

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 worldwide cross-sectional data, 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 CO2 emissions. By contrast, the relationships between educational attainment and male and female labor force participation are not statistically significant. Many estimated associations retained their direction and remained statistically significant after adding controls, although several relationships weakened in significance, and the female labor force participation result became statistically significant. Thus, 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: educational attainment, human capital, economic growth, institutional quality, political stability, climate vulnerability, cross-country analysis, development economics, governance indicators

1. 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. It may also 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 CO₂ emissions. In contrast, educational attainment is not significantly associated with male and female labor force participation rates. 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 relates to 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.

2. Literature Review

2.1. 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.

2.2. Economic Outcomes

A large body of literature has examined the relationship between educational attainment and economic performance. Many studies find that higher education levels are positively associated with economic growth, innovation, and productivity. For



example, Barro (2013), using panel regression analysis across multiple countries, found that education quality 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 show that regions with more educated workforces benefit more from R&D spillovers and exhibit higher productivity.

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.

2.3. 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.

2.4. 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.

2.5. 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 &	2020	Unemployment, public expenditure on	India	ARDL	Educational attainment negatively	1987-2017

Shastri		education,			affects the unemployment rate.	
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
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

3. Data and Methods

3.1. Scatterplot Graphics

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, and the limited sample size, this finding should be treated 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 remain 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 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. Although GDP per capita growth and educational attainment show a slight positive correlation, several countries with similar education levels still have substantially different growth rates, suggesting other factors likely play an important role. 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.

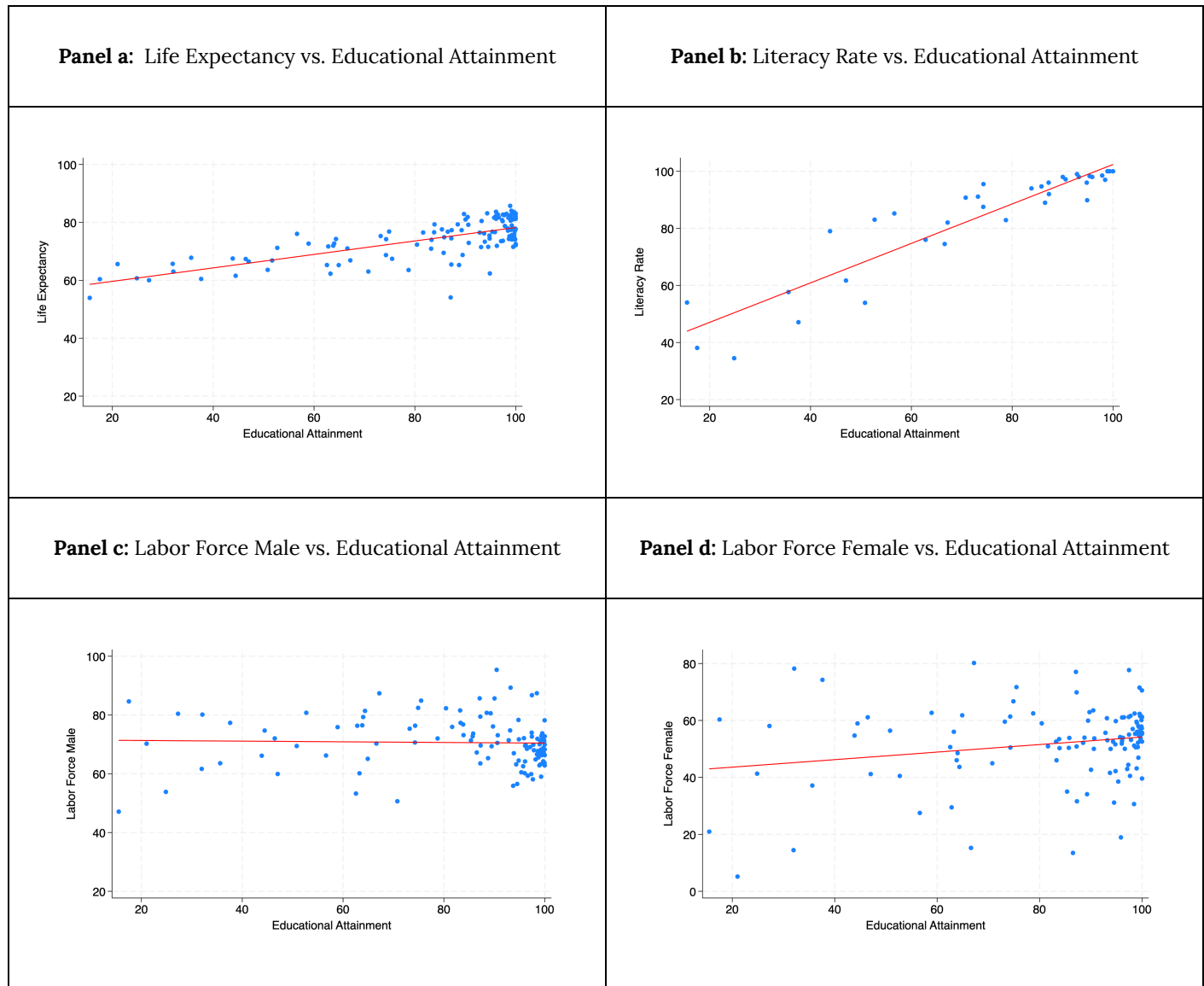


Figure 1: Scatterplots of Social Indicators versus Educational Attainment.

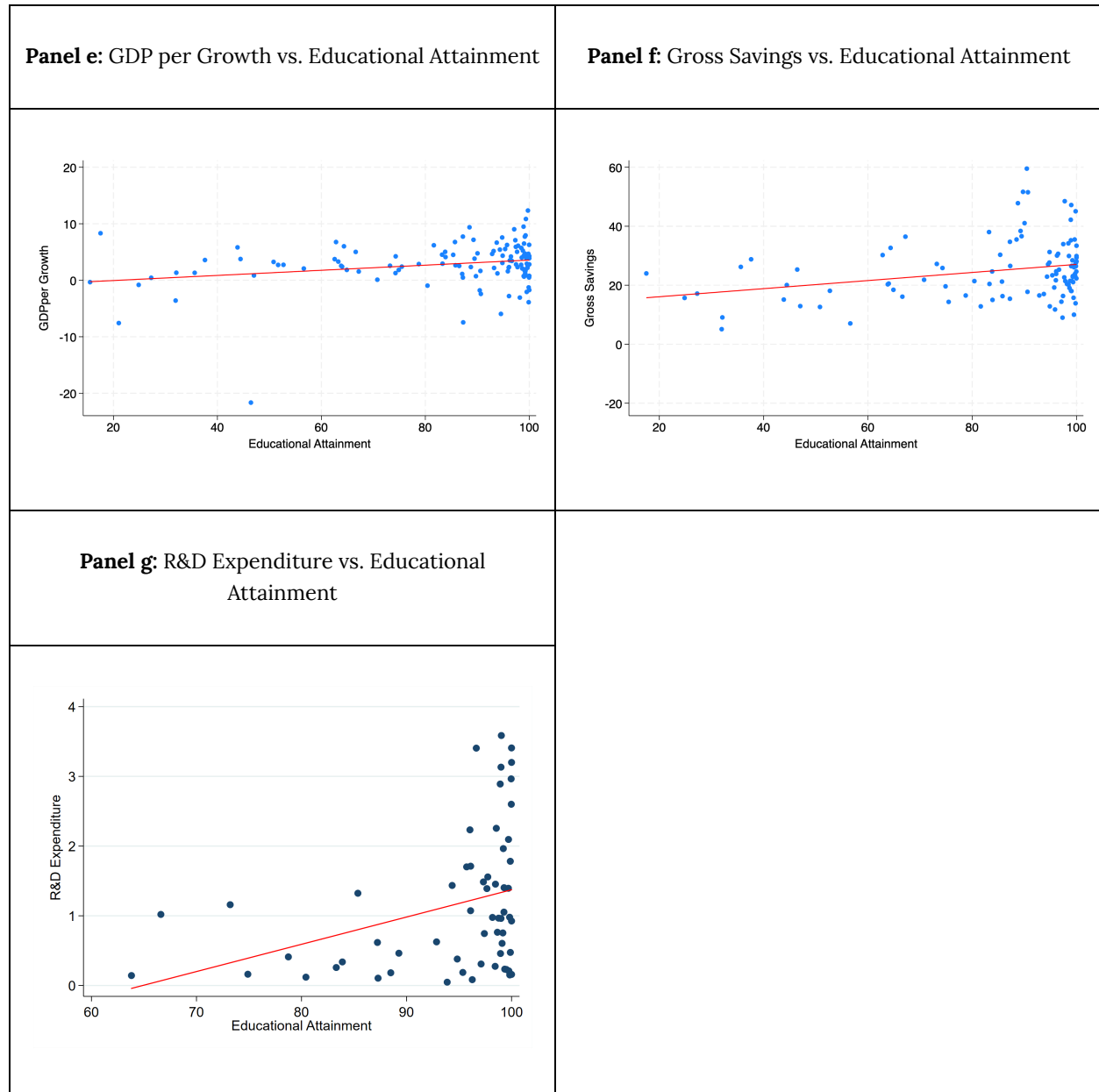


Figure 2: Scatterplots of Economic Indicators versus Educational Attainment.

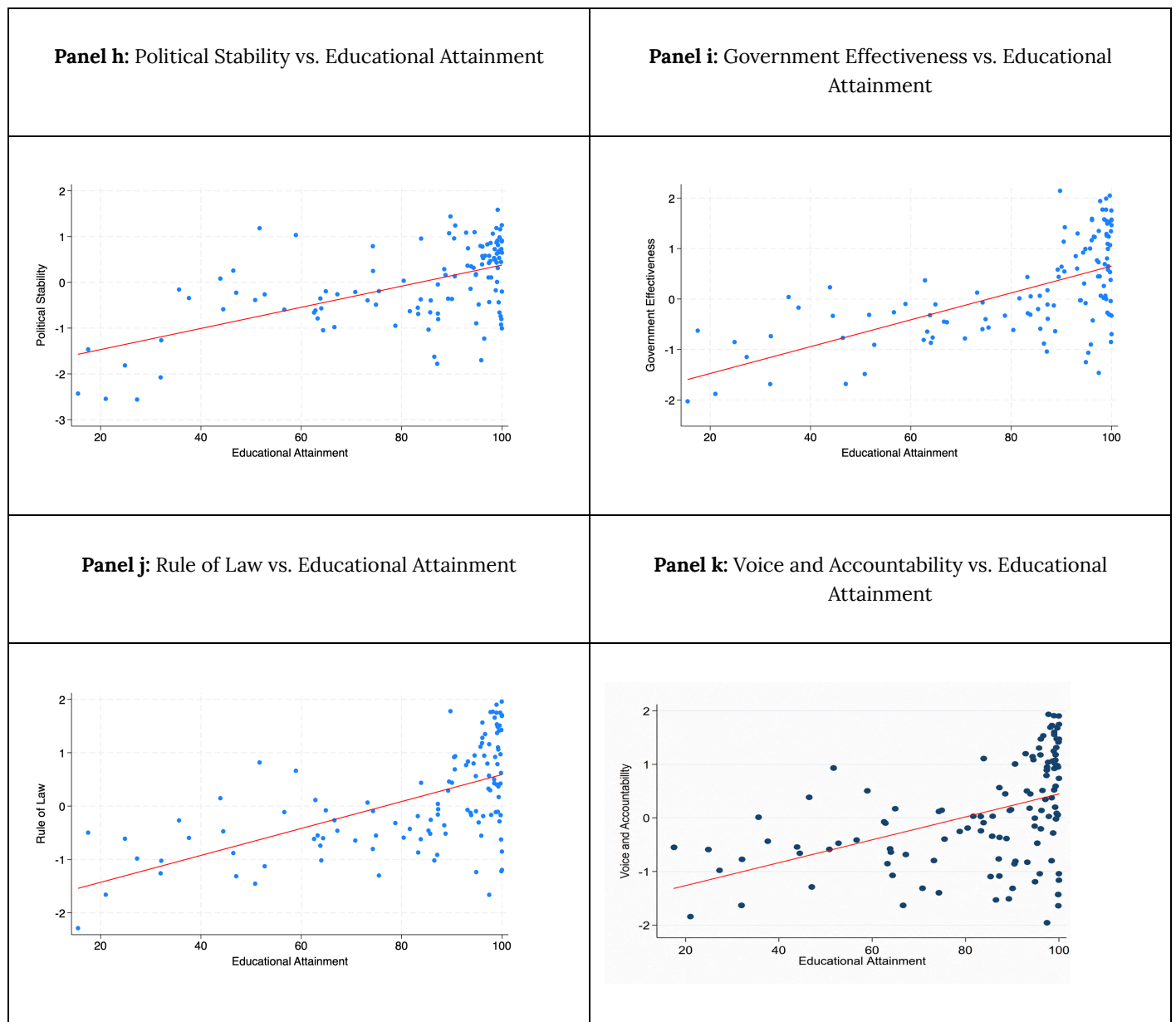


Figure 3: Scatterplots of Governance and Political Indicators versus Educational Attainment.

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, though noticeable variation remains 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 emerges, suggesting that countries with more educated populations tend to have stronger legal institutions and greater respect for legal norms. Nevertheless, variation remains across countries, suggesting that institutional quality may depend on 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.

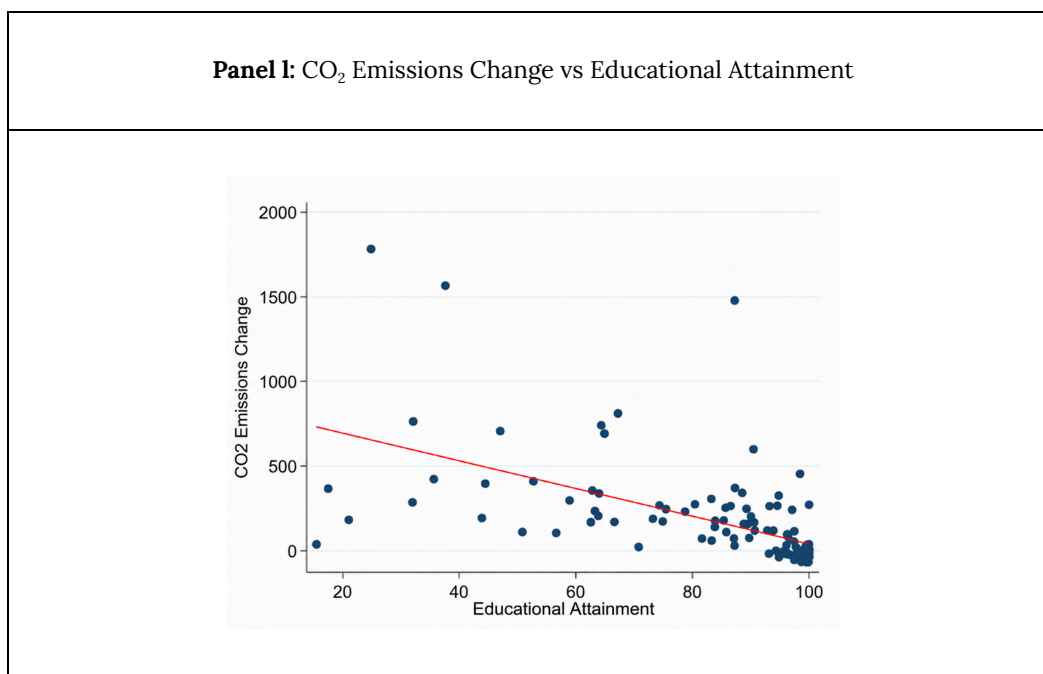


Figure 4: Scatterplots of Environmental Indicators versus Educational Attainment.

Lastly, Figure 4 illustrates the relationship between educational attainment and changes in carbon dioxide emissions. Panel I shows a negative relationship between educational attainment and changes in CO₂ emissions. Countries with higher educational attainment generally appear to experience smaller increases or larger reductions in CO₂ emissions. Although greater environmental awareness, stronger environmental policies, or the adoption of cleaner technologies may explain this pattern, the present analysis cannot identify these mechanisms. The observed association may also reflect differences in income, industrial structure, energy composition, country size, economic shocks, or other country characteristics. Thus,

the relationship shown in Figure 4 should be interpreted as a descriptive association rather than evidence that higher educational attainment causes reductions in CO₂ emissions.

3.2. Data

The analysis uses cross-sectional data from the World Bank's World Development Indicators (WDI). For each variable, the analysis uses the most recent available observation from 2022, with each country contributing a single observation. 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 (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 as the percentage change in total national emissions, excluding LULUCF, relative to the 1990 baseline (CO₂ emissions change). The 2022 observation for CO₂ emissions change was obtained directly from the World Development Indicators (WDI) and represents a percentage change rather than an absolute or per-capita measure.

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 variable in the dataset. However, the regression analyses are estimated only for countries with data on both educational attainment and the corresponding independent variable. This means the sample size varies across regression models because of missing values.

Although the underlying WDI dataset contains information for up to 265 economies, the effective regression samples are substantially smaller because educational attainment is available for only 121 economies in the selected cross-section. Each regression uses complete cases for educational attainment and the variables included in that particular specification. Consequently, sample sizes vary across outcomes and may decline further in controlled specifications because observations missing any control variable are excluded.

The effective regression sample varies by outcome because each model includes only economies with non-missing values for both educational attainment and the relevant outcome variable. The baseline models therefore use between 36 and 119 observations across the 12 outcomes, as reported in the regression tables.



3.3. Descriptive Statistics

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
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



CO ₂ emissions change	246	667.546	4308.181	-82.39	52245.455
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* Exploratory analysis due to limited sample size.

Table 2 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.

3.4. Model

Our model is as follows:

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

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), log 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 exploratory and should be interpreted with appropriate caution.

- $\text{Life_exp}_i = a_0 + b_1 \text{Edu_attainment}_i + e_i$ (model 1)
- $\text{Literacy}_i = a_0 + b_1 \text{Edu_attainment}_i + e_i$ (model 2)
- $\text{Lforce_male}_i = a_0 + b_1 \text{Edu_attainment}_i + e_i$ (model 3)
- $\text{Lforce_female}_i = a_0 + b_1 \text{Edu_attainment}_i + e_i$ (model 4)
- $\text{GDPper_growth}_i = a_0 + b_1 \text{Edu_attainment}_i + e_i$ (model 5)
- $\text{Gross_savings}_i = a_0 + b_1 \text{Edu_attainment}_i + e_i$ (model 6)
- $\text{R\&D}_i = a_0 + b_1 \text{Edu_attainment}_i + e_i$ (model 7)
- $\text{Pol_stability}_i = a_0 + b_1 \text{Edu_attainment}_i + e_i$ (model 8)
- $\text{Gov_effect}_i = a_0 + b_1 \text{Edu_attainment}_i + e_i$ (model 9)
- $\text{RuleofLaw}_i = a_0 + b_1 \text{Edu_attainment}_i + e_i$ (model 10)
- $\text{Voice and Accountability}_i = a_0 + b_1 \text{Edu_attainment}_i + e_i$ (model 11)
- $\text{CO}_2 \text{ emissions change}_i = a_0 + b_1 \text{Edu_attainment}_i + e_i$ (model 12).

While the regression analysis provides useful insight into the relationship between educational attainment and various development indicators, several limitations remain. First, the analysis uses 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.

4. Analysis and Discussion

Table 3a 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 Educational Attainment (Edu_attainment) as the explanatory variable. We indicate statistical significance at the 1% level 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, interpret these findings as exploratory and view them with more 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 3a: 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***	0.69***	-0.01	0.12
	(0.02)	(0.06)	(0.05)	(0.08)
Constant	55.13***	33.22***	71.34***	41.73***
	(1.35)	(5.50)	(4.27)	(7.48)
Observations	117	36	117	117
R-squared	0.52	0.95	0.00	0.04

Note. 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 3b 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 in the primary analyses.

Table 3c 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 3b: 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

Note. 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 3d 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 change variable includes several extreme observations, so interpret this result with appropriate caution. Greater environmental awareness, stronger environmental policies, and the adoption of cleaner technologies may explain the observed relationship, but the present cross-sectional regressions cannot distinguish among these mechanisms. The association may also reflect differences in income, industrial structure, energy composition, country size, economic shocks, or other omitted country characteristics. In addition, the CO₂ emissions-change



variable contains several extreme observations. Accordingly, interpret the result cautiously as a cross-country association rather than evidence that educational attainment itself reduces CO₂ emissions.

Table 3c: 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***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)
Constant	-2.01***	-2.05***	-2.00***	-1.69***
	(0.28)	(0.24)	(0.24)	(0.25)
Observations	118	118	116	119
R-squared	0.35	0.39	0.34	0.20

Note. 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

CO₂ emissions change is measured as the percentage change in total national carbon dioxide emissions, excluding land use, land-use change, and forestry (LULUCF), relative to the 1990 baseline. The variable therefore represents a percentage change rather than an absolute change in emissions and is not expressed on a per-capita basis. The analysis uses the 2022 observation reported by the World Development Indicators. We obtained this measure directly from the WDI database and did not construct or recalculate it.



Table 3d: Regression Results for Environmental Indicators

	(model 10)
VARIABLES	CO ₂ emissions change
Edu_attainment	-16.905**
	(6.625)
Constant	1,750.691***
	(643.920)
Observations	115
R-squared	0.086

Note. 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

4.1. 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, we included variables such as inflation and GDP (PPP, constant 2021 international dollars) where appropriate to account for observable factors that may be associated with both educational attainment and the selected social, economic, political, and environmental indicators. Regional controls were included as dummy variables for Asia, Africa, the Americas, and Oceania, with Europe serving as the reference category to account for broad geographic differences that may be associated with both educational attainment and the outcome variables. After adding these controls, we reestimated all models and compared them 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 4a: Robustness Check

	(model 1)	(model 2)	(model 3)	(model 4)
VARIABLES	Life_exp	Literacy	Lforce_male	Lforce_female
Edu_attainment	0.111***	0.674***	0.024	0.226**
	(0.025)	(0.096)	(0.055)	(0.111)
Inflation	-0.019*	-0.018	-0.000	-0.084
	(0.010)	(0.018)	(0.016)	(0.061)
GDP_PPP	0.210	-0.256	0.389	0.012
	(0.235)	(0.548)	(0.440)	(0.730)
Asia	-1.397	2.904	8.387***	-5.544
	(1.082)	(2.353)	(2.436)	(3.712)
Africa	-9.858***	-2.372	3.474	12.009**
	(1.816)	(5.504)	(3.321)	(5.364)
the Americas	-2.024**	7.362**	8.985***	4.003
	(0.947)	(2.850)	(1.866)	(2.685)
Oceania	-4.105		-5.543	-3.231

	(3.036)		(4.422)	(8.365)
Constant	62.583***	39.531**	54.307***	32.309
	(6.804)	(16.267)	(12.404)	(20.381)
Observations	118	35	95	115
R-squared	0.694	0.881	0.274	0.199

Note. Robust standard errors in parentheses

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

To assess whether the relationship between educational attainment and changes in CO₂ emissions is driven by extreme observations, we estimated four alternative specifications. First, we estimated a bivariate regression using the original CO₂ emissions-change variable. Second, we repeated the same specification after winsorizing the CO₂ emissions-change variable at the 1st and 99th percentiles. Third, we estimated the model using the original CO₂ variable while controlling for inflation, GDP (PPP, constant 2021 international dollars), and regional differences. Finally, we estimated the controlled specification using the winsorized CO₂ variable. In the bivariate specifications, educational attainment is negatively and statistically significantly associated with changes in CO₂ emissions ($\beta = -16.905$, $p < 0.05$). The coefficient remains unchanged after winsorization. In the controlled specifications, the coefficient remains negative ($\beta = -18.691$) but is statistically significant only at the 10% level. Winsorization again does not change the estimated coefficient or its statistical significance. Overall, these results suggest that the negative association is not driven by the extreme observations affected by 1st- and 99th-percentile winsorization. However, the weaker statistical significance after the inclusion of controls indicates that the relationship should be interpreted cautiously.

Table 4b: Robustness Check

	(model 5)	(model 6)	(model 7)
VARIABLES	GDPperGrowth	Gross_Savings	R&D



Edu_Attainment	0.054*	0.153*	0.048**
	(0.032)	(0.078)	(0.021)
Inflation	-0.001	-0.023	-0.021
	(0.008)	(0.031)	(0.013)
GDP_PPP	0.254	0.433	0.339***
	(0.190)	(0.389)	(0.086)
Asia	-1.949	7.844**	0.483
	(1.197)	(3.305)	(0.794)
Africa	1.447	1.319	-0.517
	(1.358)	(5.169)	(0.400)
the Americas	1.028	-3.159	-0.260
	(0.790)	(2.504)	(0.317)
Oceania	-0.029	1.480	
	(2.659)	(1.692)	
Constant	-5.738	5.888	-11.942***
	(4.791)	(7.412)	(3.129)

Observations	97	106	58
R-squared	0.176	0.223	0.351

Note. Robust standard errors in parentheses

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

Table 4c: Robustness Check

	(model 8)	(model 9)	(model 10)	(model 11)
VARIABLES	Pol_stability	Gov_effect	RuleofLaw	Voice and Accountability
Edu_attainment	0.021***	0.023***	0.021***	0.015***
	(0.005)	(0.004)	(0.004)	(0.004)
Inflation	-0.006***	-0.007***	-0.007***	-0.008***
	(0.002)	(0.002)	(0.001)	(0.003)
GDP_PPP	0.004	0.008	0.021	0.035
	(0.033)	(0.030)	(0.041)	(0.040)
Asia	-0.237	-0.097	-0.246	-1.092***
	(0.231)	(0.226)	(0.195)	(0.208)



Africa	-0.111	-0.285	-0.283	-0.563**
	(0.313)	(0.260)	(0.236)	(0.270)
the Americas	0.028	-0.374*	-0.507**	-0.271
	(0.176)	(0.191)	(0.210)	(0.205)
Oceania	0.704*	-0.072	0.447	0.540*
	(0.377)	(0.316)	(0.363)	(0.307)
Constant	-1.666***	-1.553***	-1.802	-1.569
	(0.584)	(0.431)	(1.099)	(1.123)
Observations	118	118	118	110
R-squared	0.380	0.435	0.416	0.482

Note. Robust standard errors in parentheses.

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

Table 4d: CO₂ Emissions Change Robustness Check

	(1)	(2)	(3)	(4)
VARIABLES	Original CO ₂ - Bivariate	Winsorized CO ₂ - Bivariate	Original CO ₂ + Controls	Winsorized CO ₂ + Controls



Educationalattainme	-16.905**	-16.905**	-18.691*	-18.691*
	(6.625)	(6.625)	(10.175)	(10.175)
Inflation			0.093	0.093
			(1.394)	(1.394)
GDP_PPP			-151.797	-151.797
			(104.532)	(104.532)
Asia			783.256*	783.256*
			(414.736)	(414.736)
Africa			-447.613	-447.613
			(544.097)	(544.097)
The Americas			-159.236	-159.236
			(210.130)	(210.130)
Oceania			-356.987	-356.987
			(429.450)	(429.450)
Constant	1,750.691***	1,750.691***	5,835.385*	5,835.385*
	(643.920)	(643.920)	(3,508.230)	(3,508.230)



Observations	115	115	112	112
R-squared	0.086	0.086	0.212	0.212

Note. Robust standard errors in parentheses.

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

Table 4e: Comparison of Baseline and Controlled Regression Results

Outcome Variable	Baseline Model	Controlled Model	Assessment
Life expectancy	0.23***	0.111***	Stable – remains statistically significant, although the coefficient decreases
Literacy	0.69***	0.674***	Stable – remains strongly significant
Male labor force participation	-0.01	0.024	Stable non-result – remains statistically insignificant
Female labor force participation	0.12	0.226**	Strengthens – becomes statistically significant after controls are added
GDP per capita growth	0.05**	0.054*	Weakens – significance declines from the 5% to the 10% level
Gross savings	0.14***	0.153*	Weakens substantially – significance declines from the 1% to the 10% level
R&D expenditure	0.04***	0.048**	Weakens – significance declines from the 1% to the 5% level



Political stability	0.02***	0.021***	Stable – remains strongly significant
Government effectiveness	0.03***	0.023***	Stable – remains strongly significant
Rule of law	0.03***	0.021***	Stable – remains strongly significant
Voice and accountability	0.02***	0.015***	Stable – remains strongly significant
CO ₂ emissions change	-16.905**	18.691*	Weakens – remains negative and statistically significant, but significance declines from 5% to 10%

5. 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, in the baseline specifications, educational attainment was not significantly associated with male or female labor force participation. In the controlled specification, however, the association with female labor force participation became statistically significant, indicating that this result is sensitive to the inclusion of controls. 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 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.

6. 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
GDP (constant PPP)	GDP, PPP (constant 2021 international \$)	This indicator provides values for gross domestic product (GDP) expressed in constant international dollars, converted by purchasing power parities (PPPs). PPPs account for the different price levels across countries and thus PPP-based comparisons of economic output are more appropriate for comparing the output of economies and the average material well-being of their inhabitants than	WDI World Bank	2022



		exchange-rate based comparisons.		
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 Violence/Terrorism: Estimate	Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including	WDI World Bank	2022



		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 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	WDI World Bank	2022



		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 quality of policy formulation and implementation, and the credibility of the government's commitment to such policies, ranging from	WDI World Bank	2022



		-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 accountability mechanisms for citizens—reflected in the ability to access information, governmental oversight bodies, and a robust traditional/digital	WDI World Bank	2022

		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
CO ₂ emissions change	Carbon dioxide (CO ₂) 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 (CO ₂), one of the six Kyoto greenhouse gases (GHG), from the agriculture, energy, waste, and industrial sectors, excluding LULUCF.	WDI World Bank	2022

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Data & Code Availability Statement

The data used in this study were obtained from the World Development Indicators (WDI) database of the World Bank and are publicly available. The Stata code used for the empirical analysis and generation of the reported results is publicly available in the following GitHub repository:

- Code repository: <https://github.com/miabohra/Mia-s-Research-Paper>
- Data source: World Development Indicators (WDI), World Bank.

No proprietary or confidential data were used in this study.

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Author Biography

Mia Bohra is a high school student researcher at Singapore American School in Singapore. Her academic interests include economics, particularly economic inequality, development, and the social and economic factors that shape educational outcomes. Beyond research, Mia is involved in a student-led service organization that supports underprivileged communities in Singapore and in her school's entrepreneurship club. She is also a harpist in her school orchestra. She plans to pursue undergraduate studies in economics and continue exploring questions related to economic and social development.

Mentor Contribution Statement

Prof. Dr. Abdullah Yalaman served as Mia Bohra's mentor throughout the research project. He worked closely with Mia during the development of the study, providing guidance on refining the research question, structuring the research process,



and identifying appropriate academic literature. He also supported Mia in understanding the relevant theoretical concepts and developing a suitable methodological approach for the study.

Throughout the project, Abdullah Yalaman provided guidance on data collection, data preparation, and empirical analysis, including the selection and interpretation of appropriate statistical and econometric methods. He regularly reviewed Mia's progress, discussed the interpretation of the empirical findings, and provided feedback to strengthen the clarity and academic rigor of the analysis.

Abdullah also supervised the manuscript-writing process by providing detailed feedback on the organization, argumentation, presentation of results, and overall academic writing. Multiple rounds of feedback and revision were conducted to improve the quality and coherence of the manuscript. Mia independently conducted the research, performed the analyses, interpreted the results, and prepared the manuscript, while Abdullah's role was limited to mentorship, academic guidance, and constructive feedback throughout the research and writing process.

