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The Development of Telecommunications and its Impacts on Chinese Economic Growth

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Abstract

The study examines the development of telecommunications and its impacts on Chinese economic growth since telecommunications has been undergoing dramatic reforms in the 1980s. On November 2001, China was officially the WTO member to open the market for foreign investors. It is obvious that the telecommunications infrastructure development can play a key role in economic growth in China. Furthermore, China has become the world's single largest telecommunications market since 2002.

In this research, I present evidence that it empirically not only investigates the telecommunications development and its impacts on economic growth, but also tests their relationship with initial economic condition, fixed investment, population growth, foreign direct investment as well as telecommunications infrastructure development using the panel data approach with a dynamic fixed effect model for the span of time from 2003 to 2008. I find that that mobile phone user density to be the new proxy for telecommunications infrastructure in China contributes in a major way to the economic growth. It means that mobile communication systems do have positive impact and effect on the regional economy of China.

It is a crucial determinant as findings indicate a significant and positive correlation between telecommunications development and regional growth in China, after controlling for a number of other factors. Results also show that investment in telecommunications is subject to diminishing returns.

Key words: telecommunications, fixed effect model, panel data

Table of Contents

Chapter 1	Introduction……………………………………………………..	1
1.1	Research Background and Purpose……………………..…..	1
1.2	Research Structure and Framework……………………….…	5
Chapter 2	Literature Review……………………………………………….	8
2.1	Theoretical Foundation…..……………………………………	8
2.2	Empirical Literature..	13
Chapter 3	Telecommunications Development in China…………………	24
3.1	Restructuring Institutes and the China's Telecommunications Development……………..…………..	24
3.2	The Evolution of China's Telecommunications Industry Development…………………………………………….……...	29
Chapter 4	Methodology Framework and Data Source………………..…	44
4.1	Dynamic Panel Data Approach………………………………..	44
4.2	Measurement of Variable and Data Sources…………………	48
Chapter 5	Empirical Analysis and Results………………………………..	55
5.1	Regional Telecommunications Development and Regional Economic Growth……………………………………………..	55
5.2	Empirical Analysis and Results………………………………..	59
5.3	Summary……………………………………………………....	67
Chapter 6	Conclusions………………………………………………..…….	71
	References……………………………………………...……….	77

List of Figures

Figure 1	Research Framework………………………………………..	7
Figure 2	Number of Telephone Subscribers (1949~1975)……………	32
Figure 3	China's Teledensity (1952~2003)……………………………..	33
Figure 4	China's Telephone Subscribers (1978~2005)……………….	34
Figure 5	Growth Rate of GDP and Teledensity (1975~2002)…………	39
Figure 6	Growth of Netizens and Internet Penetration Rate in China..	41
Figure 7	GDP per capita of Chinese provinces in 2008……………….	57
Figure 8	GDP and Telephone Subscribers per Capita (2008)………..	58
Figure 9	GDP and Mobile Phone Subscribers per Capita (2008)…….	58
Figure 10	GDP and Internet Subscribers per Capita (2008)…………..	59
Figure 11	Mobile Phone User Density and Annual Growth Rate of Real GDP per Capita (2003-2008)……………………………	67

List of Tables

Table 1	Relevant Literatures and Studies on the Development of Telecommunications and its Impacts…………………………	20
Table 2	Telecommunication Capacity Growth During the First-Five Year Plan……………………………………………………..	31
Table 3	Telecommunications Statistics (2003~2006)………………...	35
Table 4	Basic Telecommunications Service Providers……………….	38
Table 5	Fixed-Asset Investment in Telecommunications as Percent of GDP………………………………………………………..	40
Table 6	Market Share for China's Telecom Operators………………..	43
Table 7	Variables of Their Expected Signs, Mean and Standard Error Value…..…………….	61
Table 8	Regression Results from Modeling……………………………	66

Chapter 1 Introduction

During the last two to three decades, telecommunications industry in developing countries has been undergoing dramatic reforms. Park and Zhou (2005) investigated that the liberalization[1] started with the adoption of contractual responsibility system in the late 1980s aimed to improve the economic development, and it has been a complex relationship between political and economic systems in China. It led to the fundamental changes not only in market structure but also in regulatory institutions (Tan, 2003).

The purpose of this study is empirically to investigate the impact of the level of telecommunications development on the regional economic growth in China using a dataset of 31 regions for the span of time from 2003 to 2008. This chapter presents research background and purpose in advance; research structure and framework lately.

1.1 Research Background and Purpose

Petrazzini and Krishnaswamy (1998) indicated that telecommunications liberalization means introducing competition into the telecommunications services to set up new businesses as long as they comply with the game rule and regulation defined by government who possess the administration combining multiple roles as policy-maker, regulator and operator limiting the development of new markets and services. Telecommunications infrastructure development can play a key role in economic growth to lead

1 The term "liberalization" generally describes and accepts here "an inclusive definition of three distinct sets of measures, namely liberalizing international trade, privatizing publicly owned companies and allowing entry in certain sectors, possibly de-monopolizing state-owned companies" (Contessi, 2003).

leapfrogging[2] development with providing vital economic growth in the emerging market. Tan (2003) examined that one of the major changes is from the previous central planning economy to gradually move into market-dominated economy led to the penetration of Chinese economy by market forces. It is obvious that China has gradually shifted its priority from political struggle to economic growth since 1978, and telecommunications development was officially recognized as one of the critical infrastructures for achieving economic growth.

Generally, telecommunications infrastructure in China was extremely poor before the 1980s compared to other nations, but significant expansion has happened mostly in the past two decades, which makes China the largest infrastructures in the world. As a result of market restructuring and regulatory re-arrangement from 1990's, China's telecommunications services have witnessed a dramatic change toward higher penetration rate, decreasing price, increasing subscriber, adoption of more advanced technology, better service quality and more competition.

Regarding the first round of split and restructuring of telecommunications in China in 1999 because of the imbalance of market share, China Telecom was broken up and the businesses of mobile, paging and satellite were divested and became independent corporations. Eventually, the entire industries were made up of several operating companies bone by China Telecom: China Telecom, China Unicom, China Netcom, China Jitong, China Railcom and China Satellite. The market share of China Telecom was

2 Singh, J. P. (1999) uses the word "leapfrogging" in three ways. First, it is meant to imply that telecommunications can help developing countries skip over stages of development and become members of post-industrial society. Second, leapfrogging is used in a "engine of growth" sense to mean that telecommunications can help developing countries accelerate their pace of development. Finally, leapfrogging is used in a technical sense to signify skipping over the technological frontier or product cycle.

decreasing from 64.35% in 1999 to 50.52% in 2001.[3]

Li and Wang (2003) studied that the telecommunications industry in China was rather competitive in 2002. At the same year, China became the world's single largest telecommunications market and experienced the second round of reform. After that the distribution of market share has changed greatly. It was made up of six operating companies and about 4,000 companies that provide value added businesses. In terms of market share, China Mobile became the biggest operating company in China; China Netcom was the third, and China Unicom lowered to the fourth place. However, none of these companies had a market share above 50% then. Linked with the infrastructure expansion, China's technology capabilities in telecommunications has upgraded to a much higher level because of attracting nearly all the significant infrastructure providers to engage in various production activities and technology transfer.

In terms of the past empirical analysis, it was focused on the effect of telecommunications development on economic output. Michael (2000) researched that telecommunications are an essential implement to economic development and have a dramatic impact on GDP led to an increase in foreign direct investment. Recent studies appear to be sufficient empirical evidences to indicate a positive and significant relationship between telecommunications development and economic growth. Ding (2005) found that developed economies are highly correlated with developed telecommunication infrastructure. Furthermore, Hu and Zhou (2002) found evidence of a causal link between telecommunications development and

3 Li, M. and Wang, J. (2003), "China's Telecommunications Universal Service in a Competitive Environment," UNU/WIDER Project Conference on Spatial Inequality in Asia.

economic growth which shows that economic development will be constrained by the insufficiency of basic infrastructure: while the penetration rate of china increases by 1%, the GDP will increase by 0.5%,. Zahra, Alam and Mahmood (2009) also proved the causal relationship between telecommunications infrastructure development and economic growth that the direction of causality is from telecommunications to GDP per capita growth.

Mody and Wang (1997) used panel data on the output of 23 industrial sectors for seven costal China's growth during the second half of the 1980's. They found that both transport and telecommunications facilities have been the engine of growth during this short time period from 1985 to 1989. Demurger (2001) using panel data for a sample of 24 Chinese provinces from 1985 to 1998 examined that the development of telecommunications in rural areas helps reduce the burden of isolation and has a positive impact on economic growth. In the estimation, the introduction of the number of telephones per capita as a proxy for telecommunications development confirms the significant impact on economic growth performances and verifies Mody and Wang's (1997) results on the positive effect of telecommunications growth. Canning (1999) also approved that investment in telecommunications infrastructure in particular has a positive effect on economic growth. The effect of telecommunications development leads to growth by increasing the demand for services used in their production; the economic return on these investments are far greater than the return from the investment, because there is a direct and an indirect effect on the production.

In terms of methodology, most empirical studies employed the determinants of growth with simple correlation methods or Solow-type production function. It typically requires the assumption of an identical production function for all countries or regions (Ding and Haynes, 2004). Moreover, Poot (2000) highlighted that regression analysis remains the most commonly adopted research methodology.

In this research we defined that telecommunications development is measured as the fixed-line telephone subscriber density, mobile phone subscriber density and the number of Internet subscriber density separately different than prior studies because mobile phone subscribers in the proxy of telecommunications have overtaken fixed line subscribers since 2003.

The purpose of this study is to understand:

- Does the telecommunications industry contribute in a major way to the economic growth particularly after the restructuring implemented after WTO accession?
- Does the economic growth level significantly influence the adoption of telecommunication development (fixed-line telephone user density, mobile phone user density and Internet user density) across regions in China?

1.2 Research Structure and Framework

The research procedure is adopted to help accomplish this study. First, this study decides the research purpose. Second, review the related theoretic literatures to research purpose. Next, the study can find the foundation of telecommunications liberalization and its development in China. It is also to look up some research books and textbooks to resolve problems about the selection of research method and the resources of variable information.

This study provides empirical evidence of the relationship between telecommunications development and regional economic growth in China with a panel dataset by dynamic fixed effect model covering 31 regions of China over the period from 2003 to 2008 while controlling for a set of other variables including initial economic condition, fixed investment, employment growth, population rate, foreign direct investment, human capital and urbanization etc,. Regarding the data collection, The China Statistical Yearbook and International Telecommunication Union Yearbook and World Bank Indictor provide most of data.

Eventually, it is combined the literatures and empirical results to discuss the impacts of telecommunications development on regional economic growth in China. The framework of this study is arranged as follows: Chap 2 examines a review of the theoretical foundation and empirical literatures. Chapter 3 provides a briefly overview of China's telecommunications development, and makes an evaluation of the relationship between telecommunications industry and economic growth. As China became the single largest telecom market in 2002, it has been the most successful developing country for spreading telecommunications access in a remarkably short period of time. To understand the evolution and complex internal mechanisms of the extremely competitive scenario are essential for this study. The model will be presented in the forth chapter. Methodologies used in this study and variable measurement are listed in Chapter 4. Chap 5 presents the results of empirical analysis of the data. The last part of this study concludes with discussion based on the results of empirical estimation.

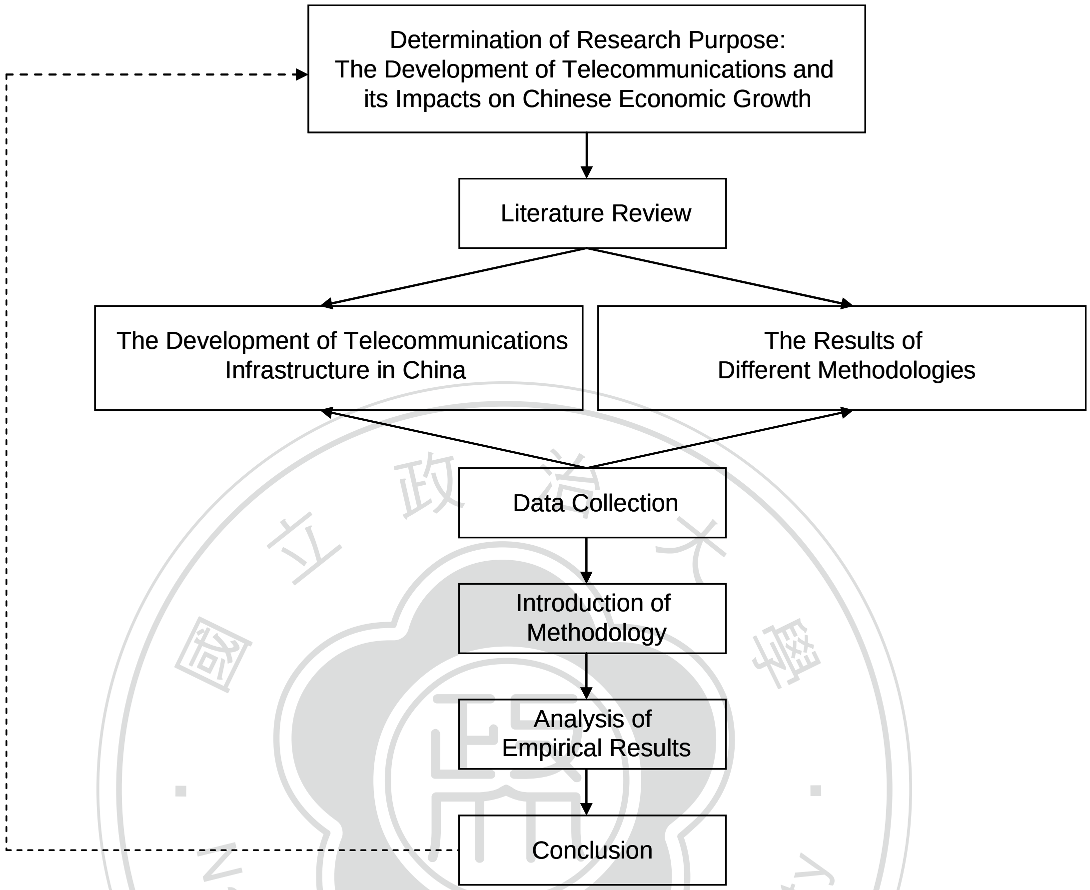

Figure 1 Research Framework

Chapter 2 Literature Review

The content of literature review in this chapter will be covered the direct effects and empirical observations of telecommunications development on economic growth.

2.1 Theoretical Foundation

The issues of economic growth related to telecommunications development have become items in macro environment and national economic since it is one of the major forces to drive the goal of developments in economic growth in the national market place (Rabayah, Awad and Naser, 2008). According to OECD's report (2004), telecommunications infrastructure developments play an important role in modern economies as in new economic activities. It becomes more efficiency, and social and economic welfare are enhanced for all stakeholders in an economy via positive externalities as regulatory reforms take effect. Furthermore, Oyedemi and Gillis (2004) came up with the several ways from the point of view of telecommunications in which it can influence economic growth:[4]

I. Reduction of Regional Infrastructure and Development Gap

One of the reasons for the persistent gap between rural and urban areas in any country is the telecommunications infrastructure gap, which results in the information gap between rural and urban areas. Governments and other financially able parties should establish communication technology links to

4 Oyedemi, T. and Gillis, B., "Macro Environment and Telecommunications 2004: Direct Effects of Telecommunications on Economic Development," Telecommunications and Social development. http://cbdd.wsu.edu/kewlcontent/cdoutput/TR501/page66.htm

facilitate information transmission.

II. Telecommunications as an Input to the Economic Production Process

Telecommunication services in any business entity are to some extent a low cost substitute for information handling labor for helping the industries more by increasing the productivity of each of these traditional inputs and thus increasing the efficiency of the entire production process.

III. Market Efficiency Effect

Telecommunications increases not only the efficiency of market operations by facilitating information flow, but also arbitrage opportunities in financial markets, which in turn lower the capital costs of production.

IV. Spillover and Externality Effects

In addition to its direct contribution to end-subscribers, the telecommunication networks generate significant spillover effects in other sectors of the economy. By possessing the characteristics of infrastructure capital, telecommunication networks generate substantial externalities both on the supply side and on the demand side.

V. Coordination of Economic Activity

Telecommunications help in the coordination of economic activity by allowing easy acquisition and transfer of information among economic units. At the aggregate economy level, telecommunications helps social planners to coordinate different economic activities at reduced communications costs.

VI. Global Telecommunication Connections

Global telecommunications can influence the global economy through similar mechanisms for helping the rapid movement of information from one country to another and allow optimal utilization of available technology, products and services around the world, thus helping to improve the global economy.

From the economic point of view, telecommunications development can lead to economic growth through both direct and indirect channels. The importance between economic growth and telecommunications development can be appropriately evaluated in the frameworks of growth theories.

Neoclassical Growth Theory

In the neoclassical model[5] which was developed by Ramsey (1928), Solow (1956), Swan (1956), Cass (1865) and Koopmans (1965), there is a constant return to scale aggregate production function with substitution between capital and labor (Ding, 2005). One feature of this model is the convergence property: the lower the starting level of real per capita GDP and the higher is the predicted growth rate which derives in the model from the diminishing return to capital (Barro, 1997). It leads the growth process within an economy to eventually reach the steady state where per capita output, capital stock, and consumption grow at a common constant rate equaling the exogenously given rate of technological progress as a primary source of growth (Islam, 1995). Islam also mentioned that there are three important

5 Antonietta Campus (1987) mentioned that Neoclassical economics is a term variously used for approaches to economics focusing on the determination of prices, outputs, and income distributions in markets through supply and demand, often as mediated thro\ugh a hypothesized maximization of income-constrained utility by individuals and of cost-constrained profits of firms employing available information and factors of production, in accordance with rational choice theory.

predictions of neo-classical model.

First, increasing capital relative to labor creates economic growth, since people can be more productive given more capital.

Second, poor countries with less capital per person will grow faster because each investment in capital will produce a higher return than rich countries with abundant capital.

Third, because of diminishing returns to capital, economies will eventually reach a point at which no new increase in capital will create economic growth. This point is called a "steady state". The steady state income level is determined by the country's saving and labor force growth rates, and some of other parameters of technology.[6]

The concept of capital in this model can be use-fully broadened from physical goods to include human capital in the form of education with a steady state ration of human to physical capital. Thus, regional economic growth differences can be interpreted as availability and mobility of capital and labor inputs in the short run. Liu (2008) cited Clark's argument that availability and quality of infrastructure has the determinative force in interregional production factor movements. Furthermore, Barro and Sala-i-Martin, 2004) pointed out that the production function is combined with a constant-saving-rate rule to generate an extremely simple general-equilibrium model of the economy.

Ding (2005) revealed that while technological change is the one of primary growth sources, telecommunications can be regarded as this kind of general purpose technology and infrastructure. Given the direct and indirect channels through which telecommunications infrastructure functions in the

6 http://en.wikipedia.org/wiki/Economic_growth

production process, these communications networks can be taken as a type of capital input and modeled in Solow's neoclassical economic growth model which is criticized as not accounting for fixed effects and appropriate causalities and correlations (Ding, 2004).

Endogenous Growth Theory

Endogenous growth theory is a response to criticism of the neo-classical growth model.[7] This approach provides a theory of technical progress as one of the central missing elements of the neoclassical model that is the major difference between the endogenous growth model and the Solow aggregate production function approach lies in the endogeneity of technical changes (Liu, 2008). In neo-classical growth models, the long-run rate of growth is exogenously determined by either assuming a savings rate (the Harrod-Domar model) or a rate of technical progress (Solow model). However, the rate of saving and technological progress remains unexplained.

Endogenous growth theory tries to overcome this shortcoming by building macroeconomic models out of microeconomic foundations. The existence of increasing returns to scale in the aggregate production function is a novelty in the endogenous growth theory. Technological change is treated as a separate factor in the aggregate production function as endogenous economic phenomenon has increased dramatically (Ding, 2005). The engine for growth can be as simple as a constant return to scale production function (the AK model) or more complicated set ups with spillover effects, increasing numbers of goods, increasing qualities, etc.

According to the endogenous growth theory, telecommunications

7 http://en.wikipedia.org/wiki/Endogenous_growth_theory

development shift from the incentive to accumulate physical capital to incentive across regions. Because networking is characterized by positive economic externalities related to diffusion and accumulation of the knowledge, stock can be achieved through investment in telecommunications infrastructure development. Waverman, Meschi and Fuss (2005) also explored the impact of telecommunications rollout on economic taken by the endogenous technical change approach that Investment in telecommunications generates a growth dividend because the spread of telecommunications reduces costs of interaction, expands market boundaries, and enormously expands information flows.

2.2 Empirical Literature

Empirical studies have revealed that successfully introducing effective competition in telecommunications development related to economic growth. Proper regulation that allows foreign market access and curbs market power also plays an important part in procuring effective competition to achieve ultimate liberalization. In most developing countries, impediments limiting commercial presence continue to be the more common barrier to international transactions in telecommunication services (Warren, 2001).

Petrazzini and Krishnaswamy (1998) highlighted that telecommunications restructuring have evolved differently in Asia and Latin America. While Asian governments have moved cautiously in bring changes to the sectors, the telecommunications reform felled in between two general trends: the choice of a high component of competition increased private participation, and no privatization of the national carrier set conditions that will trigger unique socio-economic effect.

Oliver Boylaud and Giuseppe Nicoletti (2000) used an original international database on regulation, market structure and performance in the telecommunications development to investigate the effects of entry liberalization and privatization on productivity, prices and quality of service over the period from the period of 1991 to 1997. No clear evidence could be found concerning the effects on performance of the ownership structure of the telecommunications infrastructure development.

Donyaprueth (2001) showed that less-developed countries should realize their telecommunications reform policies to their own pace and needs. This study found that liberalization reforms or extensive opening of the market did not necessarily increase penetration rates of services better than other less competition-oriented policy alternatives.

Carlo, Khalid and Aristomene (2003) summarized that telecommunication development is evaluated on the basis of degree of effective competition in fixed and mobile networks; openness to foreign investment and pro-competitive regulation. It is confirmed that the open markets promoted efficiency in telecommunications. Moreover, the performance of the sector also appeared to be critically driven by openness to competition and the quality of the regulatory framework.

Contessi (2003) revealed that the privatization processes were significantly correlated with increases in teledensity; the share of foreign-ownership in the incumbent had a positive; and the establishment of a separate regulator had a positive significant effect on teledensity using a panel of 46 transitions and emerging economies for the period from 1989 to 2000.

Tan (2003) reviewed the major theoretical debates regarding political and economic systems and technology development focusing on China's telecommunications manufacturing sector. The finding was technology development in telecommunications with the political and economic environment in China had a close relationship and future impact.

Park and Zhou (2004) traced the processes of telecommunications industry development in China. A series of restructuring efforts and policy changes since late 1980s aimed at transforming state-owned telecommunication departments into independent business entities, while keeping government ownership. It was an attempt to commercialize China’s basic telecommunications services while keeping state assets under state control for voiding a fundamental change to state ownership and its economic reform program to inject vitality into state-owned enterprises.

Wang (2006) examined that China’s telecommunications market had reformed and formed the nearly open pro-competitive market to foreign investors after WTO accession. Muhammad, Tang and Liu (2007) showed the economic growth of the country was linked with the development of the telecommunications industry. Its development had also achieved a remarkable growth after liberalization.

Besides, the effect of foreign direct investment in the telecommunications development has gained importance in the last decade, but a little research had been carried out at empirical level. Roller and Waverman (2001) claimed that investment in telecommunications industry fostered growth with a structural model taking over 20 year period to examine the impact. Gary and Scott (1997) empirically showed the relationship between gross fixed investment, telecommunications infrastructure investment and economic growth determining the direction of influence and timing (Madden and

Savage, 1997).

Roller and Waverman (1996) confirmed how telecommunications infrastructure affected economic growth. They used evidence with a structural model from 21 OECD countries to examine the relationship between telecommunications infrastructure investments and economic performance. They estimated a model which endogenizes telecommunications investment by specifying a micro-model of supply and demand for telecommunications investments. Finally, they found that the impact between telecommunications infrastructure and aggregate output was much reduced and statistically insignificant. Wallsten (1999) explored the effects of privatization, competition, and regulation on telecommunications performance in 30 African and Latin American countries using fixed effects regressions from 1984 to 1997. Privatizing an incumbent was negatively correlated with mainline penetration and connection capacity. Privatization combined with an independent regulator was positively correlated with connection capacity and substantially mitigates the negative effect on mainline penetration.

Wallsten (2000) used an original and new dataset to analyze the effects of privatization, competition and regulation that privatization under the right institutional environment can lead to substantial performance improvements. Government tended to give the newly privatized firm a monopoly concession on telecommunications services while some contend was necessary to encourage investment.

In addition, the involvement of foreign capital in the construction and operation of telecommunications infrastructure is often limited by legislation, administrative management. Limitations range from total exclusion from the entire market to equity caps in sensitive market segments before liberalization. Konan and Maskus (2002) developed a CGE model to consider the services liberalization, which yields the benefits in aggregate welfare and reorients production toward sectors of benchmark comparative advantage. However, a reduction of services barriers in a way that permitted greater competition through foreign direct investment generated large welfare gains.

Fink, Mattoo, and Rathindran (2002) examined the political economy in the telecommunications sector using a sample of 160 countries for the analysis of the effects of privatization, and a smaller sample of 40 countries for the analysis of the effects of competition that it is effective to increase teledensity and telecommunications productivity based on open market. Bernardo et al., (2002) explored the financial and operating performance of 31 national telecommunication companies in 25 countries using panel data estimation techniques. The financial and operating performance of telecommunications companies improved significantly after privatization.

Konan and Assche (2004) used a quantitative analysis with CGE model of the welfare impact of improved domestic market access for foreign telecom providers that the domestic telecommunications industry was initially monopolized. The research found not only limited foreign market access was welfare improving if regulation can prevent the domestic incumbent and the foreign services provider to form a cartel but also results emphasized the importance of market structure and the regulatory environment on the success of telecom liberalization. Ding and Haynes (2006) showed empirical evidence as well with a dynamic fixed effects model on the links between telecommunications infrastructure and regional economic growth during the period of 1986 to 2002 in China. The results showed that telecommunications infrastructure endowment was a key factor in regional economic growth in China. Michael (2008) found the effects of telecommunications using the panel data approach with a dynamic fixed effect model on long-run economic growth. It was evidences that between telecommunication infrastructures and regional growth indicated a significant and positive correlation; and showed that investment in telecommunications was subject to diminishing returns.

Ding, Haynes and Liu (2008) found that the system GMM estimation which was proposed by Caselli et al. (1996) and the system GMM estimator developed by Blundell and Bond (1998) was more likely to produce consistent and efficient estimates than ordinary least square (OLS) and fixed-effect estimation. Findings indicated a significant and positive relationship across 29 regions during 1986 to 2002 between telecommunications infrastructure and regional economic growth in China empirically testing the results by applying different panel data approaches to the study of telecommunications infrastructure in regional economic growth across China.

After reviewing the literature above, most of them focused on studying the development of telecommunications and its impacts on economic output or productivity with some evidences of a causal relationship between telecommunications infrastructure development and economic growth in both directions with using different data resources, different time periods, and different methodologies. And only few journal articles are for China's studies. Moreover, most studies of the mutual relationship between telecommunications development and economic growth have been primarily based on cross-sectional country data or regional data of developed countries. Maddala (1999) attempted to examine the causal relationship running from telecommunications development with economic growth by taking a sample of transitional economies in Central and Eastern Europe. These studies showed that it appears to be two ways, or mutual causality between telecommunications development and real economic growth at the aggregate level.

Ding (2005) also indicated that in fact telecommunications investment may have various effects for economies at different stages of development between developed and developing countries. Finally, it is important to find the adaptive methodology to investigate the interdependent relationship between economic growth and telecommunications development and its impacts during the period of 2002 to 2006 after WTO accession especially.

Datta and Agarwal (2004) indicated that there is a two- way causation between telecommunication development and economic growth in OECD which shows that telecommunications infrastructure plays a positive and significant role in economic growth using a similar data set which corrects for omitted variables bias of single equation cross-section regression after controlling for a number of other factors.

Table 1 Relevant Literatures and Studies on the Development of Telecommunications and Its Impacts

Reference	Approach	Indictor	Study Period	Main Findings
Wallsten (1999)	Panel data approach	● Number of operators ● Number of main lines ● Payphones ● Connection capacity ● Labor efficiency ● Price of local calls	1974~1997	● Competition measured by mobile operators not owned by the incumbent is correlated with increases in the per capita number of mainlines, payphones, and connection capacity, and with decreases in the price of local calls
Wallsten (2000)	Panel data approach	● Population ● GDP per capita ● Main line growth rate ● Mobile competitors ● Year fixed effects ● Mobile competitor	1987~1998	● Exclusivity periods are associated with approximately a doubling of the firm's sale price ● The increased revenues to the government come with a cost that are correlated with a 20 to 40% decrease in telephone network growth
Fink et al. (2002)	Panel data approach	● Time trend ● Teledensity ● per capita GDP ● Population ● Mobile competition ● Mobile subscriber ● Digital technology	1985~1999	● Both privatization and competition lead to significant improvements in performance ● A comprehensive reform program produced the largest gains: an 8% higher level of mainlines and a 21% higher level of productivity compared to years of partial and no reform ● Mainline penetration is lower if competition is introduced after privatization, rather than at the same time

Rossotto et al. (2003)	Panel data approach	● Growth rate of trade partners ● Real effective exchange rate ● GDP per capita ● Telecommunications performance	1990~1999	● First introduces a model to assess the benefits of telecommunications liberalization on sector performance ● Better performance of telecommunications strengthens export performance in manufacturing, including exports of intermediate products ● Better telecommunications performance is found to be a determinant of foreign direct investment inflows
Contessi (2003)	Panel data approach	● FDI ● Fixed line ● Teledensity ● GDP ● Population ● Urbanization	1989~2000	● Privatization processes are significantly correlated with increases in teledensity ● The foreign participation in the incumbent generates positive benefits
Ding and Haynes (2004)	Panel data approach	● Real GDP per capita ● Fixed investment in GDP ● Growth of population ● Teledensity ● Employment in total population ● FDI in fixed investment	1986~2002	● Telecommunications is both statistically significant and positively correlated to regional economic growth in real GDP per capita in China ● Telecommunications investment is subject to diminishing returns, suggesting thereby that regions at an earlier stage of development are likely to gain the most from investing in telecom infrastructure
Ding (2005)	Panel data approach	● Real GDP per capita ● Fixed investment in GDP ● Employment	1986~2002	● Telecommunications infrastructure endowment is significantly and positively correlated to regional economic growth ● The impact of telecommunications investment on growth is

		• Human capital • Growth of population • Transportation percentage • Teledensity		subject to diminishing returns • The determinants of mobile communications adoptions indicates that the socioeconomic characteristics played an important role in determining the initial adoption and diffusion speed of mobile communications • Higher levels of real capita income and openness had a positive impact on the diffusion rates of mobile communications
Stetsenko (2007)	Panel data approach	• GDP • Human capital • Telecommunication capital stock • Teledensity • Mobile subscriber • Fixed-line subscriber • Price • Graphic area • Diffusion rate	2001~2005	• The evidence of positive gains to economic growth from previous studies is unambiguous for high income countries • For medium and lower income countries, TI contributes to total growth • The intensive growth of TI has resulted in a large impact on GDP growth
Enowbi Batuo (2008)	Panel data approach	• GDP per capita • Teledensity • Growth of population • Investment • GDP • Population	1984~2005	• It is significant and positive correlation between telecommunication infrastructures and regional growth in Africa • Investment in telecommunications is subject to diminishing returns

Ding et al. (2008)	Panel data approach	● Real GDP per capita ● Fixed investment in GDP ● Growth of population ● Employment ● Teledensity ● Human capital ● Industrial output in SOE ● Transportation percentage	1986~2002	● The results suggest the system GMM estimation is more likely to produce consistent and efficient estimates than OLS and fixed-effect estimation ● Findings indicate a significant and positive relationship between telecommunications infrastructure and regional economic growth in China and the empirical results from different estimations suggest robust results for this particular assessment
Zahra et al. (2009)	Panel data approach	● Real GDP per capita ● Fixed investment in GDP ● Growth of population ● Teledensity ● Initial economic condition ● Telecommunication infrastructure	1985~2003	● Telecommunication is both statistically significant and positively correlated to the real GDP per capita, after controlling for investment, population growth, past level of GDP per capita and lagged growth ● Telecommunication investment is subject to increasing returns, suggesting thereby that countries gain more and more with the increase in telecommunication investment ● Granger's causality test confirms the causal relationship between telecommunication infrastructure and economic growth, but the relationship is significant from telecommunication to GDP per capita side but insignificant on GDP per capita to telecommunication development side

Source: Arranged by this research

Chapter 3 Telecommunications Development in China

This chapter provides a brief overview of telecommunications development in China and makes an evaluation of the relationship between telecommunications industry and economic growth. As China became the single largest telecom market in 2002, it has been the most successful developing country for spreading telecommunications access in a remarkably short period of time. To understand the evolution and complex internal mechanisms of the extremely competitive scenario are essential for this study.

3.1 Restructuring Institutes and the China's Telecommunications Development

The dynamism of global telecommunications markets is widely attributed to rapid technological development and an increasingly liberal policy environment. Over the past decade, a large number of developing economies have embarked on reform paths, and witnessed significant expansion of their telecommunications networks and striking improvements in productivity.[8]

Most developing countries nationalized telecommunications services in the 1960s. By the 1980s it was clear that nationalized monopoly telecommunications firms in developing countries could not effectively provide services. Since the inception of the so-called "Open Door Policy" in China, China gradually shifted its priority from political struggle to economic

8 Fink, C., Mattoo, A. and Rathindran, R. (2002), "An Assessment of Telecommunications Reform in Developing Countries," Policy Research Working Paper Series 2909, The World Bank.

development, and its economy has achieved the highest growth in the world. With the three major forces effects: state concerns, foreign influence, and market forces. China's telecommunications market has experienced from central-and-command, highly protected mechanisms towards a pro-competitive market orientation.[9] Wallsten (1999) noted that these countries began to reform their telecommunications industry spurred by changes in technology and other international organizations.[10]

In China, the structure of public telecommunications is a government monopoly under the Ministry of Posts and Telecommunications (MPT) which was established in 1949. MPT as an executive agency directly managed and controlled the operations and productions. But from the early 1980s, China's telecommunications development has caught up with the rest of the world because of the lower quality service and unsatisfactory capacity compared with countries. In 1998, the MPT was replaced by the new Ministry of Information Industry (MII) due to reorganization.

The MII took two large scale reshuffling actions targeting the inefficient state-monopoly. The first restructuring split China Telecom's business into fixed-line, mobile and satellite in 1999. China Mobile and China Satcom were created to run the mobile and satellite business respectively but China Telecom continued to be a monopoly of fixed-line services. The second restructuring in 2002 split China Telecom geographically into North and South: China Telecom (North) kept 30% of the network resources and formed China Netcom (CNC) and 70% of the resources were retained by China Telecom

9 Loo, P. Y. (2004), "Telecommunications Reforms in China: towards an Analytical Framework," Telecommunications Policy.

10 Wallsten, S. (1999), "An Empirical Analysis of Competition, Privatization, and Regulation in Africa and Latin America".

(South) or simply the new China Telecom.[11]

Eventually, China does not yet have a telecommunications law, although the government has indicated that the relevant bodies are working on drafting one. The Regulations on Telecommunication issued in September 2000 (State Council Directive 291) provide the overall legal framework for the sector. The regulations stipulate the separation of the government from the business of providing telecommunications services; the requirement for a licence for basic telecommunications and value-added services; the process of negotiating interconnection between networks for new service providers; the management of service tariffs; and the standards for the quality of services. Other basic rules governing the sector include the Regulations for the Administration of Foreign Invested Telecom Enterprises and the Administrative Measures for Telecommunications Business Operating Permits, which entered into force in 2002.

In 2008 Ministry of Industry and Information Technology (MIIT) has been established by the State Council replaced MII to formulate and implement telecommunications policy subject to State Council approval of important strategic policy documents which is the state agency responsible for regulation and development of the postal service, Internet, wireless, broadcasting, communications, production of electronic and information goods, software industry and the promotion of the national knowledge economy. The new ministry is built around the core functions of the old MII that includes formulating the government's development strategies, guidelines, policies and overall plans as well as promoting the informatization process of the national

11 International Business Publications (2007), “China: Telecommunications Industry Business Opportunities Handbook”.

economy and the social service.

China owns the world's largest telecommunication networks in terms of both network capacity and number of subscribers, and its industry has experienced double-digit growth in the past decade. China's 11th Five Year Plan started from 2006 stated that in the coming five years the Chinese government expects the telecommunication services to grow at an average annual growth rate of 10% and the revenue generated by the service segment to reach USD 114 billion by 2010.[12] Also by 2010, the number of total telephone subscribers is expected to reach 1 billion and Internet subscribers to reach 200 million. Telephone service is expected to be available in each and every village in China by the end of 2010. In 2008 pushed by the Chinese government aimed at restructuring the domestic telecommunications industry has brought around a wave of rapid development and deployment of telecommunications infrastructure throughout the country. In May, plans were announced to restructure and merge its telecommunications operators, and the purpose of shakeup in China is planned to achieve the aim to promote full competition. It is despite the fact that "no one single operator will gain all the benefits" and "internal competition between the merged entities may exist".[13]

Under the planning, the government has reconsolidated and reorganized carriers: China Unicom and China Netcom merged; China Mobile acquired China Tietong; and China Telecom acquired the basic mobile services unit of China Satcom as well as the assets and customers of China Unicom's Code Division Multiple Access (CDMA) network. Besides, the restructure also

12 U.S. Commercial Service (2006), "Doing Business in China: A Country Commercial Guide for U.S. Companies"

13 http://www.businessweek.com/globalbiz/content/may2008/gb20080529_310359.htm

emphasizes three key areas for reform:[14]

- The first area of reform concerns competition in the mobile service markets. Upon the completion of the reorganization, the government issued three third-generation (3G) licenses to the remaining three carriers. New regulations will govern roaming fees and settlement. It also highlights the need to maintain China's involvement in developing fourth-generation (4G) wireless technology standards.
- Second, the notice promotes domestic innovation through a combination of financing practices, government assistance, and administrative oversight. Finally, the state owned assets supervision and administration authorities are urged to examine independent innovation as a performance measure in assessments of telecommunications carriers.
- Finally, the notice seeks to balance different government priorities. The notice aims to promote Chinese telecom carriers' global leadership while also ensuring national security. The state-owned carriers are urged to reduce redundant build-outs and allocate resources more efficiently, thereby promoting the value of state-owned assets. As for foreign direct investment, the notice emphasizes the respective strengths of Chinese and foreign telecommunications companies, and urges them to cooperate in research and development in order to open new markets, both foreign and domestic, and achieve mutual benefits.

The new structure married the fixed line and mobile operators each other.

14 Hogan & Hartson LLP (2008), "February 2008 China Update", China Update.

Such a step is expected to generate renewed demand for foreign equipment suppliers, and lead to the issuance of third generation, 3G licenses. More specifically, these developments are expected to create new opportunities for manufacturers of mobile, data, and optical communications equipment.[15] In 2009, The MIIT formally issued 3G mobile phone licenses to three mobile operators, a move that is expected to lead to billions of dollars being invested in building new networks: China Mobile was awarded a license for TD-SCDMA, the domestically-developed 3G standard; China Telecom and China Unicom received licenses for the U.S.-developed CDMA2000 and Europe's WCDMA, respectively. The MIIT also issued 23 regulations on the requirements of 3G network operation, covering such aspects as market competition, consumer rights, subscriber information security, telecommunication charges management and facility building. It is estimated the 3G mobile phone sales would top RMB 300 billion and the network investment would lead to RMB 2 trillion in private-sector investment during the period of 2009 to 2011.

3.2 The Evolution of China's Telecommunications Industry Development

Noam (1994) sets the stage with a multistage evolutionary model of public telecommunications networks and argues that the evolution of networks is driven by the dynamics of group information and their transformation into politically based redistribution. Initially, network expansion in the first phase makes economic and technical considerations; next is due to political imperatives; the success of full services provision actually undermines the foundation of its exclusivity in the third phase; the final stage is the

15 http://www.buyusa.gov/china/en

consolidation of various national sub-networks into global operators.

In terms of the evolution of networks, it is a logical progression and can be separated:

- The cost-sharing network. Expansion is based on the fixed costs and increasing the value of interconnectivity;
- The redistributory network. The network grows trough politically mandated transfers among subscribers;
- The pluralistic network. The uniformity of the network breaks apart because the interests of its numerous participants cannot be settled;
- The global network. Various domestic subnetworks satisfy internationally and form networks that transcend territorial constrains.

Harwit (2008) stated that when the new Communist Chinese government was established on 1 November 1949, the telecommunications industry had been ravaged by years of war. The country with a population of over 500 million had some 310,000 phone lines. Liang and Zhu (1994) researched that the First Five-Year Plan (1953~1957) was one of steady economic growth and telecommunications expanded rapidly. The telecommunications development generally matched the growth of the national economy. China's telecommunications density experienced a fast growth due to a small starting base. Investment in telecommunications averaged 0.55% of total state investment annually. However, the growth rate of teledensity[16] was stagnated about 5~6% from the 1950s to 1970s compared with 0.05% in 1949 and 0.13% in 1957. More than 90% of counties had no telecommunications facilities in the

16 Teledensity means the number of landline telephones in use for every 100 individuals living within an area. A teledensity greater than 100 means there are more telephones than people. In low-income countries in Asia, teledensity stands at 1.36 (Ben and Giriji, 1998).

coastal provinces (Shahid, Tang and Liu, 2007). Table 2 summarizes the main additions to facilities and equipment of this period.

Table 2 Telecommunication Capacity Growth during the First-Five Year Plan

Capacity	Growth (%)	Facility
4,946	11	Telegraph circuits
4,684	24	Long-distance telephone circuits
647,000	64	Urban telephone exchange capacity (lines)
326,000	327	Rural telephone exchange capacity (lines)

Source: Adapted from Liang & Zhu (1994).

During the period of 1953 to 1970, telecommunications did not grow steadily; only 0.8% (RMB 360 million) of total national investment went to the postal and telecommunications services because of various political and economic reasons, and insufficient funds. China's Great Leap Forward campaign included many irrational moves toward more local control and resources to cause the enormous wastes in material and human resources as the state investment went down in the post and telecommunication sector in absolute terms was further reduced to RMB 137.2 million which was 0.5% of the total national investment (Liu, 1988). In the Second Five-Year Plan (1958~1962), the total investment in this industry was RMB 1.37 billion due to national security consideration. However, total national investment in telecommunications industry reached 1.4% (Tang and Lee, 2003).

From the 1950s to the early 1980s, the telecommunications development in China was very slow because it was not a major priority during the command economy period while the Cultural Revolution brought chaos to nearly all parts of China's political and economic system (Ding, 2005). The government did not put effort into extending the telecommunications network and the number of subscribers grew as Figure 2 shows.

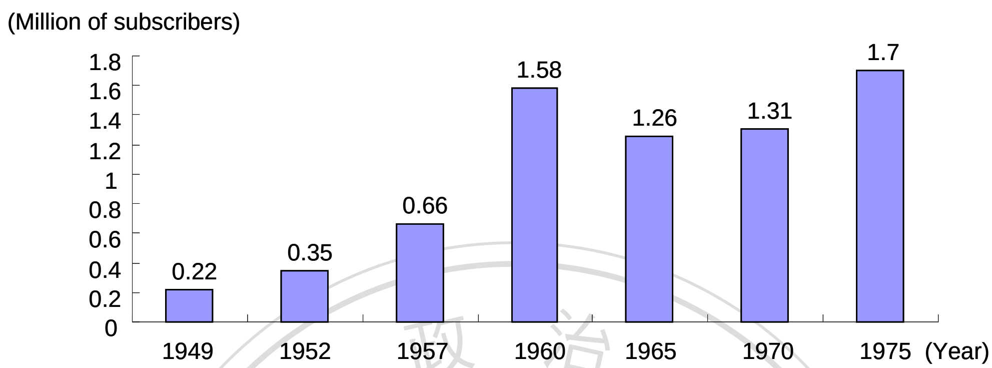

Figure 2 Number of Telephone Subscribers (1949~1975)

Source: Adapted from Harwit (2008).

Afterwards it became a priority because China recognizes it as an advance agent must take precedence in economic development. State and local authorities furnish the necessary foreign exchange to support the importation of equipment and technology. Since the Sixth Five-Year Plan (1980~1985), a number of telecommunications projects have been completed to extend capacities and services. Besides, a variety of means were used to raise funds for industry development. It was accounted for only 31% compared with 50% of investment from individual enterprises, while foreign investment has remained negligible (Liang and Zhu, 1994). Since 1980 the growth rate of teledensity has generally been slower than the growth rate of GNP per capita. Telecommunications industry has developed both in capacity and operational efficiency. Both of them were required to meet the rising demand for services for China’s opening and reforms. As Figure 3 and Figure 4 shows the China’s teledensity and the number of telephone subscribers indicates, respectively.

Before mid-1980 the telecommunications development has been very slow steadily and mainly took place after 1980s (Ding, 2005 and ITU).

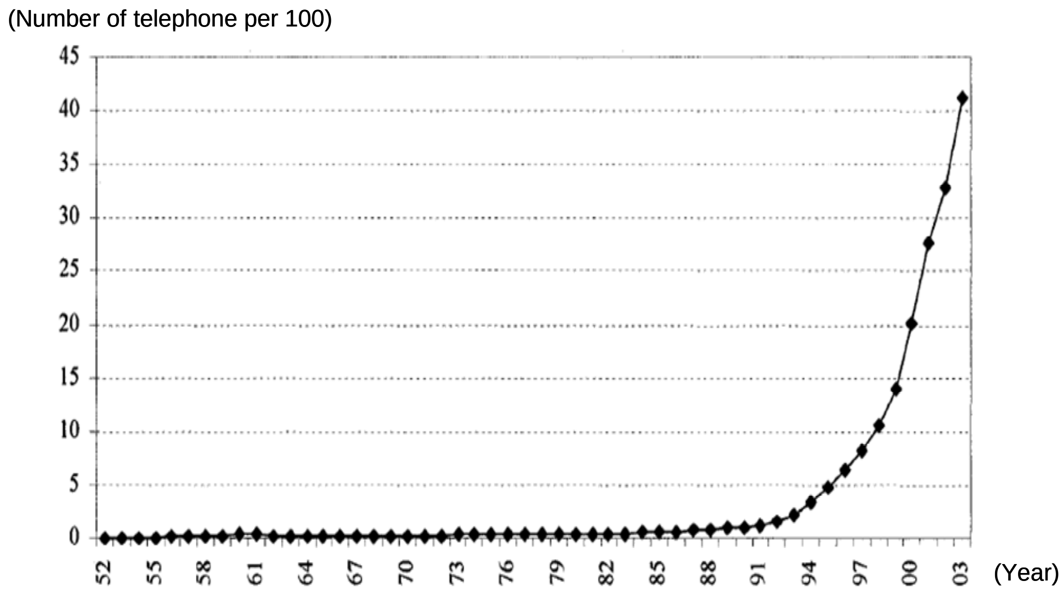

Figure 3 China's Teledensity (1952~2003)

Source: Telecommunications Infrastructure and Regional Economic Development in China (Ding, 2005)

Over the 1980s and into the next decade, central government changed its mind about the role of telecommunications industry issued policies and directives to ensure telecommunications industry would see rapid growth for economic development. A number of preferential policies designed to encourage investment were promoted. A key step was to introduce "Three 90 percent policy" as played a vital role in propelling the telecommunications sector's take off. Many directives came during this period to spur telecommunications growth including structural reorganization. Before 1990, the provincial offices took direct orders from the MPT. Following that year, the branches received autonomy accounting for their performance (Eric, 2008).

Many policies taken together were quite successful. In this period, the telecommunications sectors saw its share in national total fixed investment assume an upward trend, increasing from 0.74% in 1985 to more than 7.0% in 2001 (Ding, 2005).

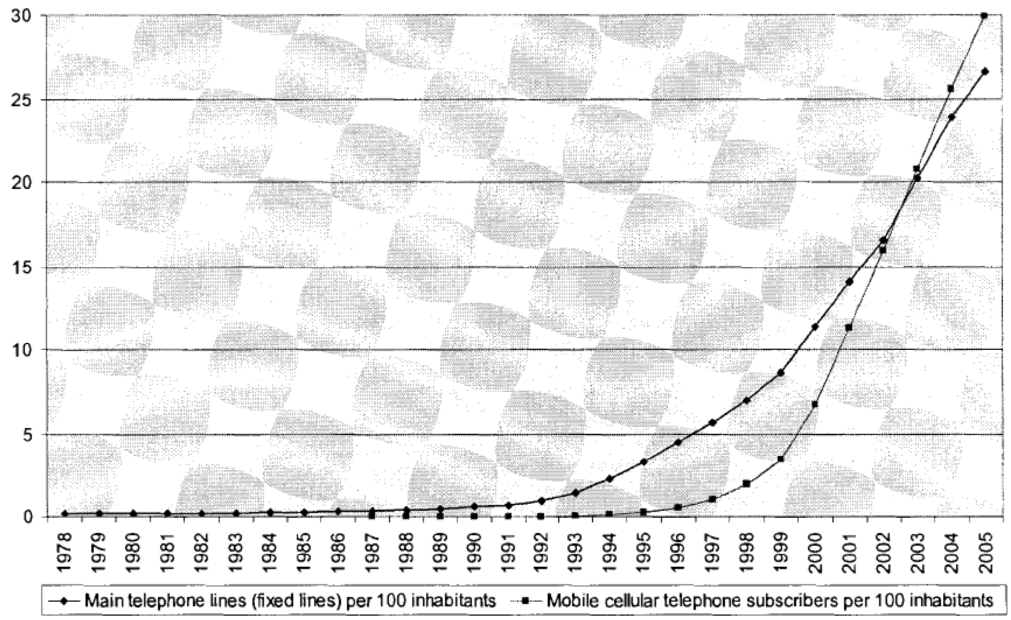

Figure 4 China's Telephone Subscribers (1978~2005)

Source: ITU World Telecommunication/ICT Indicators Database.

Table 3 Telecommunications Statistics in China (2003~2006)

Item	2003	2004	2005	2006
Main telephone lines (million)	262.7	311.8	350.4	367.8
Main telephone lines per 100 inhabitants	21.1	24.1	27.0	28.1
Mobile service subscribers (million)	270.0	334.8	393.4	461.1
Mobile service subscribers per 100 inhabitants	21.0	25.9	30.3	35.3
Public telephones (million)	15.6	22.2	26.8	29.6
Public telephones per 1,000 inhabitants	12.2	17.1	20.6	22.6
Internet subscribers (million)	79.5	94.0	111.0	137.0
Internet subscribers per 100 inhabitants	6.2	7.2	8.5	10.5
Broadband subscribers (million)	..	..	..	50.85
Broadband subscribers per 100 inhabitants	..	..	..	3.85

Source: ITU, *World Telecommunication Development Report*; ITU online information (www.itu.int/ ITU-D/ict/statistics); National Bureau of Statistics, *China Statistical Yearbook*

China's telecommunications has continued to grow during the overview period, and prices have been further liberalized. Penetration rates of fixed line services increased from 17.5 lines per 100 persons in 2002 to 28.1 lines in 2006; the corresponding figures for mobile telephones were 16.1 and 35.3, respectively. There has also been a significant increase in the use of Internet services. Overall, telecommunications services prices fell by about 53% during the period of 2002 to 2006. Meanwhile, the average charge rate per minute

(ARPU/MOU)[17] of China Mobile was reduced by 60% (see Table 3).[18]

China had six nationwide basic telecommunications service providers and about 22,000 providers of value-added services. Of the six basic providers, China Telecom and China Netcom accounted for 62% and 33% of the market, respectively, for fixed-line services at end 2006; the mobile service providers are China Mobile and China Unicom (with about one third of the market in 2006). The State remains the majority owner of all the basic telecommunication service providers[19]; however, private participation and foreign investment has been allowed gradually. Four companies (China Mobile, China Netcom, China Telecom and China Unicom) have been listed in different stock exchanges. Foreign investment is around 25% in China Mobile, 25% in China Netcom, 22% in China Unicom, and 17% in China Telecom (see Table 4).

Table 5 shows the growth in telecommunications investment versus overall GDP growth from the beginning of the reform to 2006. As indicated, the fastest growth in telecommunication investment came in the year 1985 to 1994. While the nation's GDP grew an average annual pace of about 20% over this period, investment in telecommunications rose at nearly triple rate with an annual increase of some 55% (Harwit, 2008). The average growth rate of teledensity from 1988 to 1991 doubled the rate of GDP growth and accelerated above 30% after 1992. Throughout the 1990s the growth rate of telephone lines consistently exceeded that of GDP, on average three to four times higher.

17 Average Revenue Per Subscriber (sometimes average revenue per unit) usually abbreviated to ARPU is a measure used primarily by consumer communications and networking companies, it is the total revenue divided by the number of subscribers.

18 Annual Report of China Mobile (Hong Kong) Ltd (2006).

19 These assets are held by the State-owned Assets Supervision and Administration Commission (SASAC) on behalf of the country, despite the Regulations on Telecommunications (issued in 2000), which stipulate the separation of the Government from the business of providing telecommunication services.

China now is the world's largest telephone subscriber base. Currently its service revenue alone, equipment sales not included, accounts for approximately 2.52 percent of China's total GDP in 2002 (Ding and Haynes, 2004).

Harwit stated (2008) China's telecommunications revolution proved by nearly all measures a dramatic success. Telecommunications policy making reached the top of government's agenda because it was recognized that the government to manage the rapid economic development; the government strongly believe that it was central to security and sovereignty; finally, it is important to provide the source of revenues be used to fund network deployment because of strategic financial reasons (Laperrouza, 2006). In terms of the lack of importance given to telecommunications in the developing countries especially in China before the early 1980s, telecommunications services were regarded as a "luxury" in china an often subject to cuts during hard time; the economic development discourse in china was set up in terms of primary and secondary sectors and as a result service sectors including telecommunications received marginal attention (Harwit, 2008).

Prior to its WTO accession, China's policy protected the national emerging telecom industry. Only foreign equipment vendors were allowed to invest in China with the conditions on technology transfer. International telecom carriers were banned from accessing the market. As part of the WTO commitments, the Chinese government is opening gradually the carriers market to foreign investors. There are some geographical limits to this opening but they will be progressively relaxed. In 2005 foreign investors will be allowed to invest up to 50% in Internet services, up to 49% in the mobile sector and up to 25% in fixed-line basic services in some particular cities.[20] Regarding the provisions on the administration of telecommunications enterprises with foreign investment, the government has promulgated the Decree of the State Council of the People's Republic China No.333 in 2001 and No.534 in 2008 respectively.[21]

Table 4 Basic Telecommunications Service Providers

Service	Providers
Fixed-line service	China Telecom, China Netcom, China Unicom, China TieTong
Mobile telephone service	China Mobile, China Unicom
Data	China Telecom, China Mobile, China Netcom, China Unicom, China Satellite, China TieTong (formerly China Railcom)
IP telephony	China Telecom, China Mobile, China Netcom, China Unicom, China Satellite, China TieTong
Satellite service	China Satellite

Source: Ministry of Industry and Information Technology (http://www.miit.gov.cn)

Since more investment was attracted to the telecommunications sector and given the rapid pace of technological change in recent decades, according to the government statistics the number of fixed line urban and rural subscribers increased nearly from 5.3 million and 1.4 million in 1990 to 251 million and 116 million in 2006 respectively. By July 2001 the number of China's mobile phone subscribers grew rapidly reached 120.6 million, surpassing that of the U.S. and making China the world's largest mobile phone

20 http://en.wikipedia.org/wiki/Telecommunications_industry_in_China

21 http://www.fdi.gov.cn/pub/FDI_EN/Laws/InvestmentDirection/GuidanceforSpecificIndustries/

market because the technological advances had led to a rapid fall in the cost contributed to the exploding demand for mobile phone. In March 2002, China overtook the U.S. as the world's largest fixed line telephone network in terms of capacity and subscriber base, with 190 million fixed line subscribers. Annual growth rate of telephone penetration were around 9% and 30% in the 1980s and 1990s, respectively. China's total telephone customer base in 2003 was 85 times that of 1985 and 145 times that of 1978 (Ding, 2005).

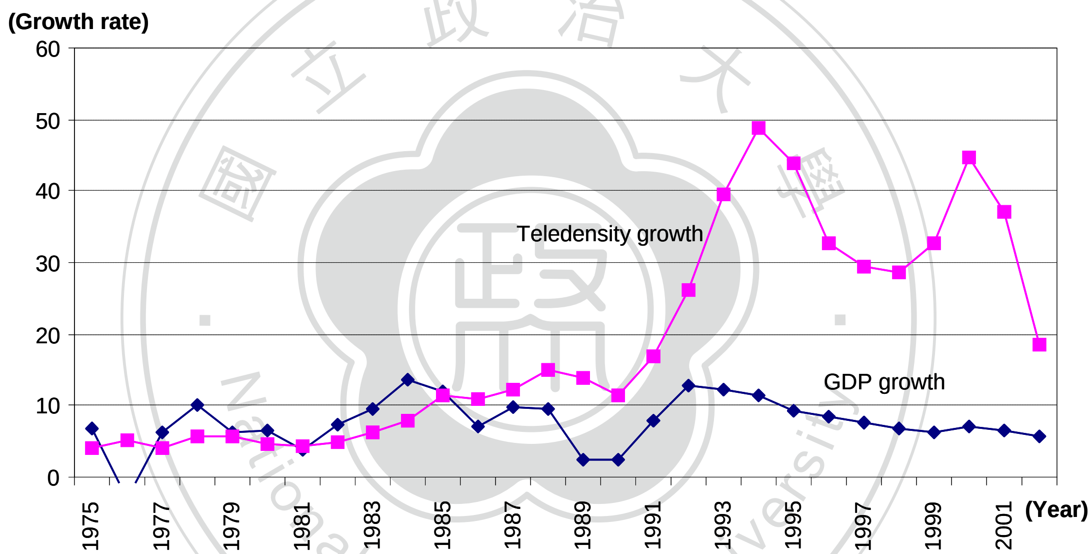

Figure 5 Growth Rate of GDP and Teledensity (1975~2002)

Source: GDP and Teledensity Growth in China (Ding, 2005).

Table 5 Fixed-Asset Investment in Telecommunications as Percent of GDP

Year	Investment (billion)	GDP (billion)	Investment as percent of GDP
1978	0.255	365	0.07
1985	1.34	902	0.15
1987	2.14	1,206	0.18
1989	4.01	1,699	0.24
1991	6.89	2,178	0.32
1992	13.7	2,692	0.51
1993	35.3	3,533	1.00
1994	69.4	4,820	1.44
1995	85.6	6,079	1.41
1996	91.1	7,117	1.28
1997	105.6	7,897	1.34
1998	150.1	8,440	1.78
1999	160.5	8,968	1.79
2000	222.4	9,921	2.24
2001	255.3	10,966	2.33
2002	207.3	12,033	1.72
2003	221.8	13,582	1.63
2004	219.9	15,988	1.38
2005	209.8	18,387	1.14
2006	218.7	21,087	1.04

Source: Adapted from Harwit (2008).

In addition, the Internet development in China on the past few years can also be highlighted. The size of netizens in China has continued to display the trend of rapid development. By the end of June, 2008, the amount of netizens in China had reached 253 million. The amount of netizens in the United States was 218 million by the end of 2007. Estimated by the growth speed of netizens in the United States in recent years, the amount of netizens in the United States would not surpass 230 million by the end of June 2008. Therefore, the size of netizens in China has leaped to the first place in the world, increasing by 91 million from the same period last year. In the first half of 2008, the net increase amount of netizens in China was 43 million. By the end of June 2008, the Internet penetration rate in China had reached 19.1%. At present, only less than 1/5 of the Chinese residents are netizens. This penetration rate is slightly lower than the average Internet penetration rate in the world, 21.1% (see Figure 6).[22]

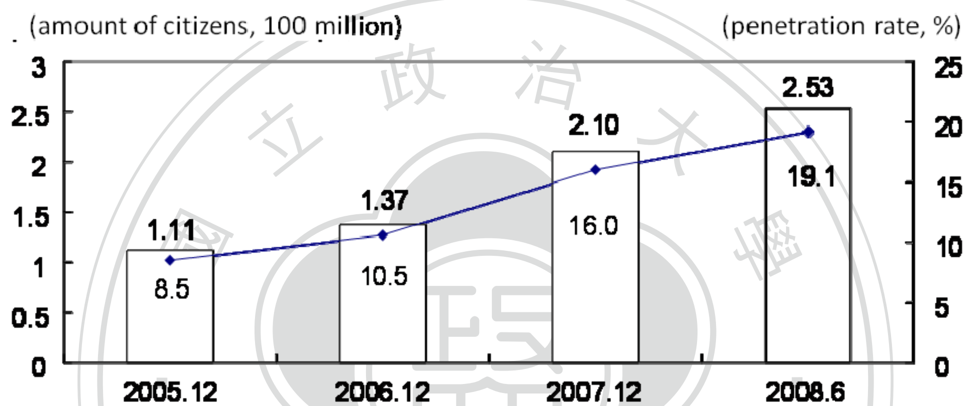

Figure 6 Growth of Netizens and Internet Penetration Rate in China

Source: China Internet Network Information Center (2008)

Although the growth of China's telecommunications market in general is faster than most other regions in the world, the momentum of growth itself is slowing down. In 2005, the six Chinese telecom carriers, China Telecom, China Netcom, China Mobile, China Unicom, China Tietong and China Satellite, made an aggregated investment of US$24.4 billion in telecom industry, down 4.7% compared with that in 2004. This is because:[23]

22 China Internet Network Information Center (2008), "Statistical Survey Report on the Internet Development in China".

23 "China: Wireless Telecommunications", U.S. Commercial Service, 2006.

- The Chinese telecom carriers have already built the world's largest well-equipped wire-line and wireless networks and the demand for expanding network coverage is not as imperative as five years ago;
- The mobile carriers and fixed line carriers who wish to obtain 3G licenses restrained from increasing investments in their existing networks so as to reserve funds for initial 3G deployment once they receive 3G licenses, though the Chinese government did not issue 3G licenses in 2005;
- The discussion among the Chinese government agencies on possible industry restructuring also made the carriers reluctant to increase investment in telecom infrastructure;
- The carriers were in the process to transform themselves from infrastructure builders to service providers. They focused much of their attention on developing new and value-added services;
- All the carriers centralized their procurement to beat down equipment price.

Regarding the assessment of telecommunications market, it is a summary measure of concentration such as the widely adopted Herfindahl-Hirschmann index (HHI) which is a coefficient of market concentration index. This index is defined according to the number of firms in the industry, with the share of each firm weighted by itself; while the concentration ratio places a weight of 1 on the share of the largest n firms and zero on the share of the other firms, this index places a weight equal to the share on the share of the firm. As a result, the index is able to incorporate information on all firms rather than just the largest n firms.[24] The value of 0 (perfect competition) ~ 10,000 (perfect monopoly) is taken. In addition, Fair Trade Commission presupposes that market structure is not highly oligopolistic if HHI after corporate merger is less than 1,000, and that market structure is not oligopolistic if HHI after corporate merger is over 1,000 and less than 1,800.

However, there are several important issues about telecommunications structure needed to be explored.

- First, in spite of the restructuring in 2002, the overall competition in telecommunications market is still weak. The market share of China Mobile increased from 36.74% in 2002 to 48.87% in 2007, but China Telecom and China Netcom decreased 9% and 5% respectively.
- Second, the definition of the competition index, and the effect of regulation and privatization are different. The HHI index is used as the competition variable and an indicator of market structure. As we can find the imbalance of market structure particularly the China Telecom North-South split in 2002. The HHI index shows the market trend is still towards monopolization (see Table 6).

Table 6 Market Share for China's Telecom Operators

Operator (%)	2003	2004	2005	2006	2007
China Mobile	37	39.19	41.82	44	49.03
Chin Unicom	14.6	13.99	13.42	14.54	13.8
China Telecom	31.6	29.65	28.37	27	24.54
China Netcom	15.3	16.96	15.05	13.41	11.54
China TieTong/ Satellite	1.5	0.21	1.34	1.05	1.09

Source: Author's calculation based on data from various sources.

24 Sawyer, M. C. (1991), "Economics of Industries and Firms: Theories, Evidence and Policy", London: Routledge.

Chapter 4 Methodology Framework and Data Source

This chapter presents methodologies used in this study and lists data sources for measurement of variables. The first section introduces a conditional convergence method for the investigation of the impact of between the telecommunications development and economic growth. The secondary section interprets variable measurement. Lastly is data source and research limitation of this study.

4.1 Dynamic Panel Data Approach

The objective of this paper is to verify the role of telecommunications development performed by explaining the different growth performances across 31 regions of China. The methodology conducted in this study adopted Ding's (2005), Kingsley's et al. (2006) and Liu's (2008) general analysis of the impact of telecommunications development on regional economic growth. The common approach to studying the sources of economic growth is to use Barro-type analysis which questioned by Islam that all the countries or regions have identical aggregate production functions.

Islam (1995) investigated that the analysis of cross-country or cross-region regressions is weak in justifying the assumption of identical production function. He revised the regression equation with a dynamic panel data model to proceed. This approach is beneficial to allow for differences in the aggregate production function across countries or regions. Ding (2006) mentioned that the method can also capture short-run autoregressive behavior by adding a lagged growth rate as an independent variable. Caselliet et al. (1996) also stated that the panel data approach is better than the cross-section regression approach due to its control over the omitted variable bias and endogeneity problem (Liu, 2008).

We follow Barro's (1991) approaches which enable us to test the conditional convergence hypotheses. Liu (2008) mentioned that the cross-section static approach would have the following specification on regions of China:

$$GRTH_i = \alpha_0 + \delta Ln(GDP)_{i,initial} + \sum_j \beta_j X_{i,j,initial} + \varepsilon_i \qquad (4.1)$$

where

i : indexes the 31 regions, municipalities, and autonomous cities in China;

$GRTH$: represents the annual growth rate of real GDP per capita;

$Ln(GDP)_{i,initial}$: represents the initial level of real GDP per capita in logarithm form for each region;

X : contains a set of variables accounting for production factors and other conditional variables at the beginning of the study period for each region;

A negative sign of the coefficient of initial real GDP can indicate the existence of conditional convergence while the set of economic condition variables are held constant. To avoid the statistically inherent small sample problem, the total number of regions must exceed some level.

The Islam panel-data Approach

Islam (1995) stated that a panel data approach is advocated and implemented for studying growth convergence. The similar equation for testing convergence in this research is defined as a dynamic panel data model and different panel data variables are used to estimate it. The main usefulness of the panel approach lies in its ability to allow for differences in the aggregate production function across economies. This leads to results that are significantly different from those obtained from single cross-country regressions. Moreover, fixed effect rather than random is recommended to implement a panel data approach for the differences of the unobservable errors.

We conduct growth theory in this research to define variables including following explanatory variables: fixed investment, foreign direct investment, employment rate, human capital, population growth, urbanization level, industrial output share from state-owned enterprises, transportation percentage, as well as telecommunications development, plus for the two level variables: the lagged GDP growth and lagged GDP per capita as the basic explanatory variable to test which has a significant impact on regional economic growth according to the guidelines in the previous growth literature.

$$\begin{aligned} GRTH_{it} = {} & \alpha_0 + \beta_1 GRTH_{i,t-1} + \beta_2 Ln(GDP)_{i,t-1} + \beta_3 INV_{i,t} + \beta_4 FDI_{i,t} + \beta_5 POP_{i,t} + \\ & \beta_6 EMP_{i,t} + \beta_7 HC_{i,t} + \beta_8 URBAN_{it} + \beta_9 SOE_{it} + \beta_{10} TRANS_{it} + \beta_{11} TEL_{it} + \\ & \beta_{12} MOB_{it} + \beta_{13} NET_{it} + \alpha_i + \eta_t + \mu_{it} \end{aligned} \tag{4.2}$$

All the definitions and measurements of the variables are the same as those in the Barro cross-section static approach; α_i, η_t and μ_{it} represent the regional dummy, temporal dummy, and error terms, respectively. The variables in Equation 4.2 are measured as follows:

$GRTH$: annual growth rate of real GDP per capita which is the dependent variable;

$GRTH_{t-1}$: represents the one year lagged GRTH;

$Ln(GDP)_{t-1}$: represents the log value of the lagged real GDP per capita in 2000 value (RMB);

INV : percentage of total investment in fixed assets in GDP;

FDI : percentage of foreign direct investment divided by total investment in fixed assets;

POP : annual population growth rate;

EMP : percentage of employed persons at year-end to total population;

HC : human capital which is measured by the average years of schooling for the population aged 6 and above;

$URBAN$: the share of urban population to total population;

SOE : the share of state-owned enterprises in total industrial output;

$TRANS$: transportation percentage as measured by the length of rail, highway, and waterway networks per square kilometer;

TEL : the number of fixed line telephone users per 100 inhabitants;

MOB : the number of mobile phone users per 100 inhabitants;

NET : the number of Internet usres per 100 inhabitants;

Furthermore, we use additional variables with square terms to explore the character of returns to investment to check whether the relationship between telecommunications and economic growth is linear because some previous researchers found that investment in telecommunications development will not significantly affect economic growth of a country until a critical mass of telecommunication development is achieved (Roller and Waverman, 2001; Savage, et al, 2003).

Diagnosis of Causality

We study another important effect that the direction of causality between telecommunications development and economic growth can be tested using the Granger Test technique.[25] Ding (2007) researched that it is to avoid causality issues by identifying the determinative effects of initial per capita income and a series of other conditional variables on the conditional convergence approach. Hence, we will use the Pairwise Granger Causality Test with the lagged values in the regression to detect the causality direction according to the approach implemented by Ding (2005) and Liu (2008).

4.2 Measurement of Variable and Data Sources

This section discusses the measurement of variables, the sources of data and the research limitation for the analysis in this research.

Spatial Units and Time Period

The dataset in this study is constructed from 2003 to 2008 compared with Ding's (2005) and Liu's (2008) research, respectively. Their study covered 29 regions in the 31 provinces, autonomous regions and municipalities from 1986 to 2002, except for Province of Tibet and the Chongqing municipality, and the initial year of 1986 is selected because the size of telecommunications infrastructure in China was small and insignificant. In this research, the 31 regions can be estimated separately.

25 Granger causality is a statistical concept of causality that is based on prediction. According to Granger causality, if a signal X1 "Granger-causes" a signal X2, then past values of X1 should contain information that helps predict X2 above and beyond the information contained in past values of X2 alone. Its mathematical formulation is based on linear regression modeling of stochastic processes (Granger 1969).

Measurement of Variables

The variables considered in growth studies range from traditional economic variables and there are many variables being used in previous literature for measurement of this variable. The empirical findings for a panel of around a hundred countries strongly support the general notion of conditional convergence. For a given starting level of real per capita GDP, the growth rate is enhanced by higher initial schooling and life expectancy, lower fertility, lower government consumption, better maintenance of the rule of law, lower inflation, and improvement in the terms of trade (Barro, 1996). For given values of these and other variables, growth is negatively related to the initial level of real per capital (Barro, 1991). In this research, we follow the consideration that China is a developing economy. Traditional economic inputs should play a dominating rule in its economic growth but those data such as cultural and political variables will not be considered because of the limitation of data (Ding, 2005).

Regional economic output consists of the dependent variables showed in Equation 4.2 including: per capita income indicators from demand perspective and per capita output indicators from perspective of supply. Except for the lagged growth variable, the choice of independent variables follows the line of analysis on growth determinants in the growth theory literature. But the lagged growth variable is suggested by Ding's (2005), Liu's (2008) and Zahra's (2009) investigation of regional economic growth. For given values of the other explanatory variables, the neo-classical model predicts a negative coefficient of initial GDP, which enter in the system logarithmic form. The coefficient of the log of initial GDP has the interpretation of a conditional rate of convergence (Barro, 1991).

Chinese Statistical Yearbook defines the data on GDP are computed by

Department of National Accounts of the National Bureau of Statistics (NBS) based on different approaches. Data on GDP and related indicators of the most recent year published in the Yearbook are not final and are subject to changes when more information from financial data and administrative records become available. Where a census has been conducted, historical data of GDP of the previous years may also undergo change. Gross Domestic Product is a measurement of value which changes depending on changes of price and production. GDP at constant prices converts the gross domestic product based on the current price into a value based on the price of the base period. Since China started GDP calculation, seven constant-price base periods have been used, i.e., 1952, 1957, 1970, 1980, 1990, 2000 and 2005. As the calculation of constant-price GDP is based on different base periods, the constant-price GDP data in Chinese Statistical Yearbook shall also be announced in accordance with various periods.

Considering the general structure applies to most growth model, three factors: physical capital K(t), labor L(t) and knowledge T(t) are the major compositions of production function: $Y(t) = F〔K(t), L(t), T(t)〕$. Capital K(t) represents the durable physical. Labor L(t) represents the inputs associated with the human body. This input includes the number of workers and the amount of time. In Chinese Statistical Yearbook 2008, it defines “number of employed persons at year-end” as the statistics is the population aged 16 and over of the whole country. Data on economically active population, employed persons and employed persons by urban and rural areas since 1990 are estimated on the basis of the 2000 National Population Census. Regarding the total investment in fixed assets, it refers to the volume of activities in construction and purchases of fixed assets and related fees in China, expressed in monetary terms during the reference period. Foreign investment refers to foreign funds received during the reference period for the construction and purchase of investment in fixed assets (covering equipment, materials and technology), including foreign borrowings (loans from foreign governments and international financial institutions, export credit, commercial loans from foreign banks, issue of bonds and stocks overseas), foreign direct investment and other foreign investments.

Initial human capital addresses the quality of labor force. The role of human capital has been highlighted by endogenous growth theory (Romer, 1990). Countries and regions with higher levels of human capital are supposed to expect higher growth rates than territories with lower levels. Different explanations have been provided by the literature which is usually proxied by the average number schooling of years or the percentage of population with secondary or tertiary studies (Ramos, 2009). This study follows Ding (2005) and Liu (2008) in approximation of human capital for regions in China with average years of schooling for population aging greater than 6 following the World Bank approach.

Urbanization is the physical growth of urban areas from rural areas as a result of population immigration to an existing urban area. Effects include change in density and administration services. It is also defined by the United Nations as movement of people from rural to urban areas with population growth equating to urban migration.[26] At the end of 2007, China's total population was 1.32 billion, with 727 million (55%) and 593 million (45%) residing in the rural and urban areas respectively. The rural population fraction

26 http://en.wikipedia.org/wiki/Urbanization

was 60.9% in 2001 and 73.6% in 1990.[27] The annual population growth rate was estimated at 0.52% (2007 estimate). This study uses the urbanization rate as an independent variable for explanation of regional economic growth performance.

Telecommunications infrastructure development is measured as the number of fixed-line telephone user density, mobile phone user density and Internet user density, respectively. This kind of approaches has been applied in previous literature but only involved fixed-line telephone user density (e.g., Ding, 2005 and Liu, 2008). Inclusion of mobile phone user density in the proxy of telecommunications is important because of the fact that mobile phone subscribers in China have overtaken fixed line subscribers since 2003. Ding (2005) found that the correlation between the number of total telephone lines and capital stock of telecommunications sector as high as 0.99. Thus, total number of telephone lines is a reliable indicator for telecommunications development according to past research. So this study follows the same definition to extend the study with the variable of mobile phone subscriber density and Internet subscriber density because there are now an estimated 298 million Internet subscribers in China with a year-on-year increase of 41.9% published by China Internet Network Information Center in 2009. China's Internet popularity rate reached 22.6%, which exceeded the world's average rate of 21.9% for the first time. The number of broadband Internet subscribers in China was 270 million and the number of the national .CN domain names increased to 13.572 million, a year-on-year increase of 50.8%. Hence, this study conducts the number of Internet subscriber density as a variable in this research.

27 http://en.wikipedia.org/wiki/Urbanization_in_the_People's_Republic_of_China

Another type of infrastructure included in this study is transportation percentage. This study uses the total lengths of length of railways in operation, length of highways and length of navigable inland waterways as measurement of transportation infrastructure for regions in China. Length of railways in operation refers to the total length of the trunk line for passenger and freight transportation. The calculation is based on the actual length of the first line if this line has a full or partial double. Length of highways refers to the length of highways which are built in conformity with the grades specified by the highway engineering standard formulated by the Ministry of Transport, and have been formally checked and accepted by the departments of highways. Length of navigable inland waterways is an indicator reflecting the size and development of inland water network. It refers to the length of the natural rivers, lakes, reservoirs, canals, and ditches open to navigation during a given period, which enables transportation by ships and rafts.

Data Sources

Data for 31 regions of China for the span of time from 2003 to 2008 is utilized in this research. The aggregate regional economic data of real GDP per capita, employment, population, fixed investment, urbanization, transportation percentage, foreign direct investment, total stated owned enterprise industrial output, telecommunications infrastructure for different regions is collected and then calculated from China Statistics Yearbook and Statistical Yearbook of China Telecommunications.

In this study, we should collect historical data from following:

- China Statistics Yearbook (various years)
- Statistical Yearbook of China Telecommunications (in Chinese,

various years)

- World Bank, World Development Indictors (http://www.worldbank.org/)
- International Telecommunication Union Yearbook

Research Limitation

Data quality is a significant issue for any quantitative analyses. As a developing country, the aggregate levels of economic data are gathered by different levels of statistical agencies. The data of study mainly come from National Bureau of Statistics and Ministry of Industry and Information Technology's annual statistical data. However, the data is not the first-hand information; reliability and accuracy of data within the panel dataset used in this study may not be as high as those of developed countries. Furthermore, according to the announcement expressed by National Bureau of Statistics of China, regional data in Chinese Statistical Yearbook are provided by the statistical bureaus of the provinces, autonomous regions and municipalities. The sum of the regional data is not equal to the national total due to the decentralized accounting approach. Therefore, it is inevitable that some of these data will have some imperfections.

Chapter 5 Empirical Analysis and Results

This study presents the empirical analysis which is conducted comprising a series of socio-economic variables. This chapter is organized as follows: section one presents the regional growth disparity among provinces. Section two provides empirical evidence and discusses the regression analyses findings. The final section concludes.

5.1 Regional Telecommunications Development and Regional Economic Growth

As described in Chapter 3, at the beginning of the reforms the telecommunications industry was one of the least developed industries in China. In 1980, China had only 43 telephones per 1,000 residents. Most residents did not have telephone services. But now telecommunications development has been the one of the fastest-growing industries during the past two decades. Since the first analog mobile phone network was established and put into operation in China in 1987. After reforms in this country, three large telecommunication operators (China Mobile, China Telecom and China Unicom) now dominate the Chinese market. The number of mobile phone subscribers in China surpassed the number of fixed-line subscribers in 2003. Into 2010, China Mobile continued to be the world’s largest mobile operator in terms of number of subscribers.

As of the end of 2003, China had more than 270 million mobile phone subscribers, 277 million fixed line connections, and 79 million Internet subscribers. Till 2009, there had been 680 million mobile phone subscribers.[28] As brief review of the average growth rate of main telephone line from 1988 to 2003 double the rate of GDP growth and accelerated above 30% after 1992 (Ding, 2005). The growth rate of telephone lines has exceeded GDP development since 1985. With an average annual GDP growth rate above 10%, China already became the second largest economy ahead of Japan after the United States in 2009.[29]

Additionally, the rapid growth has widened the economic gap among regions and appears the large disparities in per capita income between regions. It explores the phenomenon of regional inequality and large difference in growth performance accompanied by the rapid GDP growth. The economic development in coastal provinces has generally been more rapid than in the interior. Besides, rising inequalities have resulted from increasing income disparities between urban and rural areas and across regions.[30] There is a concentration of regions in GDP per capita in 2008 with higher figures in the coastal areas. Regions in western and central China usual have much lower GDP per capita. The region with biggest and lowest figures can be found in Shanghai with RMB 72,536 and Guiehou with RMB 8,789, respectively (see Figure 7). As Figure 8, 9 and 10 shows, there is a high correlation between GDP per capita in natural logarithm and three different telecommunication subscribers . It is obvious that the level of telecommunications development in regions is closely correlated to its economic growth level.

According to the conditional convergence hypothesis, it states that relative regional earnings will not converge toward unity, but towards a stable

28 http://www.china.org.cn/business/2009-07/22/content_18183326.htm

29 http://en.wikipedia.org/wiki/Economy_of_the_People's_Republic_of_China

30 http://www.adb.org/media/Articles/2007/12084-chinese-economics-growths

differential. If countries possess the same technological possibilities and population growth rates but differ in savings propensities and initial capital-labor ratio, then there should still be convergence to the same growth rate, but just not necessarily at the same capital-labor ratio.[31] It means that the telecommunications development will converge by controlling for a set of variables reflecting regional specific effect differences in the stay-state equilibrium (Barro, 1991).

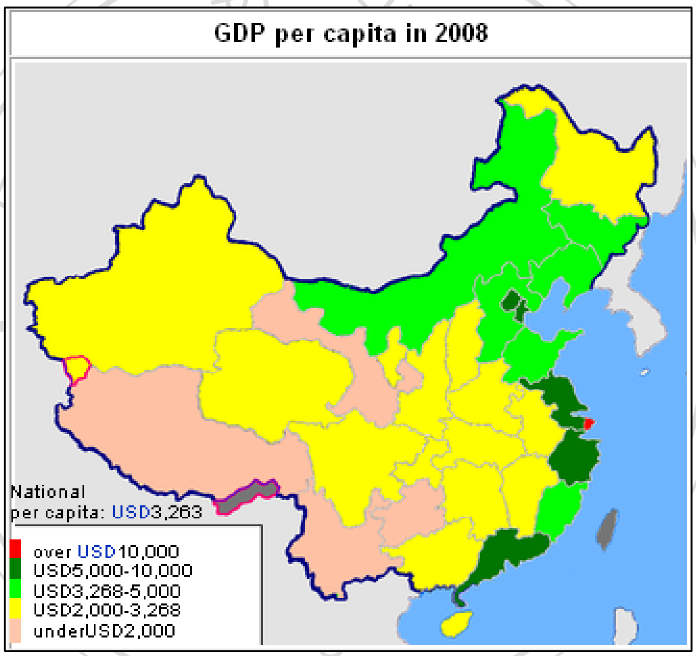

Figure 7 GDP per capita of Chinese provinces in 2008[32]

31 http://homepage.newschool.edu/het/essays/growth/neoclass/solowconv.htm

32 http://en.wikipedia.org/wiki/File:GDP_per_capita_of_Chinese_provinces.PNG

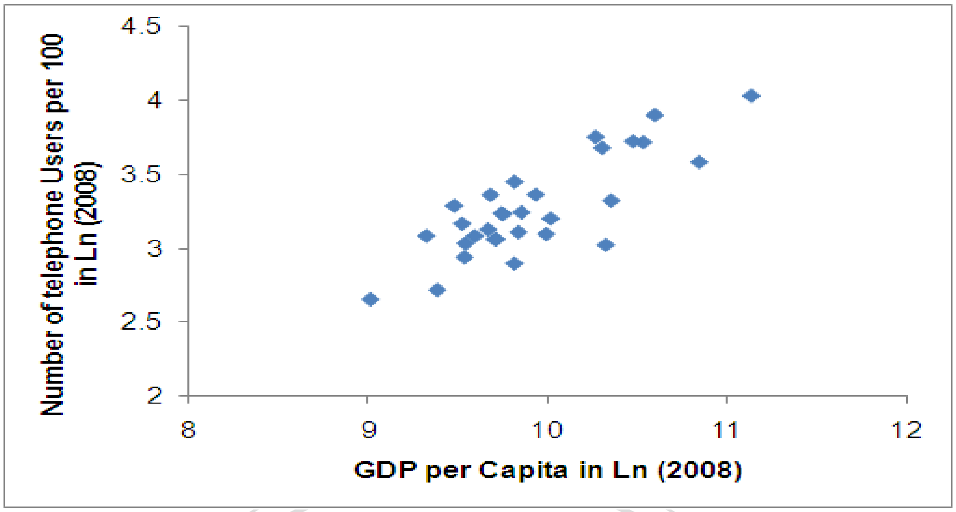

Figure 8 GDP and Telephone Subscribers per Capita (2008)

Source: Author's calculation based on China Statistical Yearbook

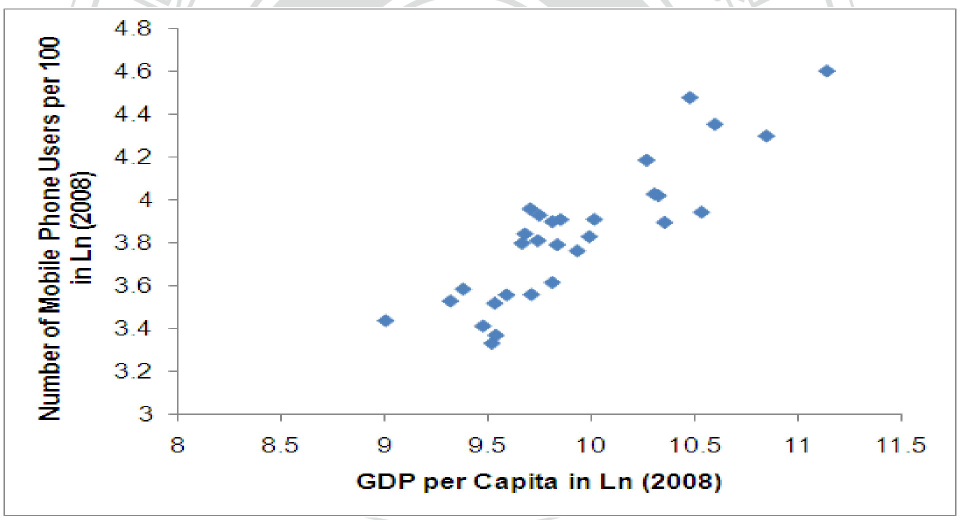

Figure 9 GDP and Mobile Phone Subscribers per Capita (2008)

Source: Author's calculation based on China Statistical Yearbook

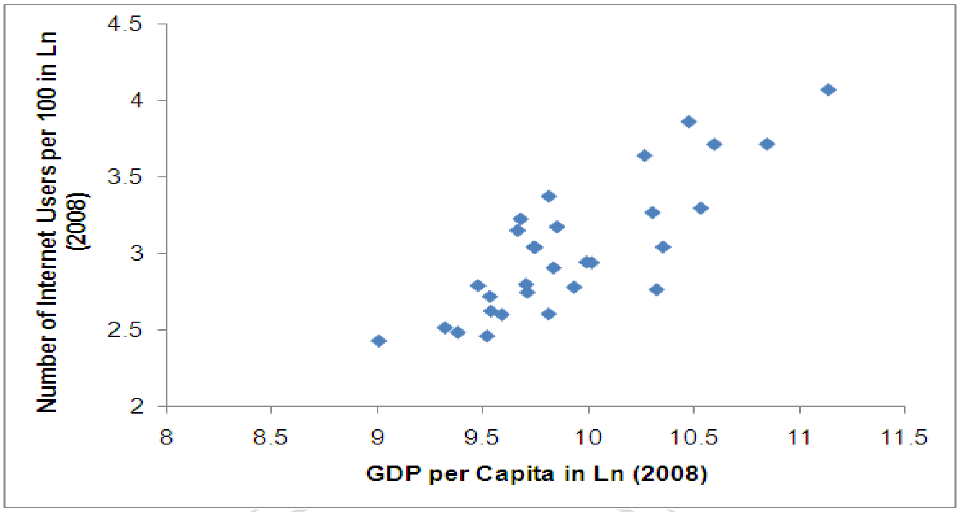

Figure 10 GDP and Internet Subscribers per Capita (2008)

Source: Author's calculation based on China Statistical Yearbook

5.2 Empirical Analysis and Results

As outlined in Chapter 4, the study follows Barro-type conditional convergence framework based on growth equation to investigate the determinants of regional economic growth. A set of initial conditioning variables and production factors are included in Equation 4.2.

Model Specification

Following the traditional operation on the initial conditioning variables under the conditional convergence framework, this study conducts an initial screening test on the significance levels of all possible independent variables highlighted in Equation 4.2 which are considered as growth factors if it is statistically significant at the 10% level (Ding, 2005; Liu, 2008). To keep on watch the model specification and characteristic, we will not remove these insignificant variables. Table 7 shows a list of variables and its mean value and standard value in the final model, respectively. It is expected that there are positive interrelationships between regional growth and other variables, which are considered that they always are expected signs and are highly significant during the test.

Table 8 shows the regression results from modeling. In model A estimated by using a fixed effects model, almost 80 percent of the variation in the growth rates can be explained by this model. For employment rate (EMP), human capital (HC), SOE industrial output (SOE), transportation percentage (TRANS), the number of fixed line telephone user per 100 inhabitants (TEL) and the number of Internet user per 100 inhabitants (NET) are not significant. It is noteworthy that POP, SOE, TRANS, TEL and NET show a negative sign for its coefficient. It may be due to multicollinearity,[33] low data quality or other possible issues.

The coefficients of most of the variables of interest are significant (most at 1 percent level). It confirms that China's regional growth rates are positively related to fixed investment, foreign direct investment, urbanization, lagged growth rates in previous year and mobile phone user per 100 inhabitants; and are negatively related to the initial level of real GDP per capita and population growth.

33 Multicollinarity is an inevitable issue in any multivariate regression analysis. The correlation between independent variables can reduce reliability and robustness of the results in terms of values and signs of coefficients as well as significance of some independent variables (Liu, 2008).

Table 7 Variables of Its Expected Signs, Mean and Standard Error Value

Variables	Explanation	Expected Sign	Mean	Standard Error
GRTH	Annual growth rate of real GDP per capita (%)			
$GRTH_{t-1}$	One year lagged GRTH (%)	+	13.92	0.98E-01
GDP_{t-1}	Lagged real GDP per capita in 2000 value (RMB)	-	9.43	6.42
INV	Total investment in fixed assets in GDP (%)	+	52.70	0.48E-01
FDI	FDI divided by total investment in fixed assets (%)	+	3.06	0.14
POP	Annual population growth rate (%)	-	0.67	0.15
EMP	Total employed persons to total population (%)	+	51.57	0.16
HC	Average years of schooling for the population aged 6 and above (%)	+	8.03	1.43
URBAN	The share of urban population to total population (%)	+	45.64	0.21
SOE	The share of state-owned enterprises in total industrial output (%)	-	0.46	3.15
TRANS	Transportation percentage (%)	+	5.63	0.20
TEL	Number of telephone subscribers per 100 inhabitants	+	28.43	0.11
MOB	Number of mobile phone subscribers per 100 inhabitants	+	37.45	0.75E-01
NET	Number of Internet subscribers per 100 inhabitants	+	12.56	0.69E-01

Source: Author's calculation based on data from various sources.

Note: The expected sign of POP is negative since a lower population growth rate relates to growth rate

The result on Table 8 shows the MOB variable is positive and significant at the 1% level in Model A, suggesting a positive relationship between telecommunication development and economic growth. Most of the previous studies use number of fixed lines as the proxy for telecommunications infrastructure (e.g. Hardy, 1980; Savage et. al, 2003, and etc.), but we have found the number of mobile phone users to be the new proxy for telecommunications infrastructure in China. As discussed before, the MOB variable has been separated from the whole telephone users (MOB+TEL) to investigate the economic growth effect. According to the report published by Ministry of Industry and Information Technology of China, it appears a net increase of 9.367 million mobile phone users and a decrease of 1.497 million fixed line telephone users in February 2010. The new data report states that China had a phone user base of 1.07 billion with a net increase of 7.8 million. It revealed that the number of the country's mobile phone users has been ranked the first in the world.

In terms of causality study, previous discussion and some investigations have indicated a two-way causation between telecommunications development and economic growth. We test the causality relationship using lagged values of MOB_{t-1} to replace current value of MOB on Equation 5.1. If the positive effect of MOB on economic growth is a result of reverse causality, the coefficient of the lagged values of MOB should be insignificant. Model B on Table 8 report the results using lagged mobile phone user density to replace current index to check whether the positive effect is totally caused by reverse causality.

$$GRTH_{it} = \alpha_0 + \beta_1 GRTH_{i,t-1} + \beta_2 Ln(GDP)_{i,t-1} + \beta_3 INV_{i,t} + \beta_4 FDI_{i,t} + \beta_5 POP_{i,t} + \beta_6 EMP_{i,t} + \beta_7 HC_{i,t} + \beta_8 URBAN_{it} + \beta_9 SOE_{it} + \beta_{10} TRANS_{it} + \beta_{11} TEL_{it} + \beta_{12} MOB_{i,t-1} + \beta_{13} NET_{it} + \alpha_i + \eta_t + \mu_{it}$$

(5.1)

As shown on Table 8 in Model B, the coefficients of the lagged values of MOB, MOB_{t-1} are significant at 1 percent level and have an almost same magnitude when compared to the current value. These results give support to the argument that the positively relationship is not merely due to reverse causality. Telecommunications infrastructure for mobile communication systems does have positive impact on the regional economy of China. Regarding the linearity, some researches indicate the relationship between telecommunications development and economic growth might not be linear. Roller and Waverman (2001) revealed that investment in telecommunications development would not significantly affect economic growth until the infrastructure development is achieved a critical mass.[34]

In our research, we add MOBSQ variable as a square of MOB as Equation 5.2 to examine the character of returns to scale to telecommunications investment. The purpose of introducing a square term is to check whether the relationship between economic growth and telecommunications is linear.

$$GRTH_{it} = \alpha_0 + \beta_1 GRTH_{i,t-1} + \beta_2 Ln(GDP)_{i,t-1} + \beta_3 INV_{i,t} + \beta_4 FDI_{i,t} + \beta_5 POP_{i,t} + \beta_6 EMP_{i,t} + \beta_7 HC_{i,t} + \beta_8 URBAN_{it} + \beta_9 SOE_{it} + \beta_{10} TRANS_{it} + \beta_{11} TEL_{it} + \beta_{12} MOB_{it} + \beta_{13} MOBSQ_{it} + \beta_{14} NET_{it} + \alpha_i + \eta_t + \mu_{it}$$

(5-2)

If the coefficient of MOBSQ (β_{13}) is negative and significant while the

34 Roller and Waverman (2001), the level of “critical mass” is about 40 mainlines per 100.

coefficient of MOB (β_{12}) is positive and significant ,((β_{13}) <0 and (β_{12}) >0), then we have support for a "diminishing returns" hypothesis. Hence, a unit increase in MOB density would have a smaller magnitude of growth for a region with greater level of MOB density. In contrast, positive signs for both coefficients, (β_{12}) and (β_{13}) would present "increasing returns", ((β_{13}) >0 and (β_{12}) >0). If, however, the coefficient of MOBSQ (β_{13}) is positive and significant while the coefficient of MOB(β_{12}) is negative and significant, ((β_{13}) >0 and (β_{12}) <0), then we have evidence in support of a "critical mass" theory, as investment in telecommunications infrastructure would not significantly affect economic growth until a critical mass of telecommunication infrastructure is achieved (Ding, 2005).

According to the report published by Ministry of Industry and Information Technology of China, China's mobile phone penetration rate has surpassed 40 percent in 2007. Furthermore, it has reached 54.3 percent in the end of 2009. Newly-added mobile phone subscribers in west and central China kept rising. By the end of June 2009, mobile phone penetration rate was 43.2% in central China and 43.8% in west China comparing with the 72% in east China which is higher than the country's average level.[35]

As Table 8 in Model C shows, it evidences that the results support the assumption of diminishing returns of telecommunication investment in China because the coefficient of MOBSQ is negative and significant at a 1 percent level while the coefficient of MOB is positive and significant at a 1 percent level as well. Furthermore, the results are matched with Ding's findings in 2005; the size of the effect of telecommunication infrastructure on the economic growth is inversely related to its prior level. This indicates that the higher the level of

35 http://www.chinaeconomicreview.com/china-eye/

telecommunications infrastructure, the smaller the magnitude of the effect of a marginal increase in mobile density on economic growth.

This suggests diminishing returns and implies that regions at an earlier stage of development in China are likely to gain the most from further investment in telecommunications infrastructure. An investment in telecommunications infrastructure in those regions would lead to a higher growth rate than that in already developed regions. The positive incremental effect decreases for those regions with more developed telecommunications infrastructure. Since regions in the central and western China usually have a lower level of telecommunications infrastructure, a strategy for investment in these regions should have a larger impact on growth (Ding et al., 2006). Figure 11 shows the relationship between mobile phone user density and annual growth rate of real GDP per Capita.

Table 8 Regression Results from Modeling

Variables	Coefficient					
	Model A		Model B		Model C	
$GRTH_{t-1}$	0.21*	(2.13)	0.21*	(2.13)	0.17*	(1.81)
$Ln(GDP)_{t-1}$	-29.77***	(-4.64)	-29.52***	(-4.61)	-32.02***	(-5.21)
INV	0.14***	(2.95)	0.15***	(3.04)	0.12***	(2.71)
FDI	0.37***	(2.66)	0.31*	(2.29)	0.32*	(2.34)
POP	-0.88***	(-5.96)	-0.9***	(-6.14)	-0.86***	(-6.07)
EMP	0.27	(1.73)	0.25	(1.63)	0.34*	(2.27)
HC	0.12	(0.09)	-0.06	(0.04)	0.76	(0.56)
URBAN	0.81***	(3.94)	0.81***	(3.92)	0.66***	(3.30)
SOE	-1.97	(-0.65)	-1.67	(-0.55)	-1.95	(-0.67)
TRANS	-0.18	(-0.91)	-0.18	(-0.93)	-0.26	(-1.35)
TEL	-0.16	(-1.40)	-0.13	(-1.2)	-0.16	(-1.48)
MOB	0.2***	(2.64)			0.56***	(4.72)
MOB_{t-1}			0.18***	(2.62)		
MOBSQ					-0.03***	(-3.83)
NET	-0.1	(-1.37)	-0.1	(-1.38)	0.21	(0.29)
Dependent variable: GRTH						
Intercept	233.76***		233.97***		245.54***	
	(4.08)		(4.08)		(4.49)	
R^2	0.80		0.80		0.82	
Adj. R^2	0.72		0.72		0.75	
Residual	801.05		801.65		722.95	

Source: Author's calculation based on data from various sources.

Notes:

1. Definition of each variables is listed in Chapter 4.1
2. t-statistics in parentheses;
3. *** significant at 1% level; ** significant at 5% level; *significant at 10% level;
4. Number of groups: 31
5. Period: 2003~2008

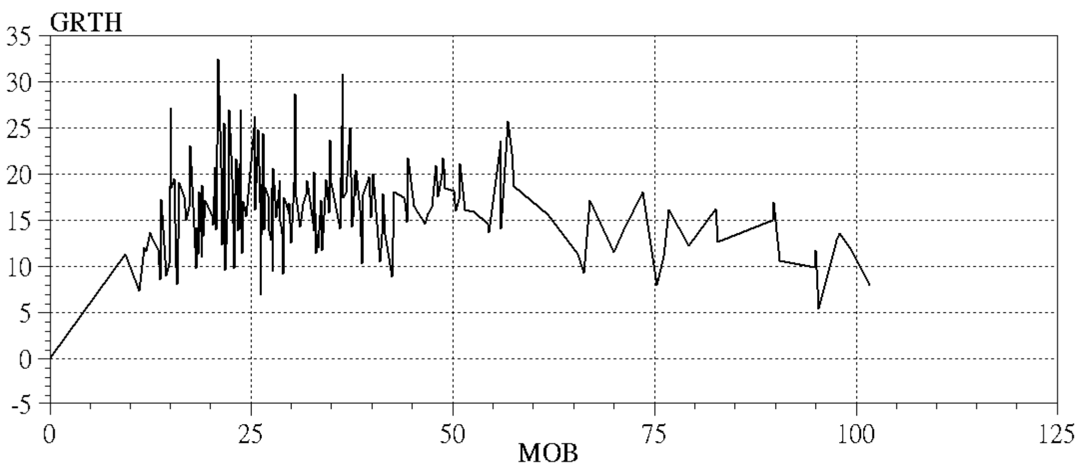

Figure 11 Mobile Phone User Density and Annual Growth Rate of Real GDP per Capita (2003-2008)

Source: Author’s calculation based on China Statistical Yearbook

5.3 Summary

The analysis founds that the telecommunications investment is subject to diminishing returns. Besides, it is in support to the conditional convergence hypothesis, which suggests that controlling for other factors, regions with higher levels of GDP per capita tend to grow at a slower rate in China. This paper also confirms that fixed investment (INV), foreign direct investment (FDI) and urbanization (URBAN) have a positive effect on economic growth, while population growth (POP) has a negative effect on regional economic growth. As for the other socio-economic variables, employment rate (EMP) and human capital (HC) in China seems not to be helpful given the positive impact but lack of statistically significance in this study.

Due to the special telecommunications infrastructure development in China, it shows the relationship with statistically significant and positively correlated to regional economic growth in real GDP per capita even if the lagged telecommunication variable is also significant, supporting the recognition that telecommunications infrastructure boosts regional economic development.

Estimation results reported on Table 8, it provides some additional evidence on the determinants of economic growth compared with other investigations in the existing literature. However, it may differ with previous investigations used the dynamic fixed effect model and different study period.

First of all, the results are supported even after controlling for lagged real GDP per capita and other factors as well. The economic growth rate including real GDP growth rates and per capita income growth rates is frequently used as measure of regional economic growth (Liu, 2008). Barro (1991) tests convergence of economies by examining the relationship between economic growth rates and initial economic conditions. Islam (1995) adds dynamic characteristic to Barro's convergence framework with use of a panel data approach for getting higher estimated convergence phenomena. A method is used in analyzing conditional convergence with holding constant the steady state of each economy with a set of proxy variables. Within our research, the technique is to hold examination of coefficient sign of the lagged GDP variable to reveal the existence of conditional convergence. In fact, we found that the coefficient of GDP_{t-1} as the logarithm of lagged GDP per capita after controlling the lagged dependent variable is negative and significant at 1 percent level. The result suggests that regions with higher levels of GDP per capita tend to grow at a slower rate controlling for other conditional variables. Besides, it provides more confirmation of Demurger's (2001), Ding's (2005) and Liu's (2008) findings of a conditional convergence among regions in China in the period of 1985 to 1998 and 1986 to 2002 period, respectively. The results may contribute to the further argument on the convergence issues for China since evidence shows conditional convergence is a possibility

Second, the study uses regional economic growth from capital factors as the dependent variable in the final model, given the fact that telecommunications development is actually an important type of productive capital factor. In terms of physical capital, economic capital is a major production factor, which should have a significant impact on growth performance. It is confirmed INV is a key factor contributing to economic growth with positive and significant relationship at the 1 percent level. Furthermore, this also confirms these findings in previous studies that China's economic growth has been driven by accumulation of fixed-assets (Mody and Wang, 1997). Another key factor is FDI as a main engine of China's growth, which has significantly contributed to increased total factor productivity growth (Graham, 2001). China's FDI consists largely of greenfield investment. As expected, FDI has the significant effects on its economic growth.

As showed, the coefficient of urbanization and population growth are positive and negative with significance at 1 percent level, respectively that the urbanization and population growth has been impacting on China's economic growth. Ernesto (1993) examined that countries that have rapid economic growth and dramatic structural changes have also experienced major shifts in the spatial distribution of population and economic activities.[36] At the end of 2008, China's total population was 1.33 billion, with 723 million (54%) and 607 million (46%) residing in the rural and urban areas respectively. The rural population fraction was 64% in 2001 and 74% in 1990. The annual population

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36 Ernesto M. Pernia (1993), "Urbanization, Population Distribution and Economic Development in Asia", Asian Development Bank.

growth rate was estimated at 0.59% (2006 estimate). Concurrent with the decreasing rural population and increasing urban population, China's main focus of its industry and economic activities has also moved from the rural to urban areas.[37] Furthermore, the result shows that the population growth has a negative effect on growth of real GDP per capita. It has been confirmed by previous researches that rapid population growth complicates the task of providing and maintaining the infrastructure, education and health care needed by modern economies relates to a lower level of GDP per capita.

37 http://en.wikipedia.org/wiki/Urbanization_in_China

Chapter 6 Conclusions

This chapter concludes the empirical analysis of telecommunications development and its impacts on economic growth since the infrastructure development can play a key role in economic growth. Considering the research topics, this study adopted Ding's (2005), Kingsley's et al. (2006) and Liu's (2008) general analysis is to analyze the economic growth in 31 regions for the span of time from 2003 to 2008. Aggregate data for the each region's status mainly from China Statistics Yearbook and Statistical Yearbook of China Telecommunications is utilized and calculated in this research.

This study employs a dynamic panel data approach with a series of socio-economic variables including initial economic conditions, fixed investment, foreign direct investment, population growth, employment rate, human capital, urbanization, transportation percentage, station-owned enterprise output while specifying regional economic growth in aggregate physical capital and production factors. Furthermore, regional and industrial differences in labor and capital productivity and its variances on regional economic output changes are estimated based on the framework, and the testing results for the hypotheses outlined in Chapter 1 are elaborated.

The results are robust even when controlling for past levels of GDP per capita, lagged growth, and other factors. It further indicates that the telecommunications development is subject to diminishing returns; infers that the positive effect of telecommunications on GDP growth is largest for regions with the lowest level of telecommunications infrastructure (Ding and Haynes, 2006; Michael, 2008). In this research, it evidence in support to the conditional convergence hypothesis while controlling for other variables that regions with higher levels of GDP per capita tend to grow at a slower rate in China (Ding, 2005). This paper also confirms that fixed investment, foreign direct investment and urbanization have a significantly positive effect on real GDP per capita while population growth has a negative effect on economic growth.

Telecommunication Development and Regional Economic Growth

China is a developing country with a developed market's telecommunications development. The centrally planned system has enabled huge restructuring of the telecommunications development affecting regional growth since 1999. It has experienced rapid economic growth at the aggregate level but there has been a great inequality in growth performance for different regions during the past two decades (Ding, 2005). It is obvious that different regions in China present the different development outcomes in fixed line telephone, mobile phone and Internet density. After testing the relationship using dynamic growth model, it shows that telecommunications development specifies the importance of regional economic growth, as measured by mobile phone user density with statistically significant and positively correlated to regional economic growth in real GDP per capita.

When the current value of MOB variable is replaced by the lagged value (MOB_{t-1}), its coefficients are kept at 1% level and have almost magnitude when compared to the lagged values. These results are in support to the argument that the positive relationship between telecommunications development and regional economic growth is not merely due to reverse causality.

Compared with previous studies, we employed that telecommunications development is measured as the fixed line telephone user density, mobile phone user density and the number of Internet user density separately because mobile phone users as the new proxy of telecommunications have overtaken fixed line subscribers since 2003. That is why we define this subject starting from 2003 after WTO accession. Finally, we found that only mobile phone user density has statistically significant and positively correlated to regional economic growth in real GDP per capita in China different than previous studies.

Scale of Returns of Telecommunications Investment

According to neo classical growth theory, the growth rate of a country is inversely proportional to its initial level of income due to diminishing return to capital. It leads to the concept that poorer countries are growing faster than rich ones (Zahra, 2009). Barro (1997) mentioned that one feature of this model is the convergence property: the lower the starting level of real per capita GDP and the higher is the predicted growth rate which derives in the model from the diminishing return to capital.

The one of results in this research are that the impact of telecommunications development on economic growth is subject to diminishing returns to scale because the coefficient of the square of mobile phone density (MOBSQ) is negative and significant at a 1 percent level while the coefficient of mobile phone density (MOB) is positive and significant at a 1 percent level as well. Compared with previous researches, the results are matched with Ding's findings (2005) and Michael's findings (2008), respectively. The size of the effect of telecommunication infrastructure on the economic growth is inversely related to its prior level. This indicates that the higher the level of telecommunications infrastructure, the smaller the magnitude of the effect of a marginal increase in mobile density on economic growth. This suggests diminishing returns and implies that regions at an earlier stage of development in China are likely to gain the most from further investment in telecommunications infrastructure. An investment in telecommunications infrastructure in those regions would lead to a higher growth rate than that in already developed regions (Ding et al., 2006).

Growth Factor

This research using dynamic panel data approach finds some evidences in support to the conditional convergence hypothesis by estimating a series of socio-economic variables while controlling for a set of variable reflecting regional differences. It indicates that fixed investment, foreign direct investment, population and urbanization are major factors contributing to economic growth. This result confirms previous researched findings that China's economic growth has been driven by accumulation of fixed-assets (Mody and Wang, 1997).

Foreign direct investment (FDI) as a main engine of China's growth has significantly contributed to increased total factor productivity growth. As expected, it is confirmed since the coefficient of FDI is positive and significant at the 1 percent level as well and significant effect on its economic growth.

Economic growth and urbanization are closely linked. As showed, the coefficients of urbanization and population growth are respectively positive and negative with significance at 1 percent level, respectively. Ernesto (1993) examined that countries that have rapid economic growth and dramatic structural changes have also experienced major shifts in the spatial distribution of population and economic activities. Moreover, the result shows that the population growth has a negative effect on growth of real GDP per capita. It seems that regions do not enjoy benefits from the rapid growth of population and migration of population from rural to urban areas. This may reflect the traditional diminishing returns on productive inputs; the over-supply of labor lowers the overall regional productive efficiency (Liu, 2008).

However, this research does not find the significant evidence in support to a positive effect of employment rate, human capital, state-owned enterprise output and transportation percentage on economic growth in China. It may be the fact that China is still in the developing phase. These state owned enterprises and labor-intensive industries still dominate the whole industrial structures. It can be expected that with development of the overall economy and industrial structure adjustments towards service-intensive or technology-intensive end, the human capital variable will show a positive impact for regions in China.

Direction for Future Study

Future researches are necessary in the following directions: First, the future studies can understand the infrastructure mechanism through telecommunications system and is influenced by economic growth conducting some infrastructure factors including the capacity of long-distance telephone exchanges, the capacity of local office telephone exchanges, the capacity of mobile phone exchanges and broadband subscribers port of Internet in Equation 4.2 to observe the roles of economic growth. Additionally, more research efforts are necessary to understand the spillover effects of telecommunications development on regional economic growth to understand the infrastructure investments on economic output. Furthermore, future study may consider observing the effect of Internet user density with regional economic growth because China owns the largest Internet user in the world due to a massive jump of over 60% of the Chinese getting online with the rapid economic growth. Given the fact that Internet subscriber base in China has reached 401 million with 30.7 percentage of penetration rate in 2010, which actually is another important variable of telecommunications development even if Internet user density does have negative impact on the regional economy of China in this research.

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