The Impact of Gender Inequality in Education on Long-Run Economic Growth

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I dedicate this to Asha Sekar, my wonderful mother who has provided endless support and encouragement to pursue what is important to me.

Contents

Abstract

Through the use of cross-country and panel regressions, this thesis will study the impact of gender inequality in educational attainment on long-run economic growth; whether gender inequality in education restricts economic growth. Regressions will be run for 56 different countries across seven different regions (including developing and developed economies), over a 40-year period between 1970 and 2010. The purpose of this study is to provide updated results on gender inequality in education and economic growth, as previous literature has provided results that only account for a time frame up to the year 2000. Both the cross-country and panel results of this study suggest that gender gaps in education impede economic growth; thus, an increase in gender equality aids economic growth and development. The regions with the highest levels of gender inequality are the Middle East and North Africa, South Asia, and Sub-Saharan Africa, and thus these regions suffer the most, taking longer to close their gender gaps than other regions. Further, South Asia and Sub-Saharan Africa also experience the slowest economic growth due to their higher levels of gender inequality in education.

Statement of Originality

This work has not previously been submitted for a degree or diploma in any university. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

(Signed)_____ Date: 08/01/2018

Tara Kumar

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List of Abbreviations

CEDAW	Convention on the Elimination of all Forms of Discrimination Against Women
ECA	Eastern Europe and Central Asia
ED70	The initial level of male education in 1970
EAP	East Asia and Pacific
GED	The average annual growth in the level of male education during 1970–2010
GDP	Gross Domestic Product
ICTs	Information and Communications Technologies
LAC	Latin America and Caribbean
MENA	Middle East and North Africa
MDGs	Millennium Development Goals
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
PPP	Purchasing Power Parity
RED70	The gender gap in educational attainment in 1970 as a female–male ratio
RGED	The gender gap in the growth in educational attainment during 1970 – 2010 as a female-male ratio
SA	South Asia
SSA	Sub-Saharan Africa
UN	United Nations
UNGA	United Nations General Assembly
UNDP	United Nations Development Programme

Chapter 1: Introduction

This chapter introduces the topic and motivation of this thesis.

The access and opportunity to education is a fundamental human right that can also assist a country's economic growth and development. However, a substantial education gap exists in many countries where more men receive and attain higher levels of education than women (Subrahmanian, 2005).

Since 1970, a movement to increase gender equality in education and all aspects of societal and economic development has been spurred through initiatives and in worldwide programs, including the United Nations Development Programme (UNDP) founded in 1966, the Convention on the Elimination of all Forms of Discrimination Against Women (CEDAW) international treaty adopted by the United Nations General Assembly (UNGA) in 1979 and the Millennium Development Goals (MDGs) implemented by the United Nations (UN) in 2000 (Abu-Ghaida & Klasen, 2003).[1] However, increases in gender equality have been slow and inconsistent for the poorer regions of the world (Abu-Ghaida & Klasen, 2003). To achieve gender equality in education, it is important to understand the past and present barriers that hinder the closing of this gender–education gap. Subrahmanian (2005) identified that discrimination arises from the identification and valuation of male and female contribution, which gives rise to different and unequal investments, opportunities and expectations for men and women. Gender inequality has been built on the historical naturalisation of typical gender expectations and also through cultural, religious and societal norms, and different practices and expectations (Subrahmanian, 2005; Wilson, 2003). Political and institutional corruption has also negated gender equality in education, which further restricts women's opportunities for education (Branisa et al., 2013). As a result, women are typically employed more in informal and

[1] See UNDP *Human Development Report* (various years), UN Women publications and World Bank (2001) for further information on these initiatives.

unpaid work and receive less education; thus, they experience lower educational attainment (Subrahmanian, 2005). Different countries and regions experience different levels of cultural, religious and societal influence, which affect gender inequality in education to varying extents (Subrahmanian, 2005). Poorer regions that experience high levels of corruption and cultural and religious influence experience the most gender inequality in education and overall development, along with the slowest movement towards achieving equality.[2]

The concept of wellbeing is defined by a wide range of measurements that include income and wealth, employment, housing and living conditions, health status, education and skills, environmental quality and personal security (OECD, 2011). Measuring wellbeing helps to assess the general quality of life and living conditions of a country, as well as its development. It is important to study the impact and implications of gender inequality in relation to wellbeing (Klasen & Lamanna, 2009) because there has been—and continues to be—substantial gender gaps in its many factors. These include access to and control over economic resources, educational attainment and opportunities, mortality, access to employment, wages and political power (Klasen, 2004). As a result, gender-related factors are important to include when assessing the wellbeing and subsequent development and growth of a population.

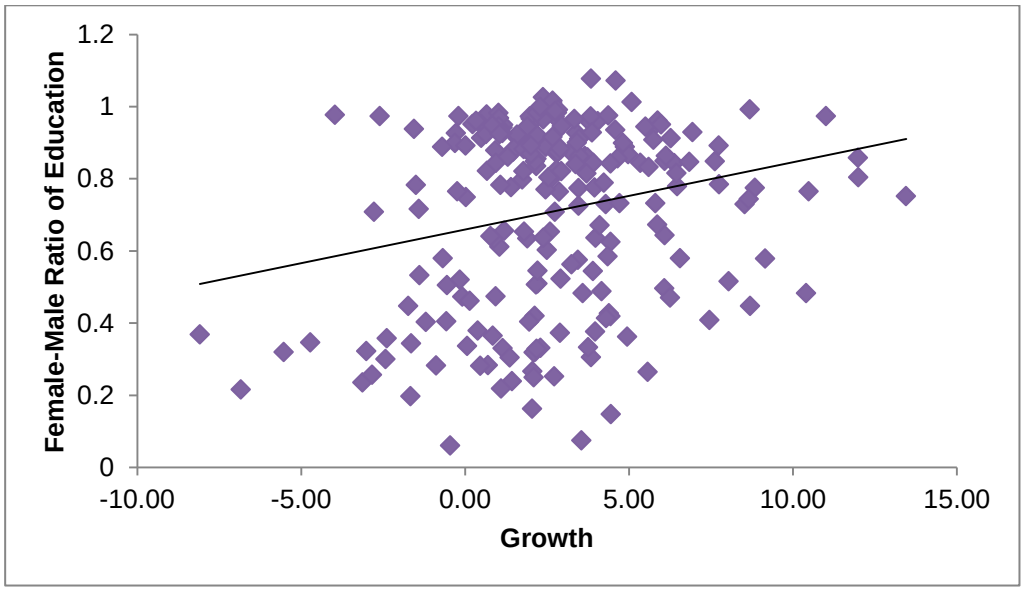
There is extensive literature that studies gender inequality in relation to wellbeing that has since been extended to include the instrumental effect it has on economic growth (Klasen & Lamanna, 2009). Therefore, this thesis will focus on studying the levels of gender inequality in one factor of wellbeing: education, and will assess the long-run impact had on a country's economic growth.

To measure this impact, two main female–male ratio education variables will be developed: the female–male ratio of education at the beginning of a time period and the female–male ratio in the growth of education over time. Both variables represent the gender gap in educational attainment upon which to observe their effect on economic growth. To provide a

[2] Several literature shows this; see, for example, Branisa, Klasen and Ziegler (2013), Dollar and Gatti (1999), Hill and King (1995), Klasen (various years) and Klasen and Lamanna (2009).

visual representation of these relationships, two scatter plots are presented below: the first depicts the direct relationship between the female–male ratio of educational attainment and economic growth; the second depicts the direct relationship between the female–male ratio of the growth in educational attainment and economic growth. Both scatter plots have been constructed using panel decade data from 1970–2010 for 56 different countries (both developed and developing).

Figure 1.1: Relationship between Female–Male Ratio of Education and Economic Growth by Decade (1970–2010)



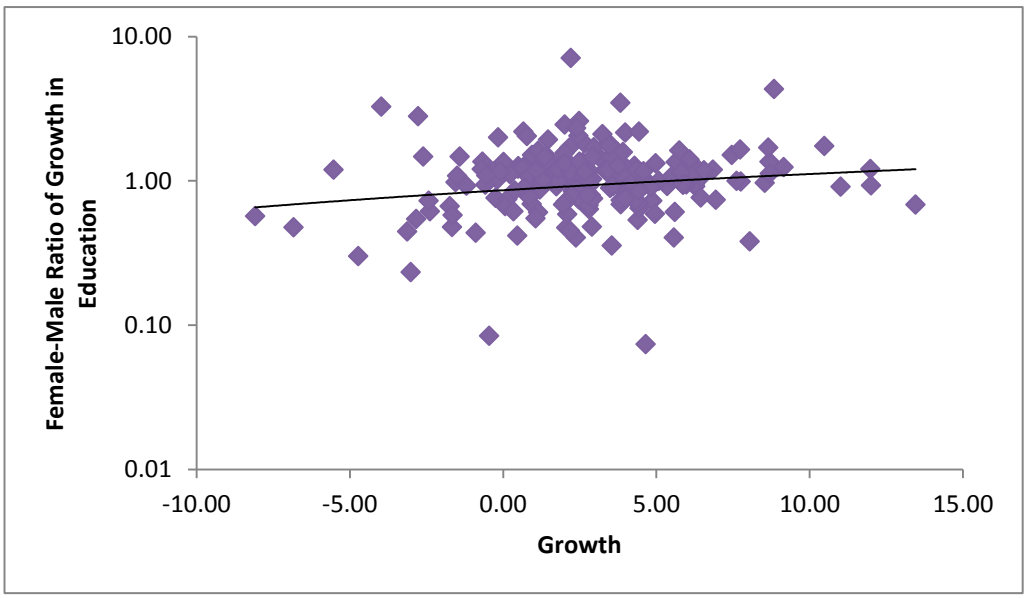
Source: Data calculated from Barro and Lee (2016b) and Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015).
Notes: For a full list of the 56 countries included, see Appendix Table A1. Female–male ratio of education has been calculated using average years of female and male education for population aged 25 and over.

Figure 1.1 shows the direct relationship between economic growth and the female–male ratio of educational attainment. This ratio is constructed using data from Barro and Lee (2016) that tracks the total years of schooling by decade for females and males aged 25 years and over for 56 countries over the 40-year period between 1970 and 2010 (1970, 1980, 1990 and 2000). Economic growth refers to the per capita annual compounded growth rate at chained Purchasing Power Parity (PPP) adjusted real GDP, which is calculated using data from Penn World Table

(PWT) 9.0 (Feenstra, Inklaar & Timmer, 2015). Growth has been compounded annually for each decade over the 40-year period for the 56 countries.

The scatter plot shows a positive correlation between the female–male ratio of educational attainment and economic growth, which suggests that an increase in the ratio of education corresponds with an increase in economic growth. This positive relationship motivates further study to analyse the impact of an increase in the female–male education ratio on growth conditional upon other regressors found to impact economic growth, such as investment rates and population growth. It is important to note that when interpreting this relationship, the results show that an increase in female educational attainment (measured by the total years of schooling for females) in relation to male educational attainment corresponds with an increase in economic growth because the ratio is calculated as female–male. Thus, the positive correlation suggests that an increase in female educational attainment promotes economic growth.

Figure 1.2: Relationship between Female–Male Ratio of Growth in Education and Economic Growth by Decade (1970–2010)



Source: Data calculated from Barro and Lee (2016b) and Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015).
Notes: Female–male ratio of growth in education has been calculated using average years of education for population aged 25 and over.

Figure 1.2 shows the direct relationship between economic growth and the female–male ratio of the growth in educational attainment. Similar to the first ratio, this ratio is constructed using data sourced from Barro and Lee (2016) on the total years of schooling for females and males aged over 25 for 56 different countries. However, as this is a growth ratio, the values are calculated as the absolute average annual growth rates for each decade between 1970 and 2010. Economic growth for Figure 1.2 is the same as the economic growth variable calculated in Figure 1.1.

The correlation in this scatter plot is relatively weak and the unconditional correlation between the two variables does not indicate a strong relationship. However, this disassociation prompts further research on the possible conditional correlation between the two variables, with the inclusion of additional regressors to observe the relationship between the female–male ratio in the growth of education and economic growth. Previous literature that observed this link in earlier time periods found a significant positive relationship between the two variables, with the addition of other regressors found to also impact economic growth (see Klasen, 2000 and 2002; and Klasen & Lamanna, 2009).

This thesis will also observe the conditional relationship between the variables, for an updated time frame.

Chapter 2: Literature Review

This chapter consists of a literature review on gender inequality in education and its impact on economic growth and development. Split into theoretical work and empirical work, this section outlines both the theoretical and empirical studies of significance for this topic.

2.1 Theoretical Work

The theoretical work suggests that a negative correlation between gender inequality in education and economic growth exists. Two papers of significance here are Galor and Weil (1996) and Lagerlöf (2003).

First, Galor and Weil (1996) found a significant relationship between fertility and economic growth in their study on the correlation between gender inequality, the education gender gap and economic growth. They discovered that fertility imposed a substantial impact on long-run growth because lower fertility levels allowed for increased human capital and encouraged economic growth and development.[3] Previously, this relationship between fertility and economic growth was studied as a component of both growth theory and family economics. However, Galor and Weil (1996) built a general equilibrium model to incorporate both categories of the literature. They combined a model of household fertility and labour supply choice with a growth model in which the separate wages of men and women were determined endogenously. The impact of education (defined as the accumulation of human capital)[4] on fertility was also explored.

They discovered that lower fertility as a result of a lower gender gap in education leads to higher capital and output and also higher relative wages for women. This creates a 'positive feedback' loop (Galor & Weil, 1996, p. 385) that further lowers fertility because higher relative

[3] A large range of literature also outlines the relationship between lower fertility and increased growth. See, for example, Hill and King (1995), Dollar and Gatti (1999), Klasen (2000 and 2002), and Klasen and Lamanna (2009).

[4] Commonly when modelling education, the level and accumulation of human capital is used as measurement. See, for example, Galor and Weil (1996), Lagerlöf (2003) and Dollar and Gatti (1999).

wages for women increases female employment and the cost of having children more than household income. Thus, a lower gender gap appears to encourage an increase in economic growth and development (Galor & Weil, 1996).

Second, Lagerlöf (2003) developed a theoretical growth model in which increasing gender equality in education accounted for growth in per capita income. As the gender gap becomes smaller, women's time becomes more expensive. Further, as Galor and Weil (1996) similarly found, fertility falls and human capital and per capita income growth increases (Lagerlöf, 2003). The increase in human capital lowers mortality and temporarily increases population growth simultaneously with per capita income growth. Over time, mortality rates level out and fertility continues to fall; thus, causing a decrease in population growth. Per capita income growth continues to increase before stabilising on a balanced growth path. Therefore, an increase in gender equality creates an increase in long-run economic growth (Lagerlöf, 2003).

2.2 Empirical Work

This section is categorised into the different types of empirical studies that are significant to gender inequality in education and long-run economic growth. Overall, the empirical literature suggests that gender inequality in education has a negative impact on economic growth; thus, increased gender equality leads to increased growth and, in particular, increased female education spurs economic growth and development.

2.2.1 Negative Results

While a number of studies have found that gender inequality in education impedes economic growth (for example, see Hill & King, 1995; Dollar & Gatti, 1999; Klasen, 2000 and 2002, Abu-Ghaida & Klasen, 2004; and Klasen & Lamanna, 2009), some earlier studies have concluded that gender inequality may instead increase economic growth. Further, by ways of promoting female education, increased gender equality in education may also decrease economic growth. Barro and Lee (1994) and Barro and Sala-i-Martin (1995) found a negative partial correlation between female secondary education and economic growth and a positive partial correlation between male secondary education and economic growth. However, studies have

since identified possible econometric issues with these earlier findings and thus produced opposite results. Dollar and Gatti (1999) found that the addition of regional dummy variables produced results with a positive relationship between female education and economic growth. These variables can also rectify the potentially inaccurate findings of these earlier studies, which were caused by the combination of lower growth in the Latin American region and unexpectedly high female secondary achievement (Dollar & Gatti, 1999). Klasen (2000) and Klasen (2002) also identified issues with multicollinearity; for most countries, the male and female education levels were closely correlated in studies conducted by Barro and Lee (1994) and Barro and Sala-i-Martin (1995).

2.2.2 Non-Economic Indicators and Development

Macro-economic literature on gender inequality in education and subsequent economic growth shows that female education is important for economic development in both economic and non-economic indicators[5] (Hill & King, 1995; Knowles & Owen, 1997; World Bank, 2001; Knowles, Lorgelly & Owen, 2002). An increase in education overall enhances labour market productivity and economic growth and development. However, an increase in the educational attainment of females specifically has shown to positively impact measures of social wellbeing, which further indirectly improves the economic growth and development of a country. These measures include improved family health, lower child mortality rates, higher life expectancy rates and the improved functioning of political processes (Hill & King, 1995; World Bank, 2001). Despite these improvements, men in several developing countries (primarily in SA and the Middle East and Africa) still have access to substantially higher levels of schooling than females (Knowles et al., 2002) where a significant gender education gap is present.

Hill and King (1995) explored the impact of a gender gap in education on the economic and social development of a country. They found that a gender gap in educational attainment is associated with lower economic growth and that gender disparity in education can also lower

[5] Non-economic indicators include fertility, mortality and life expectancy rates.

social wellbeing (Hill & King, 1995). They also found that an increase in female education and, in particular, female primary and secondary enrolment rates leads to a decrease in infant mortality and fertility rates. The expectations of women to marry early, engage in housework and related unpaid labour and have children have created significant barriers to education for women primarily in Asia, Africa and the Middle East (Hill & King, 1995). These barriers keep the gender gap in education alive, despite evidence that proves education and the promotion of gender equality in educational attainment and enrolment benefits women.

However, female primary and secondary enrolment rates have increased and female educational attainment has risen since the 1990s[6] (Abu-Ghaida & Klasen, 2003). Despite these growths, there is a significant variation in the speed by which the gender education gaps are closing between different regions. Countries in the Organisation for Economic Co-operation and Development (OECD), East Asia and the Pacific (EAP), Eastern Europe and Central Asia (ECA) and Latin America and the Caribbean (LAC) appear to be closing their education gaps the fastest. Also, countries in the OECD exhibit minimal gender education gaps, while South Asia (SA), the Middle East and North Africa (MENA) and Sub-Saharan Africa (SSA)—the regions with higher initial levels of gender inequality in education—appear to be closing their gender education gaps at a much slower rate[7] (Abu-Ghaida & Klasen, 2003). This regional disparity can be attributed to the same primary barriers to education for women, which also affects SA, MENA and SSA: culture, religion, institutions, political corruption and those pertaining to economic development (Hill & King, 1995; World Bank, 2001).

2.2.3 Empirical Growth Modelling

Previous studies have explored the effect of gender inequality in education on economic growth through empirical growth modelling. The Solow neoclassical growth model has set the foundation for theoretical growth accounting. However, as growth modelling has developed

[6] For information on education enrolment and data on educational attainment rates, please refer to Barro and Lee (2001 and 2013).

[7] See Barro and Lee (2013) for educational attainment statistics by country and region.

since the 1950's, the Solow neoclassical growth model alone has become restrictive in nature when studying the impacts of different measurements of human capital on growth. The simplicity of this past established model as a model for capital accumulation has given rise to the need for augmentation.

Mankiw, Romer and Weil (1992) estimated a neoclassical growth model in which a positive correlation is shown between human capital (a measurement of educational attainment), income and economic growth. Knowles, Lorgelly and Owen (2002) estimated an augmented version of Solow's neoclassical growth model based on Mankiw et al. (1992) to empirically estimate the different long-run effects of male and female schooling on labour productivity and growth. This was achieved by including male and female education as separate explanatory variables in the growth model. The model was also reparametrised to include the gender education gap (Knowles et al., 2002) to observe its impact on economic growth and development.

Using data from a range of different countries from 1960–1990, the impact of male and female human capital and the education gender gap on the steady-state level of income was estimated. The results showed that female education contributed more to labour productivity than male education did, with female education having a statistically significant positive effect on labour productivity (Knowles et al., 2002). Therefore, the results suggest that gender gaps in education and specifically lower female education impede economic development.

2.2.4 Cross-Country and Panel Regressions

From the 1990s, the availability of accurate, consistent and reliable country data on the economic growth and development of both developing and developed economies has increased, which allows for quality cross-country comparisons (Bandiera & Natraj, 2013). This has prompted the increased use of cross-country and panel regressions as a method of research in to the determinants of economic growth. These regressions were primarily introduced by Robert Barro (1991) and have since been used across a wide span of macro-economic literature on

gender inequality and economic growth and development (Klasen & Lamanna, 2009; Bandiera & Natraj, 2013).

Barro has also published various macro-economic datasets for use and specifically for education; he and Jong-Wha Lee have since developed educational attainment datasets compiled by country (Barro & Lee, 2001; 2013). For these sets, data was compiled for the educational attainment rates of the adult population—both for total population rates and rates disaggregated by gender for several countries across a wide time frame. The most recent update (Barro & Lee, 2016)[8] consisted of an educational attainment dataset for the adult population aged both 15 and over and 25 over across 146 countries; this was broken down into 5-year intervals from 1950–2010. As observed, the dataset allowed for cross-country and panel regression analysis up to 2010. In relation to its increased use to observe the impact had on economic growth stemming from the 1990s, most studies have since estimated the relationship between gender inequality in education on growth rather than on income (Bandiera & Natraj, 2013). The education datasets developed by Barro and Lee have been used in much of the cross-country and panel regression literature related to education and economic growth (see Klasen, 2000 and 2002; and Klasen & Lamanna, 2009).

Following the use of Barro's regressions (1991, 1996 and 1998), Dollar and Gatti (1999) estimated two equations to observe the impact of gender inequality in education on growth for more than 100 countries (both developing and advanced economies) over three decades. The paper addressed three main questions (Dollar & Gatti, 1999, pp. 1–2):

1. Is lower investment in girls' education simply an efficient economic choice for developing countries?
2. Does gender inequality reflect different social or cultural preferences about gender roles?

[8] Refer to the Barro and Lee dataset website (barrolee.com) to view the education datasets.

3. Is there evidence of market failures that may lead to under-investment in girls, failures that may decline as countries develop?

To address these questions, a number of measures of gender inequality were developed, including access and achievement in secondary education and improvement in health by gender, as represented by life expectancy. Using Ordinary Least Squares (OLS), the regressions indicated a robust result that gender inequality in secondary education negatively impacts the growth of a country (Dollar & Gatti, 1999). The results also suggest that under-investing in schooling for girls is not an efficient economic choice and that an exogenous increase in the access and opportunity to education for girls creates a better environment for economic growth, particularly in middle-income countries. From a social aspect, Dollar and Gatti (1999) outlined that gender inequality in education and other areas[9] can be largely explained by religious and cultural expectations and societal preferences. They also indicated that societies heavily influenced by these preferences tend to experience more significant side effects for gender inequality, namely lower economic growth. The regressions were also run for a number of religions; the results found that the level of gender inequality varied for each faith. Muslim and Hindu religions were associated with high levels of gender inequality in education, whereas Protestantism was associated with low inequality (Dollar & Gatti, 1999). Ultimately, the components of each individual religion partly dictated the associated gender inequality its members experienced.

The third question that Dollar and Gatti (1999) addressed relates to the reversed relationship between gender inequality in education and economic growth and whether lower economic growth leads to higher gender inequality in education. Dollar and Gatti (1999) observed that gender equality and economic development was mutually reinforcing and that increases in income led to lower gender inequality; thus, it is possible that the market failures

[9] Areas such as employment, political power and household decision making (see Dollar & Gatti, 1999).

experienced in developing economies may hinder investments in girls' schooling, but may improve as these economies develop.

Similarly with the cross-country and panel regressions, Klasen (2000) conducted a more extensive study to explore the impact of gender inequality in education on long-run economic growth.[10] The study used a sample of 109 countries to explore the instrumental direct and indirect impacts of gender inequality in education. This determined whether gender bias reduced economic growth and assessed its effect on fertility and child mortality rates. The study was achieved by first conducting a cross-country (basic specification) study, followed by further cross-country regressions and panel regressions. Data was collected for the time period of 1960–1992.

Five equations were estimated from obtaining data on income and growth, investment rates, population growth, working age population growth, openness (defined as exports plus imports as a share of GDP), educational attainment and educational expenditures. Klasen (2000) used data on educational attainment that referred to the total years of schooling for the adult population; this differs from Dollar and Gatti (1999) who defined education as the share of the adult population with some amount of secondary education. For the cross-country basic specification, regression one measured the direct impact of education and gender inequality in education on economic growth, controlling for investment rates, population growth and working age population growth. Regressions two to four measured the indirect impact of education and gender inequality in education on economic growth through each of the three control variables; gender inequality and gender bias in education may also influence investment, population growth and working age population growth and thus indirectly impact economic growth. Using path analysis, the total effect of education and gender inequality in education on long-run economic growth was determined by adding both the direct and indirect effects. Regression five was a reduced form regression that omitted the control variables; therefore, it measured the total effect

[10] Klasen (2000) also observed the impact of gender inequality in employment on long-run economic growth; however, this will not be discussed in the thesis, as the focus is on education only.

of gender inequality in education on long-run economic growth directly on its own (Klasen, 2000).

For the basic specification, the regressions were first run using cross-country data, treating the entire time period from 1960–1992 as one observation for each country. The results showed that the annual growth per capita was slowest in SSA from 1960–1992, averaging 0.7 per cent each year. Wellbeing was shown to be the lowest across Africa and SA, which each experienced the highest rates of child mortality, as well as in MENA, which had the highest levels of fertility.[11] In 1960, gender inequality in African schooling was observed as very high, with women obtaining half the amount of education than men, as measured in years. SA and the Middle East had an even larger education gap. From 1960 to 1990, women in Africa experienced the lowest average annual growth in total years of schooling and a slower increase in educational attainment than males, along with SA and MENA. This is contrasted with EAP where female educational attainment expanded 44 per cent faster than male educational attainment. Overall, the results showed that SA, Africa and the Middle East suffered the harshest conditions for female education, as compared to EAP, which first began with better conditions for women in education and experienced faster improvement in women's education opportunities, thus closing the initial gender gaps sooner (Klasen, 2000).

Following the basic specification cross-country study, an extensive cross-country and panel analysis was conducted, splitting the time frame into three decades. Panel regressions were run for each decade, thus generating an observation for each decade and country. The results showed that the effect of gender inequality in education on economic growth was as strong in developing countries as it was in developed countries; thus, it is the certain level of inequality in education that influences its impact on the actual economic growth of a country. Concluding observations showed that gender inequality in education restricts economic growth, both directly

[11] Separately, Klasen (2000) also estimated models of fertility and child mortality to observe the impact of education and gender inequality in education on economic growth with the inclusion of non-economic indicators.

through distorting incentives and indirectly through affecting investment and population growth (Klasen, 2000). SSA appeared to suffer the most; the effect of gender inequality in education on economic growth was larger in this region because it had the highest level of education inequality when compared to other regions. Therefore, promoting female education in SSA may have a higher pay-off than the other regions because it needs to improve equality the most. Gender inequality in education also leads to significant effects on fertility and child mortality, while higher inequality leads to higher fertility and higher child mortality. These findings have important implications on both the economic growth of a country and the development and wellbeing of its people, primarily in developing countries[12] that suffer the most with high education inequality and high levels of fertility and child mortality (Klasen, 2000).

Klasen (2002) conducted an updated study that followed the same model[13] used in Klasen (2000). He first conducted a cross-country study in which the entire time frame from 1960–1992 served as one observation for each country; he followed this with a panel study in which the five-equation model was re-estimated using panel data that split the independent and dependent variables into three decades (1960s, 1970s and 1980–1992). This updated study also separated the chosen countries into seven distinct regions: MENA, EAP, SA, SSA, OECD, LAC and ECA. Acknowledging the previous results of Klasen (2000)—in which the level of gender inequality showed to be stronger in SSA, MENA and SA—both the cross-country and panel models were also estimated using only developing countries and further only African countries to assess whether the results differed.

The results showed that gender inequality in education was more apparent in SA, MENA and SSA, which is consistent with Klasen (2000). Additionally, an important point to outline from Klasen (2002) is that gender inequality in initial education levels has a significant impact on economic growth and that higher initial levels of gender inequality leads to lower growth.

[12] Developing countries are primarily within the regions of MENA, SA and SSA.

[13] Klasen (2000) observed the impact of gender inequality in employment on long-run economic growth as well as education, but Klasen (2002) focused only on education.

Specifically (given the time frame of 1960–1992) if SSA, SA and MENA initially had more balanced education levels for females and males in 1960 and had further encouraged and promoted gender equality in education, their annual economic growth rates could have grown up to 0.9 per cent faster (Klasen, 2002). The effect of gender inequality in education on economic growth is persistent and thus significantly affected by initial and past levels of gender bias in education. Klasen (2002) also observed that gender inequality in education limits long-run economic growth directly through lowering the levels of average human capital (educational attainment) and indirectly through affecting investment and population growth.

Klasen and Lamanna (2009) conducted an updated study following Klasen (2002) in which they observed the extent that gender inequality in education lowers long-run economic growth.[14] They also used cross-country and panel regressions, but for an updated time frame of 1960–2000. Klasen and Lamanna (2009) used the same econometric specification as Klasen (2002); however, with two additional equations to calculate a lower-bound estimate of both the direct and indirect effects of education and gender bias in education on long-run economic growth, thus taking the total number of years of schooling as a measure for average human capital. The model was then re-estimated using panel data, which was split into decades (1960–1969, 1970–1979, 1980–1989 and 1990–2000). This updated study also provided a list of countries used for analysis (see Klasen & Lamanna, 2009), which was split into the same seven world regions that Klasen (2002) defined.

The results showed that gender bias in education considerably reduced economic growth, as characterised by the discrimination towards women in the access and opportunities to education (Klasen & Lamanna, 2009). This discrimination imposed costs not only for the women, but also for the society as a whole, thus limiting economic growth and societal development. In SA and SSA, women continued to experience high levels of discrimination in educational attainment; in MENA, gender gaps in education experienced a reduction over the

[14] Klasen and Lamanna (2009) also observed the impact of gender inequality in employment on long-run economic growth; however, this will not be discussed in this chapter, as the focus is on education only.

updated time frame—however, a noticeable gap was still present. Further, countries in EAP appeared to be closing its education gender gaps at a substantially faster rate than SA, SSA and in MENA.

The results also showed that when analysing the 1990s (the updated portion of the time frame), gender inequality in education seemed to restrict economic growth. Findings from earlier data also reached the same conclusion (Klasen & Lamanna, 2009). Thus, gender inequality in education has remained a driver of lower economic growth and development. Klasen and Lamanna (2009) concluded that although there have been improvements to the gender education gap, gender inequality remains a significant barrier to increasing both economic growth and societal wellbeing and development.

Chapter 3: Methodology

This chapter consists of the methodology, which includes the regressions used and associated variables.

Since the inception of cross-country and panel regressions, each have been used in much of the empirical growth work that studies the determinants of gender inequality and economic growth. Likewise, this thesis will study the impact of gender inequality in education on long-run economic growth using the same cross-country and panel regressions, which have been constructed following Klasen (2002) and Klasen and Lamanna (2009), and will be tested across an updated time frame of 1970–2010. Klasen and Lamanna (2009) conducted the most recent cross-country and panel study on this topic up to the year 2000.

The study in this thesis was conducted on 56 different countries[15] and categorised into seven different world regions: EAP, ECA, LAC, MENA, OECD, SA and SSA.[16] Following Klasen (2002) and Klasen and Lamanna (2009), both the direct and indirect effects were accounted for when measuring and observing the impact of gender inequality in education on economic growth. The direct impact can be identified as the impact of gender inequality, specifically in education on economic growth. Previous literature also showed that education and gender inequality in education could have an impact on other variables that affect economic growth, namely investment, population growth and labour force growth. Thus, gender inequality in education can also have an impact on economic growth indirectly through these other determinants of growth.

For both the cross-country and panel regressions, the model was estimated for all regions together (basic specification), as well as a separate estimation that included the regions with the

[15] This thesis was conducted on a smaller scale than previous literature, as fewer countries were included. Countries were also chosen based on the availability of data.

[16] See Appendix Table A1 for a full list of countries included, categorised by region. Countries have been categorised into regions based on Klasen and Lamanna (2009) and the World Bank classification of countries (see https://datahelpdesk.worldbank.org/ for country and region classifications).

lowest observed gender inequality[17] (ECA, LAC and OECD) and another estimation that included the regions with the highest observed gender inequality (MENA, SA and SSA).[18]

3.1 Cross-Country Regressions

First, as this study focuses on long-run economic growth, the cross-country regressions were run using country data for the 40-year period from 1970–2010, treating the entire period as one observation for each country (similar to Klasen, 2002 and Klasen & Lamanna, 2009). A number of regressors found to also affect long-term economic growth were included in the following regressions: investment rates, population growth, labour force growth and openness. Following Klasen and Lamanna (2009), four different education variables were generated using education values of the population aged 15 and over: the initial level of education in 1970 (ED70), the gender gap in educational attainment in 1970 as a female–male ratio (RED70), the growth in the level of education during 1970–2010 (GED) and the growth in the female–male ratio of educational attainment during 1970–2010 (RGED). ED70 and GED were constructed using male educational attainment values, generating an upper-bound estimate for the impact of gender inequality in education on economic growth. The estimate is upper-bound because the male education level is held constant; thus, allowing the assumption that the gender education gap could be decreased by increasing the number of girls placed in schooling, without decreasing the number of boys (Klasen & Lamanna, 2009).[19] Table 3.1 provides a list of all variables used in the cross-country regressions, their definitions and their data sources.

Allowing for the observation of both the direct and indirect effects of gender inequality in education on long-run economic growth, the following five equations were estimated using OLS:

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[17] See descriptive statistics in Table 4.1 for education figures by region.

[18] EAP will be included in the estimations, but as the benchmark reference region.

[19] For ED70 and GED, female, male or total average education could have been used as measurement; all would simply provide different interpretations of the impact of the gender gap and a different level-bound estimate for the impact of gender inequality in education on economic growth. Klasen and Lamanna (2009) used male education to generate an upper-bound estimate, and this thesis will be following the same measurement.

1. $G = \alpha + \beta_1 INV + \beta_2 POPGRO + \beta_3 LFG + \beta_4 ED70 + \beta_5 GED + \beta_6 RED70 + \beta_7 RGED + \beta_8 X + \varepsilon$
2. $INV = \alpha + \beta_9 POPGRO + \beta_{10} LFG + \beta_{11} ED70 + \beta_{12} GED + \beta_{13} RED70 + \beta_{14} RGED + \beta_{15} X + \varepsilon$
3. $POPGRO = \alpha + \beta_{16} OPEN + \beta_{17} ED70 + \beta_{18} GED + \beta_{19} RED70 + \beta_{20} RGED + \beta_{21} X + \varepsilon$
4. $LFG = \alpha + \beta_{22} OPEN + \beta_{23} ED70 + \beta_{24} GED + \beta_{25} RED70 + \beta_{26} RGED + \beta_{27} X + \varepsilon$
5. $G = \alpha + \beta_{28} OPEN + \beta_{29} ED70 + \beta_{30} GED + \beta_{31} RED70 + \beta_{32} RGED + \beta_{33} X + \varepsilon$

Equation 1 measured the direct impact of education and gender inequality in education on long-run economic growth by controlling for investment, population growth and labour force growth. Equations 2 to 4 measured the indirect impact of education and gender inequality in education on growth through investment, population growth and labour force growth respectively; this was done so by measuring the growth in these variables with the inclusion of the education variables. Equation 5 was a reduced form regression that omitted investment, population growth and labour force growth. This equation measured the total effect of gender inequality in education on long-run economic growth directly on its own. Each equation controlled for regional variation through the inclusion of regional dummy variables.[20] All X terms included the natural logarithm of per capita GDP in 1970 to observe convergence, control for regional variation and, if not listed in the equation already, openness.

[20] Regional variation includes geographic and environmental, political, institutional, trade and conflict differences that are experienced within regions (Klasen & Lamanna, 2009). Dummy variables are used to control for regional variation for all regions, with EAP as the benchmark reference region.

Table 3.1: Variables, Measurements and Data Sources (Cross-Country Regressions)

Variable	Variable Name	Measurement	Data Source
G	Growth	Per capita annual compounded growth rate at chained PPP adjusted real GDP (in USD 2011) 1970–2010	Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015)
INV	Investment	Average annual investment rate for 1970–2010	Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015)
POPGRO	Population Growth	Annual compounded growth rate of total population 1970–2010	Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015)
OPEN	Openness	Average annual openness rate, measured as exports plus imports as a share of GDP for 1970–2010	Penn World Table 7.1, retrieved from FRED, Federal Reserve Bank of St. Louis (2016)[21]
LFG	Labour Force Growth	Annual compounded growth rate of total labour force 1970–2010	Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015)
ED70	Male Education 1970	Average number of years of total schooling for male population aged 15 and over in 1970	Barro and Lee (2016a)
GED	Growth in Male Education	Absolute annual growth in the average years of total schooling for male population aged 15 and over 1970–2010	Barro and Lee (2016a)

[21] Data files for openness have been compiled separately for each country. For reference, see Appendix Table A2 for a complete list of data file names for each country.

RED70	Ratio of Education 1970	Female–male ratio of the average years of total schooling for population aged 15 and over in 1970	Barro and Lee (2016a)
RGED	Ratio of Growth in Education	Female–male ratio of the absolute annual growth in the average years of total schooling for population aged 15 and over 1970–2010	Barro and Lee (2016a)
logGDP70	Log of GDP 1970	Natural logarithm of per capita real GDP in 1970 (USD 2011)	Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015)

3.2 Panel Regressions

Following the cross-country regressions, the panel regressions were run by re-estimating the cross-country model to fit panel data. The panel data was constructed by decade for the 40-year period from 1970–2010 and thus split into one observation for each decade for each country. Similar to the cross-country model, the panel regressions were used to measure the direct and indirect impact of gender inequality in education on economic growth. Variables measuring any form of growth (G, POPGRO and LFG) were measured as the average annual compounded growth for each decade; variables denoting average rates for each time period (INV and OPEN) were measured as average annual values for each decade; and the education variables were measured as initial values at the beginning of each decade.[22] Using initial values for the education variables allowed for the partial control of any endogeneity issues with these variables. Moreover, using a fixed effects model[23] and country-specific effects permitted the

[22] logGDP70 was also measured as the initial log GDP value for each decade (1970, 1980, 1990 and 2000).

[23] Fixed effects is the preferred model specification based on the Hausman test.

control for unobserved heterogeneity. Thus, by using panel data, more robust estimates were able to be generated.

Similar to Klasen and Lamanna (2009), the education variables were measured as initial values for each decade to control for endogeneity. For the purposes of the panel study, and as GED and RGED were no longer included, two education variables were included: ED70, which denoted the initial level of male education for each decade (thus generating an upper-bound estimate for the impact of gender inequality in education on economic growth), and RED70, which denoted the female–male ratio of initial levels of education for each decade.

For this thesis, the relationship of focus is education (and gender inequality in education) and its impact on economic growth. Regarding simultaneity issues, there is a possibility that causality runs from economic growth to education rather than contrariwise, as identified for this study. This is addressed by the use of control variables and panel data, which divided the dependent and independent variables into decades with initial values within a fixed effects model. Table 3.2 provides a list of the variables used in the panel regressions, along with their measurements and data sources.

The following five equations were estimated for the panel data using fixed effects:

1. $\mathbf{G = \alpha + \beta_1 INV + \beta_2 POPGRO + \beta_3 LFG + \beta_4 ED70 + \beta_5 RED70 + \beta_6 X + \varepsilon}$
2. $\mathbf{INV = \alpha + \beta_7 POPGRO + \beta_8 LFG + \beta_9 ED70 + \beta_{10} RED70 + \beta_{11} X + \varepsilon}$
3. $\mathbf{POPGRO = \alpha + \beta_{12} OPEN + \beta_{13} ED70 + \beta_{14} RED70 + \beta_{15} X + \varepsilon}$
4. $\mathbf{LFG = \alpha + \beta_{16} OPEN + \beta_{17} ED70 + \beta_{18} RED70 + \beta_{19} X + \varepsilon}$
5. $\mathbf{G = \alpha + \beta_{20} OPEN + \beta_{21} ED70 + \beta_{22} RED70 + \beta_{23} X + \varepsilon}$

Similar to the cross-country model, equation 1 measured the direct impact of education and gender inequality in education on economic growth; equations 2 to 4 measured the indirect impact of education and gender inequality in education on economic growth through investment, population growth and labour force growth; and equation 5 was the reduced form regression that measured the total effect of gender inequality in education on economic growth on its own. Each equation controlled for regional, decade and country variation. All X terms included the natural

logarithm of per capita GDP at the beginning of each decade to observe convergence and, if not listed in the equation already, openness.

Table 3.2: Variables, Measurements and Data Sources (Panel Regressions)

Variable	Variable Name	Measurement	Data Source
G	Growth	Per capita annual compounded growth rate at chained PPP adjusted real GDP (in USD 2011) for each decade from 1970–2010	Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015)
INV	Investment	Average annual investment rate for each decade from 1970–2010	Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015)
POPGRO	Population Growth	Annual compounded growth rate of total population for each decade from 1970–2010	Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015)
OPEN	Openness	Average annual openness rate, measured as exports plus imports as a share of GDP for each decade from 1970–2010	Penn World Table 7.1, retrieved from FRED, Federal Reserve Bank of St. Louis (2016)
LFG	Labour Force Growth	Annual compounded growth rate of total labour force for each decade from 1970–2010	Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015)
ED70	Male Education (1970, 1980, 1990, 2000)	Average number of years of total schooling for male population aged 25 and over[24] at the beginning of each decade	Barro and Lee (2016b)

[24] Education variables use education data for the population aged 25 and over for panel regressions, based on Klasen (2002) and Klasen and Lamanna (2009).

		from 1970–2010	
RED70	Ratio of Education (1970, 1980, 1990, 2000)	Female–male ratio of the average years of total schooling for population aged 25 and over at the beginning of each decade from 1970–2010	Barro and Lee (2016b)
logGDP70	Log of GDP (1970, 1980, 1990, 2000)	Natural logarithm of per capita GDP at the beginning of each decade from 1970–2010 (USD 2011)	Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015)

Chapter 4: Growth Data and Descriptive Statistics

This chapter presents data on the economic growth by region and descriptive statistics of both the variables used in the cross-country regressions and of other variables of interest. The purpose of this chapter is to provide an understanding of the important variables included in the regressions and in the study of gender inequality in education and economic growth.

4.1 Growth Data

As this thesis was intended to observe the impact gender inequality in education has on economic growth, data on regional annual compounded per capita growth is presented in Figures 4.1 and 4.2.

Figure 4.1 shows that the fastest growing region over the 40-year period from 1970 to 2010 was EAP, with a compounded annual per capita growth rate of 3.58 per cent. The slowest growing region was SSA, with a growth rate of 1.58 per cent. LAC exhibited the second slowest regional growth, with an annual compounded per capita growth rate of 2.25 per cent. Countries within OECD and SA showed slightly faster growth, with 2.53 per cent and 2.58 per cent, respectively. ECA exhibited the second fastest growth rate over the 40-year time frame, with a rate of 3.43 per cent. These results remain fairly consistent with that of Klasen and Lamanna (2009). However, the one region that displayed substantially higher growth results compared to previous literature was MENA, with a growth rate of 3.20 per cent; thus, the region progressed from the fourth fastest growing region to the third—and with a considerable gap in percentage growth between itself and the now fourth fastest growing region, SA.[25]

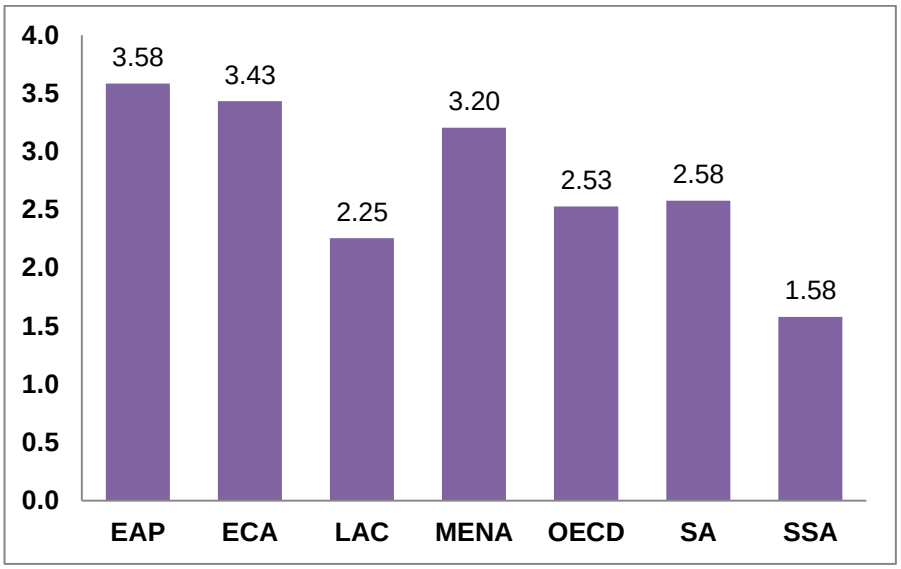
To better understand the patterns and changes in the growth rates of all regions across 1970–2010, these results have been ordered by decade (reflective of panel data), as shown in Figure 4.2.

[25] Note that results may also differ to previous literature based on the number and choice of countries included in the studies.

Figure 4.2 illustrates the compounded annual growth rate of each region by decade. It shows that MENA exhibited the fastest growth rate of any region in any decade from 2000–2010. This may provide insight to how the region has experienced much higher compounded overall annual growth across 1970–2010 when compared with the annual growth results across 1960–2000 from Klasen and Lamanna (2009). The substantial growth in the 2000s appears to have spurred a higher overall compounded annual growth rate.

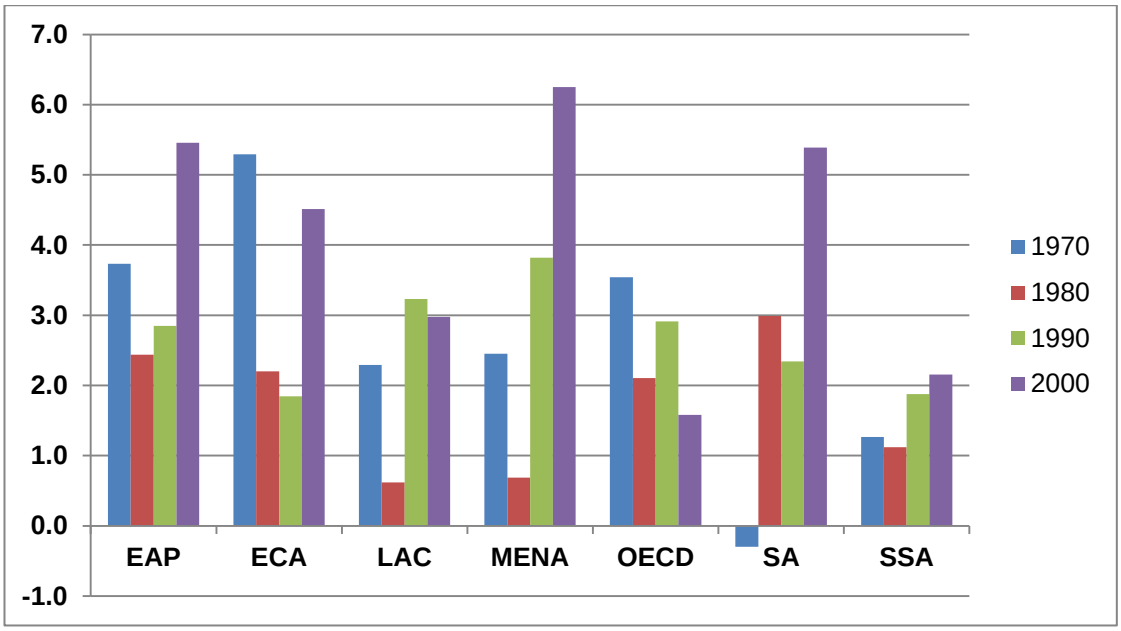
The results by decade showed that EAP, MENA, SA and SSA had their fastest regional growth in the 2000s; in particular, EAP, MENA and SA experienced a considerable jump in growth when compared to the 1990s. ECA experienced its lowest growth during the 1990s, which is consistent with most transitional countries in this region; this resulted in low per capita annual compounded growth (Klasen & Lamanna, 2009). OECD and LAC experienced relatively average growth across the decades, with LAC showing a recovery from low growth in the 1980s. SA was the only region to experience negative per capita growth, as shown in Figure 4.2 for the 1970s.

Figure 4.1: Real Per Capita Compounded Annual Growth Rate by Region (1970–2010)



Source: Data calculated from Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015).
Notes: Numbers represent growth percentage values. Sample of 56 countries included across seven regions, see Appendix Table A1 for a full listing. Regions include EAP, ECA, LAC, MENA, OECD, SA and SSA. Figures refer to unweighted averages.

Figure 3.2: Real Per Capita Compounded Annual Growth Rate by Region and Decade (1970–2010)



Source: Data calculated from Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015).
Notes: Results are growth percentage values. Sample of countries used is the same as in Figure 4.1; see Appendix Table A1 for a full listing. Figures refer to unweighted averages.

This negative growth appears to be a result of the fairly substantial negative per capita growth experienced by India, Bangladesh and Sri Lanka in the 1970s.[26] However, despite this negativity, SA exhibited substantial compounded annual per capita growth from the 1980s onwards. Further, SSA experienced a steady increase in per capita growth over the decades; however, this growth rate was still relatively low when compared to the other regions.

4.2 Descriptive Statistics

Table 4.1 provides descriptive statistics for the variables used in the cross-country regressions, as well as a number of other variables of interest.

[26] See Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015) for growth data.

Table 4.1: Descriptive Statistics (Cross-Country Regressions)

	Total	EAP	ECA	LAC	MENA	OECD	SA	SSA
G	2.70%	3.58%	3.43%	2.25%	3.20%	2.53%	2.58%	1.58%
INV	20.99%	23.87%	23.09%	17.29%	22.49%	27.39%	15.74%	16.15%
POPGRO	1.66%	1.84%	0.24%	1.75%	2.22%	0.64%	2.13%	2.52%
LFG	2.20%	2.66%	0.04%	2.76%	3.06%	0.91%	2.64%	2.84%
OPEN	64.10%	97.38%	63.70%	43.31%	93.34%	40.99%	45.56%	61.35%
GDP70	5,582	2,690	4,738	5,718	3,644	16,235	1,813	2,485
GDP10	16,571	13,839	18,314	12,937	12,072	44,115	5,604	5,540
RED70	0.68	0.66	0.84	0.89	0.44	0.91	0.45	0.53
RGED	1.15	1.22	1.21	1.20	1.11	1.23	1.02	1.03
ED70	4.84	4.59	6.95	4.81	3.19	8.17	3.20	2.96
ED10	8.87	8.64	11.12	8.54	8.26	11.66	6.93	6.96
FED70	3.76	3.12	5.87	4.37	1.59	7.49	1.93	1.79
FED10	8.22	8.07	10.87	8.38	7.24	11.49	5.60	5.81
GED	0.10	0.10	0.10	0.09	0.13	0.09	0.09	0.10
FGED	0.11	0.12	0.13	0.10	0.14	0.10	0.09	0.10

Source: Statistics have been calculated using data from Penn World Table Version 9.0, Barro and Lee (2016a) and Federal Reserve Bank of St. Louis (2016).
Notes: GDP70 and GDP10 refer to the per capita real GDP in 1970 and 2010. ED10 refers to the average total years of schooling for males aged 15 and over in 2010. FED70 and FED10 refer to the average total years of schooling for females aged 15 and over in 1970 and 2010. FGED refers to the absolute annual growth in the average total years of schooling for females aged 15 and over between 1970–2010. Please note that not all ratio calculations using ED70 and FED70 are equal to RED70 values due to rounding.

As outlined in Figure 4.1, compounded annual growth was the fastest for EAP, ECA and MENA and the slowest for SSA over 1970–2010. Overall, LAC, OECD and SA experienced average growth. The average annual investment rates were the highest for OECD, with 27.39 per cent, followed by EAP and ECA; the lowest rates were for SSA and SA, with 16.15 per cent and 15.74 per cent. The annual compounded population growth and labour force growth rates were the lowest for ECA, with only 0.24 per cent annual population growth and 0.04 per cent overall labour force growth for 1970–2010, as compared to the total average of 1.66 per cent and 2.20 per cent, respectively. One explanation for these low figures is that many of the countries within ECA were in transition during the 1990s, which restrained growth and development and created unemployment difficulties. The average openness (measured as exports plus imports as a share of GDP) was shown to be the highest for EAP, with close to 100 per cent, followed by MENA with an openness rate of 93.34 per cent. This contrasted with OECD, LAC and SA; each

exhibited the lowest rates of openness at less than 50 per cent. Regarding per capita GDP,[27] SA and SSA had the lowest values in both 1970 and 2010, while OECD (which consists of developed economies) exhibited the highest per capita GDP for 1970 and 2010.

For the education variables, the RED70 values showed that the female–male ratio of education in 1970 was the lowest for MENA and SA, with a ratio of 0.44 and 0.45; conversely, it was the highest for OECD and LAC, with ratios of 0.91 and 0.89. Therefore, OECD and LAC had the closest levels of education between females and males, whereas MENA and SA had the largest gap between female and male education. Further, it appeared that all RED70 ratios were below 1; thus, the total average education levels were higher for men than women for all regions in 1970. This can be observed by noting that all ED70 values were higher than FED70 values for each region. Next, the education values for 2010 (ED10 and FED10) reached the same conclusion of higher total average male education levels than female education levels. However, when compared, the education gaps as ratios appeared to be smaller, which suggests that they are closing.

The final important cross-country variables to observe are the educational growth variables. One trend to note is that when comparing the average annual male growth in education across 1970–2010 (GED) with the average annual female growth in education (FGED), female education had higher overall annual growth than male education for all regions.[28] This is reflected in the RGED values, as the ratios for each region are above 1. This result differs from previous literature such as Klasen and Lamanna (2009), who observed that only LAC, EAP, OECD and ECA had RGED values above 1. This suggests that over the more recent decades (2000–2010), the female–male ratio in the growth of education may have increased in MENA,

[27] Per capita GDP is measured in USD(2011); see Penn World Table, Version 9.0 (Feenstra, Inklaar & Timmer, 2015).

[28] Equal GED and FGED values are exhibited within both SA and SSA in the descriptive statistics to 2 decimal places; however when extended further than 2 decimal places, FGED values are slightly higher than GED values for both regions.

SA and SSA in particular, which resulted in a growth ratio value above 1.[29] Therefore, the growth in average annual female education across the 40-year time period from 1970–2010 has been higher than the growth in average annual male education. One particular factor that may have driven this increase in the growth of female education is the development of MDGs. MDGs have set markers for real-world issues that aim to be solved (United Nations Development Programme 2011, 2014 and 2016), and as there was increased encouragement for achieving these development goals by 2015, the development and implementation of MDGs involving the promotion of gender equality and the increase in education worldwide in particular may have assisted the increase in the growth of female education in the 2000s.

[29] RGED values may also differ due to the number and choice of countries included in this study.

Chapter 5: Results

This chapter consists of the cross-country and panel regression results that observed the direct and indirect impact of gender inequality in education on economic growth. As the focus is on long-run growth, results are first provided for the cross-country regressions over 1970–2010, followed by the panel regressions, which are split into decades for all 56 countries. Panel regressions were run using fixed effects, as it is the preferred specification method based on Hausman's specification test. The five-regression model was also run separately for regions that experience lower gender inequality (ECA, LAC and OECD) and for regions that experience higher levels of gender inequality in education (MENA, SA and SSA)[30] for both cross-country and panel data. This was used to observe whether the results differed between regions with the largest and smallest gender gaps.

5.1 Cross-Country Regressions

5.1.1 Basic Specification (All Countries)

Table 5.1 presents results for the cross-country basic specification for all countries and regions. Overall, a similar fit of regression results was observed and likened to Klasen and Lamanna's (2009).

Regression one showed the direct effect of gender inequality in education on long-run economic growth, controlling for investment, population growth and labour force growth. The results showed strong conditional convergence with a negative and highly significant logGDP70 coefficient of –2.17. This strong conditional convergence is consistent with the results found in Klasen (2002) and Klasen and Lamanna (2009), as well as with the overall consensuses reached in previous empirical and theoretical literature. The control variables results showed a large significant positive impact of investment rates on long-run economic growth, as well as a significant positive impact of labour force growth. As expected, population growth had a

[30] EAP will be included in all models as the reference region.

negative effect on economic growth; however, this was not significant. Openness was positive and significant and substantially larger than the results shown in Klasen (2002) and Klasen and Lamanna (2009). Regionally, all excluding SSA had a positive coefficient of growth in relation to the reference region (EAP), but only MENA and OECD were significant.

The education variables showed that both the initial male education in 1970 (ED70) and the growth in male education (GED) variables were positive and significant. These positive values are expected (Klasen & Lamanna, 2009) because any growth in human capital may give rise to increased economic growth. The results differed slightly from Klasen and Lamanna (2009); however, in which both variables were also positive, but only GED was significant in their study. For the two main education variables of interest (the ratios), the results showed positive coefficients for both RED70 and RGED; however, only RED70 was significant. This suggests that overall; the female–male ratio in the initial education levels in 1970 was significant and had a strong impact on the long-run economic growth for all regions.

Although RGED was also positive, it was not significant. This differs from Klasen and Lamanna (2009) who observed the opposite results in which RGED was highly significant. Aside from the updated time frame used for this thesis, the variations in these significant variables could also be affected by the number and selection of the countries included in this study. Compared to Klasen and Lamanna (2009), a smaller collection of countries and (based on the availability of data) a smaller selection of poorer countries with higher levels of gender inequality and lower economic growth were used.

Regressions two to four showed the indirect impact of gender inequality in education on long-run economic growth through its impact on investment, population growth and labour force growth. For regression two, the results showed that GED was the only significant education variable.

Table 5.1: Gender Inequality in Education and Long-Run Economic Growth (Cross-Country Basic Specification)

Dependent Variable	GROWTH (1)	INV (2)	POPGRO (3)	LFG (4)	GROWTH (5)
INV	0.05**				
	[0.03]				
POPGRO	–0.64	–6.33**			
	[0.51]	[2.83]			
LFG	0.47*	6.38***			
	[0.34]	[2.29]			
ED70	0.25**	0.99	–0.08	–0.16	0.24**
	[0.12]	[0.76]	[0.10]	[0.14]	[0.14]
GED	14.84***	95.50***	1.08	2.37	20.62***
	[5.45]	[33.13]	[3.87]	[6.23]	[5.06]
RED70	3.07***	–6.54	–0.72	–0.19	3.28***
	[1.11]	[5.84]	[0.74]	[1.17]	[1.06]
RGED	0.26	0.57	0.04	0.26	0.47
	[0.48]	[3.03]	[0.56]	[0.76]	[0.55]
OPEN	0.01**	0.03	0.00	0.00*	0.01***
	[0.00]	[0.03]	[0.00]	[0.00]	[0.00]
logGDP70	–2.17***	2.49	0.07	0.09	–2.04***
	[0.25]	[2.03]	[0.15]	[0.30]	[0.25]
ECA	0.77	3.68	–1.32***	–2.10***	0.56
	[0.75]	[5.22]	[0.32]	[0.53]	[0.73]
LAC	0.53	–5.98**	0.07	0.39	0.46
	[0.63]	[3.37]	[0.39]	[0.52]	[0.70]
MENA	1.22**	–4.73*	0.06	0.09	0.99**
	[0.54]	[3.44]	[0.40]	[0.51]	[0.57]
OECD	2.14***	3.44	–0.84**	–0.98*	2.34***
	[0.82]	[4.31]	[0.44]	[0.73]	[0.84]
SA	0.58	–2.82	0.09	0.06	0.40
	[0.57]	[2.82]	[0.35]	[0.53]	[0.63]
SSA	–0.58	–1.86	0.49*	0.14	–1.04**
	[0.63]	[2.96]	[0.33]	[0.42]	[0.57]

Constant	13.22***	–14.47	1.91**	1.81	12.06***
	[1.81]	[14.33]	[1.05]	[1.82]	[1.67]
Adj R2	0.72	0.54	0.61	0.60	0.66
Observations	56	56	56	56	56

Notes: Robust standard errors presented under all coefficients. ******* refers to 1 per cent, ****** to 5 per cent and ***** to 10 per cent significance level using a one-tailed test. Omitted region is EAP.

Regressions three and four showed that no education variables had a significant impact on population growth and labour force growth, which is consistent with Klasen and Lamanna (2009), who also observed that no education variables were significant for these two regressions. Overall, the indirect impact of gender inequality in education on long-run economic growth was quite small and minimally significant.

Regression five was a reduced form regression that showed the direct impact of gender inequality in education on economic growth by omitting investment, population growth and labour force growth. Similar to regression one, regression five showed strong conditional convergence, with a highly significant negative logGDP70 coefficient of –2.04. This was also consistent with the reduced form cross-country regressions in Klasen and Lamanna (2009). Further, all region coefficients were positive (except for SSA), and MENA and OECD were significant. Also, SSA was now significant (and negative) in relation to the reference region (EAP). Openness was still highly significant.

The education variables in regression five showed results that were consistent with regression one. All education coefficients were positive; however, ED70, GED and RED70 were significant, while RGED was not. The coefficients for GED, RED70 and RGED were all larger than the coefficients in regression one, which suggests that gender inequality in education had a sizeable negative impact on long-run economic growth. However, in terms of significance, the results showed that gender inequality specifically in initial education levels (RED70) appeared to have a significant negative impact on growth. Overall, the results differed slightly from Klasen

and Lamanna (2009) in which all four education variables were significant for their reduced form regression.[31]

5.1.2 ECA, LAC and OECD (Cross-Country Lower Gender Gap)

Table 5.2 presents the results for cross-country regressions run using the regions with lower levels of gender inequality in education. A similar fit of regression results to the cross-country basic specification is shown.[32] Similar to the cross-country basic specification, regression one results showed strong conditional convergence, with a negative and highly significant logGDP70 coefficient of –2.85. Both investment and openness were highly significant and, additionally, the investment coefficient was substantially larger than the coefficient for the basic specification. This suggests that investment has a larger impact on economic growth within regions with a smaller gender education gap. Regionally, all three had positive coefficients of economic growth; however, only LAC and OECD were significant in relation to the reference region (EAP).

The education variables for regression one showed that only ED70 and RED70 were significant, which suggests that the initial education values and initial gender education gaps had a strong impact on the long-run economic growth of the regions with an overall smaller gender education gap. This is similar to the results of the cross-country basic specification.

Regressions two to four showed that, indirectly, only the initial male education in 1970 (ED70) and the growth in male education over 1970–2010 (GED) had a significant impact on economic growth through investment rates. The indirect impact of gender inequality in education was not significant because neither of the ratio coefficients (RED70 or RGED) were significant. Similarly, only ED70 and GED were significant in the reduced form regression (regression five). Thus, the education variables for regressions two to five suggest that for regions with a smaller gender education gap, the impact of the female–male ratio of education in 1970 and the

[31] As mentioned previously, this could be attributed to the number and choice of countries used in this study.

[32] However, regression five showed a lower fit of results compared to regression five of the cross-country basic specification.

Table 3.2: Gender Inequality in Education and Long-Run Economic Growth (Cross-Country Lower Gender Gap Regions)

Dependent Variable	GROWTH (1)	INV (2)	POPGRO (3)	LFG (4)	GROWTH (5)
INV	0.11***				
	[0.03]				
POPGRO	–0.34	–2.65			
	[0.57]	[6.09]			
LFG	0.07	4.77			
	[0.45]	[4.62]			
ED70	0.30**	1.95**	–0.05	–0.03	0.52***
	[0.13]	[1.00]	[0.10]	[0.13]	[0.15]
GED	8.44	142.28**	–3.53	–0.76	25.62***
	[6.79]	*[49.46]	[5.75]	[6.59]	[7.72]
RED70	1.94*	–5.92	–0.79	–1.70	0.78
	[1.28]	[10.40]	[1.25]	[1.61]	[1.87]
RGED	–0.05	2.23	–0.58	–0.50	0.25
	[0.38]	[3.97]	[0.64]	[0.84]	[0.58]
OPEN	0.01***	0.04	0.00	0.00	0.02**
	[0.00]	[0.04]	[0.00]	[0.00]	[0.01]
logGDP70	–2.85***	1.16	0.20	0.39	–2.62***
	[0.49]	[3.58]	[0.26]	[0.52]	[0.62]
ECA	0.92	3.98	–1.46***	–2.44***	0.82
	[0.94]	[6.92]	[0.44]	[0.62]	[0.88]
LAC	1.86**	–4.05	–0.05	0.31	1.64*
	[0.82]	[5.13]	[0.53]	[0.76]	[1.09]
OECD	3.09**	5.01	–1.22**	–1.84*	3.30**
	[1.33]	[6.76]	[0.70]	[1.13]	[1.52]
Constant	18.85***	–18.86	2.00	1.31	16.33***
	[3.28]	[21.58]	[1.70]	[3.22]	[3.77]
Adj R2	0.71	0.51	0.60	0.65	0.49
Observations	33	33	33	33	33

Notes: Robust standard errors presented under all coefficients. ******* refers to 1 per cent, ****** to 5 per cent and ***** to 10 per cent significance level using a one-tailed test. Omitted region is EAP.

female-male ratio in the growth of education from 1970–2010 is not significant. This may be due to the smaller gender education gaps that already exist in these regions, which subsequently affect the decrease of the gap less significantly.

5.1.3 MENA, SA and SSA (Cross-Country Higher Gender Gap)

Table 5.3 presents results for the cross-country regressions run using the regions with higher levels of gender inequality in education. A substantially better fit of regression results was observed for regressions one, two and five when compared to the basic specification. The regression one results in Table 5.3 show strong conditional convergence, with a highly significant negative loggGDP70 coefficient of –1.61. This was similar to the basic specification (and lower gender gap model); however, the rate of convergence was slightly smaller (compared to –2.85 and –2.17). The control variables showed a negative value of investment, but this was not significant. Both the population growth and labour force growth coefficients were significant and substantially larger than the basic specification and lower gender gap models. Therefore, the results suggest that the impact of population and labour force growth is significant on economic growth. This indicates that the levels of human capital and the reduction of population growth in poorer countries are important because many of these countries need to facilitate more area and economic resources for larger populations. Openness was also significant, showing the same coefficient as the other two models (0.01). Regionally, only SSA had a negative coefficient; however, none of the regions showed significance in growth in relation to the reference region (EAP).

The education variables GED, RED70 and RGED were positive; however, only GED and RED70 were significant. The results suggest that directly, the growth of male education across 1970–2010 and the female–male ratio of education in 1970 had a significant impact on economic growth—which is similarly implied by the cross-country basic specification model regarding GED and RED70.

Table 5.3: Gender Inequality in Education and Long-Run Economic Growth (Cross-Country Higher Gender Gap Regions)

Dependent Variable	GROWTH (1)	INV (2)	POPGRO (3)	LFG (4)	GROWTH (5)
INV	–0.02				
	[0.04]				
POPGRO	–1.50**	–6.73*			
	[0.63]	[4.09]			
LFG	1.01**	5.20*			
	[0.44]	[3.03]			
ED70	–0.08	–1.11	–0.27*	–0.49**	–0.14
	[0.28]	[1.26]	[0.16]	[0.24]	[0.25]
GED	25.70***	100.10**	2.91	2.76	22.66***
	[7.44]	[43.62]	[4.01]	[6.47]	[5.29]
RED70	2.98**	–1.79	–0.42	0.70	4.26***
	[1.18]	[7.00]	[0.85]	[1.24]	[1.10]
RGED	1.79	6.20	1.48**	1.79**	1.30
	[1.57]	[7.40]	[0.79]	[1.04]	[1.24]
OPEN	0.01**	0.07**	0.00	0.01***	0.02***
	[0.01]	[0.04]	[0.00]	[0.00]	[0.01]
logGDP70	–1.61***	4.04*	0.16	0.13	–1.77***
	[0.35]	[2.41]	[0.15]	[0.26]	[0.25]
MENA	0.47	–5.91**	–0.06	–0.02	0.62*
	[0.47]	[3.24]	[0.37]	[0.51]	[0.47]
SA	0.73	–1.14	0.33	0.34	0.60
	[0.66]	[3.32]	[0.35]	[0.50]	[0.67]
SSA	–0.50	–1.46	0.59*	0.17	–1.14**
	[0.62]	[4.07]	[0.37]	[0.42]	[0.65]
Constant	8.61***	–26.95*	–0.19	0.08	9.36***
	[3.02]	[19.35]	[1.31]	[2.08]	[2.47]
Adj R2	0.77	0.61	0.14	0.12	0.73
Observations	32	32	32	32	32

Notes: Robust standard errors presented under all coefficients. ******* refers to 1 per cent, ****** to 5 per cent and ***** to 10 per cent significance level using a one-tailed test. Omitted region is EAP.

Regressions two to four showed that indirectly, GED was the only significant education variable for the investment regression; however, RGED was now significant and positive in both the population growth and labour force regressions. For the population growth regression, the significant positive RGED coefficient suggested that an increase in the female-male ratio of the growth in education had a positive effect on population growth. Although, as the overall effect of population growth directly on economic growth was (and expected to be) negative, this positive RGED does not overall seem to assist economic growth, but could instead be motivated by other factors not captured in the regressions, such as better health and living conditions, and an improvement in environmental factors, that motivated an increase in RGED and subsequently an increase in population growth. Thus, for regions with higher gender inequality, the female–male ratio of the growth in education had a significant indirect positive impact on long-run economic growth primarily through labour force growth. As regression one (growth) also showed significance in labour force growth, this confirmed the indirect positive impact of RGED on long-run economic growth through this control variable.

Regression five showed that GED and RED70 were significant, with similar coefficient values comparable to regression one. Thus, directly, GED and RED70 had a significant impact on economic growth alone. LogGDP70 also showed strong conditional convergence, with a negative highly significant coefficient of –1.77. Similar to regression one, openness was also significant; however, the value had doubled and was also now highly significant. Regionally, SSA was still the only negative coefficient; however, now MENA and SSA were, in relation to the reference region (EAP), both significant in terms of growth. When compared to regression one, the coefficient values were also significantly larger.

5.1.4 Final Cross-Country Observations

Overall, the results showed that the female–male ratio of initial education (RED70) had a significant impact on long-run economic growth across 1970–2010. This was a direct impact for the cross-country basic specification, as well as for the two regional breakdowns. These results suggest that the initial education levels and initial gender inequality in education is important and

significant for subsequent economic growth. The direct effect of an increase in the female–male ratio of initial education was stronger for the higher gender gap model compared to the lower gender gap model, with RED70 coefficients of 2.98 and 1.94 for regression one. This result suggests that although the initial education levels were significant for all regions, those with higher levels of gender inequality in education (MENA, SA and SSA) experience a greater increase in long-run growth, with a larger female–male initial education ratio.

Further, when considered directly, RGED did not appear to be significant for any of the models; however, indirectly, it was significant and positive for population growth and labour force growth in the higher gender gap model. Regarding the labour force growth regression, this suggests that there was an indirect positive impact of the increase in the female–male ratio of growth in education across 1970–2010 on long-run economic growth for countries with higher levels of gender inequality in education. When considering the countries with substantially larger gaps to grow and to increase gender equality, the female–male ratio in the growth of education seemed to be of more significance. An increase in this ratio seemed to further help close these gaps as there tends to be more opportunities to develop and an increased necessity to improve and promote equality within higher gender gap countries.

5.2 Panel Regressions

5.2.1 Basic Specification (All Countries)

Table 5.4 presents results for the panel basic specification, which considers all 56 countries across all seven regions and uses panel data for each country and decade between 1970 and 2010.[33] Regression one showed strong conditional convergence, with a highly significant negative logGDP70 (which now denotes the log of per capita GDP at the beginning of each

[33] For this thesis, panel regressions have been run for the same five equations established in the cross-country regressions, but with panel data. Klasen and Lamanna, (2009) however, run a variety of panel regressions in their study, some with the elimination of certain regions and certain decades for different equations, thus an accurate and reliable comparison of panel results between this thesis and their study is unable to be established. Panel results in this thesis are used to help determine an answer to the question of the impact of gender inequality in education on economic growth, without comparison to previous literature.

decade) coefficient of –6.72. Investment rates and labour force growth showed to have a positive effect on economic growth, and population growth showed to have a negative effect. However, these results were not significant. Further, openness was negative, with a coefficient of –0.01, and this result was also not significant. For all decades (1970s, 1980s and 1990s) in relation to the reference decade (2000s), the results were negative and highly significant, with coefficients of –4.60, –4.42 and –2.55 respectively; thus, this suggests that growth in the most recent decade (2000s) was larger than the growth in earlier decades. The values of the coefficients also suggest that growth for each decade gradually increased leading up to the 2000s.

The education variables showed that RED70 (now denoting the female–male ratio of education at the beginning of each decade for the population aged 25 and over) was positive, large and highly significant, with a coefficient of 7.66. This result suggests that there is a significant positive impact of increased gender equality in education on economic growth. ED70 (denoting the level of male education at the beginning of each decade) was small and negative; however, it was not significant.

Regressions two to four suggest that indirectly, the female–male ratio of education at the beginning of each decade (RED70) had a significant positive effect on economic growth through its impact on investment rates and population growth. Thus, increased gender equality had a positive impact on economic growth indirectly through its impact on these two control variables. ED70 also had a significant but smaller impact on investment and population growth; however, this impact seemed to be negative on growth through investment.

Regression five (the reduced form growth regression) showed strong conditional convergence, with a highly significant negative logGDP70 coefficient of –6.13; this was consistent with regression one. The results were also consistent with the decades in regression one, showing highly significant negative coefficients for all decades in relation to the reference decade (2000s). Coefficients for the 1970s, 1980s and 1990s were –4.08, –4.05 and –2.50 and, as in regression one, also showed a gradual increase in growth leading up to the 2000s. Openness

had a very small negative effect on growth, which was also consistent with regression one; however, this value was not significant.

Table 5.4: Gender Inequality in Education and Economic Growth (Panel Basic Specification)

Dependent Variable	GROWTH (1)	INV (2)	POPGRO (3)	LFG (4)	GROWTH (5)
INV	0.04				
	[0.04]				
POPGRO	–0.25	–2.58**			
	[0.38]	[1.35]			
LFG	0.19	0.82**			
	[0.21]	[0.47]			
ED70	–0.01	–2.07***	–0.12**	–0.06	–0.06
	[0.31]	[0.64]	[0.06]	[0.15]	[0.29]
RED70	7.66***	11.38*	–1.19**	–0.64	9.31***
	[3.14]	[7.22]	[0.63]	[1.33]	[3.00]
OPEN	–0.01	0.03*	0.01***	0.00	–0.01
	[0.01]	[0.02]	[0.00]	[0.01]	[0.01]
logGDP70	–6.72***	0.25	–0.27	–0.84**	–6.13***
	[0.82]	[1.84]	[0.22]	[0.39]	[0.76]
1970s	–4.60***	–2.31	–0.07	–0.32	–4.08***
	[1.18]	[2.98]	[0.29]	[0.65]	[1.12]
1980s	–4.42***	0.67	0.20	–0.01	–4.05***
	[0.90]	[2.28]	[0.23]	[0.47]	[0.86]
1990s	–2.55***	–1.41	0.11	-0.40	–2.50***
	[0.65]	[1.55]	[0.14]	[0.31]	[0.58]
Constant	48.48***	45.77**	5.24**	12.26***	64.71***
	[6.42]	[23.43]	[2.50]	[4.10]	[7.97]
Adj R2	0.50	0.73	0.75	0.57	0.51
Observations	215	215	221	215	221

Notes: Robust standard errors presented under all coefficients. ******* refers to 1 per cent, ****** to 5 per cent and ***** to 10 per cent significance level using a one-tailed test. Number of observations differs due to some missing openness and labour force growth data. Omitted decade is 2000s.

The education variables for regression five were consistent with the regression one results in which ED70 was small and negative, but not significant. RED70 was positive and highly significant, and substantially larger than the value in regression one; its coefficient was 9.31. Therefore, these results suggest that for the reduced form regression—in which the direct impact of gender inequality in education on economic growth was measured on its own, omitting the control variables of investment, population growth and labour force growth—there was a large and highly significant positive impact of gender equality in education on economic growth, by means of an increase in the female–male ratio of education levels at the beginning of each decade.

5.2.2 ECA, LAC and OECD (Panel Lower Gender Gap)

Table 5.5 displays the results of the panel regressions run including only the regions with a lower gender education gap (ECA, LAC and OECD). Overall, a slightly lower fit of regression results is observed compared to the panel basic specification. Regression one showed strong conditional convergence, with a highly significant negative logGDP70 coefficient of –6.96. This is similar to the logGDP70 coefficient of the panel basic specification. The control variables showed that investment and labour force growth were positive and population growth was negative, which is consistent with regression one of the panel basic specification. However, the investment, population growth and labour force growth coefficients were now significant. Coefficients were also larger than those found in the basic specification regression. These results suggest that for the countries with lower levels of gender inequality, the control variables had a larger and more significant impact on economic growth. Further, openness neither had an effect nor was significant. Similar to the results of the panel basic specification, the coefficients for each decade were negative and highly significant, with coefficients of –5.48, –4.97 and –2.38 for the 1970s, 1980s and 1990s respectively. Therefore, this suggests that each decade experienced lower growth in relation to the benchmark decade (2000s). The coefficient values also suggest a gradual increase in economic growth across the decades leading up to the 2000s, which is further consistent with the basic specification of regression one.

The education variables results were similar to the basic specification in that ED70 was negative but not significant and that RED70 was positive and highly significant, with a coefficient of 9.02. This value was also substantially larger than the coefficient value of the basic specification, which suggests that for the countries with a lower gender gap, the direct impact of the female–male ratio of initial education at the beginning of each decade on economic growth is quite large and positive. However, when considering all countries, the effect was still large and positive, as shown in the panel basic specification.

Regressions two to four of the lower gender gap model showed that indirectly, gender inequality in education had an impact on economic growth, but only through investment and not population growth or labour force growth. However, this particular effect was substantial, with a positive RED70 coefficient of 20.99. This suggests that when considering countries with a lower gender gap, gender inequality in education has a substantial significant indirect impact on economic growth through investment; such that a higher female–male ratio of education levels at the beginning of each decade (and subsequently lower gender inequality) has a positive impact on growth. This substantially large coefficient may also have been motivated by other factors not considered in the regressions, such as increased institutional environment conditions, thus capturing the effects of these factors had on growth in investment.

The reduced form regression (regression five) showed strong conditional convergence, with a negative highly significant coefficient of –7.48. Openness did not appear to have an impact and was not significant, which is consistent with regression 1 of this lower gender gap model. The results were also consistent with regression one for the decades, as each displayed highly significant negative coefficients of –5.94 (1970s), –5.17 (1980s) and –3.00 (1990s). These values also showed a gradual increase in growth over the decades in relation to the benchmark decade (2000s).

The education variables results were consistent with regression one in which ED70 was negative but not significant and RED70 was positive and highly significant, with a coefficient of 9.05. This suggests that there is a significant positive impact of gender equality in education on

economic growth directly for countries with a lower gender gap. This conclusion is similar to the panel basic specification model.

Table 5.5: Gender Inequality in Education and Economic Growth (Panel Lower Gender Gap Regions)

Dependent Variable	GROWTH (1)	INV (2)	POPGRO (3)	LFG (4)	GROWTH (5)
INV	0.08*				
	[0.05]				
POPGRO	–0.53*	–4.52***			
	[0.40]	[1.27]			
LFG	0.58**	1.01*			
	[0.26]	[0.63]			
ED70	–0.25	–1.62**	–0.13	–0.12	–0.41
	[0.32]	[0.71]	[0.12]	[0.24]	[0.33]
RED70	9.02***	20.99**	–0.46	–1.99	9.05***
	[3.14]	[9.05]	[1.22]	[1.90]	[3.26]
OPEN	0.00	0.03	0.01**	0.01	0.00
	[0.01]	[0.03]	[0.00]	[0.01]	[0.01]
logGDP70	–6.96***	–3.76	–0.34	–0.97	–7.48***
	[1.09]	[3.04]	[0.69]	[0.83]	[1.10]
1970s	–5.48***	–0.21	0.15	–0.33	–5.94***
	[1.43]	[3.42]	[0.67]	[1.09]	[1.46]
1980s	–4.87***	2.49	0.35	–0.01	–5.17***
	[0.99]	[2.38]	[0.41]	[0.68]	[1.00]
1990s	–2.38***	–0.08	0.21	–0.54	–3.00***
	[0.73]	[1.78]	[0.25]	[0.44]	[0.70]
Constant	49.66***	37.78**	6.16	11.27**	79.19***
	[8.99]	[22.70]	[7.92]	[6.39]	[13.99]
Adj R2	0.50	0.78	0.63	0.63	0.43
Observations	131	131	132	131	132

Notes: Robust standard errors presented under all coefficients. ******* refers to 1 per cent, ****** to 5 per cent and ***** to 10 per cent significance level using a one-tailed test. Number of observations differs due to some missing openness and labour force growth data. Omitted decade is 2000s.

5.2.3 MENA, SA and SSA (Panel Higher Gender Gap)

The results in Table 5.6 outline the regressions run including the regions with a higher gender education gap (MENA, SA, and SSA). A similar fit of regression results to the panel lower gender gap model is observed for regressions one – three, with regressions four and five exhibiting slightly lower results. For regression one, logGDP70 showed strong conditional convergence, with a negative highly significant coefficient of –6.88; this is similar to the results of the panel basic specification and the lower gender gap model. Investment was positive and both population growth and labour force growth were negative; however, none of these control variables were significant. Thus, these variables had no significant impact on economic growth in the direct growth regression. This was similar to the panel basic specification, but different to the results of the panel lower gender gap model in which all three variables were significant. Consistent with the basic specification, openness was negative, with a coefficient of –0.01, but not significant. Further, the decades were highly significant and negative with coefficients of –4.66 (1970s), –4.55 (1980s) and –3.07 (1990s). These coefficients suggest that, with respect to the benchmark decade, there was lower economic growth, but a gradual increase leading up to the 2000s. The decade results for regression one were similar to the results of both the basic specification and lower gender gap model.

Regarding the education variables, ED70 was positive, unlike both the basic specification and lower gender gap model; however, it was not significant. Similar to both previous panel models, RED70 was positive and significant, with a coefficient of 7.52. This value was slightly lower than the other models, but its impact was still large and significant. Therefore, it still suggests that an increase in gender equality (through an increase in the female–male education ratio) increases economic growth.

Overall, regressions two to four for the higher gender gap model showed that the indirect impact of gender inequality in education on economic growth through investment, population growth and labour force growth was minimal. RED70 was significant only through population growth and ED70 was significant (and negative) only for investment.

Regression five (reduced form regression) showed strong conditional convergence, with a highly significant negative logGDP70 coefficient of –5.88. Openness was negative, but not significant. Overall, these results were similar to regression one of this higher gender gap model,

Table 5.6: Gender Inequality in Education and Economic Growth (Panel Higher Gender Gap Regions)

Dependent Variable	GROWTH (1)	INV (2)	POPGRO (3)	LFG (4)	GROWTH (5)
INV	0.04				
	[0.06]				
POPGRO	–0.10	0.26			
	[0.61]	[1.44]			
LFG	–0.06	0.71			
	[0.27]	[0.67]			
ED70	0.09	–2.87***	–0.07	–0.01	–0.01
	[0.49]	[0.81]	[0.08]	[0.15]	[0.42]
RED70	7.52**	4.51	–1.55*	–1.78	9.39**
	[4.41]	[9.68]	[0.94]	[1.86]	[4.30]
OPEN	–0.01	0.02	0.00**	0.00	–0.01
	[0.01]	[0.03]	[0.00]	[0.01]	[0.01]
logGDP70	–6.88***	3.37*	–0.44**	–1.10***	–5.88***
	[1.08]	[2.32]	[0.24]	[0.43]	[0.90]
1970s	–4.66***	–9.75***	–0.13	–0.88	–4.09***
	[1.83]	[3.71]	[0.45]	[0.75]	[1.66]
1980s	–4.55***	–5.14**	0.29	–0.22	–4.18***
	[1.52]	[2.72]	[0.33]	[0.55]	[1.35]
1990s	–3.07***	–4.44***	0.16	–0.37	–2.92***
	[0.97]	[1.81]	[0.18]	[0.35]	[0.85]
Constant	71.51***	9.05	6.96***	12.04***	62.43***
	[11.66]	[21.96]	[2.62]	[3.85]	[9.25]
Adj R2	0.53	0.74	0.65	0.27	0.55
Observations	119	119	125	119	125

Notes: Robust standard errors presented under all coefficients. ******* refers to 1 per cent, ****** to 5 per cent and ***** to 10 per cent significance level using a one-tailed test. Number of observations differs due to some missing openness and labour force growth data. Omitted decade is 2000s.

and to the results of the panel basic specification reduced form regression. The coefficients for the decades were negative and highly significant at –4.08, –4.05 and –2.50 for the 1970s, 1980s and 1990s respectively. Thus, these results indicate negative economic growth (in relation to the level of growth experienced in the 2000s) that gradually increases leading up to the 2000s. Overall, the results were similar to both regression one of the higher gender gap model and to the reduced form regression results for the panel basic specification and lower gender gap model.

Lastly, the education variables for ED70 were negative and, similar to regression one, not significant. RED70 was positive, large and significant and had a coefficient of 9.39. This value was the largest for all three of the models, which suggests that (directly) the largest impact of gender equality in education on economic growth is experienced by regions with a higher gender education gap.

5.2.4 Final Panel Observations

Overall, the results showed that gender equality had a direct positive effect on economic growth, with large, positive and significant RED70 coefficients for all three of the panel regression models. By using panel data, it is clear that an increase in the female–male ratio of education levels at the beginning of each decade from 1970–2010 leads to an increase in economic growth. When observing the direct impact on economic growth by controlling for investment, population growth and labour force growth in regression one, RED70 had a larger positive effect for the lower gender gap model (ECA, LAC and OECD). However, the effect of the female–male education ratio appeared slightly larger for the higher gender gap model (MENA, SA and SSA) when observing the direct impact through the reduced form regressions, with a RED70 coefficient of 9.39 for the higher gender gap model's reduced form regression. Conversely, the coefficients were 9.31 for the panel basic specification model and 9.05 for the lower gender gap model reduced form regressions. Overall, the impact of increasing gender equality in education was significant and positive on economic growth for all regions.

Finally, for each of the growth regressions (both direct and reduced form) of the three panel regression models, every decade (1970s, 1980s and 1990s) experienced lower growth

compared to the benchmark decade (2000s), but gradually increased leading up to the 2000s. Every decade's figures were highly significant; thus, economic growth across the decades from 1970–2000 leading up to 2010 has experienced a noted gradual increase.

Chapter 6: Conclusion

This final chapter consists of a conclusion of overall results, general caveats and suggestions for further research.

Overall, gender inequality in education had a negative impact on long-run economic growth. Conversely, gender equality promoted growth and development. The results produced in this thesis confirmed the findings in previous literature (which accounted only for data concerning the years 2000 and prior) that observed this same conclusion. The negative impact of gender inequality in education on economic growth still remains a persistent issue to study.

Overall, the regions that suffered the most from gender inequality in education were MENA, SA and SSA. These regions experienced the highest gender gap in both education levels in 1970 and 2010 (as observed through the RED70, ED70, FED70, ED10 and FED10 figures in Table 4.1) and also the lowest ratio of female–male growth in the level of education (as observed through the RGED figures). Previous literature (Klasen 2002; Klasen & Lamanna, 2009) also identified MENA, SA and SSA as the regions with the highest levels of gender inequality in education. When comparing this thesis to previous literature, the gender gaps within these regions are still persistent, but they are gradually closing. Over time, the growth of female education (measured in years) is growing faster than male education (in years) and this can be observed by the RGED values in Table 4.1, which denotes the average annual female–male ratio of the growth in education across 1970–2010. Across the 40-year time frame, the RGED ratio was above 1 for every region, suggesting that the average annual female growth in education exceeded the average for annual male growth in education for all regions. Therefore, the gender gap is closing, even for MENA, SA and SSA; however, this is occurring at a much smaller rate than other regions (see Table 4.1 for regional statistics).

Further, the region that was most impacted by gender inequality in education was SA, which is consistent with Klasen and Lamanna's (2009) findings. Both MENA and SA begin with extremely low female–male initial education ratios in 1970 of less than 0.5 (0.44 and 0.45

respectively). However, over the 40-year period between 1970 and 2010, female education compared to male education in MENA (RGED value of 1.11) grew much faster than SA (RGED value of 1.02) and therefore SA shows to suffer the most. MENA also experienced a relatively large compounded annual growth rate of 3.20 per cent over the 40-year period, which is noticeably larger than SA's in this study (2.58 per cent) and in previous literature. Thus, the harmful impact of gender inequality in education on long-run growth for MENA is decreasing faster than for SA. Aside from these two regions, SSA also suffers from a large gender gap; however, overall, the results show a gradual but consistent closing of the gap.

The use of cross-country regressions highlighted certain issues to consider when assessing the accuracy and reliability of the results, such as omitted variable bias, unobserved heterogeneity and endogeneity. These issues have been addressed by using various regressors as control variables identified in the literature to impact economic growth, control for regional and country variation, and use of panel data and initial values of the education variables in the panel regressions. Although this has increased the control of these issues, further work needs to be done to produce more accurate results that allow for increased certainty and confidence in the conclusions reached. One possible factor to include in further research is the increased global integration of technology and the increased use and accessibility of information and communications technologies (ICTs) since the 1990s. This could be a contributing factor to the increased growth in female education represented by the RGED values above 1 for all regions by means of increased remote access to education worldwide. Further, the topic of gender inequality in education can affect a mix of economic and socio-economic indicators. To better understand and form complete measurements of and impacts on economic growth and development, future research should include other non-economic and social indicators such as fertility, mortality and life expectancy rates. Certain literature has included this in the past and has presented the impact of gender inequality in education on these rates. Future research could benefit from including these additional indicators to observe the effect of gender inequality in educational attainment in more detail.

Overall, the cross-country regressions showed that gender equality in education promotes long-run economic growth, which is indicated by the direct significant positive impact of an increase in the female–male ratio of initial education levels (RED70). RED70 was significant for all regions; however, its impact was larger for regions with a higher gender gap (MENA, SA and SSA). The effect of an increase in gender equality was stronger for regions where the most improvement in gender equality is needed. Further, there was an indirect significant positive impact of the female–male ratio in the growth of education (RGED) when only considering the higher gender gap regions. Indirectly through labour force growth, gender equality in education had a positive impact on long-run economic growth for MENA, SA and SSA, as indicated by an increased female–male education growth ratio. Therefore, gender equality is beneficial for the growth of all countries and regions, but primarily for MENA, SA and SSA, where the benefit is larger due to a greater necessity to close the gender education gap.

The scatter plots that depict the relationships between education and growth in Chapter 1 showed a minimal unconditional correlation between RGED and growth. The results from the cross-country regressions also showed limited correlation between the two variables that were conditional on other control variables, with significance occurring only indirectly for the higher gender gap model. However, an indirect relationship was still identified between the female–male ratio in the growth of education and long-run economic growth, though it is limited.

Through the use of initial education values for each decade, the panel regressions also concluded that gender equality aids economic growth for all countries and regions. The female–male ratio in initial education levels for each decade was positive and significant for the panel basic specification, lower gender gap and higher gender gap models, thus concluding that increasing equality in education promotes growth.

References

Abu-Ghaida, D. & Klasen, S. (2004). The costs of missing the millennium development goal on gender equity, *World Bank*, *32*(7), 1075–1107. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.200.5170&rep=rep1&type=pdf

Bandiera, O. & Natraj, A. (2013). Does gender inequality hinder development and economic growth? Evidence and policy implications, *The World Bank Research Observer*, *28*(1), 2–21. Retrieved from https://elibrary.worldbank.org/doi/abs/10.1093/wbro/lks012

Barro, R.J. (1991). Economic growth in a cross section of countries, *The Quarterly Journal of Economics*, *106*(2), 407–443. Retrieved from https://www.jstor.org/stable/2937943

Barro, R.J. (1996). Determinants of economic growth: A cross-country empirical study, *NBER Working Paper Series*, 1–118, Cambridge, MA.

Barro, R.J. (1998). Human capital and growth in cross-country regressions, *Swedish Economic Policy Review*, *6*(2), 1–58. Retrieved from www3.kau.se/kurstorg/files/g/53FAF9221b01020CB1HkPm5674C0/growthbarro.pdf

Barro, R.J. & Lee, J.W. (June 1994). Sources of economic growth, *Carnegie-Rochester Conference Series on Public Policy*, *40*, 1–46. Retrieved from http://www.sciencedirect.com/science/article/pii/0167223194900027

Barro, R.J. & Lee, J.W. (2001). International data on educational attainment updates and implications, *Oxford Economic Papers*, *53*(3), 541–563. Retrieved from http://www.nber.org/papers/w7911

Barro, R.J. & Lee, J.W. (2013). A new data set of educational attainment in the world, 1950–2010, *Journal of Development Economics*, *104*, 184–198. Retrieved from http://www.nber.org/papers/w15902

Barro, R.J. & Lee, J.W. (2016a). *Education Attainment for Population Aged 15 and Over* [Data file]. Retrieved from http://www.barrolee.com/data/yrsch.htm

Barro, R.J. & Lee, J.W. (2016b). *Education Attainment for Population Aged 25 and Over* [Data file]. Retrieved from http://www.barrolee.com/data/yrsch2.htm

Barro, R.J. & Sala-i-Martin, X. (1995). *Economic growth* (2nd ed.). New York: McGraw Hill.

Branisa, B., Klasen, S. & Ziegler, M. (2013). Gender Inequality in Social Institutions and Gendered Development Outcomes, *World Development, Vol. 4,* 252–268. Retrieved from http://dx.doi.org/10.1016/j.worlddev.2012.12.003

Dollar, D. & Gatti, R. (1999). *Gender inequality, income, and growth: Are good times good for women?*, (Policy Research Report on Gender and Development, Working Paper Series Number 1). Retrieved from The World Bank Development Research Group.

Feenstra, R.C., Inklaar, R. & Timmer, M.P. (2015). The next generation of the Penn World Table, *American Economic Review*, *105*(10), 3150–3182. Retrieved from Groningen Growth and Development Centre Faculty of Business and Economics: https://www.rug.nl/ggdc/productivity/pwt/

FRED Federal Reserve Bank of St. Louis. (2016). *Openness: Penn World Table 7.1* [Data file]. Retrieved from https://fred.stlouisfed.org/categories/33105

Galor, O. & Weil, D.N. (1996). The gender gap, fertility, and growth, *The American Economic Review, 86*(3), 374–387. Retrieved from http://www.jstor.org/stable/2118202

Hill, M.A. & King, E. (1995). Women's education and economic well-being, *Feminist Economics, 1*(2), 21–46. doi:10.1080/714042230

Klasen, S. (2000). *Does gender inequality reduce growth and development? Evidence from cross-country regressions,* (Policy Research Report on Gender and Development, Working Paper Series Number 7). Retrieved from The World Bank Development Research Group.

Klasen, S. (2002). Low schooling for girls, slower growth for all? Cross-country evidence on the effect of gender inequality in education on economic development, *The World Bank Economic Review, 16*(3), 345–373. Retrieved from https://www.jstor.org/stable/3990191

Klasen, S. (2004). Gender-related indicators of well-being. In M. McGillivray (Ed.) *Human well-being*: *Concept and measurement (studies in development economics and policy)* (pp. 167–192). London: Palgrave Macmillan.

Klasen, S. & Lamanna, F. (2009). The impact of gender inequality in education and employment on economic growth: New evidence for a panel of countries, *Feminist Economics, 15*(3), 91–132. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/13545700902893106

Knowles, S., Lorgelly, P.K. & Owen, P.D. (2002). Are educational gender gaps a brake on economic development? Some cross-country empirical evidence, *Oxford Economic Papers*, *54*(1), 118–149. Retrieved from http://www.jstor.org/stable/3488655

Knowles, S. & Owen, P.D. (1997). Education and health in an effective-labour empirical growth model, *Economic Record, 73*(223), 314–328. doi: 10.1111/j.1475-4932.1997.tb01005.x

Lagerlöf, N. (2003). Gender equality and long run growth, *Journal of Economic Growth*, *8*(4), 403–426. Retrieved from http://www.jstor.org/stable/40215889

Mankiw, G.N., Romer, D. & Weil, D.N. (1992). A contribution to the empirics of economic growth, *Quarterly Journal of Economics*, *107*(2), 407–437. Retrieved from https://eml.berkeley.edu//~dromer/papers/MRW_QJE1992.pdf

OECD (2011). How's Life?: Measuring well-being, OECD Publishing. Retrieved from http://dx.doi.org/10.1787/9789264121164-en

Subrahmanian, R. (2005). Gender equality in education: Definitions and measurements, *International Journal of Educational Development*, *25*(4), 395–407. Retrieved from https://doi.org/10.1016/j.ijedudev.2005.04.003

United Nations Development Programme. (2011). *Human Development Report 2011: Sustainability and Equity: A Better Future for All*. New York: Palgrave Macmillan. Retrieved from http://hdr.undp.org/sites/default/files/reports/271/hdr_2011_en_complete.pdf

United Nations Development Programme. (2014). *Human Development Report 2014: Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience*. New York: Palgrave Macmillan. Retrieved from http://hdr.undp.org/sites/default/files/hdr14-report-en-1.pdf

United Nations Development Programme. (2016). *Human Development Report 2016: Human Development for Everyone*. New York Palgrave Macmillan. Retrieved from http://hdr.undp.org/sites/default/files/2016_human_development_report.pdf

United Nations Entity for Gender Equality and the Empowerment of Women. (2000). *Progress of the World's Women* [Investigative report]. UN Women Headquarters. Retrieved from http://www.unwomen.org/en/digital-library/publications/2000/1/progress-of-the-world-s-women-2000

Wilson, D. (2003). Human rights: promoting gender equality in and through education, Paper commissioned for the EFA Global Monitoring Report 2003/4, *The Leap to Equality*. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.614.5078&rep=rep1&type=pdf

World Bank. (2001). Engendering Development: Through Gender Equality in Rights, Resources, and Voice. *World Bank Policy Research Report.* Washington, DC: World Bank. Retrieved from http://siteresources.worldbank.org/PGLP/Resources/Engendering_Development.pdf

Appendix

Table A1:

List of Countries Used by Region

EAP	ECA	LAC	MENA	OECD	SA	SSA
-Cambodia	-Albania	-Argentina	-Algeria	-Australia	-Bangladesh	-Benin
-China	-Bulgaria	-Barbados	-Egypt, Arab	-Canada	-India	-Botswana
-Fiji	-Cyprus	-Brazil	Rep.	-Denmark	-Maldives	-Central
-Indonesia	-Hungary	-Chile	-Iran,	-France	-Nepal	African
-Malaysia	-Poland	-Colombia	Islamic Rep.	-Germany	-Pakistan	Republic
-Philippines	-Romania	-Costa Rica	-Jordan	-Italy	-Sri Lanka	-Ghana
-Singapore		-Guatemala	-Malta	-Japan		-Kenya
-Thailand		-Mexico	-Morocco	-Norway		-Mauritius
-Vietnam		-Peru	-Syrian Arab	-United		-Mozambique
			Republic	States of		-South Africa
			-Tunisia	America		-Uganda

Notes: Countries categorised into regions based on Klasen and Lamanna (2009) and The World Bank classification of countries (see https://datahelpdesk.worldbank.org/for country and region classifications). Please note that The World Bank has categorised Hungary as part of ECA, whereas Klasen and Lamanna (2009) have classed it as a country in OECD; this thesis has followed the World Bank classification for Hungary.

Table A2:

Complete List of Openness Data Files for Each Country

Country	File Code
Albania	OPENRPALA156NUPN
Algeria	OPENRPDZA156NUPN
Argentina	OPENRPARA156NUPN
Australia	OPENRPAUA156NUPN
Bangladesh	OPENRPBDA156NUPN
Barbados	OPENRPBBA156NUPN
Benin	OPENRPBJA156NUPN
Botswana	OPENRPBWA156NUPN
Brazil	OPENRPBRA156NUPN
Bulgaria	OPENRPBGA156NUPN
Cambodia	OPENRPKHA156NUPN
Canada	OPENRPCAA156NUPN
Central African Republic	OPENRPCFA156NUPN

Chile	OPENRPCLA156NUPN
China	OPENR2CNA156NUPN
Colombia	OPENRPCOA156NUPN
Costa Rica	OPENRPCRA156NUPN
Cyprus	OPENRPCYA156NUPN
Denmark	OPENRPDKA156NUPN
Egypt, Arab Rep.	OPENRPEGA156NUPN
Fiji	OPENRPFJA156NUPN
France	OPENRPFRA156NUPN
Germany	OPENRPDEA156NUPN
Ghana	OPENRPGHA156NUPN
Guatemala	OPENRPGTA156NUPN
Hungary	OPENRPHUA156NUPN
India	OPENRPINA156NUPN
Indonesia	OPENRPIDA156NUPN
Iran, Islamic Rep.	OPENRPIRA156NUPN
Italy	OPENRPITA156NUPN
Japan	OPENRPJPA156NUPN
Jordan	OPENRPJOA156NUPN
Kenya	OPENRPKEA156NUPN
Malaysia	OPENRPMYA156NUPN
Maldives	OPENRPMVA156NUPN
Malta	OPENRPMTA156NUPN
Mauritius	OPENRPMUA156NUPN
Mexico	OPENRPMXA156NUPN
Morocco	OPENRPMAA156NUPN
Mozambique	OPENRPMZA156NUPN
Nepal	OPENRPNPA156NUPN
Norway	OPENRPNOA156NUPN
Pakistan	OPENRPPKA156NUPN
Peru	OPENRPPEA156NUPN
Philippines	OPENRPPHA156NUPN
Poland	OPENRPPLA156NUPN
Romania	OPENRPROA156NUPN
Singapore	OPENRPSGA156NUPN
South Africa	OPENRPZAA156NUPN
Sri Lanka	OPENRPLKA156NUPN
Syrian Arab Republic	OPENRPSYA156NUPN
Thailand	OPENRPTHA156NUPN
Tunisia	OPENRPTNA156NUPN
Uganda	OPENRPUGA156NUPN
United States of America	OPENRPUSA156NUPN
Vietnam	OPENRPVNA156NUPN

Notes: Listed openness files are from FRED (Federal Reserve Economic Data), Federal Reserve Bank of St. Louis (2016). Files can be obtained from: https://fred.stlouisfed.org/categories/33105