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The Effect of Gender Inequality on Growth: A Cross-Country Empirical Study

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Abstract

Recently, a large amount of economic literature has focused on the empirical determinants of economic growth, especially the impact of human capital. These studies have established that human capital is a very significant determinant of growth. However, relatively few studies have examined the effect of misallocation of human capital on the basis of gender. Furthermore, those that study gender inequality consider different measures of inequality, different control variables, and different data sets. This study attempts to investigate the robustness of these previous findings. Using OLS regressions and more recent data than past studies, the results highlight the fact that cross country regressions, especially those dealing with older education data, must pay close attention to the presence of outlier countries in the data set.

I. Introduction

Gender inequality in developing countries has been much publicized in the last twenty years. Across the globe, women are less educated and receive worse healthcare than their male counterparts (Quibria 1995; World Bank 2000). In a much publicized series of papers, Amartya Sen concluded that because of these inequalities there were 100 million "missing women" worldwide (Sen 1992). While some programs have been initiated to try to counteract these problems, recent evidence suggests that the number of missing women has only increased in the last decade (Klasen and Wink 2002).

Many international organizations have taken notice of these inequalities. One of the United Nations Millennium Development Goals targets gender inequality specifically. Their goal is to "Eliminate gender disparity in primary and secondary education preferably by 2005, and at all levels by 2015" (United Nations 2006). Unfortunately, many countries failed to meet the 2005 target and Abu-Ghaida and Klasen (2004) find that 45 countries are off track to eliminate gender inequality by 2015. This situation is thus of substantial concern to policymakers—the relative deprivation of a group of people across the globe warrants significant attention. However, does this unequal treatment incur additional consequences for society as a whole? Specifically, does the under education of women in developing countries hurt growth? If it can be shown that gender inequality in education leads to slower growth in the country as a whole, governments and non-governmental organizations would have even more reason to invest in women's education.

A cursory glance at cross country data might lead one to believe that gender inequality in education could be an important component of growth. The following table contains female to male ratios of primary and secondary enrollments averaged over 2000-2005, broken down by World Bank Income Classification. As can be seen in Table 1, low income countries have much less female education relative to males than lower middle income countries, while upper middle income and high income countries have no inequality in primary and secondary education.

Table 1: Gender Inequality by Income

World Bank Classification[1]	Female-Male ratio of primary and secondary enrollment
Low Income	84.4
Lower Middle Income	97.8
Upper Middle Income	100.0
High Income	100.0

Source: World Development Indicators (2008)

Relatively few studies in the economic literature have examined the possible effect of gender inequality in education on growth. In addition, results have been mixed

[1] Classifications are as follows: Low Income—per capita GNI < $905 US; Lower Middle—$906 US < per capita GNI < $3565 US; Upper Middle—$3566 US < per capita GNI < 11,115 US; High Income—per capita GNI > $11,116 US. All figures are in 2006 US dollars.

as these studies have come to varying conclusions based on differing empirical models, control variables, and data sets. Therefore, further investigation is needed to establish the robustness of these previous results. Are these results sensitive to changes in model specification and data sets, or does gender inequality have a significant, robust effect on economic growth?

This study attempts to examine the robustness of the impact that gender inequality in education has on growth. Specifically, it pays attention to gender inequality at different levels of education, the effect of regional control variables on the analysis, and the sensitivity of results to outlier countries in the data set. Ordinary Least Squares (OLS) regressions are run on a cross section of countries, examining the impact of gender inequality in primary and total education on economic growth. Preliminary results show that gender inequality in primary education has a significant effect on growth, and that regional control variables have an important impact on the regression coefficients for gender inequality. However, after examining the data more closely, it becomes apparent that the results of this cross-country analysis are skewed greatly by the undue influence of one outlier country. This highlights how sensitive studies of gender inequality can be to changes in the data set.

The paper is structured as follows. Section II outlines recent developments in the economic literature related to gender inequality and its impact on economic growth. Section III presents the theoretical justifications for gender inequality's impact on growth, as well as the empirical model used in this study. Section IV then presents the data set used, while Section V discusses the methodology. Section VI presents the results and section VII concludes, discussing avenues for future research.

II. Literature Review

Over the past twenty years, there has been a wave of new empirical growth studies that examine the determinants of growth. The majority of this literature can be divided into one of two different groups. The first follows the Solow (1956) growth model and thus includes measures for capital stock, population growth, and savings/investment rates as the determinants of growth. The second set of papers follows the approach of Barro (1991) and includes a wide variety of variables that can be theoretically linked to growth, such as government expenditure, investment, population growth, and religion, but are not based off of a formal model. These "Barro-style" papers vary widely in their inclusion of different control variables and have been criticized because their theoretical justifications for including these variables are often somewhat ad hoc.

Because of the criticisms "Barro-style" regressions have faced, a number of sensitivity analyses have attempted to determine which variables are actually robust determinants of growth. Sala-i-Martin (1997) investigates these determinants, running over two million regressions to derive the distribution of the regression coefficients, which he uses to make inferences about the robustness of the variables. He includes initial GDP, education, and life expectancy in every regression and concludes that the other robust determinants of growth can be grouped into 9 broad categories: regional dummies, political variables, religious variables, market distortions, types of investment, primary sector production, openness, types of economic organization, and former Spanish colonies. This paper is criticized by Hendry and Krolzig (2004) as well as Hoover and Perez (2004), for having too lenient a definition of robustness. These studies use a different methodology, which eliminates variables within the context of essentially one regression equation. Their results find that revolutions, religion, investment, openness, initial GDP, life expectancy, and education are robust determinants of growth. Further work has been done by Sala-i-Martin et al. (2004) and Ciccone and Jarocinski (2007), who both use a Bayesian averaging of classical estimates approach to estimate the distribution of each regression coefficient, allowing them to assign significance levels. These later papers have shown initial GDP, education, life expectancy, government expenditure, region, investment, openness, and religion to be robust determinants of growth.

This large literature has routinely concluded that education is a significant determinant of growth, but none of these sensitivity analyses have considered the effect of gender inequality in education. However, because gender discrimination has been such an important issue in the eyes of the world community, a relatively large literature has emerged examining the effects of gender inequality on productive efficiency. Adeoti and Awoyemi (2006) examine the effect that gender inequality in employment has on productive efficiency for rural cassava farms in southwest Nigeria. Their findings indicate that increased gender inequality decreases productive efficiency. Furthermore, Esteve-Volart (2004) finds that when studying different states in India, those with higher rates of gender discrimination exhibit lower GDP growth rates compared to others.

There are also a few studies that have examined the effect of gender inequality on efficiency on a country-wide level. Psacharopoulos (1994) finds that returns to female education are positive and higher than their male counterparts in a sample of developing countries. In addition, Psacharopoulos and Patrinos (2004) update the Psacharopoulos

(1994) results, concluding that rates of return to education are still higher for women than for men. Tzannatos (1999) studies the effects of underinvestment in women's employment on productive efficiency in the economy of a group of Latin American countries. He finds that if occupational gender segregation ended, income for males would decrease slightly. Nevertheless, due to increases in female wages, real GDP for the country as a whole would increase significantly.

These findings give motivation to study the effects of gender inequality on growth on a country-wide scale. If gender inequality hurts productive efficiency then countries with higher rates of gender inequality should grow slower. There are relatively few studies that have addressed these potential consequences of educational gender inequality though. One of the first papers to do so was Barro and Lee (1994), which uses a panel data set of 138 countries over the years 1960 to 1990 to examine the empirical determinants of growth, including separate base period measures for the stocks of both male and female education. While male education has a significant positive effect on growth, Barro and Lee report the "puzzling finding" that female education has a negative effect.

Because of this "puzzling finding", multiple studies have attempted to investigate Barro and Lee's results, finding two separate problems. Stokey (1994), as well as Lorgelly and Owen (1999) use a battery of econometric tests to determine the robustness of the Barro and Lee results. Stokey (1994) concludes that the Barro and Lee result is biased by the inclusion of the four East Asian tiger countries. Lorgelly and Owen (1999) support Stokey's conclusion, but assert that there are also a few countries in Sub-Saharan Africa that are influential to the result. Offering further evidence against the Barro and

Lee result, Dollar and Gatti (1999) use a data set, drawn from different sources and including different countries, to investigate the relationship between gender inequality in education and growth. After employing a two-stage least squares technique to control for the endogeneity of female education, their results show that countries with higher rates of gender inequality in education grow slower than countries with less gender inequality.

The other problem with Barro and Lee's (1994) results is that they are plagued by multicollinearity. The female and male education variables are highly correlated to each other, and hence the regression cannot separate out the individual effects for both male and female education. In fact, the Dollar and Gatti (1999) results are also affected by this very problem. Esteve-Volart (2000) addresses this issue by reformulating the model to include secondary education as a measure for the overall education level of society and the logged ratio of male to female primary education as a measure of gender inequality. Using Barro and Lee's (1994) data set, she finds that gender inequality in primary education has a significant negative impact on growth.

Klasen (2003) continues along this line, arguing that there are both direct and indirect effects of gender inequality. Directly, gender inequality represents a market distortion in the sense that human capital is no longer being allocated efficiently as more talented women are not being granted as much education as their male counterparts. Gender inequality also has indirect effects though. Increases in women's education may decrease child mortality, fertility, and population growth; all of which may have a stimulating effect on the economy. He tests these predictions by running a series of regressions, which estimate the different paths through which gender inequality influences growth. He finds that gender inequality has both significant direct effects and significant indirect effects. In addition, he concludes that the direct effect is stronger and has a more inhibitive effect on growth than the indirect effect. This result suggests that the market distortions in human capital created by educational differences between males and females plays an important role in the growth process.

Not all studies agree that gender inequality hurts growth though. Seguino (2000a; 2000b) finds that in a sample of export-oriented Asian nations, higher rates of gender inequality in wages actually have a significant positive effect on growth. She attributes this result to the ability of firms to pay female labor less than males without fear of backlash or revolution, thus spurring investment. There are two key differences between this study and those that find gender inequality to have a negative impact on growth. First, Seguino's studies use a different sample of countries, focusing mostly on export-oriented East Asian countries. Many of these countries are the same as those mentioned in Stokey (1994) that biased the Barro and Lee (1994) dataset because of their high growth rates and high gender inequality. In addition, Seguino studies gender differentials in wages, not education. This is an important distinction, as Klasen (2003) finds that gender inequality in employment is less significantly related to growth than inequality in education.

So, while multiple studies have tried to address the consequences of gender inequality in education on growth there is no clear consensus on what the true effect is, or how robust these results are. Some studies have found that gender inequality has a negative effect on growth, while others have found gender inequality to have a positive effect. These results are further complicated because different authors have used a variety of different control variables, measures for gender inequality, and data sets.

III. Theory

As stated previously, this study seeks to examine the robustness of previous findings regarding the connection between gender inequality in education and growth. The first step in doing so though is to examine the theoretical ties between gender inequality and growth. Previous studies have highlighted two different ways in which gender discrimination can affect growth. The first way is through direct effects due to market distortions. An underinvestment in women's education can be seen as a misallocation of society's resources, and in order for society to achieve an optimal growth level it must allocate its human capital effectively. If a society discriminates on the basis of gender, it is not allowing women who possess more natural talent than their male counterparts to acquire the human capital they need to be fully productive.

There are also indirect effects on growth from the under education of women. Increases in female education have been shown in numerous studies to improve fertility rates, child education, and child health. Multiple studies have researched the positive effects of female education on a myriad of development related goals. Behrman et al (1999) find that children of more literate mothers in India study nearly two more hours a night. In addition, less gender inequality in education has been shown to lower fertility rates by increasing the opportunity cost of a woman's time. These lower fertility rates lead to less population growth, increasing per capita income (Todaro and Smith 2006). Furthermore, less education for women has been well established to have a negative effect on child health.[2] Klasen (2003) also argues that if there is a gender wage gap due to discrimination, then increases in education may not necessarily lead to corresponding increases in wages. This will allow firms to initially hire cheap, highly skilled female

[2] See Schultz 1993, Hill and King 1995, Quibria 1995, as well as Subbaro and Raney 1995.

labor. His theory is supported by Seguino (2000a; 2000b) who shows that gender inequality in wages leads to higher investment and growth in East Asian export-oriented countries.

The growth process however is also influenced by a range of different factors besides gender inequality. Consequently, a number of control variables are included in this study. These include controls for conditional convergence, human capital, investment, government expenditure, openness, and region. In addition to having strong theoretical justifications for their inclusion, as discussed below, these controls have also been shown to be significant determinants of growth in the majority of empirical growth papers. Furthermore, they have been determined to be robust growth determinants in multiple sensitivity analyses.

One prediction generated by the neoclassical Solow (1956) growth model is that *ceteris paribus* countries with lower initial levels of GDP will grow faster because they are farther away from their steady-state level of output. In the early 1990's, a very large literature emerged attempting to determine the existence of this "conditional convergence" mechanism. These studies have reported almost conclusively that a conditional convergence mechanism does exist, in models based on both the Solow framework and "Barro-style" regressions.[3]

In addition, human capital is well established to help a country grow because more human capital leads to higher productivity. Empirically, most papers have relied on education as a proxy for human capital. Education can be expected to help the growth process in two ways. First, a well educated workforce is better trained, increasing productivity and hence growth. Also, better educated workforces are better able to adopt

[3] See Barro (1991), Barro and Sala-i-Martin (1992), and Mankiw, Romer, and Weil (1992).

new technologies than a less educated workforce, meaning the country is better able to grow through technological improvement.

In addition to education, life expectancy has also been used as a proxy for human capital. This is because life expectancy proxies for areas of human capital that education does not. A healthier work force is more productive regardless of education level, improving efficiency on a country wide scale and resulting in growth. This is one area that may not be picked up by education, and therefore life expectancy should also be a significant determinant of growth.

Another component of growth is government expenditure, which can be expected to have both positive and negative effects on growth. First, government expenditure may have positive effects on growth through investment in infrastructure, such as communications, roads, or hospitals. All of these may improve growth. On the other hand, many times government expenditure is not efficient from an economic standpoint. This may be true because corruption and over-hiring are major problems in many developing nations (Pritchett 1999). Secondly, even if the expenditure is efficient from an economic standpoint, the taxes that are used to fund this spending may not be. If this is true, then the taxes will create distortions in the macro-economy, and lead to lower growth. Therefore, while the effect of government expenditure may be somewhat ambiguous, there is some reason to believe it may have an overall negative effect on growth.

The economic climate in a country is very important for encouraging growth. Higher levels of investment mean that firms are acquiring more capital, and capital accumulation has been well established to be a significant determinant of growth. This is especially true if the growth of the capital stock is greater than that of the labor force, because then capital deepening will allow individual workers to have more capital to work with, increasing the productivity of firms, and thus stimulating the economy.

The openness of an economy has a significant impact on growth for a number of reasons. Sachs and Warner (1995) argue that openness generates growth because it creates incentives for increased specialization, allows for countries to benefit from their comparative advantage, facilitates diffusion of knowledge, and increases domestic competition. All of this will improve the productive efficiency in the country, hence spurring growth.

Most studies that have looked at gender inequality have also included a set of regional dummy variables in their empirical models. These variables are intended to capture factors specific to certain regions that are not captured by the other control variables in the regression. Barro and Lee (1994) include regional dummies for Latin America, Sub-Saharan Africa, and East Asia in their empirical growth equation, and they find that the coefficients for these regional controls are significant. This is most likely due to the fact that there are other factors specific to these regions that are not being picked up in the regression. For instance, Latin America has been crippled by high inflation and stifling debt. These would have a very negative impact on growth, but would not be picked up by the set of control variables in the regression equation. However, the coefficients for the same set of regional dummy variables are insignificant in Barro (1997). Barro thus concludes that the 1997 regression accurately accounts for the cross-country variation. However, in Barro (2003), the coefficients for regional controls are once again significant. This highlights the sensitivity of cross country studies to changes in the data set. Because much of the empirical growth literature, and almost all of the gender inequality literature, include regional dummies whose coefficients are found to be very significant, this may suggest that there are still factors correlated with region that are not being picked up in cross-country growth regressions.[4]

Given all of the above considerations, the empirical model studied in this paper is as follows:

$$\left(\frac{\Delta Y}{Y}\right) = b_0 + b_1 \ln(gdp) + b_2 Inv + b_3 GovtExp + b_4 Open + b_5 LifeExp + b_6 Ed + b_7 GenderIneq + b_8 Region$$

This equation will be estimated using OLS. Many studies concerned with short run effects have used panel techniques such as Seemingly Unrelated Regressions. As Hall and Jones (1997) point out, though, these papers study only transition dynamics because the data set is sliced up into five or ten year intervals. These studies do not contain information about the long run determinants of growth. Therefore, in order to establish whether or not gender inequality has any effect on growth in the long run, this study uses a cross sectional analysis.

IV. Data

This study uses cross sectional data taken from 71 developed and developing countries covering the years 1960-2000. A list of all the countries included in this study is provided in Appendix 2. The time span used in this paper is ten years longer than previous cross-sectional studies and includes data from the 1990's, which past gender inequality studies do not.[5] In addition, the data set is regionally diverse. Twenty percent

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[4] See Dollar and Gatti (1999), Esteve-Volart (2000), Klasen (2003), and Barro (2003)

[5] Klasen (2003) and Knowles et al. (2002) use cross sections over the years 1960-1990.

of the data set is in Sub-Saharan Africa, nineteen percent is in Latin America, and nine percent is in East Asia.

As a measure of gender inequality, this paper uses the ratio of average years of schooling in the male population to average years of schooling in the female population in 1960. This technique is used by both Klasen (2003) and Esteve-Volart (2000). By expressing gender inequality as a ratio instead of including separate stocks of male and female education, multicollinearity is substantially reduced. Because there is potential for the results to vary greatly by level of education, this study considers gender inequality ratios for primary as well as total years of schooling separately.

The control variables included in the analysis can be grouped into three separate categories. First, a number of macroeconomic indicators have been determined to have a strong effect on growth. The natural log of the GDP per capita for each country in the year 1960 is included to control for the conditional convergence mechanism. Furthermore the amount of investment in each country helps growth via capital widening and capital deepening. This variable is measured by the ratio of investment to GDP, averaged over the entire time period. Also, because the economic literature has determined government expenditure to be a possible barrier to economic growth, the ratio of government expenditure to GDP, averaged over the entire time period, is also included in the study.

As previously mentioned, openness has been well established in the economics literature to have a beneficial impact on growth. To capture this effect, the ratio of exports plus imports to GDP is included as a control variable in the study. This may not be the best measure of openness, as most sensitivity analyses find that the number of years an economy has been open, measured and first employed by Sachs and Warner (1995), is a robust determinant of growth.[6] These data are only available through the year 1995, however. As a result, following the methodology of Barro (2003), the ratio of exports plus imports to GDP averaged over the entire time period is used.

The second set of control variables considered in the analysis proxy for the stock of human capital, which has been well established to be a very significant determinant of growth. This study utilizes two different proxies for human capital. To account for the health of the population, the study uses the life expectancy at birth in 1960. Moreover, to account for the education level of the population, this study utilizes the average years of education attained by the adult population in 1960. Many empirical growth studies have focused on average years of secondary schooling of the population as a measure of education levels, while many sensitivity analyses have highlighted the importance of primary education.[7] To account for all levels of schooling, this study uses average years of total schooling, as in Klasen (2003).

The third category of control variables that are included in this analysis are regional dummy variables for Latin America, Sub-Saharan Africa, and East Asia. These variables take the value of 1 if a country is in the particular region and 0 otherwise. These three regions are chosen because they are the ones which had the most unusually high or low intervals of growth during the time period considered in this study, and have been shown to be the most robust regional controls in sensitivity analyses.

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[6] See Sala-i-Martin (1997), Hendry and Krolzig (2004), Hoover and Perez (2004), or Sala-i-Martin et al. (2004).

[7] See Mankiw, Romer, and Weil (1992), Barro (1997), or Esteve-Volart (2000) for examples of empirical growth papers focusing on secondary education. Sensitivity analyses such as Sala-i-Martin (1997), Sala-i-Martin et al. (2004), and Ciccone and Jarocinski (2007) all focus on primary education.

Table 2 below lists the variables included in the study along with descriptive statistics. It is important to note that this data set has an extreme outlier in the country of Togo. This country has relatively normal values for all the control variables, but the gender inequality numbers are 16.15 for primary educational gender inequality and 12.81 for total educational gender inequality. The nation with the next highest ratio for gender inequality is Syria, which has a primary education gender inequality value of 4.76 and a total educational gender inequality value of 4.68. Moreover, the rest of the countries in the data set have primary education and total educational gender inequality ratios that are clustered within the range .97 to 4.76 and .95 to 4.68 respectively. It should also be noted that there were a couple of countries with similar levels of gender inequality to Togo in 1960, but due to incomplete data were not included in the analysis. Furthermore, including Togo, these countries with a total educational gender inequality ratio greater than 5.00 had on average less than .75 years of total schooling in the population. This highlights the fact that these massive ratios are reflective of relatively small differences in education levels between males and females

Table 2: Included Variables and Summary Statistics

Variable Name	Mean	Standard Deviation	Minimum	Maximum
Real GDP per capita in 1960[8]	968.91	766.53	101.63	3290.95
Life Expectancy in 1960	57.52	11.30	35.68	73.50
Average yrs of education in 1960	3.68	2.50	0.07	9.56
Investment averaged over 1960-2000 (% of GDP)	17.47	8.09	2.59	44.79
Government Exp. averaged over 1960-2000 (% of GDP)	20.32	8.66	5.56	57.77
Exports + Imports averaged over 1960-2000 (% of GDP)	61.21	41.02	11.42	220.09
Primary Educational Gender Inequality in 1960 (gender ratio)	1.86	1.96	0.97	16.15
Total Educational Gender Inequality in 1960 (gender ratio)	1.85	1.61	0.95	12.81

A detailed description of the variables included in the analysis, along with data sources, are provided in Appendix 1. The data used in this study are drawn from four different sources. Data on income and growth are based on per capita incomes between 1960 and 2000 adjusted for purchasing power parity. These are expressed in constant 1985 U.S. dollars using the chain index, as reported in the Penn World Tables Mark 6.2 (Heston et al. 2006). Investment, government expenditure, and openness are also drawn from the Penn World Tables. The data on years of schooling are based on Barro and Lee (2001) and refer to the average years of total schooling in the adult population, aged 25 and older. Ratios of gender inequality are calculated from years of schooling measures drawn from Barro and Lee (1993).[9] Finally, data on life expectancy are drawn from the World Bank's World Development Indicators (2008).

[8] Real GDP per capita is shown for clearer interpretation. The regressions consider the natural log of GDP.
[9] The Barro and Lee (2001) data were accessed on the Harvard CID website (http://www.cid.harvard.edu/). The Barro and Lee (1993) data were accessed on the NBER website (http://www.nber.org/pub/barro.lee/).

V. Methodology

This paper attempts to examine the robustness of the impact of gender inequality in education on economic growth in three ways. Because different studies investigating the relationship between gender inequality and growth have examined gender inequality at different levels of education, the present study will consider gender inequality in primary as well as total years of schooling. Furthermore, regressions are run both with and without regional dummy variables to determine how much of an effect these controls have on the analysis. Lastly, to determine the impact of Togo on the results, regressions are run both with and without Togo included in the data set.

Specifically, this study considers four different versions of the empirical growth model posited in the theory section. Models 1 and 2 examine gender inequality in total education, as opposed to models 3 and 4, which study gender inequality in primary education. In addition, models 1 and 3 include regional dummy variables while models 2 and 4 do not. These four regressions are in fact run with and without Togo in the data set. Models which include Togo in the analysis are denoted with an A, while models which do not include Togo are denoted with a B.

The regressions are all estimated using OLS. As mentioned earlier, many studies concerned with short run effects on growth have used panel techniques such as Seemingly Unrelated Regressions. Since the purpose of this study is to investigate the connection between gender inequality and long term growth rates, this study uses a forty year cross section. Dollar and Gatti (1999) use a two-stage least squares technique to control for the endogeneity of gender inequality. It is more probable however that gender inequality is endogenous to levels of income and not rates of change. Consequently, since this study examines the effects of gender inequality on growth rates, OLS is suitable. In addition, the regressions use robust standard errors because cross-country aggregate data tend to be extremely heteroskedastic.

VI. Results

The results show that the inclusion or exclusion of Togo has a substantial impact on the results. While the coefficients of the control variables have fairly similar magnitudes and significance levels for each set of regressions, the results for gender inequality change dramatically. When Togo is included in the dataset, the results show that gender inequality has a significant impact on economic growth. On the other hand, when Togo is excluded, the coefficients for gender inequality are insignificant, whether regional controls are included or not in the regression. This holds true for gender inequality in both primary and total education.

Table 3 shows the results of the regressions with Togo included in the data set. As can be seen, the coefficient for initial GDP is negative, signifying the presence of a conditional convergence mechanism. Moreover, the coefficient for life expectancy is significant and positive in every model, indicating the importance of good health for a country to grow. The coefficient for investment is also significantly positive, highlighting the importance of capital widening and deepening in economic growth. It is important to note that the coefficient for investment becomes less significant when regional controls are included. This may suggest that investment is important in explaining cross-regional variation in growth rates. In other words, investment is probably one of the reasons for why different regions are growing at different levels, so when regional controls are included in the regression equation the coefficient for investment loses some of its significance.

Table 3: Regression Results (Togo Included)

	(1A)	(2A)	(3A)	(4A)
Primary Ed. Gender Inequality			-0.142*** (4.38)	-0.101** (2.25)
Total Ed. Gender Inequality	-0.159** (2.59)	-0.098 (1.21)		
Ln(GDP)	-1.244*** (4.93)	-1.597*** (6.09)	-1.251*** (5.00)	-1.604*** (6.18)
Life Expectancy	0.103*** (4.75)	0.113*** (4.11)	0.103*** (4.75)	0.114*** (4.11)
Education	-0.017 (0.22)	0.052 (0.61)	-0.013 (0.17)	0.051 (0.61)
Investment	0.036* (1.84)	0.062*** (2.77)	0.035* (1.82)	0.062** (2.75)
Government Expenditure	-0.011 (1.04)	-0.017 (1.66)	-0.010 (0.99)	-0.015 (1.57)
Openness	0.007* (1.99)	0.004 (1.59)	0.007** (2.02)	0.006 (1.61)
Latin America	-0.645** (2.38)		-0.650** (2.42)	
Sub-Saharan Africa	-0.580 (1.32)		-0.615 (1.41)	
East Asia	1.039** (2.05)		1.005** (2.02)	
R-Squared	0.71	0.63	0.71	0.63
Sample Size	71	71	71	71

Dependent Variable is the average annual per capita growth rate for each country over 1960-2000.
-Values in parentheses are absolute *t* statistics, based on robust standard errors.
* denotes significance at the .10 level.
** denotes significance at the .05 level.
*** denotes significance at the .01 level.

The coefficients for the Latin America and East Asia dummy variables are very significant, indicating that these regions had significantly different rates of growth from the rest of the world. During the time period considered, the average annual per capita rate of growth in the world was 2.26. However, the average for Latin America was 1.51, while the average for East Asia was 4.37. On the other hand, the coefficient for the Sub-Saharan Africa dummy is not significant. This result may seem to suggest that the control variables included in the empirical model, life expectancy especially, explain the poor growth in Sub-Saharan Africa. Many diseases, especially malaria and AIDS, have taken a large toll in Sub-Saharan Africa and these diseases are definitely hurting growth.

Surprisingly, the coefficients for the education level of the society as a whole are never significant, both with and without regional dummy variables included in the model. This is probably due to the inclusion of life expectancy as a proxy for human capital. If any of the four models are estimated with life expectancy excluded, the education level of the country in 1960 has a positive effect on growth, and the coefficient for education is significant at the .05 level. This may indicate that both variables are actually proxying for very similar forms of human capital, and that life expectancy is more accurately describing the human capital levels in a country. It may also be the case that the insignificance of the education coefficient is due to a lack of variation in the data. In 1960, many countries had extremely low levels of education, and this might lead to a lack of significance in that particular regression coefficient.

The coefficient for government expenditure is not significant in any of the regressions, but it does have the predicted sign and relatively large *t* statistics for models 2 and 4, when the regional controls are excluded. In fact, when Togo is excluded from the analysis, the coefficient on government expenditure becomes significant at the .10 level for both models 2 and 4.[10] This increase in significance, when the dummy variables are excluded, is most probably due to the fact that government expenditure is explaining

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[10] See Table 4 for the results with Togo excluded.

some of the cross-regional variation. Government expenditure may be one of the reasons why some regions are growing at different rates and thus its coefficient becomes less significant when regional controls are included. The fact that the significance is so weak may signify that some government expenditure is indeed good for growth. For instance, investment in communications, education, or energy may promote growth, even if funded through inefficient taxes. However, the results do show that high government expenditure is correlated with lower growth rates, implying that perhaps excessive government expenditure could be harmful to growth.

The coefficient for openness, on the other hand, is significant only after controlling for region. This may be due to the fact that, in terms of openness, there exists a great deal of variation within region, which would generate an additional impact on growth beyond what is captured by the regional control variables. As different countries within these regions opened up at different times, those countries that opened up sooner may have received more of a benefit from having an open economy. Moreover, because the openness variable is averaged over the entire time period, countries that opened up sooner have higher values for openness. This is especially evident in the cases of Chile and Venezuela. Chile opened up in 1976, while Venezuela did not open until 1990 (Sachs and Warner 1995). Furthermore, Chile's economy grew at a rate of 2.37 percent per year from 1960-2000, while Venezuela only grew at a rate of 0.37 percent. Thus, it is evident that there is much variation in openness within regions which has an important impact on growth.

Likewise, the results for gender inequality change depending on whether or not the analysis controls for region. The coefficients for gender inequality in both primary and total education, in fact, become more significant with the inclusion of the regional control variables. This may be due to a similar reason as openness, in that variation in gender inequality within regions is particularly important in explaining growth. However, no conclusions should be drawn regarding the impact of gender inequality on growth, since these results are driven by an outlier in the data set.

As previously mentioned, Togo is an extreme outlier in the data set and removing it from the analysis changes the results drastically. Table 4 below presents the regression results when Togo is excluded from the data set. It is important to note that while the coefficients for the control variables keep similar significance levels and magnitudes, the coefficients for gender inequality in both primary and total education become insignificant. This highlights the importance of checking for outliers, since Togo is obviously driving the gender inequality results in models 1A-4A.

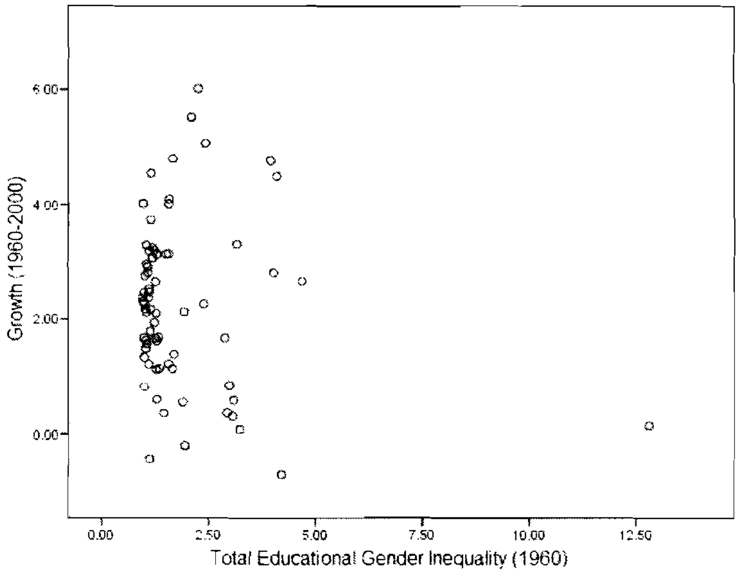
Table 4: Regression Results (Togo Excluded)

	(1B)	(2B)	(3B)	(4B)
Primary Ed. Gender Inequality			-0.032 (0.20)	-0.090 (0.50)
Total Ed. Gender Inequality	0.025 (0.14)	0.148 (0.80)		
Ln(GDP)	-1.249*** (4.78)	-1.537*** (5.72)	-1.253*** (4.89)	-1.560*** (5.83)
Life Expectancy	0.105*** (4.76)	0.119*** (4.27)	0.105*** (4.73)	0.119*** (4.28)
Education	0.004 (0.06)	0.060 (0.71)	-0.002 (0.03)	0.056 (0.67)
Investment	0.037** (1.87)	0.060** (2.59)	0.036* (1.84)	0.061** (2.62)
Government Expenditure	-0.013 (1.09)	-0.019* (1.73)	-0.012 (1.04)	-0.018* (1.67)
Openness	0.007** (2.05)	0.005 (1.61)	0.007** (2.03)	0.006 (1.61)
Latin America	-0.567** (2.06)		-0.599** (2.18)	
Sub-Saharan Africa	-0.687 (1.61)		-0.669 (1.58)	
East Asia	0.922* (1.84)		0.947* (1.88)	
R-Squared	0.71	0.64	0.71	0.63
Sample Size	70	70	70	70

Dependent Variable is the average annual per capita growth rate for each country over 1960-2000.
-Values in parentheses are absolute *t* statistics, based on robust standard errors.
* denotes significance at the .10 level.
** denotes significance at the .05 level.
*** denotes significance at the .01 level.

Figure 1 below depicts a graph plotting the gender inequality ratios against the average annual per capita growth rates.

Figure 1: Gender Inequality v. Growth



As can be seen, there is one data point that is an extreme outlier. This point represents Togo, which has a total educational gender inequality ratio of 12.81. While the rest of the data points have total educational gender inequality ratios that are clustered within the range of 0.95-4.68, Togo is far to the right. Furthermore, Togo had an average growth rate of 0.15 from 1960-2000, while the sample average was 2.26. This sort of outlier is called a design outlier, often referred to as a leverage point, and tends to distort the OLS estimates (Temple 2000). The very existence of this point causes the regression line to have a negative slope, and consequently generates the negative significant coefficient. Hence, while the regression line might have been fairly flat without Togo, with this point included, it has a negative slope.

It should be noted that the initial data set consisted of 118 countries, but 47 of them were not included in the analysis due to incomplete data. Within these excluded countries, there are 4 observations which have total educational gender inequality ratios above 4.68, the second highest ratio included in this analysis, after Togo. Unfortunately, there is only data on per capita growth rates for one of these excluded countries. No conclusions can be drawn, therefore, but Togo might not have been such an extreme outlier had this study had more complete data.

As stated previously, the reason why the ratio of gender inequality for Togo is such a large outlier is due to the fact that in 1960 the education levels in Togo were extremely small. In fact, Togo had only .32 and .40 average years of primary and total male schooling, respectively, and it had only .02 and .03 average years of primary and total female schooling, respectively. Thus relatively small differences in education attainment between males and females lead to large gender inequality ratios. This is especially true with the case of Togo, as the difference between .397 and .031 probably does not represent as large a gender disparity as a ratio of 12.81 may lead one to suggest. Therefore, the extremely small numbers for educational attainment, combined with the use of gender inequality ratios, may be skewing the results for gender inequality.

To try to correct for the problem of outlier gender inequality ratios, regressions were run with gender inequality measured as differences in stocks of average years of female and male education in 1960 as opposed to gender ratios. This was done for gender inequality in both primary and total education, as well as both with and without the regional controls included in the regression equation. Measuring inequality as a difference eliminates the problem of Togo being a massive outlier, because the difference is only .366, as opposed to a ratio of 12.81. Unfortunately, the coefficients for gender inequality, when measured as a difference, remain insignificant despite the inclusion of Togo.

VII. Conclusion

This paper attempts to investigate the robustness of previous results on the relationship between gender inequality in education and growth, paying particular attention to changes in model specification and outlier countries. Regressions are run using measures for gender inequality at different levels of education, including and excluding regional controls, as well as including and excluding outlier countries. The results show that studies of gender inequality are particularly susceptible to outlier countries in the data set. Due to the fact that educational attainment figures in 1960 are so low, educational gender inequality ratios can be greatly skewed by small differences in male and female education levels. Furthermore, the results show that studies can also be affected by the inclusion or exclusion of regional control variables.

The fact that this study's results are so sensitive to the inclusion or exclusion of one country highlights the need for future papers on gender inequality to pay particular attention to the data set. In order to investigate the impact on long run growth, studies need to utilize cross sectional data taken from much older time periods, and these educational attainment numbers are extremely low. This creates a situation where it is rather likely for extremely large outliers to be present due to only slight differences in actual male and female education numbers. A difference of .397 to .031 years of schooling probably does not represent as large a gender discrepancy as the ratio might lead one to believe. To address this, differences in average stocks of male and female educational attainment might be used to measure gender inequality, as opposed to ratios. However, when applied to this data set, the coefficients for gender differences in education remain insignificant. This further highlights the fact that future studies on gender inequality in education, especially those using cross-sectional data dating back to the 1960's, should be extremely aware of the potential impact that outlier countries could have on their results.

The fragility of the results regarding gender inequality in this study is noteworthy because the use of Barro and Lee data for educational attainment across countries is extremely common in the empirical growth literature. Many papers studying gender inequality in education have in fact looked at educational gender inequality numbers drawn from this very data set.[11] Both Esteve-Volart (2000) and Klasen (2003) measure gender inequality as ratios and consider data dating back to 1960, when education levels were extremely low. It could thus be quite possible that their data set includes outliers which could be biasing their regression results. On the other hand, these studies do include data for more countries, which might make their results less sensitive to outliers. Unfortunately, neither of these papers includes a discussion on outliers.

This study's results do not suggest that governments and international organizations should not invest in gender equality. First of all, there are a number of reasons to invest in gender equality outside of its possible impact on economic growth. In addition to gender inequality being a worthy goal in and of itself, greater levels of female education have been shown to have a positive impact on child education, health, and mortality rates. Moreover, although previous studies on the relationship between

[11] See Esteve-Volart (2000), Knowles et al. (2002), or Klasen (2003)

gender inequality in education and growth are sensitive to changes in model specification and data, they need not be discounted. These studies include data for more countries than the present study, and their results may hence be less sensitive to outliers. Furthermore, future studies that are able to utilize even more complete data sets may find that indeed there is a robust effect of gender inequality in education on growth. This study's findings nevertheless do suggest that future researchers in this area should be extremely careful when constructing their data set due to the fact that, given the nature of the data, there exists a strong potential for outliers to have a distorting influence on the analysis.

VIII. References

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IX. Appendices

Appendix 1: Included Variables

Variable Name	Definition	Data Source[12]
Ln(GDP)	The natural log of GDP per capita in year 1960.	Penn World Tables 6.2
Life Expectancy	The life expectancy at age 0 in year 1960.	World Development Indicators (2008)
Education	The average years of total schooling in the adult population in year 1960.	Barro and Lee (2001)
Investment	The ratio of investment to GDP averaged over 1960 to 2000.	Penn World Tables 6.2
Government Expenditure	The ratio of government expenditure to GDP averaged over 1960 to 2000.	Penn World Tables 6.2
Openness	The ratio of exports plus imports to GDP averaged over 1960 to 2000.	Penn World Tables 6.2
Primary Educational Gender Inequality	The ratio of male to female average years of primary education in 1960.	Barro and Lee (1993)
Total Educational Gender Inequality	The ratio of male to female average years of total education in 1960.	Barro and Lee (1993)
Latin America	Dummy variable that is 1 if country is in Latin America and 0 otherwise.	
Sub-Saharan Africa	Dummy variable that is 1 if country is in Sub-Saharan Africa and 0 otherwise.	
East Asia	Dummy variable that is 1 if country is in East Asia and 0 otherwise.	

[12] The Barro and Lee (2001) data were accessed on the Harvard CID website (http://www.cid.harvard.edu/). The Barro and Lee (1993) data were accessed on the NBER website (http://www.nber.org/pub/barro.lee/). Penn World Tables 6.2 data were taken from Heston et al. (2006).

Appendix 2: Included Countries

Algeria	Ghana	Malaysia	South Africa
Argentina	Greece	Mauritius	Spain
Australia	Guatemala	Mexico	Sri Lanka
Austria	Honduras	Mozambique	Sweden
Barbados	Hong Kong	Nepal	Switzerland
Belgium	India	Netherlands	Syria
Bolivia	Indonesia	New Zealand	Thailand
Brazil	Iran	Nicaragua	Togo
Canada	Ireland	Niger	Trinidad & Tobago
Chile	Israel	Norway	Turkey
Colombia	Italy	Pakistan	Uganda
Costa Rica	Jamaica	Panama	United Kingdom
Denmark	Japan	Paraguay	United States
Dominican Rep.	Jordan	Peru	Uruguay
Ecuador	Kenya	Philippines	Venezuela
El Salvador	Korea	Portugal	Zambia
Finland	Lesotho	Senegal	Zimbabwe
France	Malawi	Singapore	