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Gender Separate Effects of Human Capital on Economic Growth

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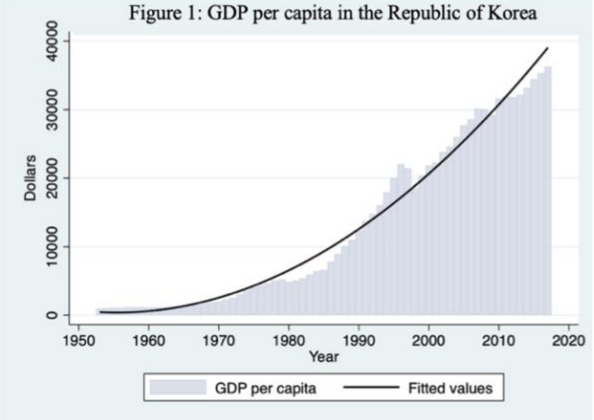
I. Introduction

In 2018, the World Bank reported that values of purchasing power parity (PPP) adjusted real gross domestic product (GDP) per capita ranged from just $742 in Burundi to $126,597 in Qatar.[1] There is no doubt that there are remarkable worldwide differences in living standards, which has caused a large amount of economic literature to be devoted to explaining this disparity. The question as to why some countries are poor, and others rich, is a major topic of investigation within macroeconomics. The factors that have been found to foster economic growth have traditionally included physical capital and labor; however, more recently, consensus has been reached – human capital accumulation also plays a major role in cross-country differences in economic growth and development. For example, Figure 1 depicts the GDP per capita of the Republic of Korea, which has demonstrated persistent growth since 1953, allowing for its development from a country with a GDP per capita of less than $1000 in 1953 to an industrialized economy with a GDP per capita of approximately $36,000 in 2017. Korea's experience with growth differs dramatically from other countries that failed to grow over the past 60 years. Argentina began in a better position relative to Korea in terms of GDP per capita in the 1950s, yet Argentina failed to grow over the subsequent years. Argentina's lack of growth caused their standards of living and GDP per capita to remain fairly stagnant, allowing Korea's GDP per capita to surpass that of Argentina. Korea, which began as a relatively poor country, is now a wealthy, industrialized economy, while Argentina remains relatively poor.

Figure 1: GDP per capita in the Republic of Korea



[1] PPP is an economic theory of exchange rate determination based on the comparison of prices across countries for a similar "basket of goods."

This example of Korea and Argentina teaches us an important lesson: the categorization of countries as low- or high-income, less developed or developed, or rich or poor is variable over time and dependent upon a country's capacity to grow. Cross-country differences in living standards come from cross-country differences in growth, and this growth is likely due to an increased focus on policies that advance human capital in the form of education and subsequent technological progress.[2] Accordingly, it is of central interest for policy makers to determine how countries can create and implement these policies that spur growth and development.

Human capital is a key component for economic growth, but human capital itself is a heterogenous good that can vary not only internationally, but also intranationally on a variety of dimensions, such as gender differences in education and health. Understanding this variability in human capital within countries is thus integral to understanding the subsequent growth that is initiated by its development. Exploring gender inequality as a contributory factor to intranational heterogeneity in human capital can provide further insight to cross-country differences in growth and development. Currently, insufficient investment into women's human capital due to cultural, religious, or historical institutions and practices is likely to contribute to overall macroeconomic issues, as highlighted by the United Nations' Sustainable Development Goal (SDG) 5: Gender Equality. SDG 5 presents gender equality as attainable through increased access to education and health care, which is considered to be "not only a fundamental human right, but a necessary foundation for a peaceful, prosperous and sustainable world" (United Nations, 2020, para. 1).

This paper examines the gender-separate effects of human capital on economic growth, treating human capital as dually influenced by both health and education. The availability of gender disaggregated data for two dimensions of human capital – life expectancy and education –

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[2] Human capital is defined as skills, knowledge, or on the job experience of a population.

over a 50-year time span and across 98 countries allows for a broad examination of gender and long-term economic growth. Upon controlling for fertility, we find that there is no statistically significant difference between the effects that the male and female human capital dimensions have on economic growth as accumulation of both is equally important. Furthermore, our results also shed light on the different effects that human capital's components, health and education, have on countries at different levels of development. We find that health effects, regardless of gender, are more prominent for growth in low-income countries, whereas education effects are more significant for high-income countries.

The remainder of this paper is organized as follows: in section II, we review the relevant literature; in section III, we specify the primary model; in section IV, we present the data; in section V, we discuss the results of the primary model; in section VI, robustness checks in regard to development status and educational measure are conducted and suggestions for extensions are given; and, lastly, section VII concludes and discusses policy implications.

II. Literature Review

Two prominent theories that seek to explain economic growth have emerged since the 1950s: the neoclassical growth theory introduced by Solow (1956) and endogenous growth theory introduced by economists like Romer and Lucas (1980s) as a rejoinder. The former emerged in the 1950s in an attempt to understand the most important factors that promote economic growth.[3] Ultimately, the Solow growth model provides a basis of analysis to explain why some countries are rich and others poor. The model is constructed using the following production function:

$$Y = AL^{1-\alpha}K^{\alpha},$$

[3] See Solow (1956).

where, L is labor, K is physical capital, A represents technological progress, Y is output, and $0 < \alpha < 1$. Due to the constraint placed on α, the elasticity of output with respect to capital, the production function exhibits diminishing marginal returns to physical capital and to labor.[4] This assumption of diminishing marginal returns in the Solow model suggests that sustained economic growth is not explained simply by changes to physical capital and labor. The idea of convergence is also implied, suggesting that poorer countries possess greater returns to capital than richer countries, allowing poor countries to "catch up" to rich countries in terms of GDP per capita.[5] In the context of the Solow growth model, persistent growth can only be observed through exogenous technological progress (A); however, this "A term" in the Solow model remains unexplained, meaning that the engine of growth also remains unexplained. In response to Solow's theory, endogenous growth theory seeks to examine the engine behind this technological progress and, consequently, persistent long run economic growth.[6] In short, endogenous growth theory seeks to explain the "A term" that triggers economic growth. The simplest endogenous growth model is the so-called AK model where the exponent on K is equal to 1, and diminishing marginal returns no longer being present. This key assumption results in the following production function:

$$Y = AK.$$

Technological progress is still represented by A, but K is interpreted to include not only physical capital, but also human capital in the form of knowledge. Through the inclusion of a broader interpretation of "capital" to include human capital, endogenous growth theory is able to explain sources of technological progress that remained unexplained in the Solow model, but due to its

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4 Labor is assumed to grow at some constant rate n, technological progress to grow at some constant, exogenous rate g, and investment adds to the existing stock of physical capital.

5 A distinction should be drawn between absolute convergence and conditional convergence. Absolute convergence states that all countries will converge to the same steady state level of output, whereas conditional convergence asserts that each country converging to its own steady state level of output.

6 See Lucas (1988).

assumption of constant marginal returns, is unable to provide a convincing explanation for convergence.

Barro (1991) takes Solow's model to the data, finding that the model as it stood was not enough to explain cross country differences in growth. In fact, Barro (1991) finds that there is little empirical support to conclude that poorer countries grow more rapidly than rich countries, as per capita growth rates were not sufficiently explained by just initial levels of GDP per capita. Subsequently, Barro (1991) relies upon endogenous growth theory to determine other influential factors for growth – most importantly, human capital. Barro (1991) finds human capital as measured by primary and secondary school educational enrollment to have a positive, significant effect on growth. More specifically, Barro (1991) finds that upon controlling for human capital, initial levels of GDP per capita have a negative effect on growth, which provides empirical support for conditional convergence in the Solow model. Overall, upon examination of the source of technological progress, Barro (1991) finds that poor countries grow faster than rich countries *if* their initial stock of human capital is higher compared to the level that is generally associated with their stage of development.

To further interpret human capital's role in the context of economic growth, Mankiw, Romer, and Weil (1992) provide an explicit theoretical framework by modifying the Solow growth model to include human capital as another factor of production. This modification results in the following production function:

$$Y = (EL)^{1-\alpha-\beta}K^{\alpha}H^{\beta},$$

where EL is effective labor, K is physical capital, H is human capital, $0 < \beta < 1$, $0 < \alpha < 1$, and $0 < \alpha + \beta < 1$.[7] The elasticity of output with respect to physical capital is represented by α, with

[7] $E^{1-\alpha-\beta}$ corresponds to exogenous technological progress, A, in the original Solow model. Under this functional form, technological progress is introduced as labor enhancing, whereas in the Solow model previously presented, A was introduced as a multiplicative constant. This introduction of A as labor enhancing is typical in macroeconomics.

β representing the elasticity of output with respect to human capital. Due to the restrictions on α and β, the production function exhibits diminishing marginal returns to labor and to physical and human capital as in the original Solow model. Using this framework, Mankiw et. al. (1992) map their model to the data, ultimately finding that human capital is an important determinant for economic growth, with the Solow model requiring human capital as an additional factor of production in order to yield conditional convergence. Human capital under the augmented production function is assumed to grow at a rate determined by the investment into human capital. In order to measure this human capital investment term, Mankiw et al. (1992) use secondary school enrollment, as the economic effects of being enrolled in school will not be observed instantaneously.[8] Interestingly, Barro (1991) also uses secondary school enrollment as a measure for human capital, but instead of interpreting the term as a flow variable (investment), he interprets educational enrollment as a stock variable. Data on educational attainment, which are better suited as a measure of human capital *stock*, would have been preferable for Barro's (1991) interpretation, but were not widely available until after the publication of these papers, forcing the interpretation of enrollment as a stock variable in Barro (1991). In general, regardless of the nuanced interpretations of stock and flow variables, both theoretically and empirically, human capital is important to consider in order to observe conditional convergence in the context of the Solow growth model.

While education plays a central role in generating human capital, the health of a population can also be an influential factor in this respect. Knowles and Owen (1997) are primarily concerned with the addition of health as a component of human capital, as populations with low longevity, poor healthcare systems, or other health-related issues are unable to be effective workers, in turn

[8] This means, for example, that the effects of investment into human capital will not be observed until a later point in time. This is in contrast to stock variables, which consider the *current* amount of human capital (ie educational attainment) or of physical capital (ie cash or machinery).

affecting a country's overall output. Furthermore, Knowles and Owen (1997) note that health and nutrition have been found to play a significant role in improving labor productivity, especially within developing countries. To explore the role that health may play as a determinant of human capital accumulation, Knowles and Owen (1997) modify the Solow model further, constructing the following augmented production function:

$$Y = (ES^{\beta}X^{\psi}L)^{1-\alpha}K^{\alpha},$$

that now considers health (X) in addition to education (S) as labor augmenting variables that enhance the productivity term, E and labor, L. Physical capital, as usual, is denoted by K. Knowles and Owen (1997) also ensure that the production function also retains the properties of diminishing marginal returns to physical capital and labor through restrictions placed on $\alpha, \beta,$ and ψ.[9]

Knowles and Owen (1997) also compare this functional form to one in which health and education were taken as separate factors of production instead of as labor augmenting:

$$Y = K^{\alpha}S^{\beta}X^{\psi}(EL)^{1-\alpha-\beta-\psi}.$$ [10]

As labor augmenting variables in Knowles and Owen (1997), health (X) and education (S) are treated as a component of technological progress and do not exhibit diminishing marginal returns, which is not the case if treated as separate factors of production as presented above. The differing theoretical interpretations of these variables, however, do not affect the empirical results – Knowles and Owen (1997) find that no significant differences are observed when drawing empirical comparisons between treating human capital as labor augmenting or as a separate factor of production. In both papers, they do, however, find a highly significant role for health and a less significant role for education in economic growth, regardless of specification. Likewise, the

9 β and ψ are labor augmenting elasticities of education and health, respectively (Knowles and Owen, 1997, p. 316).
10 See Knowles and Owen (1995).

omission of the health proxy negatively affects the fit of the model, whereas the omission of education is found to be insignificant for the model's fit. Accordingly, their results suggest that health status may be a more significant determinant of growth than education.

The papers previously mentioned support the idea that human capital is integral for persistent economic growth. Moreover, it is found that health as well as education are both important dimensions to human capital. There is, however, heterogeneity present within human capital both across and within countries due to numerous cultural, historical, or geographic factors. Thus, understanding the sources of this heterogeneity is of primary interest to design effective policy to spur growth. Numerous factors contribute to human capital heterogeneity, but one source of interest is that of gender inequality. It has been documented that traditional roles for women as homemakers, religious preferences, or regional factors have often caused human capital accumulation to not be seen as an appropriate investment for women, leading to lower educational attainment among women compared to men, especially in poorer countries.[11] Nonetheless, educating women allows for their incorporation into a larger educated labor force, reduced fertility, and increased intergenerational human capital accumulation, all of which contribute to long-term, sustained economic growth.[12] Returns to investment in the human capital of women is potentially different from that of men, causing a gendered examination of growth to be of interest. We observe in the data that there remains to be a gender gap in human capital that may be exploited for growth policy, especially if investment into women yields equivalent or greater returns when compared to investment in men. Yet, there has been no general consensus to the relationship between gender and macroeconomic growth, with results differing dependent upon econometric techniques, country sample, and minor changes in specification.

11 See Dollar and Gatti (1999).
12 See Benavot (1989); Behrman et al. (1999); Klasen (2002); Doepke and Tertilt (2019); Martín (1995).

Barro and Lee (1994) is one of the early studies to introduce gender as an important consideration for economic growth. They intend to further examine the engine behind growth with better data on educational attainment (stock variable) instead of educational investment (flow variable). Data on educational stock allow for interpretations and policies based on current levels of human capital, whereas data on educational investment consider the potential human capital that can be generated. Barro and Lee (1994) are concerned with the former interpretation, which is facilitated by educational attainment data. Compared to Barro (1991), Barro and Lee (1994) also include life expectancy and gendered secondary school attainment as measures of human capital. This allows for Barro and Lee (1994) to consider the effects that both gender inequality and health have upon economic growth, even though this is not their primary interest. Instead, they are interested in the general sources of growth, which happened to include gendered variables. Upon this consideration of gender and health, the model constructed produces “puzzling” findings in regard to the female secondary education variable. In all specifications of the model, secondary education of women is found to have an insignificant, negative effect on growth, whereas male education is found to be beneficial for economic growth. Barro and Lee (1994) explain this result with the “catch-up effect,” in which poorer countries grow more rapidly than rich countries. In this case, however, Barro and Lee (1994) posit that low (high) female educational enrollment is associated with poorer (richer) countries and in turn rapid (slower) growth. Thus, it appears as though educating women has a negative effect on growth, when it actually may just be a result of the catch-up effect with female educational attainment being associated with a country’s level of income.

Dollar and Gatti (1999) build on Barro and Lee (1994), focusing specifically upon the relationship between gender inequality and growth. The specification of their model is similar to that of Barro and Lee (1994), but centers on specific development regions, allowing Dollar and

Gatti (1999) to take into account inherent geographical factors that may affect growth.[13] Furthermore, Dollar and Gatti (1999) control for fertility in all estimates, allowing them to determine the direct effects of female education without misattribution of fertility effects to women's education due to omitted variable bias.[14] Their primary interest is that of persistent gender inequality in the developing world and its effect on growth – they hypothesize that if women are not adequately included in the educational system, workforce, or economic fabric of a country, negative effects will be visible in lower rates of growth and overall GDP per capita.

Under this specification, Dollar and Gatti (1999) find that in general, both male and female education are found to be insignificant for growth. However, they theorize that gender inequality's distortionary effects on growth will vary based on development status.[15] Upon this dividing by development status, they find that within less developed countries, both male and female education remain to be insignificant for growth, but for developed countries, the expansion of female secondary education significantly benefits growth in GDP per capita.

Dollar and Gatti's (1999) results appear to differ from those of Barro and Lee's (1994). Dollar and Gatti (1999) attribute this to the fact that they considered the unique effects that geographical location may have on growth, most notably Latin America, which has high rates of female secondary school attainment, but low growth. They determine that when consideration for Latin America's unique characteristics is excluded, female education then becomes associated with the poor growth observed in Latin America. Another important distinction between Dollar

[13] Development status is determined by the percent of women with secondary educational attainment - a country is placed in the less developed sample if less than 10.35 percent of women have attained secondary education, and in the "more developed" sample if more than 10.35 percent of women have attained secondary education.

[14] It has been found that educating women is associated with reduction of fertility [Barro and Lee (1994); Dreze and Murthi (2004); Keats (2018)], which, consequently, is associated with higher growth rates and GDP per capita. Controlling for fertility allows for the estimation of the direct effects of educating women on growth, not the indirect effects that are observed through decreased fertility.

[15] It is expected that economies that rely on wage-labor (primarily industrial economies), will receive higher returns to education compared to economies that do not rely on wage-labor (ie agrarian economies).

and Gatti (1999) and Barro and Lee (1994) is the addition of fertility controls in all estimations.[16] This is due to the fact that Dollar and Gatti's primary interest was in the direct effects of educational gender inequality on growth, whereas Barro and Lee were taking a broader view of growth that happened to include a gendered lens that was not necessarily the focus of their research.

Overall, both dimensions of human capital, education and health, are clearly important factors to consider when examining economic growth. There remains to be, however, room for investigation into the heterogeneity of human capital, specifically in regard to gender disparities, as there is at least one result present in the literature that suggests that human capital of women possesses an insignificant effect on growth. Therefore, our objective is to investigate the gender-separate effects of human capital dimensions on economic growth. Compared to existing literature, we use gender-separate regressions as noted by Benavot (1989), as opposed to estimating gendered effects in the same equation, and gender-disaggregated data on not only educational attainment, but also on health.

III. Model Specification

Given the findings provided by previous theoretical and empirical studies on the determinants of economic growth, we are interested in further examining the gender-separate effects of human capital on growth. In the aforementioned studies that consider gendered determinants of economic growth, male and female education variables are estimated within the same equation. We rely on an observation by Benavot (1989) that remarks that there is a

[16] Barro and Lee (1994) do include both fertility and population growth rate within one specification that yields the result of female education having a marginally beneficial effect on growth, which is in line with the results from Dollar and Gatti (1999). Differences in other results may also be explained by different econometric specification and techniques. Dollar and Gatti (1999) use data from 1975-1990 and use two stage least squares, whereas Barro and Lee (1993) use data from 1965-1985 and the seemingly-unrelated (SUR) technique or instrumental variables estimation (INST).

multicollinearity concern when estimating gendered effects within the same equation – male and female educational attainment tend to move together, as countries with strong (weak) educational systems in general will provide higher (lower) gender-neutral access to education. The same applies to life expectancy – countries with better gender-neutral health observe a high positive correlation between gendered health variables – institutional changes affect both genders in the same direction, even if the magnitude is different. Accordingly, separate estimations for gendered education and life expectancy variables may be more precise compared to including male and female variables within the same equation.

Health and education are both crucial components to the overall human capital of a worker. Thus, they are both included within the gender-separated regressions by using male (female) life expectancy and male (female) educational attainment. As opposed to previous studies, the measure of education that is used within the ensuing regressions is total educational attainment, instead of just secondary or primary school attainment. The nature of the Barro-Lee dataset from which the data was acquired disaggregates educational attainment by primary, secondary, and tertiary schooling. Primary schooling generates basic skills in reading, writing, and mathematics, with secondary education preparing students for the workforce or tertiary education, and tertiary education allowing further opportunities for specialization.[17] Total years of attainment was elected for the primary model, since the inclusion of just secondary or primary attainment disregards the positive effects that may be garnered from tertiary schooling. As Barro and Lee (1994) note, tertiary schooling may be the level of schooling that presents the greatest opportunity for innovation and technological progress that in turn spur growth.

[17] See United Nations (2019). The definitions for primary, secondary, and tertiary education are established by the 2011 United Nations Educational, Scientific, and Cultural Organization's (UNESCO) International Standard Classification of Education (ISCED). Primary education is ISCED level 1, secondary education refers to ISCED levels 2 and 3, and tertiary education is ISCED levels 5-8. More detailed definitions of the ISCED levels can be found in section IV.

Thus, the following general statistical model was constructed:

$$GR6010_i = \beta_0 + \beta_1 lnGDP60_i + \beta_2 I/Y_i + \beta_3 G/Y_i + \beta_4 Fert_i + \beta_5 lnLife_i + \beta_6 Edu_i + u_i.^{18} \quad (1)$$

This model specification resembles those of Barro (1991), of Barro and Lee (1994), and of Dollar and Gatti (1999) in terms of the control variables used ($lnGDP60, I/Y$, G/Y, and $Fert$). The dependent variable, $GR6010$, is the growth rate of GDP per capita from 1960 to 2010, $lnGDP60$ is the natural logarithm of the GDP per capita in 1960, I/Y is the investment to output ratio, G/Y is the government consumption to output ratio, $Fert$ is the fertility rate, $lnLife$ is the natural logarithm of life expectancy, and Edu is educational attainment. $lnLife$ and Edu are considered to be determinants of human capital and are the variables of interest within all models presented within this paper. Further details on the structure of the data can be found in section IV.

Further considerations were made in regard to the effects that health and education may have in countries at different stages of development. For primarily less developed countries, education may be less of a determinant of economic growth, with the general health of the population being more indicative of the growth that a country observes. This is due to the fact that occupations within this type of economy require less formal education. For economies that rely primarily on wage-labor and, in turn, formally educated workers, gains in growth are likely to be observed through increases in education. Within developed economies, health capital is likely to already be established, with marginal returns to increases in health being smaller compared to returns from education. Thus, the primary model was re-estimated by dividing the sample based on development status as defined by the income classifications provided by the World Bank. Each specification (male, female, and total) was estimated using a sample of high-income countries and again using a sample of low-income countries.

[18] The same model form is estimated three times using data for male, female, or aggregate measures for $lnLife$ and Edu.

Robustness checks in regard to the measure of education were also conducted. Three additional specifications of the primary model were estimated using the average years of primary, secondary, or tertiary educational attainment of the male, female, and total populations. This is in contrast to the original measure of average total years attained.

Furthermore, a feedback loop between education and life expectancy may also be present. As Knowles and Owen (1997) remark, "[p]oor nutritional status can adversely affect children's cognitive development reflected in poor educational attainment," (p. 326) with higher levels of nutrition and general health positively affecting cognitive development. Moreover, as noted in Oster et. al. (2013), human capital theory suggests that longevity is associated with higher rates of educational attainment, as education is viewed as an investment that will accrue positive returns over time. Likewise, education positively affects health primarily through the associated increases in education to increases in wages. Higher wages driven by increases in educational attainment provide access to prerequisites for health – food, shelter, health care, etc. Education thus exerts some influence on health, with health simultaneously being a prerequisite for education.

The following general model was estimated due to the mutually responsive relationship between health and education:

$$GR6010_i = \beta_0 + \beta_1 lnGDP60_i + \beta_2 I/Y_i + \beta_3 G/Y_i + \beta_4 Fert_i + \beta_5 lnLife_i + \beta_6 Edu_i + \beta_7 CAP_i + u_i.\text{[19]} \quad (2)$$

This extension includes a multiplicative interaction term between demeaned education and health variables (CAP). The inclusion of the CAP term causes the effects of life expectancy (education) to now be present in not only β_5 (β_6), but also in β_7. To measure the importance of changes in education and health have on economic growth, we demeaned the data on life expectancy and educational attainment included within the CAP term. Demeaning the health and

[19] The same model form is estimated three times using data for male, female, or aggregate measures for $lnLife$ and Edu.

education variables allows for β_5 and β_6 to now have an interpretation: β_5 (β_6) is interpreted as the effect that life expectancy (education) has on growth given that education (life expectancy) is at its average. Differences observed between the coefficient estimates on Edu and $lnLife$ between the primary model and the model's extension should be of central interest as any changes will speak to the model's stability.

IV. Data

Table 1 provides data definitions and sources for all variables included in our model:

Table 1: Data Summary

Variable	***Definition***	***Source***
RGDP	Output-side real GDP	*Penn World Tables 9.1*
Population	Total country population	*Penn World Tables 9.1*
GDP per capita	RGDP divided by population	*Own computations*
GR6010	Average growth rate of GDP per capita from 1960-2010.	*Own computations using GDP per capita*
$lnGDP60$	Logarithm of GDP per capita in 1960	*Own computations using GDP per capita*
I/Y	Average investment to GDP ratio (1960-2010)	*Penn World Tables 9.1*
G/Y	Average government consumption to GDP ratio (1960-2010)	*Penn World Tables 9.1*
$Fert$	Average expected number of live births per woman per lifetime (1960-2010)	*World Bank WDIs*
$lnLife$	Logarithm of average life expectancy at birth (1960-2010)	*World Bank WDIs*
Edu	Average total years of educational attainment (1960-2010)	*Barro and Lee, 2013*

The growth rate of real gross domestic product per capita over 1960-2010 is the dependent variable within the regression framework. The data come from version 9.1 of the Penn World Tables (PWT) and were calculated using the real GDP (output) and the respective country population.[20] The growth rate is taken as the average growth rate in GDP per capita from 1960-2010.[21]

The independent variables can be separated into two main groups: control variables and variables of interest (determinants of human capital). The control variables present in all models are government consumption (G/Y), investment (I/Y), fertility ($Fert$), and the starting level of GDP per capita in 1960 ($lnGDP60$). CAP is an additional control variable that is included in the model's extension. The variables of interest are life expectancy ($lnLife$) and educational attainment (Edu).

The data for male, female, and total education are taken from Barro and Lee's most recent 2013 data set. Barro and Lee formulate the data using the UNESCO statistical yearbook and interpolations at 5-year intervals. The observations used in this paper are the averages of these 5-year observations from 1960-2010. The measure used is total educational attainment which is reported as the number of years of formal education attained, without distinction between primary, secondary, or tertiary schooling. Measures of primary, secondary, and tertiary school attainment are used to check the robustness of the model to changes in educational attainment data. These levels of schooling follow the ISCED classifications from the UN Statistics Division's 2019 Statistical Yearbook. Primary education is defined as programming aimed at facilitation of basic skills in reading, writing, and mathematics to be further developed at the secondary level. Secondary education differs from primary in that it builds upon the foundation laid by primary education and becomes more differentiated and specialized. This level aims to prepare for both entrance into the workforce and for tertiary education. Tertiary education is the most advanced classification, building upon secondary education in terms of both complexity and specialization.

20 See Appendix for a list of countries included in each sample.
21 This is computed as the log growth rate from 1960-2010: $\frac{\ln{(GDP\ per\ capita_{2010})} - \ln(GDP\ per\ capita_{1960})}{2010-1960}$.

Two possible age groups were considered: 15 and above, or 25 and above. Little difference was present between coefficient estimates using the 15- and 25-year age groups. Results presented in this paper use data for the 25 and above age group to remain consistent and comparable with Barro and Lee (1994) and other previously reviewed studies that use a similar measure. Moreover, the 15-year age group would include segments of the population that have not yet had opportunities to pursue tertiary schooling. Since we are considering tertiary schooling in our data on educational attainment, the 25-year age group is better suited to include this schooling level. Logarithmic transformations were not performed on the data, allowing for coefficient interpretations to center on the impact of increasing years of schooling, which is a more tangible metric than percent increases in education.

Data on male, female, and total life expectancy are taken from the World Bank's World Development Indicators (WDIs) and averaged over 1960-2010. This measure is life expectancy at birth and is defined as the number of years a newborn can expect to live given the current conditions in their country at birth. Life expectancy at birth is considered to be an approximation of health's contribution to overall human capital. It should be noted that this measure considers mortality, but not morbidity.[22] The measure of life expectancy at birth is modified with a natural logarithm as in Barro and Lee (1994) due to the asymptotic nature of life expectancy data.

Government consumption and investment are shares of total output and were gathered from the PWT version 9.1 and are averaged over 1960-2010, following Barro (1991), Barro and Lee (1994), and Dollar and Gatti (1999). This allows us to capture the implications of government activity and physical capital generation for growth. The starting level of GDP per capita in 1960, $lnGDP60$, is also taken from the PWT and accounts for the initial level of development of a country.

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22 Mortality refers to a population's risk of death, whereas morbidity gauges the well-being and health quality (Hernandez and Kim, 2020, para. 4).

A natural logarithm transformation was performed on the data and follows existing literature. Fertility data were taken from the World Bank's World Development Indicators as an average from 1960-2010, which allows us to observe direct effects of education without the indirect effects that may be observed through reduced fertility. It is reported as the number of expected live births to a woman in her lifetime.

Development status was determined using classifications from the World Bank. For the purposes of this paper, countries that the World Bank classifies as low-income or lower-middle-income economies were classified as the low-income sample, and those classified as upper-middle-income or high-income economies were considered within the high-income sample.[23]

Lastly, the CAP term is only included as a variable in the model's extension and is simply a multiplicative interaction term between demeaned data on life expectancy and education. The coefficient on the CAP term is exceptionally difficult to interpret as the variable is a product of two continuous variables and also convolutes the interpretation for the coefficients on education and life expectancy. To allow for a more facile interpretation, the variables included in the CAP term were demeaned. Consequently, the coefficients on life expectancy and education in this extension have a slightly different interpretation and should be interpreted as the individual effects of health (education) on growth given that education (health) is at its mean.

Previous concerns about multicollinearity between health and education are also confirmed with correlation coefficients of 0.8775, 0.8766, and 0.8639 for the aggregate, female, and male variables, respectively. Furthermore, correlations across genders for health and education are nearly perfect, affirming the use of separate, gendered specifications.[24]

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[23] Countries classified as "low-income" within this paper have gross national incomes (GNI) per capita of $3,995 in 2018. Those classified a "high-income" have GNIs per capita of $3,996 and above in 2018. These cutoffs are determined by the World Bank Atlas method. It should be noted that the data used within the model estimation are averages from 1960-2010, whereas classifications are from 2018. We recognize that this measure is imperfect.
[24] See Appendix for the full correlation matrix and summary statistics for all variables.

V. Results

Results: Primary model

Three versions of the following linear model were estimated – one for male, a second for female, and the third with non-gender disaggregated data:

$$GR6010_i = \beta_0 + \beta_1 lnGDP60_i + \beta_2 I/Y_i + \beta_3 G/Y_i + \beta_4 Fert_i + \beta_5 lnLife_i + \beta_6 Edu_i + u_i. \quad (1)$$

Regression results for the primary model are presented in Table 4. The variables of interest within this model are the gendered human capital variables: education and life expectancy. Across all specifications, it is found that a more educated and healthier population, that is, a population with greater human capital, positively influences growth. More specifically, we can expect that increasing the education of women will have a significantly positive effect on the growth rate, as well as the education of men. This relationship between education and growth is also present in the existing literature. To examine whether differences are present between the coefficients across the female, male, and total models, the null hypothesis that the education coefficients across models are not statistically different from each other was tested.[25] This hypothesis failed to be rejected, meaning that we cannot conclude that educating women has a statistically different impact on growth compared to educating men – both have a comparable effect on the economic growth of a country. Our results differ from those in previous literature that find men and women to have different effects on growth likely due to the change in methodology to estimate gender-separate equations.[26] We do not observe differences in the returns to growth from education or health improvements across gender, but we do observe that there is a noticeable gap in the overall

[25] Null hypothesis refers to a statement that suggests that there are no significant differences across populations (in this case gender) and the differences that may be observed are simply due to small, insignificant errors. Results of the Z-tests' conclusions comparing across gendered models are reported below relevant tables in the Appendix.

[26] Barro and Lee (1994) find men's human capital to have a positive, statistically significant effect on growth, whereas women have a negative, statistically insignificant effect on growth. Dollar and Gatti (1999) find that in the full sample men's education has a weak negative effect on growth and women's education to have a weak, positive effect on growth.

educational attainment of men versus that of women. Women generally attain less years of education compared to men across countries, making this educational margin an area to exploit for economic growth policy, as there is more room for improvement in the education of women compared to that of men.

Life expectancy is taken as an approximation for the health component of human capital and enters with a positive and statistically significant coefficient in all models. Increases in the health of a population translate to an increased growth rate. The same null hypothesis was tested as in the case of education: life expectancy of men and women do not have statistically different effects on growth. This null hypothesis also failed to be rejected, suggesting that changes in both male and female health status do not have statistically different effects on growth – both are equally important for the growth of a country.

The majority of the coefficients on the control variables enter with the expected signs. However, the sign of the coefficient on the government consumption ratio enters contrary to economic intuition. Usually, the coefficient on the government consumption ratio is expected to have a negative, statistically significant effect on growth based on existing economic theory; however, in all models, government consumption enters as statistically insignificant and positive. This is likely due to the fact that the data used is cross-sectional and lacks a time-series component that does not consider the potential non-linear relationship between government consumption and growth rate as demonstrated by Barro (1990) with the Barro curve.[27] Increases in government consumption may initially help economic growth of a country, but over time and across development statuses, government consumption may shift to have a negative impact on growth.

[27] The Barro curve suggests that there is a critical, optimal point to government consumption – too low of a share of government consumption is associated with low growth, and too high of a share is also associated with low growth. For a developing country, government consumption may be necessary to spur growth, but as the country develops, decreasing government consumption may be necessary to grow at the optimal rate. This relationship is associated with time as well as development status.

Since our data is averaged over many years, we are unable to observe countries moving from one development status to another, causing this Barro-curve relationship to be unobservable.

VI. Robustness Checks and Extensions

Robustness Check: division by development status

Due to the inherent disparities in terms of access to education due to differing gender roles between developed and developing economies, the sample was split based on income classifications by the World Bank. In developing countries, women have traditionally worked as homemakers, causing education to not be an appropriate activity for women, and, instead, being primarily reserved for men. This lower level of educational attainment for women is less pronounced in what are considered developed countries, and more obvious in less developed countries. Results for all samples are presented in Table 5. This division resulted in 61 countries in the “High Income” sample and 37 countries in the “Low Income” sample. Details on these classifications can be found in section IV. As expected, education retains its positive effect on growth. The coefficient on male education in low income countries is found to be significant and positive, but insignificant in high income countries. The coefficients for total and female education are found to be insignificant in the low-income sample; however, both are statistically significant and positive for high income countries. Results presented for the “Low Income” sample, however, should be interpreted carefully, as the sample size is fairly small and insignificant coefficients may also be a result of limited data. The statistical significance of the coefficient on female education and the statistical insignificance of the coefficient on male education in high income countries may be a reflection of the fact that education of women is still an area of improvement in the developed sample – educational attainment for women has not yet reached its optimal level, while focusing on the education of men specifically does not present the same returns as educating women in primarily industrialized economies. Interestingly, the education of men is the only coefficient that enters as statistically significant across model specifications for the low-income sample. This outcome could be a reflection of the fact that men are more likely than women to receive an education in developing countries that are based on non-wage, agrarian labor. Thus, male education is found to be more significant than female education in developing countries due to implicit biases.

Female and total life expectancy are significant for both the high and low-income samples, but male life expectancy is only significant in the low-income sample. When comparing the effects of health in low and high-income countries, the coefficient on life expectancy is between three to four times greater in the low-income sample than in the high-income sample. This difference is found to be statistically significant using a z-test – the importance of health is more pronounced in low-income countries compared to in high-income countries. Z-tests were also conducted for the null hypotheses that the effects of male and female life expectancy on growth are equal and that the effects of male and female education on growth are equal. Both of these hypotheses failed to be rejected in both the low- and high-income samples. In general, we can conclude that there is a significant difference between the effects of health on growth in low-income countries and health effects in high-income countries.[28] This result holds regardless of gender. Remarkably, male life expectancy enters as statistically insignificant in the high-income sample.

Upon dividing the sample, government spending becomes significant across all specifications and enters negatively in all "High Income" specifications and positively in all "Low Income" specifications. This indicates that government spending in low income countries could be potentially helpful to spur growth, but as countries become more developed, government spending instead becomes inhibitive. These results are consistent with the hypothesis of the Barro-

[28] Results of z-tests are reported below Table 5 in the Appendix.

curve relationship as an explanation for the coefficient on government consumption in the primary model and is expected. Investment also presents results differing from the primary model, entering positively and statistically significant in all high-income specifications, but becomes negative and statistically insignificant for the low-income sample – higher investment may be valuable for growth of developed countries, but may not be in the best interest for the growth of low-income countries. Taken together, the results in regard to the coefficients on government consumption and investment ratios in the low-income sample also reflect the lack of resources for investment within these countries in tandem with the role of low-income governments to supplement this lack of investment opportunity through government consumption. Accordingly, the insignificant coefficients for investment, and positive, significant coefficients on government consumption in the low-income sample reflect this dynamic.

Fertility retains its significance and negative coefficient for the low-income sample, suggesting that high fertility negatively impacts the ability for a developing country to grow. Interestingly, fertility is found to only be slightly significant in the female specification with the high-income sample and is found to have a positive effect on growth.

Robustness Check: changes in educational attainment data

In previous literature, various proxies for education have been used. Some studies elect to use only primary schooling, others secondary schooling, and some use aggregate data, but there is not an overarching consensus in prior literature as to what proxy should be used. To examine the robustness of the estimated model to changes in the proxy used for the educational component of human capital, estimations using the average years of only primary, only secondary, and only tertiary school attainment for male, female, and total populations were conducted. Tables 6, 7, and 8 present results for total, female, and male specifications, respectively. Data were acquired from the Barro and Lee 2013 data set and transformed using $ln(1 + Edu)$. The results of the primary model are robust for all levels of attainment for male and total populations and for primary and secondary attainment for the female population. Each attainment level, across genders, except for the model using female tertiary attainment, has a positive, significant effect on growth, providing further support for the findings of the primary model. The results for the total population are essentially an average of the results in the male and female specifications. The lack of significance on female tertiary education may be due to the fact that the data on women's tertiary educational attainment are primarily concentrated around zero with little variation, causing the coefficient on female tertiary education to be insignificant.[29] This result is also a reflection of the gender gap in educational attainment, as the total and male populations are more likely to achieve more years of tertiary attainment compared to the female population. This is reflected in a greater spread in the data away from zero, allowing for a significant relationship to be established in the male and total populations.

Model Extension: interaction with health and education

The following equation was estimated three times, one with male data, a second with female data, and a third time with aggregated data:

$$GR6010_i = \beta_0 + \beta_1 lnGDP60_i + \beta_2 I/Y_i + \beta_3 G/Y_i + \beta_4 Fert_i + \beta_5 lnLife_i + \beta_6 Edu_i + \beta_7 CAP_i + u_i \text{ , (2).}$$

All regression results for this model can be found in Table 9. The interaction term (CAP) within this model does not have a clear interpretation, instead, the effects that its inclusion have upon the variables of interest should be of primary concern. The coefficients on the model's extension when compared to the primary model do not change incredibly. Upon the inclusion of the CAP variable, education, regardless of gender, has a slightly more positive effect on growth compared to the primary model. Moreover, the coefficient on education in the specification using non-disaggregated data by gender becomes more statistically significant. Life expectancy, while still

[29] The values of the data for female tertiary education only range from 0 to 1.05.

having a positive, significant effect on growth, has a less pronounced effect compared to that observed in the primary model. These results alone are not sufficient to come to more concrete conclusions as the interpretations for the coefficients on the determinants human capital are fairly abstract. Further examination into the relationship between the interaction between health and education and its relationship with growth is necessary and is a subject that we intend to pursue.

VII. Conclusions

We investigated the gender-separate effects of human capital and its subsequent effects on economic growth. Our results suggest that there is not a statistically significant difference between the human capital of men and women – both are equally imperative to growth. This result suggests that current gender inequalities are not conducive to economic growth – underinvestment in the human capital of women is not an effective policy for growth and development, and exclusion of women from the labor force, education, and general economic activity is likely a result of gender biases against women. The gender disparities that exist intranationally thus present an area for policy makers to exploit for growth.

These results also suggest that after considering differences in development status as determined by income levels, returns on growth from the betterment of health, regardless of gender, are more pronounced in developing countries, suggesting that development policy in these regions should be focused first on health, then education. However, development policy should not be taken with a one-size-fits-all mentality – each country requires specifically defined policy to address unique issues that are well beyond the realm of this paper. We can, however, provide further evidence for the necessity of human capital accumulation in both education and health, regardless of gender, as an explanatory factor as to why some countries are rich and others poor, as well as provide a policy baseline for the importance of reducing gender disparities to provide a source of progress for economic growth. Furthermore, we also investigated the possibility of a feedback loop between education and health. We have not obtained significant results at the time of writing, but we consider this relationship to be an avenue worth pursuing in the future.

It should be noted that the proxies used for education within this paper do not consider cross-country differences in education quality due to lack of availability of reliable and ubiquitous data. Life expectancy at birth as a proxy for health also presents issues – while this measure does consider mortality, it does not consider morbidity. Healthy life expectancy (HALE) or disability adjusted life years (DALYs) would be a closer proxy to health capital, as they take into account the amount of time a population spends in imperfect health. However, data on HALE and DALYs are not as extensive as that on general life expectancy. Data availability and accuracy remain to be limiting factors for further examination.

References

Barro, Robert J. (1990). Government Spending in a Simple Model of Endogenous Growth. *Journal of Political Economy, Volume 98* (No. 5), 103-125.

--- (1991). Economic Growth in a Cross Section of Countries. *The Quarterly Journal of Economics, Volume 106* (No. 2), 407-443.

Barro, Robert J. and Lee, Jong-Wha. (1994). Sources of Economic Growth. *Carnegie-Rochester Conference Series on Public Policy, Volume 40*, 1-46.

--- (2013). A New Data Set of Educational Attainment in the World, 1950-2010. *Journal of Development Economics*, *Volume 104*, 184-198.

Behrman, Jere R., Forster, Andrew D., Rosenzweig, Mark R., and Vashishtha, Prem. (1999). Women's Schooling, Home Teaching, and Economic Growth. *Journal of Political Economy, Volume 107* (No. 4), 682-714.

Benavot, Aaron. (1989). Education, Gender, and Economic Development: A Cross-National Study. *Sociology of Education, Volume 62* (No. 1), 14-32.

Doepke, Matthias and Tertilt, Michèle. (2019). Does Female Empowerment Promote Economic Development (NBER Working Paper No. 19888).

Dollar, David and Gatti, Roberta. (1999). Gender Inequality, Income, and Growth: Are Good Times Good for Women? *Policy Research Report on Gender and Development Working Paper Series, No. 1*.

Dreze, Jean and Murthi, Mamta. (2004). Fertility, Education, and Development: Evidence from India. *Population and Development Review*, *Volume 21* (No. 1), 33-63.

Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer (2015). The Next Generation of the Penn World Table. *American Economic Review, Volume 105* (No. 10), 3150-3182.

Hernandez, Jose Bien R. and Kim, Peggy Y. (2020). Epidemiology Morbidity and Mortality. *StatPearls [Internet]*.

Keats, Anthony. (2018). Women's Schooling, Fertility, and Child Health Outcomes: Evidence from Uganda's Free Primary Education Program. *Journal of Development Economics, Volume 135C,* 142-159.

Klasen, Stephan. (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, Volume 16* (No. 3), 345-373. Retrieved from

Knowles, Stephen and Owen, P. Dorian. (1997). Education and Health in an Effective-Labour Empirical Growth Model. *The Economic Record, Volume 73* (No. 223), 314-328.

--- (1995). Health capital and cross-country variation in income per capita in the Mankiw-Romer-Weil model. *Economic Letters, Volume 48* (No. 1), 99-106.

Lucas, Robert E. (1988). On the Mechanics of Economic Development. *Journal of Monetary Economics, Volume 22*, 3-42.

Mankiw, Gregory N., Romer, David, and Weil, David N. (1992). A Contribution to the Empirics of Economic Growth. *The Quarterly Journal of Economics, Volume 107* (No. 2), 407-437.

Martín, Teresa Castro. (1995). Women's Education and Fertility: Results from 26 Demographic and Health Surveys. *Studies in Family Planning, Volume 26*, 187-202.

Oster, Emily, Shoulson, Ira, and Dorsey, E. Ray. (2013). Limited Life Expectancy, Human Capital and Health Investments. *The American Economic Review, Volume 103* (No. 5), 1977-2002.

Solow, Robert M. (1956). A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics, Volume 70* (No. 1), 65-94.

United Nations. (2019). Statistical Yearbook 2019 edition: Sixty-second edition. *United Nations Statistics Division*.

--- (2020). Goal 5: Achieve gender equality and empower all women and girls.

The World Bank. (2019). Fertility rate, total (births per woman). *World Development Indicators*.

--- Life expectancy at birth, female (years). *World Development Indicators*.

--- Life expectancy at birth, male (years). *World Development Indicators*.

--- Life expectancy at birth, total (years). *World Development Indicators*.

--- (2020) World Bank Country and Lending Groups. *Data*.

VIII. Appendix

Table 1: List of Countries in Samples

Country	Country	Country
Argentina*	Gabon*	Niger**
Australia*	United Kingdom*	Nicaragua**
Austria*	Ghana**	Netherlands*
Burundi**	Greece*	Norway*
Belgium*	Guatemala*	Nepal**
Benin**	Hong Kong SAR*	New Zealand*
Bangladesh**	Honduras**	Pakistan**
Bolivia**	Haiti**	Panama*
Brazil*	Indonesia**	Peru*
Barbados*	India**	Philippines**
Botswana*	Ireland*	Portugal*
Central African Republic**	Iran*	Paraguay*
Canada*	Iceland*	Romania*
Switzerland*	Israel*	Rwanda**
Chile*	Italy*	Senegal**
China*	Jamaica*	Singapore*
Côte D'Ivoire**	Jordan*	El Salvador**
Cameroon**	Japan*	Sweden*
Democratic Republic of the Congo**	Kenya**	Syrian Arab Republic**
Congo**	Republic of Korea*	Togo**
Colombia*	Sri Lanka*	Thailand*
Costa Rica*	Lesotho**	Trinidad and Tobago*
Cyprus*	Luxembourg*	Tunisia**
Germany*	Morocco**	Turkey*
Denmark*	Mexico*	Tanzania**
Dominican Republic*	Mali**	Uganda**
Algeria*	Malta*	Uruguay*
Ecuador*	Mozambique**	United States*
Egypt**	Mauritania**	Venezuela*
Spain*	Mauritius*	South Africa*
Finland*	Malawi**	Zambia**
Fiji*	Malaysia*	Zimbabwe**
France*	Namibia*	

* and [**] represent high income and [low income] samples

Table 2: Correlation Matrix between Male, Female, and Total Education and Health

	Life Exp. (F)	Education (F)	Life Exp. (M)	Education (M).	Life Exp.	Education
Life Exp. (F)	1.0000					
Education (F)	0.8766	1.0000				
Life Exp. (M)	0.9908	0.8591	1.0000			
Education (M)	0.8723	0.9642	0.8639	1.0000		
Life Exp.	0.9979	0.8705	0.9975	0.8701	1.0000	
Education	0.8816	0.9925	0.8686	0.9891	0.8775	1.0000

Table 3: Summary Statistics for All Variables

Variable	***Observations***	***Mean***	***Std. Dev.***	***Min***	***Max***
Growth Rate 1960-2010	98	1.155	0.821	-1.451	3.465
Total Education	98	5.316	2.736	0.627	11.755
Male Education	98	5.845	2.621	0.855	11.821
Female Education	98	4.850	2.885	0.304	11.751
Total Life Expectancy	98	63.577	10.319	41.473	77.294
Male Life Expectancy	98	61.350	9.823	40.701	74.810
Female Life Expectancy	98	65.893	10.912	42.268	79.901
Fertility	98	4.442	5.302	1.716	53.832
log GDP per capita 1960	98	8.006	0.937	6.003	9.908
Investment	98	0.217	0.085	0.057	0.484
Government Consumption	98	0.174	0.065	0.015	0.432

Table 4: Summary Results – Dependent Variable: GR6010

Equation	(1)	(1)	(1)
VARIABLES	Female	Male	Total
lnGDP60	-.8530***	-.8426***	-.8606***
	(.0743)	(.0776)	(.0756)
I/Y	2.284***	2.144***	2.185***
	(.6314)	(.6810)	(.6469)
G/Y	.3314	.0474	.1995
	(.6897)	(.7337)	(.7032)
Fert	-.0186**	-.0160*	-.0160*
	(.0083)	(.0087)	(.0083)
Edu	.0611**	.0875***	.0808**
	(.0316)	(.0358)	(.0344)
lnLife	4.376***	4.171***	4.264***
	(.5138)	(.5423)	(.5326)
Constant	-11.048***	-10.127***	-10.468***
	(2.010)	(2.030)	(2.045)
Degrees of freedom	91	91	91
Observations	98	98	98
R-squared	0.7528	0.7214	0.7435

*** {**} [*] represent statistical significance at the 1% {5%} [10%] level
Standard errors are reported in parentheses

Test Statistics

A significance level of $\alpha = .05$ was used to reject the hypothesis. This corresponds to $z = 1.64$, thus the only way to reject H_0 is if the z-score is above 1.64.

$\boldsymbol{H_0}$	**z-score**	**p-value***
$lnFemaleLife = lnMaleLife$	.274	.3936
$FemaleEdu = MaleEdu$	.553	.2912

*right hand probabilities

Table 5: Results by Development Status – Dependent Variable: GR6010

Equation VARIABLES	(1) High Income Female	(1) Low Income Female	(1) High Income Male	(1) Low Income Male	(1) High Income Total	(1) Low Income Total
lnGDP60	-.8286***	-1.090***	-.8057***	-1.160***	-.8238***	-1.131***
	(.0659)	(.1730)	(.0664)	(.1667)	(.0663)	(.1660)
I/Y	3.491***	-.4511	3.351***	-1.239	3.442***	-.8290
	(.5771)	(1.441)	(.5940)	(1.354)	(.5818)	(1.367)
G/Y	-1.682**	1.558**	-1.859*	1.456*	-1.819**	1.571*
	(.8425)	(.8891)	(.8630)	(.8353)	(.8503)	(.8421)
Fert	.0412*	-.0189*	.0347	-.0182**	.0387	-.0182**
	(.0243)	(.0098)	(.0251)	(.0080)	(.0246)	(.0082)
Edu	.0853***	.0371	.1090***	.1404**	.1010***	.1066
	(.0295)	(.0741)	(.0315)	(.0737)	(.0314)	(.0757)
lnLife	1.897***	4.840***	1.113	4.546***	1.475**	4.670***
	(.6902)	(.7594)	(.7235)	(.6905)	(.7197)	(.7204)
Constant	-.9488	-11.040***	2.148	-9.355***	.7762	-10.083***
	(2.793)	(2.954)	(2.030)	(2.698)	(2.867)	(2.799)
Degrees of freedom	54	30	54	30	54	30
Observations	61	37	61	37	61	37
R-squared	0.8049	0.7478	0.7907	0.7815	0.7989	0.7743

*** {**} [*] represent statistical significance at the 1% {5%} [10%] level

Standard errors are reported in parentheses

Test Statistics

A significance level of $\alpha = .05$ was used to reject the hypothesis. This corresponds to $z = 1.64$, thus the only way to reject H_0 is if the z-score is above 1.64.

	$\boldsymbol{H_0}$	**z-score**	**p-value***
High Income	$lnFemaleLife = lnMaleLife$	.784	.2177
	$FemaleEdu = MaleEdu$	.549	.2912
Low Income	$lnFemaleLife = lnMaleLife$	.286	.3859
	$FemaleEdu = MaleEdu$	.988	.1611
Male	$HighIncomeEdu = LowIncomeEdu$	.392	.3483
	$HighIncomelnLife = LowIncomelnLife$	3.433	.0003
Female	$HighIncomeEdu = LowIncomeEdu$	.604	.2743
	$HighIncomelnLife = LowIncomelnLife$	2.868	.0019
Total	$HighIncomeEdu = LowIncomeEdu$	.0683	.4721
	$HighIncomelnLife = LowIncomelnLife$	3.138	.0008

*right hand probabilities

Table 6: Model Robustness with different Educational Proxies – Dependent Variable: GR6010

Equation	(1)	(1)	(1)
VARIABLES	Total Primary	Total Secondary	Total Tertiary
lnGDP60	-.8219***	-.8753***	-.8316***
	(.0715)	(.0725)	(.0735)
I/Y	2.521***	2.164***	2.268***
	(.6589)	(.6314)	(.6520)
G/Y	.2345	.1914	.2481
	(.7088)	(.6859)	(.7100)
Fert	-.0166*	-.0166**	-.0138
	(.0085)	(.0082)	(.0084)
ln(1+Edu)	.3660*	.6557***	.7634*
	(.1863)	(.0072)	(.4083)
lnLife	4.456***	4.137***	4.726***
	(.5160)	(.4964)	(.4538)
Constant	-11.741***	-9.953***	-12.373***
	(1.600)	(1.863)	(1.656)
Degrees of freedom	91	91	91
Observations	98	98	98
R-squared	0.7390	0.7553	0.7380

*** {**} [*] represent statistical significance at the 1% {5%} [10%] level
Standard errors are reported in parentheses

Table 7: Model Robustness with different Educational Proxies – Dependent Variable: GR6010

Equation VARIABLES	(1) Female Primary	(1) Female Secondary	(1) Female Tertiary
lnGDP60	-.8223***	-.8900***	-.8282***
	(.0694)	(.0713)	(.0720)
I/Y	2.520***	2.307***	2.313***
	(.6460)	(.6093)	(.6366)
G/Y	.3622	.2400	.3475
	(.6908)	(.6663)	(.6953)
Fert	-.0171**	-.0166**	-.0147*
	(.0082)	(.0079)	(.0082)
ln(1+Edu)	.2805*	.6328***	.6199
	(.1570)	(.1933)	(.4144)
lnLife	4.442***	4.060***	4.765***
	(.5082)	(.4803)	(.4318)
Constant	-11.708***	-9.629***	-12.702***
	(1.837)	(1.852)	(1.590)
Degrees of freedom	91	91	91
Observations	98	98	98
R-squared	0.7514	0.7698	0.7489

*** {**} [*] represent statistical significance at the 1% {5%} [10%] level
Standard errors are reported in parentheses

Table 8: Model Robustness with different Educational Proxies – Dependent Variable: GR6010

Equation VARIABLES	(1) Male Primary	(1) Male Secondary	(1) Male Tertiary
lnGDP60	-.8028***	-.8364***	-.8184***
	(.0747)	(.0750)	(.0758)
I/Y	2.563***	2.142***	2.277***
	(.6863)	(.6740)	(.6806)
G/Y	.0809	.1170	.1574
	(.7448)	(.7250)	(.7364)
Fert	-.0160	-.0163	-.0135
	(.0089)	(.0087)	(.0088)
ln(1+Edu)	.3921*	.5704***	.8166**
	(.2150)	(.2084)	(.3899)
lnLife	4.458***	4.223***	4.587***
	(.5201)	(.5010)	(.4749)
Constant	-11.8902***	-10.424***	-12.260***
	(1.772)	(1.853)	(1.649)
Degrees of freedom	91	91	91
Observations	98	98	98
R-squared	0.7136	0.7257	.7168

*** {**} [*] represent statistical significance at the 1% {5%} [10%] level
Standard errors are reported in parentheses

Table 9: Summary Results with CAP term – Dependent Variable: GR6010

Equation	(2)	(2)	(2)
VARIABLES	Female	Male	Total
lnGDP60	-.8398***	-.8357***	-.8485***
	(.0757)	(.0787)	(.0766)
I/Y	2.377***	2.186***	2.268***
	(.6397)	(.6870)	(.6520)
G/Y	.3402	.0377	.1967
	(.6902)	(.7365)	(.7031)
Fert	-.0213**	-.0169*	-.0176**
	(.0088)	(.0089)	(.0085)
Edu	.0778**	.0977***	.1003***
	(.0364)	(.0400)	(.0394)
lnLife	3.955***	3.932***	3.811***
	(.6842)	(.6759)	(.6947)
CAP	-.1199	-.0820	-.1363
	(.1284)	(.1376)	(.1341)
Constant	7.449***	7.470***	7.554***
	(.6391)	(.6789)	(.6525)
Degrees of freedom	90	90	90
Observations	98	98	98
R-squared	0.7552	0.7225	0.7464

*** {**} [*] represent statistical significance at the 1% {5%} [10%] level
Standard errors are reported in parentheses