The Impact of the Information and Communication Technology (ICT) on Gender Equality and Development

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ABSTRACT

The purpose of this study is to examine the impact of the information and communication technology (ICT) on gender equality and development. Especially, after the 1990s, ICT became very popular and commonly expected that it has direct and indirect impact on gender equality through different channels such as internet, computers, and mobiles etc.

Both theoretical and empirical research methods were used in this study. The empirical part of the study consists of two different applications. First, the impact of ICT on gender equality was examined in this study by using dynamic panel data analysis for 209 countries for the period from 2000 to 2010. Empirical results showed that it has positive and significant impact on gender equality. Second, we analysed the impact of gender equality and ICT on child development by using cross-country data by taking the average values of variables on 137 countries. It showed that the improvement in gender equality and access to ICTs increase the child development in these countries.

As a result, this study recommends that any improvement in ICTs lead higher-level gender equality in the societies. And simultaneous improvement in ICT and governance and institutional quality variables leads higher and beyond impact than their individual effects on gender equality, which creates higher-level child development and well equipped next generations.

Keywords: gender equality, development, information and communication technology (ICT)

ÖZ

Bu çalışmanın amacı Bilgi ve İletişim Teknolojilerinin (BİT) toplumsal cinsiyet eşitliği ve kalkınma üzerindeki etkisini incelemektir. Özellikle 1990lardan sonra BİT popular olmaya başlamış ve internet, bilgisayarlar ve cep telefonları gibi farklı araçlar sayesinde BİT'in toplumsal cinsiyet eşitliği üzerinde direk yada dolaylı etkilerinin olması beklenmektedir.

Bu çalışmada hem teorik hem de ampirik araştırma yöntemleri kullanılmıştır. Çalışmanın ampirik kısmı iki farklı uygulama içermektedir. İlk olarak, 2000-2010 yılları arasında 209 ülke için dinamik panel veri analizi kullanılarak BİT'in toplumsal cinsiyet üzerindeki etkisi incelenmiştir. Ampirik sonuçlar BİT'in toplumsal cinsiyet eşitliği üzerinde pozitif ve anlamlı bir etkisi olduğunu göstermiştir. İkinci olarak, 137 ülke için kesitli veri kullanılarak toplumsal cinsiyet eşitliği ve BİT'in çocuk gelişimi üzerindeki etkisi analiz edilmiştir. Bu çalışmanın sonuçları da toplumsal cinsiyet eşitliği ve BİT'e ulaşılabilirlikteki iyileşmelerin bu ülkelerdeki çocuk gelişimini artırdığını göstermektedir.

Sonuç olarak bu çalışma göstermiştir ki, BİT'teki iyileşmeler toplumlarda daha yüksek seviyelerde cinsiyet eşitliğine öncülük etmektedir. Ayrıca BİT ve yönetim ve kurumsal kalite değişkenlerindeki eş zamanlı iyileşmeler, daha yüksek seviyede çocuk gelişimi ve iyi donanımlı yeni nesiller de oluşmasına sebep olan toplumsal cinsiyet eşitliği üzerinde bunların tek başlarına olan etkilerinden daha yüksek ve ileri bir etkiye sebep olmaktadır.

Anahtar Kelimeler: toplumsal cinsiyet eşitliği, kalkınma, bilgi ve iletişim teknolojileri (BIT)

To My Son, Balkı

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LIST OF ABREVIATIONS

AGDI	African Gender and Development Index
AWPS	The African Women's Progress Scoreboard
BECTA	British Educational Communications and Technology Agency
CDI	Child Development Index
DAI	Digital Access Index
DAW	United Nations Division for the Advancement of Women
DOI	Digital Opportunity Index
EDEP	Equally Distributed Equivalent Percentage
ESCWA	United Nations Economic and Social Commission for Western Asia
EUROSTAT	Statistical Office of the European Communities
GDI	Gender Related Development Index
GDP	Gross Domestic Product
GEM	Gender Empowerment Measure
GER	Gross Enrolment Ratio
GGG	Global Gender Gap Index
GNP	Gross National Product
GSI	African Gender Status Index
HDI	Human Development Index
ICT	Information and Communication Technology
ICT-OI	ICT Opportunity Index
IDI	ICT Development Index
ITU	International Telecommunication Union
OECD	Organization for Economic Cooperation and Development

PPP	Purchasing Power Parity
RSW	Relative Status of Women
SIGE	Standardized Index of Gender Equality
SIGI	Social Institutions and Gender Index
UNICEF	United Nations International Children's Emergency Fund
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNCTAD	United Nations Conference on Trade and Development

Chapter 1

INTRODUCTION

The main aim of this study is to examine the relationship between information and communication technology (ICT) and gender inequality. In 2000, United Nations declared its third goal as promoting gender equality and empower women. Therefore, before analyzing its link to development, we should understand the concept of gender equality and discuss its importance and outcomes for the societies. Chapter 1 explains all these and different measurement methods of gender equality. First of all, we should know that the social equality between men and women is a human right for all. Then, additionally, we can say that gender equality is a milestone of development process of the countries. Because, we expect that equality between women and men may increase labor force participation rate of females to the markets, then in turn it will lead higher-level economic development for the countries. At this point, we are expecting that ICT can be used as a tool to empower women through different channels as directly or indirectly by providing different opportunities for the women, such as distance education, health services, new job opportunities etc. Chapter 2 discusses the outcomes of technology in general and different measures of ICT. However, in the literature, there were different views and approaches to the outcomes of ICT on gender equality as we discussed in chapter 3. Therefore, at Chapter 4, we first examined the impact of ICT on gender equality in education and gender equality in employment by using dynamic panel regression with country fixed effect with Arelona Bond System Generalized Method of Moments and we found that there is significant positive relationship between ICT

and gender equality in education and employment. In the light of these emprical results, we tried to analyze the outcome of gender equality on child development, which is a dimension of overall development of countries. The following goal of United Nations, after its third goal, was to reduce child mortality and improve maternal health. In addition to take well child development into account as children's right, it also effects future economic development of societies with better psychological and physical health, and higher level education, then, in turn, more qualified labor force and participation rate in the future. From this economic point of view, we analyzed if gender equality is really effects child development with better access to ICTs and improved institutional quality by using indexes to cover more than one dimension of gender equality and child development. More detailed information and empirical results regarding this research are discussed in Chapter 5. However, we first have a closer look at the main concepts regarding the gender equality to understand the importance of this study.

1.1. Basics Concepts of Gender Inequality

The main objective considered by this study is to examine the relationship between gender inequality and information communication technology (ICT). Firstly, we should try to understand the concept of the inequality. The measurement of the inequality by gender in the labour force has long been of interest to both sociologists and economists. UNESCO (2000) identifies equity and inequality in different ways. According to the UNESCO: "Equality between men and women entails the concept that all human beings, both men and women, are free to develop their personal abilities and make choices without the limitations set by stereotypes, rigid gender roles and prejudices ... Gender equity means fairness of treatment for women and men, according to their respective needs. This may include equal treatment or

treatment that is different but which is considered equivalent in terms of rights, benefits, obligations and opportunities." (UNESCO, 2000, p. 5).

On the other hand, Magno and Silova (2007) gave the example of all students who should take "same interventions at the same time in the same way while their preferred option ,gender equity, implies the guarantee of fair educational outcomes, regardless of sex differences" (p.649). In this thesis, the concepts of equity and equality will be used equivalently, because, even in the case of well defined rights and obligations by law, equity will not bring equality. Generally, most countries and international organizations define the rights by the laws. However, there is still a broken link in applying these laws because of beliefs, cultures, stereotypes and etc. Therefore, we can define gender inequality as "obvious" or "hidden" disparity among individuals due to gender[1]. In simple terms, this is known as gender bias, gender stratification, gender gap, or differences in terms of legal, economic and the social rights between the females and the males.

Gender equality has very important impact on economic development. In the Fourth World Conference, United Nations met officially on 4-15 September 1995 in Beijing under the name of "The Fourth World Conference on Women: Action for Equality, Development and Peace". The documents of this conference were defined as The Beijing Declaration and Platform for Action (BPfA). There, it was declared that:
"The advancement of women and the achievement of equality between women and men are a matter of human rights and a condition for social justice and should not be seen in isolation as a women's issue. They are the only way to build a sustainable,

[1] en.wikipedia.org/wiki/Gender_inequality

[2] Functionings are valuable activities such as eating, starving, having healthy body, good job, and

just and developed society. Empowerment of women and equality between women and men are prerequisites for achieving political, social, economic, cultural and environmental security among all peoples." (UN, BPfA, p.16)

According to World Bank (2003), gender inequality and disparities between males and females have serious cost implications and these are negatively effecting the human and economic development. According to the European Union (EU, 2009) report on equality between men and women, the participation of women in the labour market is the main chain of the sustainable growth for the European Union countries; however, it seems that they are still seems as victims of discrimination and socio cultural barriers. Therefore, the promotions of gender equality and empowerment for the women have been determined as one of United Nation's Millennium Development Goals for the target years 2015.

Women in much of the world still have fewer opportunities than men to enjoy an accomplished life, and to make full use of their capabilities and societies' resources. Dudu (2008) states that "Compared to the men, they are less well nourished, and less healthy, more vulnerable to physical violence, less literate, faced with greater obstacles in economic and political life, and have fewer or no choices in marital decisions"(p.3). On the other hand, UNDP's Human Development Report of 1999 indicates that there is no country in the world which women have equal capabilities as men. According to the UN gender thematic review written in 2003,

- Two thirds of people in the world who cannot read are female,
- Nearly seventy percent of the world's poorest people are female,
- Women represent a growing proportion of people living with HIV/AIDS,

- In only 16 countries in the world is women's representation in national parliaments above 25 percent,
- Women's contributions to the global economy are growing rapidly but their labour remains undervalued and undercounted in national accounts,
- An estimated one-quarter to one half of all women have suffered physical abuse.

Also according to World Bank, "Societies that discriminate on the basis of gender pay the cost of greater poverty, slower economic growth, weaker governance, and a lower living standard of their people" (World Bank, 2001). In short, women are faced in life with "unequal human capabilities" (Nussbaum, 2002, p. 46). Amartya Sen, who is the Nobel Prize winner of the 1998 in the field of economics, gives main theoretical framework on gender discrimination by developing "capability approach". According to the Sen's approach, focusing on what women is able to be or do something is much more important than focusing on what she can consume or the income she receives (Sen, 2001, 2005). He criticizes utility based evaluation of individual's well being and asserts that functioning and capability[2] gives much more wide view rather than money while analyzing human development and well being. Because, neoclassical approach ignores dynamics and outcomes within the family, and intra-family distribution of income while taking income as overall welfare of persons and utility as people's psychological happiness or satisfaction (Hicks,2002; Sen, 2005).

[2] Functionings are valuable activities such as eating, starving, having healthy body, good job, and fasting (Sen, 2001; Hicks,2002). Capability consists of both functioning and real freedoms (opportunity freedoms) to pursue different functioning combinations. Robeyns (2003) identifies the list of capabilities at ideal level for gender equality as life and physical health, mental well being, bodily integrity and safety, social relations, political environment, education and knowledge, domestic work and non market care, paid work and other projects, shelter and environment, mobility, leisure activities, time autonomy, respect, and religion.

Although there are number of types[3] of gender inequality (Anand and Sen, 1995; Sen, 2001), in this study, we will classify gender inequality into four types, which were most commonly referred in the literature. First one is the material equality. Material equality does not mean that female and male will become the same but rights, responsibilities and opportunities of men or women do not depend on whether they are born as male or female. Material equality exists because humans are believed to be equal (Lisaniler, 2003, p.4). Second is equal opportunity, which follows the material equality and it includes equality on rewards, human capital access, and other productive resources for work, which enable opportunity (World Bank, 2001). Even if the women have some differences in the terms of biological capacities, it should not create any socially constructed disadvantages for women relative to men. Everyone should have same rights to enter important social establishment within the border of universal principles. Third are equal conditions. To provide the equal opportunity, all people should have the equal conditions. Both equal opportunity and equal conditions move in parallel direction. An example of equal condition is the race, which implies that all humans start from the same point under the same circumstances. Subrahmanian (2003) uses "equal treatment" instead of equal conditions in her article. The last and fourth is the equal outcome, which means mechanism turning the inequalities into social equalities. It can be define as the substantive equality as well. It requires the recognition of the ways in which women are different from men (Subrahmanian, 2003). When the ways are known, it is easy to eliminate these barriers, such as norms and stereotypes shaped by the society, which reinforce inequalities between men and women in distribution of

[3] For instance, Sen (2001) defined seven types of gender inequality which are mortality inequality, natality inequality, basic facility inequality, special opportunity inequality, professional inequality, ownership inequality, and household inequality.

resources. The World Bank (2001) states that gender equality as "equality of opportunity" and "equality of voice" includes the ability to influence and contribute to development process. Therefore, The World Bank does not consider equality as the equality of outcomes. There are two reasons for not defining equality as the equality of outcomes. The first reason for this is that countries have different cultures from each other and determine the path gender equality in a different ways. The second reason is about the roles chosen by women or men. Because, they are free to choose different roles and outcome in accordance with preferences and goals.

1.2. Factors Effecting Gender Inequality

Economists explain the gender inequality with "human capital theory", which covers the major supply side explanation for gender differentials in economic outcomes. Human capital refers to the education, knowledge, ability, skill, training or experience of a person to produce economic value. Because of these reasons, individuals invest in human capital to increase their productivity and future earnings (Blau et al., 2001). Formal education and training on job are most well known examples of investment in human capital.

1.2.1. Gender Differences in Education

The World Bank (2008) emphasizes the importance of gender equality on education as follows: "Research conducted in a variety of countries and regions has established that educating girls is one of the most cost-effective ways of spurring development. Female education creates powerful poverty-reducing synergies and yields enormous intergenerational gains. It is positively correlated with increased economic productivity, more robust labour markets, higher earnings, and improved societal health and well-being" (p.xvii).

Gender equality and the empowerment is the third goal of the Millennium Development Goals whose deadline is 2015. However, the universal education, the second goal of the Millennium Development Goals, is the key factor to reach to third goal. Therefore, we can argue that education is the main component of growth and development to increase the productive capacity and to absorb modern technology. Klasen (2002) studied how gender inequality in education affects long-term economic growth by using cross-country panel regression and showed that gender inequality in education directly effects the long term economic growth by lowering the average level of human capital.

The European Commission study (2010) examined how gender inequality in education is addressed in 29 European countries and showed that gender differences keeps its persistancy in choice of study and outcomes. According to this study, girls are getting higher grades and higher pass rates from examinations than boys and boys are more likely drop out of school or repeat school years. And also, this international survey shows that girls are not good at in mathematics while dominate in humanities and arts, education, health and welfare, whereas boys are not good at reading while dominate in construction, manufacturing and engineering. However, according to the results of a World Bank study conducted in 2008, gender differences in mathematics are not related to abilities but rather to the fact that boys show more interest, engagement, and motivation in mathematics, while girls show greater anxiety about mathematics.

Another important factor in gender differences in academic achievement is that boys are encouraged by parents at home and teachers at school to take math and science courses (Gelles and Levine, 1999). A research supporting this perception is done by

Baker and Jones (1993) based on cross cultural study and found that there are smaller gender differences in mathematical performance in school, if the women have approaching equal access to higher education and the job market.

According to UNICEF (2009) findings, there are some 101 million children who are not in school and most of them are girls. The Statistics in 2008 of The World Bank mention that worldwide, 55% of all out of school children are girls. Literacy ratio shows the measure of women's access to minimum level of education, which is an important determinant of gender equality and women's ability to participate in economic life. UNICEF also noted that there are important regional differences; South Asia and West and Central Africa has the largest gender gaps at the primary level and secondary level of education. School attendance and completion are also related to gender inequalities and gap is often large in rural areas. The report by UNDP (2005) showed that in rural Pakistan, rural-urban gap in school attendance is 27% while the gap between rural girls and urban boys is 47%.

1.2.1.1. Social Discrimination in Education Relating to Gender

One of the most important factors effecting gender differences in education is social discrimination. Especially in rural areas, men are predominant within the society over women. Family, friends, teachers and communication devices can shape the behaviour and the attitudes as well. For example, if women want to enter to the educational field that generally occupied by men, she will be pressured by family, friends, and teachers not to do. One of the other constraints to female education is the safety. For example, if the school has long distance to home, parents may not prefer to send their daughter to the school due to safety concerns. Also, the poor parents may force their daughters to marry in early ages for economic reasons. As a

result, educational inefficiency creates occupational and wage discrimination against women in the future.

1.2.1.2. Opportunity Cost of Education

From the economical point of view, education is one type of the human capital investments. However, when people invest in education, there are direct and indirect costs to people such as school fees, books, etc. Because of these costs, especially the families with many children, poverty becomes the main factor behind the gender gap in education. If a family can afford school fees for one of their children, their priority will be sons. If someone needs to do household work, care for younger sisters or brothers or sick household members instead of going to school, girls are chosen. This shows that an increase in the time spent at home for these purposes is decreasing the educational investment decisions as well as the labour participation. A supporting empirical study by Stromquist (1988) on educational achievement of women in developing countries and its determinants suggest that economic conditions of the family are more important than the school related variables such as distance of school from house, existence of facilities etc. This study also emphasizes that cultural and religious factors affect both girl's enrolment and length of school, but, religion is neutral, if parents have high income and education level.

1.2.1.3. Why Education for the Women

There are reasons why the studies should focus on the impact of educating girls. First reason is based on the human capital argument. If the people invest more in education, the rate of return will be higher due to higher human capital accumulation. On this point, Haddad et. al (1990) carried an empirical study which shows higher rate of return due to education of women as compared to men in developing countries. Nowadays, it is easily can be seen that, industrialized countries reached

their current positions with large number of educated and trained labour with the high rate of physical capital accumulation.

Second reason is due to social role of women in the society. Increasing women's education does not only increase their economic productivity but also leads to increased labour force participation, lower fertility rates, later age of marriage, and better child health and nutrition. Total fertility rate shows the average number of births per women and is commonly used as a proxy for obstacles against women's entry into the labour market. King (1990) found a positive correlation between primary enrolment rates of girls and gross national product (GNP) per capita as well as life expectancy and a negative relationship between primary enrolment rates of girls and infant mortality rates and fertility rates. Another study by Blumberg (1989) concluded that education of a mother has more effect than father's on lowering infant mortality and improving family health.

Under the light of the findings in the above literature, The World Bank (2008) summarizes six desirable reasons of closing gender gap on education by widening opportunities for women on education as below:

1. Reducing women's fertility rate; one year of female schooling reduces fertility rate of women by 10% and women with formal education have healthier babies than women without it,
2. Lowering infant and child mortality rate; women with formal education are taking medical care in the case of any sickness and better informed about child care,

3. Lowering material mortality rate; it is estimated that an additional year of schooling for 1000 women helps prevent two maternal deaths. Also formally educated women prefer to have fewer pregnancy and better care during pregnancy,
4. Protecting against HIV infection; due to having family planning and having well information about diseases and how to prevent it HIV infection rate for educated women is much lower,
5. Increasing labour force participation rates and earnings; literature proved that education significantly increases income and productivity,
6. Creating intergenerational education benefits; mother's education significantly effects children's educations.

Under these circumstances, we can argue that low-level investment rates on girl's education mean waste of human and economic potential. The barriers, which keep the girls out of school, are well known. Therefore, it can be helpful to find effective policies to alleviate the barriers on girl's education and provide educational benefits on access, quality and completion.

1.2.2. Occupational Segregation

It is easy to understand the occupational segregation by examining the distribution of occupations between men and women. Men predominate in managerial, administrative and executive positions, blue colour crafts, certain kinds of manufacturing work, construction and transportation. Women, on the other hand, dominate in clerical jobs like secretary, book keeper and also in nursing, teaching, child caring and private household cleaning. This type of segregation can be defined as "horizontal segregation". In addition to unequal distribution among the

occupations, men and women are also employed in different positions within the occupations. These different hierarchies within the occupations are refered as "vertical segregation". According to the Blackburn et al. (2001), vertical dimension is the direct measure of gender inequality within the occupations, but horizontal dimensions measures the difference without inequality. They identified the Gini coefficient as overall gender segregation and studied on comparative work for different countries such as Sweeden, Canada, and the UK. Their results show that there is a positive relationship between level of segregation and human development and gender equality scores on UN measures.

On the other hand Allmond and Rubery (1998) pointed out that some developed countries such as the USA, which has low level occupational segregation, also have high inequality level by sex such as gender pay gap. The reasons of these different results are due to the two components of the occupational segregation which are vertical and horizontal.

In the literature, occupational segregation is usually explained by the demand and supply side approaches. According to the supply side explanations, preferences for job are playing very important role in occupational decisions. Women may prefer occupations which has more flexible work hours, and which are most consistent with social interest and less consistent with conventional interest due to social discrimination. The male dominance of some fields can itself discourage women from entering to these fields as well. The demand side explanation for the occupational segregation argues that employers may prefer to hire male rather than female for specific occupations. Because of the specific job requirements such as working experience, education,and training. The employer's perception that women

are on average less qualified than men may also contribute to segregation (Dolado et al., 2002).

Miller (1987) measured the wage effect due to the occupational segregation in one of his studies and found that around six-tenth of wage gap can be assigned to differences in wage related characteristics and remaining part to discrimination or preferences of women and men.

Stereotypes, social and biological differences can be seen as the reasons of occupational segregation between genders. Occupational segregation has several negative impacts on the labour market. First, it may prevent the adjustment of economy in the face of shocks having impact on labour demand because of the difficulties to access resources and market rigidity caused by occupational segregation. Second, it leads to idle human resources. For example, in vertical segregation, low level wage reward for women compared to men will create job un-satisfaction and because of this, women may be motivated to find another job or work at home in such a discouraging cases. Lyness and Heilman (2006) studied with 448 upper level employees and found that if women were promoted, they had better performance rates than men, but they were less promoted when compared to men. They also found that performance ratings are strongly related to promotions for women than men. Last, occupational segregation may result in economic and social inefficiencies such as unequal wealth distribution, poverty, etc.

1.2.3. Gender Stereotypes

Stereotypes can be defined as generalized beliefs about individuals or a social group within the society[4]. For instance, the common belief within the society is that men are more likely to be perceived as competitive and aggressive, while women are more likely to be viewed as cooperative and passive and they dislike to supervise, have less physical strength, have less willingness to travel, less ability in science and math etc. Many advertisements show mothers serving meals to their families but very few show fathers doing this. Traditionally, men work in the outside of the family as a breadwinner and enjoyed higher status, on the other hand, women work within the family as a homemaker and take the responsibility for home and children. Even if women work outside of the home, she may face a problem of double burden and men do not show any tendency to share in household work (Blau et al., 2001). Because of these stereotypes, women are perceived as disqualified for some occupations. Men, generally, have been viewed as head of the family and breadwinner, therefore, jobs and occupations held by men have been viewed as economically more valuable and they get higher wages (Massey, 2007). Bridges and Nelson (1989) also found that women employees are disadvantaged due to having fewer representatives in pay setting process and also they are viewed as passive and ineffective as stereotypically. Ridgeway (1997) also classify the effects of stereotyping from the perspective of employment inequality in goal orientation into three concepts. The first effect is that, all other things being equal, it causes expectation of greater skills and effort from men than women. These expectations also shapes the men's and women's self confidence, their judgements, and performance in the workplace. Second, it effects expectations for rewards. For example, if men think that he is superior within the

[4] en.wikipedia.org/wiki/Stereotype

organization due to some stereotyping beliefs, then, even if men and women are placed on same reward level, men can feel that he is in lower level, and react negatively. Last, women may face challenges to change the expectations about them.

1.2.4. Wage Differential

Another indicator, which shows the status of women in the labour market, is the wage differential. This is also refered as the gender wage gap, gender earnings gap, or gender pay gap. In a report written by The Council of Economic Advisers of White House(1998), the gender wage inequality is defined as follows:

"The evidence is that labor market discrimination against women persists, although it is difficult to determine precisely how much of the difference in female/male pay is due to discrimination and how much is due to differences in choices or preferences between women and men. One indirect and rough measure of the extent of discrimination remaining in the labor market is the "unexplained" difference in pay. Some studies have tried to measure discrimination directly by looking at pay differences among men and women in very similar jobs or by comparing pay to specific measures of productivity. These studies consistently find evidence of ongoing discrimination in the labor market and support the conclusion that women still face differential treatment on the job."

Most studies on the wage differential explaine wage differences between males and females by productivity related characteristics, such as experience, skills, educations, etc. However, these characteristics do not fully explain the wage gap. The unexplained part of the wage gap, the residual, refers the discrimination within the gender (Greenhalgh, 1980; Oaxaca, 1973). Oaxaca (1973) used two components in

his methodology to explain the wage gap between males and females. One of the components shows the differences due to observable characteristics of male and female and another is a measure of discrimination. A similar study by Blinder (1973), which has a similar analysis to Oaxaca (1973), and Deutsch and Silber (2003) proposed a method to decompose wage inequality due to differences in rates of return, human capital, and unobservable characteristics.

Human capital such as education and experience in labour market is often used as the most important proxy to determine of wages. An OECD study (2010a) expressed that women are paid almost a fifth less than men and pay gap is varies substantially. According to this report, there is a 30% wage gap between males and females in Japan and Korea. This means that women earn 30% less than men. The same study reports that wage gap in Belgium and New Zealand is 10%, and 20% in Britain. The report also reveals that 62% of women are in paid work, but spends twice as much time doing unpaid work compared to men.

The type of tasks realted to job has significant impact on gender pay gap (Hersch, 1991). The employer's preference and cultural factors do also relate to the gender pay gap. Hersch and Stratton (1997) investigated the impact of housework on wage gap using panel data and found that even the individual fixed effects are controlled for, increase in hours devoted to housework decreases an hourly wage rates. According to the Becker (1985), the gender pay gap due to productivity differences arises from women's responsibilities at home. This can be linked to the opportunity cost of having children. When women have children, they make choices to sacrifice their careers and these results in lower productivity, which leads to lower wages for women. This choice also effects the employee's decisions. According to the Petersen

and Morgan (1995), there are two reasons for gender pay gap as allocation of workers across job categories, and how reward system should be different for female dominated and male dominated jobs. Another study on the relationship between earnings and gender role by Judge and Livingston (2008), which focused more on the interaction between gender role orientation (beliefs about the roles for men and women at home and at work) and gender earnings rather than focusing on gender wage gap, showed that gender wage gap cannot fully be explained through economic factors, such as experience, skills, etc. But some differences can be explained through the psychological components and attitudes. Judge and Livingston (2008) found that traditional gender roles are strongly related to earnings, which means that negative association between gender role orientation and earnings for females will lead to lower wages for them. Although beliefs about gender roles become less traditional for men and women, traditional gender role orientation still continues to reinforce the gender wage gap. In summary, from the implications of the studies discussed above, we can infer that there is a strong relation between gender equality and economic growth, directly or indirectly. Figure 1 (World Bank, 2007) explaines the results of women's equality in households, markets and society. Increased equality in the end leads to poverty reduction and boosts economic development.

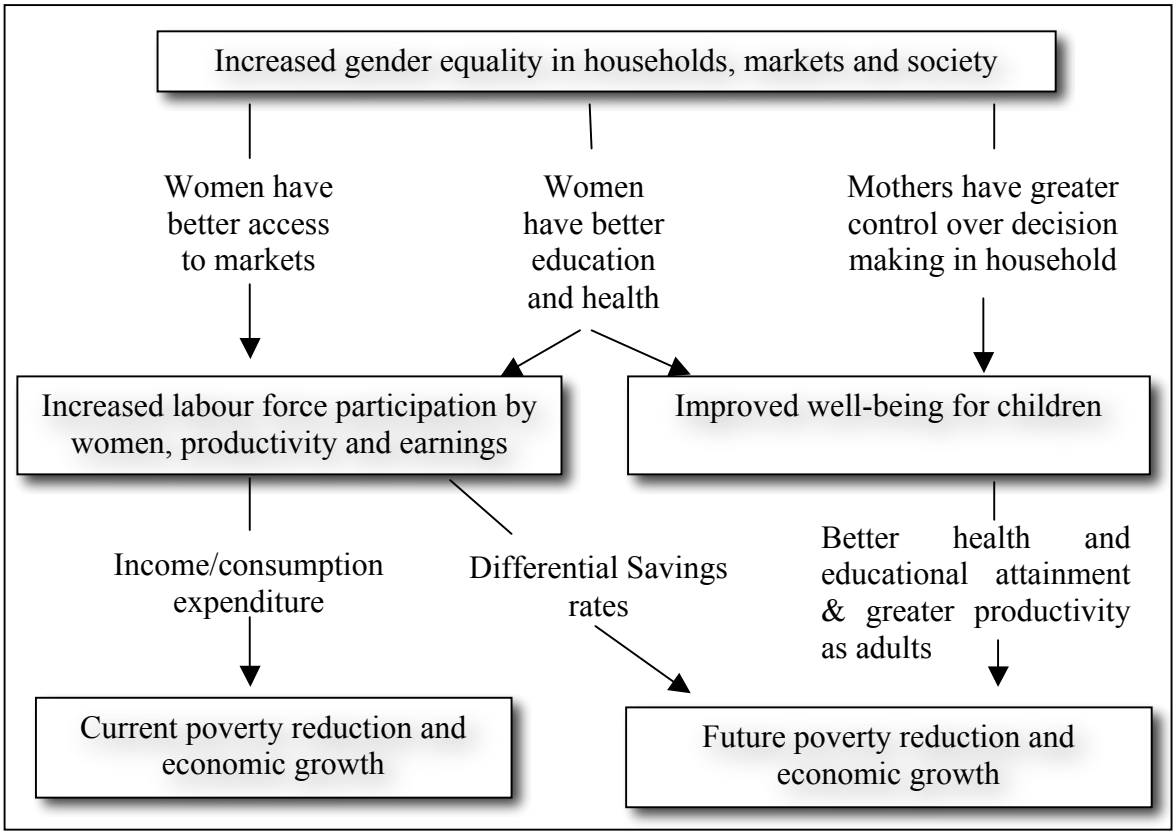

Figure 1: Women's earnings, children's well-being and aggreagate poverty reduction and economic growth
(Source: WB Global monitoring report(2007, p.109)

1.3. Measures of Gender Inequality

Measurement of different types of gender inequality and its various effects at the cross country level become a very important subject for making comparisons across countries and determining efficient political agendas against this socioeconomic development problem. Several indexes of gender inequality to capture different inequality dimensions are developed in the literature over the years. Each of these indexes have their advantages and disadvantages. Their coverage and availability whereas across countries. In this section, we examine commonly used gender inequality indexes and compare their coverage dimension, method of calculation, number of coountries they cover. We also list pros and cons of these indexes.

1.3.1. Gender Related Development Index and Gender Empowerment Measure

Gender Related Development index (GDI) and Gender Empowerment Measure (GEM) developed by United Nations in 1995[5] are the most popular indexes in the literature. GDI is calculated for 130 countries and based on i) the life expectancy at birth, ii) education including the adult literacy rate and the combined primary to tertiary gross enrollment ratios, and iii) estimated earned income. GDI is calculated separately for each of these three areas and takes values between 0 and 1, where zero means that gender equality is totally lacking in the society, and one means that there is full gender equality. GDI is designed to measure the standard of living inequalities between men and women. In order to calculate the GDI, first, female and male indices in each dimension[6] are calculated as follows:

$$\text{Dimension\_index}=\frac{\text{Actual-Minimum}}{\text{Maximum-Minimum}} \tag{1.1}$$

Second, using the dimension index calculated from (1.1), the equally distributed indexes for each dimension are obtained from the following formula:

$$X_{ede}=\left(s_f X_f^{1-\varepsilon}+s_m X_m^{1-\varepsilon}\right)^{1/1-\varepsilon} \tag{1.2}$$

where s_f and s_m are the respective shares of female and male in the population, X_f and X_m are dimension indices for female and male and ε measures the aversion to inequality which is defined as marginal social valuation of achievement (UNDP, 1995, p. 128). In calculation of GDI, ε is taken as equal to 2, which gives the

[5] For more information on these indexes see http://hdr.undp.org/en/media/hdr_1995_en_chap3.pdf

[6] The UN uses different life expectancy for males and females. For the females, life expectancy at birth is taken as maximum 87.5 years and minimum 27.5 years and it is assumed that females live 5 years longer than males. The maximum value of education dimension is taken as 100 and the minimum value is taken as 0. A value of $40000 is taken as the maximum value of estimated earned income while $100 is taken as the minimum value.

harmonic mean of the two indices. If ε takes a value of 0, the value taken by GDI will be the same as the value obtain from Human Development Index (HDI) formula. Last, the overall index is calculated by taking the unweighted average of three equally distributed indices.

Another index, also developed by UNDP for 116 countries, is Gender Empowerment Measure (GEM). GEM measures inequalities between men and women based on i) political participation and decision making, ii) economic participation and, iii) power over economic resources. There are two subcomponents of each variable in GEM, which are i) legislators, senior officials, managers, and ii) professional and technical positions. GEM is calculated as unweighted average of the three main categories with equally distributed equivalent percentages (EDEP). According to the results reported in UNDP (2009), Sweden, Norway, and Finland are the first three best countries on the ranking of the gender empowerment measure among 109 countries or areas.[7] GEM focuses on the use of these capabilities while GDI focuses on the expansion of capabilities between men and women. According to the UNDP (1995) "GDI is always lower than the HDI" (p.75), because GDI adjusts HDI for gender inequality and should always be lower when gender inequality measure is above zero. This result indeed is due to the methodology used in calculations of GDI and HDI.

Wach and Reeves (2000) make an interesting comparisons between developed and developing countries and show that "higher GDP does not guarantee gender

[7] See http://hdr.undp.org/en/media/HDR_2009_EN_Table_K.pdf for more information about components of GEM and rankings of countries.

equality" (p. 4). In their comparisons of GEM, GDI and HDI ranks with gross domestic product (GDP), for example, although Japan is richer than Mexico, Mexico is better especially in terms of its GEM ranking[8]. Another method suggested by UN to measure gender inequality is calculated as (HDI-GDI)/HDI, which is a measure of gender gap as a percentage of HDI. Since HDI and GDI will differ when there is gender gap, the value of this index will take larger values as the gender gap increases and it will be zero when there is no gender inequality.

Table 1 compares the computation methods and features of GDI and GEM as defined in the Human Development Report of 2009. The overall GDI and GEM are calculated as simple arithmetic average of three components used. For the life expectancy indicator used in GDI, UNDP made the assumption that women live five years longer than men. This assumption criticized in literature by several authors (Dijkstra, 2002; Klasen, 2006; Schuler, 2006). A second assumption in calculating GDI and GEM is made about the income component, for which the UNDP bases shares of female's and male's earned income on urban wages and female share in economically active population.

[8] Wach and Reeves (2000) used the real GDP per capita and converted them into PPP dollars for comparison. Purchasing power parity (PPP) is defined as the number of country's currency required purchasing same basket of goods and services as in the US. In Wach and Reeves (2000), the value of real GDP per capita in Mexico was 7,300 and its GEM ranking was 31, while the real GDP per capita in Japan was 20,520 and its GEM raking was 34.

Table 1. The comparison of GDI and GEM

MEASURE	INDICATORS	SUBINDICATORS	SUBINDEXES	DIMENSION INDEX (harmonic mean of population weighted shares of males and females)	OVERAL INDEX (simple arithmetic average of three scores)
GDI	life expectancy at birth	female life expectancy at birth male life expectancy at birth	female life expectancy index male life expectancy index	equally distributed life expectancy index	Gender Development Index (GDI)
	knowledge (education)	female adult literacy rate female GER[a]	female education index	equally distributed education index	
		male edult literacy rate male GER[a]	male education index		
	standard of living (share in earned income, percent, adjusted)	female estimated earned income male estimated earned income	female income index male income index	equally distributed income index	
GEM	political participation and decision making (share in parliament, percent)	female shares of parliamentary seats male shares of parliamentary seats		equally distributed equivalent percentage (EDEP) for parliamentary representation	Gender Empowernment Measure (GEM)
	economic participation and decision making	female and male shares in administrative and management positions female and male shares in technical and professional positions		EDEP for economic participation	
	power over economic resources (share in earned income, percent)	female and male estimated earned income		EDEP for income	

Source: UNDP (2009), p. 208.

[a] Gross Enrolment Ratio

GEM and GDI are criticized for several reasons. First, both GDI and GEM do not measure gender inequality since they are based on harmonic mean of shares when calculating dimension indexes (Anand and Sen, 1995; Dijkstra, 2002; Permanyer, 2010). The GDI is an index that measures the corrected overall development levels of a country against the existing gender inequalities. On the other hand, GEM measures the degrees to which women have decision-making power and access to the resources. Second, equal weights are given to each component for calculating the indexes. However, each component may not equally affect different group of sexes across the countries. The women may have advantage on all components in one country, while all components can be disadvantage for the women in some other country. Third, a limitation of these indexes is relates to choice of the various indicators. Because of social, cultural and economic reasons, choice of indicator over the other one can create important differences for ranking of countries. For instance, the earned income component shows the earning power of family members but not the distribution of income within the family, between men and women, and it can be different across the cultures.

Both GDI and GEM use the same method in calculating the earned income component. The only difference for this component, but the GDI uses the adjusted income per capita by taking the logarithmic transformation of the component while GEM uses the unadjusted income per capita, which is defined as

$$Y_f = \frac{s_f(Y)}{N_f} \tag{1.3}$$

where s_f is the female share of wage bill, Y is the GDP (PPP US$), and N_f is the female population. Female share in earned income, s_f , is defined as

$$s_f = \frac{\left(w_f / w_m\right) \times EA_f}{\left[\left(w_f / w_m\right) \times EA_f\right] + EA_m} \tag{1.4}$$

where $\left(w_f / w_m\right)$ is the ratio of female to male non-agricultural wage, EA_f and EA_m are the female and male percentage shares in economically active population aged 15 and above, respectively. The definition of economically active population may vary across countries or regions within the same country (Dijkstra, 2002). In the UNDP (1995) report, the wage ratio is computed as 75% for 55 countries, but this ratio has been used for all 130 countries due to the lack of data (p. 130). Both GEM and GDI indices use the female over male urban wage ratio calculated over the economically active population. Therefore, only the urban wage has taken into account and the effect of rural wages or women working in rural areas are ignored. This will result in both low GDI and GEM measures, especially in agricultural countries. There is also an analogous problem on choice of indicators is female share in parliamentary seats. Dijkstra (2002) gives former socialist countries as an example of less relevance of female share in the parliamentary seats indicator used in calculation of GEM. In these countries, "this share tended to be high, but parliaments did not have much power" (Dijkstra, 2002, p. 306).

A fourth criticism is that UNDP assumes that the life expectancy of women, one of the five indicators, is assumed to be, on average, 5 years longer than men. However, in addition to mortality rates, health risks of women should be taken into account as well, especially for poor countries.

In summary, although both indexes measure different dimensions of gender inequality, they do not measure dimensions such as son preference, domestic violence against women, early marriage, missing women, position both in the family and public life etc... Therefore, results heavily depend on the indicators used to measure the gender inequality.

1.3.2. Relative Status of Women (RSW)

As pointed out by several authors, there are some critics which we discuss above, about calculations and the conclusions of GDI and GEM from both the theoretical and practical point of view. Dijkstra and Hanmer (2000) defined a new alternative index known as, Relative Status of Women, which focuses on the comparisons of the achievement levels between women and men based on the HDI indicators. The index is defined as

$$RSW = \frac{1}{3}\left(\frac{E_f}{E_m} + \frac{L_f}{L_m} + \frac{w_f^*}{w_m^*} \right) \tag{1.5}$$

where E_f and E_m are female and male education attainment index, respectively, L_f and L_m female and male life expectancy index, respectively, w_f^* and w_m^* female and male rates of return to labour, respectively. If there is exact equality between men and women, RSW will be equal to 1. If RSW>1, there is men while there is discrimination against women when RSW<1. As it is seen from equation (1.5), RSW is not subject to the same critics directed towards in the GDI which considers only the absolute levels of achievement. RSW takes into account both absolute and relative achievements levels together. RSW is based on the same indicators used in GDI, however, the rankings of countries by RSW differs from the rankings given by the GDI. This result explains the one of the main criticisms directed against the calculation methodology of GDI. Moreover, unlike GDI, RSW shows weak

correlation with per capita income. Therefore, the authors state that this is due to the fact that RSW gives an idea "about a country's development level that is not captured by per capita income" (Dijkstra and Hanmer, 2000, p. 63).

RSW is the simplest gender inequality index developed in the literature, which is easy to calculate and the first alternative index developed against criticisms of the GDI. On the other hand, RSW has some drawbacks as well. RSW is based on arithmetic mean of ratios and both additive and multiplicative functions are used jointly. Beneria and Permanyer (2010), and Permanyer (2010) argue that RSW will not give desirable result in the case of symmetric distribution. If the distribution is symmetric, there should be no discrimination against men or against women. However, RSW may be is greater than 1 even if the distribution is symmetric, which implies that the men is discriminated against. Beneria and Permanyer(2010) gives an example to explain this situation. Assume that $E_f = 1,\ E_m = 0.7$ (women are better in education), $L_f = L_m,\ w_f^* = 0.7,\ w_m^* = 1$ (men are better in rates of return to labour) and the distribution is perfectly symmetric. In this case, RSW takes a value of 1.043, which implies that there is discrimination against men. As a result, they stated that this problem relating to RSW arises because of "mix of an additive function with a multiplicative one" (p. 380). RSW uses additive function to calculatte the average across dimensions and multiplicative function for measuring the gender inequalities within dimensions. Therefore, it can give some undesirable and inconsistent results in the case of symmetric distribution.

1.3.3. Standardized Index of Gender Equality (SIGE)

In order to remedy theoretical and methodological weaknesses of GDI and GEM, Dijkstra (2002) developed a new index, which is called standardized index of gender equality (SIGE). Dijkstra (2002) suggests measuring inequality by using four factors

(culture, power, access to social assets, and access to economic assets) with eight dimensions (gender identity, autonomy of the body, autonomy within the household, political power, social resources, material resources, employment, and income and time). The author uses the standardized values of different variables to avoid the overweighting problem. However, the overall SIGE index is constructed after eliminating some variables that move in the same direction. Then the number of variables are reduced and combined into five categories; education, health, labour market participation, shares in higher labour market occupations and positions, and share in parliament. In constructing the SIGE index, as indicators, Dijkstra (2002) uses relative achievement of females to males for education, health and labour market participation variables, and for the remaining two variables, she uses shares of females. In the first step, standardized value of indicator j is calculated to measure the gender inequality level of the country i as follows:

$$z_{ij} = \frac{x_{ij} - \mu_j}{\sigma_j} \tag{1.6}$$

where x_{ij} is the score of country i on indicator j, μ_j is the arithmetic mean of scores of all countries on indicator j, and σ_j is the standard deviation of scores of all countries on indicator j. The standardized z_{ij} values also measure the gender gaps within each dimension. The overall gender inequality index SIGE of country i is calculated as simple arithmetic mean of standardized or transformed scores of five components defining equation (1.6)[9], which is defined as:

$$Z_i = \frac{1}{5}\sum_{j=1}^{5} z_{ij} \tag{1.7}$$

[9] Dijkstra (2002) uses the transformation for some series to make the mean and the standard deviation more representative, if the series are not normally distributed. She used power transformation with a power of 5 as for education and 0.5 for share in parliament.

Dijkstra (2002) explaines the main advantage of SIGE as "it is a measure of gender equality as such, that it integrates the dimensions used in GDI and GEM, and that it avoids most of their methodological problems" (p. 303). Despite she argued that the relative access to education is the most important and universal indicator for gender equality (p. 320), she assigned the same weights to all dimensions to make the comparison across countries more meaningful. However, the SIGE still has some drawbacks. According to the Permanyer (2010), SIGE does not measure the existing level of inequality, but just gives opportunity to compare the "relative position of women in a given country with respect to the average relative position in other countries" (p. 189). Due to the methodology used in its calculation, the SIGE does not give any information about the women's situation for a given country or does not measure the amount of gender inequality level. Because of this drawback, one should do the same evaluations as discussed in the analysis of RSW. Another criticism by Ferrand (2010) against the SIGE relates to its aggregation method. Ferrand (2010) argues that the SIGE is a linear index and "linear indicators admit total compensation among the various forms of discrimination. But, inequalities related to gender correspond to deprivation experienced by the women affected" (p. 12). Branisa et al. (2009) make the same critique about the SIGE and point out that when inequality increases, deprivation increases more than proportionally. Therefore, in order to overcome this drawback of the SIGE, they proposed social institutions and gender index (SIGI), which uses a non linear function to allow partial compensation and to prevent total compensation among sub-indices.

1.3.4. African Gender and Development Index (AGDI)

United Nations Economic Commissions for Africa (ECA) developed AGDI in 2004 in order to inform global or regional institutions on status of women in Africa so that

these institutions implement effective policies to improve conditions. AGDI consists of two parts: "African Gender Status Index (GSI)" and "The African Women's Progress Scoreboard (AWPS)". GSI is divided into 3 blocks and 7 components in total; social power capability (with components education and health), economic power opportunities (with components income, access to resources, time use or employment), and political power agency (with components senior or higher political and management positions in public sector or civil society)[10]. All blocks have equal weight and each component has 12 sub-components. GSI, as a whole system, includes 42 indicators which are only related to the gender issues, not women specific issues. For example, the maternal mortality is not used as indicator in the calculation of GSI, as that only applies to women. GSI is defined as:

$$GSI := \sum_{i=1}^{42} w_i \left(\frac{x_i}{y_i} \right) \tag{1.8}$$

where w_i is the degree of importance of basic indicator i, x_i is the female achievement level on indicator i and y_i is the male achievement level on indicator i. Multiplicative and additive rules are used together in the calculation method of GSI. Multiplicative function is used to measure gender gaps within dimensions, but additive function is used to measure gender gaps across dimensions.

According to ECA (2004), the main strength of the AGDI is that "it is a combination of measures, unique at a global level" (p. 9). GSI covers a large number of variables that measures gender inequalities in three blocks of the GSI. As the other indexes,

[10] The report is available on:
http://www.uneca.org/eca_programmes/acgd/publications/agdi_book_final.pdf

GSI has also some weaknesses. For instance, it is constructed only for 12 African countries[11]. GSI is based on 42 indicators, allowing it to capture both quantitative and qualitative dimensions of gender inequality, which is its advantage over the other indexes of gender inequality. However, this advantage of the GSI can be its disadvantage since data on 42 variables is not available for a large number of countries, limiting the availability of GSI to a few countries.

1.3.5. Global Gender Gap Index (GGG)

A study by World Economic Forum in 2005, "Women's empowerment: Measuring the Global Gender Gap", is the main framework of the global gender gap index. The GGG index uses 4 dimensions (economic participation and opportunity, educational attainment, political empowerment, health and survival) with 25 indicators and first published by World Economic Forum in 2006 for 115 countries (World Economic Forum, 2006). The 2009 report of the World Economic Forum extended the GGG to 134 countries, but reduced the number of indicators from 25 to 14 to focus more on gender inequality, gaps and outcomes rather than gender empowerment, levels and policies, respectively (World Economic Forum, 2009). In order to compute the GGG index, first, female over male achievement ratios for each variable, and then, the weighted average of dimension specific variables within each subindex is calculated from the achievement ratios obtained in the first stage. Last, the overall index is obtained as the simple average of dimension scores. The first release of the GGG index in 2006 covered a broad area with wide range of variables for 115 countries. However, the GGG had some limitations on choosing some of the variables. For instance, one of the variables included in the 2006 release of the GGG

[11] Selected countries for GSI are Benin, Burkina Faso, Cameroon, Ethiopia, Egypt, Ghana, Madagascar, Mozambique, South Africa, Tanzania, Tunisia and Uganda.

is the fertility rate (births per women), but it is impossible to compare this variable for men and women. Permanyer (2010) argued that these kinds of variables can measure the "status of women" rather than the gender gap or inequality. The variables concerning only the women measure the absolute status of women across the countries. Berenger and Chouchane (2007) also made a similar argument as Permanyer (2010). They argued that an index of gender inequality should be constructed based on the gendered data to compare relative status of women, otherwise, the index will measure the well being of women, which is related to poverty and income. Under the light of these criticisms, the 2009 report resolved these problems by eliminating the variables that concern only women's life. Another limitation of the GGG index is that it mostly focuses on the developed countries (Jütting et al. 2008).

1.3.6. Multidimensional Gender Equality Index (MGEI)

Permanyer (2008) introduced new index, called multidimensional gender equality index (MGEI), as an alternative to the gender related development indexes. MGEI is theoretically developed but not empirically implemented. Permanyer (2008) did not list the specific variables in order to give flexibility for practical implementation in different contexts. The MGEI is based on functions that take both absolute and relative measures into account to overcome the limitations on measurement[12]. On the other hand, the indexes such as the GDI and GEM, relative achievements levels are used. Under the light of Permanyer's (2008) argument, MGEI gives opportunity to make "direct control" of the effect of gender differences on the development levels

[12] The Author discussed the differences between absolute and relative difference to measure the gender difference of respective levels. She defined the absolute value as $G_1 = |x-y|$ and relative value as $G_2 = x/y$ and gave the example of $x_A=0.1$ and $y_A=0.2$ for country A and $x_B=0.9$ and $y_B=1$ for country B to show that the G_1 for A and B is equal (they are symmetric), and even if G_1's are equal G_2 can be different for countries (not symmetric). Therefore, it can create unclear, different conclusions. Permanyer (2008) took G_1 and G_2 as complement to each other and used both in her new measure.

by using both relative and absolute achievements levels together at the calculation of the index (p. 107). Overall MGEI index is calculated by using the generalized mean whose power depends on the degree of balance (B) between dimensions and degree of aversion (ε) to inequality as follows:

$$MGEI = \bar{G}_C\left((x_1, y_1), \text{K}\ , (x_n, y_n)\right) := \left(\sum_{i=1}^{n} w_i \left(G_{\alpha,\beta}(x_i, y_i) \right)^{1+f(\varepsilon,B)} \right)^{1/1+f(\varepsilon,B)} \qquad (1.9)$$

where $G_{\alpha,\beta}(x_i, y_i) = |x_i, y_i|^{\alpha} / |x_i, y_i|^{\beta}$, and $f(\varepsilon, B) = \varepsilon(2B-1)^2$. When the distribution is perfectly balanced, $B = 1/2$, MGEI will be equivalent to the weighted arithmetic mean. On the other hand, if the distribution is not perfectly balanced, that is *B* is not equal to $1/2$, MGEI will be equal to the generalized mean.

Although the MGEI index is flexible and can overcome the measurement limitations of variables, its calculation is a little complex and it is highly sensitive to different assumptions and parameters (Permanyer, 2010). For instance, $G_{\alpha,\beta}(x_i, y_i)$is a symmetric function and its value depends on α and β, and when $\alpha = \beta > 0$, it will show the relative inequality measurement, while if $\alpha > \beta = 0$, it will show the absolute inequality measurement. Therefore, MGEI will give more meaningful results if one chooses $\alpha \geq \beta \geq 0$. The author used the scatter plot diagram to compare the GDI ranking with the MGEI ranking and it was shown that there is positive correlation between these two indexes, but MGEI has a better fit as measured by the R^2, meaning that Permanyer's MGEI emphasizes gender inequality information more than the GDI. This result is a further support to the criticism of GDI that the GDI is the adjustment of HDI.

1.3.7. The Social Institutions and Gender Index (SIGI)

This index has been constructed by a research team, formed by Branisa, Klasen, Ziegler, at OECD Development Centre in 2009. It is the first index that focuses on the social norms, traditions, family law and institutions affecting the women within the society. SIGI considers five dimensions of gender inequality, which are family code (early marriage, polygamy, parental authority, and inheritance) that measure decision power of women or men in the household, physical integrity (female genital mutilation, violence against women), civil liberties (restriction to freedom of dress, freedom of movement) that measures freedom of social participation of women, son preference (missing women) that measures the economic valuation of women, and ownership rights (access to land, bank loans, and property other than land) that measures access of women to several type of properties with 12 indicators. In the construction of the subindices, the authors used Kendall Tau-b statistics to order and rank the indicators[13] and, then, the each indicator is coded between 0 (no inequality) and 1 (complete inequality). The authors performed principal components analysis on the relevant variables and common information corresponding to these variables is extracted as the first principal component (FPC). Using the score of the FPC, the values of subindices are calculated for each different dimension as follows:

$$Subindex(Country_X) = \frac{FPC(Country_X)}{FPC(Country_{worst}) - FPC(Country_{best})} - \frac{FPC(Country_{best})}{FPC(Country_{worst}) - FPC(Country_{best})} \quad (1.10)$$

[13] More detailed calculations are available on: http://www.oecd.org/dataoecd/49/19/42295804.pdf

where, FPC is the first principal component[14], $Country_X$ is the country of interest, $Country_{worst}$ is the country with worst possible performance, $Country_{best}$ is a country with best possible performance. Then the SIGI is calculated as the un-weighted average of 5 subindices as follows:

$$SIGI = \frac{1}{5}\sum_{i=1}^{5}(x_i)^2 \tag{1.11}$$

where x_i is the value of subindex of dimension i. Each term is squared to allow partial compensation rather than total compensation among subindices. Branisa et al. (2009) computed SIGI for 102 low and middle income countries. Branisa et al. (2009), Jütting et al. (2008), and Jütting and Morrison (2009) argue that, there exist a strong relationship between discrimination in social institutions with the key elements of development such as employment, women's education etc. SIGI provides new and innovative approach to gender inequality on measurement of its root causes rather than measuring inequality in outcomes. It provides very useful information for policy makers to show the social institution problems and its dimensions for countries. Therefore, SIGI can be good measurement due to including the institutional variables, which explaines the reasons of gender equality, rather than measuring gender inequalities in well being, economic and political participation etc. However, it is a very specific measure and can be complement to other indices but not substitute them due to the variables used in the construction of SIGI. Furthermore, it may also be difficult to measure social institutions impact on gender inequality because of limited data availability and finance the surveys to collect data

[14] The Authors defined the FPC as a proxy for the common information contained by variables corresponding to subindices. It is the weighted sum of the standardized original variables that captures as much of the variance. The variance of the five components by FPC is 70% for family code, 93% for civil liberties, 60% for physical liberties and 87% for ownership rights. Therefore, they used the equal weights for each dimension.

in other countries in which qualitative data is not available. Branisa et al. (2009) used the variables in the OECD Gender, Institutions and Development cross country database in constructing the SIGI.

1.3.8. Gender Inequality Index (GII)

The UN report published in 2010, The Real Wealth of Nations: Pathways to Human Developments, introduced a new index called Gender Inequality Index (GII). GII is based on three dimensions of gender inequality which are labour market, empowerment and reproductive health with five indicators: labour force participation indicator relating to labour market dimension; secondary level and above educational attainment, and parliamentary representation indicators relating to empowerment dimension; adolescent fertility[15] and maternal mortality[16] indicators relating to reproductive health dimension. The GII measures "the loss in human development due to inequality in reproductive health, labour participation, and empowerment between men and women" (UNDP, 2010, p. 228). This is where the GII differs from inequality adjusted human development index (IHDI). Using the IHDI, one can measure the loss in human development due to inequality in education, health and standard of living across the population. According to the UNDP (2010), reproductive health is the main component that contributes to GII as an indicator of gender inequality. The UNDP estimated GII for 138 countries, which ranges from 0 (no inequality) to 1 (complete inequality). The GII is calculated by first taking geometric mean across dimensions for females $\left(g_f\right)$ and males $\left(g_m\right)$ separately as follows:

[15] It is defined as "number of births to women ages 15-19" (UNDP, 2010, p.232)

[16] According to UNDP(2010), maternal death is defined as "the death of women while pregnant or within 42 days after terminating a pregnancy due to any cause related do or by pregnancy not due to accidental or incidental causes" (p. 233).

$$g_f = \sqrt[3]{\left(\frac{1}{mmr} * \frac{1}{afr}\right)^{1/2} \left(pr_f * se_f\right)^{1/2} \left(lfpr_f\right)}$$
$$g_m = \sqrt[3]{1\left(pr_m * se_m\right)^{1/2} lfpr_m} \tag{1.12}$$

where mmr is the maternal mortality rate, afr is the adolescent fertility rate, pr_f and pr_m are share of parliamentary seats hold by female and male, respectively, se_f and se_m are attainment at secondary and higher education for females and males, respectively, $lfpr_f$ and $lfpr_m$ are labour market participation rates for females and males, respectively. Second, equally distributed gender indexes are obtained by using the harmonic mean of geometric means as follows:

$$harm\left(g_f, g_m\right) = \left[\frac{\left(g_f\right)^{-1} + \left(g_m\right)^{-1}}{2}\right]^{-1} \tag{1.13}$$

Then female and male indices are aggregated by using equal weights. Third, the geometric mean of arithmetic mean of each dimension is calculated from:

$$g_{\bar{f},\bar{m}} = \sqrt[3]{\overline{health} * \overline{empowernment} * \overline{LFPR}} \tag{1.14}$$

where

$$\overline{health} = \left(\sqrt{1/mmr * 1/afr} + 1\right)/2$$
$$\overline{empowenment} = \left(\sqrt{pr_f * se_f} + \sqrt{pr_m * se_m}\right)/2$$
$$\overline{lfpr} = \frac{lfpr_f + lfpr_m}{2}$$

(1.15)

Last, the GII is obtained from $harm\left(g_f, g_m\right)$ and $g_{\bar{f},\bar{m}}$ as follows:

$$GII = 1 - \frac{harm\left(g_f, g_m\right)}{g_{\bar{f},\bar{m}}} \tag{1.16}$$

As the other indexes of gender inequality, the GII also has some drawbacks. For instance, time use due to traditional roles of women, access to assets, physical and sexual violence, local level empowerments are not taken into account by the GII. Also, there is no equivalent value for men for female specific health indicators used in calculating GII. Therefore, the GII is biased toward inequality. The GII has also some common features with GEM and GDI, thus, it can be used as an alternative to these indexes. However, it is not sufficient to use GII as a sole indicator of gender inequality, it rather should be used as complementary index to others but not substitute. The most important deficiency of the GII is that it does not take the share in earned income into the consideration, which the other indexes do.. Moreover, it would be impossible to say whether males or females are better off simply by considering the magnitude of GII. An advantage of the GII is that new dimensions can be added easily to the index because of the form of the formula and the mathematical calculations used in the GII.

As we discussed extensively above, each index has its shortcomings and advantages. Table 2 compares seven gender inequality indexes we discussed above in terms of number of indicators used, aggregation method, and number of countries covered. Pros and cons of each index are also given in Table 2. As the compassion in Table 2 illustrates none of the indexes completely measures gender inequality. As a last point, it should be stress that there is only limited gender disaggregated data to form gender inequality indexes based on indicator variables.

Table 2. Alternative Indices and Their Comparisons

AUTHOR	INDEX	NUMBER OF INDICATORS	AGGREGATION METHOD	NUMBER OF COUNTRIES	EVALUATIONS
Dikstra and Hanmer (2000)	RSW (Relative Status of Women)	no specific list of dimensions	Means of additive rule		Pros: simple computation and concept, all dimensions have same degree of dimensions Cons: non consistent in which gender inequalities are measured within each dimension and then averaged across dimensions
Dijkstra(2002)	SIGE (Standardized Index of Gender Inequality)	5 indicators	Arithmetic Mean of z-scores	115	Pros: All dimensions have same degree of importance, compare the relative position of women vs. Men Cons: conceptual problems, doesn't explain inequality levels
Economic Commission for Africa(2004)	AGDI (African Gender and Development Index)	3 blocks-42 indicators	Redistribution of weight by subgroup to give each of the 42 indicators the same weight	12	Pros: Integrates the various points, stimulate cooperation between ministries and countries Cons: limited country coverage, women comparative advantage for biological reasons
Social Watch Gender Equality Index(2005)	GEI (Gender Equality Index)	3 indicators	Un-weighted sum between different dimensions	156	Pros: Large country coverage, comprehensive list of indicators of gender equity Cons: Omissions of some important indicators (ex: health)
World Economic Forum(2006)	GGG (Global Gender Gap)	4 dimension-25 indicators	Arithmetic Mean of indicators	115	Pros: Comprehensive list of indicators and dimensions Cons: Strong focus on developed countries and complicated calculation of indicator weights
Permanyer(2008)	MGEI (Multidimensional Gender Equality Index)	no specific list of variables	generalized mean whose power depend on the degree of balance between dimensions	140	Pros: Overall development index corrected for gender differences, innovative index, multidimensional indicators Cons: no specific list of variables, more theoretical
OECD Development Center(2009)	SIGI (Social Institutions and Gender Index)	5 indicators	Un-weighted average of five subindices	102	Pros: Inclusion of social institutions, innovative indicators Cons: very specific measure, measurement problem with some indicators
UNDP (2010)	GII (Gender Inequality Index)	5 indicators	Harmonic mean of geometric mean	138	Pros: It is easy to add new dimension due to its structure Cons: No specific health indicator for men

Sources: Adopted from Jutting et al.(2008), p.12 and Permanyer (2010)

Chapter 2

INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

2.1. Definition of ICT

In recent years, ICT sector has started to play a very important key role for the knowledge based economies in the global area in improving economic conditions. According to the World Bank's ICT Glossary guide, ICT is defined as "the combination of the hardware, software, networks, and media for the collection, storage, processing, transmission and presentation of information (voice, data, text, images), as well as related services"[17]. On the other hand, in 1998, OECD countries agreed on the following alternative definition of ICT: "a combination of manufacturing and service industries that capture, transmit and display data and information electronically"[18]. Although the definition of ICT similar to the definition of information technology (IT), according to the World Bank's definition of ICT, IT is a subcomponent of ICT. The World Bank's definition splits ICT into two parts: information communication infrastructure (ICI) such as cellar, broadcast, cable, satellite, postal; and information technology (IT), which refers to the hardware and software to collect information, storage and present it, such as wireless networks, cell phones, radio, televisions etc.

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[17] ICT Glossary Guide (100 ICT concepts) is available at: web.worldbank.org

[18] See http://www.oecd.org/dataoecd/34/37/2771153.pdf for the list of some sectors included in the definition.

2.2. ICT and Economic Development

It is commonly expected that information and Communication technologies (ICT) should have impact on socioeconomic development, especially for developing countries. The United Nations defines social development as the development of people and their capacity through education, ensuring food security, shelter, health, clean air, water, respect for human dignity for cultural and a healthy physical environment (Wiltshire, 1993). Economic development, on the other hand, is defined as "qualitative change and restricting in a country's economy in connection with technological and social progress" by the World Bank[19]. Economic development is usually measured by the level of GNP per capita (or GDP per capita) which reflects "an increase in the economic productivity and average material well being of a country's population"[20].

In recent years, ICT has become the core policy for reducing poverty and promoting economic growth, especially, for developing countries. However, there is still no specific theory that supports ICT's positive impact on economic growth. Existing literature, generally, focuses on the policy development and analyses about the ICT and socio economic development with little emphasis on theory.

2.2.1. Contribution of ICT to Productivity

One of the channels through which ICT impacts economic growth is via its effect on productivity. Jalava and Pohjola (2002) examined the main factors behind the economic performance of United States, especially in 1990s. Using growth accounting, the authors estimated the contribution of ICT use to output growth for

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[19] See : http://www.worldbank.org/depweb/english/beyond/global/glossary.html

[20] Ibid.

Finland and found that ICT's contribution increased from 0.3% to 0.7% in late 1990s compared to early 1990s (p. 205). In a study by EU in 2006, contribution of ICT to the productivity is estimated as 74% at the first half of the 1990s for EU countries. Moreover, Jalava and Pohjola (2002) found that, at the beginning of the 1990s, capital service flow including the ICT capital increases due to improvement in quality of ICT and the price of capital services decreased. They also found that during the same period the labour productivity in the industries using ICT increased (p. 190). Stiroh (2002) also reached the similar conclusion for US. using the productivity data on US manufacturing industry between 1973-1999 period, Stiroh (2002) found that ICT capital is strongly correlated with the average labour productivity, but show weak relationship with total factor productivity. European Union (2006) classified the impacts of ICT on productivity under three main criteria: production of ICT goods and services, investment in ICTs and use of ICTs. By using data for the period 2000-2003, on ICT productivity related data, such as growth of ICT capital stock, size of ICT producing sector, and labour productivity growth rate, for EU countries, they concluded that production of ICTs increases the efficiency through technological developments, and improvements. Moreover, they found that the ICT production leads to decreases in the prices of ICT goods and promotes productivity growth. The second impact, increase in investment of ICTs, leads to higher levels of capital for worker and therefore enhances labour productivity. Last, wider use of ICTs by the firms will increase their efficiency because of the adaptation of new technologies. However, higher investment in ICTs does not always bring growth in productivity. Because, in order for ICT investment to promote productivity growth it should be complemented by investment in human capital such

as education, training, organizational changes, management styles, and innovation (EU, 2006).

2.2.2. Contribution of ICT to Employment

A second significant impact of the ICT on the economy is its contribution to employment. It is expected that the increased investment in the ICT sector will lead to higher employment levels. Additionally, it can also create new employment opportunities in the ICT using (enabled) sectors. A study by the European Commission (European Commission, 2004) separated ICT related occupations into two groups: "ICT occupations" whose jobs focus on ICT knowledge and skills such as web designer, programmer, software project manager, operating system developer, call centre consultant, and "ICT enabled occupations", which heavily depend on business domain knowledge such as product developer, call centre operator, bank teller etc. ICT enabled occupations can also be defined as ICT using occupations. According to the OECD's Information Technology Report (OECD, 2010b), ICT and ICT related employment have significant share in total employment with ICT sector employment having 6% (almost 16 million; 11 million in ICT services, 5 million in manufacturing) share in total employment of OECD business sector in 2008, while ICT sector specialists, such as software engineer and, IT technicians, are around 3-4%. ICT using occupations make up over 20% .of total employment in most of the countries except in Eastern Europe (p. 127). ICT continues to create new job opportunities due to rise in ICT investment and broader use of ICT services in many businesses sectors to decrease cost and increase speed without time constraint. As it can be seen from Figure 2, the share of ICT employment over the period 1995-2008 varies across countries from 4% to 9%. The share of ICT employment is in general higher in developed countries compared to developing countries. However, there are

a few exceptions like Switzerland where the share of ICT employment is 4%, which is 5% lower than the countries with highest ICT employment share. Figure 2 also shows that, in general, there is an increasing trend in the share of ICT employment in most countries between the years 1995 and 2008.

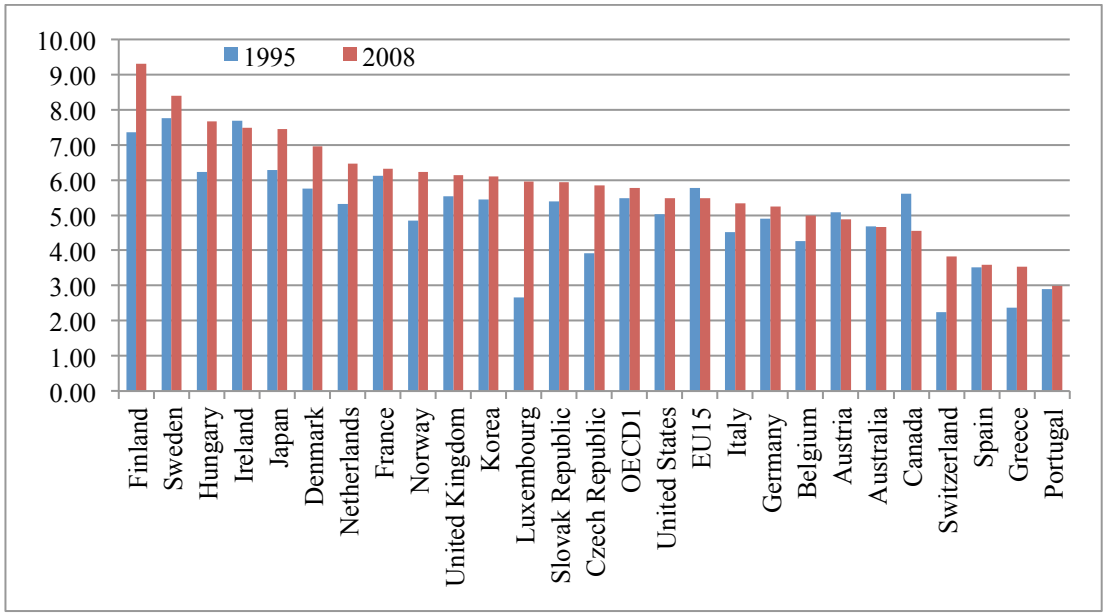

Figure 2: Share of ICT employment in business sector employment (Source: OECD Information Technology Outlook, 2010b, p.129)

2.2.3. Contribution of ICT to Socioeconomic Development

In its report published in 2009, United Nations Economic and Social Commission for Western Asia (ESCWA) pointed out that the ICT is "long term driver" for economic growth and has positive impact on socioeconomic development of countries (ESCWA, 2009, p. 4). This report explains the impact of the ICT on development by breaking up the results into two parts: social outcomes and economic outcomes. Social and economic impacts of ICT can be described as:

- *improving communication of countries isolated from rest of the world,*
- *facilitating the sharing of knowledge on specialized and/or general subjects,*
- *allowing the building up of knowledge without having time and place constraints,*

- *allowing the sharing of experiences within or between communities and countries,*
- *allowing and improving the delivery of activities,*
- *supplying innovative techniques,*
- *improving employment opportunities through training,*
- *encouraging entrepreneurships by introducing new and innovative ideas and facilitating access to microloans* (ESCWA, 2009, p. 27)

All these are the long term economic and social impact of the ICT. In the short term, on the other hand, ICT investments do increase due to the declining relative prices of ICT products, and therefore , new technologies develop and adapted to the economy in the long term, creating new outcomes and opportunities.

According to the United Nations Division for the Advancement of Women (DAW) report published in 2002, ICT provides opportunities for economic growth and human development with applications such as i) electronic commerce to access to financial markets ii) generating employment to providing opportunities for investment to entrepreneurs iii) improved agricultural and manufacturing productivity to empowerment of all sections of society iv) long distance education to telemedicine v) environmental management and monitoring to management of disasters (DAW, 2002, p. 18). However, even with these opportunities, ICT alone cannot be the substitute of basic sectors which ensure the development in the economy, but can complement them. Therefore, ICT can be a powerful tool for socioeconomic development but not alone and should be embedded into the other parts of the development chain. For example, it is expected that ICT use makes learning more effective in education, which promotes human capital accumulation. Most studies in literature conclude that ICT use indeed enhances human capital

accumulation via more effective learning (Semenov, 2005; Machin, 2006). ICT provides new tools to teachers to use in teaching process. However, skills of teachers and students and also other supportive conditions such as facilities, equipment, software, networking, number of students, types of computers, support from the parents, students motivation etc. do also play very important role to get positive impact of using ICT in education. Madon (2000) argues that it is not possible to solve complex development goals by the internet connections alone, diffusion, usage and the value of technology are also important to promote the development. Furthermore, political, economical, and sociocultural values are placed within development and use of the technology. According to Madon (2000), there is "egg and chicken" relationship between ICT and socio economical development (p. 89).

2.2.4. Contribution of ICT to Trade

ICT has both direct and indirect effects on economies of the countries. One of these impacts is to promote and facilitate a country's international trade. Especially, for the developing countries, trade of ICT products creates economic gain from increasing exports, decreases trade costs and provides new range of products. On the other hand, higher trade volume in ICT products promotes competitiveness of developed countries. Table 3 shows the export and import figures of ICT goods by main regions in 1998, 2003 and 2007. The figures reported in Table 3, among the developing economies countries in Asia, such as Hong Kong, China, Singapore, have higher shares of trade in ICT goods. The export volume of these Asian economies exceeds their import volume while other developing economies have a lower export volume compared to their import volume of ICT goods. When we consider all developing economies jointly, their export volume exceeds their import volume of ICT goods, making them net exporter of ICT goods. The major cause of developing

economies being net exporter of ICT goods is because countries such as Hong Kong and China are re-export centres. According to the UNCTAD (2009), World's main six exporters of ICT goods are China, United States, Germany, Japan, Singapore and Hong Kong. Nevertheless, exports of ICT goods doubled from 1996 to 2008 in OECD countries (OECD, 2010b). The IT outlook report of OECD (2010) indicates that main ICT exporters in 2008 were United States with 18%, Korea, Japan and Germany each with 12%, Netherland with 8%, Mexico with 7% of OECD ICT exports while the main importers were United States with 25%, Germany with 10%, Japan 7%, Netherland and United Kingdom each with 6%, of OECD total. The export share of developing countries in total ICT exports increased from 38% to 57% between 1998 and 2007.

Table 3. Percentage Shares of Exports and Imports of ICT Goods by Main Regions in 1998, 2003 and 2007.

	EXPORTS			**IMPORTS**		
REGION	**1998**	**2003**	**2007**	**1998**	**2003**	**2007**
Developed Economies	**61.84**	**50.84**	**42.43**	**66.47**	**57.54**	**52.57**
America	18.4	13.15	10.58	23.87	19.48	17.07
Asia	12.13	9.88	6.67	5.43	5.61	4.49
Europe	31.03	27.6	25.01	35.94	31.31	29.84
Developing Economies	**38.03**	**48.97**	**57.36**	**32.99**	**41.8**	**45.83**
Africa	0.14	0.16	0.17	1.02	0.9	1.1
Latin America & Caribbean	3.35	3.55	3.45	5.19	4.43	4.31
Asia	34.53	45.27	53.73	26.77	36.44	40.41
Oceania	0	0	0	0.02	0.03	0.02
Transition Economies	**0.14**	**0.19**	**0.21**	**0.54**	**0.66**	**1.59**
World	**100**	**100**	**100**	**100**	**100**	**100**
World ($ Billion)	**813.29**	**1,130.72**	**1,730.48**	**818.89**	**1,156.81**	**1,811.6**
Source: UNCTAD (2009)						

As it has been stress above the analyses of the contribution of ICT to the economy should consider both direct and indirect impacts. In order to evaluate the impact of ICT on economic activity, most studies in the literature, which are discussed above, used econometric methods or growth accounting approach due to data limitations. However, the expected impacts of ICT are indeed on tangible areas such as employment, GDP per capita, productivity growth, trade etc, which econometric and growth accounting methods used in the literature did not focus on. Moreover, it is also difficult to measure productivity levels of, especially, ICT using service industries rather than ICT producing industries. All these shortcomings results in likely under evaluation of ICT's impact, especially impact through indirect channels.

2.2.5. Contribution of ICT to Education

ICT has also uses in different fields and for different purposes in the education. Kim (2009) separates scopes of ICT in education into five components: i) a subject, such as computer studies, ii) a tool to innovative teaching and learning practice, such as digital learning environment, multimedia, iii) an administrative tool, such as education management information system, iv) providing widening opportunity for learning, such as distance learning or e-learning, v) a tool to improve thinking skills, such as and learner centred and self learning (p.5). The studies published by British Educational Communications and Technology Agency (BECTA) include good examples of long term impact of ICT on education. Using ICT using students and their performance in national tests, Harrison et al. (2002) obtained the result of positive relationship between ICT use and student's success in English and science. However, Machin et al. (2006) analyzed the student exam results and ICT use and showed that ICT has positive impact on educational performance, especially in primary schools and in English; however, it has less impact on science and no impact in mathematics. Higgins et al. (2005) concluded that performance of students who have interactive whiteboards in their schools improves in nation's literacy rate, science and mathematics tests compared to other students who do not have whiteboard in their schools. A study by Semenov (2005) for UNESCO describes the advantage and opportunities of ICT in education as follows:

ICT

- facilitates learning for children, especially for slow learners, socially, physically and mentally disadvantaged and those living in remote rural areas,
- provides more effective learning by accessing the online resources, using the powerful combination of media, video, text, graphics,

- provides internationally context for problem solving approach,
- increases the productivity and time saving for teachers (p.161).

Balanskat et al. (2006) summarized the results of studies, which are classified as qualitative and quantitative, on the impact of ICT on schools in Europe and identifies the barriers which limit to implementation of ICT in schools, which are micro level (teacher level), meso level (school level) and macro level (system level). Quantitative studies use the statistical techniques to investigate the relationship between ICT and education, while the qualitative studies are based on opinions getting from parents, students, and teachers. They concluded that results appear contradictory due to different approaches used, sample sizes and methodologies. Because of these reasons, it is not possible to make clear conclusions on the impact of ICT on education and make comparisons across countries or educational institutions.

2.3. Measurement of ICT for Development Studies

In order to evaluate the impact of ICT on education, economic development, and gender differences, one needs representative measure of ICT access to ICT, and country's potential benefit from using and access to ICTs. There have been several efforts in the literature to measure the ICT levels of countries following the increasing role of ICT for social and economic development. In this section, we summarize and compare major indexes of ICT use and access.

2.3.1. Digital Access Index (DAI)

The Digital Access Index (DAI)[21], developed by United Nations International Telecommunication Union (ITU), is the first global index, which measures the individual's overall ability in a country to access and use new ICTs. DAI has been calculated for 178 countries in 2002 and 181 countries in 2003. Countries are classified into four digital access categories as high, upper, medium and low. In order to calculate DAI, ITU used eight variables and five categories. The categories used were availability of infrastructure based on the variables fixed telephone subscribers, mobile cellular subscribers, affordability of access based on the variable internet access price, knowledge based on the variables adult literacy and school enrolment, quality of ICT services based on the variables international internet bandwidth, and broadband subscribers, and internet usage based on the variable internet users. For each category, variables are assigned values between zero (no access) and one (highest access) by dividing each variable with its maximum. The overall DAI index is obtained by arithmetic average of five categories. The results were published at the first phase of the World Summit on the Information Society (WSIS) in 2003. In terms of the rankings by the DAI, top five countries were Sweden (with the index value of 0.85), Denmark (0.83), Iceland (0.82), Korea (0.82) and Norway (0.79).

DAI is developed to determine the immediate factors that determine the access of individuals to level. In order to remove subjective bias arising from qualitative factors, DAI omits qualitative variables from the calculation[22]. DAI can be a good

[21] For more information: http://www.itu.int/ITU-D/ict/dai/index.html

[22] http://www.itu.int/newsroom/press_releases/2003/30.html

reference for a country to see its strengths and weaknesses in ICT and help developed guidelines to create effective policy on these areas.

2.3.2. Digital Opportunity Index (DOI)

Another index developed by ITU is the digital opportunity index (DOI), which measures the potential of countries to benefit from access to ICTs. Although the DOI is constructed in 2005, it is published in 2006 and updated in 2007. The index is calculated for 181 economies for the period of 2004 and 2006. The DOI is based on the concept of "digital opportunity"[23] as defined by ITU. ITU defines digital opportunity as "the whole population having easy access to ICTs with affordable prices, all homes equipped with ICT devices, all citizens having mobile ICT devices and everyone using broadband". The index is based on three categories with eleven variables, where the categories are i) opportunity, ii) infrastructure, and iii) utilization. Out of eleven variables used in constructing DOI, nine are from internationally agreed core ICT variables developed by Partnership[24] on measuring ICT for development. The DOI value of a country[25] is calculated by normalizing the value of each variable to its corresponding goalpost, which is either 0 or 100, and the subindexes are formed. The final DOI is constructed by first multiplying subindexes by their weights within each category and taking average of three category scores. Each variable has same weight within the category. The methodology used to calculate DOI is the same as the one used in constructing HDI

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[23] http://www.itu.int/ITU-D/ict/doi/index.html

[24] Partnership is an international, multistakeholder initiative to improve the availability and quality of ICT data and was launched in 2004 with currents partners, ITU, OECD, UNCTAD, the UNESCO Institute for Statistics, the UN Regional Commissions (UNECLAC, UNESCWA, UNESCAP, UNECA), the World Bank, the UN Department of Economic and Social Affairs (UN-DESA), and EUROSTAT.

[25] http://www.itu.int/ITU-D/ict/doi/methodology.html

and easy to implement. In addition to its easy implementation methodology, another advantage of the DOI is to use of goalpost, which provides targets for countries to achieve it. Moreover, because of grouping of the variables, countries can see where they have weakness or strength, which help them to form and evaluate their policies. According to the last updated DOI scores in 2007[26], countries with high DOI scores are mostly the developed economies while countries with low level DOI scores are from low income African and Asia Pacific regions, which is due to low level of infrastructure, limited availability of internet, and high prices.

2.3.3. ICT Opportunity Index (ICT-OI)

ICT Opportunity index was firstly developed and published by ITU and Orbicom[27] at WSIS 2005 to measure the digital divide, which refers digital opportunity levels across economies. ICT-OI groups economies into four categories as high, upper, medium, and low ICT opportunity economies. ICT-OI indeed combines DAI proposed by the ITU and Infostate index proposed by Orbicom. It uses the same data used in DAI, which covers the period 2001 and 2005 years, and employs the same methodology. According to the Orbicom in 2005, ICTs are both productive assets and consumables as well. Therefore, ICT-OI is based on two main concepts: info density and info use. Info density refers to a country's total capital and labour stocks, and info use refers to consumption flows of ICTs per period. ICT-OI is based on 10 qualitative and quantitative variables combined into 4 subindices[28]; i) networks (fixed telephone lines, international internet bandwidth, mobile subscribers), ii) skills

[26] http://www.itu.int/ITU-D/ict/doi/material/WISR07-chapter3.pdf

[27] Orbicom is an international network of UNESCO Chairs in communications that links communications leaders from academic, media, corporate and government circles with a view to providing for the exchange of information and the development of shared projects.

[28] http://www.itu.int/ITU-D/ict/publications/ict-oi/2007/index.html

(school enrolment, literacy), iii) uptake (computers, internet users, households with TV), iv) intensity (broadband subscribers, international outgoing telephone traffic). ICT infrastructure and skills are parts of the info density while uptake and intensity are parts of info use. The structure of the index allows a country to see its strengths and weaknesses in different ICT areas and make comparisons among economies possible. ICT-OI was calculated for 183 countries. Reference country and reference year is determined to monitor the digital divide of the specific country. However, the overall or average value of reference country changes over time. Values for different countries reflect each other's timeline[29]. According to the 2007 updated ICT-OI results[30], top three countries with high ICT-OI levels were Sweden, Luxembourg and Hong Kong. Countries with low ICT-OI levels were mostly concentrated on Africa and top three were Indonesia, Libya and Botswana. According to ITU (2009) a drawback of ICT-OI is that "countries could not easily replicate the combination in order to calculate national index as it was based on values of other countries" (p.10). Although, they use different variables and different methodologies, the results from DOI and ICT-OI are highly correlated with each other and it is calculated as 0.94 by ITU (2009). While ICT-OI focuses on main ICTs such as television, fixed phones, DOI additionally includes tariffs and mobile broadband.

2.3.4. ICT Development Index (IDI)

In 2009, ITU and Partners merged ICT-OI and DOI to create a single global index to measure digital divide and in order to see ICT efforts and potential of countries over a five-year period from 2002 to 2007. IDI was developed as a composite index and

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[29] If country A has 20% internet penetration in 2004, and County B has same value in 2006, It explains that Country A is two years behind.

[30] http://www.itu.int/ITU-D/ict/publications/ict-oi/2007/material/table1.html#low

calculated for 154 countries. It has three components: i) ICT infrastructure (access), ii) ICT intensity (use), iii) ICT skills (capability). All three components are combined to measure ICT impact (outcomes). Principles component analysis was used to determine the most important variables in each component and subindices were created from these three components. According to the report published by ITU in 2009, developed countries have higher-level ICT use and intensity while developing countries have higher improvements on ICT access. Moreover, the results show that "there is strong relationship between ICT level of countries and the level of income (in PPP US dollars), and the relationship is growing stronger over time" (p.71). Table 4 illustrates the differences among the alternative ICT indices and compares their strengths and weaknesses.

Table 4. Alternative Indices and Their Comparisons (Source: ITU)

CATEGORIES	INDICATORS	OVERALL INDEX	NUMBER OF COUNTRIES	EVALUATIONS
Infrastructure	1.Fixed telephone subscribers per 100 inhabitants	Digital Access Index (DAI) In 2002	178 countries	Pros: measure overall ability of individuals, first global index, grouping the variables to see where countries have strength and weakness Cons: ignores some qualitative factors
	2.Mobile cellular subscribers per 100 inhabitants			
Affordability	3.Internet access price as % of gross national income per capita			
Knowledge	4.Adult literacy			
	5.Combined primary, secondary, tertiary school enrolment level			
Quality	6.International internet bandwidth per capita			
	7.Broadband subscriber per 100 inhabitants			
Usage	8.Internet users per 100 inhabitants			
Opportunity	1.% of population covered by mobile phone	Digital Opportunity Index (DOI) In 2005	181 countries	Pros: measure potential of countries to benefit from access. Easy calculation method, using goalpost in calculation, grouping the variables, includes advanced ICT variables such as tariff Cons: Most of the indicators are at national level ,limited variables for ICT application
	2.Internet access tariffs as % of per capita income			
	3.Mobile cellular tariffs as % of per capita income			
Infrastructure	4.Proportion of households with a fixed line telephone			
	5.Proportion of households with a computer			
	6.Proportion of households with internet access at home			
	7.Mobile cellular subscribers per 100 inhabitants			
	8.Mobile internet subscribers per 100 inhabitants			
Utilization	9.Proportion of individuals that have used the internet			
	10.Ratio of fixed broadband subscribers to total internet subscribers			
	11.Ratio of mobile broadband subscribers to total mobile subscribers			

Info density (Networks)	1.Main telephone lines per 100 inhabitants	ICT Opportunity Index (ICT-OI) In 2005	183 countries	Pros: measures digital divide, grouping variables, including basic variables Cons: using reference country and year, shows country's timeline but not ICT levels
	2.Mobile cellular subscribers per 100 inhabitants			
	3.International internet bandwidth (Kbits per inhabitant)			
Info density (Skills)	4.Adults literacy rates			
	5.Gross enrolment rates(primary, secondary, tertiary)			
Info use (uptake)	6.Internet users per 100 inhabitants			
	7.Proportion of households with a TV			
	8.Computers per 100 inhabitants			
Info use (Intensity)	9.Total broadband internet subscribers per 100 inhabitants			
	10.International outgoing traffic(minutes) per capita			
Access	1.Fixed telephone lines per 100 inhabitants	ICT Development Index (IDI) In 2009	154 countries	Pros: measures digital divide and development potential of ICTs, provides to see ICT efforts and potential of countries, using the principle component analysis Cons: most variables are at national level,
	2.Mobile cellular telephone subscribers per 100 inhabitants			
	3.International internet bandwidth(bit/s)per internet users			
	4.Proportion of households with a computer			
	5.Proportion of household with internet access at home			
Use	6.Internet users per 100 inhabitants			
	7.Fixed broadband internet subscribers per 100 inhabitants			
	8.Mobile broadband subscribers per 100 inhabitants			
Skills	9.Adult literacy rate			
	10.Secondary gross enrolment ratio			
	11.Tertiary gross enrolment ratio			

Chapter 3

GENDER AND INFORMATION COMMUNICATION TECHNOLOGY

3.1. Introduction

Gender and technology relationship were examined by numerous studies in the literature by using different perspectives, approaches, and theoretical view points. The studies from feminist point of view largely focus on women's exemption from using information technologies due to various reasons caused by technology itself and society. We can classify the studies on gender, technology relationship under two broad headings. Scholars sharing the first view assume that technology is gender neutral and what is important is that how the technology is used (Lohan and Faulkner, 2004). Second group of scholars assume that technology is gendered, because, it is developed, and shaped by the society. However, in turn, technology itself affects the society as well (Hodgkinson, 2000; Wajcman, 2009).

Lohan and Faulkner (2004) classified the feminist studies on technology as "women in technology" studies, and "women and technology" studies (p.320). While women in technology studies generally focused on the reasons of being fewer women in technology related occupations, women and technology studies developed two opposite approach to the outcomes of technology, which are optimistic and pessimistic approach.

However, gender and technology studies can also be examined under different feminist theories such as liberal feminism, socialist feminism, eco-feminism, and post modern feminism.

3.1.1. Liberal Feminist Theory on Technology

The liberal feminist theory views technology as neutral but generally determined by men within the society because of biological sex differences between male and female. Therefore, liberal feminists do not focus on technology itself but focus on problems of women in technology (Lohan and Faulkner, 2004; Gurumurthy, 2004). The challenges against women come from stereotypical roles of women as generalized beliefs in a society. What kinds of decisions and social roles are suited for women has been formed by society. Liberal feminism accepts that male and female have same abilities, values and perceptions. French (2002) identifies these assumptions of liberal feminism as "sameness", and "human values" rather than "male values" (p.73). However, a widespread claim, although not correct, is that the women potential to use technology is not enough and efficient. A natural result of this belief is giving less opportunity to women than men in the society. Hodgkinson (2000) uses "masculinity of technology" to emphasize and explain the outcome arising from this widespread belief. According to Kelly (1987), who is cited in Hodgkinson's study, masculinity of technology concept is associated with "masculinity as image" and "masculinity as intrinsic to technologies" (p. 121). If one compares the number of male and female in technology related occupations, she will see that participation rates of women are lower than man. These kind of figures create an image and symbol in the mind of people that the technology related jobs, such as engineering, are more appropriate to male because they are mostly occupied

by male. Therefore, females will be discouraged by other people and may reject to choose such occupations just because of social barriers.

The solution offered by liberal feminism against masculinity as image is to provide positive discrimination to the women. Liberal feminists suggest that the problem will be solved when using some supportive reforms encourages women and campaigns to take up their careers in technology related occupations (Gurumurthy, 2004; Hodgkinson, 2000).

3.1.2. Socialist Feminism (Marxist) Theory

In the literature, socialist feminism sometimes is referred as "constructivist feminism" or "technology as culture approach" (Hodgkinson, 2000; Lohan and Faukner, 2004; Wajcman, 2009). Socialist feminism rejects the assumption of liberal feminism which technology is gender neutral. According to the social feminism, technology is gendered and explains the reason of lower level representation of women in technology as due to historical and cultural reasons. Because, both technology and gender is shaped by society (Landström, 2007) and both includes some signs from social values and culture in it. According to the Wajcman's study (2009), "role of technology" is "source of male power" (p.5). Therefore, this perception encourages men in being closer to technology than women. This approach sees the technology as part of capitalism and capitalism also reflects male power (Gurumurthy, 2004). Sometimes, in the literature, men, patriarchy and masculinity concepts are used instead of each other. Therefore, Hodgkinson (2000) explains such inconsistent using of concepts as limitation of socialist approach. The reasons of women's under representation in technology related occupations can be shown as the limitations to attend or access to educational or training programs about technology

rather than stereotyping. Suggested solution of socialist feminism is that "the allocation of resources for technology development should be determined by greatest benefit for the common good" (Rosser, 2005, p.17).

3.1.3. Eco- Feminism Theory

Eco feminist approach argues that technology is gendered but "essentially" and "inherently" patriarchal (Hodgkinson, 2000, p.122). Eco feminist approach has dualism on "women and nature", and "men and technology" (Gill and Grint, 1995, p.4). The association between women and nature is coming from the women capability of giving birth and makes them closer to nature. According to eco feminist approach, men are using the technology as a tool to control both women and nature (Gurumurthy, 2004). Most well known symbolic and criticized example by eco feminist approach is military technologies to show men and technology relation. Even in the using of reproductive sex selective abortion technologies simply shows men's domination over women body. Therefore, eco feminist's view on technology, rejection of all technologies, can be defined as "technophobia" (Hodgkinson, 2000, p.123). According to Hodgkinson's study (2000), eco feminists argue that it is not possible to produce gender neutral technology due to their essentialist point of view. On the other hand, while they are criticizing the reason of having masculine technology, contradictory, they are seeing gender as biological by assuming women closer to nature due to women's biology.

3.1.4. Post Structural Theory

Post structural theory is sometimes referred as "social theory of post modernity" or "third wave feminism" (French, 2002; Wajcman, 2009). According to this view, there is no universal belief or application on seeing men domination on technology (Lohan and Faulkner, 2004). This theory focuses on individual differences between

women such as class, country, race, rather than focusing on gender inequality (Wajcman, 2009). Therefore, women may react different to technology due to these factors. Post structural theory examines the power relations between social structures and institutions. Some of them are more dominant than the others and effect people through creating norms within the society or culture by using its own power. This theory argues that identity of an individual is not fixed and can be changed by experiences in the society (French, 2002).

Trauth (2011) uses the "individual differences theory" in her study to explain gender and ICT relationship. This theory includes some issues from the post structural theory and focuses on the social and individual level differences among women rather than between men and women. Individual differences theory is constructed under three main criteria which are individual identity (such as age, class, ethnicity, nationality), individual influences (such as education, experiences, trainings, abilities), and environmental influences (such as socio cultural infrastructure, attitudes, policy) (Trauth, 2006; Trauth, 2011). Therefore, both the individual differences theory and post structural theory use similar approaches in order to understand problem between women and ICT.

The issues of "language", "subjectivity" and "society" are criticized in post structural theory (Weedon, 1997; French, 2002). According to the post structural theory, the meaning can be redefined and change over time because of the language shaped by the society. French (2002) states the main idea behind this theory as "meaning is different dependant on a person's subjectivity which is situated within a historical discourse and constantly changing in a meaning" (p. 74). This theory rejects the

essentialism in liberal feminist theory. Post structural theory argues that terms such as masculinity, femininity, and experience do not have universally accepted meanings and the meaning can be redefined through language. Therefore, it provides to the researchers to focus on the subjectivity[31] of person to understand the main reason behind the problem, rather than classifying the people as male or female.

3.1.5. Cyber Feminism

Cyber feminism is another type of feminism which focuses on the technology and women interaction. According to the cyber feminism, new technologies, especially the internet, help women to empower themselves through being connected with each other in cyberspace, without facing any kinds of discrimination due to gender, colour, race and etc. Gajjala and Mamidipudi (1999) define the cyberspace as "the spaces or opportunities for social interaction provided by computers, modems, satellites, and telephone lines" (p. 8). Cyber feminism has optimistic view to concerning relationship of women with technology, and emphasizes the features of internet while connecting people in the virtual environment (Lagesen, 2008). Internet provides several opportunities for women such as sharing their ideas freely with each other, or taking distance education and health support services without having borders or distance problem etc. Therefore, one can say that cyber feminism is closely linked to development process of, especially, developing countries. Suggested solution of cyber feminism is to develop new technologies shaped by women (Gajjala and Mamidipudi, 1999; Lagesen, 2008; Wajcman, 2009). However, according to the Wajcman (2009), technology is still seen as masculine, and problems arising from socio cultural and historical roots should change to realize the

[31] Weedon (1997) defines the subjectivity as "conscious and unconscious thoughts and emotions which can account for the relationship between individual and the social" (p. 3)

suggestion. Table 5 shows the summary of the feminist theories and their views on technology.

Table 5. View of Feminist Theories on Technology

Feminist Theory	View on Technology	Features	Suggestions
Liberal Feminism/ Women in Technology	inherently neutral	• technology is determined by men because of biological sex differences and roles. • focuses on problems of women rather than technology. • assumptions are "sameness" and "human values"	encourage supportive reforms and campaigns to take up women's careers in technology related occupations to break the stereotypes in society
Socialist (Marxist) Feminism/ Constructivist Feminism/ Technology as Culture Approach	gendered	• criticizes the historical and cultural reasons • sees technology as part of capitalism role of technology is seen as source of male power	"allocation of resources for technological development should be determined by greatest benefit for common good" (Rosser, 2005, p.17)
Eco Feminism	essentially and inherently patriarchal	• focuses on dualism on "women and nature" and "men and technology" • sees gender as biological • uses technology as tool to control women and nature • criticizes the military and sex selective abortion technologies	develop appropriate technology to spread eco feminism into developing countries
Post Structural Feminism/ Social Theory of Post Modernity/ Third wave Feminsm	no universal belief or application	• focuses on individual differences between women such as class, race rather than gender inequality • examines power relations between social structures and institutions by criticizing "subjectivity", "language" and "society" • assumes that the problem is women's perspective	individual's identity is not fixed and can be changed by experiences
Cyber Feminism	optimistic view and inherently liberator	• focuses on technology and women interactions • technology helps women to empower • assumes all equals in cyberspace	development of new technologies will end male superiority

3.2. Women within ICT

ICT provides some economical, social and political opportunities to people and governments. Due to the differences in resources and capabilities, some countries or people benefit more from ICTs than the others. While "digital divide" refers the unequal distribution of ICT benefits within and between countries, regions, socio economic groups, and sectors, "gender divide" can be seen as subset of the digital divide and focuses on the low access levels of women to the ICTs (Gurumurthy, 2004; UNDAW, 2005). Hafkin and Taggart (2001) defined the digital divide as division between the information 'haves' and 'have nots' within countries by race, ethnic group, class, age, region, and gender. However, it is still difficult to find gendered disaggregated data by country and by technology to analyze it.

3.2.1. Access and Use

UNESCO (2003) defines the "access" as the ability of using ICTs and the information and knowledge provided by technology. Access to ICTs are playing important role to empower women, only if it is used for achieving socioeconomic development goals.

Most commonly used indicator to measure ICT using ratios between or among countries is internet using. Additionally, we used the gender inequality index (GII) for comparison purposes. According to the international human development indicators[32] data of UNDP for the year 2008, the countries which have higher percentage of internet users show tendency to have lower level gender inequality index (GII) values, which is the sign of having more equality between male and

[32] http://hdrstats.undp.org/en/tables/default.html

female in the case of using internet. However, it is not possible to say that there is perfect correlation between internet using and gender equality. For instance, although the percentage of total internet users are high in Australia (70.80), Austria (71.20) and Canada (75.30), they have more or less same gender inequality index value (0.30) with the countries which have low number of internet users such as China (22.50), Poland (49.00), Israel (47.90) and Greece (43.10). Denmark and Italy can be another example with the values of 83.30 and 41.80 on internet using ratios. Although, Denmark has double portion on internet using than Italy, GII values of both almost same with the values of 0.21 and 0.25, respectively.

According to the sex disaggregated data collected by International Telecommunication Union (ITU), distribution of male and female users are changing by countries. It can be clearly seen from Figure 3 that male percentage of using internet is higher than the percentage of female in most countries. Especially in some countries such as Azerbaijan, Peru, Turkey, Ukraine, and Italy, male users are dominant. On the other hand, in some countries, such as Estonia, Finland, Ireland, and United States, females have higher shares on internet using than men among their population. And also, internet using ratio of the population is very low in some countries with higher shares of female users, such as Honduras where 13.10 % of population use the internet, Nicaragua where 3.30 % of population use the internet, and Thailand where 23.90 % of population use the internet.

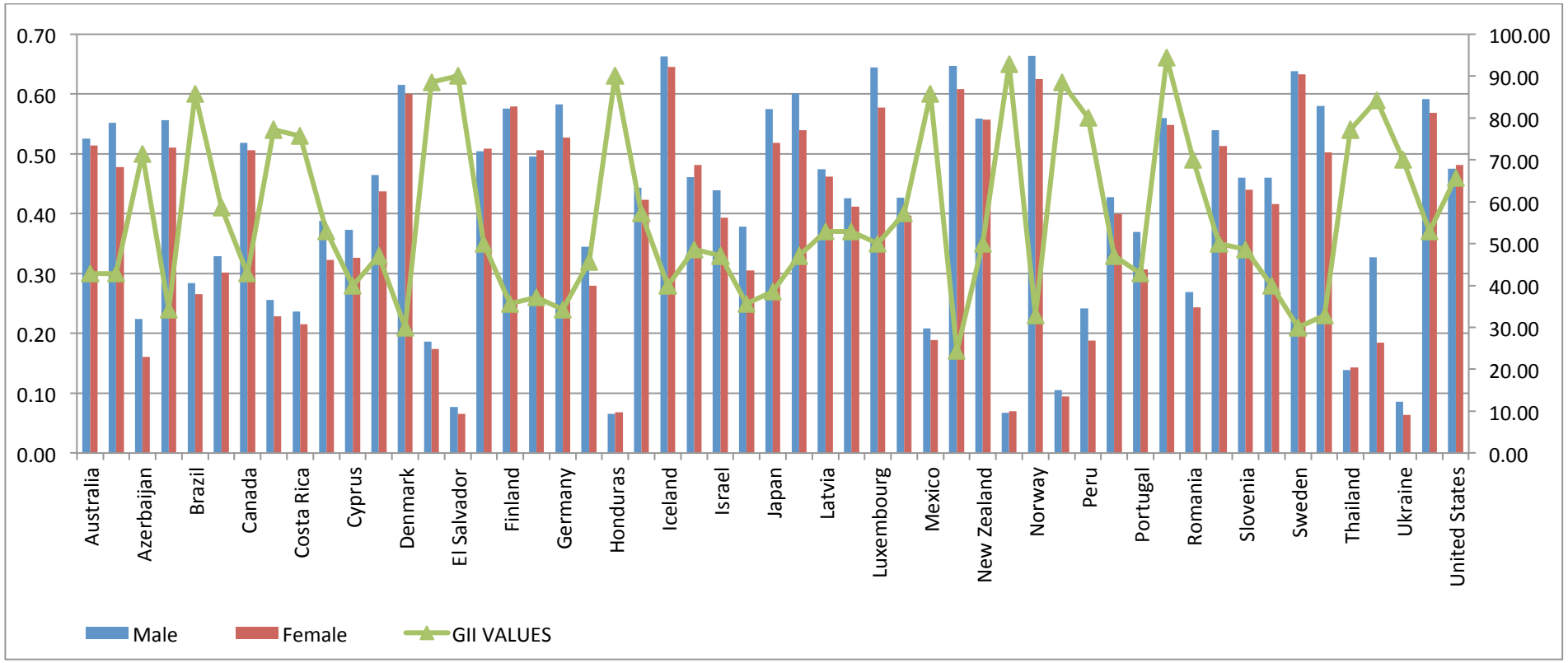

Figure 3: Internet using ratios from any location in 2009 by gender, with the GII values of countries in 2008 (Source: ITU World Telecommunication/ICT Indicators database, 2010; UNDP)

There are gaps in access to ICTs between male and female, and also among female in rural and urban areas. ICTs exist largely in urban areas (Hafkin and Taggart, 2001) and women in developing countries live mostly in rural areas (UNESCO, 2003; Gurumurthy, 2004). Therefore, it is easy to reach ICTs for people who live in urban areas. The level of accessing ICTs for developing countries is lower than the level of developed countries.

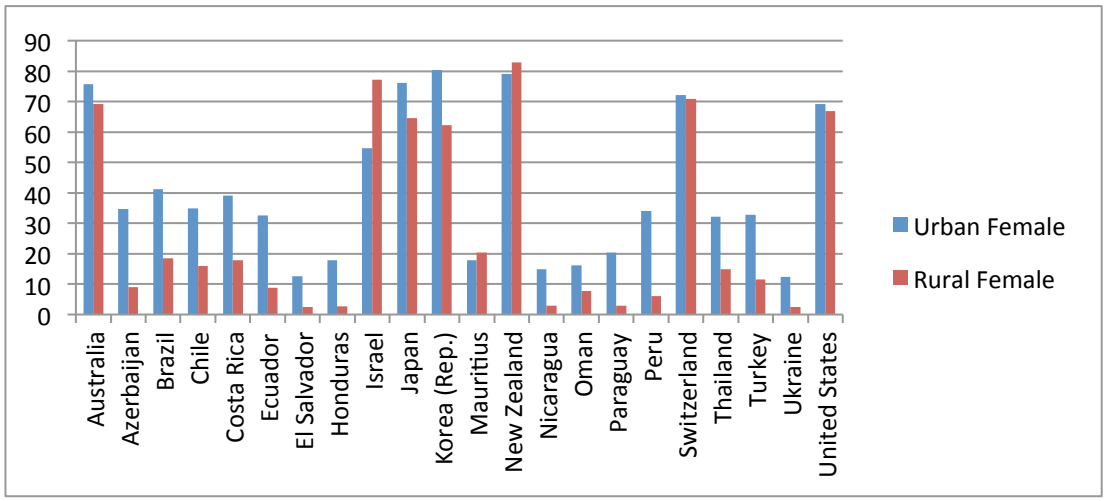

Figure 4: Internet using ratios of females from any location in 2009, by urban/rural location, (%)
(Source: ITU World Telecommunication/ICT Indicators database, 2010)

Figure 4 is drawn for countries which have data availability. It clearly can be seen from the figure, there is huge differences between females living in urban and rural areas. Infrastructural differences between regions can be explain these figures (Hafkin and Taggart, 2001; UNESCO, 2003; UNDAW, 2005). The infrastructure in ICTs is highly concentrated in urban areas and it is easy to reach ICTs for both male and female living in towns. While developed countries such as United States, Switzerland, and Australia do not have big differences between urban and rural areas, developing countries such as Brazil, Chile, and Turkey have high urban and rural differences among female on internet using. This can be the sign of well defined policy and infrastructure in developed countries. In general, the women living urban areas get the advantage of location. On the other hand, both New

Zealand and Israel, which are considered as developed county, have higher female share on ICT using in rural areas.

These figures are not changing significantly when share of using computer or cellular mobile phones by gender and by region are used as an indicator. The ability of female to access ICTs and use the information provided by these technologies depends on the factors which relates to both socioeconomic values of country and market infrastructure of ICTs such as cost, pricing, location, and culture etc.

3.2.2. Barriers to Women's ICT Use

There are some factors to explain why women's access and use of ICT is lower than men in most countries, especially in rural areas. These factors which create gender divide can be classified under two different categories as demand side and supply side factors. While demand side factors include socioeconomic and cultural factors such as poverty, cost of infrastructure, role of girls, and girl's education, on the other hand, supply side factors include institutional and political factors such as public support for women in education and ICT, training programs, and quality of ICT.

3.2.2.1. Social and Cultural Barriers

Behaviours and roles of sexes are determined by norms created by the society. Especially, men dominated, patriarchal, cultures have more conservative view on women. In such cultures, girls are needed for household works and non-wage agricultural works. The domestic responsibilities, such as childcare, cleaning, and cooking, give extra burden on women as role of mother or wife. Therefore, even if women have chance to access and use the ICT, she cannot find free time to do that due to these roles and responsibilities given by society. The limited leisure time of

women creates problem on reaching ICT devices, attending training programs, getting help to use ICT devices, and making practices about information they get.

Another cultural barrier to women's ICT use is about difficulty to reach ICT. In general, ICT is highly concentrated on urban areas. However, in rural areas, ICT centres are in public spaces. The lack of time and the location of centres creates problem for women. In patriarchal communities, women do not move freely without male control because of safety problem and social norms. Thus, women may meet with the problem to reach ICT facilities and go back home, especially late times of the day. Even if they reach these centres, male are more dominant in such public spaces (Hafkin and Taggart, 2001). This will lead women to feel them uncomfortable, and women will show tendency to stay home and not come to centres again. Therefore, the location of ICT centres and their distance from public atmosphere effects women's access to ICT through many channels in society.

3.2.2.2. Education and Skills

The using of ICT requires at least some level education and training. Even if the people have an ICT device at home, such as computer, mobile phone or internet, they cannot use it effectively without having knowledge on using them. Figure 5 shows the internet using ratios of individuals by level of education. It can be clearly seen from this figure, internet using ratio is increasing in all countries, except Azerbaijan and Bahrain, with the increasing education level. We can get same conclusion for using computer and level of education.

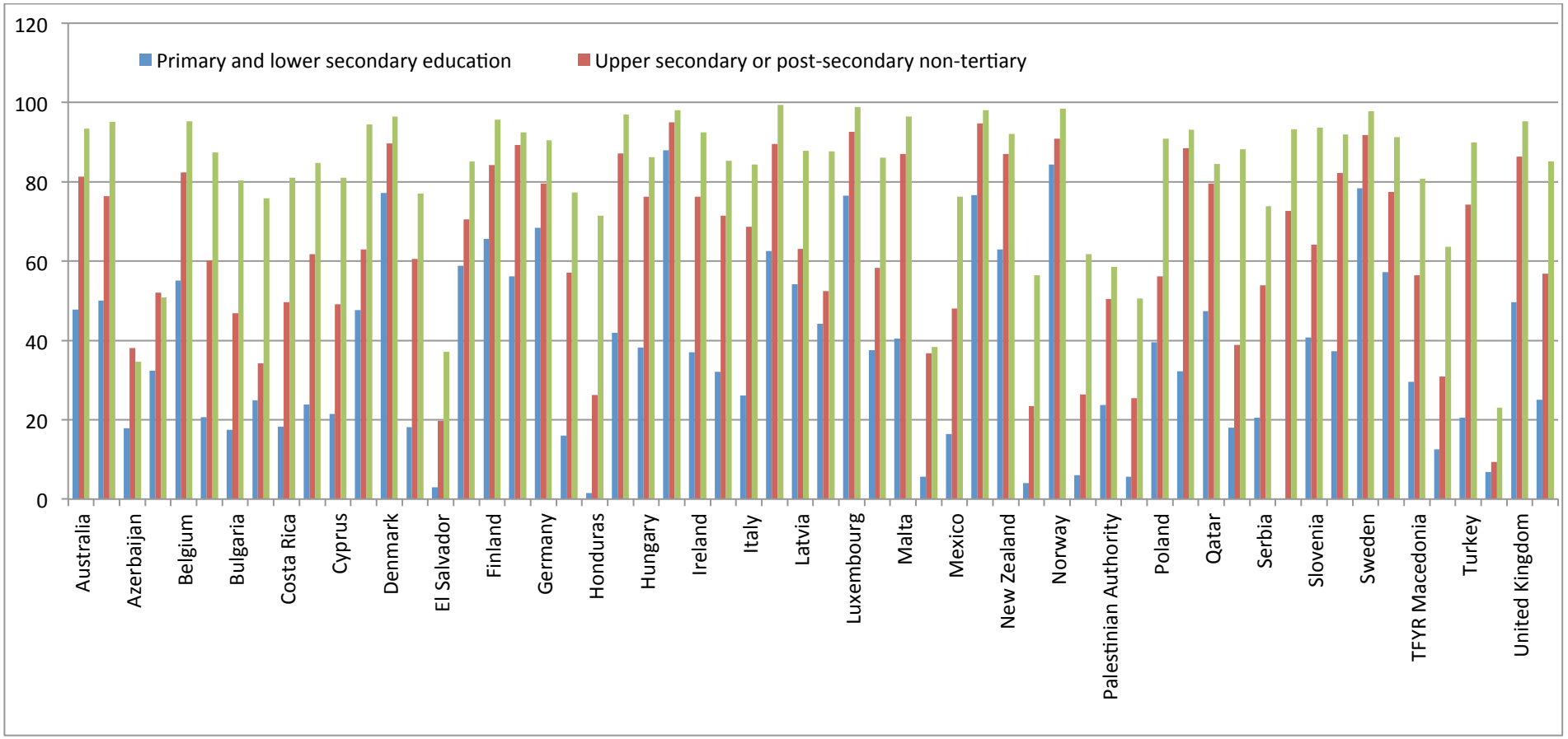

Figure 5. Internet using ratio from any location in 2009 by level of education
(Source: ITU World Telecommunication/ICT Indicators database, 2010)

In general, women are facing some problems in educational fields during their life. A common perception and stereotype about women is that they are less likely enrolled in computer science courses than boys. Socio-cultural barriers, parent's education level, perception of family and teachers to the education of girls in ICT related fields prevent communication of girls with technology. According to the education stats of OECD[33], percentage of female graduates from the field of science are 45% in Turkey and in Sweden, %47 in Finland, %43 in US, %42 in Mexico, %37 in UK, and %25 in Japan. Percentage of female graduates from engineering, manufacturing and construction are 30% in Sweden, %28 in Mexico, 26% in Turkey, %23 in UK, 22% in Finland, %21 in US, and 11% in Japan. One of the main reasons is the low literacy rates of women in the world. According to World Bank data, adult female (age 15 and above) literacy rate in the World was 79% in 2009, however, in low income countries, this ratio was 54%, and completion rate is 60% in 2008, which is very low.

According to UNDP (2001), the reasons of gender equality in ICT education can be classified as socioeconomic and cultural factors (demand side), which affect the behaviour and the choices of students and their parents, and as political and institutional factors (supply side), which has linked to the ICT affecting gender equality. Female are challenging in attending school or training programs because of sociocultural barriers, family and household responsibilities, norms, poverty, and cost of education etc. Especially in developing countries, males are having more priority to attend educational or training activities

[33] See: http://stats.oecd.org/Index.aspx?DatasetCode=RGRADSTY

3.2.2.3. Language

Web pages were developing mostly in English until few years ago. Therefore, language seems as one of the basic barriers for women to use internet as tool to empower them (Hafkin, 2002; Jorge, 2002; Ng and Mitter, 2005). According to the internet world stats[34], English is the first language with 42% internet penetration ratio among the languages used in the web. Other top languages are Chinese with 32.6% and Spanish with 36.5%. However, UNESCO (2009) reported that English was predominant language in web pages, but, predominance of English has declined from 80% in 1996 to 40% in 2008 in terms of English speaking internet users. UNESCO (2009) gives the Wikipedia, which is the multi linguistic space of internet, as an example to explain the situation. The number of articles which appear in English in2008 is about 23%, German is 7%, French is 6%, Polish, Japanese, Italian and Dutch is 4% each, Portuguese and Spanish are 3% each (UNESCO, 2009, p.38). These figures explain the women's low level access and use of ICTs, especially in developing countries. While empowering the poor and rural women, some tools of ICTs such as multimedia and tele-centres should be provide information in native language (Jorge, 2002).

3.2.2.4. Cost

Even in the case of having ICT infrastructure, people may not access it due to its cost, especially in developing countries. The people living in rural areas could not have ICT devices in their houses and, in such regions; they can share ICT access points, such as cafes, to access and use these devices (Hafkin, 2002; Jorge, 2002). However, it creates extra cost for most people, especially for disadvantages groups

[34] http://www.internetworldstats.com/stats7.htm

such as poor women. OECD, World Bank, and ITU developed ICT price baskets to provide information for policy makers and show them the importance of prices for ICT users. The most recent and comprehensive one is developed by ITU in 2009 for 150 economies, with ICT development index (IDI), and released in 2011. The ICT price basket[35] of ITU includes three sub baskets, which are fixed telephone, mobile cellular, and fixed broadband internet. ITU (2009) reported that there is a strong relationship between ICT prices and ICT development levels of countries. The ICT prices are important because of showing how the ICT services are affordable and how it affects accessibility of the user. If the user does not have enough resource to pay for fee, she would not have access to ICT devices. According to the latest figures of ITU (2011)[36], price of ICT services are decreasing in all over the world, however, one of the main factors behind the digital divide is still the price of ICT services, and most affordable ICT services are in high income countries. People living in higher income countries are paying less for ICT services when compared with the people living in lower income countries. On the other hand even in the availability of cheaper ICT services, open public areas, such as cafes, are not well suited for women as well. They may need to take public transportation to reach these areas, and it will create extra burden for their budget.

[35] ICT price basket is calculated as summation of the price of three sub basket as a percentage of monthly GNI per capita of countries, and divided by three. The overall value of basket is ranged between zero means (tariffs represent zero percent of average monthly GNI per capita, and all services are for free), and 100 (the price of all baskets are greater than or equal to monthly GNI per capita) (ITU, 2009, p. 54)

[36] http://www.itu.int/net/pressoffice/press_releases/2011/15.aspx

Chapter 4

ON THE GENDER GAP, ICT, AND INSTITUTIONAL QUALITY: A DYNAMIC PANEL DATA ANALYSIS

4.1. Introduction

Gender inequality and disparities between males and females have serious cost implications and these negatively effect the human and economic development. The development in information and communication technologies (ICT) may improve human and economic development through its direct and indirect impacts. An indirect impact may arise due its positive impact in reducing gender inequality. Gender and technology relationship were examined by numerous studies in the literature. It is commonly expected that ICT should have impact on socioeconomic development and gender equality, especially for developing countries, through different pathways such as increasing productivity (Javala and Pohjola, 2002; Sitiroh, 2002), creating new job opportunities (European Commission, 2004; OECD, 2010). This optimistic view on the relationship between ICT and gender equality is supported by Gajjala and Mamidipudi (1999), Lagesen (2008), and Wajcman (2009), among others. On the other hand, the pessimistic view emphasizes that ICT increases the gender inequality due to socio economic inequalities (Arun et al., 2004; Gigler, 2004; Koutsouris, 2010). This view is based on the argument that some factors will limit women's access to ICTs in most countries, especially in rural areas, and this will increase the gender divide through affecting women empowerment process.

According to Madon (2000), there is "egg and chicken" relationship between ICT and socio economical development (p. 89). Therefore, ICT can be a powerful tool for

socioeconomic development but not alone and should be embedded into the other parts of the development chain. Due to the differences in resources and capabilities, some countries or people benefit more from ICTs than the others. According to the studies, which are cited above, supporting the pessimistic view, the cultural barriers may also limit education of girls and in turn, it may prevent their economic participation and their access to ICT. This study examines these cultural, political, economic, and other factors, which have influence on ICT access and ICT usage of women. It is recognized that the technology opens new possibilities, approaches, and benefits while implementing the policies as well. However, the expected benefits from ICT development may not lead to significant improvements in gender gap, if governance and institutional quality does not accommodate woman to use ICT to become more active economically or more girls may not get access to education. The institutional infrastructure for our purpose covers the financial system, the system of government, and law enforcement. The social infrastructure, on the other hand, includes the health care, educational and research, and welfare systems. Good institutions and social infrastructure enhance factor accumulation in ICT through encouraging investments in human capital, and physical capital stock from investments at home and also from abroad. Good institutions and governance also work as a factor of accommodation. Institutions have the role of the "lubricant" of the economic and social system. Good institutions can be expected to improve the efficient use of the available ICT for both woman and men. Loosely put, good institutions may 'grease the wheels' of the economic and social system, enhancing the productivity and helping close the gender gap. In this study, we propose and test the hypothesis that combination of better ICT and governance and institutional quality exerts an independent influence on gender equality, over and above any

influence each of these two variables may separately have. We term this hypothesis as the "simultaneity hypothesis".

The study uses a panel data set for 209 countries for the period from 2000 to 2010 to investigate (1) the impact of ICT on gender equality, (2) the impact of governance and institutional quality on gender equality, and (3) test the simultaneity hypothesis that simultaneous improvement in institutional quality and ICT has an impact above and beyond the separate impact of both on the gender equality. The econometric estimation uses two measures of gender inequality in education and employment. As a measure of gender equality in education, the ratio of girls to boys in primary and secondary education is used. On the other hand, as a measure of gender inequality in employment, the ratio of the female to male labor force participation rates is used. The study uses six indicators of the ICT infrastructure level and ICT density. These measures include the number of computers per 100 people, the number of Internet users per 100 people, the number of telephones per 100 people, ICT expenditure as a share of GDP, ICT expenditure per capita, and mobile subscribers per 100 people. Due to the high correlation between the different ICT measures each variable is used in a separate regression. The variables for the institutional quality and governance include Political Risk Service (PRS) Group's six indicators, which are (i) Corruption, (ii) Law and Order, (iii) Bureaucratic Quality, (iv) Composite Risk Rating, (v) Government Stability, and (vi) Democratic Accountability. Since all six measures are highly correlated we construct an index of institutional quality from the underlying six series using principal components analysis, which proxies the institutional quality and governance in regressions. In each regression, variables such as the per capita real GDP, youth sex ratio, average years of schooling, public expenditure on

education per capita, urbanization ratio, and unemployment rate are used as control variables.

Two major regression equations that relate the gender equality in employment and education are estimated using a dynamic fixed effects panel data model using the Arellano-Bond system generalized method of moments (GMM). The findings of the study indicate that the women education in the field of ICT, access to ICTs and women employment surrounds many positive prospects as well as considerable confront. The regression estimates show a significant positive relationship between gender equality in employment and education, and the level of ICT infrastructure, which is a finding supported by previous studies (Klasen, 1999; Dollar and Gatti, 1999; Chen, 2004). Additionally, all estimated models reveal a positive and significant effect from institutional equality and governance in employment and education. More importantly, our empirical estimates indicated a strong positive interaction between ICT and institutional quality and governance, providing empirical support for our "simultaneity hypothesis". Thus, the estimates show that simultaneous improvement in both the ICT and institutional quality and governance creates a higher positive impact from ICT to gender gap, beyond the impact of the ICT and institutional alone. Our study, thus, contributes in three ways to the existing literature. First, we update the panel data set used in previous studies (Chen, 2004) to cover a longer period and more countries. The paper then uses dynamic panel data estimations methods to properly address the endogeneity issues, which is mostly ignored or only approached with inferior methods in the previous literature. Second, our study, to our knowledge, is the first to investigate the impact of institutional quality and governance on gender inequality. Third, we test the simultaneity

hypothesis that combination of better ICT and governance and institutional quality exerts an independent influence on gender equality, over and above any influence each of these two variables may separately have. The study obtains strong evidence in favor of the simultaneity hypothesis.

4.2. Economic Theory on Gender Equality, ICT, Institutional Quality and Governance

The objective of this study is to examine the relationship between gender gap, information communication technology (ICT), and governance and institutional quality. The study analyzes how the ICT interacts with social and institutional infrastructure to impact the gender inequality. The development in ICT may improve human and economic development through its direct and indirect impacts. An indirect impact may arsis due its positive impact in reducing gender inequality. We can define the ICT as technology and tools such as telephone, radio, and internet that people can gather information, share and distribute it, and communicate with the others. ICT covers all of these and also communications equipment and socioeconomic and socio-cultural systems. According to the World Bank (2003), gender inequality and gender gap between males and females result in serious cost effects such as more poverty, less economic growth with bad governance, and lower level of living standards for their citizens and these negatively effect the human and economic development. In short, equality in a society promotes overall socio-economic development of countries (World Bank, 2001). However, women are faced in life with "unequal human capabilities" (Nussbaum, 2002, p. 46). Amartya Sen, winner of the 1998 Nobel Prize in economics, gives main theoretical framework on gender discrimination by developing "capability approach". According to the Sen's approach, focusing on what women is able to be or do something is much more

important than focusing on what she can consume or the income she receives (Sen, 2001, 2005). On the other hand, the Neoclassical approach ignores dynamics and outcomes within the family, and intra-family distribution of income while taking income as overall welfare of people and utility as people's psychological happiness or satisfaction (Hicks, 2002; Sen, 2005). The social structure including the family as well is the main cause of the inequalities. Gender inequality leads to reduced access of women to markets, and educational and health services, then, in turn, it causes to lower well being of children and economic growth (World Bank, 2007).

One of the major questions in the literature, both on theoretical and empirical grounds, is whether ICT can help to improve gender equality within the society. Gender and technology relationship were examined by numerous studies in the literature using different perspectives, approaches, and theoretical view points. The studies from feminist point of view largely focus on women's exemption from using information technologies due to various reasons caused by technology itself and society. We can classify the studies on gender and technology relationship under two broad headings. Scholars sharing the first view assume that technology is gender neutral and what is important is how technology is used (Lohan and Faulkner, 2004). The women who have limited opportunities for participating social and economic life due to some constraints, such as time and socio-cultural norms, may become more active by using ICT applications and ICT tools.

Second group of scholars assume that technology is gendered, because it is developed and shaped by the society. However, in turn, technology itself affects the society as well (Hodgkinson, 2000; Wajcman, 2009). Lohan and Faulkner (2004)

classified the feminist studies on technology as “women in technology” studies, and “women and technology” studies (p. 320). While women in technology studies generally focused on the reasons of being fewer women in technology related occupations, women and technology studies developed two opposite approach to the outcomes of technology, which are optimistic and pessimistic approach.

According to the group supporting the optimistic view (Gajjala and Mamidipudi, 1999; Lagesen, 2008; Wajcman, 2009), it is commonly expected that ICT should have impact on socioeconomic development and improve gender equality, especially for developing countries, through different channels, such as increasing productivity (Javala and Pohjola, 2002; Stiroh, 2002), creating new job opportunities (European Commission, 2004; OECD, 2010), improving communication without time and place constraint, providing e-commerce and health services, and distance education applications (UNDAW,2002) etc. Mandour (2009) studied how gender ICT affects gender equality in Egypt by using panel regression and showed that there is positive relationship between level of ICT infrastructure and gender equality in employment .
On the other hand, the group supporting the optimistic view criticizes pessimistic view that ICT increases the gender inequality due to socio economic inequalities (Arun et al., 2004; Gigler, 2004; Koutsouris, 2010). Pessimistic view argues that some factors will limit women’s access to ICTs in most countries, especially in rural areas, and this will increase the gender divide through affecting women empowerment process. These factors which create gender divide can be classified under two different categories as demand side and supply side factors. While demand side factors include socioeconomic and cultural factors such as poverty, cost of infrastructure, role of girls, and girl’s education, on the other hand, supply side

factors include institutional and political factors such as public support for women in education and ICT, training programs, and quality of ICT.

According to Madon (2000), there is "egg and chicken" relationship between ICT and socio economical development (p. 89). Therefore, ICT can be a powerful tool for socioeconomic development but not alone and should be embedded into the other parts of the development chain. Due to the differences in resources and capabilities, some countries or people benefit more from ICTs than the others.

A question we try to examine via empirical evidence is the impact of institutions and governance as complementary to ICT. We broadly call the rules, regulations, political system surrounding the interaction of woman with ICT as institutions and governance. Local or international institutions and organizations play a significant role to improve efficient use of ICTs and help close the gender gap between women and men. Generally, most countries and international organizations define the rights by the laws. However, there is still a broken link in applying these laws because of beliefs, cultures, stereotypes, lack of accountability systems, and etc (Rao and Kelleher, 2003). Institutions behave like a lubricant of the social and economic system by producing rules and targets, regulating the power relations within and/or between the societies, and facilitating the expansion of sense of gender equality through shaping rights and legislations to improve quality of life for all. Decision making process or management of institutions can be analyzed under the governance concept, which covers the household, society, local and international government, and global institutions (Brody, 2009). World Bank defines the governance as "the traditions and institutions by which authority in a country exercised for the common

good". According to the Cheema (2005), good governance and institutional quality have positive impact on level of economic development, efficiency, sustainability, degree of access and participation. Therefore, institutions shape the rules and regulations, and economic activities of agents such as firms and families (Branisa et al., 2010). Thus, good governance provides efficient and effective allocation of resources and powers. Branisa et al. (2010) found that social institutions that take women away from decision making or bargaining process are positively associated with low level of education for girls, high rate of child mortality, and negatively associated with governance measured as rule of law, voice and accountability (p. 18).

Some changes on the structure of institutions for using ICTs may help to empower women and can be source of gender equality by suggesting new rules such as equality between men and women, rights such as equalizing women's rights, and creating new laws and policies (Prügl, 2004). For the long term economic development for a country, availability and usage of ICTs should be complemented with effective policies provided by institutions and governance to increase the awareness of the people about their rights. In this study six different dimension of institutional quality are used to analyze how ICT interacts with social and institutional infrastructure impact gender inequality: i) Bureaucratic quality, which shows the quality and strength of bureaucracy as shock absorber, ii) Composite risk rating, which shows political, economic and financial risk rates of the countries iii) Corruption, which is the failure of governance in economic, financial, and political environment, iv) Democratic accountability, which shows responsiveness of the government to its citizenships, as well as free and fair elections of the government, v) Government Stability, which shows the ability of the government to stay in office

and manage its programs vi) Law and order, which shows the strength of the legal system and practice of complying with laws. All these are the supply side components of the governance, which have impact on gender inequality in terms of promoting women's rights, providing effective allocation of resources, increasing the economic activities, and building gender sensitive governance (Rao and Kelleher, 2003; Brody, 2009). Negative measures on these six components will bring uncertainty and government will lose its capacity to manage all its resources to lead its citizens and power. On the other hand, according to the results of a study about the impact of ICT expansion in the Middle East region for the period of 1995-2003 by Shirazi (2008), expansion of the ICT decreases the digital divide and promotes democracy and freedom in the region as well.

4.3. Empirical Methodology

The focus of this study is to investigate impact of institutional quality and governance on gender equality and its interaction with ICT. Validity of simultaneity hypotheses that institutional quality and governance and ICT have interaction, ICT's impact on gender equality improves via indirect channels when institutional quality and governance simultaneously improves.

We use two empirical specifications to investigate the impact of ICT and institutional quality on gender equality. Specifications do differ mainly in terms of their dependent variables, although control variables also differ slightly across the specifications. The first specification uses gender equality in employment as the dependent variable. Gender equality in employment is defined as the ratio of female to male labor force activity rates, which is obtained by dividing the labor force participation rates for females by the labor force participation rate for males. We use six measures of ICT access and density in the specification. These are (1) number of

computers per 100 people, (2) the number of internet users per 100 people, (3) the number of telephones per 100 people, (4) ICT expenditure as a share of GDP, (5) ICT expenditure per capita, and (6) mobile subscribers per 100 people. Due to the high correlation between the different ICT measures each variable is used in a separate regression, leading to six estimations for the specification. The institutional quality and governance is proxied by six variables obtained from PRS. These six indicators are (i) Bureaucratic Quality, (ii) Corruption, (iii) Law and Order, (iv) Composite Risk Rating, (v) Government Stability, and (vi) Democratic Accountability. Since all six measures are highly correlated we construct an index of institutional quality from the underlying six series using principal components analysis, which proxies the institutional quality and governance in the estimated regressions. The construction of the institutional quality index is explained in the empirical section. In the first regression specification, per capita real GDP, female average years of total schooling for age 15 and above, total average years of total schooling for age 15 and above, urbanization ratio, and unemployment rate are used as control variables. To account for the possibility of endogeneity, most independent variables are lagged by one year.

The panel regression specification for the gender equality in employment can be written as follows:

$$\begin{aligned}\Delta RFMLFAR_{i,t} = {} & \beta_1 + \beta_2 \Delta LGDPPC_{i,t-1} + \beta_3 \Delta UR_{i,t-1} + \beta_4 \Delta U_{i,t} + \beta_5 \Delta BLST_{i,t-1} \\ & + \beta_6 \Delta BLSF_{i,t-1} + \beta_7 \Delta INSTQ_{i,t-1} + \beta_8 \Delta ICT_{i,t-1} \\ & + \beta_9 \Delta [ICT_{i,t-1}{}^{*} INSTQ_{i,t-1}] + \beta_{10} \Delta RFMLFAR_{i,t-1} + \varepsilon_{it}\end{aligned} \tag{4.1}$$

where, i denotes country, t denotes year, and Δ denotes first differences. The variables are defined as follows:

FLFPR = Labor participation rate, female (percent of female population ages 15 above)

MLFPR = Labor participation rate, male (percent of male population ages 15 above)

RFMLFAR = Ratio of Female to Male Labor Force Activity Rates, defined as FLFPR/ MLFPR

LGDPPC = Logarithm of GDP per capita (current US$)

U = Unemployment, total (percent of total labor force)

UR = Urban population (percent of total)

BLSF = Barro-Lee Average years of total schooling, age 15 and above, female

BLST = Barro-Lee Average years of total schooling, age 15 and above, total

INSTQ = Institutional Quality Index

ε = Error Term.

and ICT is one of the following measures of ICT access and density,

LIU = Logarithm of Internet users (per 100 people)

LMCS = Logarithm of Mobile cellular subscriptions (per 100 people)

LPC = Logarithm of Personal Computers (per 100 inhabitants)

LTL = Logarithm of Telephone lines (per 100 people)

ICTEPC = Information and communication technology expenditure per capita (current US$)

ICTEPGDP = Information and communication technology expenditure (% of GDP)

The second specification uses gender equality in education as the dependent variable. Gender equality in education is defined as the ratio of female to male primary and secondary school students, which is obtained as the enrollment ratio of girls at primary and secondary education level in both private and public schools to boys. The second dynamic panel regression is specified as follows:

$$\begin{aligned}\Delta RFMPSSS_{i,t} = {} & \beta_1 + \beta_2 \Delta LGDPPC_{i,t-1} + \beta_3 \Delta YR_{i,t} + \beta_4 \Delta BLST_{i,t-1} + \beta_5 \Delta BLSF_{i,t-1} \\ & + \beta_6 \Delta INSTQ_{i,t-1} + \beta_7 \Delta ICT_{i,t-1} + \beta_8 \Delta [ICT_{i,t-1}{}^{*} INSTQ_{i,t-1}] \\ & + \beta_9 \Delta RFMPSSS_{i,t-1} + \varepsilon_{it}\end{aligned} \qquad (4.2)$$

where,

RFMPSSS = Ratio of Female to Male Primary and Secondary School Students

YR = Youth Sex Ratio, calculated as ratio of the number of females between the ages 0 to 14 to the number of males between the ages 0 to 14

We estimate a dynamic fixed effects panel data model using the Arellano-Bond system generalized method of moments (GMM) method for the countries with available data. The number of observations used in each regression varies due the data availability for related variables.

4.4. Empirical Results

The study employs a panel data set for 209 countries for the period from 2000 to 2010. The data is obtained from various sources. The underlying regressions uses gender gap measures obtained from the World Bank World Development Indicators (WDI) database and the OECD. We use several variables for ICT, which are obtained from the International Telecommunication Union's (ITU) ICT Indicator's Database. The data for the governance and institutional quality is obtained from the

Political Risk Services Group's (PRS) International Country Risk Guide (ICGR) database. Average years of schooling as a share of the total population or average educational attainment were most commonly used variables in the literature as control variable. Cohen and Soto (2001) and Barro and Lee (1994, 2001) are the two main source of data on educational attainment. We combine and extend this data set in our study. Table 6 gives definitions of the variables used in the study. Descriptive statistics for all variables are given in Table 7.

Table 6. Variable Definitions

Variable	Description
RFMPSSS	Ratio of Female to Male Primary and Secondary School Students
FLFPR	Labor participation rate, female (percent of female population ages 15+)
MLFPR	Labor participation rate, male (percent of male population ages 15+)
RFMLFAR	Ratio of Female to Male Labor Force Activity Rates, defined as FLFPR/ MLFPR
GDPPC	GDP per capita (current US$)
U	Unemployment, total (percent of total labor force)
IU	Internet users (per 100 people)
MCS	Mobile cellular subscriptions (per 100 people)
PC	Personal Computers (per 100 people)
TL	Telephone lines (per 100 people)
UR	Urban population (percent of total)
BLSF	Barro-Lee: Average years of total schooling, age 15+, female
BLST	Barro-Lee: Average years of total schooling, age 15+, total
ICTEPC	Information and communication technology expenditure per capita (in dollars)
ICTEPGDP	Information and communication technology expenditure (percent of GDP)
BQ	Bureaucratic Quality
RR	Composite Risk Rating
CO	Corruption
DA	Democratic Accountability
GS	Government Stability
LO	Law and Order
YR	Youth Sex Ratio

Table 7. Descriptive Statistics

	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	Obs.
RFMPSSS	95.39	99.28	135.32	0.00	11.56	-1.91	8.15	2610
FLFPR	50.65	51.10	91.00	10.40	15.31	-0.09	3.02	4217
MLFPR	76.83	77.60	94.50	45.30	7.95	-0.39	3.08	4217
RFMLFAR	0.66	0.70	1.04	0.15	0.18	-0.60	2.82	4217
GDPPC	8984.12	2440.56	201164.00	69.12	15719.11	3.90	27.40	4357
U	8.98	7.70	59.50	0.30	6.26	2.46	13.37	2230
IU	12.79	2.67	94.52	0.00	19.99	1.88	5.75	3762
MCS	24.45	3.96	232.07	0.00	36.79	1.67	5.13	4479
PC	10.44	3.50	98.00	0.00	16.34	2.41	8.89	2240
TL	19.07	11.32	94.43	0.01	19.88	1.02	3.09	4551
UR	54.81	54.94	100.00	5.40	24.00	0.04	1.98	4760
BLSF	6.91	6.91	13.03	0.26	1.13	-0.89	14.94	5040
BLST	7.28	7.28	13.02	0.48	1.03	-0.78	15.56	5040
ICTEPC	924.34	924.34	4623.28	5.17	331.66	3.22	28.36	5040
ICTEPGDP	829.02	924.34	924.34	1.52	280.16	-2.60	7.75	5040
BQ	2.16	2.00	4.00	0.00	1.16	0.01	2.19	2771
RR	67.51	68.46	92.50	13.04	12.99	-0.69	3.72	2768
CO	2.95	3.00	6.00	0.00	1.32	0.48	2.66	2771
DA	3.79	4.00	6.00	0.00	1.70	-0.36	2.13	2771
GS	8.08	8.38	12.00	0.67	2.08	-0.63	2.99	2771
LO	3.80	4.00	6.00	0.00	1.43	-0.12	2.11	2771
YR	97.57	98.18	99.00	81.48	1.72	-2.81	14.91	4760

Since six measures of institutional quality and governance, Bureaucracy Quality (BQ), Composite Risk Rating (RR), Corruption (CO), Democratic Accountability (DA), Government Stability (GS), Law & Order (LO), are highly correlated (See Table 3, third panel) we convert these six measures into an index of institutional quality and governance using principal component analysis. Let X be a matrix defined as X=[BQ CO DA GS LO RR]. The principal components are obtained using the eigenvalues and eigenvectors of the X'X matrix, where X is the nx6 matrix of n observations on six measures of institutional quality and governance First, we obtain the eigenvalues $\lambda 1>\lambda 2>\lambda 3>\lambda 4>\lambda 5>\lambda 6$ of the X'X matrix and corresponding

eigenvectors A=[q1,q2,q3,q4,q5,q6]. Using the eigenvector corresponding to the largest eigenvalue λ1, the institutional quality index Z is obtained as Z=Xq1. Z forms the index henceforth referred to as INSTQ, and used in the empirical analysis as an indicator of institutional quality and governance. The eigenvalues and eigenvectors and corresponding loadings are reported in Table 8. We use the eigenvector in the first column which corresponds to the largest eigenvalue 3.491. The first principal component accounts for over 58.2 per cent of the total variation in the variables.

Table 8. Principal Components Analysis for Institutional Quality Variables

Eigenvalues: (Sum = 6, Average = 1)

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	3.491	2.343	0.582	3.491	0.582
2	1.148	0.574	0.191	4.639	0.773
3	0.574	0.237	0.096	5.212	0.869
4	0.337	0.045	0.056	5.549	0.925
5	0.292	0.133	0.049	5.841	0.974
6	0.159	---	0.026	6.000	1.000

Eigenvectors (loadings):

Variable	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6
BQ	0.472	-0.145	0.015	-0.348	-0.653	0.456
CO	0.421	-0.302	-0.380	0.748	-0.120	-0.119
DA	0.375	-0.324	0.774	0.125	0.361	0.096
GS	0.170	0.841	0.212	0.380	-0.080	0.260
LO	0.449	0.123	-0.455	-0.285	0.641	0.291
RR	0.479	0.247	0.063	-0.280	-0.106	-0.785

Ordinary correlations:

	BQ	CO	DA	GS	LO	RR
BQ	1.000					
CO	0.666	1.000				
DA	0.602	0.511	1.000			
GS	0.132	0.006	0.017	1.000		
LO	0.647	0.616	0.400	0.291	1.000	
RR	0.744	0.552	0.528	0.465	0.739	1.000

A major focus of this study is the interaction between ICT and institutional quality. In order give a rough idea on the relationship between these variables Figure 6 plots ICT expenditure per capita against each of six institutional quality variables. The

linear regression fits are also given in the graphs. Plots in Figure 6 show that all measures of institutional quality are positively correlated with ICT expenditure, which is a measure of ICT availability. In order illustrate that in addition to indirect impact of institutional quality via its impact on ICT, there is also a direct impact on gender equality Figures 7 and 8 plot each of six measures of institutional quality against ratio of female to male labor force activity rates (gender equality in employment) and ratio of female to male primary and secondary school students (gender equality in education), respectively. Both Figure 7 and 8 indicate that there is a positive direct impact of institutional quality on gender inequality, although some of the variables are only slightly correlated.

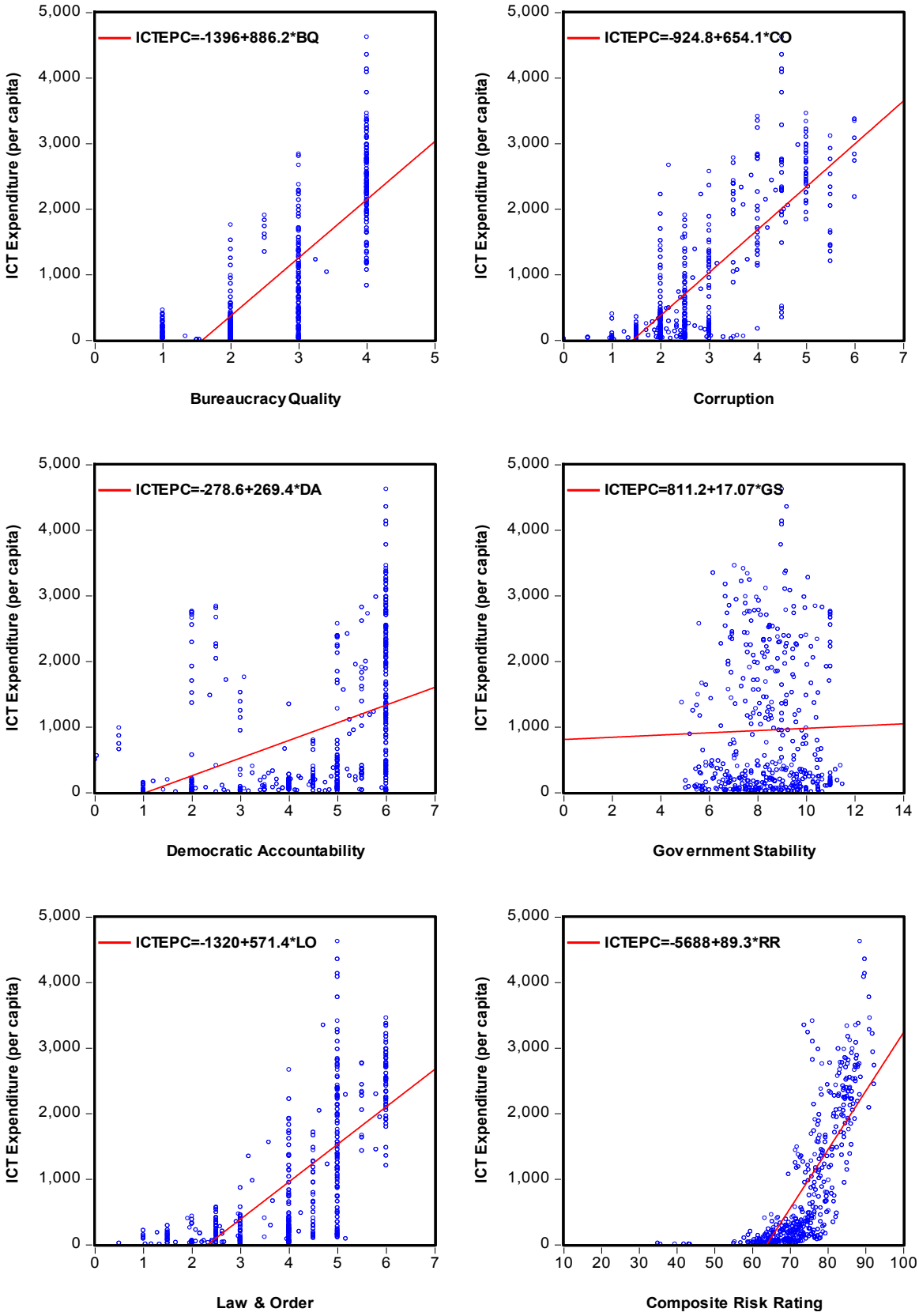

Figure 6. Institutional Quality and ICT

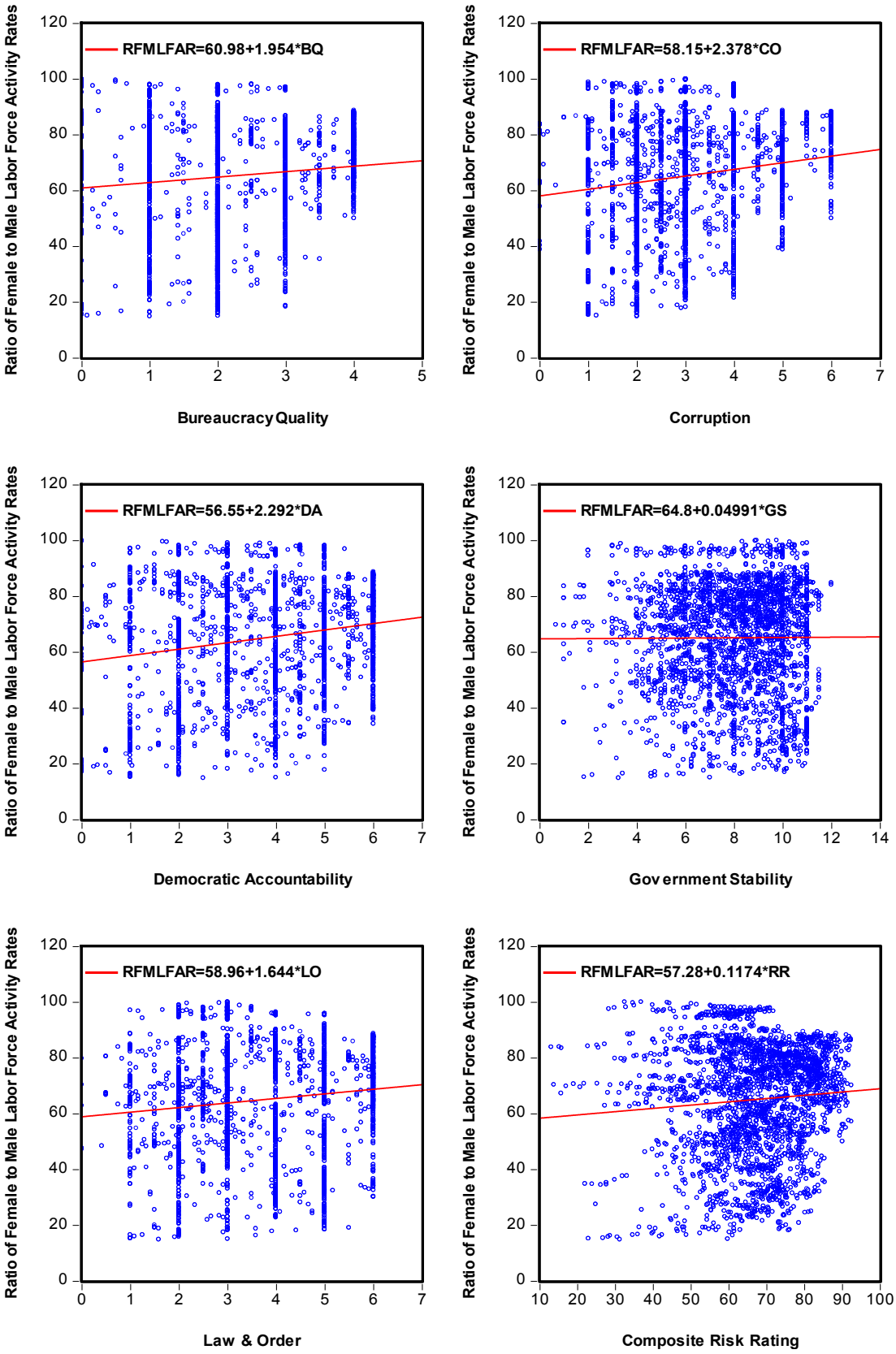

Figure 7. Institutional Quality and Gender Equality in Employment

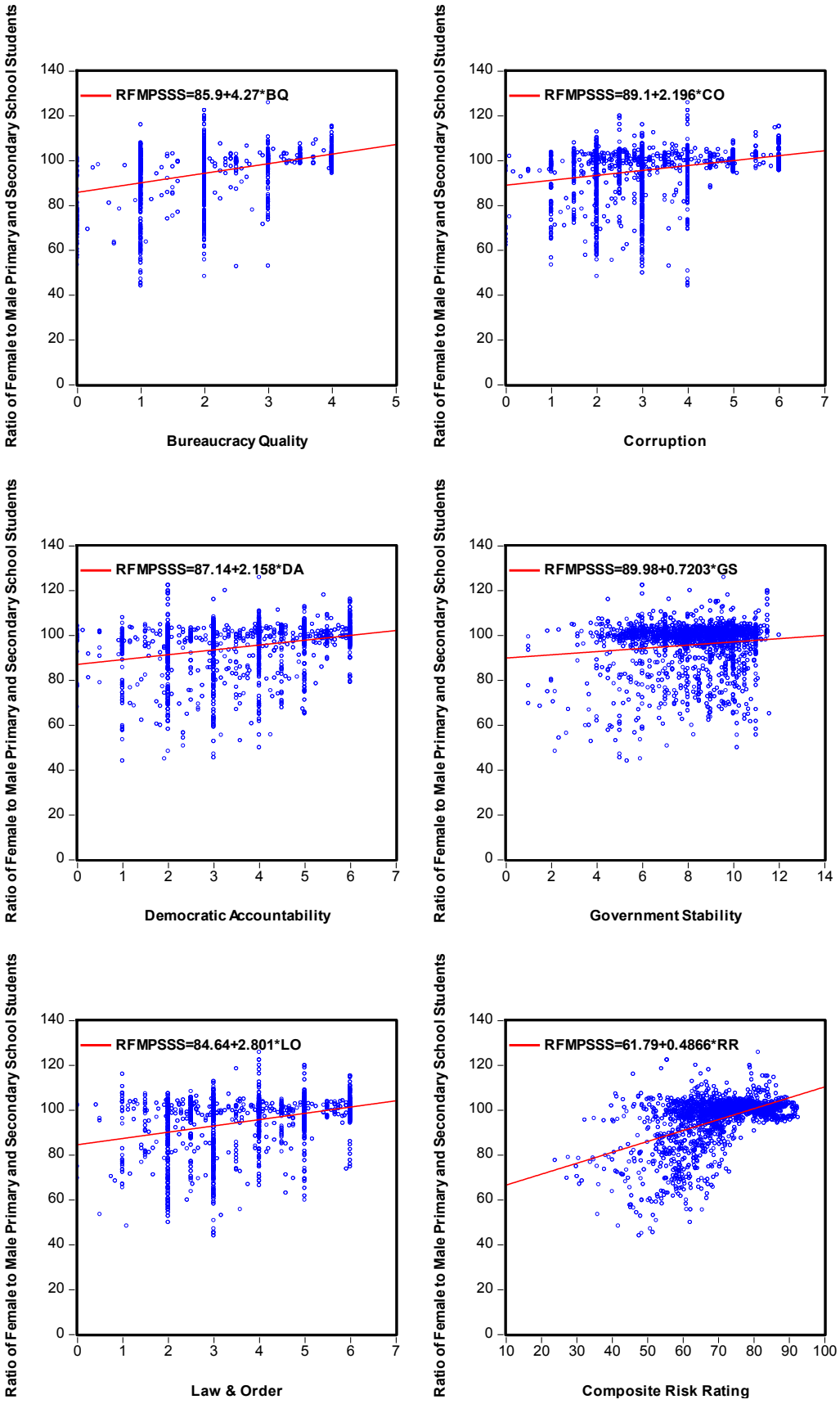

Figure 8. Institutional Quality and Gender Equality in Education

Arellano-Bond System GMM estimation is carried out for both Eq. 4.1 and Eq. 4.2 Since all six measures of ICT access and availability we consider are strongly correlated, which is shown by the Pearson correlation coefficient estimates reported in Table 9, each ICT measure was entered into a separate regression, leading to six regressions for each specification in Eq.1 and Eq. 4.2. The specification of the gender equality in employment (Eq. 4.1) and education (Eq. 4.2) holds out correlation between the lagged first-differenced of endogenous variable and the errors. Using instrumental variables (IVs) get over this problem. As instruments, using the levels of endogenous variables or lagged past differences, known as Anderson-Hsiao IV approach, is suggested by Anderson and Hsiao (1982). These instrumental variables are offered within the outline of the generalized method of moments (GMM), since there may not be highly correlation between IVs and the first difference of dependent variable. Alternative, Arellano-Bond GMM approach suggested by Arellano and Bond (1991) is another method that takes into consideration the first differences of the endogenous variable be instrumented with lags of its own levels. For first differences, Blundell and Bond (1998) indicated that lagged levels are frequently weak instruments, therefore, all information belongs to endogenous and exogenous variables should be used. This is known as the Arellano and Bond system (Arellano-Bond System GMM approach) method and even in small samples it provides more efficient unbiased estimates. In our implementation, we specify the use of the first to fifth lags of all the variables included in the regression as GMM-style instruments. We used all appropriate variables as instruments to make sure, but to avoid biasing our parameters, we included one instrument for each variable and lag distance rather than one instrument for each variable, lag distance and time period because of having large number of instruments relative to the number of observations, the parameter

estimates become biased towards FGLS (Blundell and Bond, 1998). We estimated Eq. 4.1 and Eq. 4.2 using three methods above, but report only Arellano-Bond System GMM estimations results to save space. The results from other two methods are quite close to System GMM results and available from the author upon request.

Table 9. Pearson Correlation Coefficients between Measures of ICT

	LPC	LIU	LTL	LMCS	ICTEPC	ICTEPGDP
LPC	1.00					

LIU	0.71	1.00				
	(40.8)	-----				
LTL	0.76	0.48	1.00			
	(48.0)	(22.4)	-----			
LMCS	0.67	0.87	0.45	1.00		
	(36.6)	(70.7)	(20.9)	-----		
ICTEPC	0.35	0.16	0.24	0.11	1.00	
	(15.2)	(6.50)	(10.3)	(4.35)	-----	
ICTEPGDP	-0.23	-0.37	-0.08	-0.38	0.02	1.00
	(-9.87)	(-16.2)	(-3.29)	(-16.7)	(0.83)	-----

Notes: *t*-statistic for the significance of the Pearson correlation coefficients are given in parentheses.

Arellano-Bond System GMM estimation results for ratio of female to male labor force activity rates (gender equality in employment) are presented in Table 10. Table 11 reports the Arellano-Bond System GMM estimation results for ratio of female to male primary and secondary school students (gender equality in education). Since results are qualitatively the same, we will comment on results pertaining to both Eq. 4.1 and Eq. 4.2 jointly. There are three major conclusions we can draw from the empirical results. First, in both regressions the interaction variables between the ICT and institutional quality are strongly significant (statistical significance is attained at 1 percent level in all regressions) and positive. This result establishes strong evidence

in favor of the simultaneity hypothesis that joint improvements in ICT and institutional quality have positive impact on gender equality in employment and education above and beyond the direct impacts of ICT and institutional quality and governance alone. Second, a significant direct impact from ICT measures to gender equality is found only with few exceptions. Third, the direct impact of institutional quality and governance on both educational and employment gender equalities is positive and significant uniformly across all regression estimates.

Table 10. Arellano–Bond system GMM Panel Regression
Dependent Variable: Ratio of Female to Male Labor Force Activity Rates

Independent Variables	Eq. 1.1	Eq.1.2	Eq. 1.3	Eq. 1.4	Eq. 1.5	Eq. 1.6
$\Delta RFMLFAR_{i,t-1}$	0.037519 (0.0309)	0.080496 (0.0282)**	0.069776 (0.0257)**	0.080906 (0.0260)**	0.067817 (0.0257)**	0.067945 (0.0257)**
$\Delta LGDPPC_{i,t-1}$	0.723951 (0.3760)	0.225325 (0.2762)	2.355709 (0.2830)**	0.521432 (0.2933)	1.653219 (0.2738)**	1.042393 (0.3021)**
$\Delta UR_{i,t-1}$	0.390726 (0.0587)**	0.425242 (0.0527)**	0.697569 (0.0467)**	0.385550 (0.0482)**	0.705209 (0.0423)**	0.634579 (0.0431)**
$\Delta U_{i,t}$	-0.060815 (0.0336)	-0.057839 (0.0319)	-0.035472 (0.0337)	-0.060056 (0.0308)	-0.064078 (0.0320)*	-0.039007 (0.0320)
$\Delta BLST_{i,t-1}$	0.001777 (0.0006)**	0.005028 (0.0005)**	0.002781 (0.0006)**	0.004330 (0.0014)**	0.001203 (0.0006)**	0.001923 (0.0006)**
$\Delta BLSF_{i,t-1}$	0.001613 (0.0003)**	0.004768 (0.0003)**	0.000053 (0.0004)**	0.004626 (0.0001)**	0.001469 (0.0003)**	0.002379 (0.0003)**
$\Delta INSTQ_{i,t-1}$	0.172841 (0.0457)**	0.167678 (0.0381)**	0.186616 (0.0445)**	0.153809 (0.0328)**	0.156608 (0.0408)**	0.329779 (0.0450)**
$\Delta LPC_{i,t-1}$	3.800912 (0.8037)**					
$\Delta(LPC_{i,t-1}{}^{*}INSTQ_{i,t-1})$	0.144641 (0.0177)**					
$\Delta LIU_{i,t-1}$		2.034288 (0.2451)**				
$\Delta(LIU_{i,t-1}{}^{*}INSTQ_{i,t-1})$		0.063215 (0.0056)**				
$\Delta LTL_{i,t-1}$			2.706005 (0.7128)**			
$\Delta(LTL_{i,t-1}{}^{*}INSTQ_{i,t-1})$			0.059636 (0.0175)**			
$\Delta LMCS_{i,t-1}$				2.319099 (0.2256)**		
$\Delta(LMCS_{i,t-1}{}^{*}INSTQ_{i,t-1})$				0.075535 (0.0054)**		
$\Delta ICTEPC1_{i,t-1}$					0.000010 (0.0016)	
$\Delta(ICTEPC1_{i,t-1}{}^{*}INSTQ_{i,t-1})$					0.000039 (0.0000)	
$\Delta ICTEPGDP1_{i,t-1}$						0.011913 (0.0016)**
$\Delta(ICTEPGDP1_{i,t-1}{}^{*}INSTQ_{i,t-1})$						0.000313 (0.0000)**
Observations	1087	1329	1478	1408	1479	1479
R-squared	0.98	0.98	0.97	0.98	0.98	0.98
F or Wald χ^2-statistic	77.34	121.54	115.26	101.60	109.80	109.72
Hansen's J-statistic	8.93	7.44	7.99	7.67	8.43	8.94
Levin–Lin–Chu panel unit root test (*t*-statistic)	-11.42	-11.42	-11.42	-11.42	-11.42	-11.42
Arellano–Bond test of AR(1) in residuals (*z*-statistic)	-2.33	-2.61	-2.45	-2.65	-2.34	-2.29
Arellano–Bond test of AR(2) in residuals (*z*-statistic)	-0.81	-0.84	-0.77	-0.78	-0.83	-0.79

Notes: Robust standard errors, given in parentheses, are estimated using hetroskedasticity and autocorrelation consistent covariance matrix estimation. Specifications tests were performed that indicated there was no over-all serial correlation in the errors (Wooldridge, 2002) but there was group-wise heteroskedasticity (Greene, 2003). As a result, we used a specification that considered each country a ''cluster'' and allowed a covariance structure where error terms were correlated within cluster, but uncorrelated across clusters.
** indicates significance at 1 percent level.

Table 11. Arellano–Bond system GMM Panel Regression
Dependent Variable: Ratio of Female to Male Primary and Secondary School Students

Independent Variables	Eq. 1.1	Eq.1.2	Eq. 1.3	Eq. 1.4	Eq. 1.5	Eq. 1.6
$\Delta RFMPSSS_{i,t-1}$	0.107214 (0.0344)**	0.139164 (0.0317)**	0.064483 (0.0286)*	0.130728 (0.0308)**	0.063443 (0.0287)*	0.07177 (0.0287)*
$\Delta LGDPPC_{i,t-1}$	0.376886 (0.1252)**	0.593195 (0.2846)*	0.228494 (0.0836)**	0.746318 (0.3256)*	0.268223 (0.1267)**	0.381680 (0.1057)**
$\Delta YR_{i,t}$	0.742304 (0.3263)*	4.220571 (0.3577)**	2.087670 (0.2360)**	2.165357 (0.2869)**	3.083460 (0.2140)**	3.062585 (0.2142)**
$\Delta BLST_{i,t-1}$	0.019412 (0.0042)**	0.050321 (0.0017)**	0.07372 (0.0053)**	0.0266521 (0.0049)**	0.056134 (0.0054)**	0.024512 (0.0054)**
$\Delta BLSF_{i,t-1}$	0.017482 (0.0039)**	0.036855 (0.0044)**	0.096078 (0.0049)**	0.0202970 (0.0046)**	0.071886 (0.0050)**	0.010701 (0.0050)**
$\Delta INSTQ_{i,t-1}$	0.065920 (0.0039)**	0.066539 (0.0040)**	0.177350 (0.0383)**	0.067524 (0.0036)**	0.063477 (0.0047)**	0.101453 (0.0053)**
$\Delta LPC_{i,t-1}$	1.587970 (0.6785)*					
$\Delta(LPC_{i,t-1}{}^{*}INSTQ_{i,t-1})$	0.036878 (0.0152)*					
$\Delta LIU_{i,t-1}$		1.896811 (0.2282)**				
$\Delta(LIU_{i,t-1}{}^{*}INSTQ_{i,t-1})$		0.039872 (0.0054)**				
$\Delta LTL_{i,t-1}$			5.360034 (0.6381)**			
$\Delta(LTL_{i,t-1}{}^{*}INSTQ_{i,t-1})$			0.075289 (0.0153)**			
$\Delta LMCS_{i,t-1}$				2.031191 (0.2430)**		
$\Delta(LMCS_{i,t-1}{}^{*}INSTQ_{i,t-1})$				0.039048 (0.0060)**		
$\Delta ICTEPC1_{i,t-1}$					0.003661 (0.0011)**	
$\Delta(ICTEPC1_{i,t-1}{}^{*}INSTQ_{i,t-1})$					0.005314 (0.0002)**	
$\Delta ICTEPGDP1_{i,t-1}$						0.010608 (0.0021)**
$\Delta(ICTEPGDP1_{i,t-1}{}^{*}INSTQ_{i,t-1})$						0.000245 (0.0000)**
Observations	1119	1436	1661	1518	1662	1662
R-squared	0.91	0.93	0.91	0.91	0.91	0.91
F-statistic	441.78	460.56	385.03	471.45	414.87	415.09
Hansen's J-statistic	7.63	6.44	7.99	7.67	8.43	8.94
Levin–Lin–Chu panel unit root test (*t*--statistic)	-8.41	-8.41	-8.41	-8.41	-8.41	-8.41
Arellano–Bond test of AR(1) in residuals (**z**-statistic)	-2.84	-2.86	-2.84	-2.78	-2.63	-2.92
Arellano–Bond test of AR(2) in residuals (*z*-statistic)	-0.74	-0.78	-0.78	-0.77	-0.76	-0.77

Notes: *Notes*: Robust standard errors, given in parentheses, are estimated using hetroskedasticity and autocorrelation consistent covariance matrix estimation. Specifications tests were performed that indicated there was no over-all serial correlation in the errors (Wooldridge, 2002) but there was group-wise heteroskedasticity (Greene, 2003). As a result, we used a specification that considered each country a ''cluster'' and allowed a covariance structure where error terms were correlated within cluster, but uncorrelated across clusters.
** indicates significance at 1 percent level.

Chapter 5

THE IMPACT OF GENDER EQUALITY AND ICT ON CHILD DEVELOPMENT: A CROSS COUNTRY ANALYSIS

5.1. Introduction

The objective of this study is to analyze the relationship between gender inequality, information and communication technology (ICT), and child development using cross-country data on 137 countries. Child development refers to having both physical and psychological capabilities and strengths to make activities and have successful relationships, which are appropriate for their age and development, and it covers nutrition, immunization, breastfeeding, schooling etc. In our study, child development is defined in broad sense to include also child and infant mortality. It is commonly expected that the gender equality have positive impact on improving health and nutrition of children (World Bank, 2000, 2003; Oster, 2006; Save the Children, 2008). Several studies also related technology and child development, especially on education side. It has been argued that technology should have positive impact on child's educational development (Atkinson et al., 2001; Kulik and Kulik, 1991; Pierce, 1994). The evidence on the impact of gender inequality and technology on child development until now has been mixed, if not confusing. Indeed, majority of the studies did not find much impact from gender inequality to child development and those that found significant effect noticed that the effect disappears when control variable are added.

This study differs from the previous studies in three ways. First, we utilize broader concepts of both child development and gender equality. The study uses gender inequality indexes, which are based on variables that measure several dimensions on gender inequality. Child development is not only measured by education, nutrition and mortality rates individually. We adopt a broader view of child mortality by constructing a child development index that accounts of several dimensions of child development. Second, our study defines technology again in a broader sense as the information and communication technology (ICT) developments. Several variables, such as the personal computers (per 1000 inhabitants), internet users (per 1000 people), telephone lines (per 1000 people), mobile cellular subscriptions (per 1000 people), information and communication technology expenditure per capita (current US$), information and communication technology expenditure (% of GDP), that capture both ICT access and availability is employed in the study. Third, we allow interaction between gender inequality and ICT. ICT development influences child development not only by making information more available and accessible, but also improving education and empowerment of mothers, and therefore an indirect but probably more important impact from ICT to child development exists. The study constructs the most extensive data set available in order to estimate cross-country regressions. The data set covers the 2000-20008 period, but it is transformed to a single time observation by aggregated to 2008. Several variants of the basic specification are estimated using more than dozen of control variables. Estimation controls for endogeneity by using instrumental variables estimation and heteroskedasticity by consistent estimation approaches.

5.2. Theories on Gender Equality, ICT and Child Development

Children's well being refers the concept of having both physical and psychological capabilities and strengths to make some activities and to have successful relationships which are appropriate for their age and development[37]. These also cover nutrition, immunization, breastfeeding, schooling and etc... Children have very important influence on future economic development of countries through transferring some development tools to the next generations.

There are two main theories behind this study; human capital approach and Sen's capability approach. Human capital approach refers investments in human capacities, which raise the productivity, such as education and health, job training programs, skills and abilities etc. Both education and health allows people to develop their well-beings through directly or indirectly. Health and education indicators can be taken as the components of well-being. Human capital approach focuses on the indirect ability to increase the utility level of people by increasing incomes. However, Sen's capability approach criticizes this utility-based human capital approach. According to the Sen's capability approach, income should not taken as an adequate measure of well being and this approach is people centred rather than focusing on commodities, income or wealth (Robeyns,2003). Because, utility based approach does not criticize the distribution of utility or income among the people within the family. In recent years, indexes developed to measure gender inequalities can work parallel on Sen's approach by focusing on different dimensions of capabilities. Sen (1997) classified the roles of capabilities under three headings as i) their direct impacts on wellbeing

[37] http://www.aponline.gov.in/Apportal/HumanDevelopmentReport2007/APHDR_2007_Chapter9.pdf

and freedoms, ii) their indirect role on social change, and iii) their indirect role on economic production (p.1960). According to Saito (2003), human capital approach analyses only indirect effects of capabilities through influencing economic production, while human capability approach covers all headings mentioned above. As a result, human capital approach focuses on the resources, while Sen's approach focuses on the abilities to use available resources. Sen (1997) emphasizes that capability approach should taken into consideration as complementary, rather than taking it as substitute to human capital approach. In this study, we tried to show that the ICT may be used as a tool to improve gender equality through increasing capabilities of women, and this improvement in gender equality causes an increase in the child development.

5.3. Literature Review on Gender Equality, ICT and Child Development

Children may not have freedom in each respect. However, human capability approach can be still applicable for children. Even if they could not make their choices, especially in early ages, they show reactions to reflect their wants and needs, and they learn how they make their choices in the future among the alternatives through this way. Therefore, well beings of children plays very critical role on human development and economic development in the future.

In 2000, The UN declared its third goals as promoting gender equality and empowers women, and the following goals were to reduce child mortality and improve maternal health. It is commonly expected that the gender equality has positive impact on improving health and nutrition of children (World Bank, 2000, 2003; Oster, 2006; Save the Children, 2008). On the other hand, relationship between technology and

child development examined in the literature many times as well, especially on education side, and again it is expected to have positive impact on child's educational development (Atkinson et al., 2001). However, not only nutrition and health after birth, but also maternal health also plays essential role on improving health and nutrition of new-born children.

While understanding the link between gender equality and child well being, some indicators were commonly used in the literature such as maternal mortality rates, mortality rates for infants, weight for heights as a measure of child nutrition, and mother's education as a measure of gender equality. The values of these indicators change from one country to another, and between the regions within same county. For instance, According to the World Bank data in 2009, Sub-Saharan Africa has still highest fertility and mortality rate, lowest immunization ratio for children ages between 18-23 months, and lowest ratio of girls to boys in primary and secondary education. Kirk and Pillet(1998) explain the reasons of positive relationship between fertility rates with rate of mortality in two ways; first reason is that both fertility rate and mortality rate can be explained by same determinants such as level of education and level of income. And second reason can be having short interval between the births.

A study by Cleland and Ginneken (1988) showed that each additional year on mother's education results 5-7% decrease in mortality rate of less than 5 years old child. However, they also emphasized that other economic variables associated with education such as income, quality of house, and water sanitations etc. should be

considered while analysing the relationship between education and the mortality rates.

Deasi and Alva (1998) examined the relationship between maternal education on children's height for age, infant mortality, and immunization status by using an econometric model for 22 developing countries. As a result of their study, they argued that maternal education has significant impact on these variables; however, its impact on infant mortality and children's height for age becomes weaker when introducing the control variables into the model, such as education of husband, having a clean water and toilet, while its significance on immunization remains reasonably strong. Chen and Li (2006) used sample of 2140 children in China, whose age between 0 and 4, and found similar results even they controlled the variables for income, health environment, and number of siblings as well. Additionally, they concluded that, mother's education has more impact on children's health than father's education. And also, Miller and Rodgers (2009) investigated the impact of mother's education on child nutrition for Cambodia by using the height for age which refers stunting as a long term nutrition indicator, and low weight for height which refers wasting as a short term nutrition indicator. They found that mother's education is not significant for size at birth when socioeconomic variables, such as father's education, types of occupation and earning, and household wealth, introduced to the equation. However, the results show that the mother's education is highly significant and inversely associated with stunting of children; 1/3 less stunting problem is seen for the children whose mother has at least secondary education. Miller and Rodgers (2009), on the other hand, mentioned that the mother's education is not related to wasting as much as stunting. Aslam and Kingdon (2010) also studied

on pathways of parental education and child health in Pakistan and found that father's education and health knowledge is positively related to the immunisation while mother's education, health knowledge, and empowerment within the home is strongly related to children's long term health outcomes.

A study conducted by Phukan et al. (2008) focused on the relationship between immunization which is another determinant of child health, and mother's education for India, and showed that the education level of mother has high significance on immunization, especially for children living in rural areas. However, according to the econometrics results of Burchi (2009) for Mozambique, marginal contribution of mother's education on children's nutrition is decreasing after the graduating from primary education, and graduating from secondary schooling has an indirect effect through increasing wealth for the households. And, interestingly, they found that the benefit getting from the mother's education does not depend on the location where they live in rural or urban. Another study considering the Mozambique by Garrett and Ruel (1999) showed that mother's education has a significant positive impact on child nutrition "above and beyond" the income effect (p.1971). They also concluded that higher combination of income and mother's education might lead less childhood malnutrition in long run.

There are many empirical studies in the literature analysing the link between maternal educations with child health indicators. Under the light of the findings in the above literature, it can be concluded that the education of mother is more effective determinant rather than father's education on child nutrition and well-being. Because, educated mother have higher ability to learn, participate, evaluate, and

access to economic and health related services to provide better nutrition conditions for their children and protect them from some diseases through increasing their general knowledge and health knowledge.

On the other hand, some studies argued that increased status of women in labour market might cause a negative effect on their child well being due to spending less time with their children (Smith et al., 2002; Leslie, 1998). For instance, women who work outside will have limited time for breastfeed or will have less time to play with their children. And such kinds of activities do not have any substitute for the children and plays a very important role on children's psychological and physical developments.

This study differs from previous studies in some ways; a) it uses CDI (Child Development Index) as a measure of child development and GDI (Gender related Development Index) as a measure of gender equality, which account of several dimensions of child development and gender equality, b) it defines technology in a broader sense as ICT (Information and Communication Technology) with several ICT related variables that capture both availability and access, c) it uses some institutional variables as control variables and their interaction with ICT and gender equality.

In the literature, most studies related to technology and child developments focus on the educational technology and its impact on children's performance. However, there is no any empirical study which shows the impact of ICT on children under 5 years

old. In this study we tried to analyse the indirect effect of ICT, by considering the results of mother's ICT usage and its availability for them, on child development.

5.4. Measuring the Child Development

Save the Children (2008) in UK developed a Child Development Index (CDI) to control and monitor of child well being for 88 countries in the first period (1990-1994), 118 countries in second period (1995-1999), and 137 countries in third period (2000-2006) by using three variables; i) under five years mortality rates as health indicator, ii) the percentage of under five who are moderately and severely underweight as nutrition indicator, iii) the percentage of primary school age children who are not enrolled in school as education indicator. All the variables have same weight within the index and zero is the minimum score which refers the situation where all children less than five years old are well nourished, survived, and enrolled in primary school while 100 is highest score which refers the situation where all children less than five years old are underweight and out of school. According to the results, the best country is the Japan with score 0.41 and the worst is the Niger with score 58.47.

On the other hand, there are several indexes in the literature to measure the level of gender equality and gender empowerment as we discussed in previous chapters. The most popular gender indexes are Gender Development Index (GDI) and Gender Empowerment Measure (GEM). While analysing the gender equality and child development, comparison of these two gender equality indexes with the child development index can give meaningful interpretation to understand and show the relationship between them.

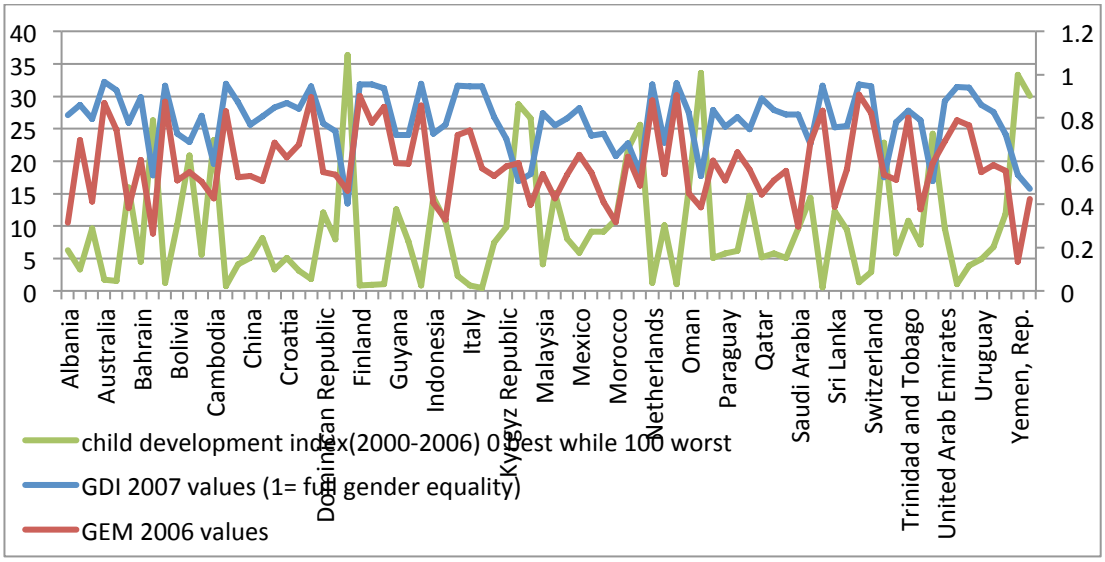

Figure 9. The Comparison between GDI, GEM, and CDI (Source: WB for GDI and GEM values, and Save the Children for CDI values)

It can be easily seen from the Figure 9, GDI and GEM values are moves in same direction. However, CDI can be seen that it is moving against the GDI and GEM. Here, we should consider that the low values of CDI show high-level child development. Therefore, analysis of child and gender related indexes shows that the countries which have lower level gender equality and empowerment will lead low level child development. And also, when we look at the correlations among the indexes, the correlation between child development (CDI) and gender development index (GDI) equals to 0.92685 while the correlation between child development (CDI) and gender empowerment measure (GEM) equals to 0.60435. Therefore, both gender empowerment and gender development has positive impact on child development. However, gender development is expected to contribute to child development to higher extend than gender empowerment.

5.5. Empirical Methodology

The focus of this study is to investigate impact of gender equality and ICT in child development. The main hypothesis is that the child development improves when ICT and gender equality is better in the countries.

The study uses average values of the data set for the period from 2000 to 2006 for 239 countries to investigate (1) the impact of gender equality on child development, (2) the impact of ICT on child development. The econometric estimation uses the gender development index (GDI) as a measure of gender equality, child development index (CDI) as a measure of child development, and six indicators of the ICT infrastructure or availability. The variables for ICT include i) Personal computers per 100 people inhabitants, ii) Internet users per 100 people, iii) Telephone lines per 100 people, iv) Mobile cellular subscriptions per 100 people, v) Information and communication technology expenditure per capita (current US$), vi) Information and communication technology expenditure (% of GDP). Due to the high correlation between the different ICT measures each variable is used in a separate regression. As a measure of institutional infrastructure quality, using principal component analysis for six variables obtained from Political Risk Group (PRS) forms an institutional quality index (INSTQ). These six variables are i) bureaucratic quality, which shows the bureaucratic quality of countries as a shock absorber, ii) composite risk rating, which shows the risk rates of countries in economical, political, and financial environment, ii) corruption, which is failure of governance in economic, political, and financial environment, iv) democratic accountability, as a measure of governance responsiveness to its citizenships, v) government stability, as a measure of ability of governments to stay in office and manage its programs, vi) law and

order, as a measure of strength of legal system of the country. Eigenvector corresponding the first principal component is used to weight each variable.

In some regressions, variables such as GDP per capita, heath expenditure per capita in current prices, urbanization ratio, literacy rate of adult female and public spending on education used as control variables. As a proxy for the countries level of development, GDP per capita is used. Public spending on education, literacy rate of female, and health expenditure variables indicate the improvement in education and health. Urbanization ratio is considered as a control variable, because, people in rural areas have more rigid views on gender roles dictated by society, and they are generally more conservative.

This study uses several empirical specifications to measure the impact of gender equality and ICT on child development. Specifications are different in terms of using the different forms of the independent variable, which is GDI, and some control variables as well because of their non linear relationship between dependent variable, which is child development index.

We estimate several variant of the following basic cross-section regression specification:

$$CDI_i = \mu + \beta_1 GDI_i + \beta_2 ICT_i + \beta_3 INSTQ_i + \gamma' X_i + \varepsilon_i \quad (5.1)$$

where i denotes the country. However, we used the average values of each variable between 2000-2006 periods because of having limited data for some variables in some periods.

CDI = Child Development Index

GDI = Gender Development Index

ICT = measure of ICT density or access, or ICT Index created by authors using factor analysis

INSTQ = a measure of Institutional Quality, or Institutional Quality Index created by using factor analysis

X = vector of control variables, which also includes interaction terms among GDI, ICT, and INSTQ

ε = Error Term.

ICT is one of the following measures of ICT access and density,

IU = Internet users (per 100 people)

MCS = Mobile cellular subscriptions (per 100 people)

PC = Personal Computers (per 100 inhabitants)

TL = Telephone lines (per 100 people)

ICTEPC = Information and communication technology expenditure per capita (current US$)

ICTEPGDP = Information and communication technology expenditure (% of GDP)

We estimate various functional forms of regression for the countries with available data to control for possible nonlinearities. However, CDI data is available for three-time period, and we used third time period, which covers the years of 2000-2006 in our study. Therefore, we first calculated the mean values of all other variables for the time period 2000-2006 to make them comparable. First, simple regressions are estimated, due to likely high multicollinearity. And also, according to the Breusch

Pagan and White test results, we used generalized least squares using White method to get consistent estimators to correct the t values and p values for the effect of heteroskedasticity. Then, general to specific modelling is used to obtain reduced models from the most general ones with or without interaction terms.

5.6. Empirical Results

The study uses the data set, which covers 239 countries for the period between 2000-2006 years. The data set obtained from different sources. CDI values obtained from the Save the Children in UK. Gender related variables and control variables are obtained from the World Development Indicators (WDI) database. We used six different variables of ICT, which are obtained from International Telecommunication Union's (ITU) ICT indicators database. Table 12 gives the definition of variables, and Table 13 shows the descriptive statistics of variables.

Table 12. Variable Definitions

Variable	Description
CDI	Child Development Index
GDI	Gender Development Index
GDPPC2005	GDP per capita in 2005 (current US$)
GDPCLCU	GDP per capita in local currency unit
HEGDP	Health Expenditure per capita (current US$)
UR	Urban population (% of total)
LRF	Literacy rate, adult female (% of females ages 15 and above)
PSGDP	Public spending on education, total (% of GDP)
IU	Internet users (per 100 people)
MCS	Mobile cellular subscriptions (per 100 people)
PC	Personal Computers (per 100 inhabitants)*
TL	Telephone lines (per 100 people)
ICTEPC	Information and communication technology expenditure per capita (current US$)
ICTEPGDP	Information and communication technology expenditure (% of GDP)
ICTI	Information and communication technology index
BQ	Bureaucracy Quality (L)
CR	Composite Risk Rating
CO	Corruption (F)
DA	Democratic Accountability (K)
GS	Government Stability (A)
LO	Law & Order (I)
INSTQ	Institutional Quality Index

Table 13. Descriptive Statistic

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque - Bera	Probability	Observation
CDI	16.97	10.89	58.47	0.41	14.48	0.88	2.82	17.74	0.00	136
BQ	2.15	2.00	4.00	0.00	1.15	0.05	2.28	2.99	0.22	137
CO	2.62	2.37	6.00	0.18	1.13	0.89	3.53	19.74	0.00	137
CR	69.63	69.32	91.34	37.85	10.88	-0.28	2.90	1.79	0.41	137
DA	3.87	4.14	6.00	0.00	1.70	-0.50	2.27	8.85	0.01	137
GDI	0.73	0.76	0.97	0.31	0.18	-0.60	2.24	12.94	0.00	154
GDPPC200	11149.58	6029.09	68270.74	261.56	12834.88	1.69	5.83	169.97	0.00	210
GDPCLCU	2.16E+13	1.73E+11	1.60E+15	1.65	1.37E+14	9.04	95.18	73527.55	0.00	200
GS	9.08	9.02	11.41	5.42	1.11	-0.24	3.02	1.33	0.52	137
HEGDP	637.48	164.23	5654.11	3.97	1131.82	2.40	8.27	453.25	0.00	214
ICTEPC	846.70	271.96	3817.60	9.57	953.63	1.01	2.84	15.16	0.00	88
ICTEPGDP	5.75	5.58	12.63	2.45	1.81	0.92	4.68	22.63	0.00	88
ICTI	445.05	172.87	1841.81	8.79	476.38	0.95	2.67	11.35	0.00	73
INSTQ	71.04	70.34	94.21	37.39	11.55	-0.23	2.86	1.36	0.51	137
IU	16.27	7.94	72.97	0.00	18.65	1.28	3.57	65.74	0.00	230
LO	3.78	4.00	6.00	1.00	1.34	-0.02	1.94	6.42	0.04	137
LRF	73.46	81.41	99.79	12.24	24.56	-0.82	2.49	18.37	0.00	148
MCS	33.47	25.58	109.15	0.00	30.05	0.73	2.31	25.07	0.00	233
PC	12.72	4.43	77.29	0.00	18.14	1.86	5.49	157.22	0.00	188
PSGDP	4.61	4.30	12.85	0.61	1.94	1.21	5.67	103.57	0.00	191
TL	21.55	13.56	87.57	0.02	20.89	0.92	2.94	33.16	0.00	233
UR	55.86	56.23	100.00	9.03	23.87	0.02	1.98	10.38	0.01	238

Since six measure of ICT, which are internet users (IU), mobile cellular subscriptions per 100 people (MCS), personal computers per 100 inhabitants (PC), telephone lines per 100 people (TL), information and communication technology expenditure per capita (ICTEPC), and information and communication technology expenditure as a share of GDP (ICTEPGDP), are highly correlated, we used them in separate regressions. Table 14 shows the correlations between six measures of ICT availability, six measures of bureaucratic quality, and other control variables with child development index and gender development index.

Table 14. Pearson Correlation Coefficients

Correlation t-Statistic Probability	CDI	GDI	IU	MCS	PC	TL	ICTEPC	ICTEPGDP	ICTI
CDI	1.000000								
GDI	-0.910263	1.000000							
	-16.30483	-----							
	0.0000	-----							
IU	-0.606802	0.772286	1.000000						
	-5.661630	9.015652	-----						
	0.0000	0.0000	-----						
MCS	-0.664747	0.811477	0.849399	1.000000					
	-6.598990	10.29813	11.93614	-----					
	0.0000	0.0000	0.0000	-----					
PC	-0.556789	0.739669	0.953850	0.795191	1.000000				
	-4.971093	8.151219	23.55747	9.725732	-----				
	0.0000	0.0000	0.0000	0.0000	-----				
TL	-0.678699	0.838484	0.926260	0.850120	0.946456	1.000000			
	-6.853550	11.41140	18.22661	11.97262	21.74229	-----			
	0.0000	0.0000	0.0000	0.0000	0.0000	-----			
ICTEPC	-0.538123	0.737947	0.938742	0.856860	0.960637	0.924489	1.000000		
	-4.734829	8.109502	20.20156	12.32597	25.64481	17.98540	-----		
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-----		
ICTEPGDP	-0.257168	0.153012	0.323929	0.252479	0.281635	0.242718	0.289887	1.000000	
	-1.973586	1.148292	2.539238	1.935125	2.176771	1.855529	2.246314	-----	
	0.0535	0.2558	0.0140	0.0581	0.0338	0.0689	0.0287	-----	
ICTI	-0.549241	0.747226	0.944119	0.864607	0.963369	0.930693	0.999757	0.291140	1.000000
	-4.874310	8.338584	21.24288	12.76170	26.64092	18.86866	336.3690	2.256918	-----
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0280	-----

(Table 14 continued)

Correlation t-Statistic Probability	CDI	GDI	BQ	CO	CR	DA	GS	LO	INSTQ
CDI	1.000000								
GDI	-0.935259	1.000000							
	-26.55410	-----							
	0.0000	-----							
BQ	-0.654379	0.735661	1.000000						
	-8.697069	10.91503	-----						
	0.0000	0.0000	-----						
CO	-0.453582	0.537135	0.718213	1.000000					
	-5.114862	6.399718	10.37327	-----					
	0.0000	0.0000	0.0000	-----					
CR	-0.696562	0.794183	0.800447	0.671491	1.000000				
	-9.756655	13.13431	13.42067	9.107003	-----				
	0.0000	0.0000	0.0000	0.0000	-----				
DA	-0.336789	0.377609	0.559022	0.578078	0.381002	1.000000			
	-3.594686	4.098345	6.775706	7.119781	4.141390	-----			
	0.0005	0.0001	0.0000	0.0000	0.0001	-----			
GS	0.004977	0.023563	-0.022980	-0.059988	0.234144	-0.437065	1.000000		
	0.050017	0.236872	-0.231011	-0.603962	2.420397	-4.883595	-----		
	0.9602	0.8132	0.8178	0.5472	0.0173	0.0000	-----		
LO	-0.484415	0.545938	0.580632	0.623499	0.709460	0.261249	0.273041	1.000000	
	-5.564806	6.548635	7.167181	8.014692	10.11711	2.719978	2.852416	-----	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0077	0.0053	-----	
INSTQ	-0.701281	0.798577	0.828390	0.701941	0.997159	0.432431	0.208929	0.736378	1.000000
	-9.886276	13.33395	14.86244	9.904623	133.0434	4.819827	2.147095	10.93826	-----
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0342	0.0000	-----

(Table 14 continued)

Correlation t-Statistic Probability	CDI	GDI	GDPPC2005	GDPCLCU	HEGDP	PSGDP	UR	LRF
CDI	1.000000							
GDI	-0.936255	1.000000						
	-23.53634	-----						
	0.0000	-----						
GDPPC2005	-0.442092	0.598164	1.000000					
	-4.352940	6.592237	-----					
	0.0000	0.0000	-----					
GDPCLCU	-0.073525	0.079504	-0.044262	1.000000				
	-0.651122	0.704391	-0.391291	-----				
	0.5169	0.4833	0.6966	-----				
HEGDP	-0.482610	0.601278	0.767802	-0.059132	1.000000			
	-4.866544	6.645905	10.58402	-0.523158	-----			
	0.0000	0.0000	0.0000	0.6023	-----			
PSGDP	-0.072420	0.030920	-0.090337	-0.067166	-0.007962	1.000000		
	-0.641284	0.273210	-0.801109	-0.594534	-0.070317	-----		
	0.5232	0.7854	0.4255	0.5539	0.9441	-----		
UR	-0.696788	0.753640	0.596834	0.031533	0.528426	-0.058711	1.000000	
	-8.579471	10.12642	6.569446	0.278631	5.497106	-0.519421	-----	
	0.0000	0.0000	0.0000	0.7813	0.0000	0.6049	-----	
LRF	-0.842831	0.879072	0.418641	0.106884	0.441161	0.130228	0.561437	1.000000
	-13.83127	16.28685	4.071276	0.949411	4.341552	1.160024	5.991969	-----
	0.0000	0.0000	0.0001	0.3453	0.0000	0.2496	0.0000	-----

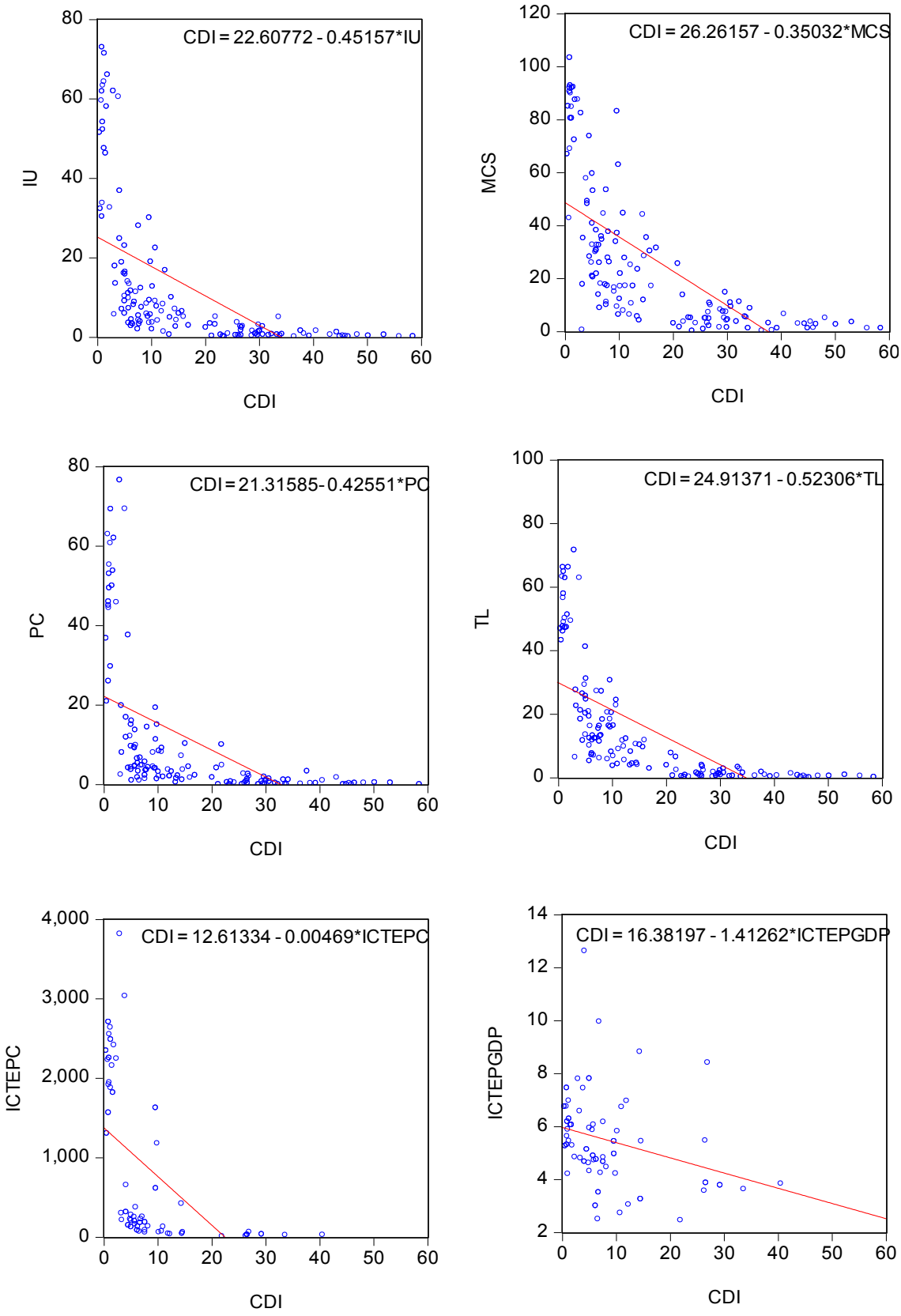

Figure 10. Child Development and ICT Variables

The main focus of this study is to analyze the impact of gender equality on child development. Figure 10 plots each of six measures of ICT availability and infrastructure against child development and it shows that all variables have positive direct impact on child development. Since all measure of ICT access and availability are highly correlated, which is shown in Table 14, each variables enter to the regression equation separately, leading to six regressions for each specifications in. From Figure 11 and Figure 12, we can make similar conclusion for relationship between measures of institutional quality variables and control variables with child development. Figure 12 plots the CDI against the GDI as a measure of equality and against control variables. The linear regression fits are also given in the graph. Figure 12 shows that there is a strong relationship between child development and gender equality. High values of child development index correspond to the low level of child development. Although it seems there is negative relationship between gender equality with child development due to the structure of the child development index, it shows positive relationship between them and supports our hypothesis as well.

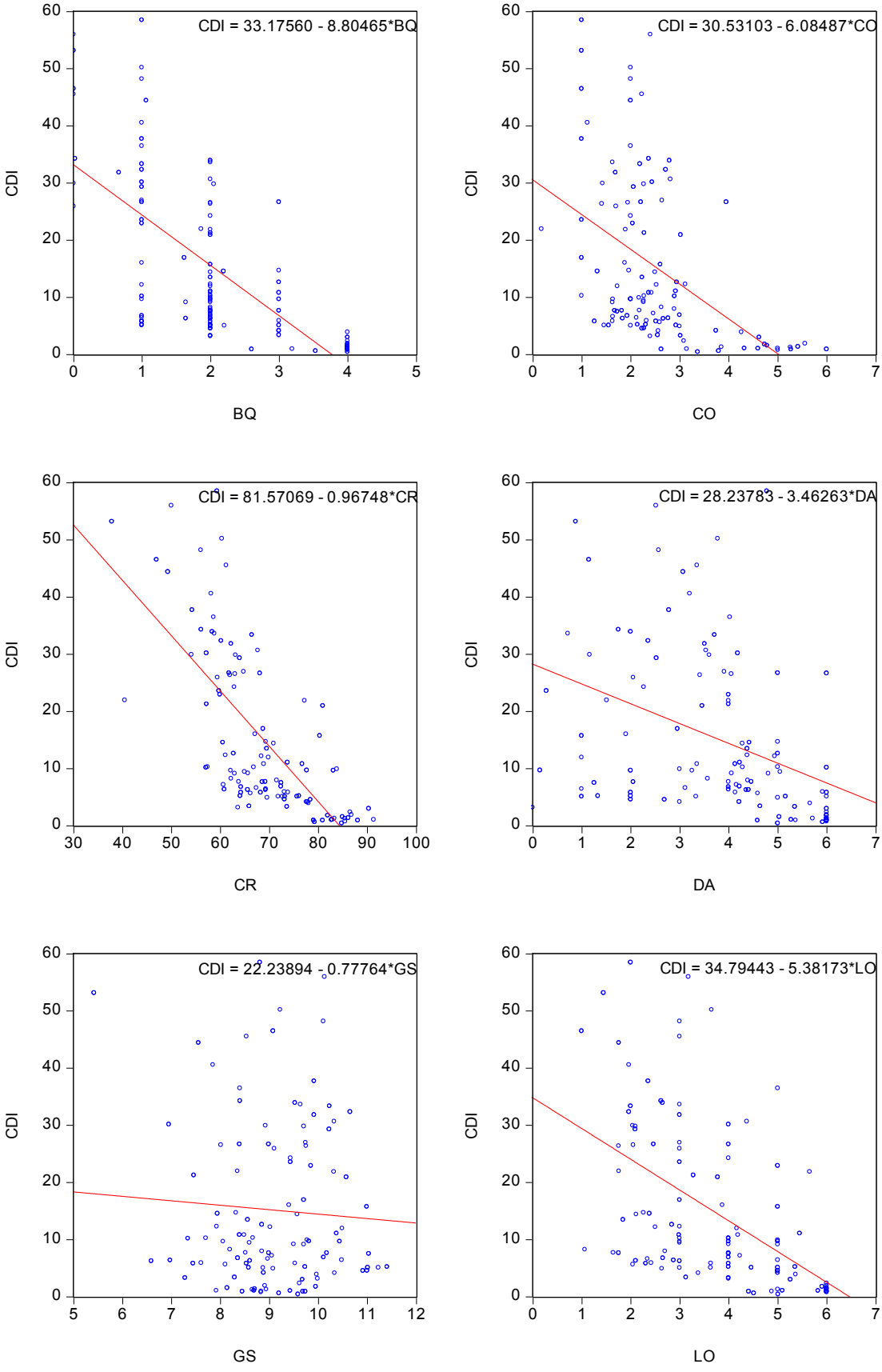

Figure 11. Child Development and Institutional Variables

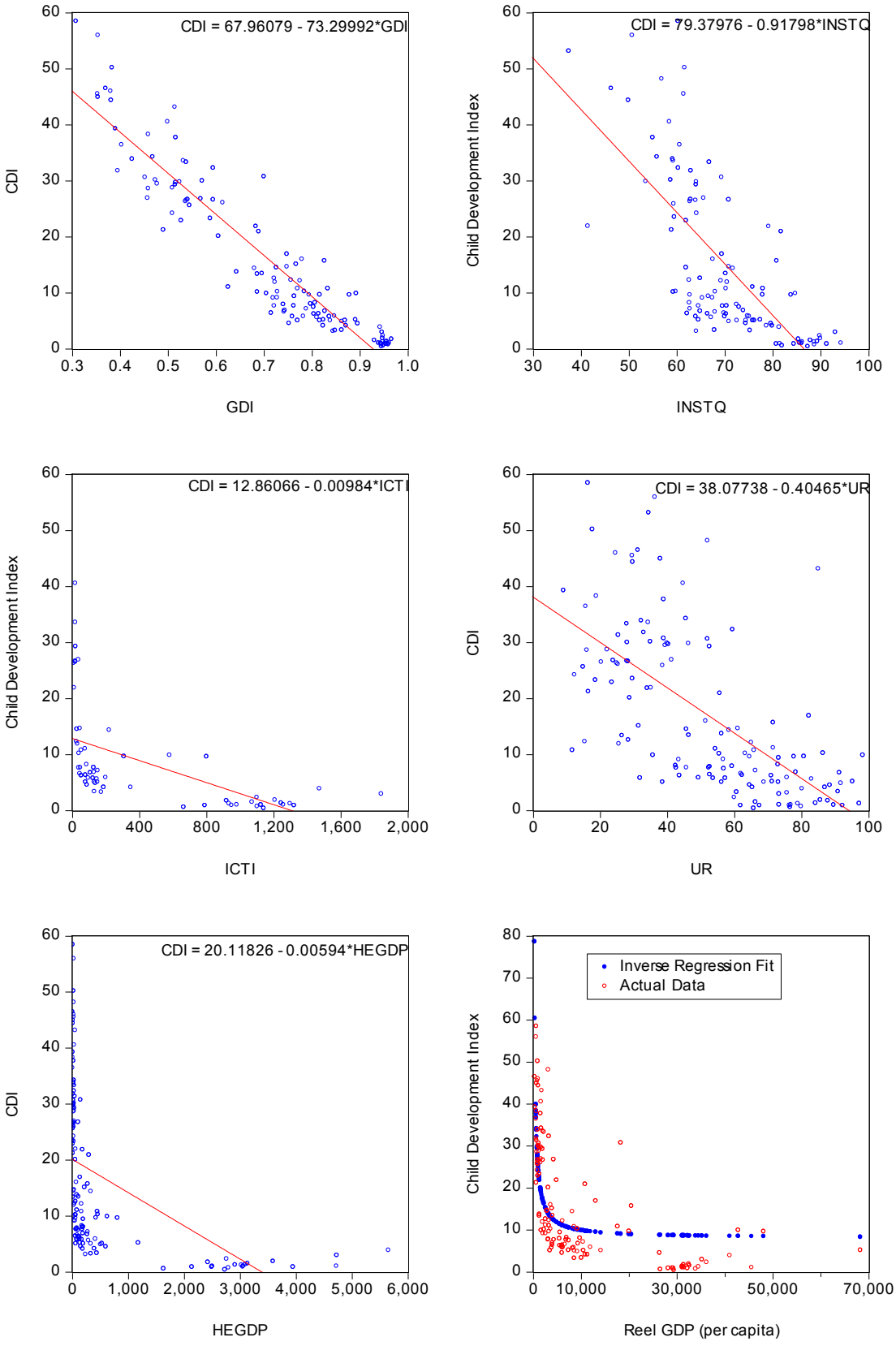

Figure 12. Child Development, Gender Equality and Control Variables

Table 15 shows the estimates of the CDI equations with various functional forms and specifications. Estimation results show that GDI and African dummy are always significant in all specifications, even if we used GDI in different form. Table 16 presents the simple estimates of CDI equation with the ICT variables. All ICT variables are highly significant in all regressions. Table 17 shows the estimates of CDI equation against the institutional quality variables, and as a result, we can say that all variables except the government stability are highly significant. However, due to the high collinearity between the ICT variables and between the institutional quality variables as shown at Table 14, we created an ICT index (ICTI) and institutional quality index (INSTQ) by using the principal component analysis to get rid of multicollinearity problem. Therefore, first, simple regressions are estimated. Generalized Least Squares (using White method) is used against heteroscedasticity. Table 18 shows the most general models by using ICT variables with other control variables. However, it is easy to see from the results that, while ICT variables are loosing their significance when we use them with other control variables, gender development index is still highly significant and it keeps its significance in all regressions.

Table 15. Estimates of the CDI Equations with Various Functional Forms and Specifications

Dep. Var:	Eq 1.1 CDI	Eq 1.2 CDI	Eq 1.3 LOG(CDI)	Eq 1.4 CDI	Eq 1.5 CDI	Eq 1.6 CDI	Eq 1.7 CDI	Eq 1.8 CDI	Eq 1.9 LOG(CDI)	Eq 1.10 CDI	Eq 1.11 CDI	Eq 1.12 CDI
CONSTANT	67.960795 (2.2227)***	-1.865410 (0.5077)***	0.921918 (0.1169)***	-0.895711 (2.2650)	-30.629249 (6.2526)***	87.532821 (5.1545)***	63.916175 (2.8989)***	-1.847861 (0.4903)***	0.918494 (0.1146)***	-1.439674 (2.2905)	-30.028822 (7.2153)***	69.946309 (4.6803)***
GDI	**-0.732999** **(0.0282)***						**-0.690251** **(0.0352)***					
LOG(GDI)		**-0.468116** **(0.0142)***	**-0.034876** **(0.0022)***	**-0.467406** **(0.0146)***	**-0.585759** **(0.0309)***			**-0.445849** **(0.0196)***	**-0.031909** **(0.0026)***	**-0.445676** **(0.0199)***	**-0.583038** **(0.0408)***	
LOG(GDPCLCU)				-0.035400 (0.0759)						-0.014888 (0.0783)		
LOG(GDPPC2005)					2.865460 (0.6135)***	**-8.439417** **(0.5759)***					2.806476 (0.7029)***	**-6.891371** **(0.5065)***
AFRICA							**2.490094** **(1.1859)****	**2.029332** **(1.1827)***	**0.269960** **(0.1254)****	**2.016024** **(1.1905)***	**0.067199** **(1.1606)**	**10.488115** **(1.5443)****
Observations:	124	124	124	124	123	132	122	122	122	122	121	130
R-squared:	0.8760	0.9022	0.7371	0.9023	0.9165	0.6075	0.8809	0.9049	0.7422	0.9049	0.9156	0.7247
Log Likelihood:	-375.6082	-360.9040	-112.7301	-360.8506	-348.3324	-476.1250	-367.2952	-353.5566	-110.0870	-353.5471	-343.4962	-446.0733
S.E.R:	5.0445	4.4804	0.6055	4.4969	4.1594	8.9863	4.9735	4.4438	0.6040	4.4623	4.2067	7.5691
SBC:	6.1359	5.8988	1.8960	5.9368	5.7813	7.2880	6.1394	5.9141	1.9228	5.9534	5.8362	6.9750
F-statistic:	861.9719	1125.3320	341.9975	558.5866	658.4774	201.1835	440.0252	566.2066	171.3149	374.3635	423.1936	167.1409
Prob(F-stat):	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WhiteTest:	14.6367***	5.3491**	3.3580*	2.8982*	5.0512***	5.7327**	13.5294***	12.4009***	3.1785**	8.1081***	8.6918***	13.4993***
BPG Test:	15.7043***	9.4302***	10.9624***	4.6637**	7.2596***	5.7454**	13.8235***	12.7751***	5.3933***	8.4634***	8.0587***	13.3083***
Jarque Bera Test:	3.4053	15.1985***	12.0453***	15.4294***	12.0277***	17.6500***	2.0563	8.3064**	12.0693***	8.4696**	10.6096***	8.9811**

Note: *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

Table 16. Estimates of CDI Equation with ICT Variables

Dep. Var:	Eq 1.1 CDI	Eq 1.2 CDI	Eq 1.3 CDI	Eq 1.4 CDI	Eq 1.5 CDI	Eq 1.6 CDI
CONSTANT	22.607717 (1.3691)***	21.315848 (1.3373)***	24.913704 (1.3776)***	26.261567 (1.5019)***	12.613336 (1.5746)***	16.381967 (4.0142)***
IU	**-0.451568** **(0.0435)***					
PC		**-0.425506** **(0.0456)***				
TL			**-0.523056** **(0.0472)***			
MCS				**-0.350317** **(0.0291)***		
ICTEPC					**-0.004688** **(0.0008)***	
ICTEPGDP						**-1.412619** **(0.6573)**
Observations:	135	132	135	135	60	60
R-squared:	0.3344	0.2883	0.4497	0.4534	0.2873	0.0811
Log Likelihood:	-524.4433	-514.6901	-511.5982	-511.1394	-206.7871	-214.4095
S.E.R:	11.8614	12.0355	10.7848	10.7482	7.7250	8.7715
SBC:	7.8422	7.8723	7.6519	7.6451	7.0294	7.2835
F-statistic:	66.8111	52.6658	108.6935	110.3420	23.3789	5.1199
Prob(F-stat):	0.0000	0.0000	0.0000	0.0000	0.0000	0.0274
WhiteTest:	4.3950**	3.6165*	2.6698	7.9631***	2.5907	0.4986
BPG Test:	9.0016***	7.6512***	7.5012***	15.0751***	4.9810**	0.8869
Jarque Bera Test:	14.9143***	13.8585***	15.9927***	8.9908**	43.7860***	36.4640***

Table 17. Estimates of CDI Equation with Institutional Quality Variables

Dep. Var:	Eq 1.1 CDI	Eq 1.2 CDI	Eq 1.3 CDI	Eq 1.4 CDI	Eq 1.5 CDI	Eq 1.6 CDI
CONSTANT	33.175602 (2.5924)***	81.570693 (7.2968)***	30.531036 (3.0096)***	28.237835 (3.8087)***	22.238943 (13.5931)	34.794436 (3.8114)***
BQ	**-8.804652** **(0.8859)***					
CR		**-0.967487** **(0.0978)***				
CO			**-6.084877** **(0.8542)***			
DA				**-3.462635** **(0.8181)***		
GS					-0.777641 (1.4621)	
LO						**-5.381732** **(0.8356)***
Observations:	111	111	111	111	111	111
R-squared:	0.4548	0.5025	0.2244	0.1505	0.0034	0.2570
Log Likelihood:	-419.4472	-414.3652	-439.0129	-444.0594	-452.9248	-436.6263
S.E.R:	10.6862	10.2080	12.7461	13.3389	14.4480	12.4750
SBC:	7.6425	7.5509	7.9950	8.0859	8.2457	7.9520
F-statistic:	90.9253	110.0964	31.5283	19.3140	0.3707	37.7030
Prob(F-stat):	0.0000	0.0000	0.0000	0.0000	0.5439	0.0000
WhiteTest:	19.1194***	17.1676***	8.1192***	8.0043***	0.9141	10.9641***
BPG Test:	23.3092***	17.8669***	9.4587***	7.5394***	1.1321	11.2713***
Jarque Bera Test:	5.9886*	7.4275**	21.3050***	26.5911***	25.6314***	19.7970***

Table 18. Estimates of CDI Equation with ICT and Other Control Variables

Dep. Var:	Eq 1.1 CDI	Eq 1.2 CDI	Eq 1.3 CDI	Eq 1.4 CDI	Eq 1.5 CDI	Eq 1.6 CDI	Eq 1.7 CDI
CONSTANT	73.727671 (6.0448)***	71.712952 (5.0829)***	72.518437 (6.1887)***	74.279536 (5.7026)***	63.797830 (6.4909)***	67.528585 (7.0554)***	68.153903 (11.0518)***
GDI	**-0.779569 (0.1037)*** **	**-0.754295 (0.0925)*** **	**-0.755748 (0.1092)*** **	**-0.798367 (0.0971)*** **	**-0.849153 (0.1344)*** **	**-0.767758 (0.1233)*** **	**-0.819906 (0.1487)*** **
LOG(GDPCLCU)	-0.038463 (0.1669)	-0.007053 (0.1618)	-0.029687 (0.1653)	-0.033635 (0.1696)	0.226269 (0.1183)*	0.070988 (0.1701)	0.226577 (0.1302)*
IU	-0.026834 (0.0935)						
HEGDP	0.005858 (0.0029)**	0.004647 (0.0027)*	0.006869 (0.0031)**	0.004916 (0.0031)	-0.001951 (0.0020)	0.003408 (0.0018)*	-0.002348 (0.0022)
UR	-0.009083 (0.0338)	-0.024217 (0.0296)	-0.009944 (0.0340)	-0.009530 (0.0325)	0.027129 (0.0412)	0.014717 (0.0410)	0.024030 (0.0429)
LRF	-0.017182 (0.0475)	-0.017577 (0.0479)	-0.017796 (0.0477)	-0.013911 (0.0466)	0.072332 (0.0839)	0.039996 (0.0838)	0.059600 (0.0844)
PSGDP	-0.287285 (0.3065)	-0.310249 (0.3140)	-0.299341 (0.3081)	-0.285868 (0.3190)	-0.888600 (0.4394)*	-0.654619 (0.5943)	-0.785156 (0.4068)*
PC		0.047808 (0.0944)					
TL			-0.084631 (0.0936)				
MCS				0.016984 (0.0454)			
ICTEPC					0.007047 (0.0028)**		
ICTEPGDP						-0.500447 (0.4562)	
ICTI							0.016449 (0.0071)**
INSTQ							-0.088270 (0.1669)
Observations:	81	80	81	81	31	31	31
R-squared:	0.8905	0.8923	0.8915	0.8906	0.9105	0.8892	0.9088
Log Likelihood:	-238.3687	-231.6147	-238.0195	-238.3505	-74.5368	-77.8513	-74.8438
S.E.R:	4.8350	4.6132	4.8142	4.8339	3.1103	3.4613	3.2119
SBC:	6.3197	6.2286	6.3110	6.3192	5.6950	5.9089	5.8256
F-statistic:	84.8271	85.1976	85.6518	84.8699	33.4448	26.3735	27.3890
Prob(F-stat):	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WhiteTest:	1.3039	1.0106	1.5374	1.2233	2.5924**	1.6585	2.5211**
BPG Test:	1.5569	1.2420	1.8612*	1.3439	3.6569***	1.7368	2.9635**
Jarque Bera Test:	5.2135*	5.5290*	4.5353	5.8473*	0.7626	2.3182	0.8743

Table 19. Estimates of CDI Equation Control Variables and Interaction Terms

Dep. Var:	Eq 1.1 CDI	Eq 1.2 CDI	Eq 1.3 CDI	Eq 1.4 CDI	Eq 1.5 CDI	Eq 1.6 CDI
CONSTANT	198.884933 (73.0172)**	67.877302 (9.3275)***	76.825654 (11.5585)***	167.746305 (82.5938)*	168.888866 (88.3284)*	14.574273 (23.1397)
GDI	**-2.483653** **(0.8914)****	**-0.734839** **(0.1329)*****	**-0.649315** **(0.1476)*****	**-2.032211** **(1.0391)***	**-1.977085** **(1.0092)***	
LOG(GDPCLCU)	0.226461 (0.1291)*	0.235790 (0.1506)	0.186140 (0.1612)	0.232720 (0.1389)	0.217074 (0.1577)	0.220276 (0.1618)
ICTI	0.008389 (0.0046)*	-0.209122 (0.1224)	-0.178913 (0.0813)**	-0.142275 (0.1379)	-0.145308 (0.1352)	-0.213765 (0.1299)
HEGDP	-0.003470 (0.0020)*	-0.012302 (0.0055)**	-0.000098 (0.0018)	-0.009937 (0.0054)*	-0.006519 (0.0130)	-0.006775 (0.0131)
UR	0.021661 (0.0417)	0.054691 (0.0276)*	0.022310 (0.0352)	0.042960 (0.0286)	0.034206 (0.0359)	0.012758 (0.0442)
LRF	0.020195 (0.0592)	0.003973 (0.0786)	0.026511 (0.0772)	-0.008101 (0.0655)	-0.003429 (0.0687)	-0.020559 (0.0783)
PSGDP	-0.586750 (0.4475)	-0.477302 (0.4074)	-0.487727 (0.4312)	-0.425497 (0.3907)	-0.413840 (0.4125)	-0.320325 (0.4654)
INSTQ	-2.131224 (1.1455)*	-0.115087 (0.1428)	-0.321604 (0.2036)	-1.665679 (1.2939)	-1.707052 (1.4233)	-0.612167 (1.0840)
INSTQ*GDI	2.661072 (1.3746)*			2.031044 (1.5780)	1.995275 (1.5944)	0.402916 (1.0901)
ICTI*GDI		0.262693 (0.1419)*		0.177681 (0.1615)	0.107207 (0.3179)	0.106372 (0.3266)
ICTI*INSTQ			0.002302 (0.0010)**		0.000750 (0.0020)	0.001618 (0.0022)
LOG(GDI)						-54.320059 (42.0513)
Observations:	31	31	31	31	31	31
R-squared:	0.9313	0.9274	0.9265	0.9386	0.9391	0.9280
Log Likelihood:	-70.4398	-71.3038	-71.4902	-68.7084	-68.5861	-71.1820
S.E.R:	2.8521	2.9327	2.9504	2.7638	2.8244	3.0711
SBC:	5.6522	5.7080	5.7200	5.6513	5.7542	5.9217
F-statistic:	31.6425	29.8003	29.4162	30.5637	26.6188	22.2477
Prob(F-stat):	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WhiteTest:	1.2624	2.2178*	2.2640*	1.2742	1.0772	1.5503
BPG Test:	1.2964	2.0419*	2.5107**	1.0707	1.0346	1.3392
Jarque Bera Test:	9.0134**	3.0936	1.2688	7.1541**	8.4633**	3.2174

Table 20. Estimates of CDI Equation Control Variables and Interaction Terms and Various Specifications

Dep. Var:	Eq 1.1 LOG(CDI)	Eq 1.2 LOG(CDI)	Eq 1.3 LOG(CDI)	Eq 1.4 LOG(CDI)	Eq 1.5 CDI	Eq 1.6 CDI
CONSTANT	90.097079 (26.0309)***	78.554205 (39.6690)*	76.096543 (31.3477)**	77.549047 (30.1673)**	0.546858 (1.5903)	65.682166 (4.5196)***
LOG(GDI)	**-0.639772** **(0.3392)***	**-0.584580** **(0.3822)**	**-0.835603** **(0.3986)****	**-0.979924** **(0.4113)****	**-0.455400** **(-0.0417)*****	
LOG(GDPCLCU)	0.011523 (0.0217)	-0.002000 (0.0269)				
LOG(ICTI)	**-15.849796** **(4.6484)*****	**-14.810385** **(8.0608)***	**-9.371703** **(4.4944)****	**-9.693952** **(4.3368)****		
HEGDP	**-0.000996** **(0.0003)*****					
UR	0.007350 (0.0041)*			0.009063 (0.0054)*		
LRF	0.002634 (0.0080)					
PSGDP	-0.064801 (0.0550)				**-0.809729** **(0.3319)****	**-0.884696** **(0.3390)****
LOG(INSTQ)	**-21.062549** **(6.0966)*****	**-18.625740** **(9.1462)***	**-17.878477** **(7.4696)****	**-17.962334** **(7.1820)****		
LOG(ICTI)*LOG(GDI)	0.142112 (1.0714)	-0.908606 (1.3478)				
LOG(INSTQ)*LOG(GDI)	**-15.996516** **(8.4727)***	**-13.916075** **(9.2947)**	**-20.536256** **(9.5220)****	**-24.129793** **(9.8497)****		
LOG(ICTI)*LOG(INSTQ	3.726099 (1.0573)***	3.408156 (1.7943)*	2.250402 (1.0639)**	2.228590 (1.0195)**		
LOG(HEGDP)		-0.214825 (0.2999)	**-0.416432** **(0.2387)***			
LOG(UR)		0.477603 (0.3724)	0.511628 (0.2620)*			
LOG(LRF)		0.556201 (0.4529)				
LOG(PSGDP)		-0.320934 (0.2544)				
ICTI*INSTQ					0.000032 (0.0000)***	
GDI						**-0.684444** **(0.0539)*****

ICTI						0.005004 (0.0011)***
Observations:	31	31	57	57	50	50
R-squared:	0.8887	0.8346	0.8420	0.8317	0.9114	0.9115
Log Likelihood:	-2.7716	-8.9119	-35.5067	-37.3025	-117.1471	-117.1036
S.E.R:	0.3380	0.4120	0.4866	0.4971	2.6266	2.6243
SBC:	1.5081	1.9042	1.8133	1.8054	4.9988	4.9971
F-statistic:	13.7933	8.7166	37.3068	41.1917	157.6773	157.9786
Prob(F-stat):	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WhiteTest:	1.7851	3.0408**	2.0409*	1.5861	5.1951***	3.2893**
BPG Test:	1.8484	2.6879**	1.6269	1.5452	5.0285***	3.3990**
Jarque Bera Test:	0.9934	0.0084	0.3605	1.9824	5.0814*	5.2056*

Chapter 6

CONCLUSION

The objective of this study was to examine the relationship between gender equality, ICT, and governance and institutional quality. The study focused on how the ICT interacts with institutional quality and governance to impact the gender equality. A panel data set for 209 countries over the period 2000-2010 is used in the study. The findings of the study indicate that the current status of women on education and employment can be improved by increasing ICT access and use. The regression estimates show a significant positive relationship between gender equality in employment and education, and the level of ICT infrastructure. A more significant relationship is found between gender equality and institutional quality. The estimates show that simultaneous improvement in both the ICT and institutional quality and governance creates a higher positive impact from ICT to gender-gap, beyond the impact of the ICT alone. Thus, ICT is more effective in reducing gender inequality in countries with better bureaucratic quality, less corruption, less political risks, more stable governments, good legal system, and better democracy.

On the other hand, we tried to analyse the impact of gender equality on child development through different channels. Although, child development is only one dimension of economic development of countries, it is very important for the countries, because child development can be seen as a kind of investment in country's future development. From the estimations, it can be clearly seen that gender equality has a significant positive impact on child development in all cases.

This impact is the most significant and most robust, and keeps its significance in all regressions.

ICT, in general, has a positive impact on child development depending on level of access to these services through different channels such as education and health services.

Institutional quality has also significant and positive impact on child development in most regressions. And, gender equality and institutional quality interacts and simultaneous improvement in both has positive impact on child development beyond their individual impacts.

Although per capita income has positive impact in general on child development, this finding is not robust and disappears in some specifications. This may be due to collinearity or the other variables in the regression measuring the welfare impact.

Among the control variables, health expenditures and public spending on education have positive and significant impact on child development.

African dummy has a significant and negative impact on child development index, implying Africa overall is the poorest in terms of child development level.

As a result, we can make three main suggestions to the policy makers. First, better opportunities for mothers improve the well being of children. Second, good institutions lead to better child development directly, and indirectly by improving the

gender equality. And last, ICT can be used as a tool to improve the well being of children.

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