The Relationship Between Female Higher Education and Output*

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December 2022

Abstract

This study analyzes the relationship between higher education attainment levels and GDP per capita among different gender groups. Dummy variables for different regions and country-level income groups are used to remove potential biases in the regression model in certain regressions. Previous theoretical literature surrounding educational attainment and GDP per capita levels is also applied to determine possible causal relationships from the regression analysis results. The simple OLS model correlating tertiary educational attainment and GDP per capita finds that these variables are positively correlated with each other at statistically significant levels for both males and females. However, when other variables such as income levels and region were incorporated into the regression model, it failed to find a statistically significant correlation between tertiary educational attainment levels and GDP per capita. Therefore, this study finds it difficult to conclude whether female tertiary educational attainment levels have any direct effects on GDP per capita.

JEL Codes: I25, O47
Keywords: Female Education, Development, Growth

* Group 8 Empirical Project

1 Introduction / Literature Review

Education cannot be neglected as a factor in the discussion of economic growth. The logic behind the relationship between education and economic development is simple: education is necessary for people to both benefit from and contribute to technological advances, which serve as the most important power of economic growth. Considering the cruciality of education for both individuals and societies, and the fact that the educational resources have been unequally distributed between different sexes in a lot of nations even until today, it is reasonable to raise curiosity towards the effects of the unequal education distributions on economic development. Barro and Lee (1993) examined the educational attainment of the two sexes for 129 countries over five-year periods from 1960 to 1985. The paper concludes that the educational attainment of men appears to be more important for both GDP growth and non-human investment than female education attainment. This finding might reflect the greater labor-force role of males in most developing countries at the time.

However, in one recent study, Gazi and Cooray (2015) gave an opposite conclusion compared to Barro and Lee (1993), suggesting that Asian economies can grow faster by investing more in female education. While there have been studies discovered a positive relationship between female education and economic growth in specific regions, such as Asia Pacific countries (Oztunc, Oo& Serin, 2015), Africa (Brempong, Paddison& Mitiku, 2005), and India (Kumar& B, 2021), one cross-continent and conclusive report is still hard to find.

This paper intended to replicate the comprehensive study of Barro and Lee (1993) in a more recent setting. Specifically, we want to explore how female tertiary education is associated with economic development across different countries. In addition, this paper explored if there are any differences in the effectiveness of female education on economy development between richer and poorer countries, as in another recent study, Bloom, Canning & et al (2014) suggests that tertiary education has a great role in promoting economic growth and alleviating poverty in Africa, challenging the conventional belief that tertiary education is less important for poorer countries.

2 Data Overview

To conduct the analysis, data from the World Bank Open Catalog was used. The World Bank database has the most accurate and comprehensive data from all countries around the world, and accounts for many different variables that are pertinent to the analysis. The time frame chosen was 2000 to 2021, due to the lack of data from previous decades as well as a need to still have a long enough period to deduce any changes in countries. The variables chosen from the database were tertiary education attainment for females, tertiary education attainment for males, and GDP per capita. Tertiary education attainment (% of population aged 25+) is the most relevant variable to explore, as it would show statistics on those who obtained degrees from higher education and omit those who simply enrolled and dropped out. Additionally, most college graduates enter the workforce immediately after graduation, making tertiary education attainment the best variable to measure the effect of education on changes in GDP. GDP per capita serves as the indicator of economic status of a certain country in a certain period. Missing data was dealt with by simply being omitted from any regressions.

2.1 Basic Regressions

After loading the dataset into R, basic regressions for females and males were conducted, with tertiary education attainment (F or M) as the independent variable and GDPC as the dependent variable. These regressions were helpful to observe any differences between the genders and to establish a baseline for future regressions with additional control variables. The attainment variables from the regressions of both genders were statistically significant (***), so we knew from the start that tertiary education attainment for both genders have a significant effect on GDP per capita around the world. Interestingly, the t-statistic for females (16.904) was higher than the t-statistic for males (13.647), which may indicate greater evidence for the effect of female education in comparison to males.

2.2 Median Dummy

Using the GDP per capita information that is provided in the World Bank dataset, we were able to create a dummy variable to represent the median GDP per capita of all the countries in the dataset. We calculated this number to be

approximately 11,337.50. Note that this reflects median GDP per capita over time and over all countries.

The coefficient of the dummy variable in all the regressions represents the additional contribution that higher educational attainment adds to GDP per capita for a country that is above the median threshold. In other words, this represents additional added GDP per capita for higher levels of educational attainment in richer countries.

In the regressions where the median dummy was applied, we also interacted the median income variable with educational attainment (either female or male depending on the regression). We did this because we believe that the relationship between the level of GDP per capita in a country and educational attainment is likely correlated to one another, therefore an interaction term must be applied to the regression to ensure an unbiased result.

In all regressions conducted using the median dummy variable and the interaction term, there was a statistically significant effect. All interaction terms were significant at the 0.001 level (***), however statistical significance varied for the median income dummy variables themselves across the different regressions.

2.3 Region Dummy

The World Bank categorizes countries by the following 7 regions: East Asia and Pacific (38), Europe and Central Asia (58), Latin America & the Caribbean (42), Middle East and North Africa (21), North America (3), South Asia (8), Sub-Saharan Africa (48).

We first regressed GDPC on tertiary education attainment (Female) controlling for the median income dummy and the region dummy variables using the World Bank region categories: deca - Europe and Central Asia; dmena - Middle East and North Africa; deap - East Asia and Pacific; dssa- Sub-Saharan Africa, dlac -Latin America and the Caribbean; dna- North America (we omitted the dummy variable dsa - South Asia — to prevent the occurrence of perfect multicollinearity).

3 Results

3.1 Regression Models

Regression 1:

$$GDP\ per\ capita = \ \beta_0 + \beta_1 * attain_{Female} + \epsilon$$

Regression 2:

$$GDP\ per\ capita = \ \beta_0 + \beta_1 * attain_{Male} + \epsilon$$

Regression 3:

$$GDP\ per\ capita = \ \beta_0 + \beta_1 * attain_{Female} + \beta_2 * income_{median} + \beta_3 * attain_{Female} * income_{median} + \epsilon$$

Regression 4:

$$GDP\ per\ capita = \ \beta_0 + \beta_1 * attain_{Female} + \beta_2 * income_{median} + \beta_3 * attain_{Male} * income_{median} + \epsilon$$

Regression 5:

$$GDP\ per\ capita = \ \beta_0 + \beta_1 * attain_{Female} + \beta_2 * income_{median} + \beta_3 * attain_{Female} * income_{median} + \ \beta_4 * deca + \ \beta_5 * dmena + \beta_6 * deap + \ \beta_7 * dssa + \ \beta_8 * dlac + \beta_9 * dna + \ \epsilon$$

Regression 6:

$$GDP\ per\ capita = \ \beta_0 + \beta_1 * attain_{Female} \beta_2 * income_{median} + \beta_3 * attain_{Male} * income_{median} + \ \beta_4 * deca + \ \beta_5 * dmena + \beta_6 * deap + \ \beta_7 * dssa + \ \beta_8 * dlac + \beta_9 * dna + \ \epsilon$$

3.2 Coefficient Table

	GDP Per Capita					
	Regression 1	Regression 2	Regression 3	Regression 4	Regression 5	Regression 6
(Constant)	4191.61*	5687.76**	4150.5	4045.6	6222.8	7782.9
	(1691.43)	(1931.66)	(2326.4)	(2840.8)	(4122.3)	(4819.3)
attain_Female	1342.85***	-	238.2	-	-191.7	-
	(79.44)		(198.3)		(228)	
attain_Male	-	1364.06***	-	216.7	-	-239.8
		(99.95)		(228.5)		(247.1)
median_income	-	-	10434**	14221.7***	7503.3*	8936.8*
			(3245.2)	(3653.2)	(3647.7)	(3996.8)
median_income *attain_Female	-	-	805.3***	-	1024.3***	-
			(219.7)		(235.7)	
median_income *attain_Male	-	-	-	767.8***	-	1040.6***
				(252.6)		(259)
deca	-	-	-	-	1332	1148.6
					(4710.9)	(4522)
dmena	-	-	-	-	20830***	22833.2***
					(5021.2)	(4831)
deap	-	-	-	-	15396.1**	13145.9**
					(4923.9)	(4776.3)
dssa	-	-	-	-	-3583	-4907.7
					(4736)	(5029.1)
dlac	-	-	-	-	-2068.1	-3302.8
					(4602.1)	(4505.4)
dna	-	-	-	-	21954**	21328.9**
					(6899.9)	(6884.9)
R-Squared	0.3741	0.2804	0.49	0.455	0.603	0.5848

Region Dummies

*Standard Errors in Brackets / * P<0.05, ** P<0.01, *** P<0.001*

3.3 Graphs

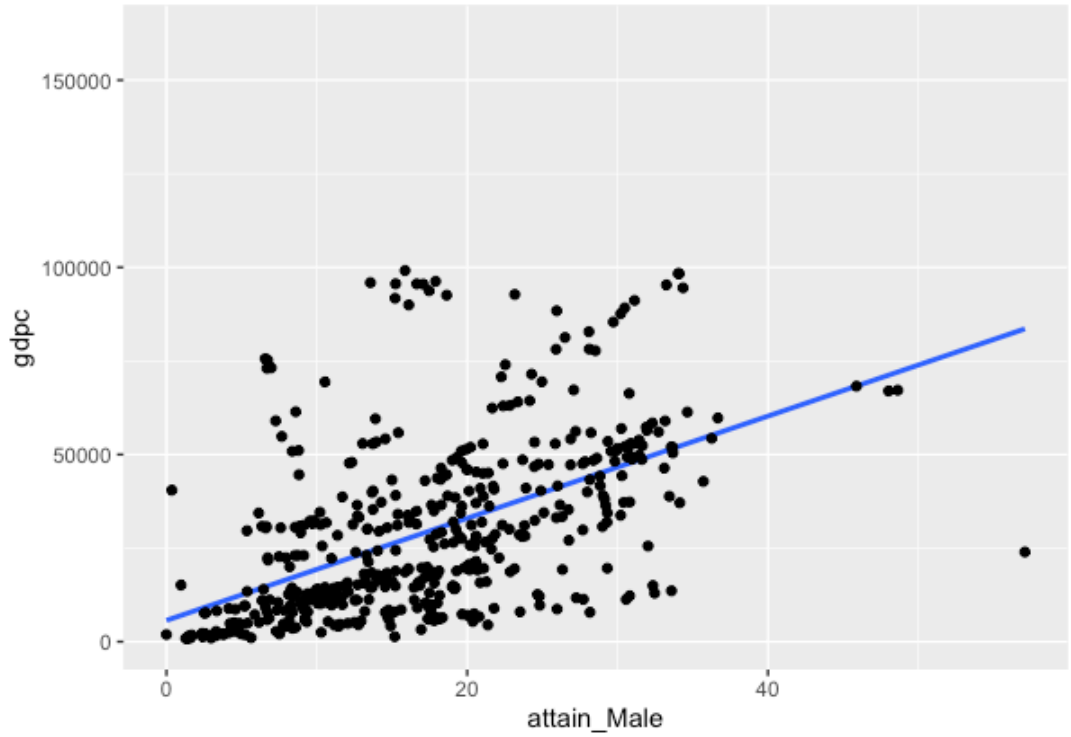

Figure 1 Male Higher Education Attainment x-axis, GDP per capita y-axis

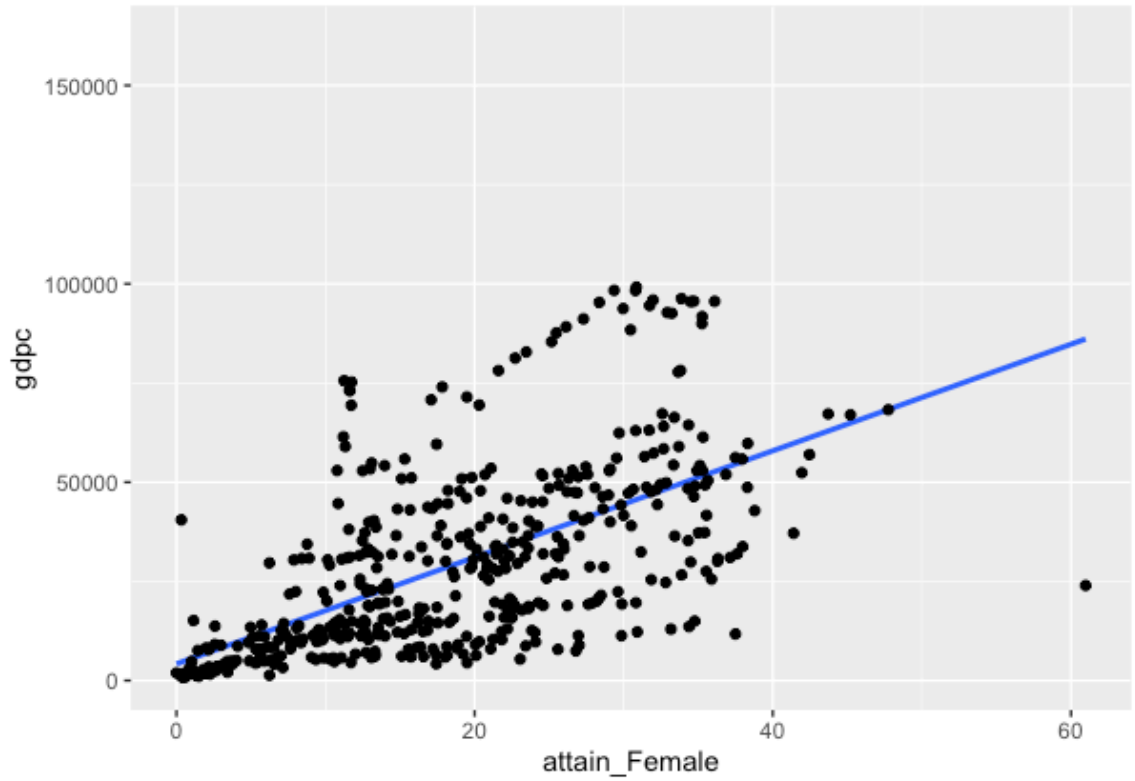

Figure 2 Female Higher Education Attainment x-axis, GDP per capita y-axis

4 Discussion

4.1 Regression 1 and 2:

The initial regressions that were conducted solely regressed female education attainment on GDP per capita (Regression 1) and male education attainment on GDP per capita (Regression 2). The results of Regression 1 suggest that a 1% increase in female education attainment is associated with, on average, a $1,342 increase in GDP per capita, ceteris paribus. This result is significant. The results from Regression 2 suggested that a 1% increase in male education attainment is associated with, on average, a $1,364 increase in GDP per capita, ceteris paribus. This result is significant. However, the R-squared value of Regression 2 indicates a weaker relationship than that of Regression 1.

4.2 Regression 3 and 4:

Following the basic regressions, the study also explores the impact of the socio-economic status of the country using a dummy variable which splits the same into two - the top 50% of the sample in terms of income level and the bottom 50%. Regression 3 results suggest that 1% increase in female education attainment is associated with, on average, a $238.2 increase in GDP per capita, ceteris paribus. In addition, an $1 increase in the median income level of a country is associated with, on average, an increase of $10,434 in GDP per capita, ceteris paribus. Furthermore, if a country is in the upper 50% in terms of income level, a 1% increase in female education attainment is associated with, on average, an additional $805.3 increase in GDP per capita, ceteris paribus. Performing the same regression on male education attainment, similar observations are discovered. The regression results suggest that 1% increase in male education attainment is associated with, on average, a $216.7 increase in GDP per capita, ceteris paribus. In addition, an $1 increase in the median income level of a country is associated with, on average, an increase of $14,221.7 in GDP per capita, ceteris paribus. Furthermore, if a country is in the upper 50% in terms of income level, a 1% increase in male education attainment is associated with, on average, an additional $767.8 increase in GDP per capita, ceteris paribus.

4.3 Regression 5 and 6:

Furthermore, regional dummy variables were also incorporated into the regression models to account for regional impacts on the relationship - for both gendered regressions. Interestingly, the results of both regressions depict a negative, but statistically insignificant, relationship between education attainment and GDP per capita. Regression 5 indicated that a 1% increase in female education attainment is associated with, on average, a $191.7 decrease in GDP per capita, ceteris paribus. Regression 6 indicates that a 1% increase in male education attainment is associated with, on average, a $239.8 decrease in GDP per capita, ceteris paribus. In terms of region, both regressions depict the Middle East and North African (MENA) region to be associated with the largest positive impact on the relationship and the Sub-Saharan African region to have the largest negative impact on the relationship.

Regression 5 depicts that a 1% increase in female education attainment in the MENA region is observed to be associated with, on average, a $20,830 increase in GDP per capita. This result is statistically significant. On the other hand, it is also observed that a 1% increase in female education attainment in the Sub-Saharan African region is associated with, on average, a $3,583 decrease in GDP per capita - the smallest in any region. This result is not statistically significant. Regression 6 depicts that a 1% increase in male education attainment in the MENA region, again, is observed to be associated with, on average, a $22,833.2 increase in GDP per capita. This result is statistically significant. It can also be observed that a 1% increase in male education attainment in the Sub-Saharan African region is associated with, on average, a $4,907.7 decrease in GDP per capita - again, the smallest in any region. This result is also not statistically significant.

5 Conclusion

The paper found that the relationship between female educational attainment and GDP per capita to be positive when regressed without external factors. Evidence was also found that a country's income level may impact the relationship positively - higher median income was, on average, associated with a higher GDP per capita. Interestingly, however, when regional effects were exclaimed, it was observed that the coefficient with the direct relationship between female educational attainment

and GDP per capita became negative. The Middle East / North African region (MENA) appeared to have the most positive impact on the relationship, while the Sub-Saharan African region, on average, was seen to have the greatest negative impact on the relationship. The relationships that were observed between female educational attainment and GDP per capita mirrored those observed between male educational attainment and GDP per capita. However, it must be noted that there remains a possible endogeneity problem within the model.

Like most studies considering the effects of female education on economic development, our study concludes the relationship between female educational attainment and GDP per capita to be positive when regressed without external factors. When compared to the effectiveness of male tertiary education on economic development (coefficient 1364.06), the effectiveness of female tertiary education is slightly lower, but still very similar (coefficient 1342.85). This matches our expectations that compared to the conclusion in Barro and Lee (1993), female education is less important on GDP growth, and the gap between the effectiveness of education for different sexes still exists but becomes much smaller. This result can be since as technology develops, there are less physically based labor force opportunities, so the chances are less biased towards men. More women begin to contribute to the process of developing the economy, so female education, or in other words the learning of skills, becomes more important to economic growth.

Our regression did not produce significant results while exploring the relationship between female tertiary education and economic development in the countries with GDPs higher than the median GDP. However, we did find a significant result when looking at the importance of male education (coefficient 767.8), which is less compared to the importance of male tertiary education to the economy in general (coefficient 1364.06). The result seems to align with the conclusion in Bloom, Canning & et al (2014), which states that tertiary education plays a greater role in promoting economic growth in poorer countries. The logic behind this finding may be that compared to primary and secondary education, tertiary education can bring more advanced technological developments, which can boost the economy in poorer countries faster.

The dummy variables for Middle East and North Africa (***), North America (**) and East Asia and Pacific (**) were however found to be statistically

significant. In some previous cross-country regression studies, such as Barro (1991), dummy variables for Sub Saharan Africa and Latin America were found to enter negatively and significantly into growth regressions. However, our data shows in the present specification that dummies for these two areas are negative and insignificant. Thus, the unusual growth experiences of these two regions are mostly accounted for by the explanatory variables.

6 Applications

The results of this study can provide a reference for countries to reallocate their educational resources to the two different sexes. Our findings suggest that the gap between the effectiveness of education for different sexes still exists but becomes much smaller, and the importance of female tertiary education becomes more important to the economy. Based on this finding, countries should create a more equal tertiary education environment for both sexes, with an emphasis on encouraging females to attain higher education. In contrast to the traditional point of view that higher education is less important for less-developed countries, we found that tertiary education can be more effective to economic development in poorer countries, which can call on the poor countries to focus more on providing higher education to their citizens. The regressions with regional effects can help us learn the regions where female tertiary education affects economic growth the greatest. The MENA area should put the most effort in encouraging women to attain tertiary education.

7 Limitations

Some of our results are insignificant, which can result from (1) too much missing data; (2) an endogeneity problem within the model. Theoretically, the regression models only account for associations, rather than solid causations. To generate more valid causal results, more control variables should be used.

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