innovation. This pattern is broadly consistent with existing literature linking education to technological development and productivity growth. Countries with a higher level of educational attainment tend to invest a larger proportion of their GDP in research and development activities. This finding suggests that an educated population fosters innovation. Panel j illustrates indicates a slightly negative association between educational attainment and voice and accountability. This result appears somewhat unexpected and should therefore be interpreted cautiously. The relationship itself is relatively weak, and the observations are fairly dispersed. One possible explanation is that improvements in educational attainment may not immediately translate into greater political participation or accountability. Additionally, institutional structures, political systems, censorship, and historical conditions may influence accountability independently of education levels. Furthermore, the relatively small sample size may also limit the reliability of this result. That is interesting, but it may be because improvements in education don't immediately translate into improvements in accountability. Panel k shows a negative relationship between educational attainment and CO2 carbon dioxide emissions change. Countries with higher educational attainment generally appear to experience lower changes in CO2 emissions. Although the relationship is not especially strong and includes several outliers, the pattern may suggest that more educated societies are associated with greater environmental awareness, stronger environmental policies, or more sustainable technologies. —suggesting that more educated societies may have lower CO2 emissions climate risk. This panel suggests that education could play an important role in environmental awareness. PFinally, panel l demonstrates displays a strong positive relationship between educational attainment and literacy rate. Though this indicator has fewer observations than other figures, the observations are closely clustered around the fitted line, indicating a relatively strong association between the two variables. This finding is expected, as higher educational attainment is generally associated with improved literacy and human capital development across countries.

~~, suggesting that education plays a critical role in human capital development.~~

## Data

Appendix 1 presents various indicators sourced from the World Bank World Development Indicators. The variables include educational attainment as a percentage of population ages 25 and above (Edu\_attainment), GDP per capita as a percentage of annual growth (GDPper\_growth), consumer price index as a proxy of inflation (Inf), political stability (Pol\_stability), literacy rate as a percentage of people ages 15 and above (Literacy), labor force participation rate as a percentage of male population ages 15+ (Lforce\_male), labor force participation rate as a percentage of female population ages 15+ (Lforce\_female), unemployment as a percentage of total labor force (Unemp), life expectancy (Life\_exp), research and development expenditure as a percentage of GDP (R&D), control of corruption (Corruption), government effectiveness (Gov\_effect), rule of law (Rule of Law), voice and accountability (Voice and AccountabilityAccountability), gross savings as a percentage of GNI (Gross\_savings)GNI, gini index (Gini), carbon dioxide emissions changeperheh intensity of GDP (CO2 emission changeclimate Risk).

## Descriptive Statistics

**Table 1.** Descriptive Statistics

| Variable         | Obs | Mean   | Std. Dev. | Min     | Max    |
|------------------|-----|--------|-----------|---------|--------|
| Edu_attainment   | 121 | 83.091 | 21.809    | 15.5    | 100    |
| GDPper_growth    | 256 | 3.31   | 6.042     | -22.746 | 62.111 |
| Gov_effect       | 205 | -.039  | .995      | -2.391  | 2.144  |
| Pol_stability    | 205 | -.035  | .999      | -2.777  | 1.661  |
| Gross_savingsGNI | 198 | 24.675 | 10.815    | -21.882 | 59.525 |
| Lforce_male      | 234 | 70.453 | 8.791     | 24.098  | 95.365 |
| Lforce_female    | 234 | 50.314 | 14.75     | 4.977   | 82.575 |
| Life_exp         | 265 | 72.796 | 7.648     | 18.818  | 85.746 |
| Rule of Law      | 205 | -.023  | 1.001     | -2.287  | 1.958  |

|                                                       |     |         |          |        |           |
|-------------------------------------------------------|-----|---------|----------|--------|-----------|
| R&D                                                   | 96  | 1.392   | 1.222    | .035   | 6.019     |
| Voice and Accountability<br><del>Accountability</del> | 203 | 8.798   | 3.443    | 1      | 14        |
| CO2 emission change<br><del>climate Risk</del>        | 246 | 667.546 | 4308.181 | -82.39 | 52245.455 |
| Literacy                                              | 95  | 81.356  | 16.122   | 27.28  | 100       |

Table 1 provides descriptive statistics for educational attainment and various social, economic, environmental, and political indicators. The Edu\_attainment has 121 observations with a mean of 83.091 and a standard deviation of 21.809, ranging from a minimum of 15.5 to a maximum of 100. GDPper\_growth has 256 observations with a mean of 3.31 and a standard deviation of 6.042, ranging from a minimum of -22.746 to a maximum of 62.111. Gov effect has 205 observations with a mean of -.039 and a standard deviation of .995, ranging from a minimum of -2.391 to a maximum of 2.144. Pol\_stability has 205 observations with a mean of -0.035 and a standard deviation of 0.999, ranging from a minimum of -2.777 to a maximum of 1.661. ~~Gross\_savingsGNI~~ has 198 observations with a mean of 24.675 and a standard deviation of 10.815, ranging from a minimum of -21.882 to a maximum of 59.525. Lforce\_male has 234 observations with a mean of 70.453 and a standard deviation of 8.791, ranging from a minimum of 24.098 to a maximum of 95.365. Lforce\_female has 234 observations with a mean of 50.314 and a standard deviation of 14.75, ranging from a minimum of 4.977 to a maximum of 82.575. Life\_exp has 265 observations with a mean of 72.796 and a standard deviation of 7.648, ranging from a minimum of 18.818 to a maximum of 85.746. Rule of Law has 205 observations with a mean of -0.023 and a standard deviation of 1.001, ranging from a minimum of -2.287 to a maximum of 1.958. R&D has 96 observations with a mean of 1.392 and a standard deviation of 1.222, ranging from a minimum of 0.035 to a maximum of 6.019. ~~Voice and Accountability h- Accountability~~ has 203 observations with a mean of 8.798 and a standard deviation of 3.443, ranging from a minimum of 1 to a maximum of 14. ~~CO2 emission changeclimate Risk~~ has ~~24679~~ observations with a mean of ~~667.54651.452~~ and a standard deviation of ~~4308.181-135.39~~, ranging from a minimum of ~~-82.3970.277~~ to a maximum of ~~52245.455630.812~~. Literacy has ~~945~~ observations with a mean of ~~81.35694.403~~ and a standard deviation of ~~16.1227.701~~, ranging from a minimum of ~~27.2874.5~~ to a maximum of 100.

## Model

$$Y_i = a_0 + b_1 X_i + e_i$$

Where  $Y_i$  is the dependent variable for observation  $i$ , referring which refers to GDP per capita growth (GDPper\_growth), political stability (Pol\_stability), (government effectiveness) Gov\_effect, gross savings (Gross\_savings)GNI, male labor force participation rate (Lforce\_male), female labor force participation rate (Lforce\_female), life expectancy (Life\_exp), rule of law (Rule of Law), research and development expenditure (R&D), CO2 emission changeclimate Risk (CO2 emissions change), voice and accountability (Voice and Accountability Accountability), and literacy rate (Literacy).

$a_0$  is the constant term, representing the expected value of the dependent variable when the independent variable equals is zero.  $b_1$  is the coefficient for the independent variable, Educational Attainment which is (Edu\_attainment). The coefficient indicates shows how much the dependent variable changes when educational attainment the independent variable changes by one unit.  $e_i$  is the error term, which represents the difference between the observed and the model's predicted valuesp observedobservedactual value and the and predicted values from the model.

We estimated 12 different models to examine the relationship between e-investigate the effect of educational attainment Edu\_attainment and various on social, economic, environmental, and political indicators. The estimated models are presented below.

$$\begin{aligned} \text{Edu\_attainment}_i &= a_0 + b_1 \text{GDPper\_growth}_i + e_i \text{ (model 1)} \\ \text{Edu\_attainment}_i &= a_0 + b_1 \text{Pol\_stability}_i + e_i \text{ (model 2)} \\ \text{Edu\_attainment}_i &= a_0 + b_1 \text{Gov\_effect}_i + e_i \text{ (model 3)} \\ \text{Edu\_attainment}_i &= a_0 + b_1 \text{GNI}_i + e_i \text{ (model 4)} \\ \text{Edu\_attainment}_i &= a_0 + b_1 \text{Lforce\_male}_i + e_i \text{ (model 5)} \\ \text{Edu\_attainment}_i &= a_0 + b_1 \text{Lforce\_female}_i + e_i \text{ (model 6)} \\ \text{Edu\_attainment}_i &= a_0 + b_1 \text{Life\_exp}_i + e_i \text{ (model 7)} \\ \text{Edu\_attainment}_i &= a_0 + b_1 \text{RuleofLaw}_i + e_i \text{ (model 8)} \\ \text{Edu\_attainment}_i &= a_0 + b_1 \text{R\&D}_i + e_i \text{ (model 9)} \\ \text{Edu\_attainment}_i &= a_0 + b_1 \text{Climate Risk}_i + e_i \text{ (model 10)} \\ \text{Edu\_attainment}_i &= a_0 + b_1 \text{Accountability}_i + e_i \text{ (model 11)} \\ \text{Edu\_attainment}_i &= a_0 + b_1 \text{Literacy}_i + e_i \text{ (model 12)} \end{aligned}$$

$$\begin{aligned} \text{GDPper\_growth}_i &= a_0 + b_1 \text{Edu\_attainment}_i + e_i \text{ (model 1)} \\ \text{Pol\_stability}_i &= a_0 + b_1 \text{Edu\_attainment}_i + e_i \text{ (model 2)} \\ \text{Gov\_effect}_i &= a_0 + b_1 \text{Edu\_attainment}_i + e_i \text{ (model 3)} \\ \text{Gross\_savings}_i &= a_0 + b_1 \text{Edu\_attainment}_i + e_i \text{ (model 4)} \\ \text{Lforce\_male}_i &= a_0 + b_1 \text{Edu\_attainment}_i + e_i \text{ (model 5)} \\ \text{Lforce\_female}_i &= a_0 + b_1 \text{Edu\_attainment}_i + e_i \text{ (model 6)} \end{aligned}$$

$\text{Life\_exp}_i = a_0 + b_1 \text{Edu\_attainment}_i + e_i$  (model 7)  
 $\text{RuleofLaw}_i = a_0 + b_1 \text{Edu\_attainment}_i + e_i$  (model 8)  
 $\text{R\&D}_i = a_0 + b_1 \text{Edu\_attainment}_i + e_i$  (model 9)  
 $\text{CO2 emission change}_i = a_0 + b_1 \text{Edu\_attainment}_i + e_i$  (model 10)  
 $\text{Voice and Accountability}_i = a_0 + b_1 \text{Edu\_attainment}_i + e_i$  (model 11)  
 $\text{Literacy}_i = a_0 + b_1 \text{Edu\_attainment}_i + e_i$  (model 12)¶

While the regression analysis provides useful insight into the relationship between educational attainment and various development indicators, several limitations should be acknowledged. First, the analysis is based on cross-sectional data and bivariate regressions, which do not permit causal inference. The estimated relationships should therefore be understood as associations rather than direct effects. In addition, omitted variable bias may exist because many other factors, such as income levels, institutional quality, regional characteristics, and healthcare systems, may influence both educational attainment and the outcome variables. Reverse causality may also be present, as wealthier or more institutionally developed countries may have a greater capacity to invest in education. As a result, the findings should be interpreted with caution and treated as preliminary evidence of broader relationships between education and development outcomes.

## Analysis and Discussion

**Table 1a. Regression Analysis**

|                | ( model 1)        | (model 2)          | (model 3)          | (model 4)           |
|----------------|-------------------|--------------------|--------------------|---------------------|
| VARIABLES      | GDPper_g<br>rowth | Pol_stabili<br>ty  | Gov_effe<br>ct     | Gross_savi<br>ngsNI |
| Edu attainment | 0.05**<br>(0.02)  | 0.02***<br>(0.00)  | 0.03***<br>(0.00)  | 0.14***<br>(0.04)   |
| Constant       | -0.95<br>(2.01)   | -2.01***<br>(0.28) | -2.05***<br>(0.24) | 13.35***<br>(3.13)  |
| Observations   | 119               | 118                | 118                | 106                 |
| R-squared      | 0.06              | 0.35               | 0.39               | 0.08                |

Robust standard errors in parentheses. The number of observations differs across regressions because some indicators contain missing data for certain countries

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1a ~~portrays~~ presents the results of four regression models, with the dependent variables being ~~in four different regression models where the dependent variables are~~ GDP per capita growth (GDPper\_growth), Political Stability (Pol\_stability), Government Effectiveness (Gov\_effect), and Gross Savings as a percentage of GNI (Gross\_savingsGNI). Each column corresponds to a distinct model, ~~with the explanatory variable being with an explanatory variable~~

as Educational Attainment (Edu\_attainment). If the results are statistically significant at the 1% level, we indicate this with (\*\*\*), at the 5% level with (\*\*), and at the 10% level with (\*). The coefficient on educational attainment is positive and statistically significant across all of the models, indicating that higher educational attainment is associated with higher levels of GDP per capita growth, greater political stability, more effective governance, and higher levels of gross savings. This suggests that countries with higher levels of educational attainment contribute to labor productivity and innovation, which enhances national output. Furthermore, the results also suggest that a more educated population is more likely to support a more effective and stable government. Higher educational attainment may also be correlated with can also lead to greater savings behavior, thereby increasing the country's income levels.

**Table 1b. Regression Analysis**

|                | (model 5)          | (model 6)          | (model 7)          | (model 8)          |
|----------------|--------------------|--------------------|--------------------|--------------------|
| VARIABLES      | Lforce_male        | Lforce_female      | Life_exp           | Rule of Law        |
| Edu_attainment | -0.01<br>(0.05)    | 0.12<br>(0.08)     | 0.23***<br>(0.02)  | 0.03***<br>(0.00)  |
| Constant       | 71.34***<br>(4.27) | 41.73***<br>(7.48) | 55.13***<br>(1.35) | -2.00***<br>(0.24) |
| Observations   | 117                | 117                | 117                | 116                |
| R-squared      | 0.00               | 0.04               | 0.52               | 0.34               |

Robust standard errors in parentheses. The number of observations differs across regressions because some indicators contain missing data for certain countries

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1b presents four different regression results examining the relationship between educational attainment (Edu\_attainment) and the male labor force participation rate (Lforce\_male), female labor force participation rate (Lforce\_female), life expectancy (Life\_exp), and rule of law (Rule of Law). Models 5 and 6 show that the relationship between educational attainment and male and female labor force participation rates is statistically insignificant. Models 7 and 8 show a positive and statistically significant relationships between educational attainment and life expectancy and rule of law, respectively, suggesting that countries with higher educational attainment tend to have healthier lives and greater respect for laws and institutions.

**Table 1c. Regression Analysis**

|  | (model 9) | (model 10) | (model 11) | (model 12) |
|--|-----------|------------|------------|------------|
|--|-----------|------------|------------|------------|

| VARIABLES      | R&D     | CO2 emissions<br><del>change in climate Risk</del> | Voice and<br>Accountability | Literacy                  |
|----------------|---------|----------------------------------------------------|-----------------------------|---------------------------|
| Edu_attainment | 0.04*** | <del>-9.63</del> -8.88**<br>*                      | <del>-0.039</del> ***       | 0.695***                  |
|                | (0.01)  | (2.49) <del>(1.50)</del>                           | (0.0003) <del>(1)</del>     | (0.06) <del>(15)</del>    |
| Constant       | -2.57** | <del>992.25</del> 882.09***                        | <del>0.0605</del> 18.10***  | <del>33.22</del> 35.76*** |
|                | (1.02)  | (228.49) <del>(144.0)</del> <del>(1)</del>         | (0.02) <del>(1.33)</del>    | (5.50) <del>(13.98)</del> |
| Observations   | 59      | <del>113</del> 59                                  | 120                         | <del>369</del>            |
| R-squared      | 0.11    | 0.35 <del>8</del>                                  | 0.06 <del>30</del>          | 0.95 <del>82</del>        |

Robust standard errors in parentheses. The number of observations differs across regressions because some indicators contain missing data for certain countries.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1c displays the results of four ~~different~~ regressions examining the relationship between educational attainment and research and development expenditures (R&D), ~~change in~~ carbon dioxide emissions (CO2 ~~emissions change in climate Risk~~), voice and accountability (~~Voice and Accountability~~ ~~accountability~~), and literacy rate (~~L~~iteracy). Models 9 and 12 show a positive and statistically significant relationship between educational attainment (Edu\_attainment) and research and development expenditures (R&D), and between educational attainment (Edu\_attainment) and the literacy rate (Literacy), suggesting that countries with higher education levels tend to invest more in research and innovation and have a greater literacy rate, indicating a more qualified human capital. In contrast, models 10 and 11 show negative, statistically significant relationships between educational attainment (Edu\_attainment) and carbon dioxide emissions (~~CO2 emission change in climate Risk~~), and between educational attainment (Edu\_attainment) and voice and accountability (~~Voice and Accountability~~ ~~Accountability~~). This suggests that improvements in education may not immediately translate into greater accountability, and that a more educated population may foster greater climate awareness and reduce ~~carbon dioxide emissions~~ ~~climate risk~~.

### Robustness Check

To verify the reliability and stability of our main findings, we conducted a robustness check by introducing additional control variables and reestimating all regression models. Specifically, we included control variables such as inflation, GDP per capita growth, and voice and accountability where appropriate, to account for other factors that might affect the relationship between educational attainment and selected social, economic, political, and environmental indicators.

After controlling for these additional variables, all models were reestimated and compared to the original results. Overall, the results remained consistent with the main findings, suggesting that the relationship between educational attainment and outcome variables is not driven by other variables. Therefore, the robustness check supports the reliability of the empirical findings.

**Table 2a. Regression Analysis**

| VARIABLES                | (model 1)<br>GDPper<br>growth | (model 2)<br>Pol_stability | (model 3)<br>Gov_effect | (model 4)<br>Gross_savin<br>gs |
|--------------------------|-------------------------------|----------------------------|-------------------------|--------------------------------|
| Edu_attainment           | 0.062*<br>(0.034)             | 0.023***<br>(0.004)        | 0.025***<br>(0.003)     | 0.114***<br>(0.039)            |
| Inflation                | -0.109***<br>(0.033)          | -0.033***<br>(0.012)       | -0.031*<br>(0.017)      | -0.457***<br>(0.101)           |
| GDPper growth            |                               | -0.004<br>(0.023)          | -0.001<br>(0.014)       | -0.174<br>(0.207)              |
| Voice and Accountability | 0.485<br>(0.341)              |                            |                         |                                |
| Constant                 | -7.163<br>(6.151)             | -1.881***<br>(0.307)       | -1.808***<br>(0.250)    | 16.131***<br>(3.115)           |
| Observations             | 112                           | 113                        | 113                     | 103                            |
| R-squared                | 0.121                         | 0.362                      | 0.372                   | 0.098                          |

**Table 1b. Regression Analysis**

| VARIABLES      | (model 5)<br>Lforce_male | (model6)<br>Lforce_fema<br>le | (model7)<br>Life_exp | (model8)<br>Rule of Law |
|----------------|--------------------------|-------------------------------|----------------------|-------------------------|
| Edu_attainment | -0.077*<br>(0.041)       | 0.054<br>(0.083)              | 0.223***<br>(0.018)  | 0.025***<br>(0.003)     |
| Inflation      | -0.293***<br>(0.076)     | -0.818***<br>(0.196)          | -0.045<br>(0.153)    | -0.020<br>(0.018)       |
| GDPper growth  | 0.138<br>(0.129)         | 0.109<br>(0.327)              | 0.010<br>(0.082)     | -0.004<br>(0.017)       |
| Constant       | 77.240***<br>(3.695)     | 47.812***<br>(7.881)          | 55.916***<br>(1.503) | -1.849***<br>(0.255)    |
| Observations   | 112                      | 112                           | 113                  | 113                     |
| R-squared      | 0.053                    | 0.077                         | 0.492                | 0.347                   |

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table 1c. Regression Analysis**

| VARIABLES      | (model 9)<br>R&D    | (model 10)<br>CO2 emissions<br>change | (model 11)<br>Voice and<br>Accountability | (model 12)<br>Literacy |
|----------------|---------------------|---------------------------------------|-------------------------------------------|------------------------|
| Edu_attainment | 0.041***<br>(0.013) | -11.289***<br>(2.712)                 | -0.038***<br>(0.011)                      | 0.733***<br>(0.070)    |
| Inflation      | -2.992**<br>(1.407) | -12.864***<br>(4.575)                 | 0.030<br>(0.036)                          | -0.917***<br>(0.100)   |
| GDPper growth  | -0.048<br>(0.038)   | -1.560<br>(8.709)                     | 0.030<br>(0.109)                          | 0.037<br>(0.266)       |
| Constant       | -1.912<br>(1.153)   | 1,151.884***<br>(261.257)             | 13.053***<br>(0.941)                      | 30.038***<br>(6.400)   |
| Observations   | 61                  | 107                                   | 113                                       | 33                     |
| R-squared      | 0.147               | 0.415                                 | 0.120                                     | 0.858                  |

Robust standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

## Conclusion

This paper used linear regression to ~~examine~~ ~~investigate~~ the ~~relationship impact between~~ ~~e~~-of educational attainment ~~and~~ on a broad range of social, economic, political, and environmental indicators ~~across countries~~. In this study, ~~E~~ educational attainment ~~in this study~~ is defined as the percentage of the population aged 25 and ~~above over~~ who have completed primary education. The findings show that higher educational attainment is positively associated with GDP per capita growth, gross savings, research and development expenditures, political stability, government effectiveness, rule of law, life expectancy, and literacy rate. In contrast, educational attainment is negatively associated with changes in CO2 emissions and with voice and accountability.

Overall, the results suggest that educational attainment is closely linked to multiple dimensions of development and institutional quality. However, because the analysis is based on cross-sectional bivariate regressions, the findings should be interpreted as associations rather than causal relationships. Other factors, including income levels, institutional conditions, healthcare systems, regional characteristics, and economic development, may also influence the ~~observed relationships~~. ~~results show a positive association between education attainment and GDP per capita growth, gross savings, R&D expenditures, political stability, government effectiveness, rule of law, life expectancy, and literacy rate, while also showing a negative association between CO2 emission change climate risk and voice and accountability.~~ Future research ~~studies~~ should employ more ~~advanced~~ ~~complex~~ methodologies, such as ~~panel data~~

analysis, GMM, ~~and~~ VAR models, instrumental variable approaches, or longitudinal analysis, to better examine causal relationships and changes over time. In addition, future studies could incorporate additional explanatory variables related to ~~see the effect of time variation.~~ Furthermore, future studies should include other factors such as freedom, democracy, healthcare, ~~and~~ technology, and institutional quality. Future research ~~using~~ should use individual-level or household-level data may also provide a more detailed understanding of how educational attainment relates to broader development outcomes.

## Appendix

### Appendix 1. Data Definition

| Indicator Symbol | Variable                                                                                         | Definition                                                                                                                                                         | Source         |
|------------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Edu_attainment   | Educational attainment, at least completed primary, population 25+ years, total (%) (cumulative) | The percentage of the population ages 25 and over who have that attained or completed primary education.                                                           | WDI World Bank |
| GDPper_growth    | GDP per capita (annual % growth)                                                                 | This indicator represents the percentage change in GDP per capita from the previous year, expressed in constant prices (base year: 2015) in United States dollars. | WDI World Bank |
| Inf              | Consumer price index (2010 = 100)                                                                | Index of the prices of consumption goods and services, as compared to a certain reference period (2010=100).                                                       | WDI World Bank |
| Pol_stability    | Political Stability and Absence of Violence/Terrorism: Estimate                                  | Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or                                       | WDI World Bank |

|               |                                                                                                 |                                                                                                                                                                                                                                                   |                |
|---------------|-------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|               |                                                                                                 | politically-motivated violence, including terrorism, ranging from -2.5 to 2.5."                                                                                                                                                                   |                |
| Literacy      | Literacy rate, adult total (% of people ages 15 and above)                                      | Adult literacy rate is the percentage of people ages 15 and above who can both read and write with understanding a short, simple statement about their everyday life.                                                                             | WDI World Bank |
| Lforce_male   | Labor force participation rate, male (% of male population ages 15+) (modeled ILO estimate)     | <del>The labor</del> <del>Labor</del> force participation rate is the proportion of the population ages 15 and older that is economically active: all people who supply labor for the production of goods and services during a specified period. | WDI World Bank |
| Lforce_female | Labor force participation rate, female (% of female population ages 15+) (modeled ILO estimate) | The labor force participation rate is the labor force as a percent of the population ages 15 and older. The labor force is the sum of all persons of working age who are employed and those who are unemployed.                                   | WDI World Bank |
| Unemp         | Unemployment, total (% of total labor force) (modeled ILO estimate)                             | Unemployment refers to the share of the labor force that is without work but available for and seeking employment.                                                                                                                                | WDI World Bank |
| Life_exp      | Life expectancy at                                                                              | Life expectancy at                                                                                                                                                                                                                                | WDI World Bank |

|            |                                                 |                                                                                                                                                                                                                                                                                                           |                |
|------------|-------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|            | birth, total (years)                            | birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.                                                                                                                                   |                |
| R&D        | Research and development expenditure (% of GDP) | Gross domestic expenditures on research and development, expressed as a percent of GDP.                                                                                                                                                                                                                   | WDI World Bank |
| Corruption | Control of Corruption: Estimate                 | Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests, ranging from -2.5 to 2.5.                                            | WDI World Bank |
| Gov_effect | Government Effectiveness: Estimate              | Government Effectiveness captures perceptions and views of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such | WDI World Bank |

|                          |                                             |                                                                                                                                                                                                                                                                                                                  |                |
|--------------------------|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|                          |                                             | policies, ranging from -2.5 to 2.5.                                                                                                                                                                                                                                                                              |                |
| Rule of Law              | Rule of Law: Estimate                       | Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, <del>and in</del> particularly the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence, ranging from -2.5 to 2.5. | WDI World Bank |
| Voice and Accountability | Voice and Accountability: Number of Sources | Voice and Accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.                                                                                     | WDI World Bank |
| Gross_SavingsGNI         | Gross savings (% of GNI)                    | Gross savings are calculated as gross national income less total consumption, plus net transfers. This indicator is expressed as a percentage of Gross National Income (GNI), which is the total income earned by all residents within an economic territory                                                     | WDI World Bank |

|                                      |                                                                              |                                                                                                                                                                                                                                                                   |                            |
|--------------------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
|                                      |                                                                              | during an accounting period.                                                                                                                                                                                                                                      |                            |
| Gini¶                                | Gini index¶                                                                  | <del>Gini index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution.¶</del>                                       | <del>WDI World Bank¶</del> |
| CO2 emissions<br>change climate Risk | Carbon dioxide (CO2) emissions (total) excluding LULUCF (% change from 1990) | Change of emissions (as %) of the current year with respect to emissions in the baseline year 1990 emissions of carbon dioxide (CO2), one of the six Kyoto greenhouse gases (GHG), from the agriculture, energy, waste, and industrial sectors, excluding LULUCF. | WDI World Bank             |

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Dear Editor and Reviewers,

Thank you very much for your detailed feedback and constructive comments on my manuscript. I appreciate the time and effort taken to evaluate my work and to provide suggestions that will strengthen both conceptual and technical aspects of the study. Below, I will provide a point-to-point response to the issues raised. All changes have been incorporated into the revised manuscript.

**Comment 1:** “In the model section, the general equation says that Y is the dependent variable and education is the independent variable, which fits the paper’s stated goal. However, the twelve equations listed immediately below reverse that relationship and place educational attainment on the left-hand side as the dependent variable.”

**Response 1:** We have corrected the model section. All 12 equations now correctly reflect the intended specifications used in the regression tables.

**Comment 2:** “Replace causal language with associative language unless stronger methods are introduced.”

**Response 2:** I have adjusted the manuscript's tone to be more modest. The language has been shifted from causal statements (e.g., leads to) to more accurate descriptions of statistical relationships, such as “is associated with”.

**Comment 3:** “Third, the manuscript needs much more care in variable definition and consistency. There are several places where the terminology shifts. For example, climate risk is described in the text as if it were a general risk measure, but in the appendix it is defined as change in carbon dioxide emissions. Those are not the same thing. Similarly, GNI is used in the regression tables to refer to gross savings as a percentage of GNI, which could easily confuse readers. The paper should standardize variable names and use the exact indicator names throughout.”

**Response 3:** We have standardized variable names across the text, tables, and appendix. “Climate risk” is now more precisely referred to as “CO2 emissions change,” and “GNI” is clarified as “Gross\_savings” to avoid reader confusion.

**Comment 4:** “Explain differing sample sizes and missing data across models.”

**Response 4:** We have re-estimated all models and corrected any inconsistent results caused by typos. We have also added an explanation in the table notes stating that the effective sample size differs across models due to missing data in the original dataset for both the independent and dependent variables. Additionally, we have added a paragraph addressing the data limitations under the model section.

**Comment 5:** “I also think the literature review can be tightened. Right now it is broad but somewhat list-like. Instead of naming many methods and countries in sequence, the review would be stronger if it were organized by theme. For instance, one paragraph on economic outcomes, one on governance and institutions, one on social outcomes, and one on environmental outcomes.”

**Response 5:** Following the suggestion, we have reorganized the literature review by themes (economic, governance, social, and environmental).

**Comment 6:** “Finally, the writing is generally readable, but the manuscript would benefit from a careful edit for grammar, repetition, and figure labeling. Figure titles repeat some labels, and a few interpretations are stated too strongly relative to the evidence. The negative result on voice and accountability is interesting, but it currently feels underexplained. The author should either discuss more possible reasons for it or present it more cautiously as an unexpected correlation.”

**Response 6:** We have carefully reread the manuscript and fixed any errors in grammar, repetition, and mislabeled figures. We have revised our interpretations to make them more appropriate for the evidence. We have also included more explanation on the negative result on voice and accountability.



Dear Editor and Reviewers,

Thank you very much for your detailed feedback and constructive comments on my manuscript. I appreciate the time and effort taken to evaluate my work and to provide suggestions that will strengthen both conceptual and technical aspects of the study. Below, I will provide a point-to-point response to the issues raised. All changes have been incorporated into the revised manuscript.

**Comment 1:** “the conclusions should be framed more carefully. The author should explicitly acknowledge omitted variables and possible reverse causality.”

**Response 1:** We appreciate this important observation and agree that the original wording occasionally overstated the strength of the conclusions. In response, we revised the paper throughout to adopt more cautious and precise language. Terms such as “causes,” “proves,” and “leads to” were replaced with phrasing emphasizing association and correlation. We also added a discussion in the methodology and limitations sections that explicitly acknowledges the possibility of omitted variable bias, the limitations of single-variable regressions, and the issue of reverse causality. Furthermore, we included a robustness check section. The purpose of this robustness analysis is to determine whether the estimated relationships remain consistent after controlling for potential omitted variable bias. The revised paper now frames the results as evidence of statistically significant relationships rather than definitive causal effects.

**Comment 2:** “The descriptive statistics section and the regression tables do not always line up neatly. The number of observations changes quite a bit, especially for R&D, accountability, climate risk, and literacy. That should be explained clearly in one sentence in the methods section and perhaps again in the table notes.”

**Response 2:** We added clarification in both the methods section and the regression table notes explaining that the number of observations differs because data availability varies across indicators and countries. Some datasets, particularly for R&D expenditure, accountability, literacy, and emissions measures, contain incomplete country coverage for the selected year range. We also reviewed the descriptive statistics and regression tables to ensure consistency and clearer labeling across sections.

**Comment 3:** Some figure discussions repeat visually obvious trends without deeper interpretation and may occasionally overstate the strength of relationships.

**Response 3:** We agree that the original discussion of figures could be more analytical. In the revised manuscript, we shortened repetitive descriptions and instead focused on interpreting the relative strength or weakness of relationships, the degree of dispersion, and the presence of notable outliers where applicable. We also moderated language where the visual evidence appeared less conclusive. These revisions were intended to make the discussion more analytical rather than purely descriptive.

**Comment 4:** “Still, the review tries to cover too many papers too quickly. As a result, the section becomes a catalog of methods and countries rather than a discussion of what is known

and what remains unclear. I would advise trimming it and focusing on the studies most relevant to the paper's own dependent variables and empirical approach."

**Response 4:** We substantially revised the literature review to focus more directly on studies most relevant to the paper's selected development indicators and empirical framework. We also clarified the paper's contribution more explicitly by stating that the study's novelty lies in combining multiple development indicators into a cross-country framework that examines the relationship between educational attainment and various development factors.

**Comment 5:** The terminology used for some variables does not align with the actual measures used in the analysis.

**Response 5:** We have fixed our terminology to make it more specific to the actual measures used in the analysis. For example, we have changed "Climate Risk" to "CO2 Emissions Change," "GNI" to "Gross\_Savings", and "Accountability" to "Voice and Accountability."

**Comment 5:** "I would recommend one more round of proofreading. There are a few awkward phrases, some repetition, and some minor labeling issues in the tables and figures."

**Response 5:** We conducted an additional round of proofreading and revised several awkward phrases, repetitive passages, and inconsistencies in table and figure labels. We believe these edits improved the clarity and readability of the manuscript.

Dear Editor and Reviewers,

Thank you very much for your detailed feedback and constructive comments on my manuscript. I appreciate the time and effort taken to evaluate my work and to provide suggestions that will strengthen both conceptual and technical aspects of the study. Below, I will provide a point-to-point response to the issues raised. All changes have been incorporated into the revised manuscript.

**Comment 1:** “To improve the credibility of the analysis, I strongly recommend introducing a small set of control variables.”

**Response 1:** To strengthen the credibility of the analysis, we conducted robustness checks by introducing additional control variables, including inflation, GDP per capita growth, and voice and accountability, where appropriate. After reestimating the models with these controls, the results remained broadly consistent with the original findings. This suggests that the observed relationships between educational attainment and the selected outcome variables are generally robust and not solely driven by omitted factors.

**Comment 2:** “The paper should consistently describe the results as associations rather than claim causality. Statements that education “drives,” “enhances,” or “contributes to” outcomes should be revised unless supported by a stronger identification strategy.”

**Response 2:** We fully agree and revised the manuscript throughout to adopt more precise and cautious language. Statements implying causality, such as “education drives” or “education enhances,” were replaced with wording emphasizing correlations and statistical associations. We also added an explicit discussion of the limitations in the limitations section, clarifying that the empirical design does not establish causality and that omitted variables and reverse causation remain possible explanations for the observed relationships.

**Comment 3:** “The model section should be carefully revised so that all equations, tables, and discussions are fully consistent.”

**Response 3:** We carefully revised the model section so that all equations consistently specify development indicators as dependent variables and educational attainment as the independent variable. The equations, regression tables, and accompanying discussion were reviewed to ensure alignment throughout the manuscript.

**Comment 4:** “The paper uses different numbers of observations across variables, sometimes quite dramatically (e.g., literacy and R&D). This variation is not clearly explained, and the descriptive statistics, regression tables, and text do not always align.”

**Response 4:** We appreciate this observation and added clarification in both the methodology section and the regression table notes, explaining that each model uses a different effective sample due to differences in data availability across indicators and countries. We also reviewed the descriptive statistics and regression tables for consistency, clarified how the samples differ across models, and added clearer reporting of observation counts for each regression. In

addition, we revised the discussion of models based on relatively small samples, such as literacy-related regressions, to interpret those findings more cautiously.

**Comment 5:** The literature review reads more like a catalog of studies than a synthesis of findings and should be reorganized thematically.

**Response 5:** We substantially revised the literature review to focus more on synthesizing major themes and findings rather than listing individual studies sequentially. The review is now separated into methods, economic, social, and environmental outcomes. We also clarified the paper's contribution more directly by emphasizing that the study brings together multiple dimensions of development within a unified cross-country empirical framework.

**Comment 6:** Results based on very small samples (e.g., literacy) should be interpreted with caution or potentially omitted.

**Response:** We agree that regressions based on relatively small samples should be interpreted with greater caution, as limited observations may reduce the reliability and generalizability of the estimated relationships. In response, we revised the discussion of variables with smaller sample sizes, particularly literacy-related models, to explicitly acknowledge these limitations and avoid overstating the findings.

**Comment 7:** "The conclusion currently makes strong policy recommendations based on the results. Given the limitations of the empirical design, these claims should be moderated. It would be more appropriate to frame the findings as suggesting broad associations and emphasize the need for more rigorous causal analysis in future work."

**Response 7:** We agree that the original conclusion overstated the policy implications of the findings. In the revised manuscript, we moderated these claims and reframed the conclusions more carefully as evidence of broad associations rather than definitive causal relationships. We also added a discussion emphasizing the need for future research using more rigorous causal methods and richer datasets before strong policy conclusions can be drawn.

**Decision: Accept with minor revisions.**

**Review:** I appreciate the author's careful revision. The paper is considerably clearer than the earlier version: the direction of the empirical models has been corrected, the terminology is more consistent, the literature review is now organized more thematically, and the manuscript is more cautious than before in describing the results as associations rather than causal effects. These are real improvements. The topic is also appropriate for the journal, since it gives a student author the opportunity to think across several dimensions of development; economic, social, political, and environmental; using accessible cross-country data.

That said, I do not think the manuscript is quite ready for acceptance without one more focused revision. My main concern is the empirical design and how strongly the results are interpreted. The paper describes the analysis as a cross-country study using "up to 205 countries," but the descriptive statistics report more than 205 observations for some variables, such as GDP per capita growth, life expectancy, and CO<sub>2</sub> emissions change. This creates confusion about whether the dataset is truly cross-sectional, country-year, or includes repeated observations. The author should clarify the unit of observation, the year or time period used for each variable, and why the number of observations differs so much across indicators. This is not merely a presentation issue; it affects how readers should interpret the regressions.

Second, the robustness-check section should be toned down. Adding a few controls is useful, but it does not establish that the observed relationships are "not driven by other variables." The current wording still risks overstating what the analysis can show. A better formulation would be that the associations remain broadly similar after including a limited set of controls, while omitted-variable bias and reverse causality remain important limitations. This distinction is especially important because many of the dependent variables; governance, income growth, savings, R&D, literacy, and emissions; are jointly determined with education.

Third, the manuscript should treat small-sample and conceptually close variables with greater caution. The literacy regression, for example, has a much smaller sample than most other models and is also very closely related conceptually to educational attainment. It is therefore not surprising that the relationship is strong, but it should not be presented as equally informative as the governance or macroeconomic regressions. Similarly, R&D is based on a relatively limited sample and likely reflects country income, institutional capacity, and industrial structure as much as education.

Fourth, the negative association between educational attainment and voice and accountability remains underdeveloped. The author correctly notes that this result is unexpected, but the discussion should either offer a more convincing interpretation or present it simply as an anomalous correlation that should not be overread.

Finally, the tables and figures need a careful final edit. Some table numbering, labels, and formatting remain messy, especially in the robustness section. Before publication, the author should make sure that every table is cleanly numbered, every variable name is defined once

and used consistently, and every regression table can be understood without relying on the surrounding text.

Overall, **my recommendation is a short final revision rather than immediate acceptance.**

The paper has improved substantially and is publishable in principle, but it still needs clarification of the data structure, more restrained interpretation of robustness checks, more cautious handling of small-sample results, and final polishing of tables and figures before it is ready for publication.

Decision: **Accept with major revisions.**

Review: The revised manuscript has improved substantially in response to the previous review. The paper is now more carefully framed as an analysis of relationships rather than causal effects, the literature review is more clearly organized, the model equations have been corrected, and the conclusion is appropriately more cautious about the policy implications of the findings. The author has also made a meaningful effort to strengthen the empirical analysis by introducing additional control variables and discussing the limitations of the cross-sectional design.

At the same time, important empirical and consistency issues remain. Addressing these seems feasible within a reasonable timeframe and should be resolved before the manuscript can be considered for publication:

1. The newly added robustness checks are a useful step, but they do not yet fully address the central concern that many of the reported relationships may be driven by broader differences in development across countries. The current models introduce variables such as inflation, GDP per capita growth, and voice and accountability where appropriate. However, GDP per capita growth is not equivalent to a country's level of economic development, and inflation does not adequately capture the broader socioeconomic differences that may confound the reported relationships.
  - a. To strengthen the analysis, **I recommend including a more direct control for development, such as GDP per capita level, preferably in logarithmic form.** Regional indicators or income-group classifications would also be helpful. These controls would allow the analysis to more clearly distinguish the relationship between educational attainment and the selected indicators from general differences between higher-income and lower-income countries.
  - b. **The discussion of the robustness checks should also be moderated.** The current results suggest that the estimated relationships remain present after introducing a limited set of additional variables, yet they do not establish that the relationships are not driven by other omitted factors.
2. **The manuscript should more clearly explain the construction of the cross-country sample.** The paper describes the analysis as using cross-sectional data from up to 205 countries, but several variables appear to include more than 205 observations. For example, the table of descriptive statistics reports more than 250 observations for some indicators.
  - a. Please clarify whether the sample includes territories or other non-country entities, whether multiple years are included for some countries, or whether the analysis uses the most recently available observation for each indicator. The manuscript should also state the reference year or data selection rule for each variable.
  - b. Add a concise summary table listing each dependent variable, the effective number of observations, the reference year or selection rule, and the controls included in each model.

3. **The voice-and-accountability variable should be carefully verified.** The appendix appears to identify this variable as “Voice and Accountability: Number of Sources,” with values ranging from approximately 1 to 14. This may represent the number of underlying sources used to construct the indicator rather than the estimated level of voice and accountability itself. If so, this variable should be replaced with an appropriate voice-and-accountability estimate or omitted from the analysis.
  - a. This issue is important because the current manuscript interprets the negative relationship as a substantive political finding and also uses the variable as a control in one of the robustness models.
4. **Several regression tables should be reviewed carefully for internal consistency.** In particular, the reported coefficient for voice-and-accountability and intercept in the bivariate regression do not appear consistent with the scales shown in the scatterplot. The R&D model also appears to use more observations after additional control variables are introduced, which would be unusual if the regressions are based on complete-case samples from the same underlying dataset.
  - a. **Please verify the underlying regressions, confirm that the reported coefficients and observation counts are correct, and ensure that the tables, scatterplots, appendix definitions, and written discussion are fully aligned.**
5. **The variable described as “inflation” should also be checked.** The appendix appears to define this variable as a consumer price index with 2010 set equal to 100, but a CPI index level is not the same as an annual inflation rate.
  - a. **Please either replace this variable with an annual inflation measure, relabel it accurately (and explain why it is appropriate), or omit it in favor of controls that more directly address the development-related confounding discussed above.**
6. **Results based on relatively small samples should be interpreted with greater caution.** This applies particularly to the literacy and R&D regressions. The revised manuscript acknowledges the smaller samples, which is helpful, but these findings are still presented alongside the main results without sufficient qualification.
  - a. **Please clearly identify these estimates as exploratory or supplementary.**  
You may also consider moving the smallest-sample regressions into a separate subsection or appendix so that the primary findings are distinguished from results that may be less robust or stable.
7. **The regression analysis would benefit from clearer thematic organization.** The literature review is now organized effectively into economic, social, governance, and environmental outcomes; the empirical section should follow a similar structure. At present, the tables and figures continue to combine indicators from different categories, which makes the broader argument somewhat difficult to follow.
  - a. **I recommend reorganizing the results into clearly labeled subsections—e.g., economic outcomes, governance and political outcomes, social outcomes, and environmental outcomes.** This would help the reader understand which results are most important and would avoid the impression that the paper is presenting a collection of loosely related regressions.

8. **The interpretation is now substantially more cautious, but a few remaining statements should still be revised.** The manuscript should consistently describe the findings as associations rather than suggest that education directly improves productivity, institutional quality, environmental awareness, or other outcomes. These mechanisms may be plausible, but the current empirical design does not test them directly.
  - a. The discussion of the CO<sub>2</sub>-emissions-change variable would also benefit from additional caution. The descriptive statistics suggest that this variable contains very large outliers. **Please report a sensitivity analysis excluding extreme observations, winsorizing the variable before analyses, or otherwise discussing whether the results are driven by a small number of unusually large values.**
9. Finally, **please conduct a careful consistency review of the tables, figure titles, variable names, and references.** For example, the robustness tables should be numbered consistently, and terminology such as “climate risk,” “CO<sub>2</sub> emissions,” and “changes in CO<sub>2</sub> emissions” should be standardized and used consistently.

The revised paper demonstrates clear effort and has improved meaningfully since the initial submission. The remaining concerns are narrower than those in my original review, but they are important for ensuring that the results are accurately defined, transparently reported, and interpreted at an appropriate level of confidence.

# **The Relationship Between Educational Attainment and Social, Economic, Political, and Environmental Indicators**

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## **Abstract**

The paper investigates the relationship between educational attainment and various social, economic, environmental, and political indicators across countries using regression analysis. Using cross-sectional data from up to 265 countries, the findings show that higher education attainment is positively and statistically significantly associated with GDP per capita growth, political stability, government effectiveness, gross savings, life expectancy, rule of law, research and development (R&D) expenditures, voice and accountability, and literacy rates. Educational attainment is also negatively associated with changes in CO<sub>2</sub> emissions. By contrast, the relationships between educational attainment and male labor force participation and female labor force participation are not statistically significant. Although these associations remain broadly similar after the inclusion of a limited set of additional control variables, the findings should be interpreted cautiously because the cross-sectional design does not permit causal inference and omitted variable bias may remain. Overall, the results suggest that educational attainment is closely associated with multiple dimensions of development and institutional quality across countries.

**Keywords:** education attainment, economic indicators, political indicators, social indicators, environmental indicators

## **Introduction**

Education is widely recognized as a critical investment in human capital, capable of generating long-term returns in increased productivity while also promoting greater innovation. Additionally, it may be associated with better governance and improved health, thereby increasing overall quality of life.

This issue is important because it helps us better understand the implications of educational attainment for society. Most studies focus on the effects of educational attainment on only one aspect of society. However, this paper examines the effects of education through social, environmental, political, and economic lenses. Specifically, this paper uses cross-sectional regression analysis to examine the relationship between educational attainment and a comprehensive range of socioeconomic, governance, and environmental indicators across countries. The results indicate that educational attainment is positively associated with GDP per capita growth, gross savings, R&D expenditure, political stability, government effectiveness, rule of law, life expectancy, voice and accountability, and literacy rate, while it is negatively associated with changes in CO<sub>2</sub> emissions. In contrast, educational attainment is not

significantly associated with male and female labor force participation rate. Because the analysis is based on cross-sectional data, these findings should be interpreted as associations rather than evidence of causal relationships.

This study contributes to the literature by examining the relationship between educational attainment and a diverse set of social, economic, governance, and environmental indicators within a single cross-country empirical framework. While many previous studies focus on individual outcomes or specific regions, this paper provides a broader comparative perspective using the most recently available data for each indicator. By examining multiple dimensions of development simultaneously, this study offers a more comprehensive understanding of how educational attainment is associated with development outcomes across countries. The remainder of this paper is organized as follows. Section 2 reviews the relevant literature. Section 3 describes the data and empirical methodology. Section 4 presents and discusses the empirical results, including the robustness checks. Section 5 concludes the paper.

## **Literature Review**

### **Social Outcomes**

The literature consistently links educational attainment to improved social outcomes, particularly in health and literacy. Sasson (2016) found that individuals with higher levels of education tend to experience longer and less uncertain lifespans. Similarly, Rogoz et al. (2022) argue that education promotes healthier lifestyles, better decision-making, and improved access to healthcare, all of which contribute to higher life expectancy. Nguyen et al. (2017) also emphasize the importance of literacy, showing that education may improve mental health outcomes through increased literacy skills.

Research on labor market outcomes presents more mixed findings. Okoli et al. (2024) and Singh and Shastri (2020) found that higher educational attainment is associated with lower unemployment rates. However, Falzone (2017) argues that education alone cannot fully explain labor force participation trends, suggesting that demographic and structural factors also play important roles. Assaad et al. (2020) similarly demonstrate that labor market outcomes may vary significantly across regions and demographic groups, particularly among women in MENA countries.

### **Economic Outcomes**

A large body of literature has examined the relationship between educational attainment and economic performance. Many studies find that higher levels of education are positively associated with economic growth, innovation, and productivity. For example, Barro (2013), using panel regression analysis across multiple countries, found that the quality of education plays a significant role in promoting long-term economic growth. Similarly, Bambi (2024) and

Diakodimitriou et al. (2025) argue that education and human capital contribute substantially to technological innovation and research and development (R&D) expenditures. Sena and Higon (2012) further demonstrate that regions with more educated workforces benefit more from R&D spillovers and exhibit higher productivity levels.

The relationship between education and savings behavior, however, appears more mixed. Wang et al. (2022) found that higher educational attainment may reduce national savings by lowering precautionary savings associated with job insecurity. Likewise, Wadood (2024) reports a negative association between education and individual saving behavior. These findings suggest that while education is generally associated with stronger economic performance, its relationship with financial behavior may be more complex and context-dependent.

### **Governance and Political Institutions**

Existing literature also suggests a strong relationship between educational attainment and institutional quality. Garcia-Sanchez et al. (2013) found that education is positively associated with government effectiveness, while Li and Sun (2022) report a strong relationship between Education, critical thinking skills, and respect for legal principles. Similarly, Arif (2022) argues that lower corruption and stronger institutions help attract more educated individuals, highlighting the close connection between governance and educational outcomes.

More broadly, researchers suggest that educated populations may be more likely to support accountable institutions and political stability. However, much of the existing literature focuses on individual institutional indicators separately rather than examining multiple dimensions of governance simultaneously.

### **Environmental Outcomes**

Researchers have also explored the relationship between education and environmental sustainability. Striessnig et al. (2013) found that greater investment in education is associated with lower climate vulnerability, suggesting that education may improve environmental awareness and adaptive capacity. These findings indicate that education may play an important role not only in economic and social development but also in sustainability and environmental outcomes.

### **Research Gap and Contribution**

Although the existing literature provides substantial evidence linking education to individual economic, social, political, and environmental outcomes, most studies focus on a single indicator, country, or region. In contrast, this paper examines the relationship between educational attainment and a broad range of development indicators simultaneously using cross-country data. By analyzing economic, governance, social, and environmental indicators

within one empirical framework, this study provides a more comprehensive understanding of the multidimensional relationship between education and development outcomes.

**Table 1.** An extensive review of the literature on the relationship between educational attainment and social, environmental, political, and economic indicators.

| Authors         | Year | Key variables                                                               | Country                        | Methodology              | Key Findings                                                                                                                                          | Data period |
|-----------------|------|-----------------------------------------------------------------------------|--------------------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Barro           | 2013 | GDP per capita growth, trade openness, rule of law                          | Global                         | Panel regression         | Economic growth is driven more by the quality of education than by years of schooling.                                                                | 1960-1990   |
| Bambi           | 2024 | R&D, GDP growth, technological innovation                                   | Central Europe and South Korea | VAR                      | Education and human capital drive innovation, causing greater investment in research and education.                                                   | 1996-2022   |
| Okoli et al.    | 2024 | Unemployment, graduation rate, inflation.                                   | Nigeria                        | Cointegration            | Higher educational attainment and expenditures significantly reduced unemployment.                                                                    | 1990-2020   |
| Nguyen et al.   | 2017 | Demographic variables, literacy rate                                        | USA                            | GEE                      | Education improves mental health via literacy.                                                                                                        | 1992-2010   |
| Falzone         | 2017 | Labor force, population                                                     | USA                            | Descriptive analysis     | Education alone can't reverse the decline in the U.S. labor force participation rate.                                                                 | 1994-2014   |
| Assaad et al.   | 2020 | Working age population, marital status, age, region, household of children. | MENA                           | Multinomial Logit Models | The decline in public-sector employment among educated women is associated with an increase in unemployment.                                          | 2000-2017   |
| Singh & Shastri | 2020 | Unemployment, public expenditure on education,                              | India                          | ARDL                     | Educational attainment negatively affects the unemployment rate.                                                                                      | 1987–2017   |
| Sasson          | 2016 | Life expectancy                                                             | USA                            | KLD                      | Less-educated individuals face shorter, more uncertain lifespans, while college-educated individuals live longer with less variation in age at death. | 1990-2010   |

|                       |      |                                                                              |                      |                                 |                                                                                                                                                |           |
|-----------------------|------|------------------------------------------------------------------------------|----------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Rogoz et al.          | 2022 | Economic freedom, fiscal policies, living standards, healthcare quality      | New EU member states | Causality, Cointegration tests  | Higher education promotes healthier lifestyles, better decision-making, and improved access to healthcare, thereby increasing life expectancy. | 2000-2019 |
| Diakodimitriou et al. | 2025 | R&D expenditures, public expenditures                                        | European countries   | LASSO, 3SLS model               | Education spending drives economic growth by boosting R&D.                                                                                     | 1996-2019 |
| Sena & Higon          | 2012 | R&D expenditure, worker productivity                                         | UK                   | GMM                             | Plants in regions with a more educated workforce gain more from R&D spillovers and are more productive.                                        | 1997–2002 |
| Arif                  | 2022 | Corruption, Income gap, Democracy gap, Contiguity, Diplomatic representation | Global               | Panel data analysis             | Controlling corruption can attract educated workers and promote brain gain.                                                                    | 1990-2000 |
| Garcia-Sanchez et al. | 2013 | Government effectiveness                                                     | Global               | GMM                             | Education improves government effectiveness.                                                                                                   | 2002-2008 |
| Li & Sun              | 2022 | Rule of law, thinking skills                                                 | China                | Correlation, frequency analysis | There is a strong positive link between critical thinking and respect for legal principles.                                                    | 2019-2020 |
| Wadood                | 2024 | Savings, financial literacy, gender, age                                     | Islamabad            | Regression                      | Education is strongly negatively associated with saving behavior.                                                                              | 2024      |
| Wang et al.           | 2022 | GNI, unemployment, gender                                                    | China                | Panel data regression, GMM      | Higher education lowers national savings by reducing job insecurity and precautionary savings.                                                 | 1991-2019 |
| Striessnig et al.     | 2013 | Climate risk, polity score, population density, HDI                          | Global               | Panel regression                | Investing in education greatly reduces climate vulnerability.                                                                                  | 1980-2013 |

Data and Methods

Scatterplot Graphics

Figure 1. Scatterplots of Social Indicators versus Educational Attainment

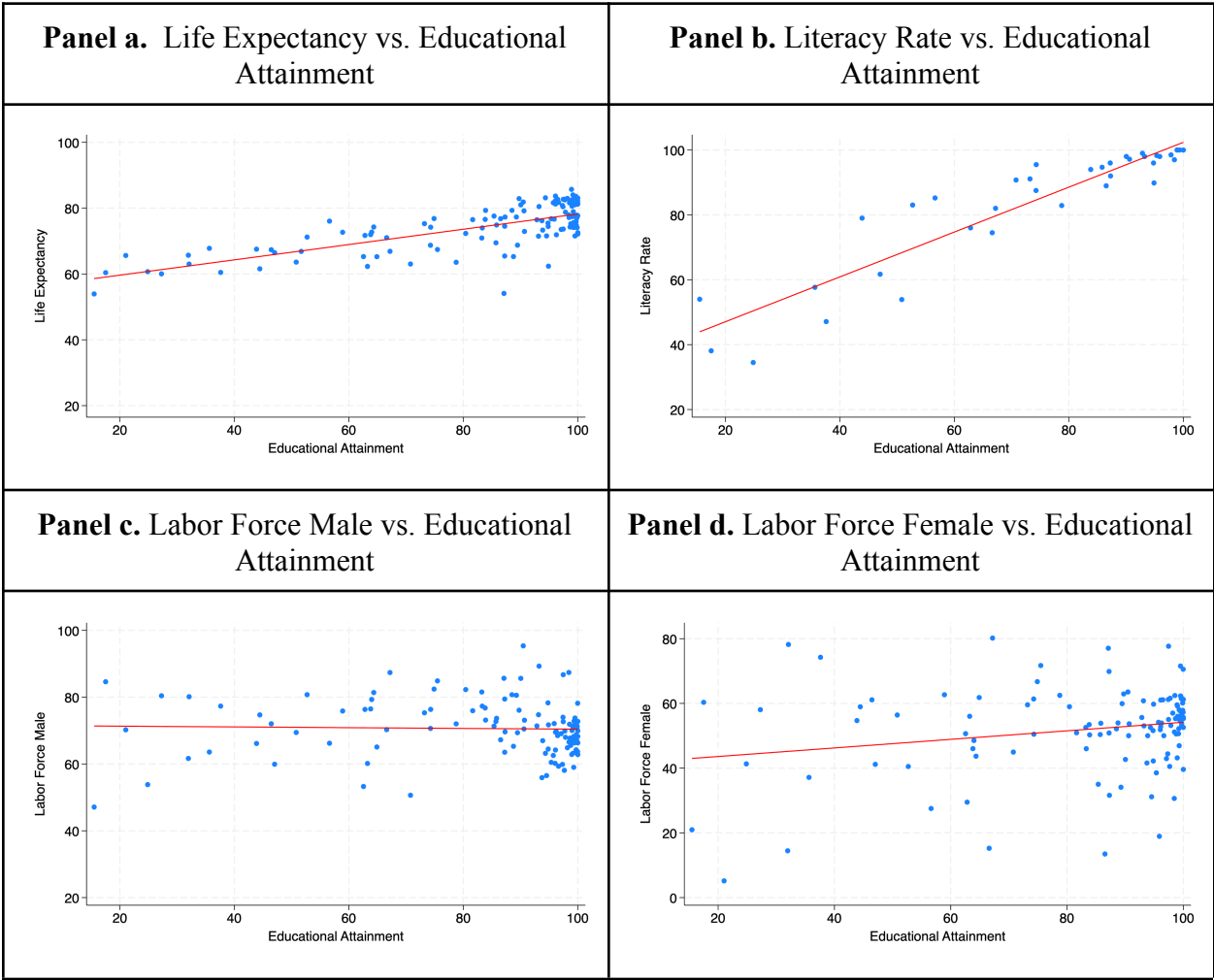


Figure 1 illustrates the relationship between educational attainment and four social and labor market indicators. Panel a displays the correlation between life expectancy and educational attainment. Countries with higher levels of education generally tend to exhibit longer life expectancies. This association may reflect broader relationships between education, healthcare access, health literacy, and living standards. Panel b demonstrates a strong positive relationship between educational attainment and literacy rate. Although this indicator is based on a relatively small sample, the observations are closely clustered around the fitted line, indicating a strong association between the two variables. Given the conceptual similarity between educational attainment and literacy, as well as the limited sample size, this finding should be regarded as exploratory and interpreted with appropriate caution. Panel c shows the association between

male labor force participation and educational attainment. The relationship appears relatively weak and nearly flat, indicating little clear relationship between the two variables across countries. The substantial dispersion of observations suggests that male labor force participation is likely more strongly influenced by labor market structure and economic conditions than by educational attainment alone. Panel d shows the relationship between female labor force participation and educational attainment. The upward trend suggests a moderate positive relationship, although the data remains fairly dispersed. This pattern may indicate that higher educational attainment is associated with greater female labor force participation, potentially through increased employment opportunities and human capital development. However, regional, cultural, and institutional differences may also substantially influence female labor force participation rates.

**Figure 2.** Scatterplots of Economic Indicators versus Educational Attainment

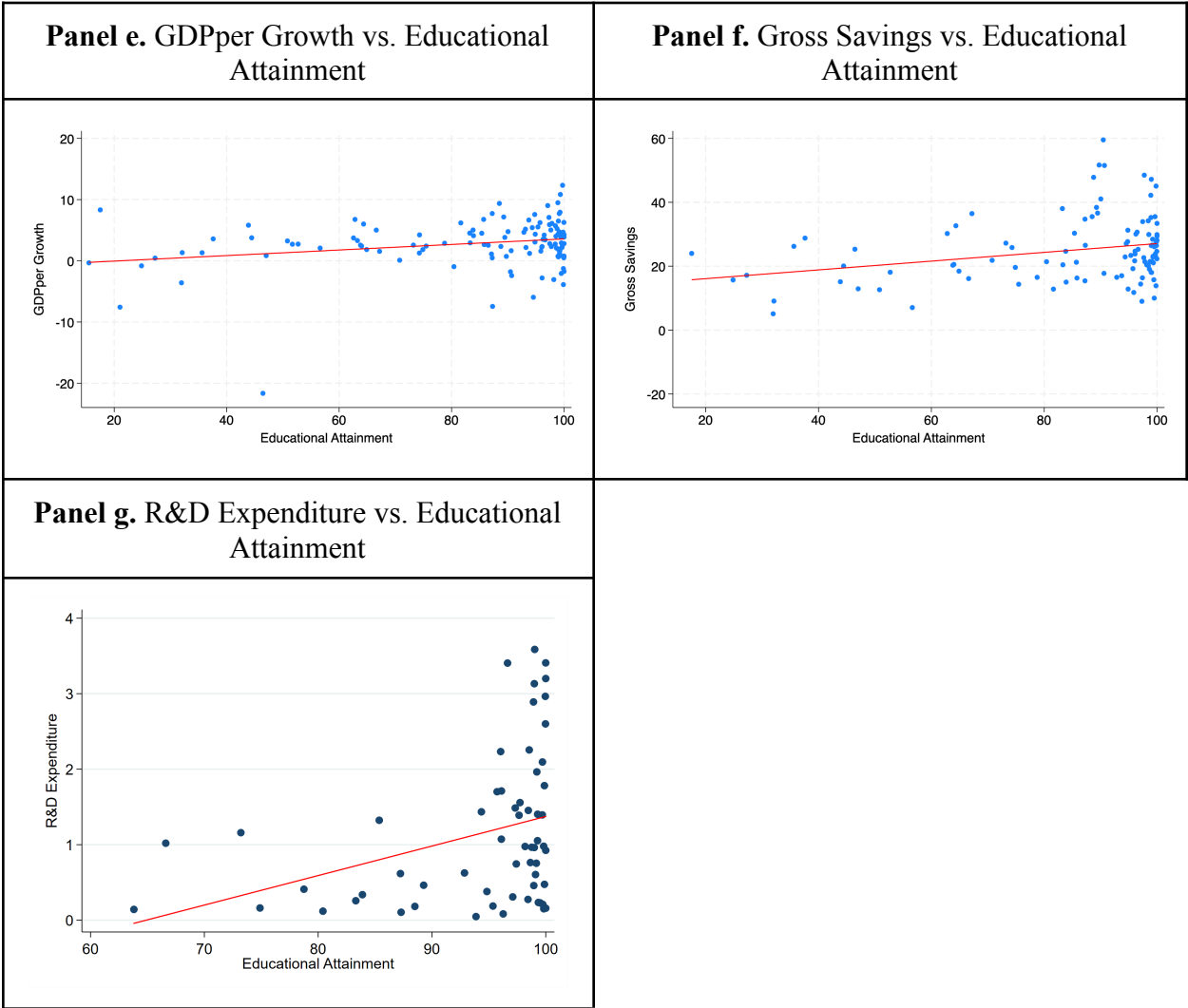
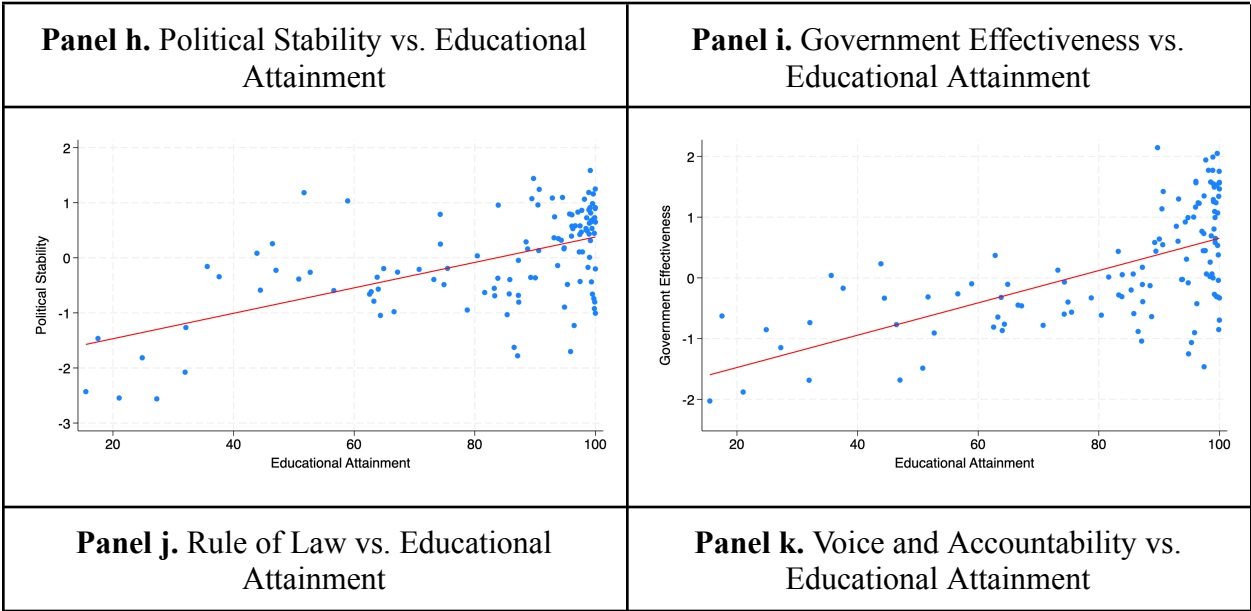


Figure 2 depicts the relationship between educational attainment and three key economic indicators. Panel e displays the association between GDP per capita growth and educational attainment. The upward trend suggests a modest positive relationship, although the data points remain widely dispersed. Though there is a slight positive correlation between GDP per capita growth and educational attainment, several countries with similar levels of education also exhibit substantially different growth rates, suggesting that other factors likely play important roles. Panel f presents the correlation between educational attainment and gross savings. A positive correlation is observed; however, the relationship appears weaker than those for government effectiveness and life expectancy. The scatterplot also contains several outliers, suggesting that savings behavior may depend on broader macroeconomic conditions, income levels, and financial systems in addition to educational attainment. Panel g shows a positive relationship between educational attainment and R&D expenditure. Although this indicator is based on a relatively small number of observations, the upward trend suggests that countries with higher educational attainment generally tend to invest more in research and development. However, because of the limited sample size, this finding should be interpreted as exploratory and viewed with appropriate caution.

**Figure 3.** Scatterplots of Governance and Political Indicators versus Educational Attainment



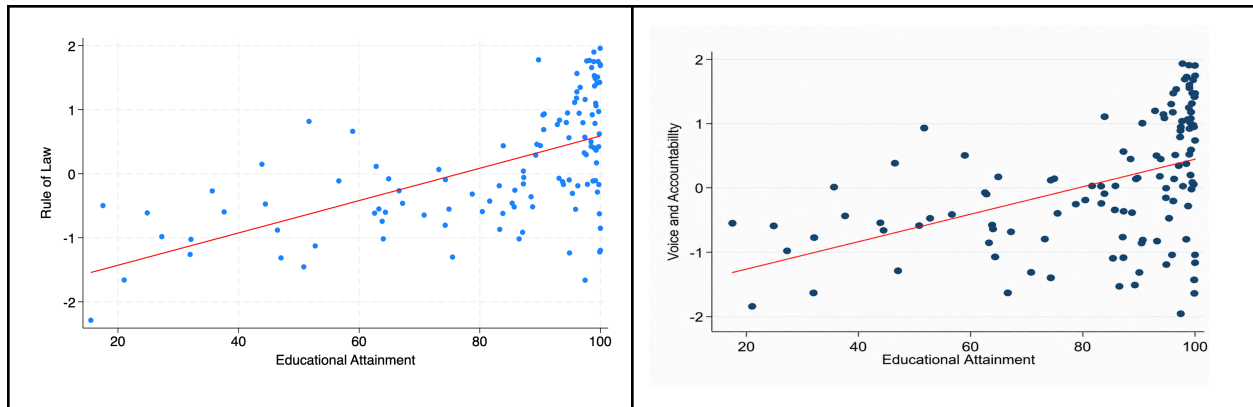
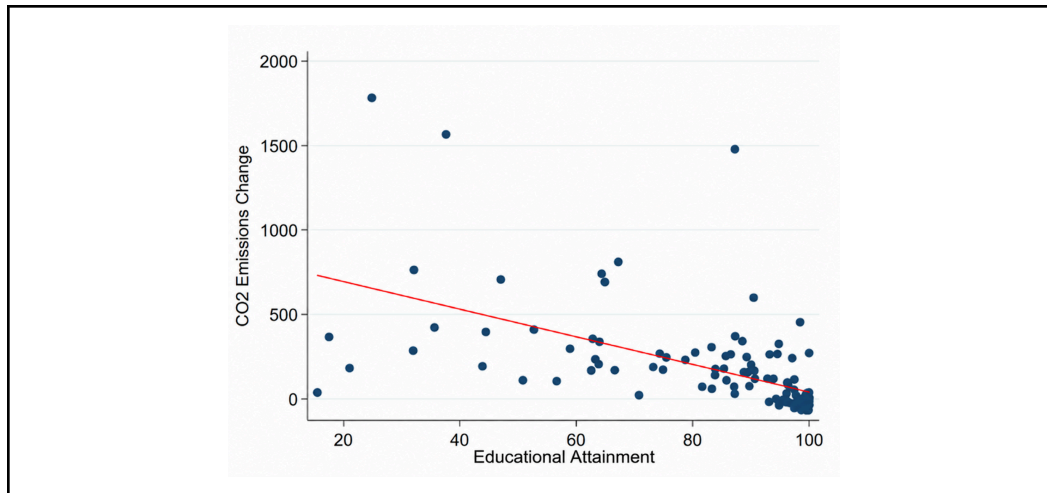


Figure 3 demonstrates the correlation between educational attainment and four political and governance indicators. Panel h illustrates the relationship between educational attainment and political stability. The scatterplot shows a moderate positive relationship, although there is still noticeable variation across observations. While countries with higher educational attainment generally appear more politically stable, the dispersion in the data suggests that political stability is also influenced by historical, institutional, and regional factors beyond education alone. Panel i examines the relationship between educational attainment and government effectiveness. Compared to the other indicators, the relationship appears relatively strong and more tightly clustered around the fitted line, suggesting that countries with higher educational attainment tend to exhibit more effective governance. Although the association is not necessarily causal, the pattern may indicate that more educated populations are associated with stronger institutional quality and public administration. Panel j presents the relationship between educational attainment and rule of law. A clear positive trend is observed, suggesting that countries with more educated populations tend to demonstrate stronger legal institutions and greater respect for legal norms. Nevertheless, some variation remains across countries, indicating that institutional quality may depend on other political and historical factors in addition to education. Panel k presents the relationship between educational attainment and voice and accountability. A positive trend is observed, indicating that countries with higher educational attainment generally tend to exhibit higher levels of voice and accountability. However, variation remains across countries, suggesting that this relationship may also reflect broader institutional, political, and historical factors. As with the other analyses in this study, this relationship should be interpreted as an association rather than evidence of causation.

**Figure 4.** Scatterplots of Environmental Indicators versus Educational Attainment

**Panel I.** CO2 Emissions Change vs Educational Attainment



Lastly, Figure 4 illustrates the relationship between educational attainment and change in carbon dioxide emissions, a key environmental indicator. Panel I shows a negative relationship between educational attainment and changes in CO2 emissions. Countries with higher educational attainment generally appear to experience lower changes in CO2 emissions. Although the relationship is not especially strong and includes several outliers, the pattern may suggest that more educated societies are associated with greater environmental awareness, stronger environmental policies, or more sustainable technologies.

## Data

The analysis uses cross-sectional data from the World Bank's World Development Indicators (WDI). For each variable, the most recently available observation from 2022 was selected, with each country contributing a single observation to the analysis. The WDI uses the terms *country* and *economy* interchangeably, defining a country as any territory for which authorities report separate social or economic statistics, regardless of political independence. Consequently, the number of observations varies across variables because data availability differs by country.

The variables include educational attainment as a percentage of population ages 25 and above (Edu\_attainment), life expectancy (Life\_exp), literacy rate as a percentage of people ages 15 and above (Literacy), labor force participation rate as a percentage of male population ages 15+ (Lforce\_male), labor force participation rate as a percentage of female population ages 15+ (Lforce\_female), GDP per capita as a percentage of annual growth (GDPper\_growth), gross savings as a percentage of GNI (Gross\_savings), research and development expenditure as a percentage of GDP (R&D), political stability (Pol\_stability), government effectiveness (Gov\_effect), rule of law (Rule of Law), voice and accountability (Voice and Accountability), and carbon dioxide emissions change (CO2 emissions change).

The study uses the most recent observation for each variable because the World Bank does not report all indicators for all countries in the same year. Therefore, the number of observations may vary slightly across indicators due to data availability. The descriptive statistics show the total number of observations available for each individual variable in the dataset. However, the regression analyses are estimated only for those countries for which data on both educational attainment and the corresponding independent variable are available simultaneously. This means that the sample size varies between the regression models due to missing values.

## Descriptive Statistics

**Table 1.** Descriptive Statistics

| <b>Variable</b> | <b>Obs</b> | <b>Mean</b> | <b>Std. Dev.</b> | <b>Min</b> | <b>Max</b> |
|-----------------|------------|-------------|------------------|------------|------------|
| Edu_attainment  | 121        | 83.091      | 21.809           | 15.5       | 100        |
| Life_exp        | 265        | 72.796      | 7.648            | 18.818     | 85.746     |
| Literacy*       | 95         | 81.356      | 16.122           | 27.28      | 100        |
| Lforce_male     | 234        | 70.453      | 8.791            | 24.098     | 95.365     |
| Lforce_female   | 234        | 50.314      | 14.75            | 4.977      | 82.575     |
| GDPper_growth   | 256        | 3.31        | 6.042            | -22.746    | 62.111     |
| Gross_savings   | 198        | 24.675      | 10.815           | -21.882    | 59.525     |
| R&D*            | 96         | 1.392       | 1.222            | .035       | 6.019      |
| Pol_stability   | 205        | -.035       | .999             | -2.777     | 1.661      |
| Gov_effect      | 205        | -.039       | .995             | -2.391     | 2.144      |
| Rule of Law     | 205        | -.023       | 1.001            | -2.287     | 1.958      |

|                          |     |         |          |        |           |
|--------------------------|-----|---------|----------|--------|-----------|
| Voice and Accountability | 203 | -0.6994 | 1.007    | -2.122 | 1.938     |
| CO2 emissions change     | 246 | 667.546 | 4308.181 | -82.39 | 52245.455 |

\* Exploratory analysis due to limited sample size.

Table 1 provides descriptive statistics for educational attainment and various social, economic, environmental, and political indicators. Edu\_attainment has 121 observations with a mean of 83.091 and a standard deviation of 21.809, ranging from a minimum of 15.5 to a maximum of 100. Life\_exp has 265 observations with a mean of 72.796 and a standard deviation of 7.648, ranging from a minimum of 18.818 to a maximum of 85.746. Literacy has 95 observations with a mean of 81.356 and a standard deviation of 16.122, ranging from a minimum of 27.28 to a maximum of 100. Lforce\_male has 234 observations with a mean of 70.453 and a standard deviation of 8.791, ranging from a minimum of 24.098 to a maximum of 95.365. Lforce\_female has 234 observations with a mean of 50.314 and a standard deviation of 14.75, ranging from a minimum of 4.977 to a maximum of 82.575. GDPper\_growth has 256 observations with a mean of 3.31 and a standard deviation of 6.042, ranging from a minimum of -22.746 to a maximum of 62.111. Gross\_savings has 198 observations with a mean of 24.675 and a standard deviation of 10.815, ranging from a minimum of -21.882 to a maximum of 59.525. R&D has 96 observations with a mean of 1.392 and a standard deviation of 1.222, ranging from a minimum of 0.035 to a maximum of 6.019. Pol\_stability has 205 observations with a mean of -0.035 and a standard deviation of 0.999, ranging from a minimum of -2.777 to a maximum of 1.661. Gov effect has 205 observations with a mean of -.039 and a standard deviation of .995, ranging from a minimum of -2.391 to a maximum of 2.144. Rule of Law has 205 observations with a mean of -0.023 and a standard deviation of 1.001, ranging from a minimum of -2.287 to a maximum of 1.958. Voice and Accountability has 203 observations with a mean of -0.6994 and a standard deviation of 1.007, ranging from a minimum of -2.122 to a maximum of 1.938. CO2 emissions change has 246 observations with a mean of 667.546 and a standard deviation of 4308.181, ranging from a minimum of -82.39 to a maximum of 52245.455.

## Model

$$Y_i = a_0 + b_1 X_i + e_i$$

Where  $Y_i$  is the dependent variable for observation  $i$ , referring to life expectancy (Life\_exp), literacy rate (Literacy), male labor force participation rate (Lforce\_male), female labor force participation rate (Lforce\_female), GDP per capita growth (GDPper\_growth), gross savings (Gross\_savings), research and development expenditure (R&D), political stability (Pol\_stability),

government effectiveness(Gov\_effect), rule of law (Rule of Law), voice and accountability (Voice and Accountability ), and CO2 emissions change (CO2 emissions change).

$a_0$  is the constant term, representing the expected value of the dependent variable when the independent variable equals zero.  $b_1$  is the coefficient for the independent variable, Educational Attainment (Edu\_attainment). The coefficient indicates how much the dependent variable changes when educational attainment changes by one unit.  $e_i$  is the error term, representing the difference between the observed and the model's predicted values.

We estimated 12 different models to examine the relationship between educational attainment and various social, economic, environmental, and political indicators. The estimated models are presented below. Unless otherwise noted, the reported regressions are based on cross-country samples exceeding 100 observations. Results based on substantially smaller samples, particularly the literacy and R&D models, are presented as exploratory evidence and should be interpreted with appropriate caution.

$Life\_exp_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 1)

$Literacy_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 2)

$Lforce\_male_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 3)

$Lforce\_female_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 4)

$GDPper\_growth_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 5)

$Gross\_savings_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 6)

$R\&D_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 7)

$Pol\_stability_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 8)

$Gov\_effect_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 9)

$RuleofLaw_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 10)

$Voice\ and\ Accountability_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 11)

$CO2\ emissions\ change_i = a_0 + b_1 Edu\_attainment_i + e_i$  (model 12)

While the regression analysis provides useful insight into the relationship between educational attainment and various development indicators, several limitations should be acknowledged. First, the analysis is based on cross-sectional data and bivariate regressions, which do not permit causal inference. The estimated relationships should therefore be understood as associations rather than direct effects. In addition, omitted variable bias may exist because many other factors, such as income levels, institutional quality, regional characteristics, and healthcare systems, may influence both educational attainment and the outcome variables. Reverse causality may also be present, as wealthier or more institutionally developed countries may have a greater capacity to invest in education. As a result, the findings should be interpreted with caution and treated as preliminary evidence of broader relationships between education and development outcomes.

## Analysis and Discussion

**Table 2a.** Regression Results for Social Indicators

|                | (model 1)          | (model 2)          | (model 3)          | (model 4)          |
|----------------|--------------------|--------------------|--------------------|--------------------|
| VARIABLES      | Life exp           | Literacy           | Lforce male        | Lforce female      |
| Edu attainment | 0.23***<br>(0.02)  | 0.69***<br>(0.06)  | -0.01<br>(0.05)    | 0.12<br>(0.08)     |
| Constant       | 55.13***<br>(1.35) | 33.22***<br>(5.50) | 71.34***<br>(4.27) | 41.73***<br>(7.48) |
| Observations   | 117                | 36                 | 117                | 117                |
| R-squared      | 0.52               | 0.95               | 0.00               | 0.04               |

Robust standard errors in parentheses. The number of observations differs across regressions because some indicators contain missing data for certain countries

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 2a presents the regression results for four social outcome variables: life expectancy (Life\_exp), literacy rate (Literacy), male labor force participation (Lforce\_male), and female labor force participation (Lforce\_female). Each model examines the relationship between educational attainment and one social indicator. Each column corresponds to a distinct model, with the explanatory variable being Educational Attainment (Edu\_attainment). If the results are statistically significant at the 1% level, we indicate this with (\*\*\*), at the 5% level with (\*\*), and at the 10% level with (\*).

The results show that educational attainment is positively and statistically significantly associated with both life expectancy and literacy. Countries with higher educational attainment tend to have longer life expectancy and higher literacy rates. However, the literacy regression is based on only 36 observations and measures a concept closely related to educational attainment. Accordingly, these findings should be interpreted as exploratory and should be viewed with greater caution than the primary results. By contrast, the relationships between educational attainment and both male and female labor force participation are not statistically significant, suggesting that higher educational attainment alone does not explain cross-country differences in labor force participation.

**Table 2b.** Regression Results for Economic Indicators

|           | ( model 5)    | (model 6)     | (model 7) |
|-----------|---------------|---------------|-----------|
| VARIABLES | GDPper_growth | Gross_savings | R&D       |

|                |        |          |         |
|----------------|--------|----------|---------|
|                |        |          |         |
| Edu attainment | 0.05** | 0.14***  | 0.04*** |
|                | (0.02) | (0.04)   | (0.01)  |
|                |        |          |         |
| Constant       | -0.95  | 13.35*** | -2.57** |
|                | (2.01) | (3.13)   | (1.02)  |
|                |        |          |         |
| Observations   | 119    | 106      | 59      |
| R-squared      | 0.06   | 0.08     | 0.11    |

Robust standard errors in parentheses. The number of observations differs across regressions because some indicators contain missing data for certain countries

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 2b reports the regression results for three economic outcome variables: GDP per capita growth (GDPper\_growth), gross savings as a percentage of GNI (Gross Savings), and research and development expenditure (R&D). Educational attainment is positively and statistically significantly associated with GDP per capita growth, gross savings, and R&D expenditure. These findings indicate that educational attainment is associated with multiple dimensions of economic development, including stronger economic growth, higher savings, and greater investment in innovation. However, the R&D results should be interpreted as exploratory because the regression is based on a relatively limited sample, making the estimates potentially less stable than those reported for the primary analyses.

**Table 2c.** Regression Results for Governance and Political Indicators

|                | (model 8)     | (model 9)  | (model 10)  | (model 11)               |
|----------------|---------------|------------|-------------|--------------------------|
| VARIABLES      | Pol_stability | Gov_effect | Rule of Law | Voice and Accountability |
|                |               |            |             |                          |
| Edu attainment | 0.02***       | 0.03***    | 0.03***     | 9.64***                  |
|                | (0.00)        | (0.00)     | (0.00)      | (1.79)                   |
|                |               |            |             |                          |
| Constant       | -2.01***      | -2.05***   | -2.00***    | 82.62***                 |
|                | (0.28)        | (0.24)     | (0.24)      | (1.84)                   |
|                |               |            |             |                          |
| Observations   | 118           | 118        | 116         | 119                      |
| R-squared      | 0.35          | 0.39       | 0.34        | 0.21                     |

Robust standard errors in parentheses. The number of observations differs across regressions because some indicators contain missing data for certain countries.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 2c presents the regression results for governance and political outcomes, including political stability (Pol\_stability), government effectiveness (Gov\_effect), rule of law (Rule of Law), and voice and accountability (Voice and Accountability). Educational attainment is positively and statistically significantly associated with all four governance indicators. Countries with higher educational attainment tend to exhibit greater political stability, more effective governance, stronger adherence to the rule of law, and higher levels of voice and accountability. These findings are consistent with the idea that more educated populations are associated with stronger institutions and greater civic participation. However, because the analysis is cross-sectional, these relationships should be interpreted as associations rather than evidence of causal effects.

**Table 2d.** Regression Results for Environmental Indicators

|                | (model 12)           |
|----------------|----------------------|
| VARIABLES      | CO2 emissions change |
|                |                      |
| Edu attainment | -8.161***            |
|                | (2.14)               |
|                |                      |
| Constant       | 857.25***            |
|                | (196.25)             |
|                |                      |
| Observations   | 112                  |
| R-squared      | 0.31                 |

Robust standard errors in parentheses. The number of observations differs across regressions because some indicators contain missing data for certain countries

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 2d presents the regression results for carbon dioxide emissions change (CO2 emissions change). Educational attainment is negatively and statistically significantly associated with changes in CO2 emissions, suggesting that countries with higher educational attainment tend to exhibit smaller increases or larger reductions in carbon dioxide emissions. This relationship may reflect greater environmental awareness, stronger environmental policies, or the adoption of cleaner technologies in more highly educated societies. However, the CO2 emissions variable contains several extreme observations, so this result should be interpreted with appropriate caution.

### Robustness Check

To assess the stability of our main findings, we conducted robustness checks by introducing a

limited set of additional control variables and reestimating all regression models. Specifically, variables such as inflation and Log GDP per capita level were included to account for some observable factors that may be associated with both educational attainment and the selected social, economic, political, and environmental indicators. Regional dummy variables for Asia, Africa, the Americas, and Oceania were also included in the robustness specifications. After including these controls, all models were reestimated and compared with the baseline specification. Overall, the estimated associations remained broadly similar to the baseline results after the inclusion of the additional controls. However, these robustness checks do not eliminate the possibility of omitted-variable bias or reverse causality, as many of the outcome variables may be jointly determined with educational attainment or influenced by unobserved factors. Accordingly, the findings should be interpreted as evidence of association rather than causal relationships.

**Table 3a. Robustness Check**

| VARIABLES         | (model 1)<br>Life_exp | (model 2)<br>Literacy | (model 3)<br>Lforce_male | (model 4)<br>Lforce_female |
|-------------------|-----------------------|-----------------------|--------------------------|----------------------------|
| Edu_attainment    | 0.118***<br>(0.025)   | 0.674***<br>(0.097)   | -0.008<br>(0.053)        | 0.212**<br>(0.104)         |
| Inflation         | -0.020**<br>(0.010)   | -0.020<br>(0.019)     | 0.004<br>(0.017)         | -0.072<br>(0.063)          |
| Log GDP per level | -0.060<br>(0.143)     | -0.152<br>(0.298)     | 0.270<br>(0.269)         | 0.698<br>(0.676)           |
| Asia              | -1.098<br>(1.062)     | 2.411<br>(1.865)      | 7.809***<br>(2.154)      | -6.604*<br>(3.407)         |
| Africa            | -9.800***<br>(1.727)  | -2.156<br>(5.471)     | 2.246<br>(2.924)         | 10.794**<br>(5.222)        |
| the Americas      | -1.851*<br>(0.982)    | 6.828***<br>(2.460)   | 8.682***<br>(1.711)      | 3.306<br>(2.759)           |
| Oceania           | -4.775<br>(2.958)     |                       | -6.194<br>(4.690)        | -2.392<br>(8.230)          |
| Constant          | 68.110***             | 35.066***             | 64.506***                | 26.032**                   |

|                                       |         |          |         |          |
|---------------------------------------|---------|----------|---------|----------|
|                                       | (3.056) | (10.598) | (5.450) | (12.906) |
| Observations                          | 119     | 35       | 116     | 116      |
| R-squared                             | 0.692   | 0.881    | 0.283   | 0.215    |
| Robust standard errors in parentheses |         |          |         |          |
| *** p<0.01, ** p<0.05, * p<0.1        |         |          |         |          |

**Table 3b.** Robustness Check

| VARIABLES                             | (model 5)<br>GDPper Growth | (model 6)<br>Gross_Savings | (model 7)<br>R&D  | (model 8)<br>Pol_stability |
|---------------------------------------|----------------------------|----------------------------|-------------------|----------------------------|
| Edu_Attainment                        | 0.069*<br>(0.040)          | 0.153*<br>(0.078)          | 0.044<br>(0.026)  | 0.021***<br>(0.005)        |
| Inflation                             | -0.002<br>(0.009)          | -0.023<br>(0.031)          | -0.019<br>(0.018) | -0.006***<br>(0.002)       |
| Log GDP per level                     | 0.294<br>(0.197)           | 0.433<br>(0.389)           | 0.055<br>(0.087)  | 0.004<br>(0.033)           |
| Asia                                  | -0.474<br>(0.734)          |                            | 0.565<br>(0.886)  |                            |
| Africa                                | -2.021<br>(1.724)          | 7.844**<br>(3.305)         | -0.438<br>(0.447) | -0.237<br>(0.231)          |
| the Americas                          | 1.795<br>(1.241)           | 1.319<br>(5.169)           | -0.282<br>(0.633) | -0.111<br>(0.313)          |
| Oceania                               | 1.374*<br>(0.807)          | -3.159<br>(2.504)          |                   | 0.028<br>(0.176)           |
| Constant                              | -7.860<br>(5.199)          | 5.888<br>(7.412)           | -3.234<br>(2.479) | -1.666***<br>(0.584)       |
| Observations                          | 87                         | 106                        | 58                | 118                        |
| R-squared                             | 0.211                      | 0.223                      | 0.195             | 0.380                      |
| Robust standard errors in parentheses |                            |                            |                   |                            |
| *** p<0.01, ** p<0.05, * p<0.1        |                            |                            |                   |                            |

**Table 3c. Robustness Check**

| VARIABLES         | (model 9)<br>Gov_effect | (model 10)<br>RuleofLaw | (model 11)<br>Voice and<br>Accountability | (model 12)<br>CO2 emissions<br>change |
|-------------------|-------------------------|-------------------------|-------------------------------------------|---------------------------------------|
| Edu_attainment    | 0.023***<br>(0.004)     | 0.021***<br>(0.004)     | 0.017***<br>(0.004)                       | -8.522***<br>(2.961)                  |
| Inflation         | -0.007***<br>(0.002)    | -0.007***<br>(0.002)    | -0.008***<br>(0.003)                      | -0.799<br>(0.482)                     |
| Log GDP per level | 0.008<br>(0.030)        | -0.009<br>(0.029)       | 0.008<br>(0.034)                          | 23.309*<br>(12.793)                   |
| Asia              |                         | -0.210<br>(0.203)       | -1.033***<br>(0.216)                      | 159.128**<br>(72.045)                 |
| Africa            | 7.844**<br>(3.305)      | -0.271<br>(0.246)       | -0.558**<br>(0.271)                       | 187.043**<br>(93.532)                 |
| the Americas      | 1.319<br>(5.169)        | -0.486**<br>(0.221)     | -0.252<br>(0.207)                         | 29.295<br>(60.310)                    |
| Oceania           | -3.159<br>(2.504)       | 0.377<br>(0.333)        | 0.460*<br>(0.267)                         | 99.726<br>(95.101)                    |
| Constant          | 5.888<br>(7.412)        | -1.226***<br>(0.428)    | -0.896<br>(0.549)                         | 563.716*<br>(286.371)                 |
| Observations      | 106                     | 118                     | 111                                       | 111                                   |
| R-squared         | 0.223                   | 0.415                   | 0.472                                     | 0.476                                 |

Robust standard errors in parentheses. CO<sub>2</sub> emissions were winsorized at the 1st and 99th percentiles to reduce the influence of extreme observations.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## Conclusion

This paper examined the relationship between educational attainment and a broad range of social, economic, political, and environmental indicators using cross-sectional data from countries worldwide. Educational attainment was measured as the percentage of the population aged 25 years and above who have completed at least primary education.

The results indicate that higher educational attainment is positively and statistically significantly associated with GDP per capita growth, gross savings, research and development expenditures, political stability, government effectiveness, rule of law, life expectancy, voice and accountability, and literacy rate. Educational attainment is also negatively associated with changes in CO2 emissions. Conversely, no statistically significant relationship was found between educational attainment and male labor force participation rate or female labor force participation rate. The literacy and R&D regressions are based on relatively small samples and should therefore be regarded as exploratory. Future research using larger and more complete datasets could provide more robust evidence for these relationships.

Overall, the findings suggest that educational attainment is closely associated with multiple dimensions of development and institutional quality. However, because the analysis is based on cross-sectional regressions, the results should be interpreted as associations rather than causal relationships. Unobserved factors, including differences in institutional capacity, healthcare systems, regional characteristics, and economic development, may also influence both educational attainment and the outcome variables. Although the robustness checks indicate that the estimated associations remain broadly similar after introducing a limited set of additional control variables, they do not eliminate the possibility of omitted-variable bias or reverse causality.

Future research could build on these findings by employing panel data analysis, generalized method of moments (GMM), vector autoregression (VAR), instrumental variable approaches, or other longitudinal methods that are better suited to identifying causal relationships. Further research incorporating additional measures of economic development, institutional quality, healthcare, and technology would provide a more comprehensive understanding of the relationship between educational attainment and broader development outcomes.

## **Appendix**

### **Appendix 1. Data Definition**

| Indicator Symbol        | Variable                                                                                         | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Source         | Year |
|-------------------------|--------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------|
| Edu_attainment          | Educational attainment, at least completed primary, population 25+ years, total (%) (cumulative) | The percentage of the population ages 25 and over who have attained or completed primary education.                                                                                                                                                                                                                                                                                                                                                                              | WDI World Bank | 2022 |
| Log GDPper_capita_level | GDP per capita (constant LCU)                                                                    | Gross domestic product is the total income earned through the production of goods and services in an economic territory during an accounting period. It can be measured in three different ways: using either the expenditure approach, the income approach, or the production approach. The core indicator has been divided by the general population to achieve a per capita estimate. This indicator is expressed in constant prices, meaning the series has been adjusted to | WDI World Bank | 2022 |

|               |                                             |                                                                                                                                                                                                                                                   |                |      |
|---------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------|
|               |                                             | account for price changes over time. The reference year for this adjustment varies by country. This series is expressed in local currency units.                                                                                                  |                |      |
| GDPper_growth | GDP per capita (annual % growth)            | This indicator represents the percentage change in GDP per capita from the previous year, expressed in constant prices (base year: 2015) in United States dollars                                                                                 | WDI World Bank | 2022 |
| Inflation     | Inflation, GDP deflator (annual % growth) ) | Inflation as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency. | WDI World Bank | 2022 |
| Pol_stability | Political Stability and Absence of          | Political Stability and Absence of                                                                                                                                                                                                                | WDI World Bank | 2022 |

|                        |                                                                                             |                                                                                                                                                                                                                       |                |      |
|------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------|
|                        | Violence/Terrorism: Estimate                                                                | Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism, ranging from -2.5 to 2.5."                                             |                |      |
| Literacy (exploratory) | Literacy rate, adult total (% of people ages 15 and above)                                  | Adult literacy rate is the percentage of people ages 15 and above who can both read and write with understanding a short, simple statement about their everyday life.                                                 | WDI World Bank | 2022 |
| Lforce_male            | Labor force participation rate, male (% of male population ages 15+) (modeled ILO estimate) | The labor force participation rate is the proportion of the population ages 15 and older that is economically active: all people who supply labor for the production of goods and services during a specified period. | WDI World Bank | 2022 |
| Lforce_female          | Labor force participation rate, female (% of female population ages                         | The labor force participation rate is the labor force as a percent of the population                                                                                                                                  | WDI World Bank | 2022 |

|                   |                                                 |                                                                                                                                                                                              |                |      |
|-------------------|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------|
|                   | 15+) (modeled ILO estimate)                     | ages 15 and older. The labor force is the sum of all persons of working age who are employed and those who are unemployed.                                                                   |                |      |
|                   |                                                 |                                                                                                                                                                                              |                |      |
| Life_exp          | Life expectancy at birth, total (years)         | Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.   | WDI World Bank | 2022 |
| R&D (exploratory) | Research and development expenditure (% of GDP) | Gross domestic expenditures on research and development, expressed as a percent of GDP.                                                                                                      | WDI World Bank | 2022 |
|                   |                                                 |                                                                                                                                                                                              |                |      |
| Gov_effect        | Government Effectiveness: Estimate              | Government Effectiveness captures perceptions and views of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the | WDI World Bank | 2022 |

|                          |                                                                       |                                                                                                                                                                                                                                                                                                |                |      |
|--------------------------|-----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------|
|                          |                                                                       | quality of policy formulation and implementation, and the credibility of the government's commitment to such policies, ranging from -2.5 to 2.5.                                                                                                                                               |                |      |
| Rule of Law              | Rule of Law: Estimate                                                 | Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, particularly the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence, ranging from -2.5 to 2.5. | WDI World Bank | 2022 |
| Voice and Accountability | Voice and Accountability - Governance estimate (approx. -2.5 to +2.5) | Voice and Accountability (VA) captures perceptions of the extent to which citizens can participate in selecting their government including electoral integrity, and of                                                                                                                         | WDI World Bank | 2022 |

|                      |                                                                              |                                                                                                                                                                                                                                                                                           |                |      |
|----------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------|
|                      |                                                                              | accountability mechanisms for citizens—reflected in the ability to access information, governmental oversight bodies, and a robust traditional/digital media landscape.                                                                                                                   |                |      |
| Gross_Savings        | Gross savings (% of GNI)                                                     | Gross savings are calculated as gross national income less total consumption, plus net transfers. This indicator is expressed as a percentage of Gross National Income (GNI), which is the total income earned by all residents within an economic territory during an accounting period. | WDI World Bank | 2022 |
| CO2 emissions change | Carbon dioxide (CO2) emissions (total) excluding LULUCF (% change from 1990) | Change of emissions (as %) of the current year with respect to emissions in the baseline year 1990 emissions of carbon dioxide (CO2), one of the six Kyoto greenhouse                                                                                                                     | WDI World Bank | 2022 |

|  |  |                                                                                                                  |  |  |
|--|--|------------------------------------------------------------------------------------------------------------------|--|--|
|  |  | gases (GHG),<br>from the<br>agriculture,<br>energy, waste,<br>and industrial<br>sectors,<br>excluding<br>LULUCF. |  |  |
|--|--|------------------------------------------------------------------------------------------------------------------|--|--|

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## **Response to Referee 2**

I sincerely thank the reviewer for the careful evaluation of our revised paper and for the positive comments. I greatly appreciate that they find the revised manuscript much clearer, more consistent, and more appropriately interpreting the empirical findings. I have carefully considered each of the remaining suggestions and have revised the manuscript accordingly. Our detailed responses are provided below.

**Comment 1:** “The paper describes the analysis as a cross-country study using “up to 205 countries,” but the descriptive statistics report more than 205 observations for some variables, such as GDP per capita growth, life expectancy, and CO<sub>2</sub> emissions change. This creates confusion about whether the dataset is truly cross-sectional, country-year, or includes repeated observations. The author should clarify the unit of observation, the year or time period used for each variable, and why the number of observations differs so much across indicators.”

**Response:** Thank you for pointing this out. This discrepancy was due to a typo in the manuscript. The study uses data for up to 265 countries, not 205. This has been corrected throughout the manuscript. The reported numbers of observations are therefore consistent with the underlying dataset. The WDI reports data for countries, territories, and other reporting entities, which the database collectively refers to as countries. Differences in the number of observations across variables reflect data availability rather than repeated observations for the same country. I have also expanded the dataset description to clarify that the analysis uses cross-sectional data from the World Bank's World Development Indicators (WDI), with the most recent available observation for each variable from 2022.

**Comment 2:** “Second, the robustness-check section should be toned down. Adding a few controls is useful, but it does not establish that the observed relationships are “not driven by other variables.” The current wording still risks overstating what the analysis can show. A better formulation would be that the associations remain broadly similar after including a limited set of controls, while omitted-variable bias and reverse causality remain important limitations.”

**Response:** I agree with this observation. The manuscript has been revised to moderate the interpretation of the robustness analyses. Rather than stating that the additional controls demonstrate the relationships are not driven by other variables, I now explain that the estimated associations remain broadly similar after including a limited number of controls, while emphasizing that omitted-variable bias and reverse causality remain important limitations of the analysis.

**Comment 3:** “Third, the manuscript should treat small-sample and conceptually close variables with greater caution. The literacy regression, for example, has a much smaller sample than most other models and is also very closely related conceptually to educational attainment. It is therefore not surprising that the relationship is strong, but it should not be presented as equally informative as the governance or macroeconomic regressions. Similarly, R&D is based on a

relatively limited sample and likely reflects country income, institutional capacity, and industrial structure as much as education.”

**Response:** Thank you for this suggestion. The discussion has been revised to explicitly acknowledge that the literacy and R&D analyses are based on substantially smaller samples and therefore should be interpreted as exploratory rather than definitive findings. Additional discussion has also been added explaining that literacy is conceptually closely related to educational attainment and that R&D investment is influenced by many broader structural factors beyond education.

**Comment 4:** “Fourth, the negative association between educational attainment and voice and accountability remains underdeveloped. The author correctly notes that this result is unexpected, but the discussion should either offer a more convincing interpretation or present it simply as an anomalous correlation that should not be overread.”

**Response:** Thank you for this valuable comment. Upon reexamining our dataset, I discovered that the Voice and Accountability variable that I used was incorrect. I therefore replaced it with the correct WDI voice and accountability measure and reestimated the regression model. After correcting for the variable, the estimated coefficient became positive and statistically significant, consistent with the existing literature.

**Comment 5:** “Finally, the tables and figures need a careful final edit. Some table numbering, labels, and formatting remain messy, especially in the robustness section. Before publication, the author should make sure that every table is cleanly numbered, every variable name is defined once and used consistently, and every regression table can be understood without relying on the surrounding text.”

**Response:** Thank you for this suggestion. I have carefully reviewed all tables and figures throughout the manuscript and made the necessary revisions to improve consistency. Specifically, I corrected the table numbering, labels, captions, and the formatting throughout the manuscript.

Dear Managing Editor,

Thank you very much for your detailed review and for recognizing the substantial improvements made in the revised manuscript. I greatly appreciate the constructive recommendations and have carefully addressed each point below.

**Comment 1:** “I recommend including a more direct control for development, such as GDP per capita level, preferably in logarithmic form. Regional indicators or income-group classifications would also be helpful...The discussion of the robustness checks should also be moderated.”

**Response:** Thank you for this suggestion. I revised the robustness analysis by replacing the previous specification with a new set of robustness regressions that include the logarithm of GDP per capita as a direct measure of economic development, together with regional dummy variables. These additional controls help account for broad differences in development and regional characteristics across countries. The revised models produced associations that remained broadly similar to the baseline results. I have also moderated the discussion to emphasize that these robustness checks do not eliminate omitted-variable bias or reverse causality and that the findings should be interpreted as statistical associations rather than causal relationships.

**Comment 2:** “The manuscript should more clearly explain the construction of the cross-country sample. The paper describes the analysis as using cross-sectional data from up to 205 countries, but several variables appear to include more than 205 observations. For example, the table of descriptive statistics reports more than 250 observations for some indicators.”

**Response:** Thank you for this helpful suggestion. I identified that the manuscript mistakenly referred to a sample of 205 countries, whereas the dataset actually contains data for up to 265 countries. This has been corrected throughout the manuscript. I have also clarified the construction of the sample. The analysis uses cross-sectional data from the World Bank's World Development Indicators (WDI) and includes the most recently available observation from 2022 for each variable. Each country contributes a single observation to the analysis. The World Bank uses the term "economy" interchangeably with "country," meaning the dataset includes countries as well as territories and other reporting entities for which separate social or economic statistics are reported. Differences in the number of observations across variables reflect differences in data availability rather than repeated observations for the same country. In addition, I have updated the data definition appendix to include the reference year for each variable

**Comment 3:** “The voice-and-accountability variable should be carefully verified.”

**Response:** Thank you for this valuable comment. Upon reexamining our dataset, I discovered that the Voice and Accountability variable that I used was incorrect. I therefore replaced it with the correct WDI voice and accountability measure and reestimated the regression model. After

correcting for the variable, the estimated coefficient became positive and statistically significant, consistent with the existing literature.

**Comment 4:** “Several regression tables should be reviewed carefully for internal consistency. In particular, the reported coefficient for voice-and-accountability and intercept in the bivariate regression do not appear consistent with the scales shown in the scatterplot. The R&D model also appears to use more observations after additional control variables are introduced, which would be unusual if the regressions are based on complete-case samples from the same underlying dataset. Please verify the underlying regressions, confirm that the reported coefficients and observation counts are correct, and ensure that the tables, scatterplots, appendix definitions, and written discussion are fully aligned”

**Response:** Thank you for this valuable comment. As described in the response to the previous comment, the Voice and Accountability variable was corrected and all related analyses were updated accordingly. In addition, I carefully reviewed and re-ran all regression models to verify the reported coefficients, intercepts, and observation counts. After reestimating the R&D robustness model, the number of observations decreased from 59 to 58 following the inclusion of the additional control variables. I also reviewed the regression tables, scatterplots, appendix definitions, and written discussion to ensure that they are internally consistent and fully aligned throughout the manuscript.

**Comment 5:** “The variable described as “inflation” should also be checked. The appendix appears to define this variable as a consumer price index with 2010 set equal to 100, but a CPI index level is not the same as an annual inflation rate. Please either replace this variable with an annual inflation measure, relabel it accurately (and explain why it is appropriate), or omit it in favor of controls that more directly address the development-related confounding discussed above.”

**Response:** Thank you for this valuable observation. I agree that the Consumer Price Index (2010 = 100) is a price-level index rather than an annual inflation rate. Accordingly, I replaced the original variable with the World Bank's "Inflation, GDP deflator (annual %)" indicator, which directly measures annual inflation. The Data section and Appendix have been revised accordingly.

**Comment 6:** “Results based on relatively small samples should be interpreted with greater caution. This applies particularly to the literacy and R&D regressions...Please clearly identify these estimates as exploratory or supplementary..”

**Response:** Thank you for this helpful suggestion. I have revised the manuscript to more clearly distinguish the literacy and R&D analyses from the primary findings. Throughout the paper (scatterplot descriptions, descriptive statistics, regression analysis, conclusion, appendix), these variables are now explicitly identified as exploratory due to their relatively small sample sizes. I

also emphasized that the limited number of observations may reduce the stability of these estimates and that they should therefore be interpreted with appropriate caution.

**Comment 7:** Reorganize the Results section.

**Response:** The Results section has been reorganized into thematic subsections similar to the structure of the literature review. The empirical findings are now organized into Social Indicators, Economic Indicators, Governance and Political Indicators, and Environmental Indicators to improve readability and strengthen the overall narrative.

**Comment 8:** Use association language consistently.

**Response:** The manuscript has been carefully reviewed to ensure that all interpretations consistently describe associations rather than causal effects. Statements suggesting that education directly improves outcomes have been revised to emphasize that the observed relationships are correlations identified within a cross-sectional framework.

**Comment 11:** “The discussion of the CO<sub>2</sub>-emissions-change variable would also benefit from additional caution. The descriptive statistics suggest that this variable contains very large outliers. Please report a sensitivity analysis excluding extreme observations, winsorizing the variable before analyses, or otherwise discussing whether the results are driven by a small number of unusually large values.”

**Response:** Thank you for this valuable suggestion. To assess whether the results were influenced by extreme observations, we conducted a sensitivity analysis by winsorizing the CO<sub>2</sub> emissions change variable at the 1st and 99th percentiles before reestimating the regression model. The results remained broadly consistent with the baseline findings, indicating that the observed association was not driven solely by a small number of extreme values.

**Comment 12:** “Finally, please conduct a careful consistency review of the tables, figure titles, variable names, and references.”

**Response:** I have completed a comprehensive review of the table numbering, figure titles, variable names, terminology, appendix definitions, references, and formatting throughout the manuscript.

**Decision:** Accept, pending major clarifying revisions.

**Review:** I am pleased with the degree of care the author took in their revisions. The paper remains ambitious in scope and has shown real intellectual growth from the initial submission to the last two revisions. For a high school student, the data engineering/assembly, careful distinction between correlation and causation, heteroskedasticity-robust standard errors, basic outlier sensitivity analysis, and reorganization of the narrative in response to our reviews are duly noted.

However, there are still inconsistencies, at times questionable methodological clarity, and nebulous variable definitions that could be greatly improved. While I am fairly certain that these are not detrimental to the actual results (and the narrative is mostly solid as-is), I feel some of these may have been oversights and carryovers from old fits and previous iterations of the paper.

**Issue 1:** Please verify the consistency of the voice and accountability analysis; the baseline regression results are not compatible with the variable's documented scale.

In the last revision, the author correctly identified that they used the wrong voice and accountability variable and replaced it with a World Bank estimate. The corrected descriptive statistics now give a plausible range of approximately -2.122 to 1.938, and the appendix describes the measure as having an approximate range of -2.5 to 2.5. However, Table 2c still reports a coefficient of 9.64 on educational attainment and an intercept of 82.62 for this outcome, which cannot plausibly generate fitted values that properly fit these aforementioned ranges when educational attainment is measured as a percentage. (The robustness table reports a plausible coefficient of 0.017.) Please correct these values if they are incorrect/out-of-date, or explain why they might appear to be inconsistent (but are not).

**Issue 2:** Replace the current GDP per capita development control with a measure that is meaningfully comparable across countries, and explain the regional controls more clearly. The appendix identifies the current control as GDP per capita in constant local currency units, but this is not directly comparable across countries. Please replace this control with a variable that is normalized across different currencies or a PPP-based measure, and then rerun the robustness models.

**Issue 3:** The paper refers to data from up to 265 economies, but note that the actual regression samples are much smaller because the data on education attainment are limited. Please state the effective sample size for each model and clarify the inclusion rules for year selection, missing data, and country/region.

**Issue 4:** Several coefficients weaken or lose statistical significance after the controls are added, and some controlled models use different samples from the baseline models. Please identify which findings remain stable and which weaken when controls are added, and acknowledge that changes in sampling complicate direct comparisons (and state why).

**Issue 5:** The author did follow my recommendation by winsorizing the change in CO2 emissions at the 1st and 99th percentiles, and the note for the robustness table documents this, which is much appreciated. However, the reported winsorized regression also adds inflation, logged GDP per capita, and regional dummy variables. Hence, the baseline model is now both unwinsorized and bivariate, while the sensitivity model is winsorized and multivariate. Because these two aspects change simultaneously, the comparison does not show clearly whether winsorization itself affects the result.

I would suggest the following sequence of models, and at least models 1 and 2 are necessary to answer my concern about whether extreme observations drive the observed relationships:

1. Original CO2 outcome, bivariate regression
2. Winsorized CO2 outcome, bivariate regression
3. Original CO2 outcome with controls
4. Winsorized CO2 outcome with controls

**Issue 6:** The outcome should also be defined much more precisely, since the descriptive statistics show a mean of 667.546, a standard deviation of 4308.181, and a maximum of 52245.455. Is this an absolute change or percentage change? What are the units, the beginning and ending years, and does it measure total national emissions or per-capita emissions? Was the calculation supplied directly by WDI or constructed by the author?

**Issue 7:** The interpretation should also be more cautious. The current discussion suggests environmental awareness, stronger environmental policies, or cleaner technology as possible explanations. These can be mentioned as hypotheses, but the paper should state that the current regressions cannot distinguish those explanations from income, industrial composition, energy composition, country size, economic shocks, etc.