



**LUND UNIVERSITY**  
School of Economics and Management

# **The effect of gender equality in education on economic growth**

**A study of developing countries in Asia**

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## **Abstract**

Gender equality is not only a human right, but is also suggested to have economic benefits. One of the rights discriminated to girls, especially in developing countries, is their right to education. The purpose of this thesis is to find the effect of gender equality in education on economic growth in developing countries in Asia. An economic growth model is modified to include a gender ratio variable and used to find theoretical evidence for the relationship between gender equality in education and economic growth. Theories indicate that educating girls increases the average level of human capital as well as generates female-specific effects that contribute to economic growth. Panel data for 18 countries is used for linear and nonlinear regression analysis. Data from 1970 to 2015 is divided into five-year periods to find the relationship between gender equality in education and economic growth. Both the level of gender equality and the growth rate of gender equality in education are explored as factors of economic growth. The regression analysis implies that a more gender equal education or a higher growth rate of gender equality benefits GDP per capita growth.

Key words: economic growth, gender equality, education

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# **1 Introduction**

## **1.1 Background**

Being born a girl is still today a reason for discrimination, thereby affecting the economic, social and political opportunities of half of the world's population. Of those living in poverty, women are the most affected as their needs and rights are prioritized last when families deal with scarce resources. Gender equality itself is an important and legitimate goal, but it also has many positive multiplier effects that benefit global growth and development. Equal education for girls is one step towards gender equality.

One of the rights discriminated to girls is their access to education. Girls have the possibility of receiving equal access to education in less than 40 percent of all the world's countries (UNESCO, 2014). The United Nations Development Programme (UNDP) has presented 17 goals to promote sustainable growth and ending all poverty, called the Sustainable Development Goals. The fourth goal included is "quality education" and the fifth "gender equality", signifying the importance the UN places on these issues for achieving global development (United Nations, 2015). The targets include provision of equal access to free, quality primary and secondary education for boys and girls by 2030.

Overall, increasing the level of education has positive effects on efficiency and development. On the individual level education improves the chances of employment and reduces poverty as well as contributes to better health (World Bank, 2018, p.39). From society's point of view education is beneficial through increased productivity, long-run development and faster rate of economic growth. In low and middle-income countries that are further behind in technological progress education can boost economic growth faster through helping the countries adapt to and use the existing technology (World Bank, 2018, p.42). These facts alone are a reason for increasing the access and level of education to both genders.

Educating girls gives not only the above-mentioned benefits, but also female-specific external effects, such as decreasing fertility and child mortality rates, as well as

benefits on children's health and education (Gakidou, et al., 2010, p.969; World Bank, 2012b, p.151).

Human capital is an essential element for economic growth. It is the source of productivity as well as the basis for technological innovation, thereby being a crucial factor for economic growth models. According to the Organisation for Economic Cooperation and Development (OECD) the average annual GDP growth rate would be 0.7 percentage points higher if all countries reached a minimum of 400 points on PISA (2010, pp.26-27).

The returns to education are closely linked to institutional factors such as rule of law, property rights and employment opportunities (World Bank, 2018, p.44). Gender discriminating norms are a factor that limits the returns to education. Women often have more restricted economic opportunities compared to men and experience horizontal and vertical segregation (World Bank, 2018, p.44). Social norms can lead to these issues becoming self-perpetuating. The empowerment of women is a prerequisite for creating an economy where education can be used efficiently by both genders and thereby the full benefits of it can be absorbed.

## **1.2 Scope of the study**

This paper focuses on the economic effect of gender equality in education in developing countries in Asia. These restrictions are taken in order to find more specific effects and explain growth for a specific group of countries. Because of these restrictions the compared countries are more alike each other in aspects such as culture and economic conditions and therefore the comparisons are more reliable.

Cedric Chebab, the head of global strategy for BMI Research, says "By 2030, Asia will account for the largest share of global GDP at around 40 percent" (Fensom, 2017). Asia makes up for over half of the world population and its continuous growth gives an additional push for the region's economy. Asia is thus growing towards becoming an increasingly important actor in the global economy.

Among the challenges Asia's long-term economic growth is facing are the aging population and slow improvement of productivity (IMF, 2017, pp.47-52). The fact that Asia, apart from some of its developed countries, has not been successful at

meeting the global technological advances is harmful directly for the productivity growth as well as indirectly through lower foreign direct investments. In the 1970s two thirds of the world's children without access to education lived in Asia (Asian Development Bank, 2018). Therefore, improving girls' education can partly be a solution to the issue. Mentionable projects for promoting education in Asia have been the Karachi Plan and the Asian Development Bank's work in the education sector since the 1960s. Yet there still exist large gender inequalities.

Other empirical research, such as Klasen's (1999), focus on Africa in order to find region specific outcomes and find positive economic effects of gender equality. It is therefore interesting and meaningful to test if similar results can be found in other regions. Outcomes that support gender equality would strengthen the overall conclusion of gender equality promoting economic growth.

More specifically, developing countries are chosen for the empirical analysis. This restriction is done due to the belief that developing countries often have larger differences in gender inequality, and the effects of it therefore could be better detected. It can also be argued that some of the female-specific effects, such as mothers' influence on children's education and health, are larger due to the gender norms typically present in developing countries.

### **1.3 Thesis purpose**

Gender equality by itself is an important target because of the equal worth of all humans, but could the empowerment of women also be economically beneficial? Proving that gender equal education promotes economic growth would be a strong argument for combatting gender inequality in education. Female education can also be seen as one of the main indicators for gender equality and the empowerment of women.

The purpose of this thesis is to find out how gender equality in education affects economic growth. The research question is as follows: how does gender equality in education affect economic growth in developing countries in Asia?

An empirical study is done in order to attempt to answer the research question. The research question is explored through regression analysis with panel data from

developing countries in Asia from 1970 to 2015, divided into five-year periods. The hypothesis of the empirical study is that gender equality in education has a positive effect on GDP per capita growth.

#### **1.4 Disposition**

A brief summary of previous empirical research is given in the following chapter. The previous studies help to understand what kind of relationship between gender equality and economic growth the existing research points at. It explains how the previous research has been conducted, giving ideas as well as thoughts for improvement.

Chapter three explains the theories that are used to investigate the relationship. A technology transfer model is explained to lay a foundation for how to analyse economic growth in developing countries. The model is modified by including gender equality in education to fully fit the research question. Channels through which education affects economic growth are described in order to understand both direct and indirect, as well as overall and gender specific effects of education on GDP per capita growth.

The data used in the empirical study is presented in chapter four. After that the method for this paper is explained. This is done to give clarity in how the upcoming results are obtained and to explain the regression process. Both linear and nonlinear regression models are shown and econometric issues are lifted and solutions presented.

In chapter six the results are presented in a table as well as verbally. The results are discussed and evaluated in the following chapter. The results and conclusions are compared to previous research and connected to policy ideas. An overview of the paper and its main results are given in the conclusion in chapter eight.

## 2 Previous empirical research

Klasen (1999) investigates the effects of gender inequality in education on economic growth in developing countries through cross-country and panel regressions. He uses cross-country data to find the effects of gender bias and education on GDP per capita growth rate between 1960 and 1992. The regressions used by Klasen measure gender education with two variables: the female-male ratio of total years of school and the annual growth in total years of schooling, both as average growth rates as well as initial levels. To catch the indirect effects of educating girls he includes the variables population growth, rate of labour force growth, investment rate and the growth in the share of females in the formal sector. Klasen also does a panel regression with 10-year periods in order to tackle the causality issue. The regressions are made on a sample of 109 countries of varying income levels as well as on a sample of African countries to see regional effects. The paper comes to the conclusion that gender inequality has a negative effect on income per capita through the direct as well as the indirect effects. The results indicate that if Sub-Saharan Africa and South Asia had more gender equal education in the 1960s their annual economic growth would have been 0.9 percentage points higher. Klasen also finds strong correlations between gender equality in education and reduced child mortality and fertility.

Klasen continues his study later together with Lamanna (2009) using more recent data from 1960 to 2000. The same empirical method is used with a special focus on Middle East, Northern Africa and South Asia. They come to the same conclusion as before, suggesting that gender inequality in education reduces economic growth. The results imply that different growth rates between regions are increasingly explained by gender inequality.

Dollar and Gatti (1999) investigate whether it is economically efficient for developing countries to invest less in girls' education, coming to a similar positive conclusion while using shorter time periods. They also examine the existence of social and cultural preferences for gender inequality as well as explore the possible market failures that lead to the under-investment of girls' education. The regressions are done for 127 countries with 5-year periods from 1975 to 1990. Dollar and Gatti found a convex relationship between female education and income. For low and lower middle



income countries there is no relationship found between the two variables. The effect of female education on income is however strong in countries with middle or high-income status. The results can be interpreted as the greater need for higher skill-level of human capital in industrialized economies compared to developing countries where agriculture societies are more dominant. The article points out the cultural, regional and religion-related factors that all affect the investment decision of female education and includes them in the regression. Dollar and Gatti use a panel growth regression to find the effects of gender inequality on income. For measuring gender inequality in education they use differential secondary school achievement. They come to the conclusion that gender inequality in education impedes economic growth. A one percent increase in the share of females with secondary education is found to increase economic growth by 0.3 percentage points. There is therefore a positive relationship between the variables, with gender equality in education increasing economic growth and higher income growth benefiting gender equality.

Barro and Lee (1994) use average years of schooling and cross-country regression with instrumental variables for the periods 1965-1975 and 1975-1985. They come to the surprising conclusion that growth rate of male schooling is more essential than that of female schooling for economic growth. Female secondary attainment is found to have a negative effect on GDP per capita growth. Barro and Lee suggest that this implies an economy at a very low-income level, and thereby shows high growth potential.

Knowles, Lorgelly and Owen (2002) introduce a more model-based technique for investigating the issue of gender inequality in education and economic growth. They research the effects of female education on productivity in the long run. They present a modified version of the Solow growth model where they distinguish between female and male education. They find female education to have a statistically significant positive effect on productivity but cannot come to the same conclusion for male education. Hence, they conclude that gender gaps reduce economic development in the long run.

The differences in results may be due to some papers measuring short-run growth while others focusing on long-run growth. The variable of gender inequality in education is also differently measured in the different papers and therefore can give varying outcomes. This paper focuses on measuring the effect of gender equality

through the use of gender ratio in enrolment of secondary schooling and with five-year periods and lags to see long-term results on GDP per capita growth.

## 3 Theory

Fundamental economic questions that have been discussed through ages are those of why some countries are rich while others are poor and what drives economic growth. Different economic models, both endogenous and exogenous, have been introduced to answer the questions. For investigating the effect of gender in human capital, a modified technology transfer model is presented to enlighten the research question of how gender equality affects economic growth. There are also several paths through which education, especially that of women, affects economic growth. Full calculations of the equations can be found in appendix 1.

### 3.1 Technology transfer model

The technology transfer model is applicable for developing countries that use and adapt to the existing technology rather than develop new<sup>1</sup>. It focuses on the transfer of technology from the technology-advancing countries to those that adapt to the progress. Fundamental assumptions in the model are that more skilful labour force can use more advanced technology, and that this in turn provides a larger range of input. The model has the following Cobb-Douglas production function:

$$Y = K^\alpha (hL)^{1-\alpha}$$

The production function shows how GDP (Y) depends on capital (K), human capital (h) and labour (L). In the model human capital is measured as the amount of goods an individual has the skills for producing. Human capital accumulation looks as follows:

$$\dot{h} = \mu e^{\psi u} A^\gamma h^{1-\gamma}$$

Where  $\mu$  represents the productivity in the education sector as well as other unmentioned factors such as socio-cultural aspects and openness. The quality of education is measured by  $\psi$  and the amount of time spent in education by  $u$ .  $A$  denotes the world leading technology level and  $\gamma$  stands for the importance of the world level of technology compared to the country's own. The technology is assumed to grow at a constant rate,  $g$ :

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<sup>1</sup> Jones and Vollrath (2013, pp.140-148) are used as a reference for the whole chapter.

$$\frac{\dot{A}}{A} = g$$

In steady state the rate of GDP per capita growth rate is equal to the human capital and technological growth rate ( $g_y = g_h = g_A$ ). The human capital growth rate depends on the productivity and quality of education, years of education, the technology gap and the importance of the world technology compared to the country's own. Increasing any of these factors thereby creates economic growth. The larger the difference between the country's own technology level and the world technology front, the faster the growth in human capital will be, hence increasing the economic growth rate.

All countries converge towards their own steady state level in the long run, which can differ for countries depending on their productivity, quality and amount of education. According to the model all countries grow at the same speed because of the transfer of world technology, thereby leading to conditional convergence. In steady state GDP per capita is defined as following:

$$y = \left( \frac{s}{n + g + \delta} \right)^{\frac{\alpha}{1-\alpha}} \left( \frac{\mu e^{\psi u}}{g} \right)^{\frac{1}{\gamma}} A$$

GDP per capita depends on capital accumulation, human capital as well as the world technology. Technology has to be adapted to the country's conditions and needs, as some technology might not be relevant due to the lack of skills or inability to combine it with the existing processes. Increasing the productivity, quality or quantity of education thereby results in a higher GDP per capita.

### **3.2 Modified technology transfer model with gender equality**

In order to analyse the effects of gender inequality in education a gender ratio variable can be included in the technology transfer model. Klasen (1999) uses a gender ratio variable in his empirical analysis in order to measure gender inequality. This idea was applied to the technology transfer model in order to see the theoretical effects of gender equality in education. The effects of education are measured in the human capital variable by including a ratio of females to males in enrolled in education, as following:

$$\dot{h} = \mu e^{\psi u} A^\gamma h^{1-\gamma} \left( \frac{s_f}{s_m} \right)$$

Where the average female enrolment in education is denoted by  $s_f$  and the average male enrolment by  $s_m$ . The closer the ratio is to one the larger the effect on human capital. The restriction of this is that a gender bias towards females creates a positive effect, which is incorrect if trying to achieve equality. It can however be assumed that since the model is in this paper used for developing countries that such gender bias is not as common as bias toward males and should therefore not cause too misleading results. A possible way to correct this is to switch the variables for female and male schooling if the education is female biased.

The GDP per capita growth rate will still be equal to the technological growth rate and the growth rate of human capital. The growth rate of human capital will now look as following:

$$g = g_h = \mu e^{\psi u} \left( \frac{A}{h} \right)^\gamma \left( \frac{s_f}{s_m} \right)$$

The growth rate is determined by the productivity in education, quality and quantity of education, the technological difference as well as the gender enrolment ratio, which in steady state is equal to the growth rate of technology. A more gender equal education enrolment increases human capital growth and the rate of economic growth according to the model.

GDP per capita in steady state is described as following with the technology transfer model with gender equality:

$$y = \left( \frac{s}{n + g + \delta} \right)^{\frac{\alpha}{1-\alpha}} \left( \frac{\mu e^{\psi u}}{g} \right)^{\frac{1}{\gamma}} \left( \frac{s_f}{s_m} \right)^{\frac{1}{\gamma}} A$$

GDP per capita in steady state depends on the same factors as before: capital accumulation, human capital and world technology. New to this equation is the factor for gender equality in education. More gender equal education should thereby increase a country's income level in steady state.

### **3.3 The possible effects of education on economic growth**

Education of both genders increases the overall productivity of labour force and creates a more knowledge based economy and society (World Bank, 2018, pp.38-39). Skills acquired through education can be used to utilize more advanced technology as assumed in the technology transfer model, which increases the economy's productivity and gives increased returns to capital. By educating more children the available human capital is more effectively used and the average quality of human capital increases. This is assuming that increasing girls' education does not decrease the education amount available to boys. Increased education thus results in economic growth.

It can, realistically, be assumed that women and men have the same average innate intelligence levels, as suggested by Stenberg and Kaufman (2011, p.266) among others. Thus there arises the question of why education is not equally provided to both genders? Gender inequality in education in favour of boys would then mean that some of the boys receiving education have a lower innate intelligence level compared to the intelligence level of the next girl in line for receiving education. Thus, education is not efficiently distributed to the available human capital and therefore the full capacity of the educational benefits cannot be reached. This is called the selection-distortion factor and leads to a lower average competence of the labour force, unless males and females are not perfect substitutes in labour force activities (Klasen, 1999, p.8). The ineffective use of human capital results in a lower rate of return to capital, and hence lower economic growth.

Gender inequality in education also decreases labour productivity by diminishing girls' possibilities of using technology and thereby diminishing the work they are able to produce. According to the World Bank (2012a, p.3), output per worker could be increased by 7-18 percent in the East Asia and Pacific region, if females worked in the same sectors, types of jobs and activities as men and had equal access to productive resources. The economy's resources are used inefficiently, resulting in less than potential economic growth. It is therefore important to achieve gender equality in education even if the amount of total education available for provision cannot be increased.

Educating girls has many multiplier effects, one of them being the environment effect. By educating a girl you educate a future family as educated mothers have a higher impact on the children's education and well being than educated fathers (Klasen, 1999, p.8). Mothers, especially in developing countries where their roles are often in the home taking care of the children, are more likely to pass along knowledge to the children. They are also more likely to prioritize the children's quantity and quality of education if they have experienced the benefits themselves. Women's empowerment and education have positive effects on children's health and level of education, resulting in positive intergenerational correlation (World Bank, 2012b, p.151). Families where women have a bigger voice in household spending have been found to increase expenditures on food and increase years of schooling for the children. This promotes the productivity of the future labour force and consequently economic growth. Similarity in education level between siblings can also strengthen the benefits of education (Klasen, 1999, p.8).

Mothers that are educated receive more respect and decision power in the family, which has been proven to reduce poverty and increase productivity (Morrison, Raju & Sinha, 2007). Bloom and Williamson (1998) explained that educated women are able to earn more and thereby save more. "Providing girls one extra year of education beyond the average boosts eventual wages by 10-20 percent" (Herz & Sperling, 2004, p.3). We can from the previous arguments understand that women use their savings competently, and this therefore leads to economic growth. Increased savings is a factor of economic growth in many growth models, such as the technology transfer model.

Klasen (1999, p.9) also explains the indirect demographic transition effect of female education. Educating women causes declined fertility and child mortality. A similar result was presented by Gakidou et al. (2010, p.969), who conclude that child mortality decreases by 9.5 percentage points for an additional year of schooling of women of reproductive age. The declined fertility generates demographic effects as the working force has lower youth dependency and more possibilities for joining the labour force, contributing to higher savings and production. This results in economic growth and increased investments during a couple of decades. These decades of demographic transition with a higher investment demand need to be met with higher

domestic savings or capital inflow as well as employment opportunities in order to benefit from the possible growth effects.

The female-specific effects can be argued to have larger outcomes in developing countries due to the position females often have in the societies. Due to the construction of the economic society and the norms in it women are often responsible for domestic work. As women spend more time with the children it is reasonable that their knowledge and decisions will be more beneficial for the next generation's education and well-being. Women's labour force participation rate is globally lower than men's, with a gender gap of 29.5 percentage in the labour force participation in 2012 (Verick, 2014, p.3). Across developing countries the labour force participation of women remains under 40 percent, with varying figures across Asia (p.4). Educating women gives them a higher possibility of competing for jobs, although other measures such as child care and norms also are needed for this to be able to happen. With educated women joining the labour force productivity is increased and more labour is available in the economy, resulting in economic growth. "Overall, women receive higher returns to their schooling investments." (Psacharopoulos & Patrinos, 2002, p.2). It can therefore be argued that the education of women is more beneficial for economic growth than that of men, especially in developing countries.



## **4 Data**

The data for this empirical study is in panel form in order to catch both time and country specific effects. The data used is from well-known and widely used sources, such as the World Bank Databank and Penn World Tables. They can be trusted to be reliable data sources and unbiased towards specific countries or regions. However, as with all data, there are possibilities of data errors and biases. All the used variables, how they are calculated and data sources are fully explained in appendix 2.

### **4.1 Countries**

The region chosen for this empirical study is Asia. The paper focuses on developing countries since gender inequality often is larger in those countries and hence improving equality could possibly have large effects. Countries are in this paper classified as developing countries if they are low or lower middle income countries as defined by the World Bank. The regression is done on 18 developing countries in Asia from 1970 to 2015. See appendix 3 for full list of countries. Three countries were omitted due to missing values for gender parity index.

### **4.2 Dependent variable**

Economic growth is measured as gross domestic product (GDP) growth rate per capita. GDP measures the value of total output of all production and services in a country during a given time period. It is not a perfect measurement and only takes into account economic factors, ignoring issues such as productivity, equality and effects on the environment. It is however a commonly accepted and comparable measure of economic growth. GDP per capita is used to measure the income level of a country, as it is adjusted to the size of the population. The growth rate of GDP per capita is hence a measure for the average increase in the income level of a country.

### 4.3 Independent variables

The basic regression model will be formulated as following:

$$\begin{aligned} &GDPpercapitagrowth_{it} \\ &= \alpha + \beta_1 * GPI_{it} + \beta_2 * avgschool_{it} + \beta_3 * popgrowth_{it} + \beta_4 \\ & * invgrowth_{it} + \beta_5 * GDPpcgrowth_{it-1} + \varepsilon_{it} \end{aligned}$$

The main independent variable is the gender parity index ( $GPI_{it}$ ) for gross enrolment ratio in secondary education. A GPI-value of one indicates gender equality in education. Values under one imply that boys are more favoured in education, and values over one suggest the opposite. The ratio measures girls' enrolment to boys' enrolment instead of comparing girls' enrolment to the average level of enrolment because of the assumption that increasing girls' education does not decrease the amount of education provided for boys. This assumption is reasonable since the access to education is currently increasing in most developing countries, and therefore boys' education would not have to decrease in order to achieve gender equality. An average measure of the variable was used in order to divide the data into five-year periods. The growth rate of GPI is calculated to find the effects of it on economic growth. The GPI variable is used to measure gender inequality in education in the regression. The hypothesis is that countries with GPI values closer to one or a higher growth rate of GPI will have a higher GDP per capita growth rate.

The second independent variable is average years of schooling completed for people ages 15 and higher ( $avgschool_{it}$ ). This variable is included because it is assumed that gender equality in education has a higher impact when the average years of education are higher. Average years of education was chosen instead of using expected years of education since average years reflects the education level of the current labour force better and therefore does not need to be lagged. A longer education is an important factor for human capital improvement and thereby economic growth.

### 4.4 Control variables

Population growth ( $popgrowth_{it}$ ) is considered to be an indirect effect of increasing gender equality in schooling. Increased gender equality is believed to have a negative effect on population growth due to decreasing fertility. Population growth overall can

have either a positive impact on economic growth since a larger population can produce more, or a negative impact due to the resource restrictions a large population creates.

Investment ( $invgrowth_{it}$ ) is an important foundation for economic growth. Economic growth requires spending on capital in order to enhance production and technology. Increasing investments can also be seen as an indirect effect of more gender equal education due to higher average human capital, which results in productivity and higher returns to investment.

Lagged GDP per capita growth ( $GDPpcgrowth_{it-1}$ ) is included since it is likely that the growth in GDP per capita is correlated with the previous growth rates. This assumption is also supported by previous empirical research that includes lagged economic growth as one of the explanatory variables of the current growth rate.

## 5 Method

All regression analyses are done with Eviews 10 student version.

### 5.1 Linear regression

The purpose of the regression analysis is to find the effect of gender equality in education on GDP per capita growth. This is done with panel data for 18 countries using five-year time periods from 1970 to 2015. The following regression is used:

$$GDPpercapitagrowth_{it} = \alpha + \beta_1 * GPI_{it} + \beta_2 * GPI_{it-1} + \beta_3 * GPI_{it-2} + \beta_4 * avgschool_{it} + \beta_5 * popgrowth_{it} + \beta_6 * invgrowth_{it} + \beta_7 * GDPpcgrowth_{it-1} + \varepsilon_{it}$$

In this regression GDP per capita growth is believed to be explained by the gender parity index ( $GPI_{it}$ ) and two lags of it ( $GPI_{it-1}$ ,  $GPI_{it-2}$ ), average years of education ( $avgschool_{it}$ ), population growth ( $popgrowth_{it}$ ), investment growth ( $invgrowth_{it}$ ) and lagged GDP per capita growth ( $GDPpcgrowth_{it-1}$ ). Comparing this to the theory we can see similar variables in both. The technological transfer model with gender equality explains GDP per capita growth to be equal to human capital growth. Human capital growth is determined by the productivity, quality and quantity of education as well as the gender ratio in enrolment. In the equation for GDP per capita in steady state we find corresponding variables for investment, population growth and human capital.

Since gender equality in education effects economic growth only after a time lag it is reasonable to include lags of the variable. The effects of equality in education become observable when the educated individuals start working and use their human capital, thereby contributing to economic growth. The effects are long-term, but there is a trade off between inclusion of lags and the amount of data in the regression. Two lags are used for most regressions. A third lag was tested but was not significant and therefore more lags were not included.

## 5.2 Nonlinear regression

A nonlinear approach is tested in order to see if such a relationship could be found between gender equality in education and GDP per capita growth. Connecting to the theory of both genders having the same average level of intelligence, the first girls to receive education could therefore contribute the most to productivity increases and hence generate the highest effect on economic growth. The last girls to receive education until education can be said to be gender equal would therefore have a lower intelligence level, and although contributing to economic growth, not to the same extent. This is assuming that the individuals will receive education in order of their intelligence levels. Assuming this would give a nonlinear relationship with diminishing returns of GPI in education on GDP per capita growth. The regression looks as follows:

$$\begin{aligned} &GDPpercapitagrowth_{it} \\ &= \alpha + \beta_1 * GPI_{it} + \beta_2 * GPI_{it-1} + \beta_3 * GPI_{it-2} - \beta_4 * GPI^2_{it} - \beta_5 \\ & * GPI^2_{it-1} - \beta_6 * GPI^2_{it-2} + \beta_7 * avgschool_{it} + \beta_8 * popgrowth_{it} \\ & + \beta_9 * invgrowth_{it} + \beta_{10} * GDPpcgrowth_{it-1} + \varepsilon_{it} \end{aligned}$$

Through the inclusion of the squared GPI ( $GPI^2_{it}$ ) the model becomes nonlinear in variables, although still linear in parameters. Two lags of the squared GPI are also included, since that is the amount of lags used of the GPI variable. The parameters for squared GPI are negative since the possible nonlinear relationship is assumed to be diminishing.

## 5.3 Endogeneity

Endogeneity is a problem within econometrics that occurs when an explanatory variable is correlated with the error term. Endogeneity results in biased and inconsistent estimates. A Hausman test is done to determine whether there is endogenous regression. The null hypothesis of the test is that the individual specific effects are random, i.e. the error terms are not correlated with the explanatory variables (Dougherty, 2011, p.525)<sup>2</sup>. The null hypothesis cannot be rejected at a five-percentage significance. In this case both fixed and random effects models are

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<sup>2</sup> All references in chapters 5.3 to 5.9 are to Dougherty (2011).

consistent, but only random effects model is efficient. Random effects model is therefore used for the regression (p.525).

#### **5.4 Multicollinearity**

Multicollinearity occurs when two or more explanatory variables are highly correlated (pp.165-166). This results in large standard error terms and therefore makes it difficult to draw conclusions from the regression analysis. An alternative to using the ratio of girls' education enrolment to boys' as the measurement for gender equality in education was using separate variables for girls' and boys' education enrolment. This alternative would possibly have given more data to analyse in order to see the differences in the different genders' effects on economic growth. The decision to instead use a ratio of the enrolment was made to avoid a multicollinearity issue in the regression. For many developing countries both genders' education enrolment levels increased over time, and it would have been difficult to distinguish which caused an effect and to what degree on GDP per capita growth. Therefore a ratio between girls' and boys' enrolment in secondary schooling is used to measure gender inequality in education.

#### **5.5 Autocorrelation**

Autocorrelation is serial correlation within the error terms. If the error terms fluctuate with another lagged error term this results in inconsistent errors in the regression. A Durbin-Watson test is done to test for autocorrelation. For all methods the Durbin-Watson value was below two, suggesting positive autocorrelation (pp.429-436).

Robust standard errors are used for correcting autocorrelation. This provides unbiased standard errors for the coefficients. Robust standard errors are larger than the original standard errors and therefore less efficient in that sense, though vital for correcting the consistency of error terms.

## **5.6 Stationarity**

Stationarity is a common requirement for regression and means that the mean and variance of the data are independent of time and the covariance only depends on the distance between the points (p.465). A common problem occurring with non-stationary data is spurious regression, which is when the estimation produces statistically significant relations between variables although no such relation exists (p.475).

We can assume that the gender parity index and average years of schooling are stationary, as they in the long run are realistically not expected to keep increasing. We also know from previous world development trends that in the long run countries' population growth slow down.

Stationarity can be tested with a unit root test where the null hypothesis is that the data has a unit root, i.e. is not stationary (p.489). Investment-, population- and GDP per capita growth show low p-values for the Levin-Lin-Chu panel data unit root test and the null hypothesis can thereby be rejected.

## **5.7 Heteroscedasticity**

Heteroscedasticity occurs when the error terms are correlated with the independent variables, resulting in biased standard errors and inefficient estimates (pp.281-283). Heteroscedasticity can be corrected by using robust standard error terms, which is done with the used data in this regression.

## **5.8 Normal distribution of error terms**

Normally distributed error terms are important for reliable estimates. To test for this the Jarque Bera test was done. The test confirmed the assumption of normally distributed error terms.

## 5.9 Omitted variables

Some variables are not used in the regression due to insufficient amount of data. Institutions are believed to have an effect on economic growth, and a variable for rule of law was supposed to be included in order to represent institutions in the regression. Data for rule of law is however only available from 1990 onward and would therefore not have contributed to the regression analysis. Due to the same reason the variables for women's labour force participation and quality of education are not included. Women's labour force participation would have been an important variable as it is important that the educated women have the possibility of using their acquired knowledge and contributing to economic growth through productivity and skills. The quality of education would have been a relevant variable, as it would have enabled better comparison between the countries' educational levels.

These variables are considered relevant and omitting them therefore results in omitted variable bias. It is possible that other variables not thought of also cause this bias. This causes the results to be biased since the effects of the omitted variables are shown in the included variables, resulting in misleading coefficients and analysis (pp.252-254).

A variable that was thought to be of significance for the regression is the countries' openness. This would have been measured as the growth in a country's exports and imports as a share of GDP. However, when performing an omitted variable test it could be concluded that trade is not a significant variable and is therefore not included in the regression.



## 6 Results

In order to explore the effect of gender equality in education on economic growth different regression models are used. First, linear and nonlinear regressions with varying amount of lags are tested. After that the growth rate of the gender parity index is used to explain economic growth.

The results from both linear and nonlinear regressions are shown below in table 1. Models 1.1, 1.2 and 1.3 are linear with varying amount of lags and variables included in order to see which factors possibly could enhance or affect the role of gender equality in economic growth. Model 1.4 is nonlinear.

In model 1.1 we receive significant values for investment growth, lagged GDP per capita growth and for the present and lagged gender parity indexes. The total significant effect of gender equality in education (the sum of the lags) becomes negative with a value of -0.015. This model is the only one in table 1 where average years of schooling becomes significant and has a positive effect on GDP per capita growth.

The added second lag of gender parity index became significant in model 1.2. Gender parity index itself is expectedly not significant because education has a long-term effect on economic growth, which appears through the addition of significant lags to the model. The sum of the significant gender parity index values adds up to 0.033. Surprisingly, neither population growth nor average years of schooling are significant. Investment growth and lagged GDP per capita growth are positive and significant.

In model 1.3 another lag of the gender parity index is included to see more long-term effects of gender equality in education on economic growth. The third lag does not become significant, but the addition of it results in significance in the GPI variable. The total sum of the significant coefficients is 0.005. Only investment growth becomes significant out of the control variables. Lagged GDP per capita growth is not included due to software restrictions.

In column 1.4 a nonlinear estimation is used but the coefficients for squared GPI are not found significant. The lagged GDP per capita growth, investment growth and the second lagged GPI-variable become significant. Only two lags of the squared GPI-

variable are tried due to the restrictions by the software. The total significant sum of the gender parity index on economic growth is here negative with the value -0.151. However, due to the insignificance of the squared GPI-variables it is unlikely a nonlinear diminishing relationship of this kind exists.

*Table 1*

	1	2	3	4
C	0.010 (0.017)	-0.048 (0.032)	-0.008 (0.033)	-0.060** (0.023)
Avgschool	0.003** (0.001)	0.001 (0.001)	0.004 (0.004)	0.002 (0.002)
Popgrowth	-0.548 (0.571)	1.080 (0.743)	0.480 (0.837)	1.048 (0.689)
Invgrowth	0.206*** (0.047)	0.166*** (0.041)	0.208*** (0.035)	0.153*** (0.047)
GDPpcgrowth(-1)	0.209** (0.097)	0.225*** (0.070)		0.218** (0.081)
GPI	0.111* (0.066)	0.005 (0.066)	-0.079*** (0.025)	-0.008 (0.132)
GPI (-1)	-0.126** (0.058)	0.173** (0.071)	0.211*** (0.024)	0.248 (0.183)
GPI (-2)		-0.140*** (0.021)	-0.127*** (0.011)	-0.151*** (0.053)
GPI (-3)			-0.006 (0.026)	
-(GPI^2)				0.010 (0.075)
-(GPI^2(-1))				0.036 (0.112)
-(GPI^2(-2))				-0.006 (0.050)
R-squared	0.680	0.682	0.733	0.681
Observations	46	33	23	33

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01

A regression with no lags for GPI was also done, but did not give any significant results apart from a positive effect of investment growth on GDP per capita growth. The results are therefore not included in the table.

Overall, the effect of gender equality in education is found to be positive in two out of four models. Model 1.2, which can be argued to best represent the true relationship due to the significance of the variables and highest R-squared value, gives a positive relationship between gender equality in education and economic growth. Population growth is not found significant in any of the columns, and average years of education only in one. Investment growth and lagged GDP per capita growth are highly significant in all models.

The regression so far uses the gender parity index variable as it is, but it could also be possible that economic growth would better be explained with the growth rate of gender parity index. The results from regression using gender parity index growth are presented in table 2.

*Table 2*

	1	2	3
C	0.023* (0.012)	0.042** (0.019)	0.019* (0.011)
Avgschool	0.003** (0.001)	-0.001 (0.001)	0.002** (0.001)
Invgrowth	0.157*** (0.022)	0.211*** (0.040)	0.207*** (0.040)
Popgrowth	-1.151** (0.467)	-0.523 (0.481)	-0.923** (0.355)
GPIgrowth	0.423** (0.168)	-0.349** (0.160)	0.293* (0.154)
GPIgrowth(-1)		0.094 (0.160)	
GPIgrowth(-2)		-0.001 (0.069)	
GDPpcgrowth(-1)			0.073 (0.064)
R-squared	0.539	0.585	0.621
Observations	54	25	53

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01

Model 2.1 is the plain model with GPI growth without lags. All variables are significant, indicating that the model is appropriate for measuring the determinants of economic growth. The coefficient for growth in gender equality in education is positive and significant with a value of 0.423. Average schooling is also significant and has a positive effect of 0.3 percentage points on GDP per capita growth. Population growth has a significant negative effect on economic growth while investment growth has a positive significant effect.

Model 2.2 includes lagged variables for GPI growth. Only the variables for investment growth and GPI growth became significant. Since the lagged variables for gender parity index growth were not significant this suggests that model 2.2 is not the best applicable for estimating the true relationship of the variables. A model with only one lag of the GPI variable was also tested and gave positive but insignificant results and is therefore not included in the table.

Model 2.3 includes a lagged variable for GDP per capita growth in addition to the variables from model 2.1. The lagged GDP per capita variable is not significant, signifying that neither this model is relevant. All other variables are significant, but not as reliable as in model 2.1 due to the inclusion of the insignificant lagged GDP per capita variable.

Overall, the regression analysis shows that growth in gender equality in education has a positive and significant effect on economic growth, as suggested by model 2.1. This supports the idea of increased GPI having a positive effect on economic growth, as shown in model 1.2.

## 7 Discussion

The main discovery of the empirical study is that gender equality in education has a positive lagged effect on GDP per capita growth. As expected, the current GPI-variable had in most cases no significant effect on GDP per capita growth. This is due to the fact that education has a long-term effect on economic growth. The believed channels through which education affects economic growth are productivity, environmental effects and demographic effects, all which show outcomes after an individual is educated rather than during the education.

The first and second lags of the GPI-variable were in all cases but one significant, supporting the hypothesis that gender equality has an effect on economic growth. Two lags of the GPI variable were found significant, meaning that the effect of gender equality in education affects economic growth for a decade. It can be concluded in this empirical study that higher gender equality contributes to higher GDP per capita growth.

Both linear and nonlinear regressions were tested in order to see what the relationship between gender equality in education and economic growth might look like. Concluding from the significance levels of the squared GPI terms it is evident that a nonlinear relationship with diminishing returns is not applicable. From the regression models used, the linear regression model was a more valid fit for finding a relationship in this data. It could however still be the case that another type of nonlinear relationship would fit the data better. Other ideas of nonlinear models were however not supported by the theories and therefore not tested. This could be a possible way to continue this study.

From the significance of the variables it can be concluded that models 1.2 and 1.3 are the most reliable for studying the relationship between the gender equality and GDP per capita growth. From these regressions it is estimated that the effect of gender equality in education on economic growth is between 3.3 and 0.5 percentage points. Since the third lag of gender parity index in method three was not significant, it suggests that method two is more reliable. Increasing the gender ratio of secondary enrolment gives a 3.3 percentage increase in GDP per capita growth with model 1.2.

An interesting observation is that the second lag of GPI in table 1 is always negative, while the first lag is positive. It is difficult to explain why this is the case since the negativity cannot be supported by the theories used. It is more likely that the negative effect caught by the second depends on something else, possibly an omitted variable, rather than education having a negative effect on economic growth. Since the first lags are of higher values the overall effect is still positive.

A higher growth rate of the gender parity index in secondary education enrolment has a positive effect on GDP per capita growth, as suggested by column one in table 2. It can therefore be concluded that high gender equality in education, as well as high growth in gender equality in education both have positive effects on economic growth in developing countries in Asia.

Demographic effects were one of the theoretical effects mentioned about girls' education. This channel is included in the regression in the population growth variable. Theory implies that a higher education level of girls will decrease population growth. The results however do not find the population growth variable to be significant in any of the regression methods in table 1. It could be possible that this effect too would be observable with a lagged population growth variable, but due to software restrictions such experiments could not be done. A possible explanation could be that Asia already has experienced the demographic effect the theory predicts. One of the challenges Asia's economy currently is experiencing is the aging population which implies that Asia has already experienced this transition and therefore the indirect effect of gender equality in education no longer has a strong effect. In table 2 the coefficient for population growth is negative and significant, providing some evidence for the theoretical analysis. This empirical analysis hence provides only some evidence for the negative effect of population growth on GDP per capita growth.

Gender ratio in education is one of the factors of GDP per capita growth in the technological transfer model with gender equality. A more gender equal education enrolment should result in higher human capital growth and thereby higher economic growth in steady state. The empirical results thus confirm the theory. This provides more guidance for the policymakers in Asia's developing countries through another possibility for increasing human capital growth. It would not only be a human right and a development goal for everyone to receive education, but it would also generate

economic benefits. This is the same conclusion as Klasen (1999) came to, calling it a “win-win strategy” to invest in girls’ education (p.27).

Investment growth is a significant and relatively constant variable in all methods used. This gives strong evidence for the importance of investment for GDP per capita growth, which also was included in technology transfer model. This could be an indirect effect of the, mostly, increasing trend of gender equality in education over the time period. With a more gender equal education the productivity of human capital will increase and therefore generate higher returns to capital investments. Although a possible effect, it cannot be proven with the regression model used and the indirect relationship can hence only be speculated.

In comparison to Klasen (1999) this paper used much smaller time periods in order to catch more specific effects. The empirical results could nevertheless support his conclusion through confirming positive effects of gender quality in education on GDP per capita growth. Klasen came to the conclusion that education had indirect effects on economic growth through increased investments and decreased population growth, which cannot be confirmed in this study. The results from this empirical study as well as previous evidence (for example Klasen, 1999; Dollar & Gatti, 1999; Klasen & Lamanna, 2009) support the view that gender equality in education increases economic growth.

An important way to promote girls’ education is to decrease the costs of education. Reduced costs have both a direct effect of making school more affordable, but also decreases the opportunity cost of education as discussed by Herz and Sperling (2004, p.9). The government is an important actor in education policies and should focus on cutting education fees and building schools in order to achieve gender equality, increase school enrolment and promote economic growth. Focusing on girls’ education is important and can be done through providing female facilities at schools, hiring female teachers and by discouraging gender stereotypes in order to encourage female learning and re-construct social norms (Herz & Sperling, 2004, p.11).

Asia is currently experiencing problems with achieving productivity growth and struggles to match the world technological front (IMF, 2017, pp.47-52). An important factor for solving these issues is increasing the quality of education. It is important to have a sufficient amount of qualified teachers and make sure that the education

framework is updated (Herz & Sperling, 2004, p.12). This promotes education of both genders, and can particularly result in a higher enrolment of girls if the education is efficient and relevant.

## **7.1 Problems**

The determination of education's effects on economic growth is challenging due to measurement difficulties. Enrolment rates of secondary schooling were chosen due to the high data availability, but it would have been ideal to complement with the quality of education. The quality of education is a much varying concept and has a significant effect on how education affects human capital. It is not therefore fully valid to compare countries from only enrolment rates and average years of education. A more qualified comparison would be to compare the abilities learned by those receiving education. Quality of education was however not included as a variable because of the lack of data that is caused by difficulties in measuring education quality.

It is also important to take into account that gender quality in education alone cannot accomplish much. Other institutional factors are needed in addition in order for the society and economy to be able to benefit from the full effects. It is important that the educated women have the opportunity to contribute to productivity by participating in the labour force. If the case is that women are unable to join the labour force, then their education can be seen as a misused investment. Women's labour force participation was one of the variables that would have been interesting and possibly explanatory to include in the regression, but was not included due to the lack of sufficient amount of data. Overlapping with this factor are the society's norms and the cultural mindset of women's role in the economy. It is important that the economy and society empowers women and thereby gives them the possibility to receive education and use their knowledge and skills to generate economic growth. There exists a mutual relationship between gender equality in education and the empowerment of women, hence educating girls is a step towards right direction.

The data set of this empirical study only includes countries that currently are classified as low or lower middle-income countries. It could however be possible that a different result would have been obtained if countries that developed from a lower income status to a higher during the time period had been included in the regression. The effect of gender equality in education could have been a significant contributor to



those countries' growth. This is an idea for a possible extension that could be made from this paper.

There is of course always the issue of measurement and data errors, which can distort the results. This is something that is hard to correct. The availability of data, especially from developing countries, is another problem that causes a less than ideal ground for regression. The regression analyses include a very limited amount of observations, which makes the conclusions less reliable.

As with most regression, it is hard to be completely sure of the correlation between the variables. The results from this paper suggest that gender equality in education cause GDP per capita growth due to the significance of GPI-lags. It can however not be rejected that a higher GDP per capita growth could decrease gender inequality in education.

## 8 Conclusion

The purpose of this empirical study was to find what the effect of gender equality in education is on economic growth in developing countries in Asia. The empirical study was done with panel data using five-year periods in order to catch the effects in 18 countries between 1970 and 2015. The hypothesis was discussed through theories and an empirical study. The overall conclusion is that reducing gender inequality in education benefits economic growth.

Increasing the gender ratio in secondary enrolment results in a 3.3 percentage increase in GDP per capita growth in developing countries in Asia. Increasing the growth rate of gender parity index in school enrolment also has a positive significant effect on economic growth. The empirical study therefore suggests that high gender equality or a high growth rate of gender equality in education promotes economic growth. The positive results are also in line with much of the previous research.

This was an expected result from the theoretical analysis. The modified technology transfer model with gender equality confirms the empirical results. According to the model the GDP per capita growth rate is equal to the human capital growth rate. The human capital growth rate depends on the productivity in education, quality and quantity of education, the technological difference as well as the gender enrolment ratio. The conclusion is also supported by the channels through which education, especially that of women, can affect economic growth. Increased productivity, environmental effects and the selection-distortion factor are possible ways of how this occurs.

The effects of education are believed to be long-term and have benefits over generations. This was not fully explored in the empirical study since only two lags of the gender equality variable were significant. The results that were found significant were with five to ten year lags. This indicates that the time frame in which investments in gender equality in education starts to show positive returns is relatively short, possibly giving more of a reason for investment as the time trade-off is shorter. The quicker the effects of a policy for improving gender equality are, the more beneficial it is for the issue of gender equality and the economical gain of the investment.

A restriction of this model is that many variables that were thought to have an effect on economic growth and bind together the independent and dependent variables could not be included. A more accurate model would include variables such as women's labour force participation and quality of education in order to more specifically analyse the effects of gender equality in education on economic growth. This could be a possible way to improve the study. The low number of observations is another issue that weakens the reliability of the conclusions.

In conclusion it can be stated that increasing gender equality increases economic growth. It is therefore not only a good target from human development point of view, but increasing gender equality also promotes economic growth.

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## Appendix 1

$$Y = K^\alpha (AhL)^{1-\alpha}$$

$$\tilde{y} = \frac{Y}{hL} = \tilde{k}^\alpha \quad (1)$$

$$\widetilde{\Delta k} = \Delta \left( \frac{K}{hL} \right) = s\tilde{y} - (\delta + g_h + n)\tilde{k}$$

In steady state:

$$\widetilde{\Delta k} = 0$$

$$\tilde{y} = \tilde{k}^\alpha$$

$$s\tilde{k}^\alpha = (\delta + g_h + n)\tilde{k}$$

$$\tilde{k} = \left( \frac{s}{\delta + g_h + n} \right)^{\frac{1}{1-\alpha}} \quad (2)$$

Combining (1) and (2):

$$\tilde{y} = \left( \frac{s}{\delta + g_h + n} \right)^{\frac{\alpha}{1-\alpha}}$$

$$y = \tilde{y} * h = \left( \frac{s}{\delta + g_h + n} \right)^{\frac{\alpha}{1-\alpha}} * h$$

In steady state:

$$g_h = \mu e^{\psi u} \left( \frac{A}{h} \right)^\gamma \left( \frac{s_f}{s_m} \right) = g$$

$$h = \left( \frac{\mu e^{\psi u}}{g} \right)^{\frac{1}{\gamma}} \left( \frac{s_f}{s_m} \right)^{\frac{1}{\gamma}} A$$

Combining the output per capita and the human capital equations gives:

$$y = \left( \frac{s}{\delta + g_h + n} \right)^{\frac{\alpha}{1-\alpha}} \left( \frac{\mu e^{\psi u}}{g} \right)^{\frac{1}{\gamma}} \left( \frac{s_f}{s_m} \right)^{\frac{1}{\gamma}} A$$



## **Appendix 2**

### **GDP per capita growth**

The data for annual GDP and the population are from Penn World Tables (Feenstra, Inklaar & Timmer, 2015). The variable used is real GDP at constant 2011 US\$ prices. Purchasing power parity adjusted values would have been chosen, but less such data was found. In the trade off between PPP-adjusted GDP and more values it was decided that the amount of GDP values were more significant for the regression to give as reliable results as possible. The data for population, which was used for calculating the GDP per capita values, was obtained from the same source. The growth rate of GDP per capita was calculated with the compound annual growth rate formula for five-year intervals, shown below:

$$CAGR = \left( \frac{y_{T+5}}{y_T} \right)^{\frac{1}{5}} - 1$$

### **Gender parity index**

The data is obtained from United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics. It is calculated by dividing female gross enrolment ratio in secondary education by male gross enrolment ratio in secondary education. For the first regression table the data is used in its original form, and in the second table it is used as a growth rate. The growth rate for each five-year period is calculated with the compound annual growth rate formula.

### **Average years of schooling**

The data is obtained the Barro-Lee Education Attainment Dataset (2013).

### **Population growth**

The data for population was obtained from the Penn World Table (Feenstra, Inklaar & Timmer, 2015). The compound annual growth rate formula was used to calculate the growth of population.

### **Investment growth**

The investment growth was calculated with the compounded annual growth rate formula with data for gross capital formation at constant 2010 US\$ prices from World Development Indicators from The World Bank Databank (2018).

## Appendix 3

List of included countries:

Afghanistan

Armenia

Bangladesh

Cambodia

India

Indonesia

Kyrgyzstan

Laos

Mongolia

Myanmar

Nepal

Pakistan

Philippines

Sri Lanka

Syria

Tajikistan

Vietnam

Yemen

Number of countries: 18

Bhutan, Timor-Leste and Uzbekistan also fit the criteria of low or lower middle income countries in Asia, but did not have enough available data to be included in the regression analysis.