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ICT policy and Investment's influence on economic growth: A case of China

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ABSTRACT

The Information & Communication Technology(ICT) investment contribution to the economic growth has been a significant topic among the researchers since the middle of 20th century. Although the developing countries' ICT industry has taken off at the third industry revolution and gains great economy success, some developing countries, for example China, are comparably late in this technology transformation. In order to promote deepen the ICT's combination with manufacturing and service industry, China polished strategic policy to support ICT development. This paper analyzes China's ICT capital's contribution to the total factor productivity and the related ICT policy, so as to find out China's ICT investment and policy's influence on the economic growth.

Keywords: ICT, productivity, economy, policy, analysis, Solow, Cobb-Douglas

INTRODUCTION

The development of world productivity has experienced several times of revolutions in the history, starting from the agricultural revolution, industrial revolution and the information revolution, each of these revolutions has changed the production and life style profoundly and massively in the period of time, which gives great impact on the mankind from various aspects. As a result, every revolution keeps evolving human's knowledge towards the law of nature and science, as well as the ability to transform the world. As the utilization of the information and communication technology (ICT) deepens and expands in different industries and society sections, researchers and economists has found great potential in terms of digitalization in economy and significant positive influences and contributions that ICT has brought in to the economy growth.

As it is commonly acknowledged that the impact of ICT on economy growth is valid and certified to be positive among the previous developed countries, but there is some differences if we are talking about the developing countries instead. Because of the insufficiency of capacities for instance appropriate level of human capital or R&D expenditures, it results of less outcome gained from the ICT investment (Niebel, 2017). Being a developing country, China is facing the same problems as other developing countries do.

According to the research report of the Organization for Economic Co-operation and Development (OECD), the direct and indirect contribution of capital investment to the growth of gross national product is one of the important sources of economic growth in advanced countries. Countries around the world are actively investing in communication development, investing a large amount of research funds to enhance the research and development (R&D) base and energy of the capital communication industry, and develop competitive key technologies to reach the ubiquitous information society. For instance, on one hand, the Germany is one of the earliest countries that dedicates to the fourth revolution with the transition in digitization of manufacturing with the policy called "Industry 4.0"; and Japan also has published its own strategy - "Society 5.0", in order to realize a sustainable community, for it is necessary to make efforts to revitalize and maintain the local community and area conveniency by adapting ICT into comunity service. On the other hand, since 2015, the China Academy of Information and Communications Technology (short for "CAICT") has been publishing the white paper on China's digital economy development and employment annually in response to the high speed of expansion development in world digital economy. The digital economy, hence includes two main sections: the information and communication industry, and the combination and adaptation between technology and economy. The ICT industry provides fundamental support in production, technology and service etc, which benefits and modifies the structure in agricultural, industrial and service industry.

In view of the fact that the contribution of ICT investment and application to GDP growth is not limited to the hardware manufacturing of this industry, the purpose of this study is to analyze the contribution of China's ICT capital utilization to GDP growth based on the economic growth model and how China's strategic policy contributes to the ICT development and endorsement in other industry such as manufacturing industry and service industry. Hereby, in this study, it is provided with the hypothesises:

H1: The ICT investment contributes positive effects to China's productivity
H2: China's strategic policy benefits the ICT development.

1. ICT definition and development status

1.1. ICT definition

In 1962, Mark Lupu attempted to conceptualize the “knowledge domain,” which first mentioned the information domain. Subsequently, Mark Borat (1962) first proposed four industrial division theories, and the newly established information domain was the fourth domain. Since then, OECD, EU countries, the United Nations and China and other countries and regions have begun to pay attention to and study the development of information-related industries and statistical calculations. As a core part of the information domain, the information and communication technology (ICT) domain is bound to become the focus of attention. The ICT refers to the collection of production service departments engaged in information and communication technology (ICT), not only related to the manufacture of related products in the process of information collection, storage, processing, and circulation, but also the economic activities and infrastructure for information services. This chapter will introduce the most influential North American Industry Classification System (NAICS), the OECD, the UN Statistical Commission and China's current definition of the ICT, and based on these standards, combined with the ongoing development of the ICT, the ICT definition standards declared in this study.

1.2. Status of ICT development

Recently, the spread of IT technology such as personal computers, the Internet, mobile phones and media networks have not only changed people's lives but also reversed the current economic development trend. Information communication technology has gradually become an essential area in the national economy, and the number amount of ICT investments in many countries around the world has increased over the past two decades. Jorgenson’s (2016) research shows that it is vital for a state to seize the opportunity of the ICT revolution to promote economic growth. From 1992 to 2010, the proportion of global ICT investment in GDP has increased from 3% to 8%. The ICT brings together industries such as electronics, communications, software, networking, computer workstations, and information media. These industries have strong technological innovation capabilities and strong effects that can be directly applied to the production processes in agriculture, area, and services. Change is the first operating mode of the economic system. Under its impetus, the Total Factor Productivity (TFP) of some developed and developing countries have been significantly improved.

In an early research from Cette et al (2004) has confirmed that the ICT can potentially increase output growth in a period of medium to long term via the capital deepening effects and total factor productivity. Shreyer (2001) accounted that because the TFP or the Solow residual demonstrates the positive growth rates where the growth rates of output rises in a faster speed than the growth rate of all combined input, which reveals the precise resembling of the observable factors affecting the improvement of output productivity. In this case, total factor productivity is an indicator for analyzing the efficiency of various types of production resources. In addition to the defficiency of productivity (labor productivity or capital productivity), it can be used as a reference indicator for studying the changes in real income and employment. The trend is more important as an important essential reference for researching technological changes, export competitiveness and production cost burden (Liu et al, 2015).

At present, the academic community has reached an understanding that information technology will have a positive impact on economic growth, especially for developed and industrialized countries. Kamel (2009) believes that the development of the ICT may be the most significant change since the industrial revolution. Its essence is the spread of ICTs throughout society and ensuring that it promotes socio-economic development. ICT has been regarded as a strategic emerging domain, and one of the pillars of the “Third Industrial Revolution” and “Internet Plus,” and is expected to become the new engine for the future economic increase. The driving role of ICT in economic increase is mainly reflected in the capital deepening effect and the improvement of TFP. With rapid technological advancement, the price of ICT products has been declining, which has prompted more companies to invest in ICT capital. In the production process, ICT capital has been used to replace traditional capital, which is the so-called capital deepening process. This is not only increases the amount of capital invested by the company, improves the quality of capital, but also helps to reduce production costs and increase output. Since 1995, the growth rate of ICT investment in G7 countries has reached double digits. Jorgenson (2003) attributed this to the rapid decline in the price of ICT equipment and software. After 1995, the semiconductor production cycle was shortened from three years to two years, which greatly accelerated the popularity and investment speed of ICT.

Also, Lipsey et al. (2005) argue that ICT is a general-purpose technology that has the spillover effect of technology. If the technology is widely used in the production process, the productivity of the enterprise will be significantly improved. Also, ICT can drive a series of technological innovations and add them to a variety of different product architectures in technology applications, which can improve the efficiency of enterprise organization management. At the same time, ICT has the effect of economies of scale. Therefore, Moshiri and Nikpour (2010) pointed out that ICT's technology spillover effect combines knowledge, scale economy, and innovation to change the company's organizational structure in various industries, thus changing the company. The overall development status will ultimately affect the economic level.

From an empirical point of view, some scholars have examined the contribution of ICT to economic growth. In early research, Solow (1987) questioned the effect of ICT on productivity. It believed that ICT made a great contribution to investment and consumption, but it did not play a role in improving productivity. This is called ICT’s "Productivity Paradox." With the improvement of post-processing data and statistical methods, the positive impact of ICT on productivity has gradually been confirmed, and the mystery of “productivity paradox” is almost solved. Brynjolfsson and Hitt (2003) found through empirical research that ICT capital has a significantly higher effect on total factor productivity than non-ICT capital, and pointed out that ICT capital investment lags behind productivity and economic growth, sometimes even seven years. This is the reason why Solow discovered the “productivity paradox.” Bartel et al. (2007) also confirmed this with data from different national companies and pointed out that ICT has a significant pulling effect on corporate productivity. Vu (2011) compares the multiplier effect of the ICT sector in EU member states and finds that the multiplier effect and output of the ICT sector in 2000-2005 are not apparent due to the lag effect of ICT investment, but the multiplier effect after 2005 showing an upward trend.

1.3. History of China's ICT Development

China's ICT began in the 1950s. After more than half a century of development, the sector covers a growing number of industries, and its output value and scale continue to expand. It has now become a pillar domain of the country. Reviewing the development process of the ICT can be divided into the following four stages: the germination stage, the initial stage, the growth stage, and the mature stage.

Firstly, the inception stage of the ICT before the reform and opening up from the 1950s to the end of the 70s, the ICT at this stage was mainly the telecommunications domain, and the scope of its popularization was relatively small, mostly for the defense and scientific research work, and the practical application of society. The utility ratio is relatively small, and the development is slow.

Secondly, the initial stage of the development of the ICT was from 1978 to 1991. At this stage, the ICT was reformed and began to serve the social economy. At this stage, the state completed the accumulation of capital by collecting telecommunication initial installation fees and surcharges and achieved steady development of the telecommunications domain. However, the telecommunications domain at this stage is a monopoly domain. At the same time, the state has also focused on the development of consumer electronics products and has formed several major consumer electronics gathering areas in the North Supreme Region, but the manufacturing of other electronic information products is still relatively lagging.

Thirdly, the growth phase of the ICT began in 1992 and ended in the late 20th century. The 14th National Congress listed the electronic information domain as a pillar domain of the national economy. The state began to attach importance to the construction of information technology and initiated several digitalization construction projects. At the same time, the telecommunications domain has undergone reforms again, ending the era of monopoly. At this stage, the coverage of the ICT has been dramatically expanded, and industries such as hardware equipment manufacturing, software, and information services have been added, and the leap to the modern ICT has been realized. However, at this stage, ICT technology research and development and innovation are relatively few, which has formed an absolute obstacle to the upgrading and optimization of the domain in the future.

Fourthly, the mature stage of the ICT derived from the beginning of the 21st century to the present, and it is the rapid development of China's ICT for more than ten years. During this period, the application of information technology has been extended to various industries and sectors in the industrial society. ICT manufacturing and ICT services have been significantly developed, especially in the manufacturing domain, which has become the center of electronic information product manufacturing in the world. The investment in ICT-related technology research has increased, the capacity for independent innovation has increased, and the core competitiveness of the domain has increased.

1.4. Mechanism of ICT policy to promote economic growth

Information and communication technologyis the primary driver of the economy and will be a global development and social change. Kozma (2005) shows that ICT can lead to education reforms and investment in education, which ultimately affects the national economy. Seo et al. (2009) show that there is a positive correlation between ICT investment and economic growth, and those with reliable economic infrastructure and open trading system have experienced more existing ICT investments. Sassi's (2013) research on countries in the Middle East and North Africa shows that ICT agents have a positive and significant direct impact on economic growth. Wang (1999) shows that the IT-led development strategy adopted by Taiwan has been highly recognized by other Asian newly industrialized economies (NIEs) in their National Ministry of Information Domain initiatives, and has drawn national IT capabilities and federal IT investment. Coherently, the result and evidence of Vu's (2011) research, which examines the effects of ICT on growth, the association between ICT penetration and growth, and causal effects of ICT penetration on growth , also confirmed that ICT as one of the important source of growth can suggest that, firstly, strategic focus on promoting ICT penetration is essential to the economic growth; secondly, the impact of penetration of the Internet on growth is urgent and strategic to promote the diffusion of technology; thirdly, countries with lower level of ICT penetration are encouraged to take aggressive method in promoting the diffusion of ICT, because ICT penetration is a top priority to economic development.

1.5. The combined effects of economic growth

Kuppusamy (2009) used the ARDL econometric method to study the impact of private and public sector ICT investments on Malaysia's economic growth during the period 1992-2006. The empirical results of Chavula (2013) show that ICT has had a significant positive impact on Africa's economic growth during this time, indicating that investment has brought good returns. Chavula's research also shows that fixed-line, mobile phone, and Internet use have had a significant impact on the lives of African people, suggesting that investment in the ICT will positively affect the national economy. Some scholars believe that ICT's promotion of the economy is unilateral. Lee (2005) shows that ICT promotes economic growth in many developed countries and newly industrialized economies (NIEs), but not in developing countries. Bollou (2008) research shows that many African countries have implemented market liberalization and invested heavily in their ICT.

Regarding the factors affecting the economy of the ICT, it attempts to empirically verify the theoretical assumptions that the ICT factors affect the development of the national economy. To this end, Jin (2015) uses a research model to test the relationship between ICT and development through statistical evidence. The factors that are selected as variables that reflects ICT factors, as supply and demand balance models widely use these factors. At the same time, some socio-economic factors such as population size, consumer inflation, state corruption, and education are used as control variables, that’s why in this research the Human capital (education) is included as independent variable. Gomez (2012) believes that from the perspective of development, ICTs are more critical to the intangible benefits of development, such as empowerment, self-esteem and social cohesion, which is one of the essential factors affecting the economy.

2. Introduction to ICT Growth Model Methodology

2.1. China's ICT investment quota measurement method

As a major indicator of the development of ICT in a country, ICT investment shows the use of ICT by various industries and the state's support for the ICT industry. In general, industry investment data mainly includes accumulated data, fixed asset investment data, fixed asset formation data, total capital formation data, inventory investment data, and new fixed asset data. According to the definition:

ICT investment = ICT intermediate use investment + ICT fixed asset investment + ICT inventory investment in the production process.

2.2. ICT Capital Stock Estimation

Capital stocks are a very important variable in macroeconomic and industrial economic studies. The capital stock can not only reflect the accumulation of production factors in the industry but also studies such as industry investment functions, industry TFP, and economic growth are also inseparable from the calculation of capital stock. In view of ICT capital stock, this paper selects the perpetual inventory method which is more commonly used at home and abroad for estimation. The specific formula is $K_t = K_{t-1}(1-\delta_t) + I_t$. Among them, K_{t-1} and K_t represent the t-1 period and the t period capital stock, δ_t is the depreciation rate, and I_t is the new investment amount of the t period measured by the constant price.

2.3. ICT impact on new economic growth model calculation

Measuring the productivity of multiple input factors is the ratio of output to a certain aggregate input indicator. That is, the total input is the result of indexing all the inputs used for production, resulting in the progress of the overall total factor productivity, which is the basic factor of total factor productivity concept (Jorgenson and Vu, 2011). Therefore, total factor productivity is an indicator for analyzing the efficiency of various types of production resources. In addition to the efficiency of productivity (labor productivity or capital productivity), it can be used as a reference indicator for studying the changes in real income and employment. The trend is more important for the study of technological changes, export competitiveness and production cost burden. Assuming that there are three kinds of input capital, ICT capital, non-ICT capital and human capital, in the economic system, the Cobb-Douglas production function with the same scale return can be set as follows:

$$Y = Af(K_{nic}t, K_{ict}, L) = AK^{\alpha}_{nict}K^{\beta}_{ict}L^{\gamma} \qquad (1)$$

where Knict is non-ICT capital, Kict is ICT capital, and L is labor input , A represents technology, which is the total factor productivity (TPF). α and β are the production elastic coefficients of non-ICT capital, ICT capital and labor force respectively. This method provides a solid line to identify how growth in inputs, especially capital input that is formed in different type, can effect the country's or specific industry's growth (Cardona et al, 2012).

Meanwhile, there will be a further introduction the growth of GDP per labor unit y, where $y = Y/L$, and k, the capital per unit of labor L, thus $k = K/L$. Basing on the methodology of Cardona et al (2012) have done in their empirical research, we can log-linearize this Cobb-Douglas production function, and both sides of equation should be divided by y, the function will be ended up in an exponential function like below:

$$\Delta \ln Y_{it} = \Delta \ln A_{it} + \alpha \Delta \ln K_{nict} + \beta \Delta \ln K_{ict} + \gamma \Delta \ln L_{it} \qquad (2)$$

$$\Delta \ln A_{it} = \Delta \ln Y_{it} - \alpha \Delta \ln K_{nict} - \beta \Delta \ln K_{ict} - \gamma \Delta \ln L_{it} \qquad (3)$$

Consequently, the equation. (3) explains how the TFP growth is related with accordance to other components such as labor productivity. After rewriting the production function, it will be as:

$$\Delta \ln y_{it} = \Delta \ln A_{it} + \Delta(\alpha+\beta) \ln k_{it} \quad (4)$$

From this model, the labor productivity growth rate can be obtained by the capital deepening, which is the increasing amount of capital per unit of labor $\Delta(\alpha+\beta)\ln k_{it}$, or the improvement in technology, which is TFP growth rate $\Delta \ln A_{it}$.

As though the TFP can measure certain technological change, it does not capture full impact that TFP growth has on the output growth. Biagi (2013) stated that because “the growth-accounting methodology is inherently static”, and the control of the human capital is hard, while the distinction of ICT and non-ICT capital can be ambiguous. That’s the human capital has been incorporated into the model:

$$TPF = \beta_0 + \beta_1 ICT + \beta_2 HC + \beta_3 R\&D + \beta_4 L + \varepsilon \quad (5)$$

This function elaborates the linear relationship between TFP and ICT capital investment, R&D capital investment, human capital and the economic growth rate. Where the HC(human capital) here is accountied for the comination of labor force quantity, quality(education level).

In the linear regression model, the β_1 to the $\beta_4$will be estimated. If the sum of this three coefficients equals to 1, it is the constant return of scale; if their sum is bigger than 1 then it is the return to scales are increasing, if smaller than 1 it is a decreasing return. The constant $\beta 0$ is the A, technology. Notice that the non-ICT capital is not in the selected variables because the non-ICT capital is hard to define, and could be less relevant to the TFP on this point. Also, because the ICT capital deepening effects might be minimized by a large non-ICT capital indicators.

3. Case Study

3.1. Contribution of the ICT to total TFP

ICT input intensity refers to the proportion of total investment placed by ICT investment in the production process. The power of ICT investment in the domain can reflect the degree of information and automation of trade, and indirectly reflects the popularity of ICT in national economic production. In order to reflect the contribution of ICT investment towards the economic growth in terms of TFP methods. According to the OECD Main Science and Technology Indicat ors, the indicators of trades in R&D is one the the proxy measures of the industrial and economic impact of scientific ad technological activities. In this chapter, we will try to estimate the relationship between ICT and the economic prosperity by analyzing the statistics from the Conference Board's alternative growth measures for China from 1992-20178. We decide to use the adjusted data because the adjusted data will remove the calendar effects and gives a more sophisticated process in detection of fluctuating statistics. The complete tables of original and official from 1991 to 2018 are available in the Appendix for further investigation.

The regression variables are selected as below, where Δln(HC) is a composite index that measures average achievement in three asic dimensions of human development including a long and healthy life, knowledge and a decent standard of life, and the Δln(ICT) equals to the ICT capital contribution, The Δ ln(R&D) is the Gross Domestic Expenditure on R&D. In addition, the Δ ln(L), which is the labor inut quantity will be selected as an data control variables.

	HDI	R&D	Capital Input - ICT	Labor Input - Quantity	Total Factor Productivity
1992	2.16	14.79	16.98	1.07	2.07
1993	1.92	8.73	11.36	1.00	4.44
1994	1.69	2.38	23.53	0.98	1.38
1995	1.85	0.17	32.48	0.93	0.95
1996	1.64	8.91	25.13	1.10	-0.62
1997	1.61	23.88	25.27	1.27	-2.83
1998	1.41	9.22	25.81	1.21	-4.54
1999	1.39	24.76	26.29	1.11	-0.54

2000	1.71	19.41	23.13	1.01	1.21
2001	1.35	14.06	23.09	0.97	1.56
2002	1.50	22.77	22.61	0.82	2.53
2003	1.96	16.54	31.57	0.64	0.31
2004	1.93	19.41	35.36	0.67	1.64
2005	1.89	19.92	23.78	0.61	2.71
2006	2.16	17.95	28.90	0.48	2.77
2007	2.12	14.60	25.13	0.45	2.42
2008	1.48	15.38	33.51	0.39	-1.20
2009	1.31	14.60	23.16	0.34	-0.41
2010	1.73	13.82	26.18	0.36	3.71
2011	1.13	13.73	17.65	0.39	0.30
2012	1.12	15.78	12.89	0.39	-1.66
2013	0.97	12.53	17.39	0.36	-0.23
2014	1.23	8.96	14.58	0.36	-0.33
2015	0.68	8.77	19.45	0.31	-2.71
2016	0.67	9.41	13.70	0.23	-1.86
2017	0.53	7.93	13.17	0.12	-0.68

Figure 1. Linear regression variables (1992-2017)

Source: The Conference Board Total Economy Database™ (Adjusted version), April 2019; The UN development report; OECD statistic.

	Coefficients	Standard Error	t Stat	P-value
Intercept	-2.37006	1.26909	-1.86754	0.07585
HDI growth	4.64337	0.87090	5.33172	0.00003
Gross Domestic Expenditure on R&D	0.00407	0.05182	0.07851	0.93816
Capital Input - ICT	-0.12062	0.05472	-2.20423	0.03880
Labor Input - Quantity	-2.26727	0.99668	-2.27483	0.03352

Figure 2. Aggression Statistic

Source:; The UN development report; OECD statistic.

Noted from Figure 2 where the coefficients are calculated for each of the independent variables. THC coefficient is 4.643 , the R&D coefficient is 0.004, and the ICT coefficient is -0.121, and L coefficient equals to -2.27. As a result, the sum of β1to β4equals to 2.26, which is a positive number. The A is the intercept coefficient -2.37, which contribute negative effects, and the constant A is the logarithm of A, thus A equals to 0.093.

The P-Value indicates that human development index growth is most likely significant to the contribution to TFP, while the R&D does not show specific positive influence. The ICT capital in put P-value is smaller than 0.05, which is rather significant, and it indicates that each percentile growth rate rise in the ICT capital input will decrease approximately 0.012% growth for TFP. Also the labor input quantity shows a good relevance in increasing TFP.

3.2. Analysis of China's ICT contribution to the results

The linear regression of the productivity function has revealed a relatively straight forward picture of the ICT capital contribution to the total factor productivity. The result of ICT coefficients is -0.12, which is lower than the developing countries' average level according to Niebel's(2017) estimation 0.077. The contribution is too small for ICT capital input. It is responding for the common phenomenon that the ICT contribution to the TFP has a sign of slowing down. Statistically, the coefficient of human capital (including labor capital) and non-ICT capital seem to be the more prominent and positive indicators, so that Steinmueller(2001) belived that these two coefficients are significant. However, Niebel in his same research published in 2017 holds the opinion that, the reason non-capital and labor capital look to be important could be the caused by an indicator wrong measuring process. More precisely, he highlighted the labor capital dedicates highly in the developing and emerging countries is because the fact that their industry is built on the large number of low-cost employees. This theory explains that why the labor and non-ICT capital seem to be taking so much share in the contribution to TFP.

Given the ICT capital input taking a slope downwards growth in China in the last 9 years' period, as well as the fact that the ICT capital share contributes around 2% to the TFP can be well concerning. Hofman et al(2016) did a research on the ICT contribution to TFP of Latin America, it is examined the fact that even though the contribution of ICT capital in the U.S is smaller than non-ICT and labor capital comparing to Latin America, the U.S still holds a very high TFP explaining 29% GDP growth. In this case, it is hard to ignore the economic value should be taken into comparison or adjusted. The fact that China has a very low TFP of yearly average is significant, but the gross economic volume is indeed large, whether it is too low of a economic growth contribution or it is not the determination remains to be further discovered.

As is indicated in the Figure 1 and 2, The GDP growth rate is slowing down after the peak period in 2010, where also is the point TFP reached the highest. However, the result varies far differently from alternative statistics to official statistics. Despite distinctiveness, the TPF is highly relevant to the GDP growth regarding the trends.

The ICT capital contribution is relatively corresponding, and on the average ICT capital contributed around 0.38% and 0.42% respectively from alternative and official data, which is approximately 0.4%. On comparison with OECD data where the ICT capital contribution in the United States could be 0.53 during the year of 1985-2010, and the EU nations have slighty lower contribution rate than the US. (Miller and Atkinson, 2014). Nonetheless, it remains true that the ICT capital contributon in China is slowing down and is still behind the developed countries' data from last few decades.

From the Table 2, it shows a clearer spec that the ICT capital input once took off in the 1990s to early 2000s, when the GDP was at a higher growth rate comparing to the other period. The result indicates a possibility that, in China,the ICT capital deepening and technological progress has been weakening its influence on the GDP growth after the late 2000s and early 2010s, even though ICT capital is not the only factors that matters. Simultaneously, the non-ICT capital seem to be contributing more to the productivity growth relevantly. Meanwhile, it could be another implication that the ICT penetration to other industry has become mature and result in higher productivity for the non-ICT industry.

Notice that in the Table 2, labor share contributed to the TFP experiences a rise and fall obviously, however, the labor quality contribution to the GDP growth rate has been rather low. The CAICT(2019) announced that, the transformation of economy shocked the traditional labor force, which drives the society to adapt with technology changes. With the development of digitized economy, the whole ICT related industry has provided more than 12 million occupations in the year of 2017. There is possibilities that the Artificial Intelligenc(AI) taking over some service jobs which might cause unemployment crisis in low-tech industry. The labor quality could be improved and enhanced in order to cope with technology trends.

The overall ICT contribution to the overall manufacturing revenue is becoming more and more important, but the profit has only increased by 0.4 times according to the The 43rd China Statistical Report on Internet Development. On behalf of China's ICT industry, the overall value-added rate is still relatively weak.

3.3. Analysis of China's ICT Policy

According to the impact of the ICT on the national economy, it can be seen that the ICT service has entered a stage of rapid development in recent years, especially the combination of the Internet and traditional service industries such as catering, entertainment, education, the rise of Internet finance, etc (CAICT, 2019). Both have received extensive attention and have a large number of potential consumer markets, so attaching importance to and supporting ICT services is also indispensable in industrial development policies. Therefore, for the development of the ICT, the recommendations should be given fundamentally on technology, technical facilities, and service.

In response with the global trends, Chinese government has proposed its new technology policy initiative “Made in China 2025 (MIC 2025)” in 2015. Accordingly, it is a policy that aims at forming a higher-level industry framework as China is now experiencing the transformation period in its industrialization, where the combination of high-tech is gradually adopted into each different industries. The whole MIC 2025 project covers industries constitute of China’s priory value-added manufacturing industries including aerospace and aviation equipment, next-generation information technology and agricultural machinery etc. Especially, the whole MIC 2025 takes the combinations of industrialization and information digitilization, manufacturing and ICT into main focus, so as to intensify the fundamental basics in industrialization and brands qualification. Coherently, MIC 2025 propels “clean development”, and further stricter environment governance method and other manufacturing transformation framework. The project emphasises the importance to set up and follow international standard in service industry and manufacturing industry. Presumably, this innovation-drived blueprint is encouraging the Research and Development (R&D) investment into not only the high-tech industry but also whole-rounded application in other areas, on both government and business enterprises level, turning China into one of the advanced manufacturing countries in this ten-year project.

While the MIC 2025 project points out the future developing direction in mordenizing Chinese economy, as well as boosting productivity and putting innovation as the economy growth driver, it is still a concern that the problems behind this motivation. Wayne M. Morrison(2018), from the U.S. Congressional Research Service, stated that “One key Chinese motivation for MIC 2025 is to avoid hitting the so-called ‘middle-income trap’...”. In fact, China is now facing and experiencing a stage where other developed and industrialized countries, for example Japan, once were at - the declining birth rate and aging population is progressing in the society. Meanwhile companion with the fading of demographic dividend(which is the advantage that the share of the working-age population will contribute to the economic growth), China’s industry transformation is on the go, which naturally drives the manufacturing industry to adapt with ICT as a key method. Although, it is also concerning to improve the labor quality and quantity in the high-tech area.

Furthermore, the commercial finance such as guidance policy finance and development finance, is strengthening support for priority areas such as next-generation IT, high-end equipment and new materials, multidimensional capital market development, domestic and overseas financing of enterprises, and overseas resources development, R & D center, and contributing establishment for high-tech companies, supporting manufacturing industry by issuing financial funds and reinforcement of intelligence manufacturing field, utilizing PPP (public-private partnership) system and entering into serious manufacturing projects by private funds It also proposes the creation of tax revenue measures that are effective for structural change in manufacturing, formulation and implementation of manufacturing human resource development plans, and promotion of the development of small and medium enterprises..

3.3.1. Suggestions to Enhancement of ICT Technology Innovation Capabilities

To enhance the technological innovation capability of the ICT, it is possible to adopt an utterly independent innovation of technology, a combination of comprehension and innovation. In Shao’s(2015) resport, he suggested that China should continue to vigorously develop in the technical field where there are already advantages, and realize the transformation of technology into products and services, thereby furthur enhancing the competitiveness of products and services. At the same time, encouraging the higher education elite to investigate in the technical field that has not been dominated where exists a particular gap in knowledgea particular gap in knowledge. In the R&D of technological innovation organizations, the government, universities and entreprises plays significant roles.

3.3.2. Suggestions to the construction of ICT infrastructure

Chinese government should accelerate the construction of broadband information infrastructure, continue to implement the "Broadband China" strategy, incorporate the installation of broadband facilities into the social and economic development plans of all regions, continuously expand network coverage, accelerate the popularization and application of broadband, and improve the universal service mechanism, especially It is the construction, operation, and maintenance of broadband facilities in rural and priority areas. At the same time, it is necessary to enhance the service capabilities of mobile communication networks, increase the network access rate, promote interconnection between systems, strengthen market supervision.

3.4. Other Impacts of China's ICT

Proper ICT infrastructure construction accounts for 70% of new job opportunities for Chinese SMEs. According to the 2015 Global Competitiveness Report (World Economic Forum, 2015) on the contribution of ICT technology to economic growth, China, together with South Africa and Chile, has become the top three countries in which ICT development has contributed significantly to its economic growth. The large-scale investment in the ICT sector has contributed positively to South Africa's GDP growth, as evidenced by increasing economic activity, increased innovation and stimulating productivity growth. China has taken firm steps in using the investment in the ICT to encourage economic development. However, in the face of the challenges currently facing, if China wants to go further and more stable, the steps need to be bigger, regardless of the government. This is true of all sectors of the private domain, investors and social groups. Although the South African government has realized the positive effects of ICT investment on economic growth, policy advances including broadband are still not satisfactory.

With the advent of the digital economy era, ICT infrastructure construction will play an increasingly important role in stimulating economic growth. For ordinary Chinese families, if the speed of the network is upgraded from 0.5MB to 4MB, even if they do not consider other possible cost factors, they will increase their expenses on the internet connection fee by an average of 46 US dollars per month of each household or family(China Internet Network Information Center, 2019). For telecommunication operators, providing cheap and fast network connectivity in remote areas is a challenge because population density in remote areas cannot be compared to cities, and the number of natural customers cannot be guaranteed. As for the telecommunication companies, fixed customers are the basis for their ICT infrastructure investment; on the government departments, only a certain number of fixed customers can ensure the operator's infrastructure investment, and ultimately the local economy increase. China's SMEs account for 10% of the total employment, but good ICT infrastructure can account for 70% of new employment opportunities for Chinese SMEs.

Conclusion

This study has applied an economic growth model of total factors productivity to interpret the ICT capital investment to China’s productivity or the TFP, and introduce China’s strategic policy that includes the ICT development and endorsement in terms of its impacts and contributions. Due to the imperfection and limitation, the analysis did not cover other possible related factors in specific.

The main focus is to give brief explanation of the production function, at the same time includes the ICT status in China. The result shows that China is confronted with the fear of economic growth slowing down and the ICT effects on TFP growth is less notable in nowadays to the start-up and booming era of the 2000s. However, on the academic research level, it is of complication and complexion to decide whether this change in ICT capital growth rate slow down as a complete minus to the economy. Although it is academically admitted that ICT does has a significant positive effects to the TFP, this study gives a different conclusion. The relatively opposite results in this study could be related to factors for instance the less-accuracy of the database, too short period is included, and certain selected variables is not considerably relevant to TFP contribution. In this case, the author did not reach the conclusion with the first hypothesis in the end.

The analysis of China’s supportive strategy in promoting the ICT investment in various industries, and give out some possible suggestions regarding of the circumstances exclusively. As a fact that China is still at the stage where fundamental ICT is being established. The scale of China's IT market and telecommunications will continue to grow steadily. This conclude the H2, that is beneficial to the future ICT development and promotion.

Appendix

Note: Explanation for indicators

GDP	Growth of GDP, change in the natural log
Labor Input - Quantity	Growth of Labor Quantity, change in the natural log
Labor Input - Quality	Growth of Labor Quality, change in the natural log
Capital Input - Total	Growth of Total Capital Services, change in the natural log
Capital Input - ICT	Growth of Capital Services provided by ICT Assets, change in the natural log
Capital Input - Non ICT	Growth of Capital Services provided by Non-ICT Assets, change in the natural log
Labor Quantity Contribution	Contribution of Labor Quantity to GDP growth (7=2*13 averaged over two years)
Labor Quality Contribution	Contribution of Labor Quality to GDP growth (8=3*13 averaged over two years)
Total Capital Contribution	Contribution of Total Capital Services to GDP growth (9=4*14 averaged over two years)
ICT Capital Contribution	Contribution of Capital Services provided by ICT Assets to GDP growth (10=5*15 averaged over two years)

Non-ICT Capital Contribution	Contribution of Capital Services provided by Non-ICT Assets to GDP growth (11=6*16 averaged over two years)
Total Factor Productivity	Growth of Total Factor Productivity (12=1-7-8-9)
Labor Share	Share of Total Labor Compensation in GDP
Capital Share	Share of Total Capital Compensation in GDP, calculated as 1 minus the labor share
ICT Capital Share	Share of ICT Capital Compensation in GDP
Non-ICT Capital Share	Share of Non-ICT Capital Compensation in GDP

Table 1 Growth Accounting and Total Factor Productivity, 1990-2018 (Original version)

1.1 China (alternative) in percentage

NR	INDICATOR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	GDP	3.8	8.9	13.3	13.0	12.2	10.4	9.4	8.8	7.5	7.4	8.2	8.0	8.7	9.5	9.6	10.8	12.0	13.3	9.3	9.0	10.1	9.2	7.6	7.5	7.0	6.7	6.5	6.6	6.4
2	Labor Input - Quantity	2.9	2.3	1.1	1.2	1.4	1.6	1.9	2.3	2.4	2.1	1.4	1.6	1.5	1.6	2.1	1.7	0.1	-1.0	-0.6	0.7	1.9	0.7	0.6	0.1	0.4	0.1	-0.1	0.1	-0.1
3	Labor Input - Quality	0.3	0.3	0.3	0.3	0.3	0.3	0.8	0.5	0.4	0.5	0.6	0.6	0.8	0.6	0.6	1.2	1.3	0.0	0.8	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
4	Capital Input - Total	6.8	4.2	6.5	8.8	9.1	8.6	8.7	9.1	11.1	11.0	11.0	10.2	10.1	10.9	10.7	10.8	10.9	10.3	10.4	11.6	11.0	10.3	10.1	9.8	9.1	8.5	8.3	8.2	8.0
5	Capit	13.5	14.2	18.0	12.8	31.0	37.0	31.6	32.0	46.5	45.8	40.9	28.8	24.5	23.2	24.4	24.8	20.2	13.4	13.4	14.7	16.2	14.1	15.5	14.4	13.1	9.5	8.9	10.5	11.5
6	Capital Input - Non ICT	6.5	3.9	6.1	8.6	8.5	7.7	7.9	8.1	9.3	8.8	8.8	8.8	9.0	9.8	9.4	9.5	10.0	10.0	10.2	11.3	10.6	10.0	9.8	9.4	8.8	8.4	8.3	8.0	7.8
7	Labor Quantity Contribution	1.6	1.2	0.7	0.7	0.8	0.9	1.1	1.4	1.5	1.3	0.8	0.9	0.9	0.9	1.1	0.9	0.0	-0.5	-0.3	0.4	1.1	0.4	0.4	0.1	0.2	0.1	-0.1	0.1	0.0
8	Labor Quality Contribution	0.1	0.2	0.2	0.2	0.2	0.2	0.5	0.3	0.2	0.3	0.4	0.3	0.5	0.4	0.3	0.6	0.6	0.0	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
9	Total Capital Contribution	3.1	1.9	2.7	3.5	3.7	3.4	3.5	3.6	4.4	4.4	4.4	4.3	4.3	4.5	4.7	5.2	5.5	5.4	5.3	5.3	4.9	4.5	4.3	4.0	3.6	3.3	3.3	3.2	3.2
10	ICT Capital Contribution	0.1	0.2	0.2	0.1	0.3	0.4	0.5	0.5	0.9	1.1	1.1	0.8	0.8	0.8	0.9	1.0	0.8	0.5	0.5	0.5	0.5	0.4	0.5	0.4	0.4	0.3	0.2	0.3	0.3
11	Non-ICT Capital Contribution	3.0	1.7	2.5	3.4	3.4	3.0	3.0	3.1	3.5	3.3	3.3	3.4	3.5	3.7	3.8	4.2	4.7	4.9	4.8	4.8	4.3	4.1	3.9	3.6	3.2	3.1	3.1	3.0	2.9
12	Total Factor Productivity	-1.0	5.6	9.7	8.7	7.5	5.9	4.4	3.5	1.4	1.5	2.5	2.4	3.1	3.7	3.4	4.1	5.8	8.3	3.8	3.0	3.9	4.0	2.6	3.1	2.9	3.0	3.0	3.0	2.9
13	Labor Share	55.3	53.2	62.2	58.3	60.4	60.3	60.0	60.6	60.2	60.5	59.0	57.4	58.7	57.8	53.6	50.5	48.6	46.0	51.4	56.5	55.4	56.6	57.7	59.8	61.1	60.5	60.3	60.3	60.3
14	Capital Share	44.7	46.8	37.8	41.7	39.6	39.7	40.0	39.4	39.8	39.5	41.0	42.6	41.3	42.2	46.4	49.5	51.4	54.0	48.6	43.5	44.6	43.4	42.3	40.2	38.9	39.5	39.7	39.7	39.7
15	ICT Capital Share	1.0	1.2	1.1	1.0	1.0	1.4	1.5	1.7	2.1	2.7	2.8	3.1	3.2	3.7	3.9	4.0	4.1	3.8	3.7	3.3	3.0	2.9	3.0	2.7	2.7	2.6	2.4	2.4	2.3
16	Non-ICT Capital Share	43.7	45.6	36.8	40.8	38.6	38.3	38.5	37.8	37.7	36.9	38.2	39.6	38.1	38.5	42.5	45.5	47.3	50.1	44.9	40.2	41.5	40.5	39.3	37.5	36.2	36.9	37.3	37.4	37.4

Source: The Conference Board Total Economy Database™ (Original version), April 2019

1.2 China (official) in percentage

N	INDICATOR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	GDP	3.8	8.9	13.3	13.0	12.2	10.4	9.4	8.8	7.5	7.4	8.2	8.0	8.7	9.5	9.6	10.8	12.0	13.3	9.3	9.0	10.1	9.2	7.6	7.5	7.0	6.7	6.5	6.6	6.4
2	Labor Input - Quantity	2.9	2.3	1.1	1.2	1.4	1.6	1.9	2.3	2.4	2.1	1.4	1.6	1.5	1.6	2.1	1.7	0.1	-1.0	-0.6	0.7	1.9	0.7	0.6	0.1	0.4	0.1	-0.1	0.1	-0.1
3	Labor Input - Quality	0.3	0.3	0.3	0.3	0.3	0.3	0.8	0.5	0.4	0.5	0.6	0.6	0.8	0.6	0.6	1.2	1.3	0.0	0.8	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
4	Capital Input - Total	6.8	4.2	6.5	8.8	9.1	8.6	8.7	9.1	11.1	11.0	11.0	10.2	10.1	10.9	10.7	10.8	10.9	10.3	10.4	11.6	11.0	10.3	10.1	9.8	9.1	8.5	8.3	8.2	8.0
5	Capital Input - ICT	13.5	14.2	18.0	12.8	31.0	37.0	31.6	32.0	46.5	45.8	40.9	28.8	24.5	23.2	24.4	24.8	20.2	13.4	13.4	14.7	16.2	14.1	15.5	14.4	13.1	9.5	8.9	10.5	11.5
6	Capital Input - Non ICT	6.5	3.9	6.1	8.6	8.5	7.7	7.9	8.1	9.3	8.8	8.8	8.8	9.0	9.8	9.4	9.5	10.0	10.0	10.2	11.3	10.6	10.0	9.8	9.4	8.8	8.4	8.3	8.0	7.8
7	Labor Quantity Contribution	1.6	1.2	0.7	0.7	0.8	0.9	1.1	1.4	1.5	1.3	0.8	0.9	0.9	0.9	1.1	0.9	0.0	-0.5	-0.3	0.4	1.1	0.4	0.4	0.1	0.2	0.1	-0.1	0.1	0.0
8	Labor Quality Contribution	0.1	0.2	0.2	0.2	0.2	0.2	0.5	0.3	0.2	0.3	0.4	0.3	0.5	0.4	0.3	0.6	0.6	0.0	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
9	Total Capital Contribution	3.1	1.9	2.7	3.5	3.7	3.4	3.5	3.6	4.4	4.4	4.4	4.3	4.3	4.5	4.7	5.2	5.5	5.4	5.3	5.3	4.9	4.5	4.3	4.0	3.6	3.3	3.3	3.2	3.2
10	ICT Capital Contribution	0.1	0.2	0.2	0.1	0.3	0.4	0.5	0.5	0.9	1.1	1.1	0.8	0.8	0.8	0.9	1.0	0.8	0.5	0.5	0.5	0.5	0.4	0.5	0.4	0.4	0.3	0.2	0.3	0.3
11	Non-ICT Capital Contribution	3.0	1.7	2.5	3.4	3.4	3.0	3.0	3.1	3.5	3.3	3.3	3.4	3.5	3.7	3.8	4.2	4.7	4.9	4.8	4.8	4.3	4.1	3.9	3.6	3.2	3.1	3.1	3.0	2.9
12	Total Factor Productivity	-1.0	5.6	9.7	8.7	7.5	5.9	4.4	3.5	1.4	1.5	2.5	2.4	3.1	3.7	3.4	4.1	5.8	8.3	3.8	3.0	3.9	4.0	2.6	3.1	2.9	3.0	3.0	3.0	2.9
13	Labor Share	55.3	53.2	62.2	58.3	60.4	60.3	60.0	60.6	60.2	60.5	59.0	57.4	58.7	57.8	53.6	50.5	48.6	46.0	51.4	56.5	55.4	56.6	57.7	59.8	61.1	60.5	60.3	60.3	60.3
14	Capital Share	44.7	46.8	37.8	41.7	39.6	39.7	40.0	39.4	39.8	39.5	41.0	42.6	41.3	42.2	46.4	49.5	51.4	54.0	48.6	43.5	44.6	43.4	42.3	40.2	38.9	39.5	39.7	39.7	39.7
15	ICT Capital Share	1.0	1.2	1.1	1.0	1.0	1.4	1.5	1.7	2.1	2.7	2.8	3.1	3.2	3.7	3.9	4.0	4.1	3.8	3.7	3.3	3.0	2.9	3.0	2.7	2.7	2.6	2.4	2.4	2.3
16	Non-ICT Capital Share	43.7	45.6	36.8	40.8	38.6	38.3	38.5	37.8	37.7	36.9	38.2	39.6	38.1	38.5	42.5	45.5	47.3	50.1	44.9	40.2	41.5	40.5	39.3	37.5	36.2	36.9	37.3	37.4	37.4

Source: The Conference Board Total Economy Database™ (Original version), April 20

Table 2 Growth Accounting and Total Factor Productivity, 1990-2018 (Adjusted version)

2.1 China(Alternative) in percentage

NR	INDICATOR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	GDP	0.1	4.7	7.9	10.5	8.4	9.2	7.6	4.4	2.2	5.7	7.2	7.5	9.0	7.6	9.5	10.9	11.5	10.6	7.3	8.6	12.2	7.7	5.4	6.8	6.1	3.8	3.8	4.2	4.0
2	Labor Input - Quantity	2.9	2.2	1.1	1.0	1.0	0.9	1.1	1.3	1.2	1.1	1.0	1.0	0.8	0.6	0.7	0.6	0.5	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.2	0.1	-0.1
3	Labor Input - Quality	0.3	0.3	0.3	0.3	0.3	0.3	0.8	0.5	0.4	0.5	0.6	0.6	0.8	0.6	0.6	1.2	1.3	0.0	0.8	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
4	Capital Input - Total	5.3	7.4	9.6	9.9	12.1	14.5	14.3	13.3	12.7	11.5	10.8	10.8	11.2	12.8	13.2	12.8	13.3	13.2	13.4	14.9	14.5	12.7	12.3	12.4	11.4	11.7	10.4	9.0	8.4
5	Capital Input - ICT	15.6	20.8	17.0	11.4	23.5	32.5	25.1	25.3	25.8	26.3	23.1	23.1	22.6	31.6	35.4	23.8	28.9	25.1	33.5	23.2	26.2	17.6	12.9	17.4	14.6	19.4	13.7	13.2	12.8
6	Capital Input - Non ICT	5.1	7.1	9.5	9.9	11.9	14.2	14.1	13.0	12.4	11.1	10.5	10.5	10.9	12.3	12.6	12.4	12.8	12.9	12.7	14.6	14.0	12.5	12.3	12.2	11.3	11.4	10.3	8.9	8.3
7	Labor Quantity Contribution	1.4	1.0	0.5	0.4	0.5	0.4	0.5	0.7	0.6	0.6	0.5	0.5	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.0
8	Labor Quality Contribution	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.3	0.2	0.2	0.3	0.3	0.4	0.3	0.3	0.5	0.5	0.0	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	Total Capital Contribution	2.8	3.9	5.2	5.4	6.5	7.7	7.3	6.3	5.9	5.4	5.1	5.2	5.6	6.7	7.3	7.4	8.0	8.0	8.0	8.7	8.1	7.0	6.7	6.6	6.1	6.1	5.3	4.6	4.3
10	ICT Capital Contribution	0.2	0.2	0.2	0.1	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.6	0.4	0.5	0.5	0.7	0.5	0.5	0.4	0.3	0.3	0.3	0.4	0.3	0.3	0.2
11	Non-ICT Capital Contribution	2.6	3.6	5.0	5.3	6.2	7.3	7.0	6.1	5.6	5.1	4.8	4.9	5.4	6.3	6.7	7.0	7.5	7.5	7.3	8.2	7.6	6.6	6.4	6.3	5.8	5.7	5.1	4.4	4.1
12	Total Factor Productivity	-4.1	-0.4	2.1	4.4	1.4	1.0	-0.6	-2.8	-4.5	-0.5	1.2	1.6	2.5	0.3	1.6	2.7	2.8	2.4	-1.2	-0.4	3.7	0.3	-1.7	-0.2	-0.3	-2.7	-1.9	-0.7	-0.6
13	Labor Share	48.7	47.1	44.5	45.9	47.3	47.2	50.7	53.8	53.2	52.5	53.4	50.9	48.4	46.1	44.4	39.9	39.6	39.4	41.3	42.8	44.7	45.2	46.1	46.6	47.3	48.7	48.9	48.9	48.9
14	Capital Share	51.3	52.9	55.5	54.1	52.7	52.8	49.3	46.2	46.8	47.5	46.6	49.1	51.6	53.9	55.6	60.1	60.4	60.6	58.7	57.2	55.3	54.8	53.9	53.4	52.7	51.3	51.1	51.1	51.1
15	ICT Capital Share	1.1	1.1	1.1	1.0	1.0	1.1	1.0	1.0	1.1	1.2	1.1	1.1	1.2	1.5	1.7	1.7	1.9	1.9	2.3	2.2	2.1	2.0	2.0	1.9	1.9	2.0	1.9	1.9	1.9
16	Non-ICT Capital Share	50.3	51.8	54.4	53.1	51.7	51.7	48.3	45.2	45.7	46.3	45.5	47.9	50.4	52.5	53.9	58.4	58.5	58.7	56.4	55.1	53.2	52.7	51.9	51.5	50.8	49.3	49.2	49.2	49.2

Source:The Conference Board Total Economy Database™ (Adjusted version), April 2019

2.2 China (Official) in percentage

N	INDICATOR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	GDP	3.8	8.7	13.2	12.9	12.2	10.5	9.5	9.0	7.8	7.7	8.5	8.3	9.0	9.8	9.9	11.2	12.6	14.0	10.0	9.6	10.5	9.5	8.0	7.9	7.5	7.1	7.0	7.0	6.8
2	Labor Input - Quantity	2.9	2.3	1.1	1.2	1.4	1.6	1.9	2.3	2.4	2.1	1.4	1.6	1.5	1.6	2.1	1.7	0.1	-1.0	-0.6	0.7	1.9	0.7	0.6	0.1	0.4	0.1	-0.1	0.1	-0.1
3	Labor Input - Quality	0.3	0.3	0.3	0.3	0.3	0.3	0.8	0.5	0.4	0.5	0.6	0.6	0.8	0.6	0.6	1.2	1.3	0.0	0.8	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
4	Capital Input - Total	6.8	4.2	6.5	8.8	9.1	8.6	8.7	9.1	11.1	11.0	11.0	10.2	10.1	10.9	10.7	10.8	10.9	10.3	10.4	11.6	11.0	10.3	10.1	9.8	9.1	8.5	8.3	8.2	8.1
5	Capital Input - ICT	13.5	14.2	18.0	12.8	31.0	37.0	31.6	32.0	46.5	45.8	40.9	28.8	24.5	23.2	24.4	24.8	20.2	13.4	13.4	14.7	16.2	14.1	15.5	14.4	13.1	9.5	8.9	10.5	11.6
6	Capital Input - Non ICT	6.5	3.9	6.1	8.6	8.5	7.7	7.9	8.1	9.3	8.8	8.8	8.8	9.0	9.8	9.4	9.5	10.0	10.0	10.2	11.3	10.6	10.0	9.8	9.4	8.8	8.4	8.3	8.0	7.9
7	Labor Quantity Contribution	1.6	1.2	0.7	0.7	0.8	0.9	1.1	1.4	1.5	1.3	0.8	0.9	0.9	0.9	1.1	0.9	0.0	-0.5	-0.3	0.4	1.1	0.4	0.4	0.1	0.2	0.1	-0.1	0.1	0.0
8	Labor Quality Contribution	0.1	0.2	0.2	0.2	0.2	0.2	0.5	0.3	0.2	0.3	0.4	0.3	0.5	0.4	0.3	0.6	0.6	0.0	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
9	Total Capital Contribution	3.1	1.9	2.7	3.5	3.7	3.4	3.5	3.6	4.4	4.4	4.4	4.3	4.3	4.5	4.7	5.2	5.5	5.4	5.3	5.3	4.9	4.5	4.3	4.0	3.6	3.3	3.3	3.2	3.2
10	ICT Capital Contribution	0.1	0.2	0.2	0.1	0.3	0.4	0.5	0.5	0.9	1.1	1.1	0.8	0.8	0.8	0.9	1.0	0.8	0.5	0.5	0.5	0.5	0.4	0.5	0.4	0.4	0.3	0.2	0.3	0.3
11	Non-ICT Capital Contribution	3.0	1.7	2.5	3.4	3.4	3.0	3.0	3.1	3.5	3.3	3.3	3.4	3.5	3.7	3.8	4.2	4.7	4.9	4.8	4.8	4.3	4.1	3.9	3.6	3.2	3.1	3.1	3.0	2.9
12	Total Factor Productivity	-1.0	5.4	9.6	8.6	7.5	5.9	4.5	3.7	1.7	1.8	2.9	2.8	3.4	4.0	3.7	4.5	6.5	9.0	4.6	3.7	4.3	4.4	2.9	3.5	3.4	3.4	3.4	3.4	3.3
13	Labor Share	55.3	53.2	62.2	58.3	60.4	60.3	60.0	60.6	60.2	60.5	59.0	57.4	58.7	57.8	53.6	50.5	48.6	46.0	51.4	56.5	55.4	56.6	57.7	59.8	61.1	60.5	60.3	60.3	60.3
14	Capital Share	44.7	46.8	37.8	41.7	39.6	39.7	40.0	39.4	39.8	39.5	41.0	42.6	41.3	42.2	46.4	49.5	51.4	54.0	48.6	43.5	44.6	43.4	42.3	40.2	38.9	39.5	39.7	39.7	39.7
15	ICT Capital Share	1.0	1.2	1.1	1.0	1.0	1.4	1.5	1.7	2.1	2.7	2.8	3.1	3.2	3.7	3.9	4.0	4.1	3.8	3.7	3.3	3.0	2.9	3.0	2.7	2.7	2.6	2.4	2.4	2.3
16	Non-ICT Capital Share	43.7	45.6	36.8	40.8	38.6	38.3	38.5	37.8	37.7	36.9	38.2	39.6	38.1	38.5	42.5	45.5	47.3	50.1	44.9	40.2	41.5	40.5	39.3	37.5	36.2	36.9	37.3	37.4	37.4

Source:The Conference Board Total Economy Database™ (Adjusted version), April 2019

References

Bartel, A., Ichniowski, C., & Shaw, K. (2007). How does information technology affect productivity? Plant-level comparisons of product innovation, process improvement, and worker skills. The quarterly journal of Economics, 122(4), 1721-1758.

Biagi, F. (2013). ICT and Productivity: A Review of the Literature. JRC Technical Reports 2013/09

Bollou, F., & Ngwenyama, O. (2008). Are ICT investments paying off in Africa? An analysis of total factor productivity in six West African countries from 1995 to 2002. Information Technology for Development, 14(4), 294-307.

Brynjolfsson, E., & Hitt, L. M. (2003). Computing productivity: Firm-level evidence. Review of economics and statistics, 85(4), 793-808.

Cardona, M. Kretschmera, T. Strobel, T. (2012). ICT and productivity: conclusions from the empirical literature. Information Economics and Policy 25 (2013) 109–125

Cette, G. Mairesse, J. Kocoglu, Y. (2004). ICT diffusion and potential output growth. Economics Letters 87 (2005) 231-234.

Chavula, H. K. (2013). Telecommunications development and economic growth in Africa. Information Technology for Development, 19(1), 5-23.

China Internet Network Information Center(2019), The 43rd China Statistical Report on Internet Development.

China's Association of Information & Communication Technology (2019), The Whitebook China's Digitization Economy Development. Available at: http://www.caict.ac.cn/kxyj/qwfb/bps/201904/P020190417344468720243.pdf

Gomez, R., & Pather, S. (2012). ICT evaluation: are we asking the right questions?. The Electronic Journal of Information Systems in Developing Countries, 50(1), 1-14.

Hofman, A. Aravena, C. Aliaga, V(2016). Information and communication technologies and their impact in the economic growth of Latin America,1990–2013. Telecommunications Policy 40 (2016) 485 – 501

Hong, J. (2016). Causal relationship between ICT R&D investment and economic growth in Korea. Technology Commercialization Strategy Section, ETRI, 218 Gajeongno, Yuseong-gu, Daejeon 305700, Republic of Korea.

Jin, S., & Cho, C. M. (2015). Is ICT a new essential for national economic growth in an information society?. Government Information Quarterly, 32(3), 253-260.

Jorgenson, D. W, Vu, K. M. (2011). The rise of developing Asia and the new economic order. Journal of Policy Modeling, 33(5), 698-745.

Jorgenson, D. W. (2003). Information technology and the G7 economies.

Jorgenson, D. W., & Vu, K. (2005). Information technology and the world economy. Scandinavian Journal of Economics, 107(4), 631-650.

Jorgenson, D. W., & Vu, K. M. (2016). The ICT revolution, world economic growth, and policy issues. Telecommunications Policy, 40(5), 383-397.

Kamel, S., Rateb, D., & El-Tawil, M. (2009). The impact of ICT investments on economic development in Egypt. The Electronic Journal of Information Systems in Developing Countries, 36(1), 1-21.

Kozma, R. B. (2005). National policies that connect ICT-based education reform to economic and social development. Human Technology: An interdisciplinary journal on humans in ICT environments.

Kuppusamy, M., Raman, M., & Lee, G. (2009). Whose ICT investment matters to economic growth: private or public? The Malaysian perspective. The Electronic Journal of Information Systems in Developing Countries, 37(1), 1-19.

Lee, S. Y. T., Gholami, R., & Tong, T. Y. (2005). Time series analysis in the assessment of ICT impact at the aggregate level–lessons and implications for the new economy. Information & Management, 42(7), 1009-1022.

Lipsey, R. G., Carlaw, K. I., & Bekar, C. T. (2005). Economic transformations: general purpose technologies and long-term economic growth. OUP Oxford.

Liu, K.C. Wang, J.F. Yang, H.Y. (2015). ICT Investment Impact Analysis of Taiwan's GDP. Journal of e-Business 2 (2015) Vol. 17, 139-182

Miller, B. , Atkinson, R.D. (2014). Raising European Productivity Growth Through ICT. The Informatioon Technology & Innovation Foundation

Morrison, W. M (2018). The Made in China 2025 Initiative: Economic Implications for the United States. Congressional Research Service 7-5700, IF10964.

Sassi, S., & Goaied, M. (2013). Financial development, ICT diffusion and economic growth: Lessons from MENA region. Telecommunications Policy, 37(4-5), 252-261.

Schreyer, P. (2001). Information and communication technology and the measurement of volume output and final demand – a five-country study. Economics of Innovation and New Technology 10 (5), 339–376.

Seo, H. J., Lee, Y. S., & Oh, J. H. (2009). Does ICT investment widen the growth gap?. Telecommunications Policy, 33(8), 422-431.

Solow, R. M. (1987). We'd better watch out. New York Times Book Review, 36.

Steinmueller, W. E. (2001). ICTs and the possibilities for leapfrogging by developing countries. International Labour Review, 140(2), 193–210.

Steyn, J. (Ed.). (2010). ICTs and Sustainable Solutions for the Digital Divide: Theory and Perspectives: Theory and Perspectives. IGI Global.

Vu, K. M. (2011). ICT as a source of economic growth in the information age: Empirical evidence from the 1996–2005 period. Telecommunications Policy, 35(4), 357-372.

Vu, K. M.(2011), ICT as a source of economic growth in the information age: Empirical evidence from the 1996–2005 period. Telecommunications Policy 35 (2011) 357–372

Wang, E. H. H. (1999). ICT and economic development in Taiwan: analysis of the evidence. Telecommunications Policy, 23(3-4), 235-243.

World Economic Forum (2015), The Global Competitiveness Report 2015-2016. http://reports.weforum.org/global-competitiveness-report-2015-2016/

邵 永裕(2015)「中国製造 2025」の戦略構想と将来展望 Mizuho Global News 2016 vol.85 16-17