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Exploring the GDP-Education Relationship: A Comparative Study of Developing and Developed Nations

Yuyao Wen[1,a,*]

[1]*New York University Shanghai, Shanghai, 200122, China*
a. yw6955@nyu.edu
**corresponding author*

Abstract: This study investigates the relationship between a country's GDP and the advancement of its education system, focusing on the dynamics in developing versus developed countries. In a multivariate linear regression model, this article used years of schooling as a proxy for educational progress and GDP per capita, among other variables. The analysis of the Barro & Lee Dataset, encompassing 88 countries, revealed a positive correlation between GDP and education, particularly strong in developing nations. The findings imply a ceiling effect, indicating that increases in GDP initially result in significant educational gains, which diminish as GDP continues to grow—observed particularly in developing countries. These insights underscore that economic prosperity and educational advancement are interconnected, yet the relationship varies depending on a nation's developmental stage. This study offers a nuanced understanding of the interplay between economic performance and education, which can inform economic and educational policies, especially in developing countries. Policymakers can utilize this research to design strategies that align with their country's developmental context, thus fostering economic growth supported by robust educational advancements. The study's novelty lies in its detailed comparison across varying stages of national development and its potential implications for policymaking.

Keywords: Gross Domestic Product (GDP), education system advancement, developing and developed nations, economic prosperity, policy implications

1. Introduction

This research examines the relationship between a country's Gross Domestic Product (GDP) and the progress of its education system. This topic is crucial for policymakers, economists, and educators as this paper delves into this connection across a range of nations with a focus on contrasting the dynamics between developing and developed countries.

To measure the development of a nation's education system, this research employs the years of schooling as a proxy variable. This choice is supported by scholarly literature, which confirms its effectiveness in representing the educational progress of a nation.

The study utilizes data from the renowned Barro & Lee Dataset, which encompasses information from 88 countries, both developed and developing as of 2015. The dependent variable is the average number of years of schooling, while the independent variables include factors such as GDP per capita (logged to account for the wide range of values), unemployment rate, gross savings rate, FDI inflow

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as a percentage of GDP, and a binary variable indicating whether a country is classified as developed (1) or developing (0).

In terms of the research methodology, the paper utilizes a multiple linear regression model as well as a linear & quadratic fitting process to conduct an extensive quantitative analysis. The outcomes are quite compelling, revealing a correlation between a country's GDP and the development of its education system. Interestingly, this correlation appears to be notably stronger among developing countries.

The implications of these findings are profound. It can potentially guide economic and educational policies, particularly in developing nations. By understanding the relationship between GDP and education, this research can pave the way for economic growth that is supported by strong educational advancements.

2. Purpose of the Study

The goal of this study is to examine the connection between a country's GDP and the development of its education system. Specifically, this paper aims to compare this relationship within both developed nations. By using the number of years individuals spend in school as a measure of progress, the goal is to offer a nuanced understanding of how economic performance and education interact. The potential discoveries have implications for many groups of stakeholders. Policymakers can use these insights to make decisions regarding the economy and educational policies in developing countries. Economists can gain a better comprehension of the interconnectedness between education and economic growth. Educators will be reminded of the importance of investing in education and may advocate for increased resource allocation. Ultimately, this study aims to emphasize the role that education plays in driving economic growth while also providing comparisons across different stages of national development.

3. Literature Review

Numerous studies have examined the relationship between health, as measured by Gross Domestic Product (GDP), and educational system improvement. Human capital theory, for example, contends that investment in education supports growth by increasing employee productivity and encouraging innovation. [1].

3.1. The Relationship Between GDP and Education

Early research conducted by Barro concluded a positive correlation between schooling rates, life expectancy, and subsequent economic growth [2]. Additionally, Mankiw, Romer and Weil in 1992 contribute to this narrative with their augmented Solow model that incorporates capital [3]. This model significantly improves its ability to predict per capita GDP disparities among nations.

3.2. Developing vs. Developed Countries

When comparing emerging and developed countries, this paper finds differences in the dynamics of the link between GDP and education. According to a 2008 study conducted by Hanushek and Woessmann, education plays an important effect in both developed and developing countries' growth [4]. However, as Bils and Klenow have pointed out, the influence of education on growth is generally greater in developing countries [5]. This could be due to the fact that education supports development and catch-up procedures [6].

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3.3. Average Years of Schooling as a Proxy for Education

The average years of schooling is widely used as a proxy metric for analyzing the quality and advancement of a country's education system. Psacharopoulos and Patrinos have indicated that this metric effectively represents the level of a population [7]. The Barro and Lee dataset, which is widely recognized internationally, further supports the reliability of this measure.
However, Hanushek and Kimko argued that cognitive skills measurements are directly linked to growth than simply measuring educational attainment [8]. Despite this criticism, these measures often do not have the level of coverage across countries and time periods as the average years of schooling.

3.4. Further Considerations and the Role of Other Economic Indicators

While there is extensive research on the relationship between GDP and education, it is important to further explore the impact of other economic indicators on this relationship. For example, factors such as the unemployment rate, gross savings rate and foreign direct investment (FDI) inflow as a percentage of GDP can also play a part in understanding the dynamics between GDP and education. These economic indicators can provide an additional understanding of how economic conditions influence or are influenced by the education system [9].

3.5. Identifying the Research Gap and Conclusion

Despite the significant progress so far in understanding the relationship between GDP and education, there are still gaps that need to be addressed. This paper has not fully explored how other economic indicators co-influence this relationship. Additionally, while average years of schooling is commonly used as a measure of development, the research requires evidence to support its validity.

The study aims to fill these gaps by conducting an analysis of the connection between GDP and education. The research will consider a range of indicators and further validate the use of average years of schooling as an indicator of educational development. By examining these dynamics in both developed nations, this paper hope to contribute to an understanding of how economic prosperity and educational development interact.

4. Research Question and Objectives

The primary goal of this research is to investigate the relationship between a country's GDP and the growth of its education system, with a particular emphasis on how this relationship differs between developing and developed countries. This paper aims to understand how economic prosperity aligns with progress in education, as both factors significantly contribute to a nation’s well-being and future prospects.

Two objectives have been developed to achieve the research goals. First, this study will look into the relationship between GDP per capita and the typical number of years spent in school across 88 countries. This goal gives us a better understanding of the connection between a nation's economic standing and the expansion of its educational system.

In order to further explore the analysis, this paper will look at how the average number of years spent in school varies across developed and developing nations. By doing this, the study can find any trends or distinctions between these two categories. This goal aids in our understanding of how various developmental phases may affect the correlation between economic success and academic advancement.

In line with these objectives, this paper proposes the following hypotheses:

H0(1): posits no significant correlation between GDP per capita and the average years of schooling across all nations, while H1(1) posits a significant correlation.

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H0(2): suggests that the relationship between GDP per capita and average years of schooling does not differ between developing and developed countries. Conversely, H1(2) suggests a significant difference.

By taking this dual approach, this research can delve deeper into the dynamics between economic output and educational development, which can potentially provide valuable insights for future economic and educational policies.

5. Methodology

5.1. Data Collection

This study has utilized the Barro & Lee dataset and economic data from The World Bank [10][11], which offers information on variables such as GDP, education, unemployment rate, gross savings rate and FDI inflow as a percentage of GDP, among others. It is worth mentioning that the Barro & Lee dataset, which was used for this study, only includes data up until 2015. Therefore, the analysis is based on information from that year. This dataset is highly regarded in research because it provides coverage of global economies and includes a wide range of economic indicators.

This study gathered information from 88 nations spread over six continents, including 35 in Europe, 18 in Asia, 11 in Africa, 12 in North America, 8 in South America, and 4 in Oceania. Both developed and emerging countries make up this diversified mix, exhibiting a wide spectrum of geographic origins. The findings are guaranteed to be applicable to a variety of situations and appropriately represent economic realities thanks to the broad sample.

5.2. Descriptive Analysis

A descriptive analysis of the data collected is conducted. Summary of the descriptive analysis is presented in Table 1 below.

Table 1: Summary of descriptive statistics of the collected data.

	Mean	Standard deviation	Minimum	Maximum
Education	9.999	2.391	2.783	13.275
GDP per capita	19654.25821	21941.59048	559.4457465	105462.0126
Unemployment rate	7.459659095	4.970554782	0.170000002	24.97999954
Saving rate	22.57759231	7.666096557	5.242783221	45.56898651
Net FDI	7.796502586	19.80334534	-4.207287687	145.4631353

5.3. Quantitative Model

In terms of the quantitative analysis, this paper utilized a regression model to explore the relationships between a single dependent variable and a number of independent variables. In this case, the dependent variable is GDP per capita. To account for outliers and normalize the distribution, the research transformed it using natural logarithm. This approach ensures that the model is able to handle extreme values and ensures that the data is suitable for statistical analysis.

The model equation is outlined as follows:

$$\begin{aligned} Average\ years\ of\ schooling &= \beta_0 + \beta_1 ln(GDP\ per\ capita) + \beta_2 Unemployment\ Rate \\ &+ \beta_3 Gross\ Savings\ Rate + \beta_4 FDI\ Inflow\ as\ \%\ of\ GDP + \beta_5 Developed \\ &+ \beta_6 [ln\ (GDP\ per\ capita) \times Developed] + \varepsilon \end{aligned} \quad (1)$$

In this equation:

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$Average\ years\ of\ schooling$ is the dependent variable.

1) $ln(GDP\ per\ capita)$, $Unemployment\ Rate$, $Gross\ Savings\ Rate$, $FDI\ Inflow\ as\ \%\ of\ GDP$, and $Developed$ (a dummy variable indicating whether the country is developed or not) are the independent variables.

2) $ln\ (GDP\ per\ capita) \times Developed$ is an interaction term to capture the joint effect of the log of GDP per capita and whether a country is developed on its average year of schooling.

3) β_0 is the y-intercept of the equation.

4) β_1 to β_6 are the coefficients that represent how the dependent variable changes when the corresponding independent variables vary by one unit while keeping all other variables constant.

5) ε is the error term, which captures the variation in the dependent variable that isn't explained by the independent variables.

This study also does a further analysis using linear and quadratic fitting to investigate the relationship between the number of school years and the log of GDP per capita. The linear fitting examines how these two variables are linearly correlated, while the quadratic fitting helps us identify any potential quadratic relationship. Graphs will be used to visually represent these connections in a way that's easy to understand.

The linear fitting model is:

$$Average\ years\ of\ schooling = \alpha_0 + \alpha_1 \ln(GDP\ per\ capita) + \mu \quad (2)$$

The quadratic fitting model is:

$$Average\ years\ of\ schooling = \delta_0 + \delta_1 \ln(GDP\ per\ capita) + \ln\ (GDP\ per\ capita)^2 + \nu \quad (3)$$

In both models, α_0 and δ_0 are the y-intercepts, α_1, δ_1 and δ_2 are the coefficients of the variables, while μ and ν are the error terms.

By examining the coefficients, the research can gain insights into how the log of GDP per capita impacts the years of schooling. This will contribute to an understanding of how economic conditions and education are related. The use of linear and quadratic fitting analysis also allows us to identify non-linear relationships, which enhances the reliability and robustness of the findings.

6. Results and Analysis

In this section, the results of the quantitative models are presented together with an explanation of how they relate to the research question and objective.

6.1. Results of Multiple Linear Regression Model

First, the results of the multiple linear regression model are presented below in Table 2.

Table 2: Results of the multiple linear regression.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Edu	Edu	Edu	Edu	Edu	Edu
Ln GDP	1.3576***					1.6503***
	(0.1543)					(0.3675)
Ln GDP # Developed						-1.1875**
						(0.4776)
Unemployment rate		0.1077***				0.0655
		(0.0377)				(0.0397)
Saving rate			0.0427			0.0206

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Table 2: (continued).

			(0.0352)			(0.0272)
Net FDI				0.0179***		0.0039
				(0.0062)		(0.0039)
Developed					2.9888***	11.5317***
					(0.3989)	(4.3487)
Constant	-2.4798*	9.1958***	9.0361***	9.8595***	8.5048***	-5.8304*
	(1.4877)	(0.4473)	(0.8243)	(0.2695)	(0.3479)	(3.2300)
Observations	88	88	88	88	88	88
R-squared	0.5453	0.0501	0.0187	0.0220	0.3950	0.6021

The results from the multiple regression analysis offer some intriguing insights into the relationship between a nation's GDP and its education system's development.

6.1.1. Objective 1: Correlation Between GDP Per Capita and Average Years of Schooling

Model (1) provides evidence for a significant and positive correlation between the natural logarithm of GDP per capita (Ln GDP) and the average years of schooling (Edu). The coefficient estimate for Ln GDP is 1.3576 ($p < 0.01$), suggesting that a 1% increase in GDP per capita is associated with an increase in the average years of schooling by 1.3576 years, all others being equal. This supports H1(1), implying a strong positive association between a country's economic strength and the level of its education system's development.

6.1.2. Objective 2: Differences Between Developing and Developed Countries

Model (6) introduces an interaction term between Ln GDP and a binary variable indicating whether a country is developed (Developed). The coefficient for Ln GDP # Developed is -1.1875 ($p < 0.05$), indicating that the correlation between GDP per capita and average years of schooling is weaker in developed countries than in developing ones. This supports H1(2), suggesting that while economic prosperity does correspond with educational progress, the strength of this relationship diminishes as a country reaches a higher level of development.

The coefficient for the dummy variable “Developed” itself is positive and significant (11.5317, $p < 0.01$), suggesting that developed countries, regardless of their GDP, tend to have higher years of schooling on average.

6.1.3. Influence of Other Variables

Unemployment rate and net FDI also show significant correlations with education level in some models. A higher unemployment rate correlates with higher average years of schooling, perhaps because people tend to invest in education during periods of high unemployment. Net FDI shows a positive correlation with education level, indicating that foreign investments may stimulate educational development. However, the saving rate does not show a significant association with the average years of schooling in any model, implying it may not be a crucial factor in influencing a nation’s education development.

6.2. Results of Linear & Quadratic Fitting

Also, the results of linear & quadratic fitting is shown below in Table 3.

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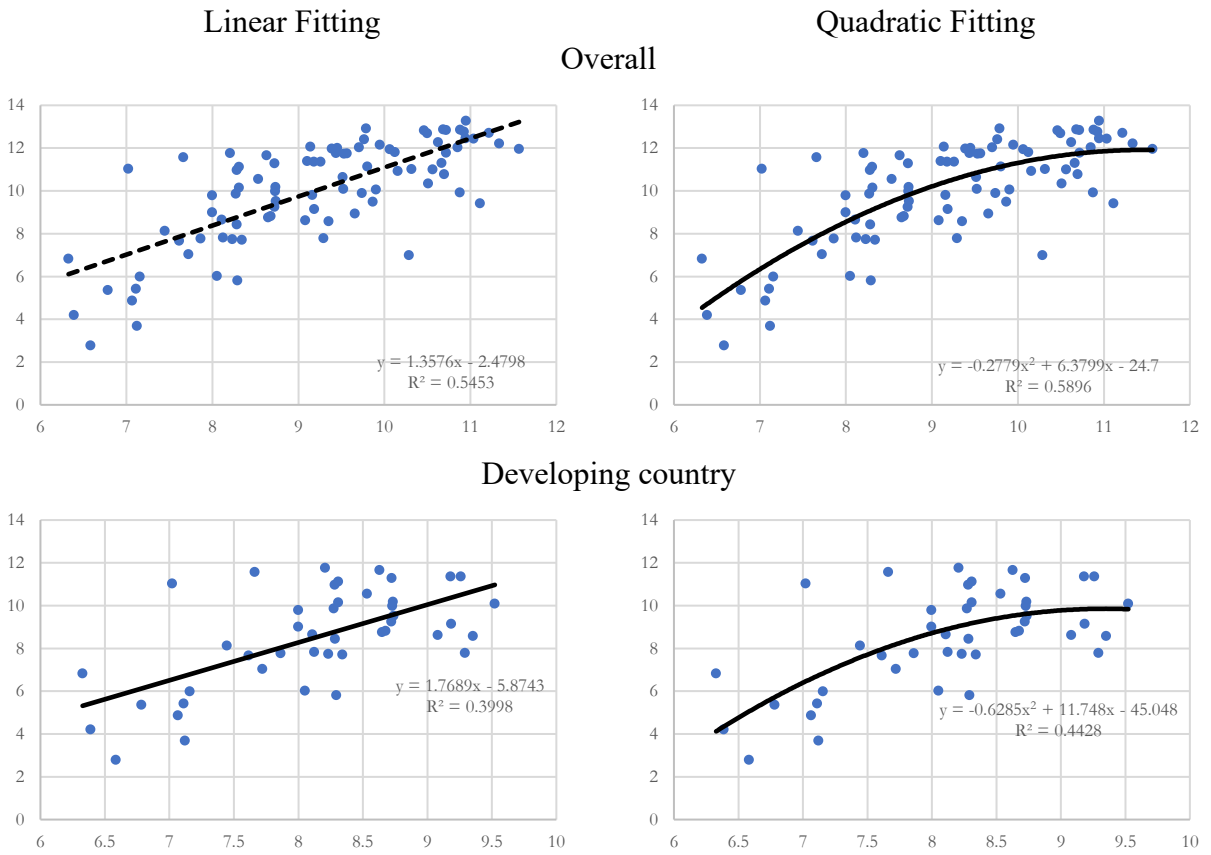
Table 3: Results of the linear & quadratic fitting.

VARIABLES	(1) Overall Edu	(2) Overall Edu	(3) Developed Edu	(4) Developed Edu	(5) Developing Edu	(6) Developing Edu
Ln GDP	1.3576***	6.3799***	0.4478*	-7.0796	1.7689***	11.7481**
	(0.1543)	(1.7885)	(0.2432)	(8.6134)	(0.3605)	(5.5982)
Ln GDP-sq		-0.2779***		0.3673		-0.6285*
		(0.0954)		(0.4206)		(0.3460)
Constant	-2.4798*	-24.7003***	6.9008***	45.3116	-5.8743*	-45.0479*
	(1.4877)	(8.2928)	(2.4956)	(43.8931)	(3.0209)	(22.5121)
Observations	88	88	44	44	44	44
R-squared	0.5453	0.5896	0.0515	0.0648	0.3998	0.4428

As shown in Figure 1, graphs are also drawn to visualize the relationship between the log of GDP per capita and average years of schooling, be it linear or quadratic.



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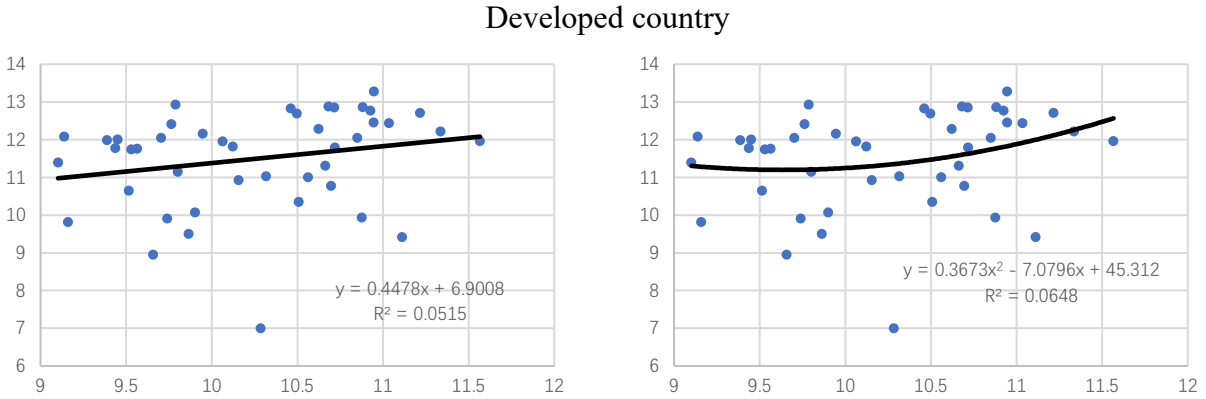

Figure 1: Graphs of linear & quadratic fitting.

Photo credit: Original

6.2.1. Linear Fitting Model

The earlier observation that there is a substantial positive association between Ln GDP and Edu for all nations has been verified by the linear fitting model in Column (1). According to the coefficient of 1.3576 (p 0.01), an increase in average schooling of 1.3576 years is predicted for every 1% increase in GDP per capita.

When splitting the data between developed and developing nations, the positive association persists, although with different magnitudes. In developed countries (Column (3)), a 1% increase in GDP per capita is associated with an additional 0.4478 years of schooling ($p < 0.05$), while in developing countries (Column (5)), it is correlated with an additional 1.7689 average years of schooling ($p < 0.01$). This again strengthens the hypothesis that the strength of the correlation between GDP and education is higher in developing countries.

6.2.2. Quadratic Fitting Model

The quadratic model introduces a squared Ln GDP term, allowing for the possibility that the relationship between GDP per capita and average years of schooling is quadratic.

For all nations (Column (2)), the Ln GDP squared coefficient is negative and significant (-0.2779, $p < 0.01$), suggesting that the relationship between GDP per capita and average years of schooling is indeed curvilinear, with the rate of increase in schooling years slowing down as GDP per capita rises. When the research again separates the data between developed and developing countries, the quadratic term is not significant for developed nations (Column (4)), suggesting a linear relationship. However, for developing nations (Column (6)), the quadratic term is negative and significant (-0.6285, $p < 0.05$), indicating a curvilinear relationship similar to that found in the overall sample.

6.2.3. Overall Interpretation

Overall, these results indicate that there is an intricate relationship between GDP per capita and average years of schooling. It seems that this relationship follows a linear pattern in developed countries but exhibits a curvilinear pattern in developing nations. The shape of the curve in developing nations suggests that initial increases in GDP per capita lead to substantial improvements in schooling years. However, these gains gradually decrease as GDP per capita continues to rise.

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One possible reason for this trend could be a "ceiling effect", where there are fewer opportunities to further increase the years of schooling once a certain level of economic development is reached [12]. This explanation might also clarify why the correlation between GDP per capita and education is weaker in developed countries that are already closer to this "ceiling" compared to developing nations.

7. Conclusion

The study aimed to examine how a nation's GDP per capita relates to the development of its education system, with a focus on understanding any differences between developing countries. The findings reveal a nuanced relationship highlighting the interplay between economic and educational progress.

Through the regression analysis, the paper found sufficient evidence supporting a positive correlation between GDP per capita and average years of schooling across all nations. This finding supports the notion that economic prosperity generally goes hand in hand with educational advancements. However, it was discovered that the connection between economic strength and educational development is not as strong in developed countries. This suggests that as nations progress to stages of development, the correlation between wealth and education may weaken.

After conducting analyses using linear and quadratic fitting models, some additional insights were gained. In developed countries, there appears to be a linear relationship between GDP per capita and average years of schooling. On the other hand, in developing nations, this relationship follows a curvilinear pattern. Initially, increases in GDP per capita lead to significant gains in schooling years. However, these gains start to diminish as GDP per capita continues to grow.

These findings support the idea of a "ceiling effect", where the potential for increasing years of schooling becomes limited once a certain level of economic development is reached [12]. This could be the reason why the connection between GDP per capita and education is not as strong in developed countries, which are closer to reaching a certain limit compared to developing nations.

To sum up, although economic prosperity and educational advancement are undoubtedly connected, how they relate to each other depends on the stage of development of a country. Therefore, policymakers who want to promote education in line with growth need to be aware of these dynamics and devise strategies that suit their country's developmental context.

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