

Econometric Exploration: Unraveling the Dynamics Between GDP per Capita and Literacy Rates

Course: ECON 301

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Submitted To:

- **Dr. Sayema Haque Bidisha**
Professor
The Department of Economics,
University of Dhaka;
- **Most. Kaniza Muhsina**
Lecturer
The Department of Economics,
University of Dhaka

Submitted By: Group 12

1. **Md Hasin Israaq**
Roll: ZH-135-057
Section: A
2. **Tasnuva Afrin**
Roll: SN-135-094
Section: B
3. **Mastura Zaman**
Roll: FM-135-065
Section: B
4. **Laiba Binte Yunus**
Roll: Readmission (Reg-2019816238)
Section: B

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Abstract:

The rising number of GDP per capita has a significant effect on education. This research paper investigates, using a quantitative approach, the relationship between GDP per capita and literacy rate. Through this econometric investigation, we hope to add empirical knowledge to the discussion on the relationship between economic development and literacy, with implications that will be beneficial to both scholars and policymakers.

Introduction

Understanding the relationships between economic prosperity and educational results is crucial as the world community works toward inclusive growth and sustainable development. The conventional consensus indicates a positive correlation between GDP per capita and literacy rates, with higher GDP per capita potentially translating into more educational investment, better access to learning materials, and stronger infrastructure. But a closer look is necessary due to the intricate nature of this interaction. The connection between Gross domestic product per capita and literacy rate is a diverse one. A higher GDP per capita is an indicator of greater economic prosperity that can lead to improved educational opportunities and outcomes. A greater literacy rate results from a decrease in the number of people undergoing financial barriers to education as GDP per capita rises. Numerous nations worldwide have seen this favourable association. Strong economies typically spend greater resources on their educational institutions. Governments in economically prosperous nations often have the resources to make major investments in education, from setting up and maintaining schools to providing excellent instructors and learning equipment. A greater number of the population will get education more easily when the economy is doing well. Families with higher income levels have the money to pay for the expenses related to schooling, including uniforms, school fees, and transportation. Robust education systems are made possible by economic success, which also contributes to workforce development, innovation, individual empowerment, and global competitiveness. The benefits of prioritizing and funding education are seen not just at the individual level but also greatly impact the nation's overall socioeconomic growth. The correlation shown between economic success and literacy highlights the significance of adopting a comprehensive strategy for development that acknowledges the interdependence of social, educational, and economic elements.

Background

Economists, decision-makers, and scholars have always had a strong interest in the relationship between economic progress and academic results. One important field of research that sheds insight on the complicated behavior between a country's economic development and the educational achievement of its population is the link between GDP per capita and literacy rates. This econometrics assignment explores this complex relationship and attempts to measure the degree to which GDP per capita affects literacy rates across different nations. A variety of statistical techniques will be employed in this econometric investigation to examine a dataset that includes GDP per capita and literacy rates for a range of nations. The study will utilize regression analysis to evaluate the strength and importance of the correlation, while accounting for any confounding variables including government spending on education, cultural influences, and socioeconomic metrics. A variety of statistical techniques will be employed in this econometric investigation to examine a dataset that includes GDP per capita and literacy rates for a range of nations. The study will utilize regression analysis to evaluate the strength and importance of the correlation between education and GDPPC.

Literature Review

Exploring the intricate dance between a country's economic well-being and literacy rates, research consistently reveals a positive connection. Rahman (2013)¹ dives into the mix, investigating how GDP, per capita GDP (PGDP), literacy rates, and unemployment rates are linked. Surprisingly, despite common belief, Rahman finds a significant positive relationship between PGDP and literacy rates. This suggests that boosting literacy could be a key to reducing unemployment and fostering overall economic growth—an insight challenging the idea that GDP operates independently of these factors.

“Gross domestic product (GDP) and per capita GDP (PGDP) are basic measures of the economic performance of a country. The literacy rate is the percentage of people with the ability to read and write.

Unemployment rate is the percentage of the total labour force that is unemployed but actively seeking employment and willing to work. This paper investigates the relationship among GDP, PGDP, literacy rate and unemployment rate. It is observed that GDP is not significantly related with PGDP, literacy rate or, unemployment rate. There exist significant positive relationship between PGDP and literacy rate but significant negative relationship between PGDP and unemployment rate and between literacy rate and unemployment rate. Therefore taking proper initiative to increase literacy rate of a country will reduce its unemployment rate and increase PGDP resulting development of the country.”

- Rahman (2013)

Adding more colour to the canvas, Coulombe (2006)² brings in a unique perspective by using literacy data from the 1994-1998 International Adult Literacy Survey. The findings from a panel analysis of 14 OECD countries show that literacy scores carry more weight than traditional measures like years of schooling. Coulombe's work highlights the tangible impact of literacy on both short-term growth and long-term prosperity, emphasizing the influence of literacy on GDP per capita and labour productivity. The study also points out that investing in women's education and improving literacy across the board significantly contribute to economic growth.

“From the demographic profile of the 1994-1998 International Adult Literacy Survey, we derive synthetic time series over the 1960-1995 period on the literacy level of labor market entrants. This information is then used as a measure of investment in education in a two-way error correction panel data analysis of cross-country growth for a set of 14 OECD countries. The analysis indicates that direct measures of human capital based on literacy scores contain more information about the relative growth of countries than measures based on years of schooling. The results show that, overall, human capital indicators based on literacy scores have a positive and significant effect on the transitory growth path and on the long-run levels of GDP per capita and labor productivity. Quantitatively, our results indicate that the skills associated with one extra year of schooling increase aggregate labor productivity by approximately 7 %, which is consistent with microeconomic evidence (Psacharopoulos, 1994). Moreover, we find that investment in the human capital of women is more important for growth than investment in the human capital of men and that increasing the average literacy skills over all individuals has a greater effect on growth than increasing the percentage of individuals that achieve high levels of literacy skills.”

- Coulombe (2006)

Taking the exploration to the Asian continent, Mehmood (2014)³ employs a more people-centric approach. Using a pooled mean group (PMG) method, Mehmood digs into the roles of a robust health sector and high literacy rates in Asian economic growth. The results, spanning from 1990 to 2012 across 26 Asian countries, reveal a long-term connection between income per capita, health expenditures, and literacy rates. The study shows that not only does higher literacy lead to increased health spending, but it also sets off a positive feedback loop with growing demands for health services. In simpler terms, Mehmood emphasizes that literacy isn't just about economic growth—it's about the well-being of the entire society.

“Well-functioning health sector and high literacy rates are desirable features of an economy. To explicate their role for Asian countries, in economic growth this paper estimates their role using pooled mean group (PMG) estimation technique. Long run relationship is examined for a sample of 26 Asian countries with data for 1990 to 2012. PMG estimates are augmented by other estimators like FMOLS and DOLS to quantify the contribution of health sector and literacy. Results show the presence of long run relationship between income per capita, health expenditures, and literacy rate. Uni-causality is found from income per capita to health expenditures and bi-causality between income per capita and literacy rates. Results reveal that higher literacy rates lead to increased health expenditures due to increase demand of health services.

Recommendations are made on the basis of empirical analysis.”

- Mehmood (2014)

In a nutshell, Rahman, Coulombe, and Mehmood's work collectively paints a picture of the intertwined nature of GDP per capita, literacy rates, and economic development. Their discoveries suggest that literacy isn't just about reading and writing; it's a key player in shaping a country's economic trajectory. These findings invite us to see education not just as a personal asset but as a societal engine, urging us to invest in literacy for both individual empowerment and the broader prosperity of our communities.

Data

Data Source

For the empirical investigation in this research paper, we draw upon robust datasets to analyze the relationship between GDP per capita (GDPPC) and adult literacy rates. The GDPPC data is sourced from the International Comparison Program and the World Development Indicators database, both provided by the World Bank. Additionally, the Eurostat-OECD PPP Programme contributes to the comprehensiveness of our GDPPC dataset. These sources ensure the reliability and comparability of our economic indicators, facilitating a thorough examination of the economic dimension of our study.

Complementing our economic data, adult literacy rates are derived from the UNESCO Institute for Statistics (UIS) using the UIS.Stat Bulk Data Download Service. The UIS is renowned for its authoritative and globally recognized educational statistics. By accessing the UIS database, we ensure the accuracy and consistency of our adult literacy rate data. The utilization of these datasets not only strengthens the empirical foundation of our research but also aligns with best practices in academic research, promoting transparency and reliability in our analysis.

It is crucial to note that the data retrieval process was conducted with precision, emphasizing the importance of up-to-date and reputable sources. The combination of GDPPC data from the World Bank and adult literacy rate data from the UIS equips our research with a solid basis for exploring the dynamic relationship between economic

development and literacy, contributing to the scholarly discourse on this critical intersection.

Data Description:

Dependent Variable: We will be using the dependent variable **Literacy rate, adult total (% of people ages 15 and above)**, which is defined as the percentage of people ages 15 and above who can both read and write with an understanding of a short simple statement about their everyday life.

Independent Variables: For our independent variables, we have **GDP per capita, PPP (current international \$)**. This indicator provides per capita values for gross domestic product (GDP) expressed in current international dollars converted by purchasing power parity (PPP) conversion factor. GDP is the sum of gross value added by all resident producers in the country plus any product taxes and minus any subsidies not included in the value of the products. conversion factor is a spatial price deflator and currency converter that controls price level differences between countries. The total population is a mid-year population based on the de facto definition of population, which counts all residents regardless of legal status or citizenship.

Research Question

1. Does GDP per capita influence literacy rates?

Methodology of The Study

Data methodology is the process of choosing and applying appropriate methods for collecting and analyzing data to answer a research question. There are different types of data, such as quantitative, qualitative, primary, secondary, descriptive, and experimental, and each type requires a different data collection method.

In this study, we want to show the impact of our explanatory variable on the Literacy rate. A stepwise simple linear regression analysis was performed with Literacy Rate as the dependent variable. The adoption of a semi-log model is based on the application of logarithmic transformation, which proves to be a convenient method for normalising a highly skewed variable in a dataset. In cases where variables exhibit nonlinear

relationships, errors in predictions may be skewed detrimentally. Using logarithms on one or more variables enhances model fit by reshaping the distribution of features into a more bell-shaped and normally distributed curve and mitigating the impact of extreme values by compressing the scale of the variable. Taking the logarithm of a variable also made its effects more interpretable in percentage terms. Our predicted model is:

$$\text{Literacy_rate} = \beta_1 + \beta_2 \log(\text{GDP_PC}) + \epsilon_i$$

Here,

Literacy_rate = Literacy rate, adult total (% of people ages 15 and above)

GDP_PC = GDP per capita, PPP (current international \$).

GDP = Gross Domestic Product

β_1 = Intercept Coefficient

β_2 = Slope coefficient of GDPPC

ϵ_i = Error Term

Hypothesis:

Hypothesis setup

A hypothesis setup for a two-tailed test is a way of testing whether the mean of a population is different from a specified value. The null hypothesis states that the population mean equals to the value, while the alternative hypothesis states that the population mean is not equal to the value.

$$H_0: \beta_1 = 0$$

$$H_1: \beta_1 \neq 0$$

Here, we have a level of significance $\alpha=0.05$. So, if we find $t_{\text{calculated}} > t_{\text{tabulated}}$, then we reject null and conclude that the effect of the explanatory variable is statistically significant.

Test Statistic

Test statistics play a pivotal role in summarizing the outcomes of statistical tests and guiding decisions on whether to accept or reject the null hypothesis. Various types of

test statistics, such as t, z, f, and chi-square, are tailored for distinct statistical tests. These statistics are typically computed as a ratio of the observed effect, like the difference between means or the correlation between variables, to the variation in the data, such as standard deviation or standard error. A larger test statistic suggests a higher likelihood that the observed effect is significant rather than a result of chance.

The utility of test statistics extends to determining the p-value, representing the probability of obtaining a test statistic as extreme or more extreme than the observed one under the assumption that the null hypothesis is true. Alternatively, comparing the test statistic to a critical value, which demarcates the rejection and acceptance regions of the null hypothesis, provides a basis for decision-making. If the test statistic surpasses the critical value, the null hypothesis can be rejected. Conversely, if the test statistic falls below the critical value, acceptance of the null hypothesis is appropriate.

- One-sample t-test: This type of t-test is used when you have one group or sample and you want to compare its mean with a theoretical or population mean. The formula for a one-sample t-test is:

$$t = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

Where- \bar{x} = mean of the sample,
 μ = mean of the population,
 σ = standard deviation,
 n = number of observations

Source	SS	df	MS	Number of obs	=	80
Model	12413.3432	1	12413.3432	F(1, 78)	=	101.34
Residual	9554.77329	78	122.497094	Prob > F	=	0.0000
				R-squared	=	0.5651
				Adj R-squared	=	0.5595
Total	21968.1165	79	278.077424	Root MSE	=	11.068

Literacy_r~e	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
logGDP_PC	12.08245	1.200255	10.07	0.000	9.692926	14.47197
_cons	-30.23698	10.91091	-2.77	0.007	-51.95892	-8.515038

Table 1: Simple Regression on Stata

After running a simple regression on Stata, the above result came up. From this it is clear that the calculated t value of logGDP_PC, $t_{\text{calculated}}=10.07$, which is significantly larger than the tabulated t value, $t_{\text{tabulated}}=1.664$.

$$t_{\text{calculated}} > t_{\text{tabulated}}$$

Decision

We reject the null hypothesis as the $t_{\text{calculated}}$ value is greater than $t_{\text{tabulated}}$ or critical value.

Result

The result is statistically significant. That means, literacy rate has a positive relationship with GDP.

Results: Descriptive and Econometrics

Descriptive Analysis

The study utilized data from 80 countries spanning the year 2022. Although data was initially collected for all 206 available countries or regions, some were excluded due to missing data, managed using a Stata command. Regarding Literacy Rate, the mean was 78.89, accompanied by a Standard Deviation (SD) of 16.57. The data exhibited a maximum of 99.99997 for Uzbekistan and a minimum of 27.28 for Chad. The skewness for Literacy Rate was -0.93552, and the kurtosis was 0.68. Statistics for the other variable, GDP Per Capita are presented below. Logarithm was taken for this variable to compress the scale of the variables.

Variable	Mean	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis
Literacy rate	78.88975519	99.999977	27.280001	16.57110302	-0.935516124	0.682020893
GDP PC	13748.95799	87729.191	836.18757	15010.1414	2.635674267	9.206708989

Table 2: Central tendency and dispersion of data

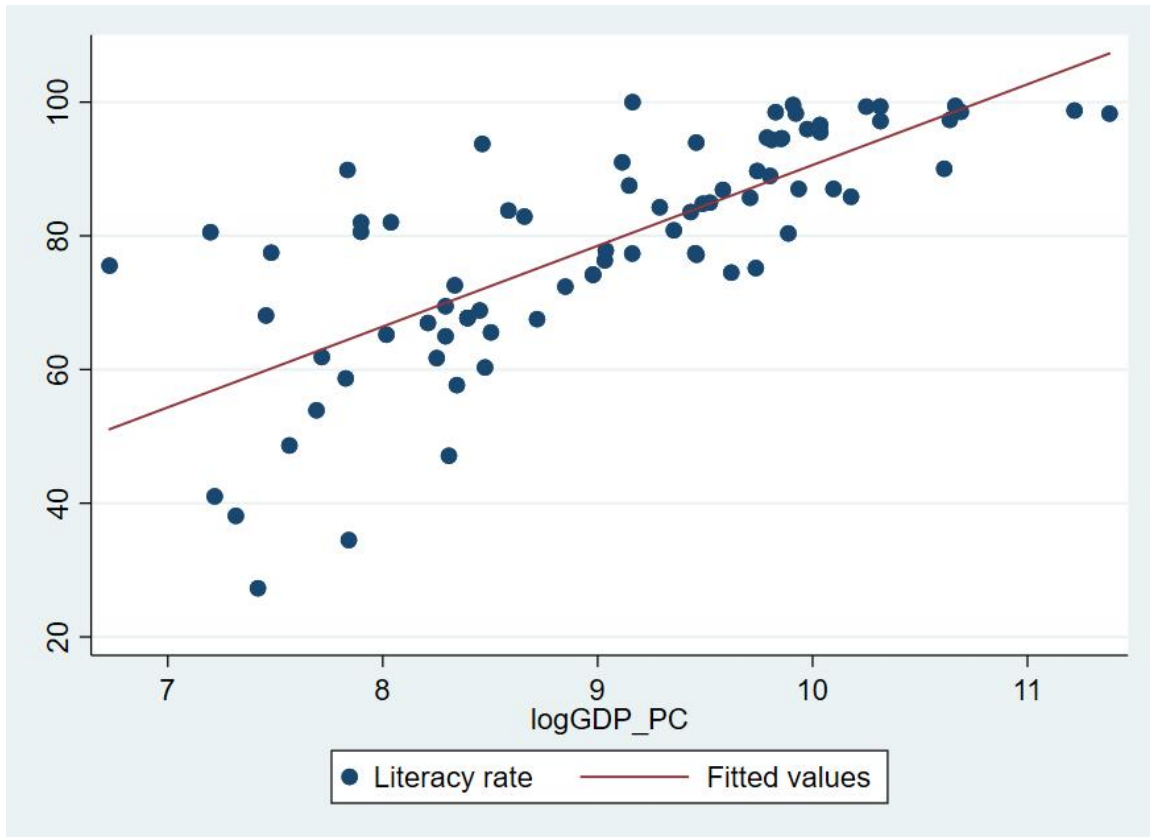


Figure 1: Scatter Diagram for Literacy rate and log(GDP_PC)

The scatter diagrams depict Literacy Rate on the Y-axis and Log(GDP_PC) on the X-axis, indicating a positive correlation between the variables. This implies that an upward trend in the explanatory variable corresponds to an increase in Literacy Rate as well.

Econometric Analysis

Source	SS	df	MS	Number of obs	=	80
Model	12413.3432	1	12413.3432	F(1, 78)	=	101.34
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Table 3: Simple Regression on Stata

$$\text{Literacy rate} = -30.23698 + 12.08245 \cdot \log_{10} \text{GDP_PC} + \epsilon_i$$

In our semilog regression model, Literacy Rate is selected as the dependent variable, while GDP per capita serves as the independent variable. The intercept term (β_1) is calculated at -30.23698; however, in semilog models, the intercept's economic interpretation is not straightforward. The results indicate that, keeping all other independent variables constant, a 1% change in the log of GDP per capita corresponds, on average, to a 12.08% change in Literacy Rate, ceteris paribus.

By conducting an Analysis Of Variance (ANOVA), we derived an F-value of approximately 101.34. This substantial F-value suggests that GDP per capita factors indeed exert a notable impact on Literacy Rate. The findings affirm a positive correlation between literacy rate and GDP per capita, aligning with our initial hypothesis. Further reinforcing this, hypothesis tests demonstrate that the positive correlation is statistically significant across all levels of significance. Consequently, we reject the null hypothesis that changes in per capita GDP have no effect on literacy rate. This underscores the meaningful influence of economic factors, specifically GDP per capita, on literacy rates, emphasizing the importance of economic development in fostering higher literacy levels.

Conclusion

Our investigation of the relationship between literacy rates and per capita GDP reveals an intriguing story that highlights the significant influence of financial stability on academic performance. As seen, the positive relationship between GDP per capita and literacy rates acts as a pivot, supporting our initial theory that per capita GDP has a significant impact on literacy rates.

As we delve deeper into the complexities of educational obstacles, our research reveals a startling truth: there is a tenuous link between student dropout rates and financial instability. The story then turns to the predicament of students battling endless financial situations, wherein financial assistance is becoming less and less available due to rising expenses. These students suffer greatly from the costs associated with books, stationery, notes, and extra fees for lessons and tests. Beyond academics, the financial barrier forces some people to enter the employment too soon under the influence of family expectations.

Students' emotional and physical health are affected by the ripple effects of economic instability, which extend beyond the domain of financial restrictions. Their lives are shadowed by the uncertainty brought on by financial difficulties, which affects not only their academic endeavors but also has an adverse effect on their general health. Another severe result of low GDP is the reality of hunger, which stunts pupils' intellectual growth since they cannot afford healthful food. When combining the many issues that our research has shed light on, it is clear that the disturbance term—which represents implicit factors—has a significant effect on dropout rates. Given these implicit impacts, it is important to interpret data cautiously, as demonstrated by our semilog regression model's acknowledgement of the possible existence of specification bias. This warning remark applies to upcoming research projects as well, asking academics to exercise caution while navigating any possible biases.

Our results are consistent with the original hypothesis, even after taking these complexity and potential biases into account. The fact that the per capita GDP and literacy rates continue to positively correlate shows how economic forces continue to have an impact on educational achievements. Our findings call for both academic focus and a complete, holistic strategy to address the many problems that students experience in their pursuit of an education as we traverse the complex interactions between economics and education.

References

1. Rahman, M. Shafiqur. "Relationship among GDP, Per Capita GDP, Literacy Rate and Unemployment Rate." (2013).
2. Coulombe, Serge and Jean-François Tremblay. "Literacy and Growth." *Topics in Macroeconomics* 6 (2006): n. pag.
3. Mehmood, Bilal et al. "Health Expenditure, Literacy and Economic Growth: PMG Evidence from Asian Countries." (2014).

Appendix

Appendix 1

Table: Countries' and Regions' Data

Country Name	GDP_PC	Literacy_rate	logGDP_PC
Albania	18551.716	98.5	9.828318
Angola	6973.6963	72.400002	8.8499
Benin	4056.1083	47.099998	8.30798
Bosnia and Herzegovina	20376.892	98.300003	9.922156
Brazil	17821.737	94.690002	9.788175
Burkina Faso	2545.8635	34.490002	7.842225
Burundi	836.18757	75.540001	6.728853
Cabo Verde	9082.8376	91	9.114141
Cambodia	5349.4638	83.779999	8.584752
Chad	1668.023	27.280001	7.419394
Chile	30208.806	97.160004	10.31589
Comoros	3832.469	61.709999	8.251265
Congo, Dem. Rep.	1337.3911	80.540001	7.198476
Dominican Republic	22833.526	95.5	10.03598
Ecuador	12822.114	93.94812	9.458926
Egypt, Arab Rep.	15090.991	74.5	9.621853
Gabon	16470.584	85.690002	9.709332
Gambia, The	2509.8295	58.669998	7.82797
Georgia	20113.377	99.574989	9.909141
Guatemala	10818.172	84.269997	9.288982
Guinea-Bissau	2190.4392	53.900002	7.691857
Guyana	40641.787	90.029999	10.61255
India	8379.0625	76.322777	9.033491
Iran, Islamic Rep.	18075.055	88.959999	9.802288
Kenya	5763.9101	82.879997	8.659371
Lao PDR	9384.2657	87.519997	9.14679
Lesotho	2694.5466	82.010002	7.898985
Madagascar	1774.0687	77.480003	7.481031
Malawi	1732.0303	68.080002	7.457049
Morocco	9518.7061	77.349998	9.161015
Niger	1505.2427	38.099998	7.31671
Oman	41724.339	97.339058	10.63884
Sao Tome and Principe	4738.1917	93.75	8.46341
Senegal	4208.965	57.669998	8.344972
Sierra Leone	1931.0673	48.639999	7.565828

Somalia	1364.1017	41.025002	7.218251
Tanzania	3096.8845	82.019997	8.038152
Tunisia	12489.718	83.559998	9.432661
Uganda	2693.8153	80.589996	7.898714
United Arab Emirates	87729.191	98.285408	11.38201
Uzbekistan	9532.5119	99.999977	9.162463
Zimbabwe	2530.646	89.849998	7.83623
Africa Eastern and Southern	4169.0195	72.600403	8.335436
Africa Western and Central	4798.4345	60.312698	8.476045
Arab World	16913.653	75.171532	9.735876
Central Europe and the Baltics	42799.33	99.427521	10.66428
Early-demographic dividend	11550.168	80.828011	9.354455
Europe & Central Asia	43894.581	98.541061	10.68955
Europe & Central Asia (excluding high income)	28289.465	99.325691	10.25025
Europe & Central Asia (IDA & IBRD countries)	30183.167	99.349823	10.31504
Fragile and conflict affected situations	4932.192	65.555367	8.503539
Heavily indebted poor countries (HIPC)	3032.4443	65.218521	8.017124
IBRD only	17027.559	89.700996	9.742588
IDA & IBRD total	13662.289	84.961456	9.522395
IDA blend	6113.1217	67.533218	8.718193
IDA only	3992.648	69.471649	8.29221
IDA total	4682.9214	68.838257	8.451677
Late-demographic dividend	22814.232	96.590591	10.03514
Latin America & Caribbean	19096.591	94.600121	9.857265
Latin America & Caribbean (excluding high income)	18212.818	94.346092	9.809881
Latin America & the Caribbean (IDA & IBRD countries)	19000.161	94.512901	9.852202
Least developed countries: UN classification	3679.6855	66.964149	8.210583
Low & middle income	13213.673	84.795341	9.489007
Low income	2244.9657	61.870621	7.716445
Lower middle income	8416.1805	77.795631	9.037911
Middle East & North Africa	19676.629	80.35759	9.887187
Middle East & North Africa (excluding high income)	12764.038	77.399498	9.454387
Middle East & North Africa (IDA & IBRD countries)	12837.791	77.176361	9.460149
Middle income	14513.172	86.869331	9.582812
North America	74519.726	98.740669	11.21882

Other small states	26345.668	85.837479	10.17906
Pre-demographic dividend	3993.719	64.977951	8.292479
Small states	24284.943	87.019661	10.09761
South Asia	7931.1379	74.187759	8.978552
South Asia (IDA & IBRD)	7931.1379	74.187759	8.978552
Sub-Saharan Africa	4423.4888	67.715012	8.394684
Sub-Saharan Africa (excluding high income)	4420.9434	67.711639	8.394109
Sub-Saharan Africa (IDA & IBRD countries)	4423.4888	67.715012	8.394684
Upper middle income	21487.642	95.955971	9.975233
World	20645.484	87.011749	9.935252

Source: WDI

Appendix 2

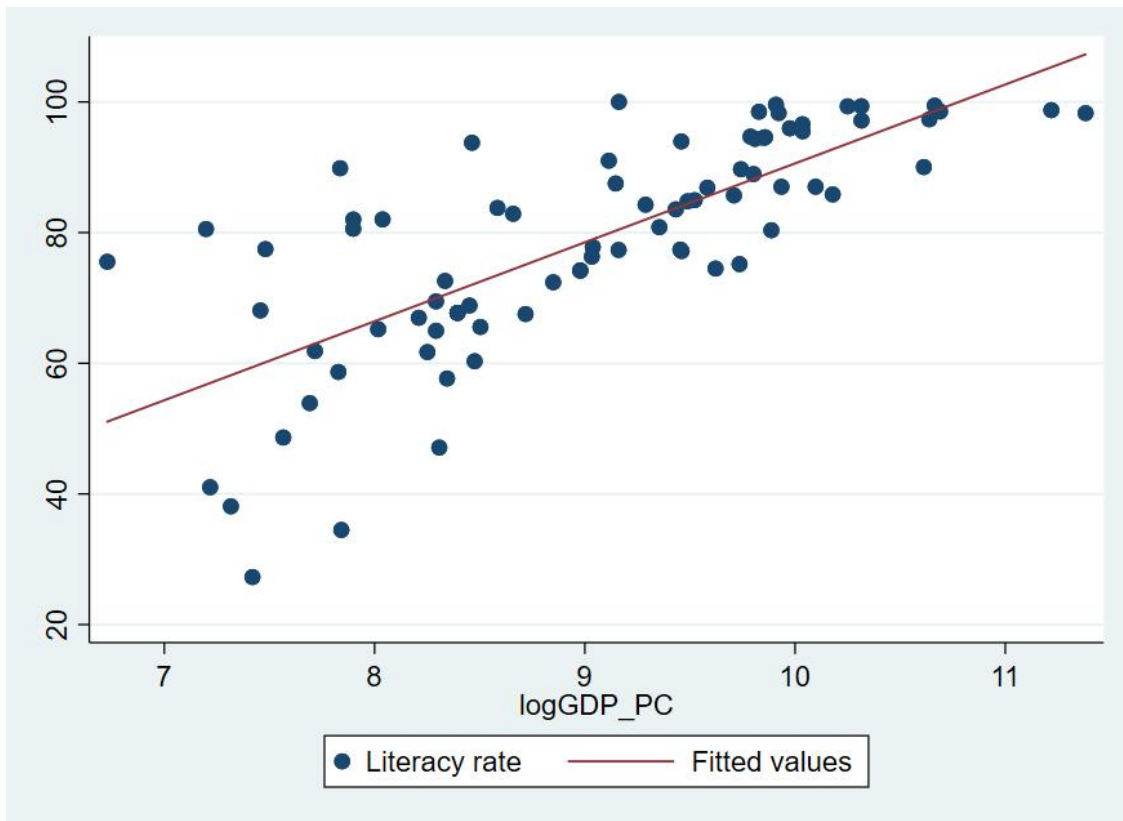
Table 2: Central tendency and dispersion of data

Variable	Mean	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis
Literacy rate	78.88975519	99.999977	27.280001	16.57110302	-0.935516124	0.682020893
GDP PC	13748.95799	87729.191	836.18757	15010.1414	2.635674267	9.206708989

Source: Authors' Calculation

Appendix 3

Figure: Scatter Diagram for Literacy rate and log(GDP_PC)



Source: Authors' Calculation