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The Impact of ICTs on Farmer Life in China

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Abstract

The past decades have been observing the dramatic development and the rapid distribution of information and communication technologies (ICTs). In China, the telephone density rate rose from 0.38 sets per hundred persons in 1987 to 13 sets, an increase of almost 34 times by the end of 1999. The UNDP believes that those nations that succeed in harnessing the potential in ICTs can look forward to greatly expanded economic growth, dramatically improved human welfare. David F. Barr further pointed out that the greatest challenge for developing countries is to ensure that telecommunication services are extended effectively and efficiently throughout the rural and remote areas.

Recognizing the significant impact of ICT application on economic development, especially in rural China, the author endeavours in this paper to address two main topics: (1) Conceptual studies, the characteristics of ICTs and their economic significance. (2) The impact of the application of ICTs on farm households, including both the determinants of access to ICTs and the impact of ICTs on farm households. In order to more accurately investigate the relationship between ICTs and farm households, a case study on telephone subscription in farm households was conducted by RCRE in the rural areas of three sample provinces.

The results of analysis suggest that ICTs, such as telephone and Internet access, have a potentially significant impact on farm households in such various economic and social aspects as these: industrial patterns, market extension, improvement in education and health-care. The main determinants of telephone subscription for a farm household are net annual income, the educational level of head of household, the number of household members with professional titles, and sideline business types. There is a positive relationship between duration of telephone possession and the change in annual net income of a farm household. The result also shows there is no relationship between telephone subscription and shift of sideline business types of farm households in the short run.

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1 INTRODUCTION

" Information and Communications Technology (ICT) is one of the most potent forces in shaping the twenty-first century. Its revolutionary impact affects the way people live, learn and work and the way government interacts with civil society. "[1]

1.1 OVERVIEW OF THE DEVELOPMENT OF ICTS

The world has been witness to the dramatic development of Information and Communications Technologies (ICTs) in recent decades. Specifically in the 1990s, the pace of the distribution of ICTs accelerated considerably. Globally speaking, the number of fixed and mobile connections increased from about 0.5 million in 1990 to 1.3 million in 1999. During this moment of intense connectivity, the expansion of mobile services grew at an annual rate of about 50 percent. Meanwhile, based on the large size and sustained growth of the fixed-telephone network, Internet service experienced a 20-fold growth, from about seven million Internet accounts in 1990 to over 140 million in 1999[2].

The dramatic development and the rapid distribution of ICTs have brought tremendous challenges and opportunities to countries around the world, especially to developing countries and their rural areas. The UNDP believes that those nations that succeed in harnessing the potential in ICTs can look forward to greatly expanded economic growth, dramatically improved human welfare, and vitally enhanced forms of democratic government. Observing the opportunity that lies ahead of rural areas in developing countries, David F. Barr[3] points out that the greatest challenge for developing countries is to ensure that telecommunications services, along with the resulting benefits in economic, social, and cultural development that these services promote, be extended effectively and efficiently throughout their rural and remote areas. In the past, those areas with few or no telecommunications services have often been at a disadvantage in relation to urban areas. These rural and remote areas will in fact benefit most from the advent of telecommunications; this is because alternative methods of sharing information are more costly and more difficult to obtain than they are in densely populated areas.

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[1] *G8 Okinawa Charter on Global Information Society July 22, 2000*

[2] *Björn Wellenius, Carlos Alberto Primo Braga, Christine Zhe-Wei Qiang, Investment and growth of the information infrastructure: summary results of a global survey*

In addition to the opportunities, the challenges ICTs bring are also tremendous. Despite the forces of market liberalization and globalization; despite efforts at reforming public policy, the goal of achieving universal access to ICTs and to the Global Information Infrastructure has remained elusive, and the disparity between the developed world's and the developing world's access to ICTs is growing. Today, 96 percent of Internet host-computers reside in the world's highest-income nations, whose citizens comprise only 16 percent of the world's total population[4]. In developing countries, the lack of awareness of and knowledge about the economic and social implications of ICTs, coupled with weak evidence about the consequence of the impact of ICTs on rural areas, makes the situation even worse. No doubt, there is a compelling demand for systematic studies that examine and clarify both the real and the potential impact of ICTs on social and economic development. Studies based in solid, reliable evidence will assist politicians and decision makers in developing countries when they sit down to compose comprehensive strategy and implementation-packages. Reliable economic studies of the sort that follows hope, thereby, to contribute to these leader's enlightened efforts to convert the immense challenges that ICTs bring to their developing countries into great opportunities.

1.2 RESEARCH OBJECTIVES

Most previous studies of ICTs assume one of three perspectives. The first perspective places ICTs within the context of the industrial sector, focusing on the production of electronic products and components, computer hardware and software, and telecommunications equipment. The second perspective places ICTs in the context of generic industry-technologies (applicable across industries) and production process. The third perspective views ICTs within the context of an information infrastructure. This perspective emphasizes the means of development of ICTs and pays detailed attention to their supporting-services and to their means of production. Among the three perspectives, the last one in particular has generated a variety of views. Although popular and academic papers are rife with discussions of the impact of ICTs on the economy and society in general, the evidence for the social and economic impact of ICTs specifically on farm households in rural and remote areas remains scarce because of a lack of unambiguous evidence and a lack of related data. This paper attempts to contribute to the efforts to study ICTs within the paradigm of the third perspective.

[3] *David F. Barr, SR Telecom Inc. Canada. Integrated rural development through telecommunication, 1999*
[4] *UNDP agenda for action 2000-2001*

What are the significant characteristics of ICT development? Can the economic significance of ICT application be demonstrated and quantified? What is the impact on economic and social development, especially on farm households in rural China? These central questions about ICTs are the main themes of this paper. In order to provide an empirical analysis of the impact of ICTs on rural development and farm households, the following research focuses on three major objectives. The first objective is the conceptual study of ICTs; it summarizes the principal characteristics of and the economic significance of ICTs. The second objective is to examine the relationship between the application of ICTs and rural development on a macroeconomic level. The third objective is to conduct an empirical case study of ICTs on a microeconomic level, namely, the farm household.

The core of the research is a *farm household survey* that motivates the main argument of this paper to address the following two very intertwined issues: to investigate and to quantify the determinants of ICT access for farm households; subsequently, to estimate the impact of ICTs on farm households. However, due to a lack of related available data, a limitation is adopted in this part of the analysis: because ICT application in developing countries, especially in their rural areas, is dominated by telephone service rather than by the mobile phone, the Internet, and the digital cable-TV network (applications that predominate in developed countries), the research concentrates primarily on residential telephones.

Organized to achieve these objectives, this paper is divided into five chapters and structured as follows: it begins with an introduction to the current level of ICT development and the objectives of the research. *Chapter two* focuses on previous conceptual studies of ICTs. *Chapter three* describes the relationship between ICTs and rural development in general. The core of the research grapples with the issue of the impact of ICTs on rural development, especially on farm households in rural China. *Chapter four* first provides a background to the case study of ICT application in rural China, second presents a statistical analysis based on the survey data, and finally estimates the determinants and effects of telephone subscription. *The final chapter* provides the conclusions of the research and discusses its implications for the implementation of policy.

2 THEORETICAL STUDIES OF ICTS

> "The greatest potential of the technology lies in enabling us to do new things"[5]

The history of the development of ICTs reflects the fact that they are very new and very rapidly changing technologies. The electronic computer is just over 55 years old; the "PC" computer is less than 20 years old; the World Wide Web has been known to the public for less than 6 years. Nowadays, ICTs are playing an increasingly powerful and important role in economic development. These powerful technologies are recasting the business world into a fleeter, more competitive form, and they are transforming industrial society into a new era—the information age.

As an information age driven by ICTs comes ever closer, two compelling questions need to be answered: What are the unique features of these technologies in comparison with previously invented technologies? What are their implications for social and economic development? Answering these questions is, however, complicated, for ICTs embrace a variety of technologies; all of which are developing at breakneck speed. In attempting to find the answers to these questions, the following discussion proceeds in a pragmatic way by starting with the conceptualization of ICTs in technical terms; it then continues to explore their economic significance.

2.1 INFORMATION AND COMMUNICATION TECHNOLOGIES

Technological innovations in micro-electronic chips, microwaves, satellites, fiber optics and information-processors are the motors of the information revolution and form the unique characteristics of ICTs. With the expansion of computational power –- resulting in a lower cost of transmitting information and the convergence of various technologies through digitalization –- these advanced technologies enable the construction of a whole new society in cyberspace[6]. In linking individuals and organizations so that they may more directly and more easily exchange knowledge and information, and in creating an electronic commerce-platform and global marketplace, new ICTs (from email to cellular telephone to digital TV to teleconferencing to personal computers to local networks to the World Wide Web) enable

[5] *Bernard Woods,* "Ceres"*, The FAO Review, No. 158 – March-April 1996*
[6] *James Bond, the Driver of the Information Revolution-Cost, Computing Power and Convergence, July, 1997*

more and more people to share information without having to be in the same place at the same time. ICTs, thereby, dramatically extend the frontier of communication possibilities.

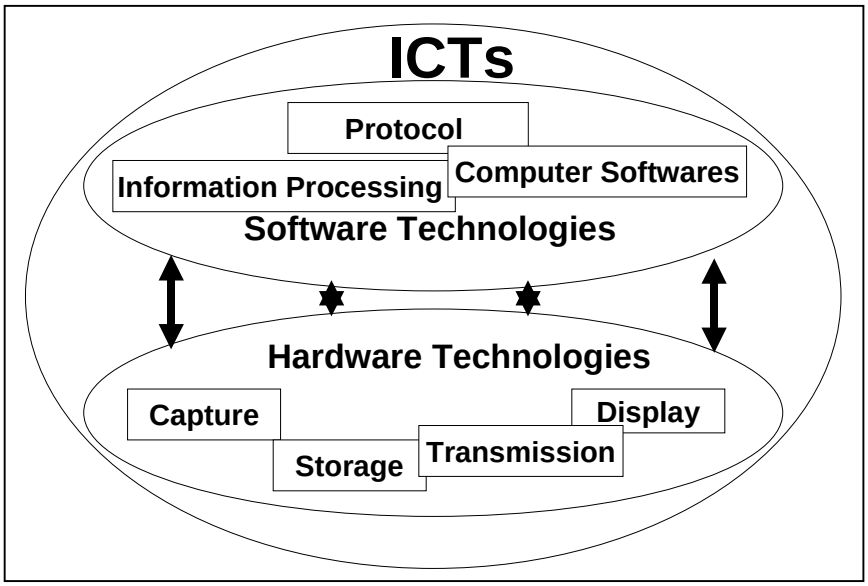
2.1.1 The Conceptualization of ICTs

Naturally, there is simple curiosity about what ICTs really are. Unfortunately, neither an accurate nor a universally accepted definition of ICTs exists. Because of their dynamic and relatively unpredictable developmental perspectives, it seems extremely difficult to obtain an accurate conceptualization of ICTs. In his recent research into the subject, Hamelink[7] proposes a comprehensive concept of ICTs as Information Communication Technologies (ICTs) that encompass all of those technologies that enable the handling of information and that facilitate different forms of communication between human sectors, between human beings and electronic systems, and between discrete electronic systems. These technologies can be subdivided into the following four categories: capturing technologies, storage technologies, transmission technologies, and display technologies[8]. A shortcoming of Hamelink's definition is that to some extent it ignores the importance of information-processing technologies. However, these intangible intellectual technologies, more commonly called software, do play as important a role as do hardware technologies. Therefore, to keep a balanced emphasis, the content of ICTs should be divided into the following two categories: technologies of hardware, technologies of software. Hardware technologies include all hardware-manufacture technologies involved in information capture, storage, transmission, and display; software technologies consist of all information-processing technologies, such as various computer software, information-processing technologies, and network protocols (Figure 1).

[7] *Pavlic B and Hamelink C (1985): The New International Economic Order: Links between Economics and Communications*

[8] *Here ICTs refer mainly to two-way information communication technologies, such as, telephone, fax, computer, digital TV, Internet, wireless and satellite communication. Capturing technologies, input devices that collect and convert information into digital form, include keyboards, mice track-balls, and touch screens. Storage technologies, producing a variety of devices to store and retrieve information in digital form, include magnetic tapes, floppy disks, and hard disks. Processing technologies create the systems and applications software that are required for the performance of digital ICTs. Communications technologies, producing the devices, methods and networks transmit information in digital form, include digital broadcasting, integrated services, digital networks, digital cellular networks, local area networks (LANs), and wide area networks (WANs such as the Internet). Display technologies, which create a variety of output devices for the display of digitized information, include display screens for computers and digital television with automatic picture adjustment.*

Figure 1: Definition of ICTs



Source: the author

Based on these definitions, the most prominent characteristics of ICTs can be outlined broadly in both technical and economic terms. However, in an effort to narrow and to deepen the discussion, this study concentrates mainly on the information processing and communication capabilities of ICTs rather than on their concrete role in automating production processes. Moreover, it focuses more on the role of ICTs as an intermediary, or facilitator than on their role as direct contributors to economic development through the development of the software and hardware industries.

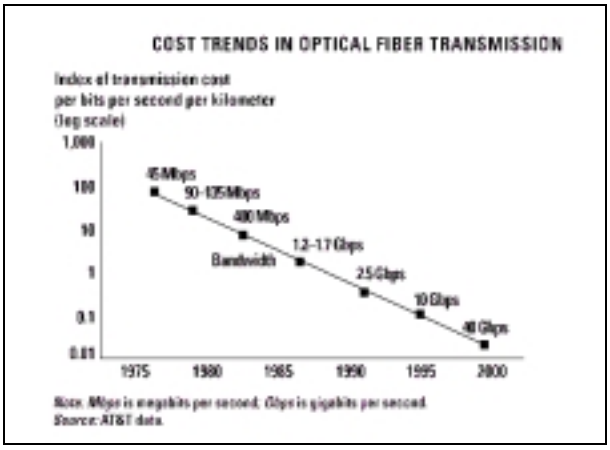
2.1.2 General Characteristics of ICTs

The last two decades have been witness to profound technological shifts in ICTs: micro-electronic technologies, fiber optics and wireless communication technologies, and information processing technologies. As a result, computers have become ubiquitous; new communications technologies have been multiplied; Internet technology has become a widely used means of doing business. These inventions and applications of ICTs have brought about an exponential reduction in the cost of transmitting information, an increase in the power of computing, an opportunity for leapfrogging over a traditional development period, a shift from analog to digital information technologies, and a new way of communicating in the social and economic spheres.

(1) Rapid development and exponential reduction in relative cost

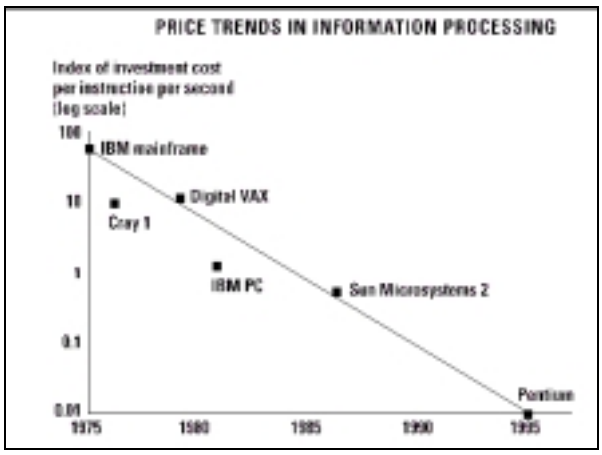
In the past few years, the rapid development and exponential reduction in the relative cost of ICTs have been astounding to most of us. In accordance with Moiré's Law, the speed, capacity, and versatility of computer hardware double every 18-24 months. The innovation of new communication technologies, including fiber-optics, cheap electronics, smart, wireless and satellite communication, quite evidently improves the capacity of their performance, decreases the cost of transmitting information, and shrinks geographical distance. Integrated-circuit miniaturization and microchip-technology applications have relentlessly increased the power of information processing (Figure 2, 3).

Figure 2: Cost Reduction in Optical Fiber Transmission



Source: James Bond, the World Bank Group, 1997[9]

Figure 3: Price Trends in Information Processing



Source: James Bond, the World Bank Group, 1997

For some of today's world-leading ICT producers, the cycle of upgrading ICTs can no longer be counted in years but must be counted, instead, in months or even in weeks. Through rapid development and cost reduction in information transmission and processing, the innovation of new ICTs also makes their application more affordable and practicable for almost everyone. For instance, the cost of a voice-transmission circuit has fallen by a factor of 10,000 as a result of the development of fiber optics, cheap electronics, and smart wireless. The trend of cost decline in ICTs is projected to continue into the foreseeable future. It will increase the rate of ICT penetration in both industrial and developing countries in coming years. This is particularly important for developing countries because they could begin to claim possession of services previously and exclusively available only to industrialized countries. Generally, the unprecedented development of ICTs has made it possible to extend basic communication services to remote areas and to tiny segments of populations in

[9] *James Bond, the Driver of the Information Revolution-Cost, Computing Power and Convergence, July, 1997*

developing countries, as well as to provide the more advanced services that are being increasingly required by modern societies.

(2) Pervasiveness

The ICT industry is one of the few whose products and services create an input to nearly every other industry in an economy. The widespread application of ICTs has shifted the emphasis in production from mechanics to electronics, and it has shifted the emphasis in the economy from industry to information. Schumperter[10] in his work in the 1930s addressed the pervasiveness of certain types of technology in periods of economic development. A technology has pervasive economic effects and employment implications if it satisfies the following conditions:

- Generates a wide range of new products and services.
- Generates strong industrial interests as a means for profitability and competitive advantage.
- Reduces the cost and improves the performance of the processes, services, and products of many sectors of the economy.

According to Schumperter's criteria of identifying a pervasive technology, ICTs are the most pervasive technical innovation in the post World War II era[11]. ICTs generate a wide range of new products and services, such as new information industries that are based on the production and application of ICTs. There is no doubt that information industries have become a new, powerful engine of social and economic development, especially in western, developed countries. For instance, in 1991, information-age capital spending by U.S. companies exceeded industrial-age spending for the first time[12]. As some economic historians assert, the pervasiveness of ICTs in society amounts to a "second industrial revolution".

ICT infrastructure may be viewed as an input or as a catalyst to productive processes and to social activities. Their function in reducing the cost of information flow and in aiding faster, and better economic and administrative decision-making has spread into a range of organizational types. Increased use of these technologies can improve the performance and

[10] *Arjun Bedi, the Role of Information and Communication Technology in Economy-Partial Survey, 1999*
[11] *OECD Report 1998*
[12] *Thomas Stewart,* the Information Age in Charts, *Fortune, April 4, 1994*

productivity of private firms and public sector organizations. Nowadays, most countries, both developed and developing, apply ICTs in many social and economic sectors, such as macroeconomic planning, public administration, education, health-care, manufacturing, finance and banking, transportation, commerce, publishing, energy conservation, and environmental management[13].

(3) "Leapfrogging" Technologies

A striking feature of ICT development is that instead of developing in a continuous manner, they "Leapfrog". The stages of the innovation of telecommunication technology clearly reflect this aspect of ICT development. Before the 1960s, telecommunications were dominated by analog technologies. However, during the 1970s and 1980s, with the innovation of digital electronics, with the increasing application of computer technologies to telecommunications, and with the increasing development of very wide-band systems, the dominant position of analog technology in telecommunications was replaced by digital technology. The new digital technology is different from analog; it is more powerful, more reliable, and more compatible. Concerning this feature, some researchers[14] believe that the new ICTs can help a society bypass intermediate development stages. Taking advantage of this bypass, developing and under-developing countries could leapfrog these intermediate stages and catch up with developed countries in the ICT sector. Moreover, these countries might invest only in the newest ICTs and thereby save on the expenditure of mending and upgrading their outdated information communication systems. The World Development Report of 1998 demonstrates the evidence for that claim. For example, telephone networks in developing regions, such as Djibouti, the Maldives, Mauritius, and Qatar, are fully digitalized. In contrast, many industrial countries still continue to rely heavily on older analog technology[15].

(4) Digitalization and Convergence of Multimedia

Digitalization is another crucial characteristic of ICT development. It enables the convergence of audio, image, and computing technologies (so-called multimedia) by converting various forms of information into digital representation -- 0, 1 series codes. The digitalization and convergence of multimedia enable ICTs to penetrate almost all social and

[13] *The World Bank Discussion Paper, The East Asian Miracle and Information Technology, strategic management of technological learning*
[14] *Knowledge for Development, Word Development Report 1998/99, The World Bank*

economic sectors and, thereby, facilitate the rapid development of various services such as home-shopping, on-line entertainment, educational programs, electronic publishing, and other communication services. For example, digitalized TVs and computers can converge into one integrated product and link to the Internet, which can provide Web TV and E-commerce services for users in their home. Furthermore, providing standard media-presentation forms, digitalization has made equipment more flexible and compatible, and it has improved operational facilities so that the overall system is more efficient.

(5) Net Structure of Communication

The development of ICTs introduces a new concept of communication—networks. A network structure allows a more efficient and flexible form of communication, which is similar to the neural networks of the human brain. Unlike the former telephone network "one to one" model, the new communication structure of ICTs, especially the Local Area Networks and Large Area Networks, is "many to many". This feature of ICTs enables interactive multi-directional communication and negotiation, which not only improves the efficiency of information communication but also enhances the efficiency of innovations and decision-making.

Based on this feature of ICTs, another natural corollary of ICT application is that the diffusion of ICTs can create "virtual reality", which is regarded as a natural extension of interactive multimedia, such as "virtual organizations and communities" and "visual conference". Taking advantage of this aspect of ICTs, "virtual organizations and communities" not only can function like the real ones but also can save huge costs on their construction and performance. In particular, the "visual international conference" saves huge transportation and energy costs, saves precious time for politicians, dignitaries, and other highly time-constrained participants, and facilitates knowledge transfer, and thereby, enables more efficient resource allocation.

Due to these characteristics, ICTs will continue to rush forward. While making some spectacular business dreams reality, they also bring myriad tragic frustrations to the business world. During the past two years, Wall Street has witnessed a dramatic change in enthusiasm for the prospects of ICT development. As the bubble of unrealistic dreams burst, arguments erupted and views on the promising economic effects of ICTs swung from

[15] *Arjun Bedi, the Role of Information and Communication Technology in Economy-Partial Survey, 1999*

optimism to relative pessimism. However, this is not the fault of ICTs themselves; rather, it is a result of unrealistic expectations of these technologies. While enthusiasm for ICTs cooled, two questions requiring more careful attention from the academic and business world arose: Do these new technologies really change basic economic law? What is their real significance in terms of economic and social aspects? The following subsection attempts to answer two questions.

2.2 ECONOMIC SIGNIFICANCE OF ICTS

According to the theory of technology economics, technological change is a key source of economic growth. The assertion is proven by the fact that an historical correlation exists between higher rates of economic growth and technological innovation. During the industrial revolution in England from 1780 to 1860, the rate of economic growth increased from 0.5 percent per year to more than 2 percent per year. In the late 19th century in the United States, the advent of electrification, new power-generation, and better transportation infrastructure resulted in high growth rates surpassing 4 percent per year[16]. Recent econometric studies have found evidence of a causal link between ICT development and economic growth.

Obviously, with the rapid adoption of information technologies, today's business world is different from that of a couple of decades ago. Now the new term "New Economy" has become popular in academic fields, which implies the necessity of a new set of economic principles to describe the business world. Some researchers argue that there is nothing new to be found when we compare the present with descriptions of what happened a hundred years ago when the 20th-century's industrial giants emerged. Drawing from the infrastructure of the emerging electricity and telephone networks, these industrialists transformed the U.S. economy, just as today's Silicon Valley entrepreneurs are drawing from computer and communications infrastructure to transform the world's economy[17]. Nevertheless, even if "new" is true, there are still a few unchanged basic economic concepts available to investigate how these technologies affect the business world. Treating ICTs as an intermediary and facilitator, these basic economic theories explain the effect of ICTs on economic development and on social and institutional changes. Within these theories, transaction costs and externalities play a fundamental role in generating these changes.

[16] *infoDev working paper, The network revolution: opportunities and challenges for developing countries*
[17] *Carl Shapiro, Hal R. Varian, Information Rules: A Strategic Guide to the Network Economy*

2.2.1 ICTs and Transaction Costs

As we know, a transaction is inherently an information-processing activity. Effective buying, selling, brokering, and transporting require a continuous supply of up-to-date information on the availability and price of numerous goods and services. The development of ICTs and their application, the so-called "information revolution", have cut the marginal cost of information processing and transmission to almost zero. Because information cost is one of the critical parts of transaction costs in the economy, ICTs are expected to significantly reduce the transaction cost.

The potential effects of ICTs on market information for buying and selling may be illustrated by Norton's framework (1992), as we know:

$$G = P^{+} - P^{-}$$

Where P^{+} is the price paid by the buyer, and P^{-} is the price received by the seller. Obviously, if the level of transaction costs G is very high, then there is no market participation, and we are then confronted with market failure.

Furthermore, consider a market with inverse demand and supply functions:

$$P^{+} = a - bQ$$
$$P^{-} = c + dQ$$

Where Q is quantity, P^{+} is the price paid by the buyer, and P^{-} is the price received by the seller. The price gap G between the buying and the selling price may be defined as the transaction cost. Equilibrium in this market is defined by:

$$Q = \frac{a-c-G}{b+d}, P^{+} = \frac{ad+b(c+G)}{b+d}, P^{-} = \frac{bc+d(a-G)}{b+d}$$

A key drawback associated with information deficiency is that it limits the extent of trade and hampers the functioning of markets. In such an environment, a reduction in the cost of acquiring information should lead to an increase in search activity, reduction in market uncertainty, and an increase in equilibrium quantity of products[18].

[18] *Arjun Bedi, the Role of Information and Communication Technology in Economy-Partial Survey, 1999*

Generally, the rapid upgrading of ICTs is enabling a massive increase in cross-border information flow that serves to reduce the risks associated with unfamiliarity, thus stimulating consumer demand. Based on the substitutability between ICTs and alternative transportation means, the benefit of ICT-use can be measured by estimating the transportation cost. However, this approach only presents a partial benefit of ICT-use. Associated externalities should also be considered.

2.2.2 The Externality of ICTs

Although ICTs are not pure public goods, ICT infrastructures, the so-called "information super highway," just like other public infrastructure, such as railway and super high way, are inherently provided publicly. In light of experience with significant economic externalities provided by the automobile super-highway in industrialized countries (developed decades ago), it is natural to predict that ICT application can create a strong economic externality in present society.

To describe the externality of ICTs, the telephone network externality serves as a good example. With the development of digitalization technology, telephone networks are digitalized and converged with the Internet, which makes the function of telephone systems more similar to networks. As an interactive medium, the usefulness of any single connection depends on the prior existence of other subscribers in the telephone network. Therefore, the greater the number of subscribers connected to the telephone system, the greater its utility, and thus, the more attractive joining that network will be to any prospective subscribers. Eli Noam provided a measurement of the utility of telephone networks in terms of subscriber numbers: the more people can be reached, the more useful is the network. He also suggests that initially high average costs decline rapidly as more subscribers join the system (i.e. as the utility increases). This fall in costs continues until the system has expanded to a stage whereby new subscribers can only be added by accepting increasing average cost. Meanwhile, utility increases dramatically at first, but it is followed by a reduction in the rate of increase as the number of new subscribers begins to tail off[19].

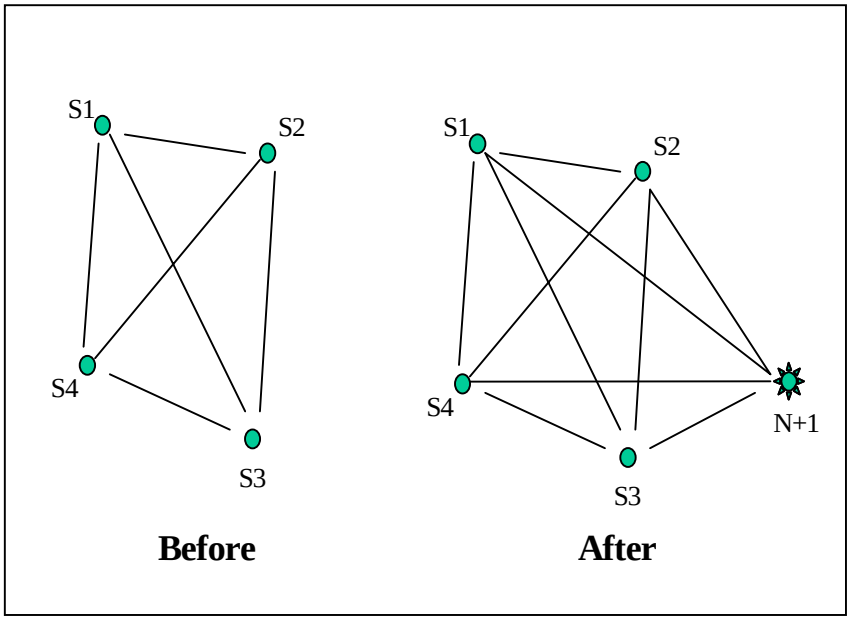
To further understand the externality of ICTs, a network may be another good example. A network externality is the benefit gained by incumbent users of a group[20] when an additional

[19] *Roderick Flynn, Paschal, The long-run diffusion and techno-economic performance of national telephone networks: a case study of Ireland, 1922-1998*

[20] *The group can be thought of as a network of users.*

person joins the group. When the benefit is positive, the additional user receives a positive network externality. The growth of the Internet illustrates Metcalfe's law[21], which states that the value of a network equals the square of the number of its interconnected nodes. As new users join the Internet, its value for all users increases geometrically. Metcalfe's law illustrates how networking PCs radically increases their value as a knowledge tool[22]. Figure 4 illustrates the change of a network when an additional user subscribes to it by using a topological graph. The S refers to a subscriber who is linking to the network. From the figure, we can see that when a new subscriber, labeled with "N+1", enters the network, the linking lines among the subscribers increase by N, where N is the number of subscribers, excluding the new one. Here N is equal to 4.

Figure 4: Change in the Value of a Network by the Entrance of a New Subscriber



Source: the author

On a microeconomic level, it is believed that network externality acts on the utility function of an individual, generating interdependent decision-making processes. For the production function, the network externality may be defined as follows. Let

$$Y_i = Y(K_i, L_i, N_{il})$$

be the production function of individual **i**, characterized by a certain amount of capital (K_i), of labor (L_i), and of a certain volume of information (N_{il}). The volume of the information is dependent on three variables: first, the technology which the individual **i** used; second, the

[21] *Matcalfe was the cofounder of modern computer networking.*
[22] *James Bond, the Driver of the Information Revolution-Cost, Computing Power and Convergence, July, 1997*

number of users subscribing to the network; third, the number of data resources connected to the network. Let

$$N_{il} = N(T_{il}, S_{il}, R_{il})$$

be the function of the volume of information. Where T_{il} is the ICT which the individual **i** uses, S_{il} is the number of subscribers the individual **i** can reach by using ICTs, and R_{il} is the capacity of the database the individual **i** can possibly use through the ICTs[23].

Several assumptions are made about the ability of the coefficients of these equations to simulate reality. In normal conditions, Y_i positively relates $N_{il,}$ and N_{il} has a positive relationship with T_{il}, S_{il} and R_{il} respectively. This means that an increase in N_{il} will lead to more output of the production function. Likewise, the higher the capacity and the greater the technical ability of the network, or the larger the number of subscribers linking to the networks, or the more data resources the network can access, the greater will be the volume of information.

In fact, subscriber-related externalities emerge when new ICT users subscribe to the ICT network. They not only obtain benefits for themselves but also increase the benefits of being connected to the system for current subscribers[24]. In contrast, receivers obtain externalities from the sender whom the receivers contact.

Furthermore, technologies subject to strong network effects tend to exhibit long lead times followed by explosive growth. The pattern results from positive feedback: as the installed base of users grows, more and more users find adoption worthwhile. Eventually, the product achieves critical mass and takes over the market. The history of Internet development serves as a typical sample. The first e-mail message was sent in 1969, its use was confined largely to scientific researchers until the mid-1980s,. Internet technology was developed in the late 1980s. When Internet traffic finally started growing, it doubled every year until 1995. Since then, it has grown even faster[25].

Although it is generally believed that ICTs have a great positive impact on the utility function of an individual and on economic and social development, it is important to be

[23] *Reberta Capello, Spatial Economic Analysis of Telecommunications Network Externalities, 1994, and with modification by the author*
[24] *Robert J. Sounders, Jeremy J. Warford, Björn Wellenius,* Telecommunications and Economic Development

aware of the possibility that their externalities can be a doubled-edged sword. In some cases, the effect of ICT externality could be negative. For instance, it may be harmful to the survival of the unique cultures of small communities due to the inexorable influence of western culture that dominates both the development of ICTs and the content of its information; it may also widen the gap of information between the developed regions and the developing regions because the diffusion of ICTs demands, at first, a huge amount of initial investment in both information communications infrastructure and education programs that train people how to use these ICTs[26].

On the basis of these technical features and on the basis of the economic significance of ICTs, the following chapter discusses the challenges and opportunities ICTs bring to rural China. To achieve these goals, two issues are addressed: first, the clarification of effects of ICTs on rural development in general; second, an overview of the current situation of ICT development in rural China, which serves as a research background for further analysis; finally, to complement the theoretical discussion, recent evidence of the impact of ICTs on Chinese farm households is presented in the last part of the chapter.

[25] *Carl Shapiro, Hal R. Varian, Information Rules: A Strategic Guide to the Network Economy*

[26] *Daniel Morales-Gómez and Martha Melesse, Utilising information and communication technologies for development: the social dimensions*

3 ICTS AND RURAL DEVELOPMENT IN CHINA

> "ICTs are not a panacea for rural development. ICTs alone will not bring about rural development, but can be an important catalyst." [27]

As ICTs have diffused rapidly worldwide, especially in developed countries, many researchers[28] have studied the social and economic effects of ICTs. They have consistently found that ICT applications have a positive impact on economic growth for both urban and rural communities. Comparing ICT-use in urban areas to its use in rural areas, some researchers believe that rural and remote areas will benefit most from the advent of new ICTs because alternative methods of transmitting information in those areas are more costly and more difficult than in densely populated areas.

Having observed the positive impact of ICT application in developed countries, policy makers in developing countries are turning their attention to the economic significance of ICTs in rural areas. For developing countries, the potential benefits from advances in ICTs could mean the acceleration of economic and social development and could mean the integration and inclusion of isolated, particularly rural, populations into the mainstream of social and economic activity. Fears do exist, however, that countries lacking in education, infrastructure, and institutions--the resources most needed to fully benefit from ICTs—might be further marginalized by the ICT revolution[29]. Unfortunately, there are not many directly comparable lessons available to assist decision makers in developing countries as they attempt to integrate the promotion of the ICT sector with efforts at sustainable development. The challenge of harnessing ICTs for rural development objectives is a difficult one that encompasses many issues, including the awareness of the intertwined relationship between ICTs and rural development and including the establishment of appropriate telecommunications policies for ICT implementation in rural areas.

Focusing on rural China, this chapter will explore three major issues that have needed to be addressed in the process of implementing ICTs. First, it will clarify the effects of ICTs on rural development in general. Second, it will present the current situation of ICT

[27] *Wensheng Wang, The Effect of Information and Communication Technologies on Farmer Households in Rural China, May 15. 1999,*
[28] *Henri Martin, Jean Francois Soupize, The EU and the information society in developing countries*
[29] *Don Richardson, The Internet and Rural & Agricultural Development: An Integrated Approach, 1997*

development in China. Third, with the aim of supporting the theoretical arguments, it will exhibit evidence on the impact of ICTs on farm households.

Before proceeding in this discussion, it is important to note that like most developing countries, the primary level of telecommunications development is concerned essentially with expanding a fixed-line voice- telephone network toward universal rural coverage, especially in remote areas in China. Although the causal relation between access to telephone service and economic and social development was unclear, it was generally believed that telephones appeared after a certain level of development had been achieved, and only then did they facilitate the achievement of more advanced levels of development.

3.1 RURAL DEVELOPMENT AND ICTS

Because everything we do depends on knowledge, knowledge and information are capital for development. Approaching rural development from the knowledge and information perspectives involves taking notice of the increasing presence of knowledge and information in rural areas. The International Development Research Center suggests that access to ICTs implies access to channels and modes of communication that are not bound by language, culture, or distance. New forms of social organization and of productive activity emerge that, if nurtured, could become transformational factors as important as the technology itself[30]. As efficient information intermediaries and facilitators, ICTs provide new communication channels that convey new knowledge and information resources to rural communities.

Enormous benefits await rural communities and agricultural organizations when communication improves among the non-governmental organizations, governmental services, private sector entities and educational institutes that support rural and agricultural development. By sharing information about their activities in the fields of agriculture, rural development, forestry, fishing, mining, health, and education, these agencies can better serve rural people and farmers[31]. The conclusions of previous studies have proved that ICTs offer multiple perspectives for rural development; those perspectives include the following improvements: enhancing productivity, extending the market, improving education and health- care facilities, monitoring environmental disaster, and improving governmental efficiency. However, the benefits deriving from ICT application largely depend on other

[30] *International Development Research Centre (http://www.idrc.ca), July 1996.*
[31] *Dr. Don Richardson, The Internet and Rural and Agricultural Development, 1997*

rural development essentials, especially in rural areas of developing countries, such as education, physical infrastructure and an appropriate telecommunications policy.

3.1.1 Rural Development Essentials and ICTs

It is important to be aware that ICTs do not offer a panacea for rural development. In fact, ICTs alone will not bring about rural development, but they can be an important catalyst. As the social prerequisites of rural development, several essentials should be considered when policy makers seek to secure benefits from ICT application for their rural areas. These essentials of rural development can be classified into three categories: human capital, physical infrastructure, and integrated development policies.

Human Capital

Human capital is a crucial factor for social and economic development and is becoming increasingly important in knowledge societies. It is obvious that ICTs are always associated with high technologies; in some aspects, their application requires skilled technical-support professionals and highly educated consumers. In developing countries, due to widespread illiteracy and generally low levels of education in rural populations, rural people are disadvantaged, and therefore, they lack the basic skills required to harness the benefits of ICTs. This is because most pictographic and audio-visual information usually has some text that goes with it. Hence, investment in human capital should be emphasized in order to maximize the benefits of ICTs- use.

Micro-econometric evidence also suggests that education affects the diffusion and absorption of knowledge and information[32]. No doubt, lower education levels can limit and abate the extension of ICT applications and ultimately hinder their positive impacts on rural social and economic development. Therefore, to ensure more meaningful participation in rural development, and to pave the way for the creation of a critical mass of people who effectively harness ICTs in developing countries, training and capacity building must be an integral part of all ICT-implementation projects.

Physical Infrastructure

In addition to ICTs, other fundamental infrastructure -- water, power, and transportation -- are crucial for rural development. If it is true that human beings cannot live by bread alone, it

[32] *Knowledge for Development, Word Development Report 1998/99, The World Bank*

is equally true that human beings cannot live by information alone. It is clear that without an adequate supply of water, power, fundamental transportation networks and facilities of other related infrastructures, ICTs cannot effectively contribute to economic and social development. However, in most developing countries, these infrastructures are lacking or are poorly developed in rural areas. Although satellite and wireless technologies are now used in the rural areas of some developing countries, these new technologies can do little for rural development without an adequate supply of electricity and transportation facilities. Therefore, to maximize the benefits of ICT investment in rural areas, investment in electricity, water, and transportation should be at the top of any agenda that aims at implementing an integrated-rural-development policy.

Integrated Development Policy

Appropriate integrated-rural-development policies that include sustainable economic, social, and telecommunication implementation policies, plays an important role in implementing ICTs in rural areas. In most developing countries, the formulation and implementation of policies in the ICT sector are still very rudimentary and call for an integrated set of laws, regulations, and guidelines that will shape the generation, acquisition, and utilisation of ICTs. Most countries lack policies that facilitate the harnessing of new ICTs for rural development; moreover, where policies have been formulated, proper implementation plans are needed.

An integrated-rural-development policy must embrace an appropriate telecommunications policy that specifically concerns rural areas. For instance, in most developing countries, although market liberalization reform has led to the entry of more companies, service provision is provided by government phone companies – such governmental monopoly has rendered the service rather expensive. Moreover, due to highly skewed income-distributions and due to large differences in regional income, some potential telephone-users may not be able to pay telephone tariffs that cover the full cost of telephone service. This inability to afford phone tariffs is particularly true in rural and remote areas. As a result, providing selected telecommunications services at prices below cost may sometimes be desirable in order to spread the benefits of rapid communication in rural and remote areas.

All of these essentials of rural development are required for the benefits of ICT application to be realized. On the basis of this fundamental infrastructure, ICTs offer great opportunities for rural development in many social and economic aspects.

3.1.2 ICTs and Rural Development

Speaking generally, the purpose of rural development is to improve the standard of living of the rural population. Experience indicates that the introduction of sufficient ICT services in rural areas stimulates social and economic development to achieve the goal of an improved standard of living. Balit[33] points out that the least expensive input for rural development is knowledge and information, which are essential for facilitating rural development and are essential for bringing about social and economic change. ICTs make it possible to obtain and to distribute information of all sorts and to bring about the ability to carry out all sorts of transactions electronically. There is growing evidence that the dissemination of ICTs provides increased opportunities to promote rural development in developing countries through enhancing productivity, extending the market, improving environmental monitoring, and providing more efficient governmental, educational and health-care services.

Productivity

The diffusion of ICTs makes it possible for farmers to obtain and to distribute information about various production methods and to distribute, even to share, technologies to enhance their mutual productivity. The widespread distribution of information about the utilization of fertilizer, insecticide, and machinery through ICTs could significantly benefit farmers and enable them to reduce the cost of input and to increase the output of production. In developing countries, weak linkages among researchers, frontline workers, and farmers have been a major constraint; one that has resulted in research findings not being applied by poor rural farmers. ICTs can improve and strengthen these linkages and ensure that farmers can gain access to the specific knowledge and information that are essential for improving productivity.

Access to ICTs also implies access to those channels and modes of communication through which new forms of productive organization and activities emerge. The use of ICTs can transform farm-production organization in which they collectively relate to each other. According to the production theory of economics, small-sized and self-sufficient farms have many features that disadvantage them in competition with big-sized market oriented farms, especially in the international market. Cost-effective ICTs enable small-sized farms to

[33] *Balit,S. ; Calvelo Rios, M. and Masias, L. 1996. Communication for development for Latin America: a regional experience*

restructure their social configuration and to fine tune their production organization and enhance their competitiveness in the market.

The Technical Center for Agricultural and Rural Co-operation (CTA) works towards improving the dissemination of information for the benefit of farmers through improved adoption of new technologies. CTA had launched a Rural Radio Support Program that provides radio files and text files through the websites ONEWORD and WRENmedia, which significantly improve the productivity of farm households[34].

The Market

Commercial transactions are inherently information-intensive activities. In rural and remote areas, lack of information and outdated information often cause market failure, and in their worst instances transaction cannot be carried out at all. There is much evidence to suggest that ICTs can reduce the transaction cost in a whole range of commercial activities, and they can enable a whole range of commercial functions to be carried out quickly and easily. Agricultural producers can more easily gain access to new markets through ICTs, obtain competitive prices of both output and input productions in negotiation, follow up more easily on contracts, explore potential business-development opportunities and predict market and consumption trends.

The latest evidence[35] proves that it is cheaper, for most goods, faster, and more efficient to trade online, by telephone and fax than to trade through a personal, face-to-face transaction. Therefore, electronic commerce could enable farmers to gain access to global market information and could enable farmers to open up new regional and global markets that fetch better prices and increase their earnings. For instance, the Internet was found appropriate for transmitting information across the network. In Latin America, FAO has applied ICTs in a project to establish farmer information networks through which essential information about inputs, prices, markets, weather, and credit are exchanged among farmer organizations, co-operatives, and local governments. An evaluative study of the project reported that the farmers and their associations were able to sell their produce at much higher prices than they would have fetched in the local market and they were able to strategize about when and what quantities to produce.

[34] *Hilda Munyua, Information and Communication Technologies for rural development and food security: Lessons from field experiences in developing countries*

Education

ICTs can be an economical means of investing in human capital, especially in education. The application of ICTs in educational programs can provide rural residents with educational opportunities that they could not have imaged years ago. Tele-education (or "distance learning") techniques provide a whole range of education to rural residents at low cost, from primary school to university.

In most developing countries, the multiplicity of problems facing rural education are well known. These problems include a lack of qualified teachers, a lack of quality educational materials, the inaccessibility and inflexibility of schools, an inadequate linkage between local schools and urban educational facilities, such as libraries and universities. Distance education has been used in the formal setting to enhance teacher performance and to augment learning materials. It has been pursued as a method for reaching populations who are not adequately served by the formal system. For many of the residents of the rural and remote areas in developing countries, this trans-spatial capability of ICTs has the potential to open a broad spectrum of new educational possibilities[36].

In Mexico, over 700,000 secondary-school students in remote villages now have access to the Telesecundaria program. This program provides televised classes and provides a comprehensive curriculum through closed-circuit television, satellite transmissions, and teleconferencing between students and teachers. Although students from rural areas enter the program with substantially lower mathematics and language test-scores than their counterparts at traditional urban schools, by graduation time they equal their urban counterparts in math scores and thereby cut their score deficit in half[37].

Health-Care

Telemedicine is an active and expanding field of ICT application. Good quality data-service capability is necessary so that medical readings, records, and files can be transmitted reliably in rural and remote areas. Now, instead of having to move either the patient to the doctor or vice versa, it becomes possible to move only the relevant medical information. Experience has demonstrated that in addition to direct patient care, valuable telemedicine applications include in-service coaching and training of remotely located health-care staff[38].

[35] *T.W. Oshikoya and M. Nureldin Hussain, Information Technology and the Challenge of Economic Development in Africa*
[36] *Information and Communication Technologies in Development: a UNESCO Perspective, UNESCO, Paris, September 1996*
[37] Annual Report 2000, *infoDev information for development program*
[38] *David F. Barr SR Telecom Inc. Canada. Integrated rural development through telecommunications, 1999*

In many rural areas of developing countries, due to geographic isolation and low population density, health-care is usually inadequate. There, considerable health-care discrepancies exist between rural and urban areas. For instance, medical expertise is concentrated in their capital city; so people residing in rural and remote areas are often required to travel to larger centers for specialized health treatment. The telemedicine based on ICT infrastructure can overcome the distance barriers and the lack of medical experts in remote, non-urban areas and thereby provide prompt and proper treatment to rural patients.

The Health Department of Western Australia (HDWA) is implementing a satellite-telecommunications-network infrastructure to provide tele-health services to remote and rural areas. The project delivers a wide range of services, including consultations, counseling, communications, administration, support, education, training, all of which are enabled through links with tele-centers[39].

Food Security

Because food security problems could destroy social stability and even cause a war, food security is an important issue for rural areas in developing countries. Food security can only be achieved "when all people at all times have access to sufficient food for a healthy and productive life, and has three main components: food availability, food access, and food utilization"[40]. A potentially beneficial area for the application of ICTs relates to the problem of food insecurity in rural and remote areas. ICTs provide effective means to assist in the management of starvation crises and to ensure relief facilities are responsive to those people who are without sufficient nutrition in rural and remote areas. Electronic networking can deliver critical information about food availability, food access, and food utilization to farmers, extension workers, and researchers fighting the crises caused by famine[41].

Disaster Pre-warning and Environment Monitoring

Earthquakes, floods, and other natural disasters often cause chaos in unprepared developing countries, especially in rural and remote areas where insufficient emergency-communications systems limit the effectiveness of responses by external assistance organizations. New ICTs--Geographic Information System (GIS), remote sensing, and satellite early-warning technologies -- provide tools to anticipate and to respond proactively

[39] *Angelita Martini, Telehealth Technologies in Rural and Remote Areas of Western Australia*
[40] *Haddad, L. 1997. Achieving food security in Southern Africa: new challenges, new opportunities*

to such problems. Through these ICTs, information about natural disasters and environmental hazards can be swiftly provided and make rural residents safer. In the area of emergency action, efforts are being made to provide assistance organizations with detailed information about the sites where they must intervene; this information is dispensed by the use of mobile workstations that include all necessary data. Efforts are also being made to sensitize the public to different environmental issues. ICTs are allowing much more information to be made available to the general public, much more quickly than before.

In recent decades, most rural areas in developing nations continue to suffer from severe environmental deterioration, such as serious desertification, soil erosion, and water pollution, which significantly hamper and even destroy rural development. A case example from Indonesia illustrates how ICTs played a key role in the administration and management of environmental programs. Although this example was collected from urban areas, it also seems applicable to rural regions. Government officials, discouraged by weak enforcement of water-pollution standards in Indonesia, developed a publicly accessible database that rated the degree to which companies were in compliance with these emission standards. Companies immediately reacted to this initiative and started taking steps to improve their ratings even before survey results were made public. Civil organizations used these ratings to identify factories that were not compliant with existing regulations, urging them to follow environmentally safe practices[42].

Good Governance

An effective and transparent local government plays a very important role in rural development. For instance, a strategy of sustainable development that features environmental protection laws and telecommunication regulations is essential for rural development. All of these tasks require effective governance, which can establish and adjust relevant policies opportunely and appropriately. ICTs make possible timely and effective communications between rural populations and government departments and agencies, in ways that were previously not possible.

The advent of ICTs also provides an opportunity to extend to rural areas where government services and capabilities that previously had not been provided because of prohibitive costs. ICTs make it possible for developing countries to afford an improvement in the quality of

[41] *Adam, L. (1996). Electronic networking for the research community in Ethiopia*
[42] Annual Report 2000, *infoDev information for development program*

governance. Establishing close links to the government and security authorities, ICTs improve the social security of rural communities and make the performance of government more transparent and effective, especially in rural and remote areas.

In Andhra Pradesh, India, ICT application policy focuses on the government's effort to become SMART (simple, moral, accountable, responsive, and transparent). One example where the state government makes full use of ICTs is in the registration of deeds and stamp duties. Using traditional registration methods, the Indian government had to go through cumbersome steps that could take up to 15 days to register each of the 120 million documents processed per year. This highly opaque process encouraged bureaucratic delay and corrupt practices. Today, by using a network system, the same task is accomplished in just over two hours, with improved transparency and better administrative controls.

3.1.3 Empowering Farm Households

The conventional way of analyzing the impact of technology change is by focusing on farm households as the unit of analysis. In 1965, Becker[43] first introduced new models of household economics that assume that the household acts as a unified unit of production and consumption. As a production unit, farm households must make right decisions to be viable in competitive markets. Becker's models also explicitly recognize that incomplete information and uncertainty are prime factors facing individual decision-makers. Hence, the greater the extent to which communication can be used to reduce uncertainty, the greater it can increase the probability of a correct decision. It means that improved communication and improved information resources can enhance the quality of the decisions that farm households make.

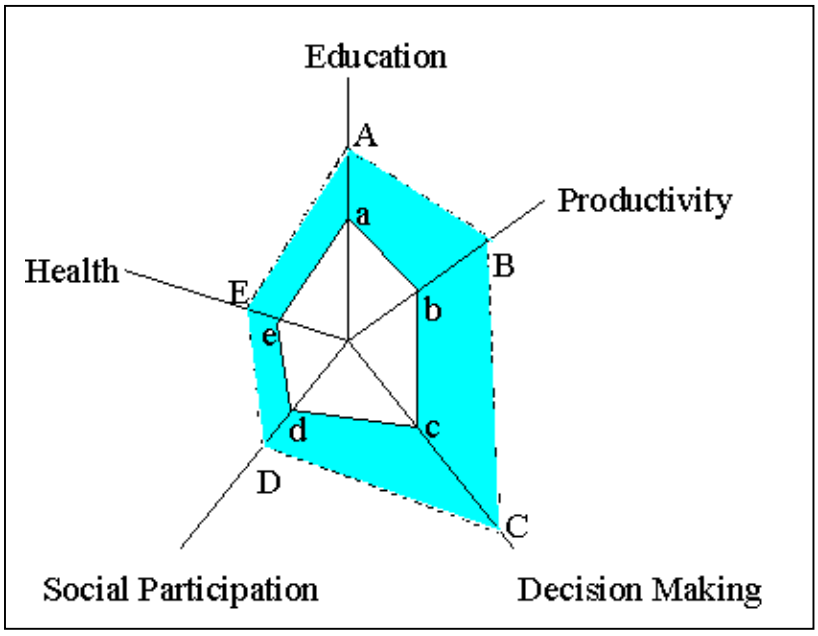
The adoption of ICTs improves the economic and social competence of farm households by fostering their productivity. In developing countries, although a subsistence farmer does not have to interact significantly with persons outside his own family, if his output is to be raised above the subsistence level, communication must take place to facilitate the division of labor—the specialization by function—that increases productivity. For a change to occur, communication, no matter how slight, is necessary for the initial coordination, reorganization, and perhaps technical innovation. ICTs offer a wide range of empowering technologies to farm households that have been heretofore an excluded segment of society.

[43] *Fay Rola-Rubzen, J. Brian Hardaker, Intra-Household Modelling Farm –Household Systems, 1999*

These technologies can also encourage social participation and improve the educational levels and health-care standards of farm households.

Generally speaking, the social and economic effects of ICTs on farm households are interlinked. "Power" is essentially embedded and situated in the perceivable and actual relationships among different aspects of an individual farm household. To summarize and explain the integrated impact of ICTs, a net graph (Figure 5) is introduced to illustrate the changes in these aspects of an individual farm household before and after the adoption of ICTs. After the adoption of ICTs, the empowerment of the individual farm household from the area of "abcde" expands to the area of "ABCDE". The shadow area illustrates the additional area of expansion that represents the improved "power" of the farm household. Although the net graph does not show the precise effects of ICT application on the farm household on each aspect, it does provide a comprehensive overview of these effects. On the one hand, the gray area suggests that the ICT application can simultaneously affect farm households in five aspects, rather than only one aspect. On the other hand, the graph illustrates that ICT applications increase the "power" of the farm household geometrically and not merely linearly.

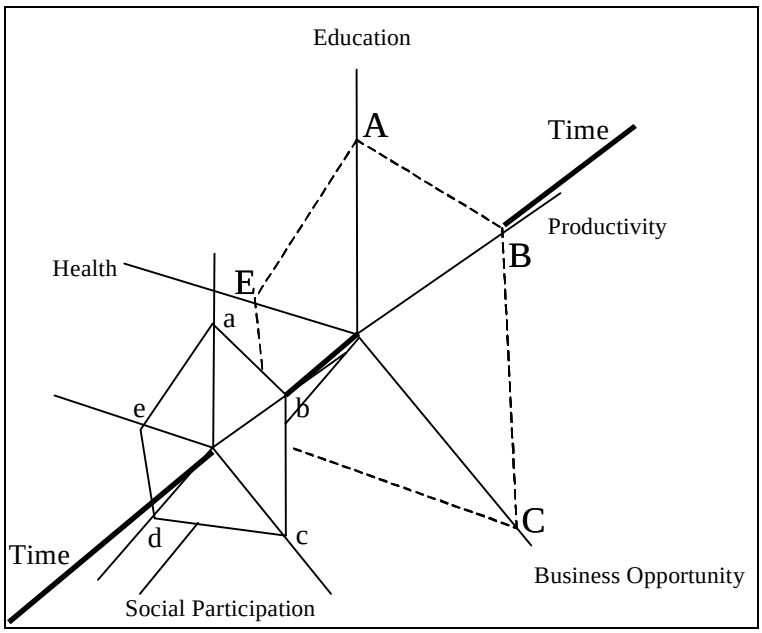
Figure 5: Impact of ICTs on a Farm Household



Source: the author

Furthermore, if the time dimension is added to the net graph, the effects of ICT application in a time series can be illustrated. According to Cronin et al.'s[44] findings, it took four years before telecommunication development had measurable effects in rural communities[45]. This means that the economic effect of the telephone may lag behind the telephone application for a certain period. Combining the time dimension and the five aspects that can be affected by ICTs, the three-dimensional net graph demonstrates the dynamic and multiple effects of ICT application on farm households (Figure 6).

Figure 6: Dynamic Impact of ICTs on a Farm Household



Source: the author

A survey on rural Internet users in North America[46] highlights the impact of the Internet on rural users. Rural Internet users indicate that the Internet provides them with a very convenient method for quickly gaining access to a large volume of information without being impeded by geographic barriers. They further report finding significant information value from the Internet in the form of new ideas, discussion groups, access to expert advice, and resources for continuing education. Additionally, they report social benefits including new opportunities to overcome geographic isolation, increased social interaction,

[44] *Cronin, F.J., Parker, E.B., Colleran, E.K., & Gold, M.A. (1993b).* Telecommunications infrastructure investment and economic development, *Telecommunications Policy, 17(6), 415-430*

[45] *C.Ann Hollifield, The effects of rural telecommunications self-development projects on local adoption of new technologies. Telecommunications Policy 24 (2000) 761-779*

[46] *Dr. Don Richardson,* The Internet and Rural & Agricultural Development: An Integrated Approach, *1997, TeleCommons Development Group, Guelph, Ontario, Canada*

opportunities to organize and to advocate for social change, equalization of urban and rural disparities, and new links between urban and rural communities.

The discussion above largely concentrates on the indirect social and economic benefits that farm households receive from ICT application. However, ICTs also can directly empower farm households by promoting their economic status, such as increasing their income. For instance, pay-phones and tele-centers derive higher revenues than residential lines; thus, pay-phones and tele-centers can directly benefit rural operators. Indeed, phone-lines represent an important source of new business generation, creating jobs and income in sectors that have never existed before.

GrameenPhone, in Bangladesh, is a good example of ICTs empowering poor farm households that illustrates the powerful manner in which village pay-phones have transformed the lives of rural people, especially of women. A few women have started small-scale enterprises through small loans from the Grameen Bank to buy mobile cell-phones that have been used to provide telephone services and have earned them a good income. This project has been tremendously successful not only in promoting the living standard of rural women but also in helping to connect their rural community to the world[47].

Having studied the effects of ICTs on rural development, many researchers have found that investment in ICT infrastructure and the resulting improvement in telecommunications services have consistently led to economic growth in rural areas[48]. ICTs have the power to cut across social and geographic distance, thereby helping people find new ways of facilitating the flow of information and knowledge. At the microeconomic level, ICTs can significantly empower farm households in many social and economic aspects, including decision-making, productivity, business opportunities, social participation, and education and health-care.

3.2 THE DEVELOPMENT OF ICTS IN RURAL CHINA

With its GDP more than quadrupling in the past ten years, China is the fastest-growing large economy in the world. The growth of ICTs, with double the growth rate of GDP, has been impressive in the developing world. There are several remarkable characteristics associated

[47] *Abdul Bayes, Jahangirnagar, Joachim von Braun, Rasheda Akhter, Village Pay Phone and Poverty Reduction: Insights From a Grameen Bank Initiative in Bangladesh, 1999*

with China's rapid development of ICTs: fast growth pace and low penetration rate, the digital divide between urban and rural areas and among rural areas.

3.2.1 Fast Growth and Low Penetration Rate

Having experienced rapid political, economic, and social change, China's telecommunication sector has been growing at annual rates of between 30 and 50 percent for the past ten years[49]. In contrast, the growth rate of the national GDP was 7 percent, and the total population increased by 1.2 percent in the same period. By the end of 1998, the capacity of national telecommunication had increased by 28 percent over 1997. For only one year, 1997-1998, China connected more than 15.77 million mobile lines with a 60 percent annual increase, 17.04 million main telephone lines with a 42 percent increase. Long-distance optical-cable increased by 22 thousand kilometers (Table 1).

Table 1: Telecommunication Development from 1997 to 1998 in China

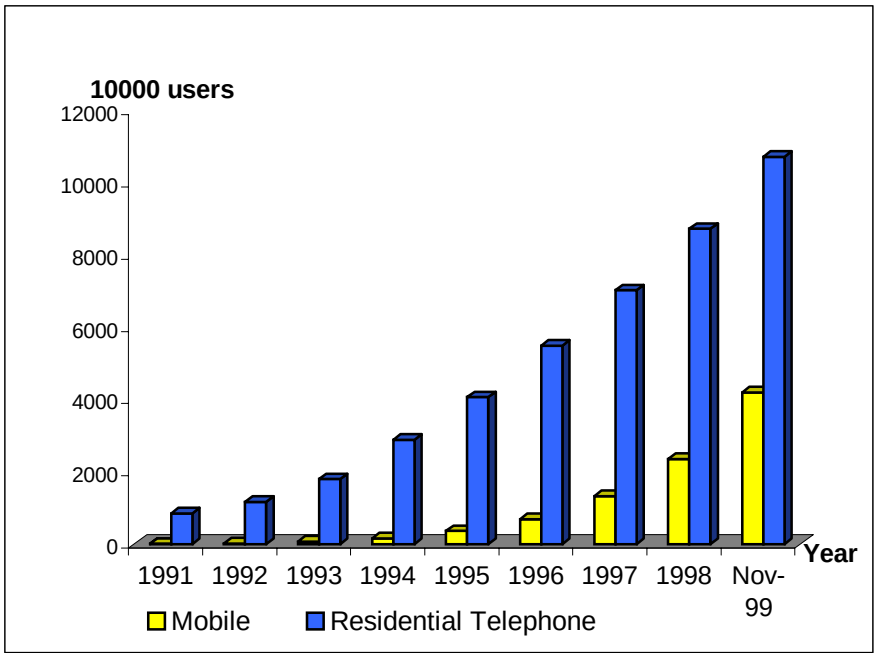
	1997	1998	Growth (%)
Local Exchangers (million sets)	112.7	134.9	19.7
Long Distance Exchangers (million sets)	4.4	4.8	10.5
Mobile Exchangers (million sets)	25.9	41.6	60
Long Distance Circuits (million lines)	1.1	1.6	42.3
Long Distance Optical Cables (thousand kilo meters)	151	173	15
Telephone Lines (million)	70.3	87.4	24.2
Telephone Sets (million)	101.1	131.4	30

Source: RCRE

Figure 7 illustrates the development trend of China's residential and mobile telephone over the past ten years[50]. By the end of 1999, the national telephone density rate had reached 13 percent; in particular, the urban telephone-penetration rate was 28.4 percent. In fact, China has become the second-largest public telephone network and the largest mobile-phone market in the world.

[48] *Edwin B. Parker, Telecommunications and Rural Development: Threat and Opportunities, 1996*
[49] *The Global Diffusion of the Internet-March 1998*
[50] *The population growth rate is about 1%, and GDP growth rate is about 8% in average at the same time period.*

Figure 7: Telecommunication Development in China



Source: RCRE

Compared to the growth of telephone penetration, the development of the Internet has been even faster. Because the Chinese government heavily invested in a dozen backbone networks and in the PC-manufacturing industry for a decade, Internet application has spread at an unprecedented pace nationwide. By June of 2000, the number of Internet users[51] reached 16,9 million, a 28-fold increase since 1997, and a 500-fold increase since 1995. Projections of future growth vary from 33 million users by 2003 to surpassing the United States in 2005; this will give China the most Internet users in the world (Figure 8)[52].

Comparing ICT development in China with ICT development in India[53] may further illuminate China's ICT diffusion in the international context. As a result of heavy investment during the 1990s, Chinese telecommunication has rapidly outgrown that of India. For example, in 1996, telephone density was 4.46 mainlines per 100 persons in China; that compares with India's 1.54 mainlines per 100 persons. The gap has continued to widen since 1996. India's investment in telecommunication was $1.794 billion in 1996; by contrast, China

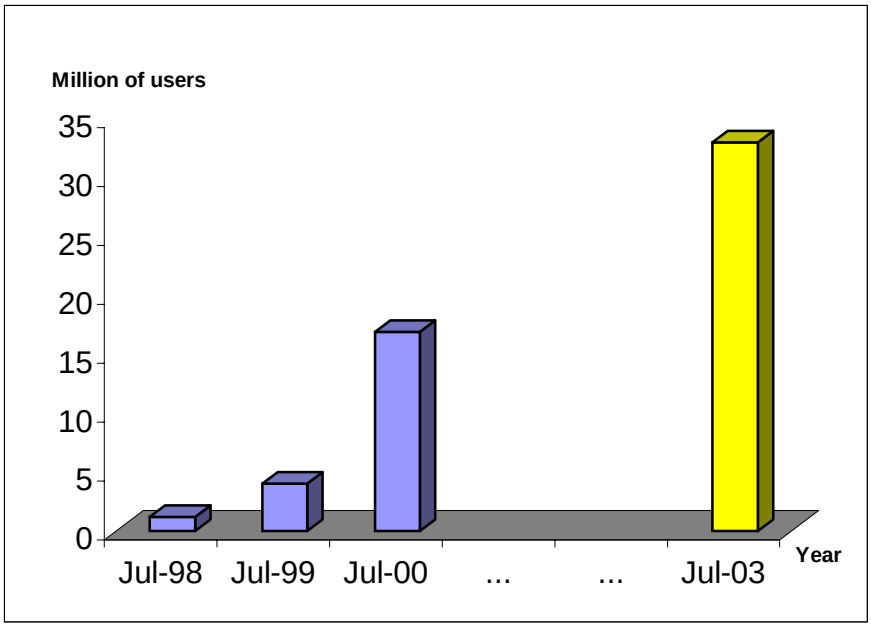
[51] *According to the Report on the Development of Internet in China (July 2000, CNNIC), an Internet-user refers to a residential Chinese citizen who owns his/her own or who shares a Network computer or a network account.*

[52] *Dong Fu, The Internet in China*

[53] *India and China are both large developing countries under relatively similar social and economic conditions, such as large population, the similar initial conditions of industry and telecommunication infrastructure, etc.*

invested $13.038 billion. Consequently, although India joined the Internet before China, the Chinese Internet quickly caught up to and surpassed India.[54]

Figure 8: The Development of the Internet in China



Source: Dong Fu, the Internet in China

However, despite the fast growth of the telephone and of Internet application, the national telephone density and the Internet user rate remain relatively low. For instance, compared with the current Internet-penetration rate of 42 percent in the United States, the penetration rate of Internet users in China reached only 1.4 percent. Furthermore, when considering that the concentration of Internet users is largely in urban areas, the rural Internet user rate is extremely low. The situation in telephone application seems much better but is still similar to the Internet situation. Indeed, two striking characteristics demand notice in China's telecommunication development: the fast pace of development and the relatively low penetration rate. Generally, these consequences result from a huge total population and a low base level of telecommunication capacity.

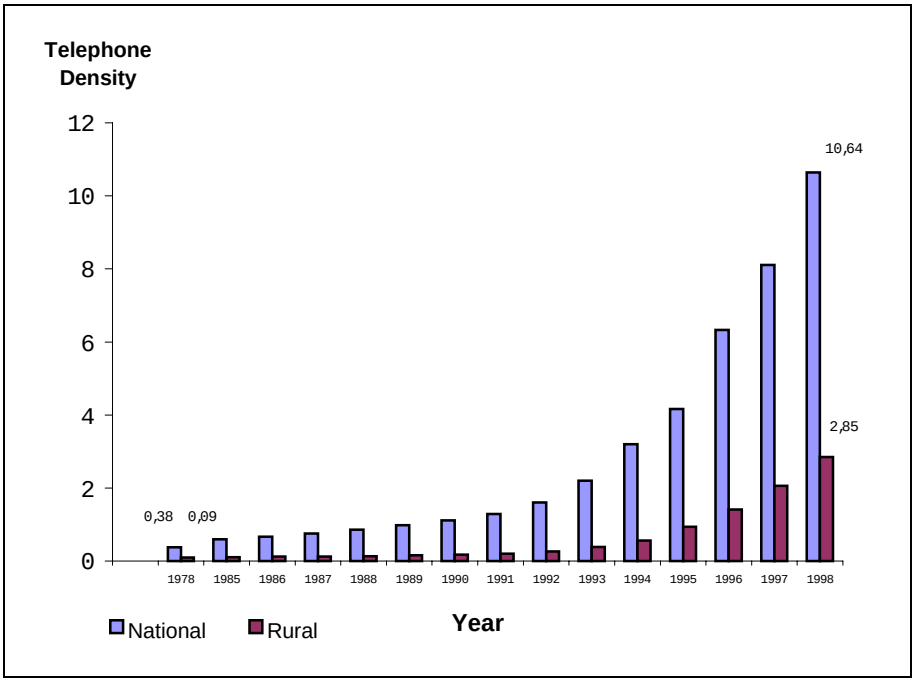
3.2.2 The Digital Divide between Urban and Rural Areas

Like most developing countries, China's telecommunication development is severely imbalanced between its rural and urban areas. Due to low population density and geographical disadvantages, the comparative cost of investment in ICT infrastructure is

[54] *Larry Press, California State University, William A. Foster,* The Internet in India and China, *University of Arizona, Seymour E.*

extremely high in rural areas. For more than four decades, rural China has been at the "Last mile of connectivity". By the end of 1998, China's rural areas had about 70 percent of the national population but only 20 percent of its total number of telephones. Compared to an urban telephone density of 27.7 percent, the rural telephone density of 2.85 percent is 10 times lower than urban telephone density (Figure 9).

Figure 9: Development of Telephone Subscription in China



Source: RCRE

Nevertheless, the situation of ICT development in rural China has improved gradually, thanks to general economic development and to the influx of ICT investment in rural areas. In 1998, the number of new telephone subscribers reached 6.913 million in rural areas, a 38.7 percent increase over 1997. The growth rate was two times more than that in urban areas. By the end of 1998, total telephone subscribers in rural area had reached 24.78 million[55], among them were 20.62 million rural household subscribers[56].

3.2.3 The Digital Divide Among Rural Areas

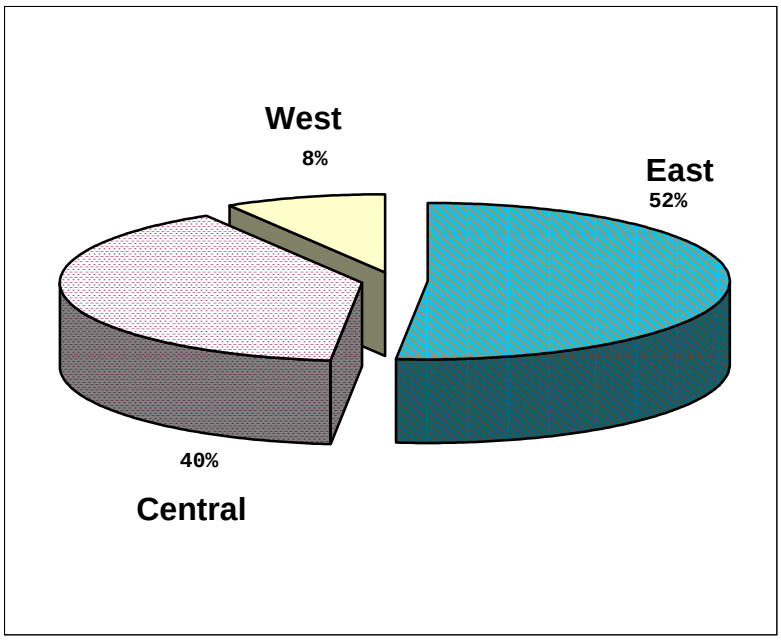
The geographical distribution of rural ICT application further illustrates the wide divide in connectivity among regions. Traditionally, China's regions are divided into three categories according their geographical location and administrative divisions: eastern, central, and

Goodman, Stanford University.

[55] *The China's urban and rural population was 379,42 million and 868,68 million respectively in 1998.*

western. Figure 10 shows that the eastern region possessed the largest segment of total telephone subscriptions, and the western region possessed the smallest fraction, six times lower than the eastern region. According to recent survey studies on the unbalanced access to ICTs in both developed and developing countries, the causes yielding these inequalities can be summarized by examining geographical and socio-economic factors in these regions. The first is the geographical accessibility of a locality. Most researchers found that there is a close linkage between geographic features and local telephone application; this linkage shows that geographic accessibility relates to telephone access. Generally, the geographic feature of each region from east to central to west is marked by plains, hills, and mountains respectively. The second are the demographical indicators; the population density of these regions appears opposite of their geographical elevation: the eastern region has the highest population density followed by the central region, while the west, the most geographically elevated, has the lowest population density. The third is the level of economic development in these regions, which paints a similar picture. These phenomena are consistent with the findings of most previous studies on telecommunications demand and supply, which have proven that regional geographical accessibility, the population density, and the level of economic development relate closely to local telephone application.

Figure 10: Rural Telephone Divide by Region



Source: RCRE

[56] *Bingsheng Ke, Xiaohui Zhang, RCRE, The Development of ICT and Its Impact on Rural Economy in China, 1999*

Compared to telephone development, the Internet is largely concentrated in urban areas. While commercial Internet access is now available in over 200 metropolitan cities from every Chinese province[57], most rural areas have not yet been networked. According to the latest Internet survey, this divide was not narrowing, but widening. To bridge the widening gap of Internet connection between rural and urban areas, the Chinese government has recently launched the "Gold Farm Engineering" project, which promotes Internet application in rural areas. Nowadays, 5000 networked telephones have been installed in rural areas, and more than 200 agricultural websites have been created[58]. Riding on the back of the government-sponsored information highway and on the back of the fast-growing telecommunication market, government organizations, research institutes, and private sectors provide information on agricultural production, techniques, and trade for both producers and consumers. Examples include *China Cereals Trade Net* (www.cctn.net.cn), run by the Information Center of MOA, which provides information on domestic and international cereal trade; *FarmChina* (www.Chinafarm.com), a B-to-B website in China specializing in agricultural products that provides an e-commerce platform to connect buyers and sellers globally.

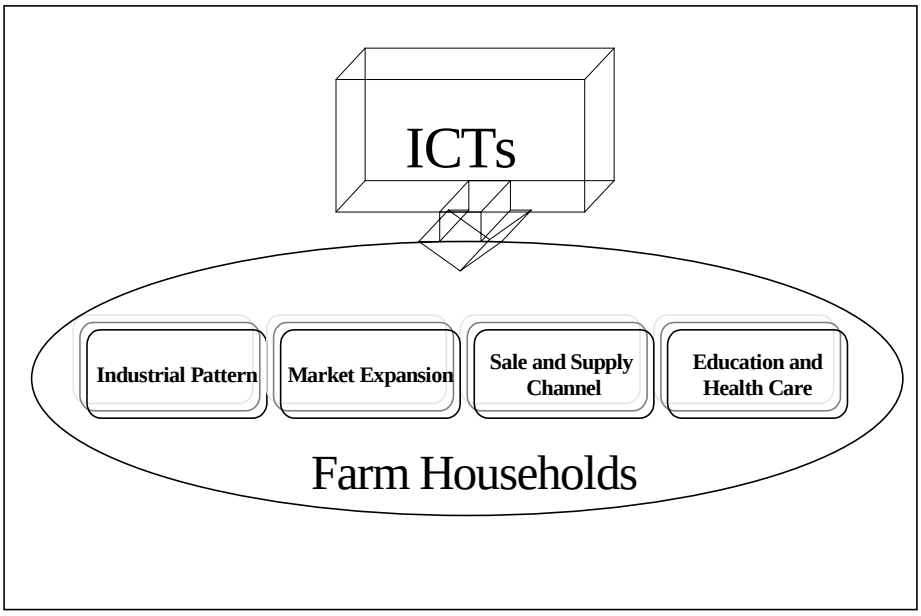
It is important to recognize the potential threats that unbalanced development of ICTs pose to the sustainable development of a nation. There are many reasons why the growing digital divide should be a cause of concern. First, the gap in the availability of ICTs is much larger than income disparities for some regions. In particular, the gap is growing in the availability of advanced ICT services, such as Internet access. Second, there is a significant threat of less developed regions, particularly in rural and remote areas, being forced into an ICT-related poverty trap. There is growing evidence that ICTs are vital for participating in social and economic activities nationwide. Regions that do not have sufficient access will be increasingly excluded from the regional or national trading system. For instance, if the poor have no access to ICTs, they might fall further behind. Third, the gap in ICT access within a region aggravates the social and economic inequalities. This will become even more serious as government and social service providers migrate on-line. The developmental impact and the risks of economic exclusion presented by the digital divide suggest that it is important that governments implement an appropriate telecommunications policy that can fully seize the opportunity for the development of ICTs and thereby reduce the threats posed by a digital divide.

[57] *Larry Press, California State University, William A. Foster, University of Arizona, Seymour E. Goodman, Stanford University*, The Internet in India and China

3.3 EVIDENCE OF THE IMPACT OF ICTS ON FARM HOUSEHOLDS IN RURAL CHINA

As the discussion above indicates, the contribution of ICTs to rural development is expected to be predominantly achieved through their adoption and applications. The diffusion of ICTs throughout all social and economic sectors in rural areas is far more important than the production of ICTs. Despite a low level of ICT application, evidence of significant social and economic impacts of ICTs on rural China has been accumulated in recent years. They have all proven that ICTs, including telephone and Internet access, have significantly positive impacts on farm households in various economic and social aspects, such as industrial pattern, market expansion, change in sale and supply channels, and improvement of education and health-care (Figure 11).

Figure 11: Evidence of the Impacts of ICTs on Farm Households in Rural China



Source: the author

3.3.1 ICT Application and Industrial Pattern

Based on small tracts of arable land per capita, about 1.6 Mu (0.11 Hectare), most Chinese farm households are self-sufficient and production sizes are usually very small. As telephone and Internet-access services penetrated counties and villages, pioneer farmers quickly adopted these technologies to expand the size of their production, to reorganize their production structures, and to enhance their operation efficiency.

[58] *Xinhua news agency, 15/11/2000 and 28/11/2000*

An interesting story happened in the suburbs of Wuhan, the capital of Hubei province. In this area, there are over a hundred specialized duck farmers. In the past, farmers got up before dawn and went to the streets to sell their ducks. Sometimes a farmer with a hand-driven truck of ducks could not find a buyer in the course of an entire day. When programmed exchangers were installed in the township at the end of 1996, the situation changed. Using telephone connections, poultry farmers contacted many hotels and restaurants in the city, and their ducks were directly sent to the customers according to the phone orders. Telephone application transformed their production from small scale to current larger scale and shifted their self-sufficient and closed-production pattern to industrial operations. As a result, by the end of 1997, all of the villagers had subscribed to telephones[59]. Other farmers who specialized in vegetable, fruit, livestock, and aquatic production benefited from the telephone service as well. In 1997, the total output value of their production reached 2300 million RMB, a 17 times increase to that of 1995.

3.3.2 ICT Application and Market Expansion

Because information is one fundamental factor in commercial activities in rural and remote areas, a lack of and outdated information often cause market failure. At worst, transaction cannot be carried out at all. There is much evidence to prove that ICTs can overcome distance and cost barriers and quickly provide accurate market information for farmers. The examples below illustrate how Internet access enables market extension.

Shuoguang county, called “the home of garlic”, is one of the biggest vegetable production bases in China. In 1997, when the garlic harvest was larger than average, farms worried about their garlic sales because of the garlic surplus and resulting sharp decline in the price of garlic in the domestic market. To tackle this problem, some farmers decided to put a garlic advertisement on the Internet website provided by the Information Center of the Ministry of Agriculture. The outcome was far more successful than they had expected: they found a foreign market and sold their garlic at a good price. Today, they have created their own website, providing commercial and production information on garlic and other agricultural production[60].

[59] *Bingsheng Ke, Xiaohui Zhang, The Development of ICT and Its Impacts on Rural Economy in China, RCRE, 1999*
[60] *News was from CCTV 1998*

The second example is given by vegetable farmers in Qinggao county in the Shandong province. Through the Information Network of the Ministry of Agriculture, they sold 2 million kilograms of vegetables and generated an additional income of 200,000 Yuan RMB[61].

3.3.3 ICTs and Change in Sale and Supply Channels

The advantages of ICT application, such as telephone and e-business make sales channels more transparent for farmers. Costs in sales channels have traditionally been significantly high in rural China, due to a lack of market data and an inability to access directly the ultimate consumers. With telephone application and the advent of Internet access, there is a much greater potential to eliminate middlemen who do not add value to the products.

For instance, Haikou village, in Jinshui town in the suburbs of Wuhan, is well known for producing balsam pear. Although villagers had had bumper harvests for years running before they installed telephones, they had not been profiting from those bumper crops because local middlemen had been forcing prices down. At one point, vegetable middlemen joined together and forced the balsam pear price (which had been already very low) down even further from 0.2 Yuan to 0.16 Yuan per kilogram. Some villagers said angrily: “We prefer throwing them away to selling them”. When the telephone lines arrived at the village in 1998, a few farmers installed telephones. Using the telephone, they contacted vegetable dealers in their neighboring province, Hunan. The vegetable dealers from Hunan came to purchase balsam pear at 0.6 Yuan per kilogram, much higher than the local middlemen’s offer. This experience led to the installation of 41 telephone sets in this village in less than 2 months[62].

On the other hand, the widespread distribution of information on the utilization of fertilizer, insecticide, and machinery through ICTs could significantly benefit farmers by reducing input costs of production. For instance, as more and more suppliers of agricultural production materials go on-line, local supply markets will become an integrated supply chain nationwide. This integration means that by using Internet, farmers can enjoy the benefits of having low cost inputs in an expanded and fully competitive market.

3.3.4 ICTs, Education and Health-Care

[61] *People Daily Sept. 22, 1998 (www.peopledaily.com)*
[62] *Bingsheng Ke, Xiaohui Zhang, The Development of ICT and Its Impacts on Rural Economy in China, RCRE, 1999*

ICTs can be an economical means of investing in human capital. The application of ICTs in education programs can provide rural residents with educational opportunities that they could neither have expected nor even have imagined years ago. Tele-education techniques can provide higher education to young rural residents and technical training to adults at low costs.

In China, for millions of farm households living in remote and mountainous areas, even if there were schools and colleges available, the lack of qualified teachers would fail to meet their demands for fundamental and advanced education. Distance education via the Internet seems to be an ideal method especially suited to the remote areas in rural China.

Nowadays, agricultural universities and research institutes have become pioneers in providing Tele-education for farmers. The Capital Farmer Network (www.capitalfamer.net), which is one of most popular websites specializing in agricultural technology, provides free on-line seminars on new agricultural techniques for farmers. Because the seminars are represented by famous agricultural experts who focus specifically on farmers needs, newly trained farmers enhance their ability to apply these techniques. However, due to a lack of infrastructure of Internet access, only a few farmers can benefit from these on-line services at present.

Telemedicine is another active and expanding field for ICTs. A good quality of data service capability is necessary so that medical readings, records, and files can be transmitted reliably. Today, instead of having to move the patient to the doctor, or vice versa, it becomes possible to move only the relevant medical information. In addition to providing direct patient care, telemedicine applications can also provide in-service coaching and training of remotely located health-care staff[63]. In the mountain areas of Yunnan province, inadequately trained village doctors usually work in primitive medical facilities, often treating their patients in isolation without consulting other skilled doctors and experts. Such conditions result in low quality diagnoses and may even delay emergency treatment. When the domain of mobile phone covers the mountain areas, village doctors use mobile telephone to consult directly with experts at provincial-capital hospitals that are several hundred miles away from the villages[64]. Mobile phones help village doctors to improve the quality of their diagnoses and to provide prompt treatment for their patients.

[63] *David F. Barr SR, Integrated rural development through telecommunications, 1999*
[64] *News was from CCTV 1998*

In addition to direct patient care, experience has demonstrated that valuable telemedicine applications include in-service coaching and training of remote located health-care staff[65]. In the mountain areas of Yunnan province, village doctors usually work in primitive medical facilities and with inadequate training; treating their patients in isolation without consulting other skilled doctors and experts. Such conditions result in a low quality of diagnoses and may even delay emergency treatment. When the domain of mobile phone covers the mountain areas, villages doctors use mobile telephone to consult directly with experts at provincial capital hospitals that are several hundreds mile away from the villages[66]. Mobile phones help village doctors to improve the quality of their diagnoses and to provide prompt treatments for their patients.

In general, ICTs have more wide-ranging impacts on farm households than the aforementioned. For instance, ICTs can provide timely information on natural disasters and environmental hazards, thereby making farmers safer. By establishing close links to government and security authorities, ICTs improve the social security of rural communities and make the performance of the government more transparent and effective, especially in remote areas.

The evidence suggests that ICTs have been providing an historic opportunity for the development of rural China. Rural China should fully seize the opportunity to achieve its social and economic development, to enhance its productivity and competitiveness, to open new markets, to improve education, social health-care systems, the environment, to bridge the information gap between rural and urban areas – should fully seize the opportunity to mend the breach between the information *haves* and the information *have-nots*.

[65] *David F. Barr SR, Integrated rural development through telecommunications, 1999*
[66] *News was from CCTV 1998*

4 DATA RESOURCES, ECONOMIC ANALYSIS, AND RESULTS

> "Once a model has been constructed and fitted to data, a sensitivity analysis can be used to study many of its properties. In particular, the effects of small changes in individual variables in the model can be evaluated" [67].

This chapter attempts to apply econometric methods for identifying and quantifying the determinants of residential telephone subscription and the ways telephones benefit those farm households who have them. This determination is achieved, first, by reviewing data resources and the situation in selected sample provinces; second, by clarifying the relationship between socioeconomic characteristics of households and telephone subscription; finally, by examining several issues pertaining to the effects of the telephone on farm households, which include a change in annual net income and a shift of sideline business types of farm households.

4.1 DATA AND SAMPLE PROVINCES

The analysis of the impact of ICT application on farm households is based on a farm household survey conducted by the Office of the Fixed Sites Rural Survey (FSRS). The range of authority of the FSRS covers the entirety of rural China, its 31 provinces and autonomous regions, excluding Taiwan, that encompass about 20 thousand farm households. To facilitate and to carry out the research efficiently, three typical provinces were carefully selected from the whole sample of extant provinces according to their geographical locations, demographical features, and rank of economic development.

4.1.1 Farm Household Survey Data

The Fixed Sites Rural Survey (FSRS) is under the guidance of RCRE and is operated and checked by statisticians from RCRE and by village statistical assistants. It is necessary to note that the selection of sample households is not entirely random. There have been some constraints placed on household participants, such as the participants needing to have at least one household member who is literate and the location of the household needing to be

[67] *Robert S. Pindyck, Daniel L. Rubinfeld,* Econometric Models and Economic Forecasts

geographically accessible. Thus, the poorest households are probably under-represented in the sample.

4.1.2 Three Sample Provinces

In order to simplify the analysis, three provinces have been selected from among all 31 provinces, municipalities, and autonomous regions. These three provinces have been selected according to the following criteria that consider several key factors related to telephone application: geographic location, demographical characteristics of a population segment, and economic factors.

Table 2: Area, Population Density, and GDP per Capita by Province, 1997

Province	Area of Land (1000 km²)	Population (Million)	Population density (Person / km²)	GDP per Capita (Yuan[68])
Jiangsu	102.6	71.48	697	9344
Shandong	156.7	87.85	560	7569
Sichuan	485.0	84.30	192	3938
National	9600	1236.26	129	6048

Source: China Statistical Yearbook 1998

The detailed indications of geographical location, economic development, and degree of isolation of the three provinces can be gleaned from Table 2. Generally, the three provinces possess 15 percent of the total territorial areas and 22 percent of the total population in China respectively. Figure 12 illustrates the geographical location of the three provinces.

Jiangsu province has a territorial area of 102.6 thousand km², with 71.48 million inhabitants. The combination of the two factors gives Jiangsu the highest population density in China. From Figure 12, we can see that Jiangsu is located in the eastern coastal area and borders Shanghai, the most breathtaking, booming economic and financial center in Asia. Jiangsu 's gross domestic product (GDP) per capita is relatively high due to the fast development of industrial sectors, particularly in village and town ownership enterprises. National comparisons show that Jiangsu sits at the top rung of Chinese domestic economic development.

The second sample province, Shandong, has 156.7 thousand km². Its population reached 87.85 million in 1997. The geographic hallmark of Shandong province is a peninsula facing the Yellow sea and the Bo sea that provides an advantageous location for international trade

with neighboring industrialized countries -- South Korea and Japan. Compared to the economic development of Jiangsu, Shandong's development was relatively lower, but it was still above the national average due to its agricultural and industrial sectors. Especially in terms of the agricultural scale, Shandong was the largest agricultural production region in China. Its several large-scale vegetable production bases supplied a considerable amount of vegetables for domestic and international markets.

Figure 12: Geographic Locations of the Sample Provinces

Source: the author

The third sample province, Sichuan, is marked by its abundant natural endowment, which explains, perhaps, why the area was called a "Heavenly Territory" in ancient times. It has a population of 84.30 million, and its economy is dominated by agricultural industry. The geographic hallmark of Sichuan is its land-locked basin located in west-central China. The surrounding mountains isolate Sichuan, and they significantly limit and hamper its economic and social exchange with other regions. However, the Yangzi river, the second-longest river in the world, wends across the whole province and provides an alternative and efficient means of transportation. Due to its geographic disadvantage, Sichuan's economic development lags far behind Jiangsu and Shandong, and it is well below the national average.

[68] *Yuan ≅ 0.22 DM, in 1997.*

From Table 2, we also can see that Sichuan is the largest province among the three regions, in terms of territorial area, while Shandong is the second-largest, and Jiangsu is the smallest province. However, if we rank the three provinces by population, the largest province is Shandong, followed respectively by Sichuan[69] and Jiangsu.

Combining the two factors territorial area and population, the table reports that Jiangsu has the highest population density of the three provinces, followed by Shandong and Sichuan. Regarding the provincial GDP, the highest is also Jiangsu, followed respectively by Shandong and Sichuan. Among the three regions, only Sichuan's GDP per capita was lower than the national average, but Jiangsu and Shandong were much higher.

4.2 OVERVIEW OF TELEPHONE APPLICATION IN SAMPLE PROVINCES

Generally speaking, the extent to which telephones have penetrated rural households can be viewed in two different ways. The first is the spatial location of those farm households that own telephones. The second is the ownership of telephones by farm households that display different socioeconomic characteristics. Estimation of these factors has been achieved, first, by investigating the spatial variations in telephone penetration by provinces and by villages within the provinces, and second, by examining the relationship between telephone subscription and the socioeconomic characteristics of farm households. The socioeconomic factors concerned include the following: household income and sale of grain, farm sizes, sideline business types, and the age and education level of the head of household.

4.2.1 Spatial Variations in Penetration

Spatially, telephone penetration varies among different provinces and within provinces; this variation has many causes. In fact, telephone penetration is high in plains and hills areas; relatively low in mountains areas, especially in areas that are experiencing low levels of economic development. The following section analyzes the variations in telephone penetration at both the provincial and village levels respectively.

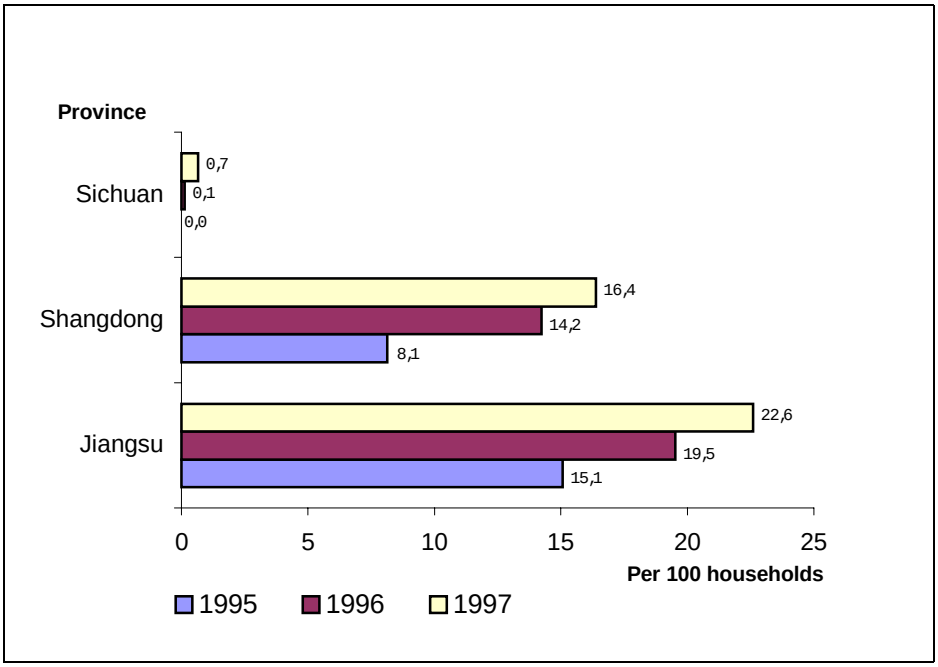
Provincial Variations in Penetration

[69] *The demographic and geographic situation in Sichuan province had been changed in 1996, after Chongqing became autonomous when the city was split from Sichuan province. Before administrative rearrangement, Sichuan had the largest population in China.*

The analyses of the FSRS data show that on average 14.3 percent of farm households had a telephone in the three sample provinces in 1997, with telephone density ranging from 22.6 percent in Jiangsu province to 0.7 percent in Sichuan province. Because the Jiangsu and Shandong provinces are located in the eastern coastal areas, where social and economic development is relatively faster than in western inland provinces such as Sichuan, they have relatively higher telephone penetration and higher income of farm households. Figure 13 presents the telephone density by sample provinces from 1995 to 1997.

From Figure 13, we can see that there is considerable variation in telephone penetration between the western inland province, Sichuan, and the two eastern coastal provinces, Jiangsu and Shandong. Telephone penetration in Jiangsu and Shandong was 22.6 and 16.7 percent respectively, which is much higher than Sichuan's 0.7 percent. These patterns of penetration are broadly reflective of geographical variations associated with differences of economic development across the regions. As the description above has stated, Jiangsu and Shandong are located in the east-coast areas. Occupying advantageous geographic positions for trade and communications, Jiangsu and Shandong have gained a level of GDP per capita above the national average due to their fast development of industrial sectors and international trade. In contrast, the mountains surrounding Sichuan province have profoundly hampered Sichuan's economic and social development, especially the lack of construction of fundamental infrastructures, such as telecommunications.

Figure 13: Residential Telephone Density by Province



Source: RCRE

Penetration Variations Within Provinces

Telephone penetration does vary among different villages within a province. Because the administrative area of a province is usually very large in China, there are considerable divisions in telephone penetration within each province. To further investigate the situation of telephone application in each province, telephone access to the villages is exhibited in Table 3. To simplify the analysis, a village where no telephone existed was defined as a village *without telephone access*; otherwise, the village is assumed to be *with telephone access*. Based on this definition, all villages had telephone access in Jiangsu province by the end of 1997. In contrast, there were two villages without telephone access in Shandong and Sichuan. The figures in the table also indicate a different degree of universal telephone service across regions. For instance, in Shandong province, although provincial telephone density had reached 16.7 percent in 1997, there were still two villages, 13 percent of the villages, without telephone access. Sichuan province presents a different picture. Despite the fact provincial telephone penetration was very low, only 0.7 percent, most villages, 83 percent, had some form of access to a telephone. This means that universal telephone service reached a relatively high level in Sichuan province.

Table 3: Number of Village Access to a Telephone in the Three Provinces

	Jiangsu			Shandong			Sichuan		
Year	Total	Access	Non-Access	Total	Access	Non-Access	Total	Access	Non-Access
1995	11	10	1	16	13	3	15	5	10
1996	11	11	0	16	14	2	15	7	8
1997	11	11	0	16	14	2	12	10	2

Source: RCRE

The data in Table 3 also suggests that although the number of villages without telephone access in each province has declined over time, two villages in both Shandong and Sichuan continued to exhibit telephone absence until the end of 1997. These exceptions may imply that conditions in regions may have made it difficult to implement universal telephone access, despite strong economic development and the adoption of new ICTs.

Table 4: Number of Telephone Subscribers in the Villages of the Three Provinces

	Jiangsu			Shandong			Sichuan		
Year	Aver.	Max	Min	Aver.	Max	Min	Aver.	Max	Min
1995	58	425	0	29	100	0	2	9	0
1996	85	440	5	50	145	0	4	20	0
1997	75[70]	440	10	60	182	0	7	50	0

Source: RCRE

The data of the statistical analysis in Table 4, containing the maximum, minimum, and average number of telephone subscribers in the villages by provinces, present more insights about penetration variations within a province. For instance, in Jiangsu province in 1997, the maximum number of telephone subscribers in a village was 440, but the minimum was 10, while the two villages had 516 and 285 households respectively. In comparison with the situation in Jiangsu province, Shandong and Sichuan show relatively moderate variation in telephone applications. This comparison suggests that the difference in penetration among villages within a province is profound in some regions.

Overall, telephone density varies spatially among different villages within a province and varies across the provinces of the country. This phenomenon matches the characteristics associated with national application of ICTs: the digital divide among regions, which implies the potential threat of sustainable rural development and social equity of rural communities. After discussion of spatial variation in telephone penetration, it remains to be seen what exact relationship will obtain between the ownership of telephones and the socioeconomic characteristics of farm households.

4.2.2 Socioeconomic Characteristics of the Household and the Telephone

Access to telephones is not only a question of the physical location of facilities relative to that of population, but it is also a question of social and economic constraints on use. The analysis so far has been purely spatial: mapping the geographical location of telephone penetration. From the analysis of spatial data, we have no sense of how the telephone is distributed among households displaying different socioeconomic characteristics. In the following part of this chapter the general contention that the socioeconomic characteristics of farm households are relevant to telephone subscription is extended further. Here, the

[70] *There were a few changes in the selection of sample villages annually.*

socioeconomic characteristics associated with farm households include net annual income, sale of grain, education levels of the head of farm households, and sideline business types.

Income, Sale of Grain, and Telephone Subscription

The relationship between income and telephone subscription can be analyzed more clearly when household income and telephone subscription are compared with other socioeconomic characteristics. Table 5 summarizes the household income, income per capita, and sale of grain of sample households in Jiangsu, Shandong, and Sichuan provinces in 1997 by telephone subscription. From the analysis data, we can see that there is a *positive* relationship between telephone subscription and the annual net income of households and between telephone subscription and the *per capita* annual net income of households. This positive correlation supports both the claim that household income is a driver of telephone subscription and the claim that households with the characteristics of high income are more likely to have a telephone. For households without a telephone, both their income and their income per capita are significantly lower than those of telephone subscribers. However, the sale of grain in farm households does not show consistent relation with telephone ownership when examining all households in the three provinces. In Jiangsu and Sichuan provinces, the relationship between the sale of grain of households and telephone subscription is negative. In other words, the sale of grain is not likely to be a determinant of telephone subscription for households in the two provinces. In contrast, the case in Shandong province is quite different. In fact, the farm households with a telephone have a higher sale of grain than those without a telephone in Shandong province. One reasonable explanation for this phenomenon could be that Shandong is the largest agricultural province in China. On the one hand, sale of grain includes a large part of provincial GDP and dominates the income of farm households in comparison with Jiangsu and Sichuan. On the other hand, grain marketing strategies drive the demand for information flow and precipitate telephone application.

Table 5: Economic Characteristics of Farm Households by Telephone and by Province in 1997

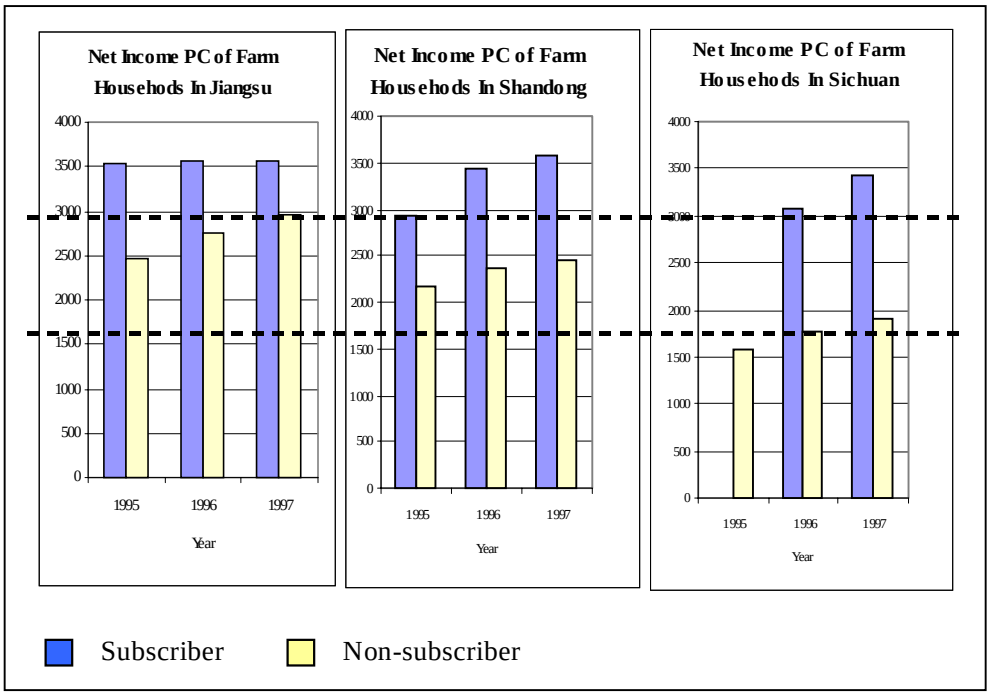
	Sale of Grain		Net Income of Households		Net Income PC	
Province	Subscriber	Non-subscriber	Subscriber	Non-subscriber	Subscriber	Non-subscriber
Jiangsu	4168	9948	12292	10414	3559	2946
Shandong	5795	4667	13402	9271	3573	2460
Sichuan	637	3478	15547	7151	3436	1898

Source: RCRE, Unit: Yuan ≅ 0.25 DM

An Income Threshold of Telephone Subscription

An important fact explored by the analysis of the data is that the net income per capita of households in each province is almost equal; moreover, the net income per capita falls into narrow intervals. There seems to be a threshold of telephone subscription in income per capita. Figure 14 clearly illustrates an interval of the threshold, where the left bar refers to average net income per capita of a farm household with a telephone, and where the right bar refers to those without a telephone. From the figure, we can see that the threshold interval is between about 2000 and 3000 Yuan in the three provinces over the period from 1995 to 1997. This threshold implies that if a farm household enters this interval of net income per capita, it is more likely that the household will be a telephone subscriber.

Figure 14: Net Income PC Threshold of Telephone Subscriber



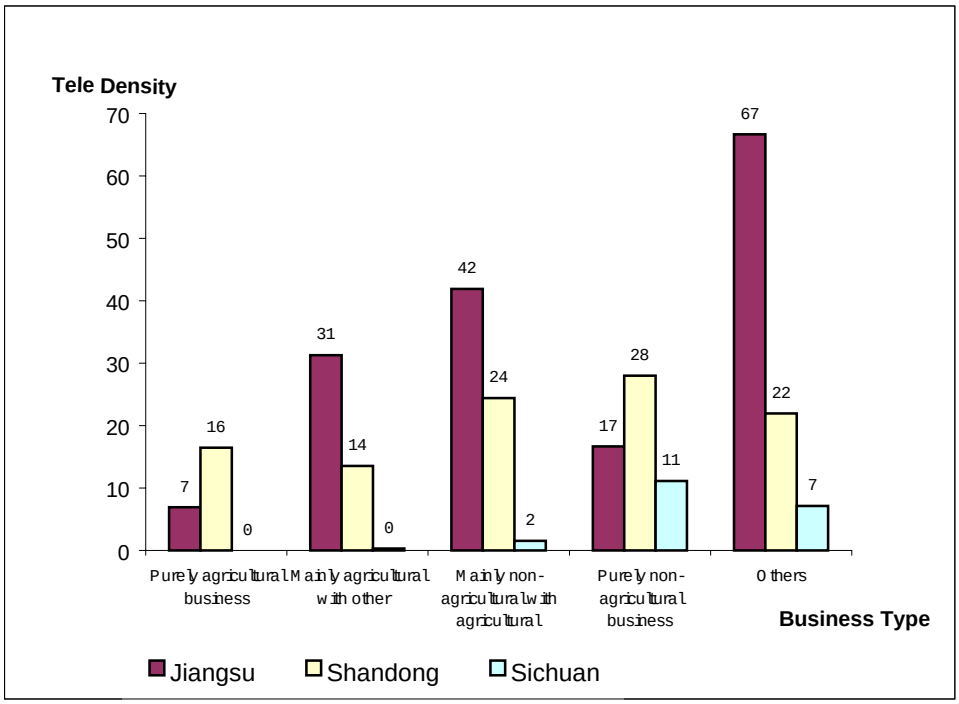
Source: RCRE

Sideline Business Types and Telephone Subscription

Sideline business types are supposed to be important to the decision of telephone subscription for a farm household, but the relationship between the sideline business types and telephone subscription becomes more complicated and varies across provinces when we look more closely at the specific social and economic situation within each province. In Jiangsu province (Figure 15), we can see that farm households with the sideline business type of "other" had the highest telephone penetration, at least 67 percent. However, the

numbers of telephone subscribers were very low, only 2 households have a telephone. Compared to households with other sideline business types, the exclusively agricultural households had the lowest telephone density, but the numbers of the subscribers were relatively high. For instance, only 7 percent of households had telephones, but the absolute number of telephone subscribers was 22.

Figure 15: Tele Density by Sideline Business Types in Three Provinces in 1997



Source: RCRE

As Figure 15 indicates, in Shandong province the distribution of telephone density was relatively even among the sideline business types in 1997. The farm households with purely agricultural and mainly agricultural business types occupied the largest part of the total number of telephone subscribers. Because its overall telephone density is very low, the case is quite unique in Sichuan province. After telephone application had penetrated into rural areas in 1996 and 1997, purely non-agricultural-business farm households obtained the highest telephone density. The second was sideline business types belonging to the category of "other". Figure 15 illustrates the distribution of telephone subscription by sideline business types clearly.

The reasons for the phenomena of the distribution of telephone subscription may differ from province to province. In Jiangsu, as the village and township enterprises developed rapidly and successfully, some farm households switched their specialization from agricultural

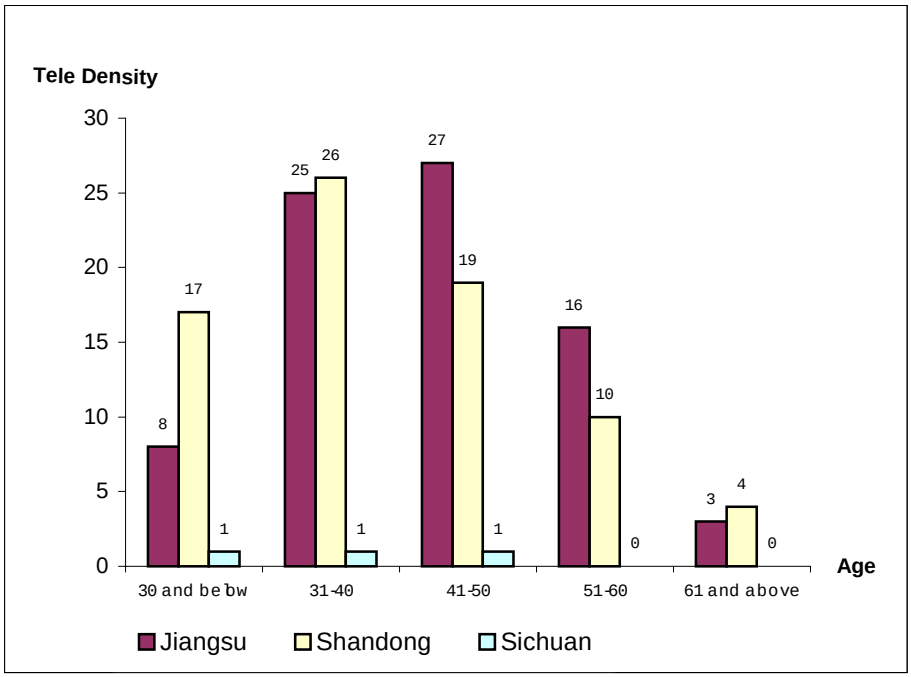
production to other businesses (sideline business types) that lie outside the agricultural domain; this switch resulted for those farm households that made it in high productivities. These farm households seem more likely to have a higher income than those who keep their specialization exclusively in agriculture. However, in Shandong, despite the recent boom in rural industries, agricultural production still continues to play an important role in the provincial economy. This suggests that most farm households improve and intensify their agricultural production rather than switch exclusively to other businesses. In Sichuan province, on the initial level of telephone application, most farm households with a telephone in Sichuan were outside the domain of agricultural production. It seems reasonable that farm households with non-agricultural types of business, such as transportation and commercial services, require more information exchange with customers who reside outside the rural communities of the sellers.

Age of the Head of Household and Telephone Subscription

Figure 16 illustrates the distribution of telephones among different age groups of the head of the household in three provinces in 1997. Generally speaking, the analysis data suggests that households where the head of the household was 31-50 years old had higher telephone density than those households whose head was either younger or older than that age range. Although there are some slight differences among provinces, it seems reasonable to conclude that the older and younger households were more unlikely to have telephones than other age groups.

Moreover, excepting Sichuan province, Jiangsu and Shandong show a similar pattern of telephone subscription of farm households. The households where the head of the households was 31 to 50 years old are more likely to have a telephone. The main reason for this pattern could be that these heads of household in the middle-age groups may accumulate more capital than do younger heads, and they may be more active in business and social communication than their elders.

Figure 16: Tele Density by the Age of Household Heads by Province in 1997



Source: RCRE

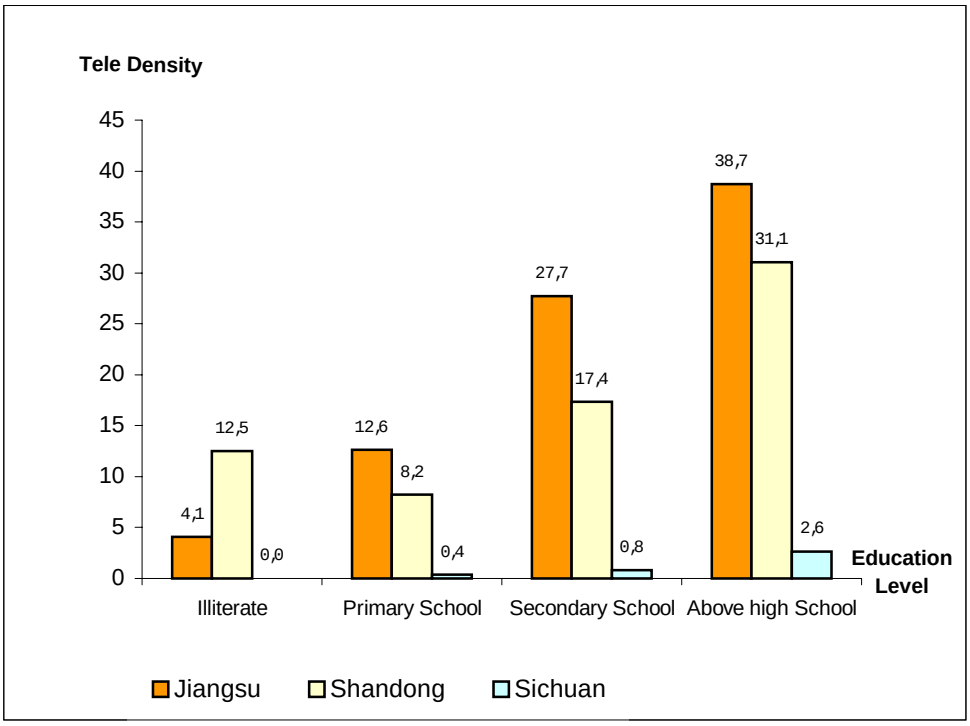
Educational Level and Telephone Subscription

Most studies[71] support the inference that an individual's level of education also influences levels of phone penetration. From Figure 17, we can see that the households where the head of household has a high level of education are more likely to have a telephone than lesser-educated villagers. This result can be interpreted from several angles. First, one of the most powerful effects that education has on farm households is to increase income. Some research results[72] show that part of the association between higher income and basic education can be directly attributed to the knowledge learned in school, which indirectly affects the demand for telephone subscription. Second, basic education represents a person's capability for adopting new technologies. This adoptive capability means that the more educated a farm household is, the more willing is that household to adopt ICTs, such as telephones. Finally, education represents a person's ability to interpret and to absorb information. Farmers who have a higher level of education are more likely to efficiently use and to profit from telephone use because they can better understand the received information and better adapt it to their own needs and local conditions.

[71] *Earl S. Ford, Division of Nutrition, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, Georgia. J. Clin Epidemiol Vol. 51, No. 1 PP. 50-60, 1998, Published by Elsevier Science Inc* Characteristics of Survey Participants with and without a Telephone: Findings from the Third National Health and Nutrition Examination Survey

[72] *Knowledge for Development, Word Development Report 1998/99, The World Bank*

Figure 17: Telephone Density by Education Level of Household Heads by Province in 1997



Source: RCRE

Generally, the statistical analysis of the FSRS survey data indicates that there are considerable variations in telephone subscription among different provinces and villages and among households that display different socioeconomic characteristics. Farm households who have a high annual income and whose head has a high level of education and is 31-50 years old are more likely to have a telephone.

4.3 ECONOMIC IMPACT OF TELEPHONE SUBSCRIPTION ON FARM HOUSEHOLDS

The previous analysis provides the answers to which kind of farm households are more likely to have a telephone and to what extent these socioeconomic characteristics affect telephone subscription. It is natural to phrase the question the other way around: how does telephone subscription impact farm households in terms of economics? To answer this question, the relationship between telephone subscription and the growth of annual net income and between telephone subscription and a shift of farm business types is examined in the following section. Econometrically, linear regression and logit functions are used respectively in presenting these relationships. The estimation method is employed to examine the change in value of the dependent variables between 1995 and 1997; this is

achieved by holding independent variables constant for the base year 1995, but variables related to telephone subscription are excepted.

4.3.1 Estimation Method and Model Specification

In these analyses, the model parameters are estimated via the maximum-likelihood estimation technique employing a Linear-regression and a Logit regression technique. The procedure was performed utilizing SPSS package. The panel data includes approximately 890 farm households and covers the period from 1995 to 1997 in three selected provinces.

In the model specification, the growth of annual net income and shift of sideline business types between 1995 and 1997 are defined as a dependent variable. To examine the relationship between telephone subscription and the change in annual net income, and to determine whether telephone subscription was associated with a shift of sideline business type, a linear regression and a logistic regression were performed. In the two models, the common independent variables that are used include the net annual income per capita, educational level of the household head, the sideline type of business. To perform these analyses, several variables with more than two categories were dichotomised. The sideline business type was divided into mainly agricultural business and other; education into less than secondary school or above; distance from village to a main road into less than 1 km or greater. As a continuous variable, the net annual income per capita was log-transformed to better approximate the normal distribution.

4.3.2 Telephone Subscription and Change in Annual Net Income

Income status is a crucial indicator for economic analysis of farm households. Access to human capital, physical capital, financial capital, and public or organizational capital not only increases the rentability of private assets but also has an effect on farm households via the process of the accumulation of original assets. Because the telephone is a part of the public assets, it is reasonable to predict that telephone subscription can affect the change in income of a household.

To focus on the dynamic impact of telephone subscription on the income of farm households over the three years, three variables related to telephone possession are introduced in the model: weighted telephone subscription and new telephone subscription in years 1996 and 1997 respectively. The weighted telephone subscription is defined as a sum of telephone

subscription for the three years, which can reflect the duration of telephone subscription of a household.

In the model, the average growth rate of annual net income per capita of a household between 1995 and 1997 is defined as the dependent variable. As discussed above, three independent variables related to telephone subscription are included in the model: weighted telephone subscription, new telephone subscription in 1996, and in 1997. In addition, the following independent variables for the base-year 1995 are also concerned in the model: net income per capita, sideline business type, education level, geographic feature of the village of the household, and distance of village to a main road.

$$GINCOME_{9597} = \beta_0 + \beta_1 WTELE + \beta_2 NEWTELE_{1996} + \beta_3 NEWTELE_{1997} + \beta_4 INPC_{1995} + \beta_5 STB_{1995} + \beta_6 EDU_{1995} + \beta_7 GFV + \beta_8 DISTANCE + \varepsilon$$

Where

GINCOME	Growth rate of net income between 1995 and 1997
WTELE	Weighted telephone subscription for the three years
NEWTELE	New telephone subscription
INPC	Net income per capita
STB	Sideline type of business,
EDU	Educational level of the head of households
GFV	Geographic feature of a village
DISTANCE	Distance of the village to a main road
	Unknown parameters
	an error term

To avoid variance across the provinces, the model was run based on the data from each separate province. However, because only a few telephone subscriptions in Sichuan province exist, the analysis results for Sichuan would be statistically unreliable. Therefore, only the analysis results for Jiangsu and Shandong are presented.

Table 6 shows the estimation of the impact of telephone subscription on the growth of annual net income per capita for households in Jiangsu province. From the table, we can see that the duration of telephone subscription and new telephone in 1997 have positive relationships with the growth rate of annual net income per capita. However, the effect of telephone subscription is not statistically significant. One of the possible reasons for this

result could be that in the household survey, public telephone access was not taken into account. In fact, the public telephone plays an important role for farm households in both daily and business activities. Another reason could be the unreasonable allocation and division of the telephone-service administrative regions, which resulted in high phone tariffs and low rates of telephone use. In Jiangsu province, although some farm households have installed telephones, they rarely use them because a call to outside of the village is charged at a long-distance rate[73]. The third reason may be that telephone subscription reflects the potential use of telephone rather than real telephone use and the purpose of the use. The other unique reason may be that farmers in some regions have been forced by local officials to install telephones in order to present the achievement of local development, regardless economic rationality. Nevertheless, to some extent, telephone subscription does show a positive effect on the change in the growth of annual net income of farm households.

Table 6: Impact of Telephone on Change in Net Income of Farm Household in Jiangsu

Independent Variables	Coefficient	T-value	Significance
Constant	1.885	7.163	.000
Telephone Weighted (1995~1997)	6.221e-03	.282	.778
New Telephone in 1996	-6.488e-02	-.767	.444
New Telephone in 1997	2.028e-02	.224	.823
LN(Net Income per capita in 1995)	-.520	-6.941	.000
Sideline Business Types			
Mainly Agricultural	-6.321e-02	-1.321	.187
Education Level			
Secondary or Above	-2.056e-02	-.663	.508
Village in Plain Areas			
Village in Plain and Hills Areas	-4.019e-03	-.071	.943
Distance to a Main Road >1km			
Number of Observations: 360			
F 8.141			
R .373 R^2 .139			

Dependent variable: Difference of Income PC (97-95) / (2*Income PC 95)

In addition, the new telephone in 1997 and 1996 do not show a statistically significant relationship with the growth of net income per capita. This phenomenon may imply that

[73] *People's Daily, 1999*

telephones release their economic and social effects gradually over the long run rather than in the short run.

The estimation result for Shandong is not similar to that for Jiangsu. Table 7 shows the estimation of the impact of telephone subscription on the growth of annual net income per capita for farm households in Shandong province. From the table, we can see that the duration of telephone subscription, and new telephone subscriptions in 1996 and 1997 have positive relationships with the growth of annual net income per capita. Although the problems that are mentioned above for Jiangsu may also occur in Shandong, the effect of the duration of telephone subscription is statistically significant at the 5 percent level. For the same reason as in Jiangsu, the new telephones do not show a statistically significant impact on the growth of net income per capita in Shandong.

Table 7: Impact of Telephone on Change in Net Income of Farm Household in Shandong

Variables	Coefficient	T-value	Significance
Constant	1.814	6.426	.000
Telephone Weighted (1995~1997)	3.920e-02	2.362	.019
New Telephone in 1996	3.236e-02	.718	.473
New Telephone in 1997	3.937e-02	.735	.463
LN(Net Income per capita in 1995)	-.543	-6.342	.000
Sideline Business Types			
Mainly Agricultural	-5.381e-03	-.145	.885
Education Level			
Secondary or Above	4.624e-02	1.470	.143
Village in Plain Areas			
Village in Plain and Hilly Areas	.116	2.414	.017
Distance to a Main Road >1km	2.397e-03	.060	.952
Number of Observations: 219			
F 6.115			
R .435 R^2.189			

Dependent variable: Difference of Income PC (97-95) / (2*Income PC 95)

Comparison of the effects of the duration of telephone subscription between the two provinces may suggest that the measurable significance of the impact of telephone subscription relates to the level of local economic development. As a local economy develops, the purpose of telephone adoption for farm households may change from

productive usage to consumption usage, such as from business use to daily use. The result of the analysis shows that the duration of telephone subscription for farm households in Jiangsu did not significantly relate to the growth of income of the farm household. In contrast, in Shandong, where the level of economic development was lower than Jiangsu's, the duration of telephone subscription demonstrated a statistically significant relationship with growth of income of farm households. It is reasonable to believe that when economic development within a province reaches a certain level, the reason for the adoption of the telephone by the farm household shifts from business use to daily use, form productive purposes to consumption purposes.

4.3.3 Telephone Subscription and Shift of Sideline Business Types

As inputs to production processes, telephones are not equally important, theoretically speaking, to all farm households with different sideline business types. In a developing country, a self-sufficient farmer with an exclusively agricultural business type does not have to interact significantly with persons outside his own family. However, farmers with "other" sideline business types may need more communications with people within or outside a rural community. For the latter, communication, no matter how slight, is necessary for production and for marketing.

The hypothesis is that the shift of sideline business types of farm household reflects the transition of their production structure. This transition can be measured by estimating the relationship between the transition of a farm household from agricultural to non-agricultural business and telephone subscription. The model is created as the following:

$$\text{Log}\frac{P_{\Delta SBT}}{1-P_{\Delta SBT}} = \beta_1 + \beta_2 \text{PROV} + \beta_3 \text{SBT}_{1995} + \beta_4 \text{EDU}_{1995} + \beta_5 \text{GEO}_{1995} + \beta_6 \text{D}_{1995} + \beta_7 \text{FPA}_{1995} + \beta_8 \text{INC}_{1995} + \beta_9 \text{Tele}_{1995}$$

Where:

P_{SBT} Probability of shift of sideline business type from a mainly agricultural to other for a farm household

PROV Provinces

SBT Sideline business types

GEO Geographic feature of the village where farm households live

PT Number of family member with professional title

D	Distance from village to a main road
FPA	Fixed productive assets
INC	Net annual income of the farm household
Tele	Telephone subscription

The estimation result indicates that there is no significant relationship between telephone subscription and the shift of sideline business types of farm households. The lack of a linkage between telephone subscription and the shift of sideline type of business might mean that telephone subscription as communication instrument influences business efficiency rather than the transition of business types in the short run. Another explanation for this phenomenon may be that telephone subscription itself does not cause of shift of sideline business types for a farm household, but may mean instead that a shift of sideline business may cause a farm household to apply for a telephone.

CONCLUSION AND POLICY IMPLICATIONS

> *"Information is critical to the social and economic activities that comprise the development process. Telecommunications, as a means of sharing information, is not simply a connection between people, but a link in the chain of the development process itself."* [74].

Conclusion

The conceptual analysis of ICTs in this paper has proven that the dramatic development and the rapid distribution of ICTs are increasingly becoming an indispensable force of economic development. Based on the new inventions in micro-electronic technologies, wireless communication technologies, and information-processing technologies, ICTs have brought about an exponential reduction in the cost of transmitting information, an increase in the power of computing, an opportunity for leapfrogging over a traditional development period, a shift from analog to digital information technologies, and a new way of communicating in the social and economic spheres.

Furthermore, the discussion about the economic significance of ICTs draws a comprehensive view of the economic effects of ICT application. Theoretically speaking, if we treat ICTs as an intermediary and facilitator, we can see that the value of ICT-use involves transaction cost, and network externality. In practice, as efficient information intermediaries and facilitators, ICTs provide new communication channels that convey new knowledge and information resources to rural communities and that offer multiple perspectives for rural development, which include enhancing productivity, extending the market, improving education and health-care facilities, monitoring environmental disaster, and improving governmental efficiency. On the microeconomic level, ICTs can directly and indirectly empower farm households in all social and economic aspects. However, ICTs do not offer a panacea for rural development, and their effects largely rely on several essentials of rural development, such as human capital, physical infrastructure, and integrated development polices.

The statistical analyses present a couple of interesting findings regarding telephone application in rural China, from the determinants of telephone subscription to the impacts of possession of telephones. After examining the relationship between relevant characteristics

[74] Heather Hudson ,*World Bank, 1995 - report on Economic and Social Benefits of Rural Telecommunications*

of a farm household and telephone subscription in terms of economics, the paper draws several conclusions. First, the main determinants of telephone subscription for a farm household are net annual income, the educational level of head of household, the number of household members with professional titles, and sideline business types. However, each of these factors shows a different effect on telephone subscription. The analysis result shows that the demand of farm households for telephones in rural China largely depends on farm household net income. The effects of education on telephone subscription show that basic education seems to play a highly important role in the possession of a residential telephone. Moreover, if the head of household has a professional title, the household is highly likely to have a telephone.

Second, there are positive relationships between the duration of possession of telephones, new telephone subscription, and the growth of annual net income of a farm household. Although some of the positive effects of these factors are not large enough to be statistically significant, the consistency of the findings makes them worth noting. They suggest that the telephone is likely to impact the income of farm households in rural China. It is important to note that these effects may be, in actuality, even larger than those that the result of the model analysis shows because there are important additional causes, ambiguous to the survey itself, that affect the results of the analysis. One such cause may be that the economic effect of the telephone usually lags behind the telephone application. For instance, Cronin et al. found that it took four years before telecommunication development had measurable effects in rural communities[75]. Moreover, another ambiguous cause might be that public telephone access was not taken into account by the household survey. However, the public telephone does play an important role for farm households in both daily and business activities. Another ambiguous cause might be the limitation of data; this might be a factor because telephone subscription reflects neither the use of the telephone nor the exact purpose of its use. Furthermore, an unexpected, but very realistic, cause may be the unreasonable allocation and division of the telephone-service administrative regions. For instance, in Jiangsu province, although some farm households have installed telephones, they rarely use them because a call to outside of the village is charged at a long distance rate.

Third, no relationship seems to exist between telephone subscription and a shift of sideline business types. This lack of a linkage may mean that telephone subscription itself does not cause of shift of sideline business types for a farm household, but may mean instead that a

shift of sideline business may cause a farm household to apply for a telephone. Furthermore, as a communication instrument, the telephone influences business efficiency rather than the specific transition of business types in the short run.

Finally, unlike most consumer commodities, telephone demand measures not just new subscribers but also those subscribers who have decided to remain connected to and to use the network over a period time. Therefore, due to data limitations and due to the complexity of the effects of ICTs, acquiring an accurate measurement of the impact of ICTs on farm households is a rather difficult matter. A more specialized and a more detailed survey along with further theoretical study of the value of ICT-use are required in the future.

Policy Implications

Generally speaking, the qualitative and quantitative analyses of ICTs that have been presented in this paper suggest many important implications for China's rural telecommunications policies. First, the research of ICTs and rural development may raise policy-makers' awareness about the importance of ICTs to rural development in China. It is natural to believe that ICTs have been providing an historic opportunity for economic and social improvement in farm households in rural China, both in technological and economic terms. However, despite the fast growth of ICT application, the national telephone density and the Internet user rate in China remain relatively low compared to most developed countries. Moreover, there is a huge digital divide not only between rural and urban but also between developed and less-developed rural areas within China. Although the analyses demonstrate the many opportunities that ICTs bring to rural development, they also present the potential threats that the unbalanced application of ICTs may pose to the sustainable development of a nation, such as forcing farm households into an ICT-related poverty trap, thereby inadvertently aggravating social and economic inequalities.

Second, these analyses provide an insight into rural demand for telecommunications service. A comprehensive understanding of the rural demand for telecommunications is crucial to the formation of an appropriate rural telecommunications policy. The measurement of the determinants of telephone subscription for farm households provides further economic insights about the particular characteristics of rural telecommunications demand. For instance, the threshold of telephone subscription in income per capita, between about 2000 and 3000 Yuan, may indicate the potential rural telecommunications market. These findings

[75] *C.Ann Hollifield, The effects of rural telecommunications self-development projects on local adoption of new technologies*

also provide implications that are distinctly useful for the drafting of policy: in order to implement an efficient telecommunications policy in rural China, the factors of utmost concern and importance should be the development of the local economy in an concerted effort to increase the income of farm households and to improve the average level of education of local farmers.

Finally, the econometric results prove that telephone subscription has a positive relationship with the growth of the income of farm households; however, the significance of the relationship changes as a local economy develops. On the one hand, policy-makers may confidently trust that investment in rural telecommunications will have a positive effect on the income of farm households. On the other hand, as a local economy develops, the purpose of telephone adoption for farm households may change from productive usage to consumption usage; this change may suggest that the implementation of a rural telecommunications policy will be applicable -- if appropriately conceived and implemented -- for the development of China's specific rural economy.

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