NUST JOURNAL OF SOCIAL SCIENCES AND HUMANITIES
Vol. 1 (July-December 2015) pp. 26-55

Exploring New Pathways to Gender Equality in Education: Does Information and Communication Technology Matter?

Ayesha Qaisrani and Ather Maqsood Ahmed

Through the use of the System Generalized Method of Moments Technique, this study aims to establish links between Information and Communication Technologies (ICTs), gender equality in education and economic growth, for segregated levels of education. The study focuses on the decade of 2000-2010 for the case of Lower Middle Income countries. Through simultaneous solution of the models, it is concluded that ICTs do have some potential to promote gender equality but the relationship is not strong enough, either due to lack of relevant statistical data or due to inefficient integration of ICTs into the society. It is, however, deduced that the strongest factor promoting gender equality is the average schooling of adult population. Furthermore, the study finds out that for lower middle income countries, gender equality at lower levels of education plays an important role in economic growth than gender equality in higher education.

Keywords: Education, Gender Equality, ICTs, Economic Growth.

1. INTRODUCTION

The 21st century has brought with itself a new revolution in the global realm – the information society, which has changed the global macroeconomic landscape [Chetty (2012)]. The importance of technology cannot be denied as it has changed the way we live, the way we work, the way we make decisions and the way we correspond with each other. Advancements in Information Communication Technologies (ICTs) not only have the capability to improve the technological arena, but they also have the potential to bring about social and economic improvements (ibid.).

ICTs have the ability to transfer knowledge and information, introducing new methods of learning, communication and working, thereby increasing the productivity of the people [Vu (2014)]. ICTs involve all those technological mechanisms through which information is dispersed and processed. In the past decade, the technological scenario has undergone rapid innovations, from personal computers to laptops, from landline telephones to cellular phones, from internet to broadband, and the more recent upgrade to 3G and 4G technologies, but it must be kept in mind that older means like the radio, newspaper and television are also included in the definition of ICT [Wamala (2012)].

The potential of ICTs to enhance people's productivity can be used to address the inequalities that the developing world faces in terms of economic opportunities [UNCTAD (2014)]. Of all the social issues and inequalities, gender inequality has received significant concern in recent years as a growth inhibiting factor [Kabeer and Natali (2013); Klasen (1999)].

Ayesha Qaisrani <Ayesha-qaisrani@sdpi.org.> works as a Research Associate at Sustainable Development Policy Institute (SDPI), Islamabad, Pakistan. Ather Maqsood Ahmed <ather.ahmed@s3h.nust.edu.pk> is Professor of Economics at the School of Social Sciences and Humanities (S3H), National University of Sciences and Technology (NUST), Sector H-12, Islamabad, Pakistan.

According to Sen (1999), growth is enhanced when people are free to make their decisions regarding education, savings, health, ownership, labour participation etc. This freedom requires the availability of equal opportunities to population. When a society restricts this freedom of opportunities to roughly half of its population, i.e. women, the repercussions will be evident in its macroeconomic indicators as well, like growth-stagnancy, poverty, income inequality, unemployment, illiteracy, etc.

Growth of an economy depends upon its resources – physical and human, among other things. Investments leading to increased physical and human capital result in higher levels of growth [Barro (2001)]. Human capital involves a quantitative aspect, i.e., the number of workers and a qualitative aspect, i.e., the skills and capabilities of those workers. According to the Human Capital Report [WEF (2013)], human capital is not just an aggregate function of education and skills, it also conceptualizes health, physical, social and economic contexts of a society. When countries ignore a major proportion of their population while making human capital investment decisions, they are, in fact, missing out a great deal in their progress by not benefitting from the potential skills and capabilities of females, which would otherwise promote growth. This leaves half of the population socially and economically deprived of their basic human rights and opportunities, increasing dependency, higher fertility rates, lower per capita incomes and overall suppression of women in social and domestic contexts.

The prospects of ICT to address gender inequality have only recently come into the limelight. The potential of ICT to empower women with opportunities to education and the resulting significance of gender equality in education to economic growth has been a motivation to carry out a detailed research in this field. Little existing literature has addressed this issue quantitatively [Chen (2004); Kucuk (2013)]. Most studies have been survey based or based on project analysis [Maier and Reichart (2007), Wheelar (2007) and Punie, *et al*. (2006)]. Some literature also focuses on the existence of gender inequality in the access and use of ICTs [Reinen and Plomp (1997); Huyer and Sikoska (2003)]. These studies focus on the barriers faced by women in benefiting from ICTs, i.e., the gender divide within the ICT sector.

The current study differs from existing literature in the sense that it takes on the impact of ICTs on gender equality in education at three separate levels of education, i.e., primary, secondary and tertiary, and then instantaneously examines the effect of gender equality at these levels on growth. It focuses on selected lower/ lower-middle income countries (as per the definition of World Bank) and takes into account the decade of 2000-2010. Another major contribution of this study is the use of latest technique, the System Generalized Method of Moments, to tackle the issue of endogeneity and recursive nature of the system. Based on the objectives of the study, this study tests whether or not ICTs promote gender equality at different levels of education and whether this gender equality in education contributes to economic growth.

Rest of the paper is organized as follows. Section 2 throws some light on the existing literature that focuses on the thematic area of ICTs and gender equality. Section 3 defines the theoretical and methodological framework guiding the study. Section 4 presents a discussion of results, while section 5 concludes the study and gives policy recommendations.

2. REVIEW OF LITERATURE

Numerous literature exits on the impact of gender inequality in education on growth, but the literature involving the impact of ICTs on gender inequality at different stages of education and simultaneously checking their impact on economic growth is relatively new. Studies involving gender inequalities and their respective impact on growth find their nature in the endogenous growth models which owe a great deal to the contributions of Romer (1986) and Lucas (1988).

Contrary to Barro's (1998) results that female education has an insignificant relation with economic growth, a large number of studies affirm that gender equality in education positively contributes to economic growth [Dollar and Gatti (1999); Schultz (2002); Klasen (2002); Knowles (2002)]. Barro justified his finding by saying that benefits of female education are not realized in many countries' labour markets because of their culture and thus the impact on economic growth is not well-observed, and in a later study the author confirmed that there in fact exists an indirect relationship between female education and economic growth by means of decline in fertility rate [Barro (2001)]. Nevertheless, evidence regarding the importance of gender equality in education for economic growth is numerous and much stronger [Lewis and Lockheed (2008); Yumusak, *et al*. (2013)].

Investing in female education is an investment in human capital, which then translates into economic growth. Dollar and Gatti (1999) carried out a study with the purpose of finding empirical relation between gender equality in terms of education and economic growth of the economy. They used religious differences, regional characteristics and civil freedom as determinants of gender inequality among other variables. Findings showed that investing in the education of females positively impacts economic growth; religious factors influence gender inequality negatively; and that there is a positive effect of higher income on gender equality. Similarly, Schultz (2002) explains the inter-generational positive impacts of investing in female education which can boost economic growth in the long run. The author found that increase in the education of females improves the quality of children in terms of education, health and nutrition.

Conversely speaking, gender inequality is in fact attributed to have a negative impact on economic growth. Pervaiz, *et al.* (2011) studied the impact of gender inequality for the case of Pakistan over the years of 1972-2009. By taking the growth of real per capita GDP and an index for gender inequality (for education, employment and health), the authors found that gender inequality index had a significant negative relation with growth of per capita real GDP, thereby, acting as a deterrent to growth.

Over the years, there has been growing interest in the role of ICTs as a means for achieving development agendas [Sandys (2005); Gurumurthy (2004); Wheeler (2007); UNCTAD (2014a)]. Hafkin and Taggart (2001) threw light on the importance of ICT for development and the need for gender issues to be highlighted from the inception of ICT in the society before the divide of access between men and women in a society increases. There are many barriers to access of technology by women which include language, geographical location, time constraints, costs, social and cultural norms, IT skills etc., and in order to narrow the gender gap in technology, these barriers must be worked upon. These findings were reconfirmed by Daly's (2003) study which took into account cultural and social norms which have the capacity to affect the relation between ICT and gender equality and entailed different scenarios in which ICT does or does not impact gender equality. The author reflected the idea that culture and institutional policies that discriminate against women before the ICT revolution will most likely not let ICT empower women. For gender equality to be achieved, a revolution is needed at the cultural and institutional level.

A noteworthy contribution in this field is by Chen (2004) as he empirically tested the potential of ICTs to impact gender equality and economic growth. He used panel data for 78 countries over the time span of 1960 to 2002 and found affirmative role of ICTs for enhancing gender equality in education and employment which ultimately contributes to economic growth. Similarly, Kucuk (2013) empirically tested the determinants of gender equality and included ICT as an important causal factor. Instead of using a panel data like Chen, Kucuk used cross-sectional data for Middle East and North Africa (MENA) region to analyse the impact of religion and oil in the extent of gender inequality. The relevant result for our thematic area is that ICTs were observed to be beneficial for gender equality in the MENA region.

Other examples include a report by InfoDev (2010) which focuses on the role of ICTs for enhancing gender equity in education in South Asian countries. The study presents theoretical underpinnings following which ICTs can play a positive role for gender equity. These technologies can bring down social, cultural and economic barriers faced by women and bring access of education within their reach. The report found that the case of ICTs for advancement of female education is stronger when one considers informal education. One can cite the example of the animated TV advertisement of sexual harassment bill in Pakistan which proved to be highly effective in spreading awareness of the bill among the masses.

A study by UNCTAD (2014b) throw light on how with the increasing access of ICTs in the developing countries, women are overcoming barriers of culture, system and norms. Though the study focuses on the role of ICTs in women entrepreneurship, the information drawn can also be applicable for increasing female education. The results are similar to an earlier study by Wheeler (2007) who finds that ICTs and particularly internet makes information more accessible, allows women to maintain social connections and builds social awareness, ultimately leading to empowerment.

There exists a research lacuna when it comes to determining the scope of ICTs for gender equality for the case of Pakistan. Some examples that do exist mostly look at the issue through a theoretical perspective. One reason could be the lack of gender segregated ICT data for Pakistan. For instance, Saghir, *et al*. (2009) throw light on the barriers faced by women of Pakistan in accessing ICTs. Computer illiteracy is highlighted as a major determinant for the lesser involvement of girls in ICT related aspects. Furthermore, existing low levels of education, pricey ICT infrastructure and cultural norms are other hindering factors in this regard.

3. FRAMEWORK AND METHODOLOGY

3.1. Theoretical Framework

In this section, the channel through which ICT leads to gender equality and how gender equality ultimately adds up to economic growth is explained. As the access to and use of ICT becomes prevalent in the society, it can increase female education levels by two pathways: by easing access to education and by the improvement in the quality of education. Access to education is made easier by the option of distant learning or e-learning. Media channels like the television, internet, video conferencing and the radio are very convenient methods of imparting education to distant places. Even if not used as a means of education, these technologies can instill awareness in the population of the rights of girls to education, thereby, convincing the orthodox minds against gender discrimination in education. Realizing the importance of education, there will be lesser dropout rates, leading to increased educational attainment amongst the population. An enlightened human resource will lead to an increase in the total factor productivity, leading to economic growth.

A wide variety of educational resources are now in the reach of those who have access to new technology like the internet. This has brought about improvements in the syllabi being taught to children, keeping local courses in line with the changing needs of societies. New and improved methods of teaching being used worldwide can be adopted to increase the quality of education being imparted. Better educated citizens with high quality education would contribute significantly to economic prosperity. Appendix 1 explains this process in the form of a flowchart.

Apart from the direct benefits of education to women, educated women have an important role in the household scheme of work. Educated mothers are more likely to refrain from discrimination between their male and female children in terms of food, health, education, etc. They are an important source of bringing up their children in a better way, leading them to become better citizens. Moreover, increased female education leads to reduction in their fertility rates [Duflo (2004)]. The increased quality and reduced quantity of children help in building up a better and stronger human resource which is extremely important for poverty reduction and economic growth.

Increased educational attainment of the population leads to a virtuous cycle in the economy. Education helps in building human capital which leads to efficient allocation of human resource. Better educated and skilled labour results in increased production and economic prosperity. With increased female education, they will be in a better position to benefit from better working opportunities and reaping higher earnings. With higher earnings, savings would increase resulting in more capital formation. Greater capital formation would lead to higher total factor productivity, thereby, resulting in economic growth.

On the other hand, increased educational opportunities to women not only improve economic prospects to them, but also lead to awareness of their political roles and rights in the society. Education informs women about their rights and therefore, gives them power to participate in the decision making process of their society. It also leads to their representation in the government, key positions in bureaucracy and political parties etc. which gives them voice, power of mobility and confidence [Tasli (2007)]. Women in strategic positions can help bring a structural change in the system in favor of women, easing up the way for other women to progress and contribute towards the overall economic prosperity. Appendix 2 shows the flowchart of this process.

3.2. Methodological Framework

In economic literature, a variety of models have been presented to explain the growth process of an economy. The economic growth models have undergone many cycles of evolution starting from the classical model of Mercantilists to the neo classical models of Solow-Swan (1956) and finally to the more recent endogenous growth models and those which incorporate human capital as a determinant of economic growth.

In the neo-classical models, the emphasis was on the accumulation of capital which determined the output per worker, both of which lead to economic growth. Capital in turn was created by increased savings. Moreover, increases in population growth also rendered to economic growth. In these models, technology was considered an exogenous variable.

The production function of the neo-classical models was:

$$Q = A\,f\,(L, K) \qquad \text{... (1)}$$

where, Q= Output, A= Technology, L= Labour and K= capital.
Here, A can also be termed as the productivity, as increases in this variable lead to increases in output with the given level of inputs.

However, the models that evolved through it, called the endogenous growth models, took technology as an endogenous determinant of growth. According to those,

$$Q= f\,(L, K, A) \qquad \text{… (2)}$$

The more recent Augmented Solow Model incorporates human capital as an exogenous determinant of the growth of an economy. Contributions by Mankiw, Romer and Weil (1992) founded that human capital promotes economic growth through the channel of technology.

The study is based on the criteria that ICT advancements can lead to gender equality in education and employment which can enhance growth. Gender equality in education once established can have impacts which are far reaching and capable of getting round the poverty and inequality traps. For this reason, we consider a systematic approach, based on a set of equations to determine the ultimate effect of ICT on gender equality and economic growth.

An effort is made to determine the impact of Information and Communication Technologies on gender equality on different levels of education, i.e., primary, secondary and tertiary. For that, the ratio of female to male enrolments is taken at all these levels separately to analyse whether or not ICTs aid in gender equality in education, and if so, at what level of education is the impact the greatest.

Taking Chen's (2004) research as reference, we include a set of independent and control variables that determine gender equality. Female to male ratio of enrolment is adopted as a general measure of gender equality in education (ibid.). This indicator is recognized by the United Nations as a measure for Goal 3 of the Millennium Development Goals which relates to promoting gender equality and empowering women.

Despite considerable advancement in the field of ICTs, data availability on the availability, access and use of ICTs remains limited, especially for the case of developing countries. Effort is being put in to determine gender segregated ICT statistics by some organizations (International Telecommunications Union, LIRNEAsia, Women in Global Science and Technology Research etc.), but they have only accumulated data for developed countries for now. There is a huge gap in the data available for least developed and low income countries. Prime reasons for this are the non-availability of human resource or funding to conduct ICT surveys, the absence of national baseline data on ICT sector [Hafkin (2013)]. In these countries, use of indicators like computers, internet connections, mobile and landline phones, fax modems, etc., dominate the statistics [Gurumurthy (2004)]. The ICT proxies used by Chen in his study included: number of computers per 1000 persons, number of internet users per 1000 persons, number of phones per 1000 persons, ICT expenditure as a percentage of GDP; and ICT expenditure per capita. We use a set of indicators representing ICTs for which data was readily available for all the sample countries. These indicators include: number of telephone users, number of mobile users and number of internet users per 100 people. These indicators represent the integration of population through ICT devices which facilitate flow of information and communication. It should be noted that although landline telephones are considered an old proxy for measuring connectivity, a large number of households, especially in developing countries still rely on landline phones for basic connections and services like access to the internet [Hamilton (2010)].

Per capita GDP is included as a measure of economic development. According to findings of Dollar and Gatti (1999), Goldin, *et al*. (2006) and Jayachandran (2014), female to male enrolment in schools and colleges tends to decline with increase in economic development. Public spending on education is also an important variable which may have a negative or positive impact on gender equality in education depending on the benefit incidence [Esim (2000); Sabir (2002)]. Average years of schooling represent the general level of education of the economy and are expected to play a positive role in improving gender equality in education [Afzal, *et al*. (2013)].

$$(Female\ to\ Male\ Ratio\ of\ Enrolment)_{it} = \alpha_o + \alpha_1(Per\ Capita\ Real\ GDP)_{it} + \alpha_2(Public\ Spending\ on\ Education)_{it} + \alpha 3(Average\ Years\ of\ Schooling\ of\ Adult\ Population)_{it} + \alpha_4(ICT)_{itk} + \mu_{it} \quad \ldots (3)$$

where, *i* represents each country cross-section under study, *t* represents time period (year), *j* represents the level of schooling (primary, secondary and tertiary) and *k* represents the ICT proxy from telephone, internet and mobile. A brief description of the variables is as follows with the source of the definition mentioned.

The study is extended by analysing the impact of gender inequality obtained from the previously mentioned models at three educational levels, on the growth rates of economies. The basic purpose is to see the economic importance of achieving gender equality. For this, taking guidance from models developed by Klasen (2002) and Anderson (2010), measures of gender equality in education in the growth equation, along with certain control variables are taken into account.

The following model is estimated:

$$(Growth\ in\ Per\ Capita\ Income)_{it} = \beta_0 + \beta_1(Gross\ Capial\ Formation)_{it} + \beta_2(Trade\ Openness)_{it} + \beta_3\ (Population\ Growth)_{it} + \beta_4\ (Estimated\ Female\ to\ Male\ Ratio\ of\ School\ Enrolment)_{itj} + \gamma_{itj} \quad \ldots (4)$$

A brief definition of the variables along with their sources are mentioned in Table 1.

Table 1. Data Sources and Definitions

Variable Name	Source	Definition
Female to Male Ratio of Primary Enrollment	World Bank	It measures the proportion of females relative to males enrolled in public and private primary schools of the country.
Female to Male Ratio of Secondary Enrollment	World Bank	It defines the percentage of females enrolled in private and public secondary schools relative to males.
Female to Male Ratio of Tertiary Enrollment	World Bank	It takes the percentage of females relative to males enrolled at private and public tertiary schooling institutions of the country.
Per Capita Real GDP	World Bank	Per capita income is taken in terms of constant US dollars for the base year 2005. It is calculated by dividing the real GDP of a country in a given year with the average population number in that given year. It indicates the economic prosperity of an economy.
Average Years of Schooling	World Bank	Adult population is taken as the population which is above the age of 25. Barro-Lee's 5 year estimates were used to entail the general education level of the population, which were interpolated to obtain annual data.
Public Spending on Education	World Bank	It is the total expenditure on education by the government expressed as a percentage of GDP. It includes the current as well as capital expenditure carried out for educational purposes. Any government spending on private or public educational institutes, administration and also any subsidies provided come under this category.
No. of Telephone Users Per 100 People	World Bank	This variable informs us about the degree of connectivity through landline telephone network.
No. of Mobile Users Per 100 People	World Bank	Mobile users approximate the degree of integration of population through the use of cellular networks. Population covered by cellular network availability is an approximation of penetration of the telecommunication network in the region which tells us the reach of the network.
No. of Internet Users Per 100 people	World Bank	This variable indicates the access of the internet and the World Wide. Web by the population. The access to internet entails the access to communication and transfer of information and education.

The time period under study is 2000-2010 and the dataset is a balanced panel dataset. Despite the fact that system GMM can be applied to unbalanced panel data, it has been argued that due to the lags of independent variables introduced as instruments, it is difficult to calculate accurate results with models having endogeneity issues [Flannery and Hankins (2012); Baum (2013)]. The study focuses on lower/ lower middle income countries. According to the definition of World Bank (2012), those countries with per capita income between $1,036 and $4,085 are defined as lower/ lower middle income countries. We have included lower/lower middle income countries as the socioeconomic dynamics of these countries are extremely different than those prevalent in the high income countries. Moreover, the policy implications may also be very different for these countries. Out of 48 countries that fit the criteria, eleven countries were shortlisted which had complete data availability for the variables in use. These countries are: Pakistan, India, Nepal, Kenya, Morocco, Nicaragua, Paraguay, Syria, Indonesia, Bolivia and Philippines.

One of the major limitations in this study is the use of proxies for ICT indicators. This was due to the unavailability of appropriate variables and statistics for the integration and use of ICT in the economies. While ITU has a huge database regarding ICTs, due to lack of national statistics, data for Pakistan was not available, which is our main country of concern. For that reason, the study relies on the number of telephone, mobile and internet users per 100 people. Although, they do give an approximation of the usage of the ICTs, but the results would have been better provided ideal data were available for ICT usage.

Another shortcoming in the data was availability of the average years of schooling estimates on 5-yearly basis. Barro-Lee's projections of mean number of schooling of adult age population, i.e., above the age of 25 were used. To convert the 5-yearly data into annual data, method of Moving Average was used. The mean schooling of population changes very slowly, so, the growth rates were calculated between the 5 year intervals and interpolated to get annual observations.

On the whole, the indicators used to proxy for certain variables provide sufficient information about the required variable, but availability of better and more accurate statistical measures could improve the study.

4. DESCRIPTIVE STATISTICS AND DISCUSSION OF RESULTS

4.1. Descriptive Statistics

This section focuses on the discussion of the trends and patterns of the dataset used, which lays the foundation of the estimations. An overview of the selected variables is given for each country under study. Appendix 11 lists down the summary statistics for the eleven countries selected.

A glance at the summary statistics' tables show that during the years 2000-2010, almost all economies selected in this study have attained gender equality at primary level, with the exception of Pakistan where the enrolment ratio is lowest, averaging at 76.87%. On the other hand, Bolivia has the highest average female to male primary enrolment rate of 99.1%. A major reason for the low average ratio is that Pakistan only started implementing free and compulsory education for all goal of MDGs in 2004, whereas, other countries had started working on it since 2000. There are fewer primary schools for girls in Pakistan than boys[1].Another major reason for

[1] See Mumtaz, (2014) reducing the Gender Gap/ Engendering PRSP2.

the wide gap is the unavailability of female teachers to teach at primary level in most rural areas of Pakistan.

In case of gender equality at secondary level enrolments, it was observed that the three South Asian nations lagged behind the other nations in the sample. Pakistan still had the lowest average for female to male secondary enrolment ratio, but surprisingly the ratio was higher than at primary level. On the other extreme, countries like Nicaragua, Paraguay and Philippines had greater female enrolment which outnumbered male enrolment rates, with average values of ratio 113.9%, 103.1% and 110.3%, respectively. These statistics show the changing perception and value towards female education. Besides the social and cultural change, these countries also have better educational institutes, ensuring that quality education is being provided which encourages female enrolment rates. Moreover, efforts made by the states to make secondary and higher education affordable have greatly driven higher female enrolment rates in these countries. Nicaragua, in particular, gained from providing special scholarships for secondary education to those girls who attend school regularly and perform well in class [Herz (2011)].

The situation of female enrollments at the tertiary level has two extremes. At one extreme lie countries like India, Nepal and Kenya where the female to male enrollment rates are as low as 69.3%, 46.1% and 59.5%, respectively. These economies are a long way from achieving gender parity at the tertiary level. One reason is that tertiary education is extremely costly, with the private sector being more expensive than the public sector. The public sector, even though affordable, imparts lower quality education and more than often, the opportunity cost for enrolling in a higher level institute is greater for girls than not opting for it [Nagarajan (2014)].

At the other extreme, countries like Paraguay and Philippines had females outnumbering males in tertiary enrollment rates, with the average ratio being 134.1% for Paraguay and 122.7% for Philippines. At these levels, the disparity is against male education. This dramatic trend is a result of greater acceptance of gender egalitarian practices, modernization and expansion of higher educational facilities, and due to the better performance of girls in secondary education which encourages them to enroll at higher educational institutions [Mather and Adams (2007)]. Apart from these factors, the major reason is the high private and social returns to female education as compared to male education in these countries [DeSilva and Bakhtiar (2011)]. Such gender gap in education in favor of women exists when there is a large gender wage gap in the labor force in favor of men and in order to close the wage gap, females study more than males.

By observing other variables included in the study, it was noticed that those countries which had high number of average years of schooling for adult population (generally higher than 4 years of schooling) had a less gender gap at all levels of enrolment. With average years of education of 8.3 years each, both Philippines and Bolivia display higher levels of female enrolment rates than other countries. Better educated society, therefore, can be a promoter of female participation in education.

The trends of all ICT proxies have been constantly on the rise, with the rates of growth being highest for mobile phones and internet. The use of telephone has dwindled in developed nations because they have been substituted with wireless technology but the rate of landline telephones is still growing in developing nations, particularly in low and lower/ lower middle income countries as they remain the main source of communication and also because internet in developing nations is still connected with landline telephone to a large extent. Therefore, telephones connections have risen over the period of 2000-2010 but at a gradual rate.

4.2. Discussion of Results

To establish the link between ICTs and gender equality on one hand and the link between gender equality and economic growth on the other, a recursive approach is to be used. A system of recursive models exists when the dependent variable of one of the models is used as an independent variable in another model, in a step-wise manner. However, our model also showed evidence of endogeneity and heteroscedasticity among some of the variables, which was confirmed by Hausman Test of Endogeneity and Park Test for Heteroscedasticity (see, Appendices 3 and 4) To encounter these problems, an instrumental variable (IV) technique is needed. System Generalized Method of Moments, being an IV technique is the most appropriate technique for this study. The GMM technique was introduced by L Hansen in 1982.

The properties of GMM include consistency, asymptotic normality and efficiency. Although a relatively new approach, the GMM has gained popularity because of its independence from unnecessary assumptions [Hall (2009)], the method has an edge over other Instrumental Variables techniques as it inherently addresses the issue of endogenity within the system and uses a richer set of instruments that can be determined from within the system. A Generalized Method of Moments approach is based on the specifications of certain moment conditions. A moment condition is explained as a function of the parameters, variables and instruments, in a way that their expectation is zero.

$$g(\theta) = E\,[\,f\,(w_t, \theta_0\,, z_t)\,] \qquad \text{... (5)}$$

In this equation, θ defines a vector of parameters, w_t includes the variables used and z_t includes the instruments. The expectation of a function of all three of these is zero for a moment condition to be defined.

In case of system GMM, same set of instruments are used for all equations employed in the system. The stronger the correlation of the instrument variable with the endogenous variable more is the strength of the instrument for defining the endogenous variable. System GMM is based on the principle that good instruments are only those generated from the system internally. These internally generated instruments could be either differences or lags of independent variables. Lags of independent variables, however, prove to be more strongly correlated with the endogenous variable and uncorrelated with the error term [Roodman (2009)]. Moreover, in panel data studies, it is very difficult to separate out external instruments which would prove to be sufficient to explain the endogenous variables.

Validity and correct identification of the model depends upon the correct choice of instruments. The correct choice is confirmed by the Sargan J-statistic which has the null hypothesis of valid over-identification of restrictions as opposed to invalid on alternative hypothesis. In other words, if the null hypothesis is accepted, it means that the instrument specification is correct. The Sargan J-statistic follows the chi-square distribution, with degrees of freedom being equal to the difference between number of instruments and number of parameters. In this study, up to two lags of independent variables were introduced as instruments for each regression.

On a broad note, results of the study are in accordance with the theoretical background. ICT has been observed to be a likely contributor to gender equality in education and impact on growth from that gender equality has been positive. Almost all of the control variables have also shown coefficient signs as per expectations and are statistically significant.

We refer to Tables 2 and 3 for detailed discussion of coefficients. Among the ICT proxies used for estimation (telephone lines, mobile usage and internet usage), only telephone lines per 100 people has given positive and statistically significant coefficients for female to male enrolment ratios at primary, secondary and tertiary level of education. Judging from the coefficients, there exists a marginal difference in the magnitude of the impact of ICTs on gender equality at each level. In statistical terms, a 1% increase in the use of ICT in the society results in a 0.21%, 0.25% and 0.28% increase in female to male ratio of primary, secondary and tertiary enrolment respectively. These results conform to the earlier empirical evidence of Chen (2004) and Kucuk (2013), the findings of which report that ICTs' integration in the society promote gender equality in education.

The coefficients of ICT remained positive when other proxies for ICT were used, but the significance of the coefficients varied. Appendices 5-10 report the coefficients for system GMM regressions when other proxies were used for female to male enrolment ratios at each educational level. The significance of the coefficients, however, varied, for different proxies of ICTs. A plausible conclusion drawn from this result is that ICTs do have the potential to promote gender equality at different educational levels, but the strength of their impact depends upon the integration of these technologies in the society.

Table 2. System GMM Results for Female to Male School Enrolments

Independent Variable	Female to Male Primary Enrollment Ratio	Female to Male Secondary Enrollment Ratio	Female to Male Tertiary Enrollment Ratio
Constant	78.4***	75.7***	23.2***
	(1.8)	(6.0)	(1.3)
Per Capita Income	0.002	0.003**	0.023***
	(0.001)	(0.001)	(0.0005)
Average Years of Schooling of Adults	1.25***	4.32***	11.42***
	(0.27)	(0.36)	(0.252)
Public Spending on Education	1.34***	-2.25***	-5.89***
	(0.29)	(0.48)	(0.16)
ICT (Telephone)	0.210*	0.253***	0.28***
	(0.12)	(0.14)	(0.04)
J-STAT	0.47	0.25	0.24
J-STAT Probability	0.92	0.97	0.62

Standard errors are reported in parenthesis.
(*) represents significance at 10%, (**) significance at 5% and (***) significance at 1%.

Table 3. System GMM Results for Growth in Per Capita Income

Independent Variable	Growth of Per Capita Income		
	Female to Male Primary Enrollment Ratio	Female to Male Secondary Enrollment Ratio	Female to Male Tertiary Enrollment Ratio
Constant	-18.7***	-9.5***	-2.1***
	(3.9)	(3.6)	(0.47)
Trade Openness	0.41***	0.28***	0.00003***
	(0.09)	(0.1)	(0.00)
Gross Capital Formation	0.06***	0.08***	0.11***
	(0.02)	(0.01)	(0.01)
Growth of Population	-1.13***	-0.93***	-0.12***
	(0.08)	(0.14)	(0.03)
Female to Male Ratio of Primary Enrollment	0.08***		
	(0.02)	--	--
Female to Male Ratio of Secondary Enrollment	--	0.025**	--
		(0.01)	
Female to Male Ratio of Tertiary Enrollment			0.001
	--	--	(0.002)
J-STAT	0.47	0.25	0.34
J-STAT Probability	0.92	0.97	0.62

Standard errors are reported in parenthesis.
(*) represents significance at 10%, (**) significance at 5% and (***) significance at 1%.

Lower/ lower-middle income countries have a very limited integration of ICTs into their system, even though the integration has observed an increasing trend over the years. Also, most of the lower/ lower middle income countries have large proportion of population living in the rural areas. The reach of ICTs in those areas is even more limited. Even though the use of ICTs has been observed to enhance quality of education being imparted in such countries (with the use of computers, internet, etc.), most schools, especially, primary schools in rural areas do not have access to such technologies. Moreover, impact of ICTs on promotion of female education would be better assessed if gender specific statistics are available [Hafkin (2001)]. With information on the degree of access of ICTs to females, it would give more accurate results of how these technologies are helping in the educational empowerment of women.

Another factor behind the varying significance of ICT indicators is that social issues, reined by cultural norms, take time to change. The widespread use of the new ICTs has only started recently. Even though the results indicate that ICTs, in fact, do contribute to the achievement of gender equality at all levels, but the strength of the impact would be more evident when these technologies have attained a deep-rooted integration in the whole society. With more time, better data and improved quality of ICTs being used in the society, the positive impact would be strengthened.

As far as other variables are concerned, it was found that the average years of schooling of the adult population is the major contributor towards gender equality. The coefficient is positive and highly significant for all three educational levels considered. The coefficient is largest for tertiary level of education, indicating that 1 year increase in the average years of schooling of adult population results in 11.4% increase in the female to male ratio of tertiary education. The coefficients for primary and secondary education are 1.25% and 4.32%, respectively. The conclusion drawn is that in a more enlightened society, there is less discrimination against female education, which in turn encourages the females of the society to opt for higher education. In other words, a well-educated society would promote gender equality in education. Moreover, in the regression results, the coefficients of average years of schooling of adult population are largest in magnitude, showing that in achieving gender equality, the most important factor is the awareness of the importance of gender equality, which comes through greater education. This finding confirms earlier results of El Sanabary (1989).

The estimated coefficient of public spending on education is positive and statistically significant when primary education equality is considered, indicating that a rise in the educational expenditure by the government raises the female to male ratio of primary enrollment. In statistical terms, a 1% rise in the public spending on education leads to 1.34% rise in gender equality at the primary level. One reason for this is the obligation of the governments, under the Millennium Development Goals, to provide free and universal primary education to all. Following this, almost all countries, have achieved this target of universal primary education. Thus public spending, at the primary level, promotes gender equality.

For secondary and tertiary education, the coefficient's sign is negative and is highly significant. This lays emphasis on the importance of target incidence of public spending. If the incidence of the public spending is poorly targeted, then it could actually worsen the gender equality. Statistically, a 1% rise in the public spending on education hampers gender equality by 2.3% at secondary level and 5.9% at the tertiary level. The variable used for this study represents the overall magnitude of government expenditure on education, regardless of how much part of that expenditure is spent on boys or girls. Morgan (2007) has highlighted the issue of gender blind budget allocations, which can hinder a country's progress towards gender equality by ignoring the dissimilar effects of public spending on males and females. The impacts of such policies, like increased budget spending on education, are not gender neutral. Different societal groups on the basis of age, gender, class etc., have different impacts from an overall government spending [Balmori (2003)].

Without conclusive evidence from gender-segregated data on public spending on education, it cannot be ascertained, contrary to the findings of the study, that government expenditure on education in fact exacerbates gender inequality. Certain examples support this finding e.g., when the public spending on education was segregated for gender in Ghana, it showed that females benefitted considerably less from that spending than males, leading to increased gender inequality [Budlender, *et al*. (2002)]. Moreover, a study by Elson (1999) found that educational expenditures in some countries unintentionally favour boys over girls. The author quoted the example of Pakistan and Kenya, where the incidence of public educational expenditure shows that Pakistan spent 56 Rupees per male and only 26 Rupees per female (according to World Bank, 1995) and Kenya spent 670 Shillings per male and 543 Shillings per male. Such examples support the negative sign of the coefficient of public spending expenditure in this study. Moreover, in developing countries, particularly lower/ lower middle income countries, the concentration of educational public spending is more on developing infrastructure and capacity building, rather than on quality of education or social aspects of education. In such a case, government's education expenditure might not involve certain needed action to address issues like gender inequality, thereby, worsening the situation.

To capture the impact of level of economic prosperity, per capita income has been used in terms of constant US dollar terms. Results show a positive but statistically insignificant coefficient for the case of gender equality in primary education. This shows that income level of population is not a significant contributor to attain gender equality at this level. This can be supported by the free provision of primary education to all by the state, which redeems population's income insignificant, since the state itself has taken the responsibility to educate all children at the primary level.

Per capita income has proved to be positive and statistically significant contributor to achieve gender equality at higher levels of education. With 1 dollar rise in the per capita income of the population, the female to male secondary enrolment ratio rises by 0.003%, and the female to male tertiary enrolment ratio rises by 0.023%. This indicates that female enrolments at higher levels of education are positively affected by higher per capita incomes. A rich nation is more likely to attain gender equality at secondary and tertiary levels than a poorer nation. There are costs to attain education, and with higher income, parents are better able to cover the educational expenditures to send their daughters to schools, who were previously ignored in terms of education. This finding is supported by Chen (2004) who claimed that higher levels of economic development contribute to gender equality.

When the impact of gender equality at each educational level was observed in economic growth, it was found to be positive and highly significant for primary and secondary female to male levels of enrolment, but statistically insignificant for tertiary education. There have been numerous studies in literature on the impact of gender equality in education on growth, but literature that segregates the educational levels and then checking the impact on growth is very limited. It is evident that gender equality in primary enrolment contributes most to economic development. With reference to Table 3, a 1% rise in the female to male primary enrolment ratio results in 0.08% increase in economic growth. In second place, gender equality in secondary enrolment contributes 0.025% to growth. Furthermore, a 1% rise in gender equality in tertiary enrolment results in 0.001% increase in growth, however, it is statistically insignificant.

It is to be noted that gender equality in education, captured by enrolment ratios does not take into account dropout rates or actual level of educational attainment. Therefore, there's a possibility that impact of such gender equality on growth could be a bit misleading. Another factor to be kept in mind is that the time period under study is just ten years, whereas, social changes like achievement in gender equality could take a longer time period to show their impact on growth.

As far as the insignificance of the coefficient of gender equality at tertiary level is concerned, Wolff and Gittleman (1993) stated that for lower/ lower middle income countries, initial levels of education contribute more to growth as compared to higher levels of education. In developing countries, primary and secondary education levels matter most as they lead to higher levels of productivity of final goods and help in adjusting to and adoption of foreign technology. Tertiary education levels have only attained importance recently in these countries; therefore, its impact on growth is not significant as yet. According to Vandenbussche, *et al*. (2004) and Periera and Aubyn (2004), developing countries are just beginning to close their technological gap, and for them “less skilled human capital formation is more important”. Higher education or tertiary level skills gain importance when countries are at the brink of their technological frontier. Moreover, we may also support this by using Barro’s (1998) conclusions that the benefits of rising female education levels (especially at tertiary levels) are not realized due to the cultural factors due to which better educated females are not able to participate in the labour force to contribute to the economic gains.

To account for growth, certain control variables have been introduced. The coefficients of trade openness, defined as the sum of imports and exports as a ratio of GDP, are positive and also statistically significant, thereby, indicating that with trade liberalisation, countries gain more in terms of economic growth. According to the results, if trade is liberalised by 1%, growth in per capita income rises by an average of 0.23%. This gain is achieved through better allocation of resources as countries make efforts to specialize in certain industries, leading to productivity rise. Moreover, as a country liberalizes its trade, it gains from technology transfers and rising factor productivity. In case of developing countries, like the ones under study, trade openness is associated with imports of intermediate and capital goods, which are then used in the domestic industry, mostly export oriented [Parikh and Stirbu (2004)]. The positive and statistically significant coefficients for growth-openness nexus is supported by the findings of Klasen (2002), Andersson (2010), Ulasan (2012), etc.

The coefficient of population growth rate is significant and negative in all three growth equations. A high rate of population growth rate indicates high dependency ratios on one hand and lower capital per worker on the other. Both the situations are growth hampering. In lower/ lower middle income countries particularly, a higher population growth rate worsens the situation as inflation, unemployment and poverty rates are already very high. With increasing population growth, per capita income would decline, there will be more mouths to feed, more jobs to be provided and more children to be educated. For every 1% rise in the population growth rate, growth of per capita GDP declines by 0.72% on average according to the results. This finding is supported by Cincotta and Engelman (1997), Maleka and Rehab (2004) and Afzal (2009).

Investment is added in the equation as gross capital formation as a percentage of GDP. The coefficients show a highly significant positive sign for all three growth equations. This is in accordance with a priori expectation that higher levels of investment positively contribute to economic growth. For every 1% rise in the gross capital formation, lower/ lower middle income economies grow by an average of 0.08%. Gross capital formation is associated with infrastructure development, increasing levels of productivity, stimulation of aggregate demand and creation of jobs. The positive significant impact of capital formation conforms to earlier findings of Klasen (2002), Pavelescu (2007), Andersson (2010) and Kumo (2012).

It was, however, noted that by changing the specification and instruments of the growth model slightly, the signs and significant of the control variables did not show robustness. Bear in mind that the factors that lead to growth generally have an effect in the longer run. A period of 10 years is too short to get robust results of impact of different factors on the economies’ growth, but since the study focused on the impact of information revolution on gender equality and the resulting impact on growth, the last decade was the most appropriate to be considered for study as ICTs only began to be extensively used in developing countries in this time period.

This study, however, is an important contribution as it attempts to correct for endogeneity and simultaneous bias in the estimations, which was previously not accounted for in gender specific growth modeling [Birdsall, *et al*. (1997); Andersson (2010)].

The overall results are comparable to those concluded by Chen (2004) to some degree. While the signs of coefficients of ICTs echo the findings of Chen, the significance of the coefficients varies. It may be because of the difference in the sample size, as Chen included the timeframe from 1960-2002 or it may also be because of the wide dataset used by Chen comprising of data for 78 countries. Our study draws out the impact of ICTs on a limited number of countries, based on their differentiated socioeconomic conditions.

5. CONCLUSION AND POLICY IMPLICATIONS

It is drawn from the empirical findings that even though ICT positively influences gender equality in education, significance of ICT proxies vary at each educational level. This indicates the lack of thorough integration of ICTs in lower/ lower middle income countries. Either the diffusion of the technologies is not deep rooted into the societal system, or their quality is not good which restricts the positive impact of ICTs to be strong and robust with all proxies used. Furthermore, for the impact to be vigorous, it must be evaluated over a longer time span as social changes require some time to take place.

Another important conclusion drawn from the study is that gender equality is most strongly affected by the average education of the adult population. It is observed that as the average number of years of schooling of the adult population rises, the prospects for gender equality rise at each level, with the strongest impact on higher education. More educated societies show less incidence of gender discrimination in education. With increasing learning, they realize the benefits of educating the females of their society and encourage them to gain education.

This study shows that for growth in lower/ lower middle income countries, gender equality is more important in primary and secondary education level than at the tertiary level. Countries with less skilled labour force benefit from higher rate of returns to lower levels of education. The proportion of people (both males and females) gaining higher education is very less so far; therefore, the impact on growth of gender equality in higher education has not yet been considerable. As countries advance, highly skilled labour force starts to play a more important role and the impact of gender equality in higher education on growth matters more.

To promote gender equality and enhance growth, the governments of lower/lower middle income countries should take the following measures:

1. To benefit, in the true essence from ICTs, governments should invest in ICT infrastructure and ensure a deep diffusion of quality ICT facilities in the society, especially in educational institutions.
2. Keenly devised distant learning programs should be initiated for that proportion of females who face barriers to leave home for education and the content of the syllabus should address the gender issues faced by women.

3. More important than the quantity, states need to adopt a holistic approach to improve the quality of public spending on education for attaining gender equality. Governments in the lower/ lower middle income countries need to make targeted efforts to reduce gender inequality at all levels of education. Some considerations could be making new schools for females, employing female instructors to be role models for young girls, making educational institutes closer to the community's vicinity, providing transport facility to girls to and from schools, providing grants and scholarships to girls based on need and merit, training teachers to be more gender friendly, etc.
4. Print and electronic media, which have the highest intensity of diffusion in lower/ lower middle income countries, should initiate mass awareness programs regarding the benefits of female educating and also highlight the importance of overall literacy levels. A more educated society would be more liberal towards female education.
5. Efforts need to be done to collect gender segregated statistics for access, use and benefits of ICTs. Indicators depicting the actual level of integration of ICTs in the society need to be developed, along with those measuring the quality of such facilities. This would provide us with comprehensive information about the impact analysis of ICTs.

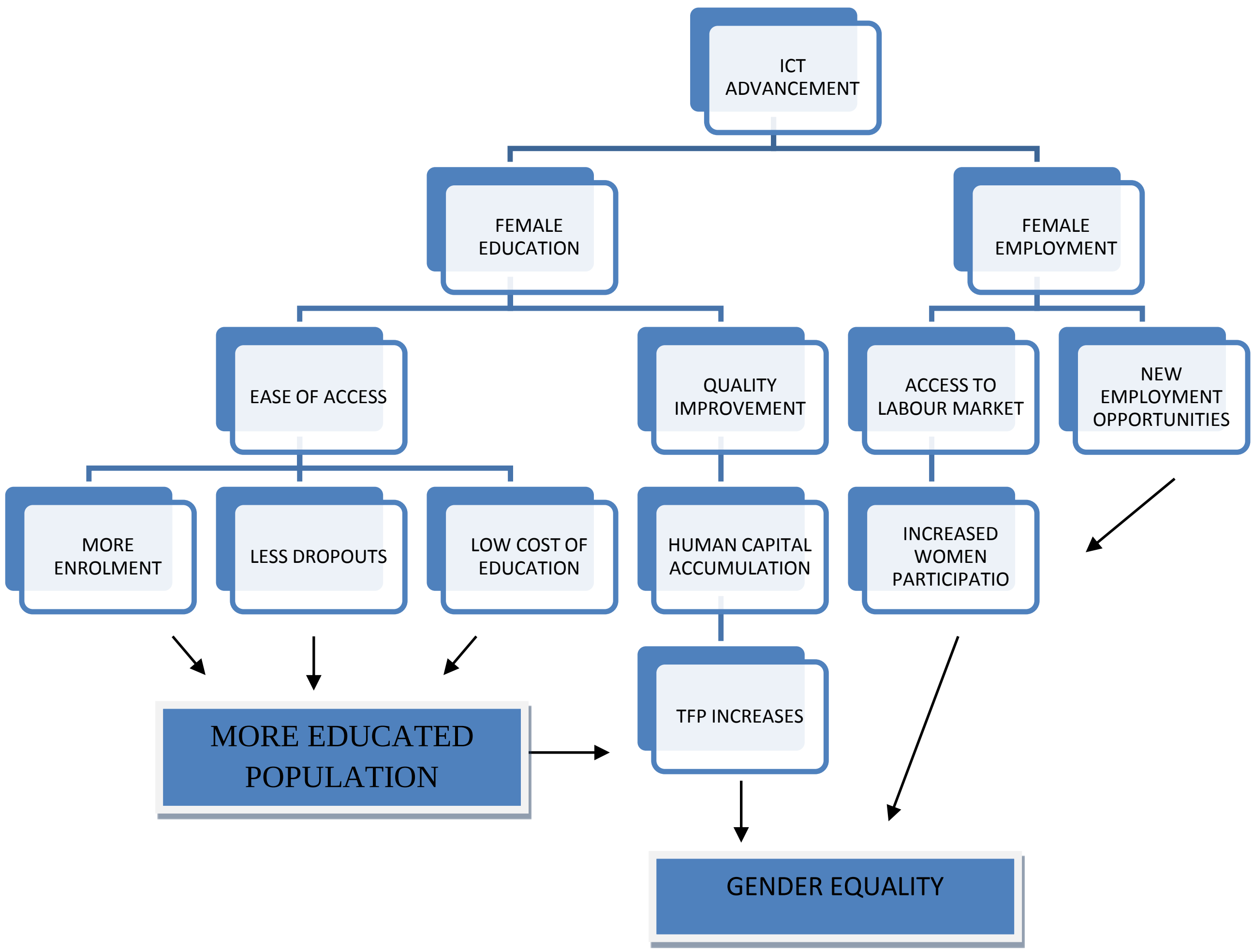
The study is quite comprehensive in relating the ICTs to gender equality and analysing the impact of gender equality on growth, however, there is still room for improvement in knowledge base. This study analyses the cross-country relationships on a macro level. For in depth analysis of impact of ICTs on gender equality, micro level studies should be carried out to see how ownership and access to ICTs empower women.

Moreover, aspects other than gender equality in education should be considered, e.g., equality in labor force participation, equality in decision making and political positions, equality in property ownerships etc. Even for the case of education, measures other than female to male enrolment ratios should be used to define gender equality. Besides the impact of ICTs on gender equality, the issue of gender divide in the use of ICTs should be analysed . Women face numerous barriers in accessing these technologies; in return, they reap fewer benefits than men from productivity gains.

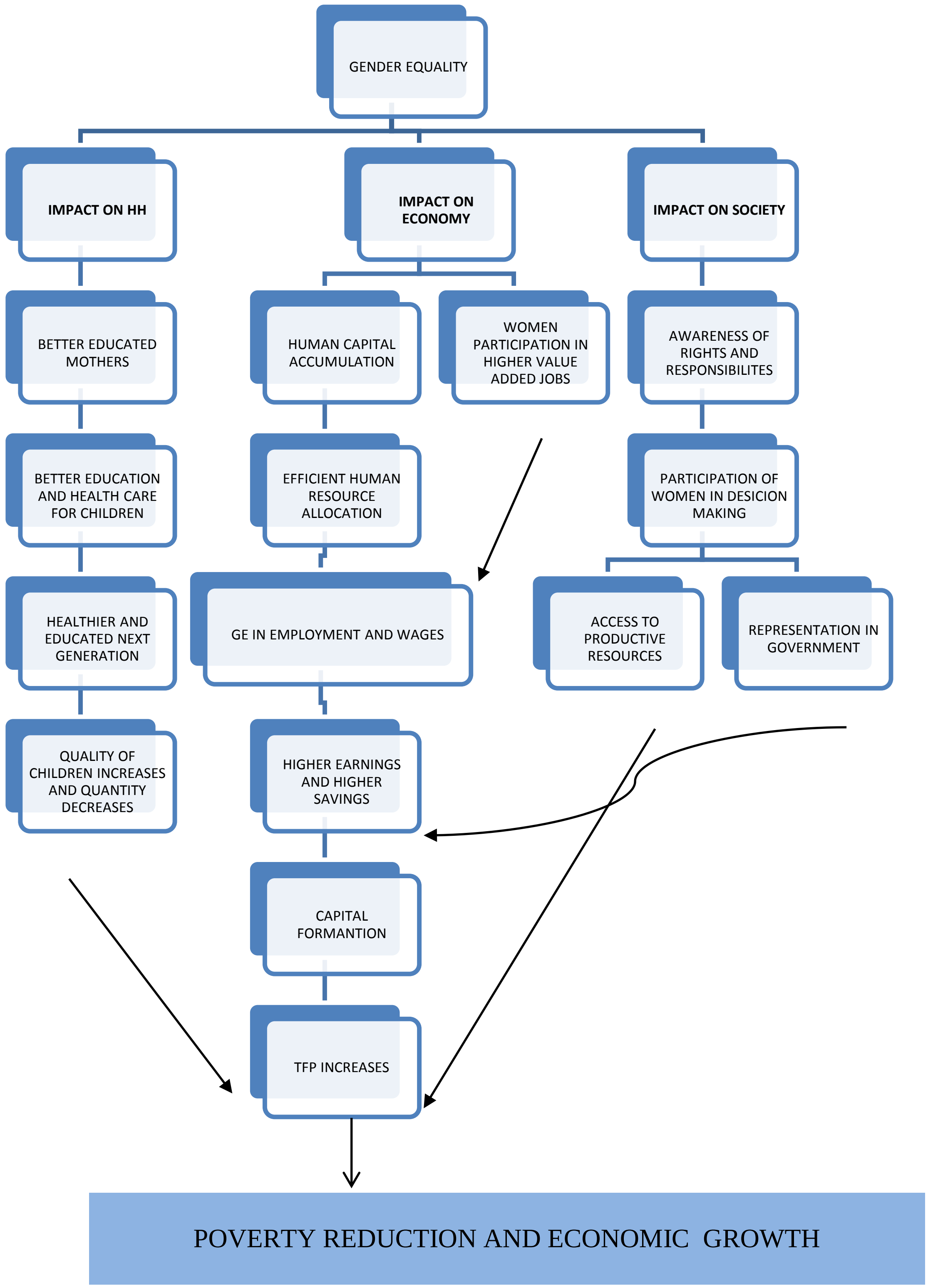
Furthermore, the empirics of this study could be reassessed by using different sample countries and/or increasing the number of years under study. Other factors that could possibly impact gender equality and economic growth could be included to re-specify the models. As till date, Generalized Method of Moments is the best available technique to address the endogeneity and simultaneous bias problems, which such models face. Future researches could include instruments other than lagged values of independent variables and examine the resultant impacts.

APPENDICES

Appendix 1: The Link between ICT Innovations and Gender Equality



Appendix 2: The Mechanics between Gender Equality and Economic Growth



Appendix 3: Hausman Test of Endogeneity

Sr. No.	Endogenous Variable	Probability
1	PCY Residual	0.005
2	Adult Schooling Residual	0.0002
3	Investment	0.093

Appendix 4: Park Test of Heteroscedasticity

Sr. No	Variable Causing Heteroscedasticity	Probability
1	Per Capita Income	0.0002
2	Public Spending on Education	0.0001
3	Average Years of Adult Schooling	0.0000

Appendix 5: System GMM Estimations for Gender Equality at Primary Education with ICT Proxies

Independent Variable	Female to Male Primary Enrollment Rate	
Constant	76.9***	82.5***
	(3.31)	(3.07)
Per Capita Income	0.001	0.005***
	(0.001)	(0.001)
Average Years of Adult Schooling	1.39***	0.66***
	(0.303)	(0.33)
Public Spending on Education	1.67***	0.87***
	(0.53)	(0.27)
Internet	--	0.20***
		(0.07)
Mobile	0.07	
	(0.07)	--
J-Stat	0.36	0.49
J-Stat Probability	0.94	0.92

(***), (**) and (*) represent statistical significance at 1%, 5% and 10% level of confidence, respectively. Values in parentheses represent standard errors.

Appendix 6: System GMM Estimations for Growth in Per Capita Income through GE in Primary Education with ICT Proxies

Independent Variable	Growth of Per Capita Income MOBILE	Growth of Per Capita Income INTERNET
Constant	-9.29*	-13.08*
	(2.25)	(8.01)
Trade Openness	0.04	0.51**
	(0.108)	(0.25)
Gross Capital Formation	0.04***	0.04**
	(0.02)	(0.02)
Growth of Population	-1.17***	-1.19***
	(0.12)	(0.08)
Female to Male Primary Enrollment	0.03*	0.07***
	(0.02)	(0.02)
J-Stat	0.36	0.49
J-Stat Probability	0.94	0.92

(***), (**) and (*) represent statistical significance at 1%, 5% and 10% level of confidence, respectively. Values in parentheses represent standard errors.

Appendix 7: System GMM Estimations for Gender Equality at Secondary Education with ICT Proxies

Independent Variable	Female to Male Secondary Enrollment Ratio	
Constant	76.01***	68.3***
	(4.99)	(4.16)
Per Capita Income	0.005*	0.005***
	(0.003)	(0.001)
Average Years of Adult Schooling	3.02***	3.87***
	(0.67)	(0.50)
Public Spending on Education	-1.5*	-0.38
	(0.86)	(0.93)
Internet		0.023
	--	(0.09)
Mobile	0.008	
	(0.03)	--
J-Stat	0.12	0.19
J-Stat Probability	0.72	0.95

(***), (**) and (*) represent statistical significance at 1%, 5% and 10% level of confidence, respectively. Values in parentheses represent standard errors.

Appendix 8: System GMM Estimations for Growth in Per Capita Income through GE in Secondary Education with ICT Proxies

Independent Variable	Growth of Per Capita Income	
	MOBILE	INTERNET
Constant	-12.7**	-10.4**
	(3.7)	(3.6)
Trade Openness	0.37***	0.31***
	(0.12)	(0.09)
Gross Capital Formation	0.09***	0.09***
	(0.03)	(0.02)
Growth of Population	-1.12***	-1.08***
	(0.14)	(0.13)
Female to Male Secondary Enrollment	0.02**	0.03*
	(0.01)	(0.02)
J-Stat	0.12	0.19
J-Stat Probability	0.72	0.95

(***), (**) and (*) represent statistical significance at 1%, 5% and 10% level of confidence, respectively. Values in parentheses represent standard errors.

Appendix 9: System GMM Estimations for Gender Equality at Tertiary Education with ICT Proxies

Independent Variable	Female to Male Tertiary Enrollment	
Constant	18.59***	33.6***
	(3.92)	(7.92)
Per Capita Income	0.02***	0.02***
	(0.001)	(0.004)
Average Years of Adult Schooling	12.6***	9.86***
	(0.68)	(0.96)
Public Spending on Education	-5.9***	-5.7***
	(0.39)	(0.62)
Internet	--	0.17
		(0.35)
Mobile	0.08**	--
	(0.03)	
J-Stat	0.23	0.07
J-Stat Probability	0.63	0.80

(***), (**) and (*) represent statistical significance at 1%, 5% and 10% level of confidence, respectively. Values in parentheses represent standard errors.

Appendix 10: System GMM Estimations for Growth in Per Capita Income through GE in Tertiary Education with ICT Proxies

Independent Variable	Growth of Per Capita Income	
	MOBILE	INTERNET
Constant	-11.5**	-12.34**
	(2.82)	(3.89)
Trade Openness	1.4E-6*	4.9E-6***
	(8.3E-7)	(1.4E-5)
Gross Capital Formation	0.11***	0.07*
	(0.03)	(0.04)
Growth of Population	-1.1***	-0.99***
	(0.05)	(0.10)
Female to Male Tertiary Enrollment	0.006	0.003
	(0.004)	(0.005)
J-Stat	0.23	0.07
J-Stat Probability	0.63	0.80

(***), (**) and (*) represent statistical significance at 1%, 5% and 10% level of confidence, respectively. Values in parentheses represent standard errors.

Appendix 11: Summary Statistics

Variable	Pakistan			India			Nepal			Kenya			Morocco		
	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range
Female to Male Primary Enrolment Ratio	76.8	7.1	17.33	95.20	6.50	17.6	92.9	9.9	29.7	96.8	1.5	4.2	90.5	2.4	8.9
Female to Male Secondary Enrolment Ratio	77.43	1.00	3.35	81.93	7.57	21.8	79.9	10.1	30.8	93.5	3.9	15.01	84.3	2.8	8
Female to Male Tertiary Enrolment Ratio	82.9	2.57	7.10	69.3	2.02	6.7	46.1	13.8	38.5	59.5	6.02	17.3	82.8	5.4	15.9
Public Spending on Education	2.3	0.42	1.12	3.5	0.40	1.2	3.6	0.6	1.8	6.5	0.7	2.2	5.6	0.12	0.4
Average Years of Adult Schooling	4.3	0.56	1.60	4	0.28	0.9	2.8	0.3	0.89	5.9	0.24	0.7	3.9	0.32	1.01
Growth Rate of Per Capita Income	2.6	2.0	5.9	5.7	2.6	6.9	2.5	1.7	6.5	1.1	2.3	6.2	3.5	2.0	6.2
Gross Capital Formation	18.5	2.6	7.34	31.9	5.4	13.8	24.4	8.7	35.3	18.08	1.5	4.9	30.3	4.3	2.15
Growth Rate of Population	1.9	0.16	0.51	1.5	0.14	1.4	1.52	0.37	1.06	2.7	0.02	0.10	0.99	0.10	0.9
Per Capita Income	684.2	70.9	178.3	762.1	154.9	422	327.0	26.7	80.3	529.9	30.3	79.90	1983.1	246	740.2
Trade Openness	33.8	3.15	9.98	38.6	9.5	25.6	46.1	4.01	12.09	63.9	7.5	18.2	68.9	6.9	18.3
Telephone	2.87	0.50	1.51	3.5	0.47	1.6	1.94	0.68	1.8	1.07	0.32	0.4	6.4	3.08	8.78
Internet	5.2	2.7	7.9	2.9	0.8	7.0	1.5	2.2	7.7	5.4	4.5	13.7	18.4	17.4	51.4
Mobile	21.7	24.2	56.8	16.9	20.1	60.1	7.4	10.2	30.0	21.3	21.4	60.2	46.5	29.7	91.9

Variable	Nicaragua			Paraguay			Syria			Indonesia			Philippines			Bolivia		
	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range
Female to Male Primary Enrolment Ratio	98.5	1.2	3.6	96.6	0.4	2.8	95.8	1.8	4.9	98.6	1.9	6.8	98.8	0.65	2.7	99.1	0.4	1.2
Female to Male Secondary Enrolment Ratio	113.9	2.3	8.1	103.1	1.3	4.7	95.9	3.9	10.6	99.4	1.1	3.1	110.3	1.2	3.8	96.9	1.2	3.8
Female to Male Tertiary Enrolment Ratio	97.2	3.2	13.2	134.1	8.7	31.2	88.18	3.2	10.3	86.9	6.6	22.3	122.68	6.9	21.2	94.2	3.4	5.2
Public Spending on Education	3.3	0.7	2.3	3.8	0.4	0.8	5.1	0.6	2.2	2.9	0.34	1.3	2.8	0.26	0.8	6.6	0.7	0.8
Average Years of Adult Schooling	5.1	0.3	1.2	6.8	0.6	2.3	4.8	0.07	0.2	5.03	0.30	1.09	8.3	0.2	0.7	8.3	0.58	1.8
Growth Rate of Per Capita Income	1.7	2.1	7.3	1.1	4.7	16.7	1.9	1.8	5.7	3.7	0.83	6.9	2.8	1.8	6.3	1.9	1.4	4.7
Gross Capital Formation	27.4	3.3	11.3	16.04	0.9	4.6	22.2	5.2	14.2	25.7	3.5	8.9	20.2	2.5	5.9	15.3	2.2	7.1
Growth Rate of Population	1.3	0.09	0.3	1.9	0.1	1.3	2.7	0.8	2.3	1.4	0.03	1.02	1.8	0.2	0.46	1.8	0.2	1.4
Per Capita Income	1159	79.6	207.3	1524	94.6	311.7	1561.2	106.9	315.4	1295.2	164.4	483.9	1209.4	119.9	342.7	1042.9	80.1	215.0
Trade Openness	73.5	8.8	23.1	95.3	10.1	28.2	74.1	7.4	21.3	60.1	6.6	20.8	96.1	4.2	25.3	62.5	6.04	16.2
Telephone	3.4	0.56	1.5	5.5	0.5	2.9	15.5	3.3	9.5	7.6	5.01	13.8	4.13	0.27	1.09	7.2	0.79	2.4
Internet	3.6	2.8	9.1	8.1	7.1	19.1	7.9	7.0	19.6	4.5	3.1	9.0	6.9	6.3	23.9	8.0	6.7	21.0
Mobile	28.5	24.7	66.1	51.2	30.5	77.6	21.8	20.0	56.7	30.7	29.7	86.3	46.5	28.1	81.2	31.4	22.9	65.3

REFERENCES

Afzal, M. (2009) Population Growth and Economic Development in Pakistan, *The Open Demography Journal, No. 2, 1-7.*

Afzal, M., A. R. Butt, R. A. Akbar, and S. Roshi (2013) Gender Disparity in Pakistan: A Case of Middle and Secondary Education in Punjab. *Journal of Research and Reflections in Education, 7*:2, 113-124.

Andersson, A. (2010) The Effect of Increased Gender Equality on Economic Growth in Developing Countries. *Jonkoping International Business School.* Retrieved from http://www.diva-portal.org/smash/get/diva2:390585/FULLTEXT01.pdf'

Balmori, H. (2003) Gender and Budgets: Overview Report, *BRIDGE (Development – Gender, University of Sussex).*

Barro, R. (1991) Economic Growth in a Cross-Section of Countries. *The Quarterly Journal of Economics, 105:2, 407-443.*

Barro, R. (1998) Human Capital and Growth in Cross Country Regressions. *Harvard University.*

Baum, C. F. (2013) *Dynamic Panel Data Estimators.* Boston College, Applied Econometrics.

Birdsall, N, D. Ross, and R. Sabot (1997) Education, Growth and Inequality: Pathways to Growth, Comparing East Asia and Latin America *John Hopkins University Press Baltimore.*

Budlender, D, D. Elson, G. Hewitt and T. Muckopadhyay (2002) Gender Budgets Make Cents: Understanding Gender Responsive Budgets, *Gender Affairs Department, Commonwealth Secretariat.*

Chen, D. C. (2004) Gender Equality and Economic Development: The Role for Information and Communication Technologies. *World Bank Knowledge for Development Program.*

Chetty, L. R. (2012) *The Role of Science and Technology in the Developing World in the 21st Century*. Retrieved March 31, 2016, from http://ieet.org/index.php/IEET/more/chetty20121003.

Cincotta, R. and R. Engelman (1997) Economies and Rapid Change: The Influence of Population Growth, *Population Action International.*

Daly, J. (2003) ICT, Gender Equality and Empowering Women, *World Summit on the Information Society.*

Desilva, S. and M. Bakhtiar (2011) Women, Schooling and Marriage in Rural Philippines, *Levy Economics Institute, Working Paper No. 701.*

Dollar, D. and R. Gatti (1999) Gender Inequality, Income and Growth: Are Good Times Good for Women? *Poverty Reduction and Economic Management Network.*

Duflo, E. (2004) The Impact of Education on Fertility and Child Mortality: Do Fathers Really Matter Less Than Mothers?, *NBER Working Paper No. 10513.*

Elson, D. (1999) Gender Budget Initiative, *Commonwealth Secretariat.*

El-Sanabary, N. (1989) Determinants of Women's Education in the Middle East and North Africa: Illustrations from Seven Countries. *World Bank: Population and Human Resources Department, Education and Employment Division.*

Esim, S. (2000) *Impact of Government Budgets on Poverty and Gender Equality*. International Centre for Research on Women, Inter-Agency Workshop on Improving the Effectiveness of Integrating Gender Into Government Budgets. London: ICRW.

Flannery, M. J. and K. W. Hankins (2012) Estimating Dynamic Panel Data in Corporate Finance. *Journal of Corporate Finance*, *19*, 1-19.

Goldin, C., L. F. Katz, and I. Kuziemko (2006) The Homecoming of American College Women: The Reversal of the College Gender Gap. *Journal of Economic Perspectives*, 133-156.

Gurumurthy, A. (2004) Gender and ICTs: Overview Report. *Institute of Development Studies, UNESCO.*

Hafkin, N. and N. Taggart (2001) Gender, Information Technology and Developing Countries: An Analytical Study. *LearnLink Project, USAID.*

Hall, A.R. (2009) Generalized Method of Moments. *University of Manchester, Oxford.*

Hamilton, H. G. (2010) *Measuring Household ICT Access and Individual Use: Jamaica's Experience.* Statistical Institute of Jamaica, Information and Technology Division. STATIN.

Herz, B. (2011) Educating Girls: What Works, *IIP Digital Publications.*

Huyer, S. and T. Sikoska (2003) Overcoming the Gender Digital Divide: Understanding ICTs and Their Potential for the Empowerment of Women, *Instraw Research Paper Series No.1*.

InfoDev. (2010) Gender Equity and the Use of ICTs in Education. In *Information and Communication Technology for Education in India and South Asia.* Price Water House Coopers.

Jayachandran, S. (2014) *The Roots of Gender Inequality in Developing Countries.* Annual Review of Economics.

Jayaweera, S. (1997) Women, Education and Empowerment in Asia, *Gender and Education, 9:4, 411-424.*

Kabeer, N. and L. Natali (2013) *Gender Equality and Economic Growth: Is There a Win-win?* Institute of Development Studies. London: Institute of Development Studies.

Klasen, S. (1999) Does Gender Inequality Reduce Growth and Development? Evidence from Cross-Country Regressions. *Policy Research Report on Gender and Development, Working Paper Series, No. 7*.

Klasen, S. (2002) Low Schooling for Girls, Slower Growth for All? Cross-Country Evidence on the Effect of Gender Inequality in Education on Econnomic Development. *The World Bank Economic Review*, *16*:3, 367.

Knowles, S., P. K. Lorgelly, and P. D. Owen (2002) *Are Educational Gender Gaps a Brake on Economic Development? Some Cross-Country Economic Evidence.* Oxford Economic Papers.

Kucuk, N. (2013) Gender Inequality in the MENA: Myth versus Facts, *Topics in Middle Eastern and African Economies, 15:2.*

Kumo, W. (2012) Infrastructure Investment and Economic Growth in South Africa: A Granger Causality Analysis, *Working Paper No. 162, African Development Bank Group.*

Lucas, R. E. (1988) On the Mechanics of Economic Development. *Journal of Monetary Economics, 22*:1, 3-42.

Maeir, S. and U. Nair-Reichart (2007) Empowering Women Through ICT-Based Business Initiatives: An Overview of Best-Practices in E-Commerce/E-Retailing Projects. *Information Technologies and International Development, 4:2.*

Maleka, L. and M. Rahab (2004) The Consequences of High Population Growth in Developing Countries: A Case Study of South Africa, *Department of Economics, University of Johannesburg.*

Mather, M. and D. Adams (2007) The Crossover in Female-Male College Enrollments Rates, *Population Reference Bureau.*

Morgan, C. (2007) Gender Budgets: An Overview, *Parliamentary Information and Research Service, Library of Parliament.*

Mumtaz, K. (2014) Reducing the Gender Gap/ Engendering. Study Commissioned under the "Support to PRSP II Formulation Project." Available at: www.finance.gov.pk/poverty/gender.pdf.

Parikh, A. and C. Stirbu (2004) Relationship Between Trade Liberalisation, Economics Growth and Trade Balance: An Econometric Investigation, *HWWA Discussion Paper No. 282.*

Pavelescu, F. (2007) Gross Capital Formation and Economic Growth in Early 2000s in EU Members and Candidate States, *Institute of National Economy.*

Periera, J. and M. Aubyn (2004) What Level of Education Matters Most for Growth? Evidence from Portugal, *Ministry of Finance, Portugal.*

Pervaiz, Z, M. I. Chani, S. A. Jan, and A. R. Chaudhary, (2011) Gender Inequality and Economic Growth: A Time Series Analysis for Pakistan. *Middle East Journal of Scientific Research, 10:4, 434-439.*

Punie, Y., D. Zinnbauer and M. Cabrera (2006) A Review of the Impact of ICT on learning. *JRC Technical Notes.*

Reinen, I. J. and T. Plomp (1997) Information Technology and Gender Equality: A Contradiction in Terminis? *ComputersEduc: Vol 28, No. 2, Elsevier Science Limited.*

Romer, P. (1986) Increasing Returns and Long Run Growth. *Journal of Political Economy, 94*:5, 1002-1037.

Romer, P. (1990) The Origins of Endogenous Growth, *Journal of Economic Perspectives, 8:1, 3-22*.

Roodman, D. (2009) Practitioner's Corner: A Note on the Theme of Too Many Instruments, *Oxford Bulletin of Economics and Statistics, 71:1*.

Sabir, M. (2002) Gender and Public Spending Education in Pakistan: A Case Study of Disaggregated Benefit Incidence. *The Pakistan Development Review, 42*:2.

Saghir, A., M. Ashfaq, and A. Noreen (2009) Gender and Information and Communication Technologies. *The Journal of Animal and Plant Sciences, 19*:2, 94-97.

Sayed, T. (2006) Secondary Education in Pakistan: Key Issues, Challenges and Reform Framework, Regional Conference on Education, Training and Knowledge Economy in South Asia.

Schultz, T. P. (2002) Why Governments Should Invest More to Educate Girls. *World Development, 30*:2, 212.

Sen, A. (1999) Development As Freedom. *New York: Anchor Books.*

Shaikh, Z. A. and S. A. Khoja (2011) Role of ICT in Shaping the Future of Pakistani Higher Education System. *The Turkish Online Journal of Educational Technology, 10:1.*

Tasli, K. (2007) A Conceptual Framework for Gender and Development Studies: From Welfare to Empowerment. *OFSE Forum, No. 32.*

UNCTAD (2014a) *Information and Communication Technologies for Inclusive Social and Economic Development*. Geneva: United Nations Conference on Trade and Development.

UNCTAD (2014b) *Empowering Women Entreprenuers through Information and Communication Technologies: A Practical Guide.* UNCTAD Current Studies on Science, Technology and Innovation. Geneva: United Nations Conference on Trade and Development.

Ulasan, B. (2012) Openness to International Trade and Economic Growth: A Cross Country Empirical Investigation. *Discussion Paper, Central Bank of Republic of Turkey.*

Vandenbussche, J., P. Aghion, and C. Meghir (2004) Growth, Distance to Frontier and Composition of Human Capital. *Journal of Economic Growth, 11:2, 97-127.*

Vu, K. M. (2014) Information and Communication Technology (ICT) and Singapore's Economic Growth. *Journal of Information Economics and Policy, 25*(4), 284-300.

Wamala, C. (2012) *Empowering Women Through ICT.* Stockholm University, The Swedish Program for ICT in Developing Regions. Stockholm: SPIDER.

Wheelar, D. (2007) Empowerment Zones? Women, Internet Cafes and Life Transformations in Egypt. *The MIT Press, 4:2.* Retrieved from http://itidjournal.org/index.php/itid/article/view/257/127.

WEF (2013) The Human Capital Report 2013. World Economic Forum, Geneva.

Wolff, N. and M. Gittleman (1993) “The Role of Education in Productivity Convergence: Does Higher. Education Matter?” In A. Szirmai, B. van Ark, and D. Pilat (eds.), Explaining Economic Growth. Amsterdam: North-Holland.

Yumusak, I. G., M. Bilen, and H. Ates (2013) The Impacts of Gender Inequality in Education on Economic Growth in Turkey. *Procedia: Social and Behavorial Sciences, 103,* 1093-1103.