ICT DEVELOPMENT AND WAGE PREMIUMS ACROSS COUNTRIES

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การพัฒนาของ ICT
และความแตกต่างของค่าจ้างแรงงานที่มีความชำนาญสูงข้ามประเทศ

น.ส.ฮงวู ได

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาศิลปศาสตรมหาบัณฑิต
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By	Miss Hongwu Dai
Field of Study	Labour Economics and Human Resource Management
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ฮงวู ได : การพัฒนาของ ICT และความแตกต่างของค่าจ้างแรงงานที่มีความชำนาญสูงข้ามประเทศ. (ICT DEVELOPMENT AND WAGE PREMIUMS ACROSS COUNTRIES) อ.ที่ปรึกษาหลัก : ผศ.ดร.มนชยา อุรุยศ

งานวิจัยนี้ศึกษาผลกระทบของเทคโนโลยีสารสนเทศและการสื่อสาร (ICT) ที่มีต่อความแตกต่างของค่าจ้างแรงงานที่มีความชำนาญสูง โดยใช้ข้อมูลจาก 64 ประเทศระหว่างช่วงปี พ.ศ. 2553-2559 แบบจำลอง Fixed Effect Model ได้ถูกนำมาใช้เพื่อศึกษาความสัมพันธ์ระหว่างการพัฒนาทางด้าน ICT และความไม่เท่าเทียมกันทางด้านรายได้ โดยใช้ตัวแปรตาม 2 ตัว คือ ความแตกต่างของค่าจ้างแรงงานที่มีความชำนาญสูงและต่ำแบบทั่วไป และความแตกต่างของค่าจ้างแรงงานที่ประกอบอาชีพที่มีความเข้มข้นของ ICT แตกต่างกัน ผลที่พบคือ 1) ความแตกต่างของค่าจ้างแรงงานที่มีความชำนาญสูงในประเทศที่การพัฒนาทาง ICT ที่ต่ำมีค่าที่สูงกว่า 2) การพัฒนาทาง ICT มีความสัมพันธ์ทางบวกกับความแตกต่างของค่าจ้างแรงงานที่มีความชำนาญสูง 3) บทบาทของดัชนีย่อยที่ใช้ชี้วัดการพัฒนาของ ICT มีความแตกต่างกัน กล่าวคือ กรณีการเข้าถึง ICT มีผลกระทบทางบวกขนาดเล็กมาก ขณะที่ดัชนีการใช้และดัชนีความชำนาญด้าน ICT มีผลกระทบทางลบอย่างมีนัยสำคัญต่อความแตกต่างของค่าจ้างแรงงานที่มีความชำนาญสูง อย่างไรก็ตามผลจากการแบ่งกลุ่มตัวอย่างประเทศได้ผลที่ต่างไป กล่าวคือการพัฒนาของ ICT มีผลกระทบทางลบต่อความแตกต่างของค่าจ้างแรงงานที่มีความชำนาญสูงในประเทศที่มีการพัฒนาทาง ICT ที่สูงกว่า

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This study examines the effect of ICT on wage premium, by using data from 64 countries during the period 2010–2016. The Fixed Effect Model (FEM) is employed to study the relationship between ICT development and income inequality, by using two dependent variables: the conventional wage premium and wage premiums for ICT-intensive occupation. The main findings are: 1) the wage premium in countries with low levels of ICT development is relatively higher; 2) the development of ICT has a positive relationship with the wage premium; 3) the roles of the three sub-indexes of ICT development are different: ICT access shows a small positive relationship, while ICT use and ICT skills are significantly negative with the wage premium.

However, the results of the split sample provide a different result. The development of ICT has a negative relationship with the wage premium in higher ICT developed countries.

Field of Study:	Labour Economics and Human Resource Management	Student's Signature ....
Academic Year:	2019	Advisor's Signature ....

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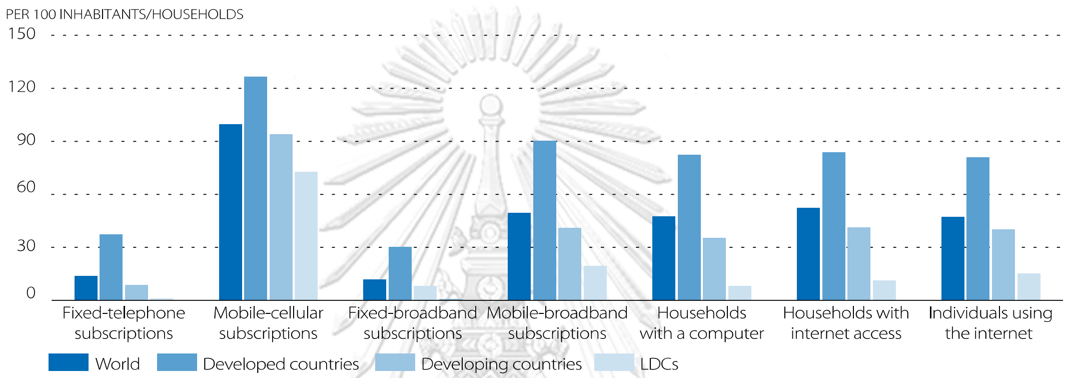
Chapter 1 Introduction

For decades, the income distribution changes in the labor market have prompted many kinds of research on the relationship between technological changes and wages. The economists argue that the trend toward greater wage inequality was caused by the new technologies primarily (Card and DiNardo 2002; Berman, Bound, and Machin 1998; Almeida and Afonso 2010; Acemoglu 2003). Popular explanations such as Skill-Biased Technological Change (SBTC), technological advances raise the relative productivity and demand for skilled labor, the wage of skilled worker over unskilled worker is increased (Acemoglu 1998). This perspective emphasizes that the return to skills is determined by a competition between the supply of skills in the labor market and the demand for more "skilled" workers under the improvements in technology (Acemoglu and Autor 2010). They also argue that increasing of wage premium in most developed countries has been attributed to the ICT diffusion which raises the wage premium for ICT related people such as computer and telecommunications networks, which has affected low-skill and high-skill workers in the labor market. Thus, SBTC induces a rise in the skill premium, which is defined as the ratio of skilled labor wage to unskilled labor wage.

Although technological changes may have triggered an increased in income inequality across countries, the readiness of the Internet (especially fixed broadband and mobile broadband), ICT intensity and related skills are still developing between countries. In fact, the full benefit and the opportunities from the rapid expansion of the digital economy do not offer equally. The global evidence in Figure 1.1 shows the levels of ICT connectivity and access vary greatly between and within countries, especially in high-speed broadband access and Internet use. Compared to low-income levels countries, relatively high cost of ICT services remains a major barrier to wider ICT access and use. It can be seen that the differences in connectivity and access levels of ICT, may lead to a varied inequality among countries, especially for Least developed



countries (LDCs).

Figure 1-1: ICT readiness overview in 2016
Source: (ITU 2016)

In addition, Figure 1.2 compares the IDI performance across countries with various level of development in the 2015-16. The performance of Least developed countries (LDCs) remain the trend of the previous period (2010-15), but below that of the higher- and middle-income developing countries. The LDCs record 0.16 points as an average improvement from 2015 to 2016, while all developing countries rise at 0.22 points (including the LDCs). It is seen that in high income countries, the development of ICT is relatively fast.

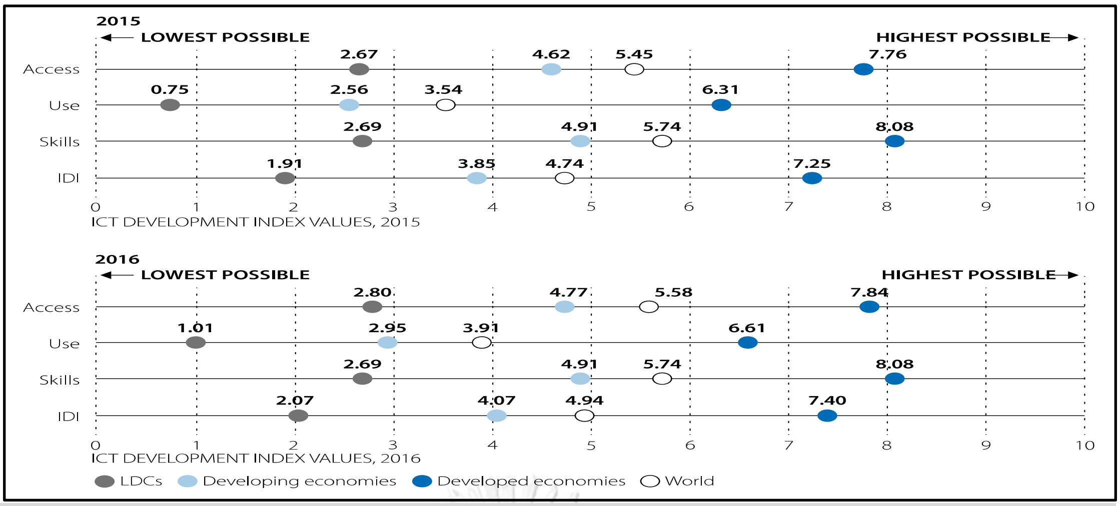
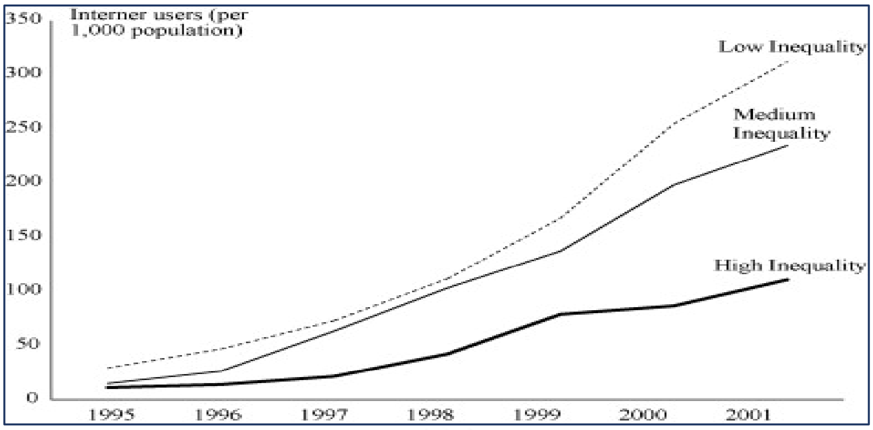


Figure 1-2: IDI values 2016
Source: ITU (2016)Measure the information Society Report

From the theoretical perspective, empirical research also investigates the ICT impacts on the economic outcome. The evidence from Gust and Marquez (2004) shows that since the mid-1990s in the U.S. the productivity has been accelerated by the greater use of information technology. Jorgenson and Vu (2005) document that price declines of ICT usage induce a substitution of ICT equipment and labor, which generates substantial economic returns for ICT users. Noh and Yoo (2008) believe that ICT popularization has increased productivity and reduces income inequality. Along with this argument, in Figure 1.3, each line measures the average of internet users (per 1000 people) from low-income inequality countries with Gini ≤ 29.99, Gini from 30 to 39.99 refers to medium income inequality countries, and high-income inequality countries with Gini over 40.00. The results show that lower income inequality countries fell backwards into Internet diffusion compare with higher income inequality countries.



No table of figures entries found. ***Figure 1-3: Average diffusion of Internet use, by income inequalities***
Source: (Y.-H.Noh and K.Yoo 2008: 1006; Noh and Yoo 2008)

Is ICT a panacea or poison of income inequality in the labor market? Although people pay more attention to ICT issues, there are relatively few studies on the specific impact of ICT on wage premium growth. It is interesting to study the effects of ICT controlled by economic, demographic, and political factors. By using cross-country data from 2010 to 2016, the value of ICT Development Index (IDI) plotting wage premium against, we can see that the wage premium has an inverted "U" shape through different levels of ICT development across 64 countries, in Figure 1.4.

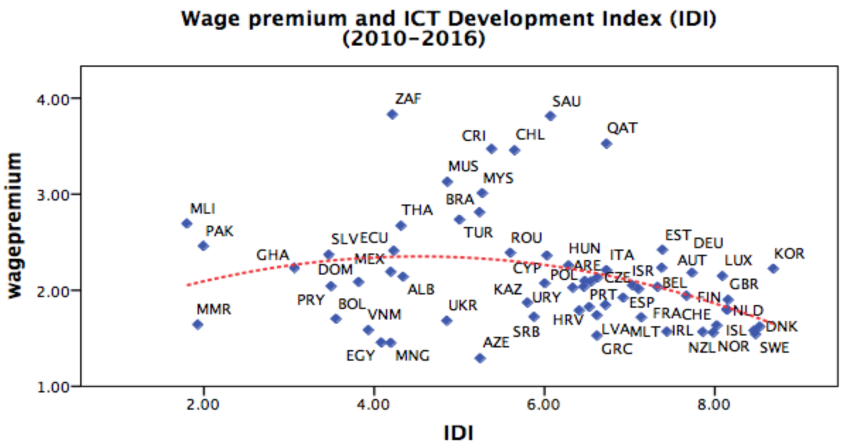


Figure 1-4: Wage premium and ICT Development
Source: ITU and ILO 2010-2016

This study focuses on how ICT development affects wage premiums. In particular, we examine whether the improvement in ICT has increased the wage premium and exacerbate income inequality. The wage premiums are constructed by using two definitions, the conventional wage premium and wage premiums for ICT-intensive occupations. Additionally, the impact of the three ICT development sub-indexes (ICT access, ICT use, and ICT skills) on these two wage premiums will also be investigated.

The paper is structured as follows, Chapter 2 presents the literature and empirical evidence, Chapter 3 constructs the conceptual framework and illustrates the methodology. Chapter 4 describes data and summaries the empirical results, then Chapter 5 concludes the paper.

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Chapter 2 Literature Review

The study refers to two branches of the literature: the impact of technological changes on income inequality in section 2.1. And the impacts of economic, demographic, and political factors on income inequality in section 2.2.

2.1 The impacts of technological changes on income inequality

Economists and policymakers are interested in the labor market effects of ICT development. A large amount of literature has emerged as that supports SBTC as the principal factor contributing to the increase of wage inequality. And most studies have employed empirical data on the impact of new technology on the labor market. In the United States, Acemoglu (1998)examines changes in the wage structure and concludes that the major cause is SBTC in production technology. SBTC accounts for a large fraction of the skill upgrading, it is an important source of the outward shift in the skilled labor demand, which is the main reason for the rising wage premium (Berman, Bound, and Machin 1998).

Why has technical change favored skilled labor? Principally, technologies like ICT considerably increase the marginal productivity of skilled workers, so unskilled workers are replaced by skilled workers who are relatively more economical.(Acemoglu 2003, 2002). Along this line, the new technology caused growth of demand for highly skilled workers, and replaced task previously performed by the unskilled. Being a consequence, technology is the skills complementary, which speeds up in the rate of technological change and increases the demand for skilled labor, eventually affects wage premiums (Katz 1992). This research persuaded many economists to conclude that the wage premium has increased because the skills demand by modern technology has risen more rapidly than the supply (Richmond and E.Triplett 2018; Jacobs and Nahuis 2002; Brynin 2006; Acemoglu 2003). Therefore, the SBTC interpretation properly explains the rise in the skill premium acting as a direct result of the marked increase in demand for skilled labor.

So far, many researchers concentrated on wage divergence and incentives to develop innovative technologies on the supply of skills in the United States. Furthermore, the cross-country aspect presents the number of challenges in income inequality. Initially, inequality raised greatly in some countries than in others, then, the relative supply of skills in each nation or globally affects the direction of technical change. An important finding of Niebel (2014), ICT impact among 21 transition economies on rising inequality. To reinforce this idea, Eurostat data for Portugal indices that difference between ICT access and ICT skills or capabilities. Mendonca, Crespo, and Simoes (2015) show that the Access Index average was almost twice the Skills Index average and that individuals in poverty were highly concentrated at the lower end of both distributions. Thus, ICT can exacerbate the existing labor market inequalities.

Moreover, as Krugman and Lawrence (1994) has pointed out, the pervasive skill-biased technical change will affect relative wages because of an integrated world economy will respond to technological transformations as a closed economy. SBTC releases low-skilled employees and reduces their relative wages by depressing the world (relative) prices of goods. Therefore, pervasive SBTC provides an explanation consistent with increased wage premiums, and within-industry substitution toward skilled workers, even in small open economy models.

2.2 The impacts of other factors on income inequality

2.2.1 Economic factors

It is widely considered that the increase in income inequality within many nations has induced a change in the comparative demand for skilled workers (Acemoglu 2003). Some empirical evidence shows a relationship between education expenditure and the supply of skilled worker, which has contributed to the increased wage dispersion (Doms, Dunne, and Troske 1997). Generally, education expenditures affect inequality. Keller (2010) state that public education does not necessarily make equal incomes and might exacerbate inequality since the opportunity cost of foregone earnings disrupts poor students' attendance. Additionally, a sizable share of skilled labor ultimately raises its wage premium when attracting complementary technical change. For developed countries like the U.S., education can increase income inequality seeing as the earnings of unskilled workers drops and rises the skill premium.

The impact of international trade and foreign direct investment (FDI) is the other approach to measure the skill premium. Trade and FDI induce industrialized countries to specialize in skill-intensive production (Berman, Bound, and Machin 1998). Standard trade theory determines that the relative wage depends on the relative output price of the labor industry. The higher the relative price of skill-intensive goods, the higher the relative wages of skilled workers (Berman, Bound, and Machin 1998). According to the traditional view, greater trade openness in developing countries can improve efficiency, also reduce income inequality. openness will increase the relative demand for unskilled workers, thereby reducing the wage gap (Goldin and Katz

2007). The research results of the Heckscher-Ohlin model show that the increase in the degree of trade openness of developing countries with low-skilled labor will lead to an increase in the wages, and reduce salaries of highly skilled workers, thereby reducing income inequality (Jaumotte, Lall, and Papageorgiou 2013). Therefore, the introduction of new technologies will be accompanied by changes in the labor demand for skilled workers. Since foreign direct investment is a supplement to skilled workers, the demand for skilled workers will decrease (Afonso, Neves, and Thompson 2016); On the other hand, Acemoglu (2002) states the increase in openness may not only be related to the increasingly competitive product market in previously protected industries, but also to technological changes. The literature usually assumes that technological change plays a role in explaining the expansion of income distribution in developed countries.

Furthermore, it has recently become fashionable to claim that labor market problems such as unemployment and wage inequality on shifts in demands against the less-skilled (OECD 2004). Autor, Levy, and Murnane (2003) suggests that due to the technological change, ICT substitute workers in routine tasks. Other studies have reached similar conclusions. For example, due to globalization and/or technological change, both the United States and Europe have experienced increased demand for highly skilled workers (Machin and Van Reenen 1998). Later, Mocan (1999) draw conclusions as income inequality is countercyclical in behavior, that is, the increase in unemployment worsens the condition of low-income groups. In other words, the rise in unemployment leads to an increase in income inequality.

2.2.2 Demographic factor

Most research attribute increased wage inequality to the raised demand for skilled workers. Katz and Murphy (1992) claimed that a simple supply and demand framework can increase the relative demand for skilled labor and combined with the observed fluctuations in the relative supply growth rate of skilled labor. Also, potentially explain the changes in skill premiums. In particular, they attribute fluctuations in income inequality mainly to changes in demographics.

The factor that has significant influence is urbanization, which is a determinant of average labor productivity. According to Kuznets (1955), the urban population had higher average per capita income and higher wage inequality, because their productivity increased more rapidly than rural population. Acemoglu (1998) points out that the industrialization and urbanization increased wage premium.

2.2.3 Political factor

Democratization reflects factors such as fairness, freedom of elections, civil liberties, also the degrees of dynamicity and civil society participation of the political system. A fairly closed political system that restricts the opposition and implements a censorship system is unlikely to support large-scale Internet use, and Internet access is an important factor affecting income distribution Muller (1988) using a large dataset found a negative correlation between democratic and inequality. Lee (2003) pointed out that there is a significant positive correlation between democracy and inequality, and the interaction between democracy and government size is significant and negative, which shows that for a sufficiently large government level, democracy can reduce non-income equality.

Chapter 3 Conceptual Framework and Methodology

This paper attempts to measure how ICT development affects the growth of wage premium. Section 3.1 introduces the skill-biased technological change (SBTC) theory; the dependent variables are defined in section 3.2, and section 3.3 elaborates the technology variables : ICT Development Index (IDI) and its three sub-indexes (ICT access, ICT use, and ICT skills.); other independent variables are represented in section 3.4; section 3.5 illustrates the Fixed Effect Model (FEM) and constructs the hypothesis.

3.1 The Skill-Biased Technological Change (SBTC) Theory

Technological changes can act as either substitute for or complement to labor. When technology acts as a substitute, it reduces the number of workers needs to hire. For a typical example, word processing decreased the number of typists needed in the workplace. This shifted the demand curve for typists left and induced progress in the availability of certain technologies which may increase the demand. On the other hand, technology acts as a complement to labor, will increase the demand for certain types of labor, and result in an increase in demand. For instance, the increased use of word processing and software has increased the demand for ICT professionals who can resolve software and hardware issues. Technology will increase the demand for skilled workers who adopt technology to enhance workplace productivity. Those workers who do not adapt to changes in technology will experience a decreased demand.

In the SBTC framework, the understanding of wage inequality plays an important role. Firstly, by using a simple labor supply and demand model, the change in wage inequality is shown in Figure 3.1. Assuming that "r" is the wage ratio of high-skilled workers to low-skilled workers, and "p" is the ratio of the number of skilled workers to the number of unskilled workers, if we simply assume that the supply of skilled workers is completely inelastic, the equilibrium point will be A. Obviously, by reducing the supply of skilled workers or increasing the demand for skilled workers, wage inequality may increase. In many developed countries, especially in the United States, the number of skilled workers has greatly increased, resulting in a shift from S to S1, which means that the relative wages of skilled workers will fall. However, the increase in demand for skilled workers exceeds the increase in supply, thus leading to an increase in wages for skilled workers. This explains why the balance actually reached point C instead of point B is the new balance point.

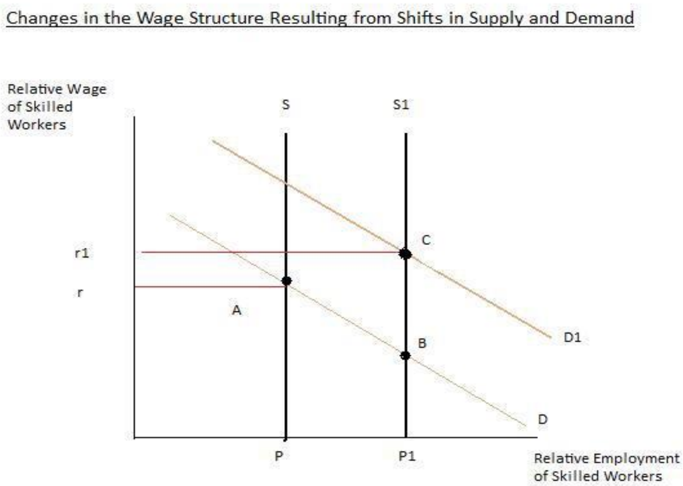


Figure 3-1: Changes in the wage structure in supply and demand
Source: Borjas (2010)

Another way of demonstrating the SBTC effect is by treating technological progress as an increase in production efficiency, thereby increasing output for a given set of resources. However, technological progress can also serve as a labor-saving innovation, enabling companies to reduce low-skilled jobs. In addition, it is proved that technological progress will shift functions to skilled workers, and as the relative demand for skilled workers increases, it will lead to increased wage inequality.

It can be concluded that technological progress is related to the supply and demand for labor, which is regarded as the main factor of income inequality. The concept of SBTC and the literature on productivity improvement also prove that technological progress is only beneficial to high skilled workers, and technological change has also accelerated income inequality.

3.2 Dependent Variables

In this paper, two dependent variables $wpremium$ and $wpremium$_ICT, which are defined as the conventional wage premium and wage premiums for ICT-intensive occupations, respectively.

3.2.1 The Conventional Wage Premium

The definition of high-skilled and low-skilled workers in this study is derived by the International Standard Classifications of Occupations 2008 (ISCO-08), and following with Angelini, Farina, and Valentini (2017) . The skill levels into two groups, "High-skill occupations refers to the workers whose occupation in skill level 3 and 4, (ISCO-08 codes: 1 Managers, 2 Professionals, 3 Technicians and associate professionals);

and Low-skill refer to skill level 1 and 2, (ISCO-08 codes: 4-9 , includes clerical support workers, servicer and sales workers, skilled agricultural, forestry and fishery workers, craft and related trades workers, plant and machine operators and assemblers, and other elementary occupations).

Table 3-1: Skill level & ICT occupations

ISCO-08 Major Groups	Skill Level	Classified
1. Managers	3+4	High
2. Professionals	4	
3. Technicians and associate professionals	3	
4. Clerical support workers	2	Low
5. Service and sales workers		
6. Skilled agricultural, forestry and fishery workers		
7. Craft and related trades workers		
8. Plant and machine operators, and assemblers		
9. Elementary occupations	1	

Source: ILO (2012) & Angelini, Farina, and Valentini (2017)

The conventional wage premium (***wpremium***) is the ratio of high skilled worker’s wage to low skilled worker’s wage, is defined as

$$\boldsymbol{wpremium} \equiv \frac{\boldsymbol{w^H}}{\boldsymbol{w^L}} \tag{3.1}$$

3.2.2 Wage Premiums for ICT-Intensive Occupations

Apart from the skill levels, ILO (2012) decided to construct a number of groupings, one of the proposed thematic views was ICT occupation, defined as "all occupations that require skills in the production of ICT goods and services". More specifically, it identifies professional and associate professional occupations in ICT as sub-major groups at the second level of the classification. ILO (2012) also suggests that the thematic view for ICT occupations will include a number of other unit groups that primarily involve the production of ICT goods and services. In this study, the term “ICT intensive” occupations are defined as ICT specialist. Figure 3.1 shows the classification of ICT-intensive occupations mainly refers to the narrow measures mentioned in the OECD (2012) report on ICT skills and employment. “ICT-intensive” is defined as all sectors that constitute occupations that directly provide ICT products or services, which includes ICT experts focused on ICT, such as software engineers. However, for occupations that only require software that uses ICT as a tool, even if their skill level is high, they are excluded from the ICT theme group (these occupations include managers and professionals).

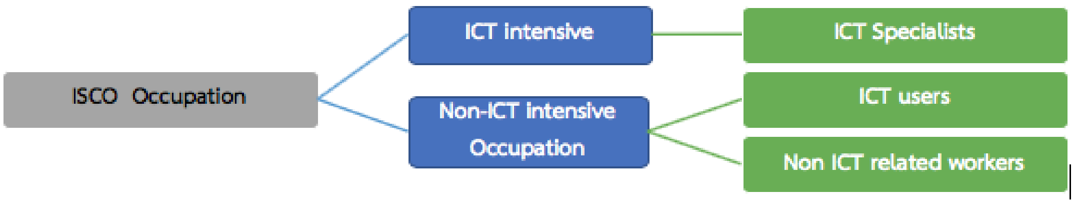


Figure 3-2: ICT occupations classification
Source: OECD (2012)

Similarly, occupations that do not require specific skills in the production of ICT products and service, for example, even considering employment relationships with companies, clerks, secretaries, industrial robot operators, electronic equipment assemblers engaged in the following activities, also are excluded from ICT-intensive occupations, the ICT intensive occupations are listed in Appendix table. B. Accordingly, $wpremium_{ICT}$ is defined as the wage ratio of ICT intensive skilled average wage to non-ICT average wage:

$$\boldsymbol{wpremium_{ICT} \equiv \frac{W_{ICT}}{W_{nonICT}}} \tag{3.2}$$

3.3 Technology Variables

3.3.1 Measure of ICT Development

The issue of the measurement of ICT at the country level and the technological readiness of nation states has been attracting the attention of researchers and policymakers worldwide, as innovative new technologies such as digital wireless telephony and the Internet become more widely diffused. As defined by the World Bank “Comprehensive Development Framework,” ICTs consist of hardware, software, networks and media for collection, storage, processing, transmission, and presentation of information (including voice, data, text and images). The five existing approaches for measurement of ICTs at the country level, including discrete non-economic measures, economic measures, technology adoption and diffusion measures, single-item index measures and digital divide measures (Kauffman and Kumar 2005).

How to identify the measurement approaches that can use to gauge the extent to which the readiness, intensity, and impacts of ICT? Kauffman and Kumar (2005) point out there are two essential features that characterize ICT measurement at the macro-level. First, the measurement needs appear to vary over time, depending on when the measurement is made and the location of the technology on the adoption and diffusion curve. This suggests the need for different measures for different stages of ICT adoption. Second, at any stage of ICT adoption, a complete representation of ICTs is possible on three inter-related dimensions—economy, society, and knowledge—and consequently, any composite index measure needs to account for all three dimensions. Many measurements on ICT can be applied by national statistical organizations. Global comparisons are somewhat more difficult to accomplish on the basis of country-level or regional-level discrete indicator measures, however. They often will not be able to provide effective assessment out of their own national or regional context. The main issues related to standards for data definitions and the lack of standardization in the process of measurement. As a result, the degree of comparability of data across countries may not be perfect. However, some useful metrics can be based on these discrete indicators. To provide an idea of the broad applications of ICT measures, Table 3.2 present information on some of the key organizations and the main measurement of ICT, particularly, this study recommend that the object of an *ICT Development Index* should be measurement of the impacts of ICT development.

Table 3-2 : Organizations ICT Measurement

ORGANIZATIONS	MAIN MEASUREMENTS
International Telecommunications Union (ITU, 2003)	80 sets of telecommunication indicators covering telephone network size and dimension, mobile services, quality of service, traffic, staff, tariffs, revenue and investment.
World Bank (2004a)	800 indicators. 24 indicators in "Information and Technology" and 11 "Communications." Indicators such as exports in high technology products, health indicators, educational indicators, gender equality-related indicators under other categories.
OECD Communication Outlook (OECD, 2003)	Data on communications sector and on policy frameworks used in Organization for Economic Cooperation and Development (OECD) countries.
PingER Project (Stanford Linear Accelerator Center)	Measurements of Internet performance by a set of specified monitoring centers across the world.
Netcraft SSL Server Survey	Measures of secure servers in the global networking context.
Internet Systems Consortium (ISC, 2004)	Tracks growth of Internet domain hosts globally on a biennial basis.
National Telecom and Information Admin (NTIA, 2002)	Tracks computer, Internet and broadband usage in the United States

Source:(Kauffman and Kumar 2005)

3.3.2 ICT Development Index (IDI)

The interesting independent variables are designed to measure the penetration of ICT development in a country. The ICT Development Index (IDI), published by the ITU, is a composite index that combines 11 indicators for ICT access, use and skills into one benchmarking measure to highlight ICT progress for 175 economies. The Index is designed to be global and reflect changes taking place in countries at different levels of ICT development.

If ICT can be properly applied and used, it will become a driving force for the development of information technology, which is crucial for countries that are moving towards an information or knowledge-based society. The development process of ICT can be described by a three-stage model using the IDI conceptual framework shown in Figure 3.3.:

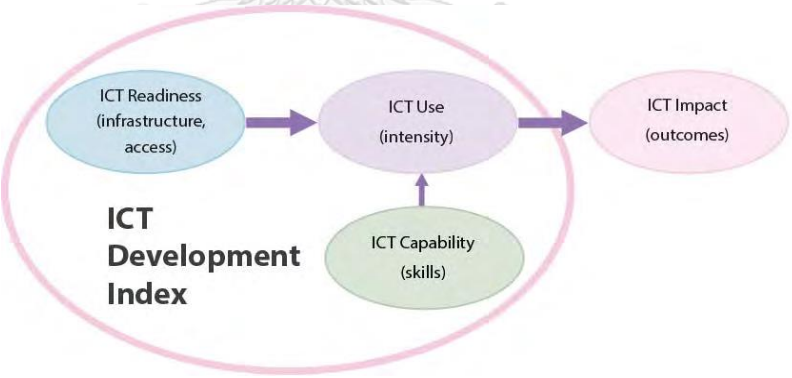


Figure 3-3. Three stages in the evolution towards an information society
Source: (ITU 2016)

Stage 1: *ICT readiness* – reflecting the level of networked infrastructure and access to ICTs;

ICT Access sub-index captures ICT readiness, includes five infrastructure and access indicators (fixed-telephone subscriptions, mobile-cellular telephone subscriptions, international Internet bandwidth per Internet user, households with a computer, and households with Internet access). When a technology is new to a country or a region, the readiness of its people to adopt it is a crucial issue. The related measures also must capture readiness in terms of a country's businesses, infrastructure and economy.

Stage 2: *ICT intensity* – reflecting the level of *use* of ICTs in the society;

ICT use sub-index captures ICT intensity, includes three intensity and usage indicators (individuals using the Internet, fixed broadband subscriptions, and mobile-broadband subscriptions).As adoption increases, the intensity of adoption, the intensity with which ICT- related activities (such as business-to-consumer and business-to-business e-commerce and e-government initiatives, etc.) are undertaken becomes more relevant. The measurement of ICT is likely to be of interest when ICTs are becoming more prevalent in a country, but have not yet reached the point where they are fully diffused and adopted, and when there are beliefs that a digital divide has been created.

Stage 3: *ICT impact* – reflecting the results/ outcomes of more efficient and effective ICT use.

ICT skills sub-index seeks to capture capabilities or skills which are important for ICTs. It includes three proxy indicators (mean years of schooling, gross secondary enrolment, and gross tertiary enrolment). As these are proxy indicators, rather than indicators directly measuring ICT-related skills, the skills sub-index is given less weight in the computation of the IDI than the other two sub-indices.

Advancing through these stages depends on a combination of three factors: the availability of ICT infrastructure and *access*, a high level of ICT *use*, and the capability to *use* ICTs effectively, derived from relevant *skills*. These three dimensions – ***ICT access, ICT use*** and ***ICT skills*** – therefore form the framework for the IDI.

Furthermore, Figure 3.4, the IDI is divided into three sub-indices: access sub-index, use sub-index and skills sub-index, each capturing different aspects and components of the ICT development process. For computation of the final index, the ICT access and ICT use sub-indices were each given a 40 percent weighting, and the skills sub-index (because it is based on proxy indicators) a 20 percent weighting. The final index value was then computed by summing the weighted sub-indices.

ICT access Index
1. Fixed (wired)---broadband subscriptions
2. Mobile-cellular telephone subscriptions
3. International Internet bandwidth (bit/s)
4. Percentage of households with a computer (%)
5. Percentage of households with Internet access (%)
ICT use Index
6. Percentage of Individuals using the Internet
7. Active mobile---broadband subscriptions
8. Fixed-broadband subscriptions
ICT skill Index
9. Mean years of schooling (years)
10.Secondary gross enrollment ratio (%)
11.Tertiary gross enrollment ratio (%)

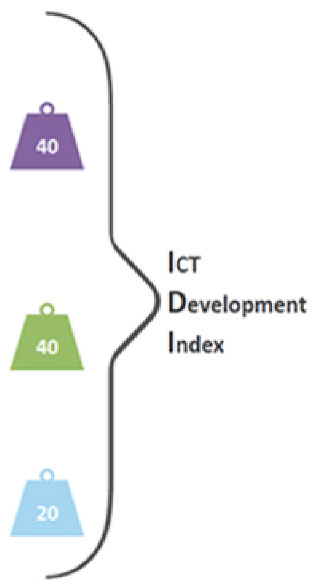


Figure 3-4: ICT Development Index: indicators and weights
Source: ITU (2012)

3.4 Other Independent Variables

In order to examine the relationship between ICT and wage premium, it is necessary to control for economic, demographic, and political factors . According to the previously literature, the expected effect of other variables on income inequality can be summarized as follows:

- *EduExp* is referred to the ratio of government expenditure on education to GDP, collected from WDI (World Development Indicators) by World Bank. Generally, education expenditures affect inequality. Keller (2010) claim that public education does not necessarily equalize incomes and might increase inequality because the opportunity cost of foregone income impedes poor students' attendance. For instance, developed country like the U.S., making higher education affordable can increase income inequality because the wage of unskilled workers drops and the skill premium rises (Selwyn 2006);
- *Openness* is a share of the sum of exports and imports of goods and services to GDP. International trade between countries with different ICT development will change relative prices and raise or lower inequality among owners of those factors (depending on whether the country has more of the relatively scarce or abundant factor after trade opening). However, increasing openness is likely to be associated, not only with increasingly competitive product markets in previously protected industries but also with technological change (Khalifa 2014);. And the literature normally presumes some role for technological change in explaining the widening of the income distribution in developed countries.

- *FDI* refers to a share of foreign direct investment are the net inflows from foreign investors divided by GDP. The technologies being introduced through FDI include new management practices and new forms of work organization. Standard trade theory tells that relative wages in each region depend on relative output prices of labor industries. The higher the relative price of the skill intensive good, the higher the relative wage of the skilled workers (Berman, Bound, and Machin 1998). Since FDI is complementary with skilled labor, the skill premium will increase (Afonso, Neves, and Thompson 2016);

- *Unemploymen*t, the ratio of unemployment to total labor force. Mocan (1999) believed that income inequality is counter-cyclical in behavior, that is, the increase in the number of unemployed people worsens the situation of low-income groups. In other words, the increase in the number of unemployed people has increased income inequality;

- *Urban*, which is a determinant of labor productivity. According to Kuznets (1955), the urban population had higher average per capita income and higher wage inequality, because their productivity increased more rapidly than rural population. In the other words, the urbanization increased wage premium;

- *Democracy* is an index measures the state of democracy from 0 to 100. Democratization reflects factors such as fairness, freedom of elections, civil liberties, also the degrees of dynamicity and civil society participation of the political system. Lee (2003) uses a panel data random effects model to argue that there are heterogeneous effects of democracy on inequality. He points out that the interaction between democracy and the size of government is significant and negative, suggesting that for large enough levels of government, democracy reduces inequality (Lee 2003). This study expects that, there is a positive correlation between democracy and inequality, because, among our data from 64 countries, the size of 48 countries is considerable.

The choice of these regressors in the specification equation (3.6) is dictated by two considerations. First, comparability with the existing literature: in order to evaluate the impact of different types of control variables on income inequality, it is important to make a few changes as possible relative to standard regressions. Second, parsimony, including too many variables would drastically reduce the number of degrees of freedom.

3.5 Fixed effect model & Hypothesis

The panel data model examines both group effects and time effects, or tests separately. When the data involves multiple countries, it is often necessary to control the characteristics of the categories that may affect the dependent variable. However, it is difficult to determine all relevant control variables. Usually, the estimation of the OLS model, the unobservable factors related to the variables in the regression, which will lead to omitting variable deviations. If these unobservable factors are time-invariant, fixed effects regression will eliminate the omitted variable bias. Moreover, even if omit variable bias may be no problem, the fixed-effect model is also a good preventive measure.

This study employs FEM to explore the relationship between technology and other control factors and income inequality in 64 countries from 2010 to 2016. When using FEM, it is assumed that certain factors of the country may affect or deviate from the predictor variables, so it is necessary to control this. This is the basic principle of assuming the correlation between the error term of the entity and the predictor variable. FEM eliminates the influence of these time-invariant features, so the influence of predictor variables on outcome variables can be evaluated. Another important assumption of FEM is that these time-invariant characteristics are unique to countries and should not be associated with other national characteristics. Every entity is different, so the error items and constants (capturing a single feature) for that entity should not be related to other entities. If the error term is related, FE is not suitable for use because the inference may be incorrect, so the relationship needs to be modeled (may use random effects), which is the main principle of the Hausman test.

Furthermore, from the perspective of statistical theory, there are many factors to consider when choosing between a fixed-effects model (FEM) and a random-effects model (REM). The Hausman test is usually used for panel model diagnosis. This test checks whether the REM estimate is significantly different from the FEM. The Hausman test is calculated as the F test, which is used to test the coefficients of the two models for zero estimation. The Hausman test results from this data set indicate that we should use FEM because the statistic is 15.32 (the complete test results are shown in Appendix Table A). Therefore, the panel data regression model-FEM will be used to estimate the relationship between ICT and income inequality.

The main model is formulated as equation 3.3, where subscript $\boldsymbol{i}$ to the intercept to indicate that the intercept of the 64 countries and $\boldsymbol{t}$ indicates of year from 2010 to

2016; $\boldsymbol{\beta}_1$ is the coefficients of the key technological variables (IDI, ICT access, ICT use, and ICT skills.), and γ is a coefficient vector of economic, demographic, and political control variables.

$$\boldsymbol{Wagepremium_{it}} = \beta_{0i} + \boldsymbol{\beta_1 ICTs_{it}} + \gamma\, \boldsymbol{Controls_{it}} + \varepsilon_{it} \tag{3.3}$$

Equation (3.3) is known as the **fixed effects regression model** (**FEM**). The term "fixed effects" is due to the fact that each countries' intercept, although different from the intercepts of the other, does not vary over time, which is **time-invariant**. Accordingly, the models for IDI sub-indexes (ICT access, ICT use, and ICT skills.), are described by the following equations:

$$\boldsymbol{Wagepremium_{it}} = \beta_{0i} + \boldsymbol{\beta}_1 \boldsymbol{ICTaccess_{it}} + \gamma\, \boldsymbol{Controls_{it}} + \varepsilon_{it} \tag{3.4}$$

$$\boldsymbol{Wagepremium_{it}} = \beta_{0i} + \boldsymbol{\beta}_1 \boldsymbol{ICTuse_{it}} + \gamma\, \boldsymbol{Controls_{it}} + \varepsilon_{it} \tag{3.5}$$

$$\boldsymbol{Wagepremium_{it}} = \beta_{0i} + \boldsymbol{\beta}_1 \boldsymbol{ICTskills_{it}} + \gamma\, \boldsymbol{Controls_{it}} + \varepsilon_{it} \tag{3.6}$$

As a part of this study, wage premiums for ICT-intensive occupations (***wpremium*_ICT),** which is another dependent variable measure the income inequality between ICT intensive skilled worker and non-ICT skilled worker, are formulated another 4 equations accordingly.

The following hypotheses will be tested in this study:

Hypothesis 1. The wage premiums are higher in low level of ICT development countries. The ICT development are varied among countries, with Lower ICT development, the effect of technical change and other factors may favoured more on skilled workers, then demand of skilled labour will increase sharply than those countries with higher level of ICT development.

Hypothesis 2. Wage premium is positively related to IDI. The skill-biased technical change will affect relative wages because of an integrated world economy will respond to technological transformations as a closed economy. SBTC releases low-skilled employees and reduces their relative wages by depressing the world (relative) prices of goods. Therefore, SBTC provides an explanation consistent with increased wage premiums.

Hypothesis 3. Wage premium is positively related to three sub-indexes of IDI (ICT access, ICT use, and ICT skills).Accordingly, the IDI as whole ICT development has a positive impact on income inequality. As specific measure of ICT readiness, intensity and capability, these effects may capture different aspect of income inequality.

Chapter 4 Data and Results

The previous chapters of the study have provided a review on empirical studies relating to the relationship between ICT and income inequality. Various studies have proved that ICT has positive impact on wage premium growth both in the developed and some developing countries. This chapter will contribute to the literature by focusing on 64 countries through 7 years from 2010 to 2016.

Section 4.1 will firstly describe the data obtained from 64 countries including the conventional wage premium , wage premium for ICT intensive occupation, IDI, and other control variables have been introduced in the previous chapter; Section 4.2, will employ the conceptual framework from chapter 3, to investigate the contribution of ICT and wage premiums. Additionally, the study will be interesting to investigate the split countries with high or low level of IDI, which are similar to or different with regard to relationship between the ICT and wage premiums.

4.1 Data

4.1.1 Data Statistics Description

The study explores the existing literature on technological changes and labour income inequality. The combined dataset consisted of 64 countries (35 developed countries and 29 developing countries) from 2010 to 2016, the cross- country descriptive statistics of each variables are available in Table 4.1.

The two dependent variables: the conventional wage premium and wage premium for ICT intensive occupation, both are drawn from ILO (International Labor

Organization) and national labor departments, then calculated accordingly with Equation 3.1 and 3.2. And, the key independent variable IDI are published by ITU (International Telecommunications).

Table 4-1. Cross-country Descriptive Statistics

Variable	Mean	S.D.	Min	Max
Dependent variables				
wpremium	2.15	0.59	1.20	4.09
wpremium_ICT	1.31	0.18	0.91	2.27
Technological variables				
IDI	5.97	1.80	1.24	8.93
*ICT access**	6.07	2.07	0.00	10.00
*ICT use**	6.19	1.70	0.00	10.00
*ICT skills**	6.06	1.92	0.00	10.00
Economic variables				
EduExp	4.92	1.42	1.14	8.56
Openness	99.30	58.90	0.20	408.00
FDI	7.61	23.20	-37.20	280.00
Unemployment	7.74	5.35	0.14	27.50
Demographic variables				
Urban	70.00	16.70	28.90	99.00
Politic variable				
Democracy	68.00	20.00	17.10	99.30

Note: Obs. = 448 (64 countries, 2010-2016), "*" is sub-index of IDI.

Source: ILO (International Labor Organization), WDI (World Development Indicators), ITU (International Telecommunications Union), UIS (UNESCO Institute for Statistics). WB (world bank), EIU (Economist Intelligence Unit), TI (Transparent Institution).

Other control variables including measures of economic, *EduExp*, government expenditure averagely is 4.92% of *GDP* cross 64 countries; *Openness* is a share of the sum of exports and imports of goods and services to GDP, the average is 99% among 64 countries, however the highest ratio is 408% which means Luxembourg may has a larger trade surplus while Myanmar only present as 0.2% ; Foreign Direct Investment (*FDI)* is roughly 7.6% , which exist a wide gap within 64 countries from 280% (Cyprus) to -37% (Mongolia), imply that some countries have a large amount of inflow investment while some countries experience serious investment outflows; and *Unemployment* are collected from WDI (World Development Indicators) by World Bank, average around 7.74% , but the worst case of Unemployment is over a quarter workers of total labor force in Greece lost their job.

Moreover, demographic indicators *Urbanization* is from 28 (Myanmar) to 99 (Qatar) among 64 countries; the last, *Democracy* that reflect the state of political freedoms and civil liberties, an index intends to measure the state of democracy the indicator democracy index from the Economist Intelligence Unit (EIU). Its average at 68, but the most democracy country as Norway's index is 99, while the index of Saudi Arabia is only 17.1.

4.1.2 Diagnostic Check.

Technological change as endogenous is described in the SBTC theory (Acemoglu 2003, 1998; Acemoglu and Autor 2010). The endogeneity of technological change means that in a specific socio-economic system type and level of technology are determined by certain specific features of the socio-economic system, such as economics, demographic and political factors. Solving endogeneity problem is the econometrics arts. Ideally, we should eliminate measurement error, introduce omitted or unobserved variables for mending the correlated missing regressors, narrow the generality of interpretation for mending sample selection bias. Throughout this study, by using OLS regression to account for the endogeneity of technology variables (IDI). Suppose our linear model is:

$$\boldsymbol{Wagepremium} = \beta_0 + \boldsymbol{\beta_1 IDI} + \mu \quad (3.7)$$

Step 1: seek out an appropriate instrument Z. Regress the endogenous variable X on the instrument(s) Z, and save the residuals v.

$$\boldsymbol{IDI} = \gamma_0 + +\gamma\, \boldsymbol{Controls} + \nu \quad (3.8)$$

Table 4-2 : Test of endogeneity

Model 1: Pooled OLS, using 448 observations

	Coefficient	*Std. Error*	*z*	*p-value*	
const	−0.446500	0.187849	−2.377	0.0175	**
EduExp	−0.0124002	0.0229486	−0.5403	0.589	
Openness	0.00654194	0.00025901	25.26	<0.0001	***
FDI	−0.00559464	0.00173457	−3.225	0.0013	***
Unemployment	0.0280358	0.00482872	5.806	<0.0001	***
Urbanization	0.0541899	0.00131163	41.31	<0.0001	***
Democracy	0.027424	0.00196292	13.97	<0.0001	***

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate, respectively. *p < 0.05, **p<0.01, ***p<0.001

Step 2: Include this residual as an extra term in the original model and estimate:

$$\boldsymbol{Wagepremium} = \beta_0 + \boldsymbol{\beta_1 IDI} + \boldsymbol{\beta_2}\nu + \varepsilon \quad (3.9)$$

Table 4-3: Test of endogeneity

Model 2: Pooled OLS, using 448 observations					
	Coefficient	***Std. Error***	***z***	***p-value***	
const	2.29806	0.0347389	66.15	<0.0001	***
IDI	−0.0254916	0.00390452	−6.529	<0.0001	***
uhat	−0.110796	0.0164498	−6.735	<0.0001	***
Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate, respectively. *p < 0.05, **p<0.01, ***p<0.001					

Step 3: Test whether $\boldsymbol{\beta_2}$ = 0

If $\boldsymbol{\beta_2}$ = 0 conclude there is no correlation between X and u.

If $\boldsymbol{\beta_2} \neq 0$ conclude there is correlation between X and u.

Table 4-4: Test of endogeneity

Test for omission of variables -
Null hypothesis: parameters are zero for the variables uhat
Test statistic: F (1, 63) = 45.3656
with p-value = P (F (1, 63) > 45.3656) = 5.76675e-09

In Table 4.2c, $\boldsymbol{\beta_2} \neq 0$ conclude there is correlation between X and u, the control variables can be considered as omitted variables. Therefore, we can conclude that in the presence of endogeneity, OLS can produce biased and inconsistent parameter estimates in this study, and hypotheses tests can be seriously misleading.

The results of the Hausman test from this dataset, suggest that we should use FEM, since the statistic is 15.32 (the full results of test shown in Appendix Table A). Therefore, the panel data regression models-FEM would be conducted for estimating the relationship between ICT and income inequality.

4.1.3 Split Samples

However, skill-biased technical change is also not a steady process. Autor et al. (1998) suggest that the pace of skill-biased technical change was likely more rapid between 1970 and 1990 than between 1940 and 1970, and the pace of skill-biased technical change slowed during the 1990s. As also discussed in Acemoglu (2002a), a relatively steady process of skill-biased technical change is likely to be a particularly poor approximation when we consider the last 200 years instead of just the post war period. In this study, once we recognize that skill-biased technical change is not a steady process, not only it becomes more important to understand when should expect it to be more rapid or slow, but also the varied level of ICT development among 64 countries.

According to Measuring the Information Society Report 2015, ITU sets out the IDI values for four quartiles, representing high, upper, medium, and low IDI levels. Table 4.3. sets out the IDI values for four quartiles, representing high, upper, medium, and low IDI levels, as these quartiles were constituted in 2010 and 2015. A comparison between IDI 2015 and 2010 shows that there has been continued progress in IDI performance over time.

Table 4-5: IDI value by IDI quartiles, 2010 and 2015

	IDI 2010					IDI 2015				
Group	**Countries**	**Average***	**Min.**	**Max.**	**Range**	**Countries**	**Average***	**Min.**	**Max.**	**Range**
High	42	7.02	5.82	8.64	2.82	42	7.90	7.00	8.93	1.93
Upper	41	4.74	3.91	5.80	1.88	41	5.95	5.05	6.93	1.88
Medium	42	3.19	2.14	3.82	1.69	42	4.13	2.93	5.00	2.08
Low	42	1.61	0.88	2.09	1.22	42	2.16	1.17	2.93	1.76
World	**167**	**4.14**	**0.88**	**8.64**	**7.76**	**167**	**5.03**	**1.17**	**8.93**	**7.76**

Note: * Simple averages.
Source: ITU.

Although most countries have increased their IDI values, the gap between countries with higher ICT content has gradually narrowed, while the gap in ICT development between low- and middle-end countries is still large, and there is a tendency to deteriorate. It is worth noting that the IDI growth in the top and bottom countries is slow, showing similar ICT changes, but they are very different in the actual development of ICT. Therefore, in order to better observe the impact of different ICT development stages on the wage premium in this study, the sample is divided into three categories.

- *"Low IDI"* , consists of 19 countries that ITU classifies as being "Low" or "Medium" performance in ICT development.
- *"High IDI"*, consists of 28 countries the ITU classifies as being "Upper" or "High" performance in ICT development.
- Dynamic countries group, 17 countries in which ICT development has relatively changed from 2010 to 2015.

For the best output of FEM, this study will only use the balanced panel data, so the 17 dynamic countries are not estimated. The split samples are presented in Appendix Table C.

4.2 Empirical Results

This section presents the results of the fixed-effect regression, which measures wage premium for ICT-intensive occupations. The main empirical question of this study is how the development of ICT affects income inequality.

Firstly, in Figure 4.3, by comparing the average of wage premiums between "Low IDI" and "High IDI" countries, from 2010 to 2016. The conventional wage premium is roughly 2.3 for "Low IDI" countries, and 1.4 "High IDI" countries; and the wage premiums for ICT-intensive occupations are 1.35 and 1.31 in split samples respectively.

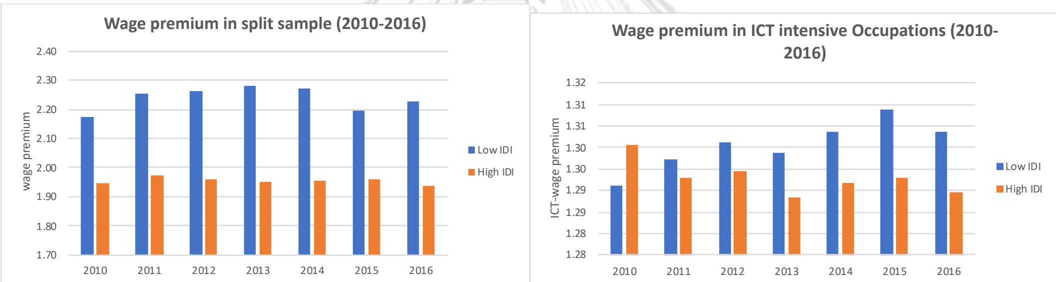


Figure 4-1: Wage premiums in split samples

Secondly, the results of Tables from section 4.2.1 and 4.2.2 are headed by IDI and its sub-indexes (ICT access, ICT use, and ICT skills.). The first specification in each regression table only estimates the ICT factor, and the remaining four specifications include different group of control variables.

4.2.1 Estimation Results from Low IDI Group

The relationship of wage premium of ICT-intensive occupations to the ICT development index, is showing a positive and significant coefficient. This result indicates that in "Low IDI" countries, the development of ICT increase the wage premium in ICT intensive occupations (increase inequality). The sub-index ICT use and ICT skills are positive and siginificant, while ICT access present the weak coefficient without stastistically significant.

4.2.1.1 Model with IDI

The results show the impact of IDI and control variables for the wage premium for ICT intensive occupation (***wpremium_ICT***) in Table 4.4.1. Countries with low levels of ICT development, workers from non-ICT intensive occupations experience higher the wage premium accordingly. Technological variable *IDI* affect the ICT wage premium positively and statistical significantly in model 1,2 and 4, when *IDI* increase 1 point, ***wpremium_ICT*** will arise 0.008 point of value.

Table 4-6: Estimation results (Low IDI) – The Wage Premium for ICT intensive Occupations

Low IDI	***Model with IDI***				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	1.2685***	1.2747***	1.3140***	1.2549***	1.2002***
	(0.0091)	(0.0328)	(0.2029)	(0.0295)	(0.1743)
Technology Factors					
IDI	0.0085***	0.0051*	0.0101	0.0086***	0.0025
	(0.0024)	(0.0029)	(0.0074)	(0.0024)	(0.0055)
Economic Factors					
EduExp		0.0065			0.0066
		(0.0043)			(0.0044)
Openness		-0.0002			-0.0002
		(0.0003)			(0.0003)
FDI		-0.0009			-0.0009
		(0.0007)			(0.0007)
Unemployment		-0.0006			-0.0007
		(0.0023)			(0.0025)
Demographic Factors					
Urbanization			-0.0009		0.0014
			(0.0041)		(0.0037)
Political Factors					
Democracy				0.0002	0.0002
				(0.0005)	(0.0005)
n	133	133	133	133	133
Adj. R^2	0.0338	0.1041	0.0386	0.0349	0.1094

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate respectively. *p < 0.05,**p<0.01,***p<0.001

While in model 2, added with economic variables, the effect is a 0.005 point increase in wage premium for ICT intensive occupation. However, the role of control variables in this table is not prominent.

4.2.1.2 Model with ICT use

The relationship between *ICT use* and ***wpremium_ICT*** in "Low IDI" countries is shown in Table 4.4.2. The ICT use is positively related to ICT wage premium. In model 2 with 4 economics variables, workers from non ICT intensive occupations experience a 0.005 point higher the wage premium when levels of ICT use increase 1 point. In model 5 under all the other control form economic, demographic, and political variables, ICT use presents a similar effect with model 2.

Table 4-7: Estimation results (Low IDI) – The Wage Premium for ICT intensive Occupations

Low IDI	***Model with ICT use***				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	1.2786***	1.2766***	1.2477***	1.2778***	1.2644***
	(0.0129)	(0.0306)	(0.1097)	(0.0234)	(0.1196)
Technology Factors					
ICTuse	0.0053	0.0052*	0.0046	0.0053	0.0050*
	(0.0031)	(0.0030)	(0.0027)	(0.0034)	(0.0027)
Economic Factors					
EduExp		0.0073			0.0072
		(0.0044)			(0.0043)
Openness		-0.0003			-0.0003
		(0.0003)			(0.0003)
FDI		-0.0010			-0.0010
		(0.0007)			(0.0007)
Unemployment		-0.0005			-0.0005
		(0.0022)			(0.0023)
Demographic Factors					
Urbanization			0.0006		0.0002
			(0.0020)		(0.0022)
Political Factors					
Democracy				0.0000	0.0000
				(0.0005)	(0.0005)
n	133	133	133	133	133
Adj. R^2	0.0227	0.1154	0.0264	0.0227	0.1182

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate respectively. *p < 0.05,**p<0.01,***p<0.001

4.2.1.3 Model with ICT skills

In Table 4.4.3, the impact of *ICT skills* and control variables for ***wpremium_ICT*** is positive and statistically significant. Model 2 as best one present this relationship in "Low IDI " countries. When 1 point of value increase in *ICT skills* , the ICT wage premium grows 0.008 point of value. In countries with low levels of, workers from non-ICT intensive occupations experience higher the wage premium accordingly. Although the role of most control variables is non-statistical significance, the effect of economic variables still relatively larger than others.

Table 4-8: Estimation results (Low IDI)– The Wage Premium for ICT intensive Occupations

Low IDI	***Model with ICT skils***				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	1.2616***	1.2622***	1.2410***	1.2298***	1.2190***
	(0.0145)	(0.0324)	(0.1384)	(0.0298)	(0.1318)
Technology Factors					
ICTskills	0.0093**	0.0080**	0.0086*	0.0103***	0.0079
	(0.0035)	(0.0036)	(0.0047)	(0.0031)	(0.0046)
Economic Factors					
EduExp		0.0071			0.0070
		(0.0042)			(0.0042)
Openness		-0.0002			-0.0002
		(0.0003)			(0.0003)
FDI		-0.0010			-0.0009
		(0.0007)			(0.0007)
Unemployment		-0.0012			-0.0010
		(0.0022)			(0.0024)
Demographic Factors					
Urbanization			0.0004		0.0004
			(0.0027)		(0.0029)
Political Factors					
Democracy				0.0005	0.0004
				(0.0005)	(0.0006)
n	133	133	133	133	133
Adj. R^2	0.029	0.1133	0.0347	0.0338	0.1201

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate respectively. *p < 0.05,**p<0.01,***p<0.001

4.2.3 Estimation Results from High IDI Group

In “High IDI “ countries, the wage premium of ICT-intensive occupations is related to the ICT development index, negatively and statistically significant. This indicates that the development of ICT decrease the wage premium in ICT intensive occupations (decrease inequality). The coefficient of sub-index ICT use is negative and siginificant, while ICT access and ICT skills present the weak coefficient without a little stastistically significant.

4.2.2.1 Model with IDI

The impact of IDI on the wage premium of ICT-intensive occupations (***wpremium*_ICT**) is shown in Table 4.5.1. In “High IDI” countries, the ICT development is related to the ICT wage premium negatively, and the effect is statistically significant. Where with 1 point of IDI growth, ***wpremium*_ICT** will drop 0.0066 point of value. In model 2, with economics control variables, ***wpremium*_ICT** will drop 0.0066 point of value decrease 0.009 point of value when IDI increase 1 point; And in model 4 and 5, a rise of 1 point of IDI induce a 0.007 decline in ***wpremium*_ICT.**

While, considering the other control variables in the Table 4.4.1, model 2 with economic variables, Unemployment is negatively correlated with income inequality with a s statistical significance, when unemployment increases 1percentage, *wpremium*_ICT decrease 0.003 point of value. Turning to Model 3, Although the role of most control variables is not prominent and has no statistical significance; the

Urbanization still has a relatively large impact and is statistically significant, which will increase 0.0066 point of *wpremium*_ICT by 1% growth. Furthermore, the political coefficient of Democracy is positive in model 4, with 1 point of democracy index growth, the ICT wage premium rise 0.0025 point of value.

Table 4-9 :Estimation results (High IDI) – The Wage Premium for ICT intensive Occupations

High IDI	***Model with IDI***				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	1.3426***	1.3977***	1.8230***	1.1415***	1.4526***
	(0.0195)	(0.0383)	(0.1484)	(0.0877)	(0.1165)
IDI	-0.0066**	-0.0090***	-0.0016	-0.0070***	-0.0073*
	(0.0026)	(0.0032)	(0.0030)	(0.0024)	(0.0040)
Economic Factors					
EduExp		0.0005			0.0008
		(0.0027)			(0.0028)
Openness		-0.0001			-0.0001
		(0.0001)			(0.0001)
FDI		-0.0002			-0.0001
		(0.0001)			(0.0001)
Unemployment		-0.0030**			-0.0027*
		(0.0013)			(0.0014)
Demographic Factors					
Urbanization			-0.0066***		-0.0021
			(0.0020)		(0.0019)
Political Factors					
Democracy				0.0025**	0.0011
				(0.0012)	(0.0010)
n	196	196	196	196	196
Adj. R^2	0.0199	0.1094	0.0865	0.0444	0.118

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate respectively. *p < 0.05,**p<0.01,***p<0.001

4.2.2.2 Model with ICT use

The relationship between *ICT use* and ***wpremium_ICT*** is shown in Table 4.5.2. In "High IDI" countries, the ICT intensity is negatively related with ICT wage premium. With the *ICT use* variable only, the ***wpremium_ICT*** decrease 0.009 point of value while *ICT use* increase 1point. Model 2 as the best model, reduce the ICT wage premium 0.013 point of value by 1 point of ICT use increase; and the

wpremium_ICT decrease also attribute to the economics control *Openness* and *Unemployment.*

Table 4-10: Estimation results (High IDI) – The Wage Premium for ICT intensive Occupations

High IDI	***Model with ICT use***				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	1.3597***	1.4376***	1.8024***	1.1589***	1.5319***
	(0.0271)	(0.0502)	(0.1266)	(0.0793)	(0.1101)
Technology Factors					
ICTuse	-0.0092**	-0.0133***	-0.0059	-0.0095**	-0.0117**
	(0.0037)	(0.0043)	(0.0035)	(0.0036)	(0.0047)
Economic Factors					
EduExp		-0.0000			0.0003
		(0.0026)			(0.0026)
Openness		-0.0002*			-0.0001
		(0.0001)			(0.0001)
FDI		-0.0002			-0.0002
		(0.0001)			(0.0001)
Unemployment		-0.0032**			-0.0028*
		(0.0013)			(0.0014)
Demographic Factors					
Urbanization			-0.0059***		-0.0025
			(0.0015)		(0.0015)
Political Factors					
Democracy				0.0025**	0.0010
				(0.0011)	(0.0009)
n	196	196	196	196	196
Adj. R^2	0.0269	0.1285	0.1256	0.0512	0.1476

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate respectively. *p < 0.05,**p<0.01,***p<0.001

In model 4 , under control from political variables, workers from non ICT intensive occupations experience a 0.0025 point declining in the wage premium when levels of democracy increase 1 point; furthermore, the growth of *Unemployment* affect the ***wpremium_ICT*** negatively with a drop about 0.0028 point of value, in model 5.

4.2.2.3 Model with ICT skills

In Table 4.5.3, the impact of *ICT skills* and control variables for ***wpremium_ICT*** is negative and statistically significant in model 2. In “High IDI” countries, when 1 point of value increase in *ICT skills* , the ICT wage premium reduces 0.004 point of value.Openness and Unemployment are also negatively correlated with ***wpremium_ICT*** with a s statistical significance. The effect of openness is relatively smaller , while unemployment rate rise 1 % will decrease the ICT wage premium 0.0027 point of value accordingly.

Table 4-11:Estimation results (High IDI) – The Wage Premium for ICT intensive Occupations

High IDI	***Model with ICT skils***				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	1.3057***	1.3702***	1.9645***	1.1102***	1.7018***
	(0.0092)	(0.0330)	(0.2057)	(0.0947)	(0.1511)
Technology Factors					
ICTskills	-0.0017	-0.0040*	0.0052	-0.0015	0.0015
	(0.0012)	(0.0020)	(0.0032)	(0.0014)	(0.0032)
Economic Factors					
EduExp		0.0003			0.0007
		(0.0029)			(0.0028)
Openness		-0.0002**			-0.0001
		(0.0001)			(0.0001)
FDI		-0.0001			-0.0001
		(0.0001)			(0.0001)
Unemployment		-0.0027**			-0.0021
		(0.0013)			(0.0013)
Demographic Factors					
Urbanization			-0.0090***		-0.0062**
			(0.0029)		(0.0023)
Political Factors					
Democracy				0.0024**	0.0011
				(0.0011)	(0.0010)
n	196	196	196	196	196
Adj. R^2	0.0009	0.082	0.0698	0.0231	0.1029

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate respectively. *p < 0.05,**p<0.01,***p<0.001

In sum, the wage premium of ICT-intensive occupations is related to the ICT development index differently in two split samples, which are shown in 4.2.1 and 4.2.2 respectively.

The positive relationship of wage premium for ICT-intensive occupations and ICT, indicates that in “Low IDI” countries, the development of ICT increase the wage premium in ICT intensive occupations (increase inequality). The sub-index ICT use, and ICT skills are positive and significant, while ICT access present the weak coefficient without statistically significant, which is not presented in the results section.. The results of sample analysis in countries with less developed ICTs prove the theoretical premise that ICT development exacerbates income inequality, and further indicate that low-level workers in "low IDI" countries face higher wage premiums.

However, in "high IDI" countries (majority are OECD countries) the development of ICT is negatively correlated with income inequality, which is not in line with the research theoretical and discussion topics. Krugman hypothesis, maintains that inequality did not increase as much in Europe because labor market institutions there encourage wage compression, limiting the extent of inequality (Krugman and Lawrence 1994). Blau and Kahn (1996) show that the major difference in overall inequality between the U.S. and many continental European economies is not in the 90-50 differential, but in the 50-10 differential. This suggests that the minimum wage, strong unions, and generous transfer programs in Europe are in part responsible for the relative wage compression in Europe.

As a result, while wage inequality increases in the “Low IDI” countries, it will decrease in "high IDI" countries. Therefore, a simple story for cross-country differences in inequality trends emerges from this model: wage compression encourages the use of more advanced technologies with unskilled workers and acts to reinforce itself in "high IDI" countries. In contrast, technological developments can harm the earnings of low-skill workers who are not protected by this type of compression in the “Low IDI” countries.

Chapter 5 Conclusion

Based on empirical results present the impact of ICTs on income inequality previously, this chapter summarizes the technological, economic, demographic, and political literature on the income growth impacts of ICTs and posit explanations for the mixed relationship on income inequality. This chapter also recommends specific policies and programs on the income inequality effects of ICTs on lower-ICT development and vulnerable populations. Finally, the study states the limitation and the suggestion on future research.

5.1 Summary of the study

This study adopts a cross-national perspective and examine the effect of ICT on wage premium, by using panel data from 64 countries during the period 2010–2016. The panel data Fixed Effect Model (FEM) is employed to estimate the impact of ICT development and the control factors of the economic, demographic, and political, on two separate measures of wage premiums : the conventional wage premium and wage premiums for ICT-intensive occupation.

SBTC as the principal factor contributing to the rise of wage inequality. The technological factors play an important and positive role in the growth of wage premiums. The estimation results consistent with the hypothesis of this study (section 3). Firstly, the wage premiums are higher in low level of ICT development countries.

According to the empirical results in section 4.2, the average of the conventional wage premium from “Low IDI ”countries are approximately 0.9 higher than “High IDI” countries, and the wage premium in ICT intensive occupation is about 0.2 higher, accordingly. Thus, we state that the wage premium is relatively higher in low ICT development countries, which is conformity with the hypothesis 1.

Secondly, ICT is positively related with wage premium, especially in low level of ICT development countries. The results of the split sample “Low IDI ”are consistent with the hypothesis 2 and 3 that ICT is positively related to income inequality, and its three sub-indicators also show similar effects on the wage premium of ICT-intensive occupations , and it has a strong and statistical significance.

Furthermore, correspond to hypothesis 3, IDI three sub-indexes: ICT use, and ICT skills, show a positive relationship with wage premium, particular, ICT skills is significantly related to wage premiums. In some case of ICT access, the development of ICT access reduces income inequality. This result may be due to the development of ICT access is related to technology readiness, which the ICT infrastructure changes may have a "positive" effect in labor market changes, thereby narrowing the wage and income gap. For example, the popularization of ICT has increased worker productivity and may tend to reduce income inequality. However, the majority models consist a positive correlation with income inequality.

In addition, the measurement of ICTs at the country level include: discrete non-economic measures, economic measures, technology adoption and diffusion measures, single-item index measures and digital divide measures (Kauffman and Kumar 2005). Based on the state of diffusion of ICTs, single-item index measures in terms of those that measure ICT-readiness as IDI sub-index *ICT access*, those that assess ICT intensity is refer to IDI sub-index *ICT use,* and those that evaluate the impacts of ICTs may closely related with IDI sub-index *ICT skills*. This study identifies the impact of the single-item index measures on income inequality. *ICT use*, and *ICT skills*, show a positive relationship with a wage premium, the development of *ICT access* might reduce income inequality in some case. Richmond and E.Triplett (2018) by using panel data from 107 countries during the period 2001–2014 to examine the empirical connection between ICT and income inequality in a cross-national, they argue that the effect of ICT on income inequality depends both on the specific type of ICT and on the measure of income inequality. Greater internet usage in general, and more mobile phone subscriptions in particular, are associated with decreased income inequality. However, increases in fixed broadband subscriptions is associated with greater inequality, especially when measured using gross incomes. The evaluation of this study concludes that the IDI sub-indexes will be able to measure the impact of ICT from a specific perspective, however, the ICT Development Index (IDI) object to measure the overall impacts of ICTs may mislead the results in this study (the full dataset estimated results are shown in Appendix Tables D). Moreover, the multicollinearity problem we found, the *t* ratios of one or more coefficients tend to be statistically insignificant., lower than 1.96, so we rejected the results of full dataset accordingly.

And the estimation of ICT on the conventional wage premium (***wpremium***) are listed in Appendix Tables F, the coefficient of most ICT variables has no statistical reference value. Exclusively, ICT skills is positive and significantly related to wage premiums in both split samples. that may imply the ICT skills increase the income inequality regardless of the level of ICT development

5.2 Policy Implication

According to theoretical and empirical analysis, the ICT development environment of the international community, from economies with high ICT performance to countries with the least connection, strives to develop from basic access and increase the intensity of ICT. However, each economy faces different challenges, depending on its economic foundation, sociodemographic structure, and degree of political democracy. Especially in countries with relatively poor ICT development, the limited impact of ICTs on income growth in lower-income populations can be partially attributed to their significantly lower ICT adoption.

While affordability is one barrier to ICT access and use, other factors include education and culture (ICT skills). To counter the possible disparity in the impact of ICTs between lower and higher-income groups, the most immediate action should be to close the disparity in ICT penetration. Many of the benefits of ICTs are not accruing to lower-income populations because access and adoption is low. The following policy recommendations are proposed to close the access and adoption gap to increase the positive benefits of ICT:

- Focus public resources and incentives for building broadband Internet access out to rural and underserved communities. For example, set and enforce regulations Smart Nation & Digital Government Office to provide the resources and to connect regions and groups that are outside main urban centers;

- Increase affordability on ICT devices and internet access. In many countries, ICT products and services are taxed in a manner similar to luxury goods, but lower-income households spend a disproportionate amount of their household income on ICTs. High taxes and interconnection fees put many ICTs out of reach of unskilled workers. Thus, it is necessary to set efficient and affordable ICT infrastructure and services policy, to provide financial support and to build long-term capabilities in public sector;
- Connect schools and libraries to broadband Internet service and ensure widespread connectivity within schools. For instance, increase connectivity to schools and libraries, especially, in the developing countries, libraries serve as hubs for skills and employment development for lower income individuals;
- Develop ICT training curricula and programs. The recommended measures, as increasing public digital literacy training, to encourage individuals in how to utilize ICTs will help drive familiarity and adoption; and incentivizing enterprises to upskill the existing workforce, even for basic ICT knowledges for less skilled worker .

In short, plans to increase ICT penetration and the impact of technology, and the income growth of low skilled workers may have combined with a wide range of social influences to produce a greater impact, economic, demographic, and political measures to empower low-income people.

5.3 Limitations and Further Study

However, there are still many limitations and challenges in making a full understanding of ICT and its impact on income inequality. As Acemoglu notes that “technology is far from the only reason why the preponderance of wealth created in recent decades has accrued to households at the top end of the economic spectrum”. In particular, the SBTC hypothesis cannot explain the drop in income inequality in High ICT development countries. Secondly, Panel data also have some limitations. The problem in this study could be distortions of measurement errors and selectivity problems. For example, the study attempts to use the year of schooling and literacy as the ICT skills, rather than the professional or technical skills of ICT-related, which employed from ITU accordingly. Therefore, the indirect evidence may have a certain educational bias, and the relevant conclusions in the study of ICT intensive occupation may have the reference value.

Another limitation is data sources. Since the data period is only 7 years, there is not enough Data on the development of the ICT , because the changes of measure on IDI occur in 2018, and the data availability of ICT intensive occupations from OECD ICT handbook comprise only 24 occupations.

Therefore, it is necessary to conduct further research with a longer period data. In terms of ICT skills, it would be more efficient to study direct data from the professional or technical skills of ICT-related survey. Additionally, further empirical research on the ICT skills intensive industry may also consider investigating the rationality of the decreasing income inequality in high ICT development countries.

APPENDIX

Table A. Comparison of Three Estimation Methods

DV: wpremium	Pooled OLS	Fixed Effect	Random Effect
const	2.2981***	2.6379***	2.4806***
	(0.1283)	(0.6138)	(0.4692)
IDI	0.2052***	0.0441	0.0265
	-0.0477	(0.0554)	(0.0653)
EduExp	0.0624***	0.0010	0.0063
	-0.0118	(0.0122)	(0.0145)
Openness	-0.0007***	-0.0006	-0.0007*
	-0.0001	(0.0004)	(0.0004)
FDI	-0.0001	-0.0000	-0.0002
	(0.0005)	(0.0002)	(0.0002)
Unemployment	-0.0179***	0.0057	0.0006
	(0.0027)	(0.0055)	(0.0053)
Urbanization	0.0061***	-0.0078	0.0017
	(0.0009)	(0.0093)	(0.0052)
Democracy	0.0016	-0.0002	-0.0016
	(0.0010)	(0.0023)	(0.0021)
DF	63	63	63
Adj. R2	0.2111	0.0122	0.0163
SSM (model)	119.4659	144.995	140.4645
RMSE	0.522258	0.11647	0.55994
n	448	448	448

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate, respectively. *p < 0.05, **p<0.01, ***p<0.001

Breusch-Pagan test statistic:

LM = 1116.64 with p-value = prob (chi-square > 1116.64) = 7.99338e-245

Hausman test statistic:

H = 15.3214 with p-value = prob (chi-square (9) > 15.3214) = 0.0824767

The results of the Hausman test suggest that we should use FEM, since the statistic is 15.32 Therefore, the panel data regression models-FEM should be conducted.

Table B. ICT Intensive Occupations

ICT Intensive Occupation
1. Managers
1330 ICT Service Managers
2. Professionals
2356 Information Technology Trainers
2434 ICT Sales Professionals
2511 Systems Analysts
2512 Software Developers
2513 Web and Multimedia Developers
2514 Applications Programmers
2519 Software and multimedia developers and analysts
2521 Database Designers and Administrators
2522 Systems Administrators
2531 Computer Network Professionals
2532 Telecommunications engineering professionals
2529 ICT network and hardware professionals
3.Technicians and associate professionals
3511 ICT Operations Technicians
3512 ICT User Support Technicians
3513 Computer Network and Systems Technicians
3514 Web Technicians
3531 Applications programmers
3532 Systems testing technicians
3541 Broadcasting and Audiovisual Technicians
3542 Telecommunications Engineering Technicians
7. Craft and related trades workers
7421 Electronics fitters
7422 Electronics mechanics and servicers
7423 ICT Installers and Servicers

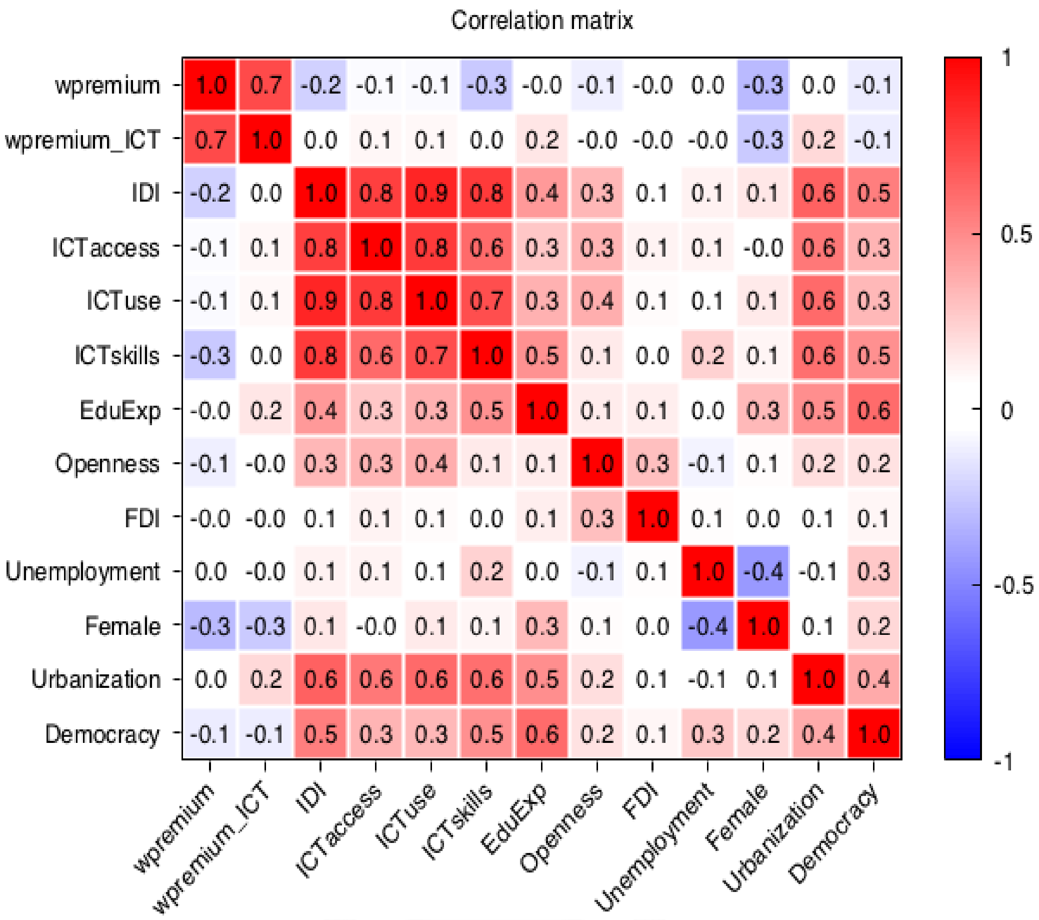
Source: ILO (2012)

Table C. Split sample—IDI performance

High IDI level Country (28)	Low IDI level Country (19)	Dynamic Country (17)
Austria	Albania	Azerbaijan
Belgium	Bolivia	Bahrain
Czech Republic	Dominican Republic	Brazil
Denmark	Ecuador	Chile
Estonia	Egypt	Costa Rica
Finland	El Salvador	Croatia
France	Ghana	Cyprus
Germany	Mali	Hungary
Greece	Mauritius	Kazakhstan
Iceland	Mexico	Malaysia
Ireland	Mongolia	Romania
Israel	Myanmar	Russian Federation
Italy	Pakistan	Saudi Arabia
Korea, Republic of	Paraguay	Serbia
Latvia	South Africa	Slovakia
Luxembourg	Thailand	United Arab Emirates
Malta	Turkey	Uruguay
Netherlands	Ukraine	
New Zealand	Viet Nam	
Norway		
Poland		
Portugal		
Qatar		
Slovenia		
Spain		
Sweden		
Switzerland		
United Kingdom		

Source: ITU (2015) and UN (2015)

Table E. Correlation Matrix



Regarding the analysis results of the full dataset are shown in Appendix Tables D, we found that there was a multicollinearity problem, because the t ratios of one or more coefficients tend to be statistically insignificant., lower than 1.96, so we rejected the results of full dataset accordingly. Thus, our remedial measures on multicollinearity are: step 1, recheck the correlation table(Appendix D), exclude the variable closely correlated (> 0.6); step 2, remove the country dummy, and split in three samples.

Table D. Estimation results –Full dataset

DV: wpremium	***Model with IDI***				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	2.0287***	2.0578***	2.6637***	2.0882***	2.6379***
	(0.1490)	(0.1905)	(0.6689)	(0.1971)	(0.6138)
Technology Factors					
IDI	0.0345	0.0211	0.0533	0.0352	0.0441
	(0.0471)	(0.0504)	(0.0515)	(0.0474)	(0.0554)
Economic Factors					
EduExp		0.0002			0.0010
		(0.0125)			(0.0122)
Openness		-0.0006			-0.0006
		(0.0005)			(0.0004)
FDI		-0.0001			-0.0000
		(0.0002)			(0.0002)
Unemployment		0.0067*			0.0057
		(0.0040)			(0.0055)
Demographic Factors					
Urbanization			-0.0067		-0.0078
			(0.0085)		(0.0093)
Political Factors					
Democracy				-0.0009	-0.0002
				(0.0021)	(0.0023)
n	448	448	448	448	448
Adj. R^2	0.0021	0.0102	0.0072	0.0024	0.0122

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate respectively. *p < 0.05,**p<0.01,***p<0.001

DV: wpremium	***Model with ICT assecc***				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	2.1696***	2.1685***	2.2335***	2.2280***	2.2126***
	(0.0543)	(0.0918)	(0.7012)	(0.1435)	(0.6798)
Technology Factors					
ICTaccess	-0.0012	0.0005	0.0010	-0.0001	0.0018
	(0.0192)	(0.0183)	(0.0183)	(0.0200)	(0.0184)
Economic Factors					
EduExp		0.0008			0.0017
		(0.0135)			(0.0128)
Openness		-0.0006			-0.0006
		(0.0005)			(0.0005)
FDI		-0.0001			-0.0001
		(0.0002)			(0.0002)
Unemployment		0.0065*			0.0053
		(0.0036)			(0.0054)
Demographic Factors					
Urbanization			0.0023		0.0011
			(0.0073)		(0.0063)
Political Factors					
Democracy				-0.0009	-0.0004
				(0.0023)	(0.0024)
n	448	448	448	448	448
Adj. R^2	0.002	0.01	0.0052	0.0022	0.0104

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate respectively. *p < 0.05,**p<0.01,***p<0.001

DV: wpremium	Model with ICT use				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	2.0649***	2.0641***	2.5749***	2.1496***	2.6481***
	(0.1151)	(0.1433)	(0.5805)	(0.1312)	(0.5110)
Technology Factors					
ICTuse	0.0186	0.0168	0.0256	0.0248	0.0300
	(0.0354)	(0.0357)	(0.0340)	(0.0414)	(0.0417)
Economic Factors					
EduExp		0.0010			0.0025
		(0.0132)			(0.0130)
Openness		-0.0006			-0.0006
		(0.0004)			(0.0004)
FDI		-0.0001			-0.0001
		(0.0002)			(0.0002)
Unemployment		0.0069*			0.0056
		(0.0039)			(0.0053)
Demographic Factors					
Urbanization			-0.0042		-0.0066
			(0.0060)		(0.0055)
Political Factors					
Democracy				-0.0015	-0.0009
				(0.0027)	(0.0029)
n	448	448	448	448	448
Adj. R^2	0.0022	0.0111	0.007	0.0028	0.0132

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate respectively. *p < 0.05,**p<0.01,***p<0.001

DV: wpremium	Model with ICT skils				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	1.5507***	1.5436***	2.6481***	1.5880***	2.5759***
	(0.2485)	(0.2990)	(0.5894)	(0.2722)	(0.5669)
Technology Factors					
ICTskills	0.1578**	0.1508*	0.2112***	0.1595**	0.2073***
	(0.0720)	(0.0767)	(0.0720)	(0.0723)	(0.0776)
Economic Factors					
EduExp		0.0012			0.0030
		(0.0119)			(0.0107)
Openness		-0.0003			-0.0000
		(0.0005)			(0.0005)
FDI		-0.0000			0.0000
		(0.0002)			(0.0003)
Unemployment		0.0063*			0.0059
		(0.0037)			(0.0057)
Demographic Factors					
Urbanization			-0.0157*		-0.0177**
			(0.0082)		(0.0085)
Political Factors					
Democracy				-0.0006	0.0000
				(0.0021)	(0.0022)
n	448	448	448	448	448
Adj. R^2	0.0217	0.0279	0.0336	0.0218	0.0372

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate respectively. *p < 0.05,**p<0.01,***p<0.001

DV: wpremium_ICT	Model with IDI				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	1.2572***	1.2797***	1.5100***	1.2225***	1.4787***
	(0.0183)	(0.0452)	(0.1851)	(0.0322)	(0.1818)
Technology Factors					
IDI	0.0185***	0.0171***	0.0300***	0.0181***	0.0268***
	(0.0037)	(0.0041)	(0.0079)	(0.0036)	(0.0070)
Economic Factors					
EduExp		-0.0010			-0.0010
		(0.0026)			(0.0026)
Openness		-0.0001			-0.0001
		(0.0001)			(0.0001)
FDI		-0.0002**			-0.0001*
		(0.0001)			(0.0001)
Unemployment		-0.0001			-0.0001
		(0.0016)			(0.0021)
Demographic Factors					
Urbanization			-0.0042		-0.0036
			(0.0026)		(0.0026)
Political Factors					
Democracy				0.0005	0.0005
				(0.0004)	(0.0005)
n	448	448	448	448	448
Adj. R^2	0.0041	0.0078	0.0083	0.0051	0.0121

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate respectively. *p < 0.05,**p<0.01,***p<0.001

DV: wpremium_ICT	Model with ICT assecc				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	1.3113***	1.3317***	1.3663***	1.2748***	1.3427***
	(0.0103)	(0.0299)	(0.1724)	(0.0248)	(0.1853)
Technology Factors					
ICTaccess	0.0003	0.0008	0.0002	-0.0004	0.0002
	(0.0037)	(0.0035)	(0.0040)	(0.0039)	(0.0037)
Economic Factors					
EduExp		-0.0010			-0.0007
		(0.0028)			(0.0026)
Openness		-0.0002			-0.0002
		(0.0001)			(0.0001)
FDI		-0.0002**			-0.0002**
		(0.0001)			(0.0001)
Unemployment		-0.0000			-0.0001
		(0.0015)			(0.0020)
Demographic Factors					
Urbanization			-0.0007		-0.0004
			(0.0022)		(0.0020)
Political Factors					
Democracy				0.0006	0.0005
				(0.0004)	(0.0004)
n	448	448	448	448	448
Adj. R^2	0.0004	0.0049	0.0007	0.0016	0.0063

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate respectively. *p < 0.05,**p<0.01,***p<0.001

DV: wpremium_ICT	Model with IDI				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	1.2572***	1.2797***	1.5100***	1.2225***	1.4787***
	(0.0183)	(0.0452)	(0.1851)	(0.0322)	(0.1818)
Technology Factors					
IDI	0.0185***	0.0171***	0.0300***	0.0181***	0.0268***
	(0.0037)	(0.0041)	(0.0079)	(0.0036)	(0.0070)
Economic Factors					
EduExp		-0.0010			-0.0010
		(0.0026)			(0.0026)
Openness		-0.0001			-0.0001
		(0.0001)			(0.0001)
FDI		-0.0002**			-0.0001*
		(0.0001)			(0.0001)
Unemployment		-0.0001			-0.0001
		(0.0016)			(0.0021)
Demographic Factors					
Urbanization			-0.0042		-0.0036
			(0.0026)		(0.0026)
Political Factors					
Democracy				0.0005	0.0005
				(0.0004)	(0.0005)
n	448	448	448	448	448
Adj. R^2	0.0041	0.0078	0.0083	0.0051	0.0121

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate respectively. *p < 0.05,**p<0.01,***p<0.001

DV: wpremium_ICT	Model with ICT assecc				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	1.3113***	1.3317***	1.3663***	1.2748***	1.3427***
	(0.0103)	(0.0299)	(0.1724)	(0.0248)	(0.1853)
Technology Factors					
ICTaccess	0.0003	0.0008	0.0002	-0.0004	0.0002
	(0.0037)	(0.0035)	(0.0040)	(0.0039)	(0.0037)
Economic Factors					
EduExp		-0.0010			-0.0007
		(0.0028)			(0.0026)
Openness		-0.0002			-0.0002
		(0.0001)			(0.0001)
FDI		-0.0002**			-0.0002**
		(0.0001)			(0.0001)
Unemployment		-0.0000			-0.0001
		(0.0015)			(0.0020)
Demographic Factors					
Urbanization			-0.0007		-0.0004
			(0.0022)		(0.0020)
Political Factors					
Democracy				0.0006	0.0005
				(0.0004)	(0.0004)
n	448	448	448	448	448
Adj. R^2	0.0004	0.0049	0.0007	0.0016	0.0063

Notes: Robust standard errors are reported in parentheses. *, **, and *** indicate respectively. *p < 0.05,**p<0.01,***p<0.001

Table E. Correlation Matrix

Table F. Estimation results –The Conventional Wage Premium (split samples)

Low IDI	***Model with IDI***				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	2.1888***	2.2354***	2.8528***	2.2165***	3.1732***
	(0.1067)	(0.1854)	(0.7577)	(0.1961)	(0.8052)
Technology Factors					
IDI	0.0129	0.0237	0.0356	0.0127	0.0566**
	(0.0282)	(0.0240)	(0.0287)	(0.0282)	(0.0263)
Economic Factors					
EduExp		-0.0073			-0.0091
		(0.0236)			(0.0245)
Openness		0.0013			0.0020*
		(0.0010)			(0.0011)
FDI		0.0009			0.0011
		(0.0011)			(0.0012)
Unemployment		-0.0240			-0.0224
		(0.0163)			(0.0169)
Demographic Factors					
Urbanization			-0.0134		-0.0181
			(0.0143)		(0.0159)
Political Factors					
Democracy				-0.0005	-0.0018
				(0.0028)	(0.0029)
n	133	133	133	133	133
Adj. R^2	0.0022	0.0308	0.0091	0.0024	0.0415

Notes: Robust standard errors are reported in parentheses. *p < 0.05,**p<0.01,***p<0.001

High IDI	***Model with IDI***				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	2.0751***	1.9757***	3.0707***	2.4816***	3.7181***
	(0.0928)	(0.1438)	(0.6160)	(0.2659)	(0.6368)
IDI	-0.0161	-0.0029	-0.0057	-0.0154	0.0147
	(0.0124)	(0.0135)	(0.0165)	(0.0121)	(0.0159)
Economic Factors					
EduExp		0.0059			0.0056
		(0.0172)			(0.0175)
Openness		-0.0009			-0.0007
		(0.0006)			(0.0006)
FDI		0.0000			0.0001
		(0.0004)			(0.0004)
Unemployment		0.0089***			0.0101***
		(0.0031)			(0.0033)
Demographic Factors					
Urbanization			-0.0136		-0.0229**
			(0.0090)		(0.0086)
Political Factors					
Democracy				-0.0050*	-0.0013
				(0.0027)	(0.0026)
n	196	196	196	196	196
Adj. R^2	0.0071	0.0586	0.039	0.013	0.0739

Notes: Robust standard errors are reported in parentheses. *p < 0.05,**p<0.01,***p<0.001

Low IDI	*Model with ICT assecc*				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	2.2281***	2.3434***	2.2279**	2.2658***	2.4165**
	(0.0432)	(0.1519)	(1.0178)	(0.1559)	(0.9476)
Technology Factors					
ICTaccess	0.0025	-0.0008	0.0017	0.0029	-0.0000
	(0.0115)	(0.0118)	(0.0113)	(0.0120)	(0.0117)
Economic Factors					
EduExp		-0.0054			-0.0045
		(0.0243)			(0.0217)
Openness		0.0010			0.0012
		(0.0010)			(0.0011)
FDI		0.0005			0.0003
		(0.0011)			(0.0011)
Unemployment		-0.0237			-0.0255
		(0.0166)			(0.0157)
Demographic Factors					
Urbanization			-0.0024		0.0009
			(0.0101)		(0.0095)
Political Factors					
Democracy				-0.0007	-0.0020
				(0.0030)	(0.0030)
n	133	133	133	133	133
Adj. R^2	0.0003	0.024	0.0016	0.0006	0.0263

Notes: Robust standard errors are reported in parentheses. *p < 0.05,**p<0.01,***p<0.001

High IDI	*Model with ICT assecc*				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	1.9882***	2.0170***	4.1913***	2.4303***	3.9445***
	(0.0494)	(0.1293)	(0.6386)	(0.2196)	(0.8866)
Technology Factors					
ICTaccess	-0.0046	-0.0071	-0.0113*	-0.0048	-0.0115*
	(0.0067)	(0.0068)	(0.0060)	(0.0067)	(0.0066)
Economic Factors					
EduExp		0.0054			0.0060
		(0.0172)			(0.0174)
Openness		-0.0010*			-0.0007
		(0.0006)			(0.0006)
FDI		-0.0000			-0.0002
		(0.0004)			(0.0005)
Unemployment		0.0093***			0.0084
		(0.0032)			(0.0065)
Demographic Factors					
Urbanization			-0.0217***		-0.0214***
			(0.0062)		(0.0065)
Political Factors					
Democracy				-0.0054*	-0.0013
				(0.0027)	(0.0025)
n	196	196	196	196	196
Adj. R^2	0.0027	0.0645	0.0477	0.0095	0.0828

Notes: Robust standard errors are reported in parentheses. *p < 0.05,**p<0.01,***p<0.001

Low IDI	***Model with ICT use***				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	2.1862***	2.2932***	2.8070***	2.2363***	2.8948***
	(0.0869)	(0.1642)	(0.6729)	(0.1570)	(0.6601)
Technology Factors					
ICTuse	0.0122	0.0120	0.0264	0.0129	0.0247
	(0.0206)	(0.0192)	(0.0185)	(0.0214)	(0.0172)
Economic Factors					
EduExp		-0.0046			-0.0029
		(0.0250)			(0.0245)
Openness		0.0009			0.0011
		(0.0010)			(0.0011)
FDI		0.0006			0.0004
		(0.0011)			(0.0011)
Unemployment		-0.0236			-0.0238
		(0.0165)			(0.0166)
Demographic Factors					
Urbanization			-0.0122		-0.0094
			(0.0123)		(0.0111)
Political Factors					
Democracy				-0.0009	-0.0026
				(0.0030)	(0.0031)
n	133	133	133	133	133
Adj. R^2	0.0036	0.0274	0.0101	0.0041	0.0336

Notes: Robust standard errors are reported in parentheses. *p < 0.05,**p<0.01,***p<0.001

High IDI	***Model with ICT use***				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	2.1653***	2.0839***	2.9741***	2.5664***	3.1659***
	(0.1422)	(0.2178)	(0.4396)	(0.2630)	(0.5898)
Technology Factors					
ICTuse	-0.0291	-0.0173	-0.0231	-0.0284	-0.0096
	(0.0196)	(0.0223)	(0.0215)	(0.0196)	(0.0239)
Economic Factors					
EduExp		0.0054			0.0055
		(0.0173)			(0.0176)
Openness		-0.0009			-0.0007
		(0.0006)			(0.0006)
FDI		-0.0001			-0.0001
		(0.0004)			(0.0004)
Unemployment		0.0083**			0.0087**
		(0.0033)			(0.0034)
Demographic Factors					
Urbanization			-0.0108		-0.0134*
			(0.0065)		(0.0072)
Political Factors					
Democracy				-0.0049*	-0.0014
				(0.0028)	(0.0027)
n	196	196	196	196	196
Adj. R^2	0.0161	0.0636	0.0339	0.0219	0.0699

Notes: Robust standard errors are reported in parentheses. *p < 0.05,**p<0.01,***p<0.001

Low IDI	***Model with ICT Skils***				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	2.0278***	2.0575***	3.0945***	1.9568***	3.1134***
	(0.1230)	(0.1754)	(0.7498)	(0.2102)	(0.7071)
Technology Factors					
ICTskills	0.0501	0.0644**	0.0862***	0.0524*	0.1051***
	(0.0292)	(0.0255)	(0.0297)	(0.0292)	(0.0294)
Economic Factors					
EduExp		-0.0035			-0.0022
		(0.0249)			(0.0239)
Openness		0.0015*			0.0018*
		(0.0009)			(0.0010)
FDI		0.0007			0.0007
		(0.0011)			(0.0012)
Unemployment		-0.0291*			-0.0276
		(0.0162)			(0.0166)
Demographic Factors					
Urbanization			-0.0218		-0.0233
			(0.0141)		(0.0144)
Political Factors					
Democracy				0.0011	0.0008
				(0.0027)	(0.0027)
n	133	133	133	133	133
Adj. R^2	0.0244	0.0621	0.0481	0.0251	0.0843

Notes: Robust standard errors are reported in parentheses. *p < 0.05,**p<0.01,***p<0.001

High IDI	***Model with ICT Skils***				
	Model 1	Model 2	Model 3	Model 4	Model 5
const	1.8371***	1.7808***	3.9291***	2.2618***	4.3710***
	(0.1058)	(0.1324)	(0.4980)	(0.2774)	(0.7325)
Technology Factors					
ICTskills	0.0160	0.0230	0.0380**	0.0154	0.0537***
	(0.0144)	(0.0137)	(0.0182)	(0.0145)	(0.0185)
Economic Factors					
EduExp		0.0056			0.0061
		(0.0169)			(0.0163)
Openness		-0.0009*			-0.0002
		(0.0005)			(0.0006)
FDI		-0.0000			-0.0002
		(0.0004)			(0.0004)
Unemployment		0.0097***			0.0116***
		(0.0033)			(0.0038)
Demographic Factors					
Urbanization			-0.0286***		-0.0368***
			(0.0075)		(0.0098)
Political Factors					
Democracy				-0.0051*	-0.0002
				(0.0028)	(0.0029)
n	196	196	196	196	196
Adj. R^2	0.0048	0.068	0.0593	0.011	0.1036

Notes: Robust standard errors are reported in parentheses. *p < 0.05,**p<0.01,***p<0.001

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