
# Infrastructure and Regional Development in the People's Republic of China

**Zhijun Zhao**

**Toshiki Kanamori**

**June 2007**

**ADB Institute Discussion Paper No. 69**

The paper was completed while Zhijun Zhao worked at the Asian Development Bank Institute (ADBI) as a visiting fellow from September 2006 to March 2007. Toshiki Kanamori was Director of ADBI's Administration, Management and Coordination department from 2003 to 2006. He is now Director General of Kobe Customs and Tariff. The authors thank Masahiro Kawai, Dean of ADBI; Douglas Brooks, Senior Research Fellow; Mamoru Umemoto, Director of Administration, Management and Coordination; and other colleagues at ADBI for their valuable comments and for providing us with the opportunity to prepare this paper.





Suggested citation:

Zhao, Zhijun and Toshiki Kanamori. 2007. *Infrastructure and Regional Development in the People's Republic of China.* Tokyo: Asian Development Bank Institute. Available: http://www.adbi.org/discussion-paper/2007/06/06/2279.prc.infra.rural/

Asian Development Bank Institute
Kasumigaseki Building 8F
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

**Abstract**

This paper investigates the relationship between infrastructure and rural economic development. It begins by reviewing the progress of Chinese economic and rural reform and analyzes the challenges faced by the government of the People's Republic of China (PRC). Then, based on the review, an endogenous growth model is created to show the channel and mechanism of public infrastructure impacting production and consumption. Next, an empirical study is carried out in order to identify the role of different kinds of infrastructure in rural development. The paper also discusses the interaction between institutional arrangement (soft infrastructure) and hard infrastructure. Finally, some suggestions and implications beneficial to the rural development of the PRC are drawn from theoretical and empirical studies.

**JEL Classification:** R11, Q18, P25

**CONTENTS**

**List of Tables**



**List of Figures**

## INTRODUCTION

Beginning in 1978, the People's Republic of China (PRC) has taken a series of steps toward marketization and globalization with the aim to promote economic growth and reduce poverty. The first and most important step was the adoption of the rural household contract responsibility system during 1978-1985. With the implementation of that policy, rural household per capita income at one time grew faster than its urban counterpart, the number of rural people under the poverty line dropped significantly, and the income disparity between rural and urban areas narrowed.

With the development of the rural economy and the successful implementation of the rural contract responsibility system, the effect of the rural household contract responsibility system began to decline and overall economic growth slowed. To sustain economic growth, the Chinese government launched a strategy in 1984 to reform state-owned and township-village enterprises, which was expected to produce a similar accomplishment to that of the rural contract responsibility reform. Meanwhile, the pace of opening to the outside world was accelerated, and the number of designated opening cities increased from four special economic zones to 14 coastal cities. After that time, the PRC went into a rapid development period of urbanization and industrialization.

With the launching of urban and enterprise reform, rural reform went through a relatively stagnant period and many issues such as land ownership, residential identity, rural infrastructure and democratic system, which are in association with rights and interests of peasants, were ignored or delayed. As a result, per capita income and consumption in rural and west region grew at a much slower rate than in the rural and west regions. The income gap between rural and urban as well as between inland and coastal areas grew continuously.

Reform and industrialization also created a great number of landless and jobless farmers. Many peasants have reportedly taken to the streets to protest or appeal to higher authorities for help with grabbed land. It is also reported that many rural immigrant laborers have not received pay for work they have done and have had to ask for help from premier Wen Jiabao. These problems have undermined Chinese social harmony and political stability, and have led to a deterioration in public security in some places. These problems, if not handled properly, might lead to political chaos.

It seems that the Chinese central government recognizes the importance of rural problems. The central government has issued four No. 1 documents dealing with rural development since 2004. No. 1 documents issued by the central government usually highlight its most important working focus. The No. 1 document of 2004 is titled "A number of policy suggestions of the Chinese Communist Party Central Committee on increasing peasants' incomes"; the No. 1 document in 2005 is titled "A number of policy suggestions of the Chinese Communist Party Central Committee and State Council about further strengthening rural work and promoting comprehensive agriculture production capacity"; the No. 1 document in 2006 is titled "A number of policy suggestions of the Chinese Communist Party Central Committee and State Council on advancing new socialist countryside constructions." The No.1 document of 2007 is also related to the countryside. These documents deal with every aspect of "agriculture, village and peasants," called "the three agricultural problems" (San nong wenti in Chinese).

In recent years, President Hu Jintao has developed a vision for a "harmonious society," including a number of perspectives on how to develop the economy and society scientifically. In the countryside, building a "harmonious society" means building new socialist village, which can be characterized in detail as "agricultural production has risen, villagers' living standards have improved, village ethics are civilized, the environment is purified and management is democratized." In connection to this strategy, the central government is

shifting the focus of its attention from urban development to rural development and the harmonious development of the whole society. Therefore, increased fiscal budget is expected to be arranged to rural infrastructure construction in the next five years or more.

In theory, the relationship between infrastructure and rural development has long been noticed by economists and most theoretical studies in this regard are based on and extended from Solow's neoclassical model (1957). Under the neoclassical model, production is determined by the physical capital stock and labor in the economy. Given a constant return to scale of technology and a constant savings rate, the economy will finally approach a steady state, which means that per capita economic growth is exogenously determined by technological progress. Though output is shared by labor and capital according to their respective contributions in Solow's neoclassical model, a residual (called the Solow residual), calculated as economic growth minus labor growth minus capital growth, remains unexplained, like something falling from heaven.

Great early efforts were made to find the determinants of sustainable economic growth and explain the residual. However, no breakthrough was made until Romer (1986) modeled the "learning by doing" effect and spillover effect of investment. Under the Romer model, sustainable economic growth can be at least partly endogenously explained by "learning by investing" represented by a function of aggregate capital.

Lucas (1988) takes another direction, grasping human capital as an independent determinant of economic growth differing from ordinary labor. His model also partly explains endogenous economic growth. At almost the same time, the R&D related model came to the attention of researchers, and the product diversified and consumption diversified model were created (Dixit and Stiglitz, 1977).

Nicholas Stern (1991) emphasizes in particular the importance of infrastructure, management and resource allocation in economic growth. He states, "The deficiencies of infrastructure, together with the weakness of management and economic organization, are likely to account for a substantial part of low factor productivity in developing countries." "It is very hard to run factories and businesses effectively when the electricity and water supplies are unreliable, the telephone and the mail services are weak, and transport is slow, costly and hazardous." In explaining why the growth of the Indian economy has been slower than that of the Chinese economy, Bhalla (2002) points out that inadequate infrastructure, multiplicity of objectives, bureaucratic procedures, and limited power of the local authorities and uncertain and unpredictable investment incentives all contribute to the difference.

Once the importance of infrastructure is recognized, it is important to understand the definition of infrastructure. However, it is difficult to clearly define infrastructure capital. Gramlich (1994) gives three definitions of infrastructure, each referring to hard infrastructure. One version defines it as large capital-intensive natural monopolies such as highways and other transportation facilities, water and sewer lines, communications systems, and so on. An alternative version refers only to tangible capital stock owned by the public sector. Broader versions of infrastructure include successive human capital formed by investment in research and development.

Wanmali and Islam (1995,1997) and Nicholas Stern (1989) argue that limiting infrastructure to hard infrastructure such as roads, telecommunications, electrification and irrigation is too narrow, and that soft infrastructure, also termed social infrastructure, is also very important. The soft infrastructure refers to the institutional environment or way in which business is done. It includes various services such as those relating to transport, finance, input distribution and animal husbandry, and marketing. Soft infrastructure and hard infrastructure are interlinked and interact with one another, and Wanmali and Islam (1997) state that Investments in infrastructure and the associated provision of services are integral to the

process of development. The key role of hard infrastructure investments in improving agriculture production and facilitating the growth of "soft" infrastructure in developing countries in particular is emphasized (Ahmed and Donovan, 1992).

Regarding the role of soft infrastructure, Nicholas Stern (1989) points out that it is imaginable that a system can allocate resources efficiently even within a framework in which individuals behave dishonestly, where the bureaucracy is obstructive, or where property rights are unclear. However, the costs involved and the distortion of incentives may constitute serious impediments to growth (Reynolds, 1983, Thomas, 1992). The absence of institutional infrastructure can lead to unsound agriculture development planning. For example, local data on climate, physiography, soil, water, vegetation and population need to be collected, stored, and analyzed by government agencies before planning agriculture development activities.

Different sectors in developing countries may have very different institutional arrangements and there may be a number of distortions preventing the allocation of resources in a way that equalizes social marginal products in different sectors. In this context the shift of resources from one sector to another may have an important effect on the overall level of output, and thus detailed studies of the institutional and other impediments to the movement of resources from one sector to another could have a substantial payoff (Chenery, 1979 and 1986).

In theoretical studies, most of the existing literature treats the flow of government expenditure as the determinant of the contribution to productivity. Arrow and Kurz (1970) were the first authors to formulate government expenditure as a form of investment. Aschauer and Greenwood (1985), Aschauer (1989a), Barro (1989), and Turnovsky and Fisher (1995) do so in a classical Ramsey framework. Barro (1990) and Turnovsky (1995) introduce government expenditures into a simple "A-K" model. The virtue of this kind of model is its tractability, as it treats public expenditure as public infrastructure; however it can be argued that public infrastructure such as education and roads should be treated as accumulated capital, rather than current flow. Futagami et al. (1993) extend the A-K model (Barro1990) to include governmental capital. Baxiter and King (1993) examine the macroeconomic implications of increases in the stocks of public goods. We support the idea that treats public infrastructure as capital stock rather than current flow.

Though the impact of public capital on the private sector's economic activity was noticed as early as 1952 (Mead), empirical studies were rarely seen before Aschauer (1989a) and Munnell (1990a, b, 1992) delivered an answer about whether a declining rate of public capital investment would cause a decline in private sector productivity growth, given the declining provision of public capital in the 1970s and the concurrent decline in the growth of the private sector's productivity.

Most early estimates on the effect of public capital are basically at the aggregate level and find unreasonably high effects. Using an aggregate Cobb-Douglass production function for private output as a function of employment, private capital and government capital stock, Rathner (1983) estimate that government stock is productive with an output elasticity of about 0.06. Using similar method, Aschauer (1989) finds a significant input of government capital in the production function with output elasticity as high as 0.39. Munnell (1990a) finds the output elasticity of nonmilitary government capital to be between 0.031 and 0.39. When estimating the Cobb-Douglass and Trans-log aggregate production function using data for the 48 contiguous U.S. states, Munnell again finds that government capital is a statistically significant input in the production function, with an output elasticity ranging from 0.06 to 0.15. Similar results are also found in regional studies such as Helms (1985), Da Silva Costa et al. (1987), Deno (1988), and Aschauer (1990).

Later on, some studies disaggregate infrastructure into different types. In evaluating the contribution of road infrastructure to economic growth and poverty reduction in the PRC, Fan and Chan-Kang (2005) examine the roles of different classes of roads and conclude that roads of a lower standard have larger impact on rural development and poverty reduction than those with higher standards. Paul Evans and Georgios Karras (1994) find fairly strong evidence that current government educational services are productive and no evidence that the other government activities considered are productive. However, they find a statistically significant negative productivity for government capital. Since some critics argue that the methodology adopted in previous studies might be problematic as regressions are likely to be mis-specified when they are estimated in levels and the data contain stochastic trends. It is suggested that models should be fitted using difference of level variables. As a result, the apparently strong positive associations between private output and government inputs disappear and, in fact, often become negative, when Hulten and Schwab (1991) and Tatom (1991) fit the models to differenced data. Munnell (1992) argues that this correction may be too radical, because differencing can destroy the long-term relationship in the data. However, when Tatom (1993) tests the variables for cointegration, which take into consideration both level and short differencing, he does not find a significant impact of infrastructure capital on productivity.

But Holtz-Eakin (1994) tries to reconcile these disparate findings. He uses a standard technique to control for unobserved, state-specific characteristics and finds essentially no role for public-sector capital at the margin. However, he argues that it would be a departure from commonsense to argue that there are no important direct impacts from the provision of road networks, bridges, water supply systems, sewerage facilities, and the host of other infrastructure service. He recommends that future research in this area should be devoted to making more precise the microeconomic linkage between the provision of infrastructure and the nature of the production process. Through such research, it is possible to identify those types of capital expenditure that provides productive spillovers and those industries and activities for which the effects are the largest. Jorgenson also recommends a microeconomic approach.

As to studies on Chinese infrastructure and rural development, empirical studies are quite rare and most are descriptive. Lin (2002) emphasizes the importance of urbanization in new village building, and states that Chinese rural problems cannot be resolved without a combination of rural population reduction and urbanization. Zhu (1990) studies the impact of a highway project in different phases and finds that the role of the project in the local economy varies by construction period: at the early stage, it creates tremendous job opportunities and improves the skill of local workers employed in the project; in the post-construction period, it promotes the development of goods production in poor regions, increases the volume of trade, reduces transportation costs, and improves social services. Zhou (2001) focuses attention on the soft environment of infrastructure and warns that corruption, which acts to reduce the economic efficiency of public investment in the PRC, should be avoided. Some scholars warn that the PRC's economy might have experienced overheated government-dominated investment in infrastructure such as roads, electricity, and water facilities, making the economy inefficient and unsustainable (Wang, 2006).

From our perspective, regardless of whether public infrastructure is treated as capital stock or current flow, existing models fail to take account of the external effect of infrastructure on the consumption side. Public infrastructure promotes not only productivity and profit, but also directly increases consumers' happiness or utility. Therefore, incorporation of external effect of public infrastructure on the consumer's objective function is an important consideration in assessing the relationship between public infrastructure and economic development. Even though an infrastructure project has no effect on the production side, its momentum in consumption side may be a good excuse for investment in infrastructure. Hence it is improper to model infrastructure as a factor that impacts production only.

In addition, in theory we don't think that it is proper to view public capital as a factor that directly contributes to production and utility. What contributes directly to production and utility is the service flow of public infrastructure produced by public capital.

From a review of the literature, we see that infrastructure and rural development pose a great challenge to the PRC's socialist countryside building. Issues in rural development and agriculture-related infrastructure should be better understood, feasible ways to solve the rural issue should be further explored, and practical suggestions should be made to the Chinese central and local governments.

In addition, there is a need for theoretical and empirical studies. An important contribution should be made to incorporate infrastructure into the consumer's objective function. In empirical studies, questions about simultaneity, nonstationarity of the time series data, and omitted variables are considered. More fundamentally, time series and cross-sectional data are used to get more reasonable answers.

The rest of the paper is organized as follows. In Part 2 and Part 3, we provide a rough discription of the rural economic rural infrastructural development of the PRC, and identify the existing problems that are challlenging government policy and institutional arrangement. In Part 4, a endogenous growth framework is developed to help analyze the implications of infrastructure on rural economic development. Although we recognize that any theoretical model is a simplification of the real world and is unable to capture all the features of the real world, it is helpful to understand how infrastructure impacts economic development and has important implications for variable selection in the econometric model. Part 5 is an empirical study based on theoretical analysis. In Part 6, some institutional arrangement deficiencies are presented and policy suggestions are made based on investigations into the rural economic and infrastructure development, theoretical analysis, and emprical studies.

## 1. RURAL ECONOMIC DEVELOPMENT

### 1.1 Key Issues for Rural Development in the PRC

Generally speaking, the rural issue in the PRC is classified into three different levels from low to high, namely, the agriculture problem, village problem, and peasant problem (in Chinese they are jointly called the "san nong wen ti").

The agriculture problem is the most important. Three decades ago, the PRC could not produce enough food and clothes to feed or clothe its people, and the biggest challenge facing Chinese was how to survive. Since food and clothes were closely related to agriculture, the agriculture problem was placed at the top of the government agenda. Thanks to the rural reform starting from 1978, the problem of survival was basically resolved by 1996 when food demand and supply were basically balanced, and supply was greater than demand in some harvest years.

The second is the village problem. In some Chinese villages, one finds dirt, garbage, and broken roads everywhere, and this has a negative impact on the quality of rural people's life. Therefore, the village problem deals largely with the living environment of villages. To a large extent it involves infrastructure such as electricity, water, village roads, environmental protection, public sanitary and infrastructure maintenance, and so on. To change the bad looks of villages and improve rural people's living standard, it is necessary first to understand the role of infrastructure building in rural areas.

Finally, to a large extent the peasant problem is related to social institutional arrangements that specify peasant rights, resource allocation and social justice. Once the agricultural

problem and village problem are resolved, it is only natural for rural populations to begin to show a greater concern for political rights, such as democracy, freedom of migration and freedom of speech, which are largely determined by institutional arrangements. Actually, the two other rural problems are also decided by institutional arrangements.

In summary, the agriculture problem, village problem and peasant problem take place at different levels, and interact with one another. They should not be treated in a unified framework. The agriculture problem is mainly related to agriculture production and is a problem of efficiency (or how to produce more output). The village problem is more closely related to the improvement of rural people's living standards and living environment. It links not only production but also consumption, and thus is a problem of development. The peasant's problem deals mainly with the development of peasants themselves as human beings, and looks especially at whether peasants can enjoy same rights and benefits as other citizens. We thus call it a problem of rights and interests. It deals with the all-round development of human beings and is located at the core of the rural issue.

### 1.2 Rural Development prior to 1978

In the first half of the last century, the PRC suffered from wars and natural disasters, and most of its people lived under the poverty line. About half of all peasants had no land and had to work for landlords to make a living. Though they worked very hard, they could not earn enough food to eat or enough clothes to wear. Therefore the biggest problem was how to survive, and the biggest desire of rural people was to have their own land and to be able to plant for themselves. It seemed that the Communist Party of China had a better understanding of the basic national situation of rural China. It told Chinese that it was the feudalism, capitalism and foreign imperialism (called the "three big mountains") that made them poor. Without dismantling the three big mountains, they would not be able to live a better life. In order to get support from peasants, the party promised that it would reallocate the land of landlords equally once it took power.

The Communist Party of China eventually won the civil war and took political power in October 1949, establishing the People's Republic of China. The party indeed fulfilled its promise to reallocate the land equally to farmers. After getting land, most rural Chinese enthusiastically engaged in agricultural production, leading the national economy to recover to prewar levels within only three years. However, following the fast economic recovery, a series of impractical objectives were put forward. One of the announced objectives was to catch up with the United Kingdom and surpass the United States within a short time. In connection with this, the Great Leap Forward and Great Cultural Revolution were launched in 1958 and 1966. However, these movements did not follow social and economic principles, and the PRC suffered severely from them. The national economy hovered at the brink of collapse. Though the socialist system had been in place for about three decades by 1978, the PRC had failed to resolve the food issue, let alone catch up with the UK or surpass the US.

Why was the PRC not able to resolve its food problem within the first 30 years after the foundation of the People's Republic of China? The primary blame should be placed on the planned economy. Under it, land was owned by the state or collectives and the results were allocated quite equally; management was loose; and the incentive and penalty system was not sufficient to make people do their best (Kanamori and Zhao, 2004). The system discouraged hard work and encouraged the dereliction of duty. Secondly, it should be attributed to closed economy. It was difficult for the PRC to share with other countries the benefits of technological progress in agriculture in its closed economy. Thirdly, too many political movements should be blamed. It has been proved to have negative influences on economic development (Barro and Xavier Martin, 1995).

## 1.3 Rural Development after 1978

### 1.3.1 Contradiction between Land and Population

On the 9.6 million square kilometers of land of the PRC reside 1.3 billion people, amounting approximately to 22% of the world's population. The population density is about 135 persons per square kilometer. The PRC is not the most densely populated country in the world, but it is if one considers the large patches of land, especially in the west, that are not suitable for inhabitation. The PRC's arable land is 130 million hectares[1], accounting for just 7% or so of the world's arable land. According to the permanent household registration system, each rural Chinese holds about 2 mu of land on average. Irrigated land is rare. Water resources per capita are about one fourth of the world average. Therefore, a large population, with little land, water or other natural resources is a basic characteristic and fundamental contradiction that the PRC will have to face in the long term. In the background of the economic opening, although a food shortage or surplus can be adjusted by the world market, past experience tells that a country with a large population like the PRC cannot depend heavily on the international food market. Preparation has to be made in advance to prevent unexpected shocks from the global market or natural disasters. The international food market can only be seen as a helpful supplement for food shortages.

### 1.3.2 Resident Registration System

With regard to institutional arrangements, we cannot but mention the Chinese permanent household registration system, which discriminates against rural Chinese. Under the permanent household registration system, Chinese are classified into agriculture residents and non-agriculture residents. Agriculture residents refers to "peasants" who engage in agriculture production. Literally, it refers to people engaged in certain jobs, rather than people who are lower in social position than others. However, in reality the meaning of "peasants" has changed, as the permanent household registration system contains preferential treatment that can only be enjoyed by urban households. Under the current permanent household system, a person's status depends on the place of birth and the status of his or her parents. Under the planned economy, peasants or agriculture residents could only engage in agriculture and were not allowed to work freely in industrial sectors or urban areas. Children of peasants were required to register as agriculture residents. They had to engage in agriculture after growing up. Only following some special situation, such as a person being recruited by a university or joining the PLA (People Liberation Army) and being promoted could the status be changed to non-agricultural resident.

The different statuses imply different treatment. For example, non-agriculture residents or urban residents are usually covered by an insurance policy, pension policy, healthcare policy and can work in cities and state-owned enterprises. Urban residents can also enjoy better educational services and infrastructure than rural ones.

The shortage of permanent household registration system and related discrimination had led to the use of strange words in the Chinese media, such as "peasant worker" (nong min gong), "peasant entrepreneur" (nong min qi ye jia), and "peasant singer" (nong min ge chang jia). Today, the term "peasant" in front of the title only represents the identity of the person registered in the registration book, and has nothing to do with agriculture. This kind of appellation represents discrimination against rural residents.

The current permanent household registration system also leads to misunderstandings in statistical data. According to the permanent household registration system, the PRC had 803.2 million rural people by identity and 790.14 rural people by residence in 1978. In 2005, the rural population by identity increased to 945 million or 73% of the population, and the rural population by residence declined to 745.44 million (Table 1).

[1] 1ha. =15 mu

**Table 1. Population and Composition**
**(unit: 1 million persons)**

| Year | Total Population | Rural Population by identity | | Rural Population by residence | | Difference Between two measurements |
|---|---|---|---|---|---|---|
| 1978 | 962.59 | 803.2 | 83% | 790.14 | 82% | 13.06 |
| 1980 | 987.05 | 810.96 | 82% | 795.65 | 81% | 15.31 |
| 1985 | 1,058.51 | 844.197 | 80% | 807.57 | 76% | 36.627 |
| 1990 | 1,143.33 | 895.903 | 78% | 841.38 | 74% | 54.523 |
| 1995 | 1,211.21 | 916.746 | 76% | 859.47 | 71% | 57.276 |
| 2000 | 1,267.43 | 928.197 | 73% | 808.37 | 64% | 119.827 |
| 2005 | 1,307.56 | 949.075 | 73% | 745.44 | 58% | 203.635 |

It is clear that in the early stage, the rural populations by identity and by residence were nearly the same. Later, the meaning of the two concepts changed a lot. For example, a lot of the rural population (registered as permanent rural household residents) left the countryside and moved into cities. It is possible that they are involved in agriculture. According to Table 1, in 1978 there were 803 million people (83% of the population) classified as rural population by identity and 790 million people (81% of the population) classified as rural population by residence. By 2005, the rural population by identity had increased to 949 million and rural population by residence had fallen to 745.5 million. The urbanization rate in terms of residence was 42% (Table 1). On the other hand, the difference between rural population by identity and rural population by residence listed in the last column shows that 1% of the rural identity population resided in urban areas in 1978, but that in 2005 203.6 million rural people by identity had moved into and were residing in urban areas. These people with rural identities were not given the same treatment as their urban counterparts, indicating that the traditional identity registration system has lagged behind the practice and is blocking urbanization and impeding social justice.

### 1.3.3 Income Composition and the Weakness of Agriculture

Household income can be classified into three types in term of sources: wage income, income from household business, and income from transfer and property. Income from household business can be further classified into farming income and non-farming income. The ratios are shown in Table 2. The proportion of wage income increased from 20.2% in 1990 to 36.1% in 2005. The proportion of income from household business fell from 75.5% of 1990 to 56.6% of 2005, and the proportion of transfer income and property income changed very little, fluctuating at about 4-7%. The change in income from household business was mainly brought about by the change of farming income, which dropped very sharply from 50.2% to 33.7%. These numbers demonstrate that farming is no longer the most important source of rural household income.

**Table 2. Composition of Household Income**

| Item | 1990 | 1995 | 2000 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|
| Net Income | 686.3 | 1,577.7 | 2,253.4 | 2,622.2 | 2,936.4 | 3,254.9 |
| From Wage | 20.2% | 22.4% | 31.2% | 35.0% | 34.0% | 36.1% |
| Farming income | 50.2% | 50.7% | 37.0% | 33.8% | 36.0% | 33.7% |
| Non-farming income | 25.3% | 20.7% | 26.3% | 25.0% | 23.5% | 22.9% |
| From transfer and property | 4.2% | 6.2% | 5.5% | 6.2% | 6.5% | 7.2% |

In addition, farming income is very sensitive to external shocks. To understand better how much farmers can benefit from farming, Table 3 lists the costs and benefits of planting three major crops: rice, wheat and corn. The table shows that a farm could at most earn cash revenue of about 370 yuan per mu from planting grain in 1995 and 2004.[2] When the market price was not so good, farmers earned much les s. For example, in 2000 farmers earned only 155 yuan per mu and in 1990, 115 yuan per mu. This may also imply how volatile the price of grain is and how vulnerable agriculture is to natural conditions and market shocks. For a country like the PRC, each rural inhabitant has only about 2 mu of land on average, so under the best conditions, one person can earn 740 yuan from planting grain. If farmers can plant two seasons, the income is 1,500 yuan. It is clear that it is unlikely that rural Chinese will become rich on agriculture alone. In developed countries such as the US and Japan, each farmer owns much more land than in the PRC. The experience of developed countries has proved that maximum efforts should be made to have more farmers leave the land in order to have more rural people enjoy the fruits of urbanization and at the same time have more urban people share the benefits of cheap rural labor. After some people leave the land, each farmer will have more land and labor productivity in agriculture will rise.

**Table 3. Output, Revenue and Cost of Three Major Crops**

| Year | Value of output | Total cost | Cash cost | Net profit | Cash revenue |
|---|---|---|---|---|---|
| 1978 | 56.05 | 58.23 | 29.36 | -2.18 | 26.69 |
| 1985 | 114.44 | 73.67 | 41.85 | 40.77 | 72.59 |
| 1990 | 199.15 | 142.89 | 83.35 | 56.26 | 115.8 |
| 1995 | 545.67 | 321.76 | 178.32 | 223.91 | 367.35 |
| 2000 | 352.96 | 356.18 | 197.12 | -3.22 | 155.84 |
| 2004 | 591.95 | 395.45 | 218.01 | 196.5 | 373.94 |

### 1. 4 Rapid Economic Growth and Uneven Income Distribution

Since 1978, the Chinese economy has experienced rapid economic growth, and more and more Chinese have escaped poverty. Many people enjoy big houses, televisions, mobile phones, refrigerators, washing machines, cars and other high-tech goods. However, not all members of society have shared the fruits of high economic growth. Income differences between rural and urban households have been widening, with no indication that this trend will stop in the foreseeable future. For example, in 1978 the urban-rural per capita income ratio was about 2.6; by 1985, with successful rural reform mobilizing the enthusiasm of rural people, rural people received benefits and the ratio was narrowed to 1.9. Thereafter, the government transferred the focus of its attention from rural to urban reform, and from agriculture to industry. As a result, rural household income slowed and the income gap widened again. In 2004 it grew to 3.2 (Table 4). The rural-urban difference is also embodied in the urban-rural consumption ratio, which is even larger than the income ratio (3.2). Part of the reason for this is that schemes such as social security, healthcare and pension plans, etc. enjoyed by urban residents are not shared with rural ones, and rural residents have to save money for unexpected events in the future. Another reason is that education and medical care are very expensive, leaving little money for other goods consumption.

[2] In 1995 China was experiencing high inflation, and the price of crops was good, benefiting farmers; income from farming in 2004 was mainly brought about by the cut policy and rising prices.

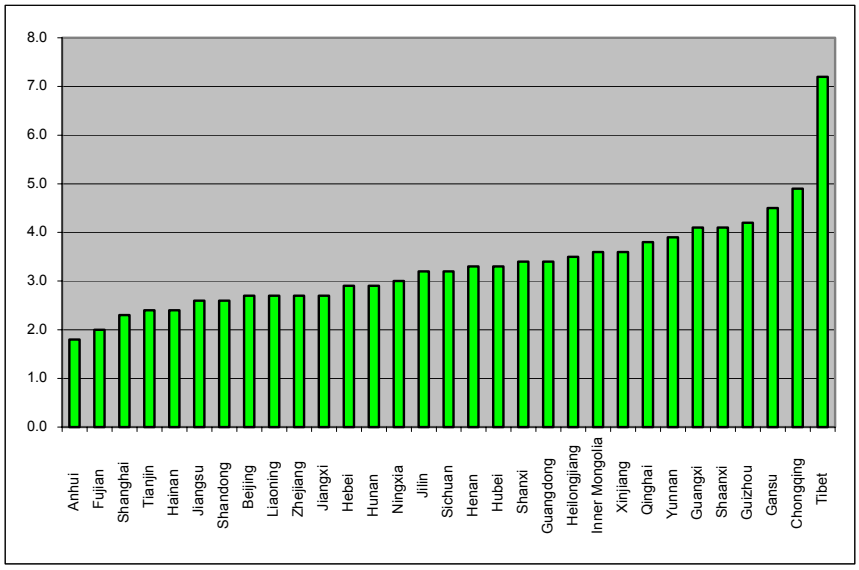
**Table 4. Net Per Capita (Disposable) Income and Consumption (Yuan)**

| Year | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| 1978 | 133.6 | 343.4 | 67.7 | 57.5 | 2.6 | 2.9 |
| 1991 | 708.6 | 1700.6 | 602 | 1840 | 2.4 | 3.1 |
| 1992 | 784 | 2026.6 | 688 | 2262 | 2.6 | 3.3 |
| 1993 | 921.6 | 2577.4 | 805 | 2924 | 2.8 | 3.6 |
| 1994 | 1221 | 3496.2 | 1038 | 3852 | 2.9 | 3.7 |
| 1995 | 1577.7 | 4283 | 1313 | 4931 | 2.7 | 3.8 |
| 1996 | 1926.1 | 4838.9 | 1626 | 5532 | 2.5 | 3.4 |
| 1997 | 2090.1 | 5160.3 | 1722 | 5823 | 2.5 | 3.4 |
| 1998 | 2162 | 5425.1 | 1730 | 6109 | 2.5 | 3.5 |
| 1999 | 2210.3 | 5854.02 | 1766 | 6405 | 2.6 | 3.6 |
| 2000 | 2253.4 | 6280 | 1860 | 6850 | 2.8 | 3.7 |
| 2001 | 2366.4 | 6859.6 | 1969 | 7113 | 2.9 | 3.6 |
| 2002 | 2475.6 | 7702.8 | 2062 | 7387 | 3.1 | 3.6 |
| 2003 | 2622.2 | 8472.2 | 2103 | 7901 | 3.2 | 3.8 |
| 2004 | 2936.4 | 9421.6 | 2301 | 8679 | 3.2 | 3.8 |
| 2005 | 3254.9 | 10493.0 | 2531 | 9393 | 3.2 | 3.7 |

Notes: (1) Income of rural households; (2) Income of urban households; (3) Rural households consumption; (4) Urban household consumption; (5) Urban-rural income ratio; (6) Urban-rural consumption ratio.

The unequal income distribution between rural and urban areas is also embodied in interregional difference in income and consumption. We find that provinces in the western region have larger income differences. Generally, the poorer the province, the bigger the income difference is. Tibet has the largest rural-urban income difference in the country, as high as seven times. Of course, there are exceptions. For example, the central province of Anhui has the smallest income difference, and the income difference in the eastern and most advanced province of Guangdong is bigger than most central provinces.

**Figure 1. Urban/Rural Consumption Ratio by Region (Rural Households=1)**




The unequal income distribution is also embodied in the revenue share between central and local government. The central government revenue share fell from 38.4% in 1985 to 22% in 1993, and this challenged the coordination and control ability of the central government. This situation was changed by the taxation reform in 1994. Following the reform, the local government revenue ratio dropped from 78% in 1993 to 44.3% in 1994, and the central government revenue ratio rose from 22% to 55.7%, taking a dominant position (Table 5). Table 5 also shows that the central government spent much less than it taxed. For instance, in 2005 it received 52.29% of total revenue, but spent 25.86% of total expenditures. This means that it taxed more and spent less, and local government taxed less and spent more, so that a large part of government revenue needed to be reallocated from the central to local governments. This required a long and complicated allocation process. This tax structure helped the central government to strengthen macroeconomic adjustment and control, but also led to tremendous transaction costs and corruption.

**Table 5. Central and Local Government Revenue and Expenditure (100 million Yuan)**

| Year | Total expenditure | Central ratio | Local ratio | Total revenue | Central ratio | Local ratio |
|---|---|---|---|---|---|---|
| 1978 | 1122.09 | 47.4 | 52.6 | 1132.26 | 15.5 | 84.5 |
| 1980 | 1228.83 | 54.3 | 45.7 | 1159.93 | 24.5 | 75.5 |
| 1985 | 2004.25 | 39.7 | 60.3 | 2004.82 | 38.4 | 61.6 |
| 1990 | 3083.59 | 32.6 | 67.4 | 2937.1 | 33.8 | 66.2 |
| 1993 | 4642.3 | 28.26 | 71.73 | 4348.95 | 22 | 78 |
| 1994 | 5792.62 | 30.28 | 69.71 | 5218.1 | 55.7 | 44.3 |
| 1995 | 6823.72 | 29.2 | 70.8 | 6242.2 | 52.2 | 47.8 |
| 2000 | 15886.5 | 34.7 | 65.3 | 13395.23 | 52.2 | 47.8 |
| 2004 | 28486.89 | 27.71 | 72.28873 | 26396.47 | 54.94 | 45.1 |
| 2005 | 33930.28 | 25.86 | 74.13529 | 31649.29 | 52.29 | 47.71 |

On the other hand, the statistical data in Table 6 shows that government has doubled its revenue every five years since 1995, but the ratio of expenditure on agriculture (or rural area)

slowed though the absolute level of expenditure on agriculture increased. The ratio of government infrastructure spending on agriculture capital construction remains extremely low; government expenditure on rural infrastructure rarely exceeds 3%. In contrast, government expenditure for overall social capital construction is basically greater than 11%. Considering the composition of the Chinese population, it is difficult to say that it is reasonable for the 58% of the population registered as rural residents to enjoy just 12.7% of public expenditures, and for the 42%[3] of the population registered as urban residents to enjoy 87.3% of public expenditures.

**Table 6. Government Expenditure for Agriculture**

| year | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| 1978 | 1122.09 | 451.92 | 40.3% | 150.66 | 13.4% | 51.14 | 4.6% |
| 1980 | 1228.83 | 346.36 | 28.2% | 149.95 | 12.2% | 48.59 | 4.0% |
| 1985 | 2004.25 | 554.56 | 27.7% | 153.62 | 7.7% | 37.73 | 1.9% |
| 1989 | 2823.78 | 481.7 | 17.1% | 265.94 | 9.4% | 50.64 | 1.8% |
| 1990 | 3083.59 | 547.39 | 17.8% | 307.84 | 10.0% | 66.71 | 2.2% |
| 1991 | 3386.62 | 559.62 | 16.5% | 347.57 | 10.3% | 75.49 | 2.2% |
| 1992 | 3742.2 | 555.9 | 14.9% | 376.02 | 10.0% | 85 | 2.3% |
| 1993 | 4642.3 | 591.93 | 12.8% | 440.45 | 9.5% | 95 | 2.0% |
| 1994 | 5792.62 | 639.72 | 11.0% | 532.98 | 9.2% | 107 | 1.8% |
| 1995 | 6823.72 | 789.22 | 11.6% | 574.93 | 8.4% | 110 | 1.6% |
| 1996 | 7937.55 | 907.44 | 11.4% | 700.43 | 8.8% | 141.51 | 1.8% |
| 1997 | 9233.56 | 1019.5 | 11.0% | 766.39 | 8.3% | 159.78 | 1.7% |
| 1998 | 10798.18 | 1387.74 | 12.9% | 1154.76 | 10.7% | 460.7 | 4.3% |
| 1999 | 13187.67 | 2116.57 | 16.0% | 1085.76 | 8.2% | 357 | 2.7% |
| 2000 | 15886.5 | 2094.89 | 13.2% | 1231.54 | 7.8% | 414.46 | 2.6% |
| 2001 | 18902.58 | 2510.64 | 13.3% | 1456.73 | 7.7% | 480.81 | 2.5% |
| 2002 | 22053.15 | 3142.98 | 14.3% | 1580.76 | 7.2% | 423.8 | 1.9% |
| 2003 | 24649.95 | 3429.3 | 13.9% | 1754.45 | 7.1% | 527.36 | 2.1% |
| 2004 | 28486.89 | 3437.5 | 12.1% | 2337.63 | 8.2% | 542.36 | 1.9% |
| 2005 | 33930.28 | 4041.34 | 11.9% | 2450.31 | 7.2% | 512.63 | 1.5% |

Source: China Statistics Yearbook 2006.
Notes: (1) Total government expenditure; (2) government expenditure for total capital construction; (3) ratio of government expenditure to total capital construction; (4) government expenditure for agriculture; (5) ratio of government expenditure for agriculture; (6) government expenditure for agriculture capital construction; (7) ratio of government expenditure for agriculture capital construction.

The present fiscal situation is clearly imbalanced. It has been described as follows: the central and provincial fiscal situation is very good, the prefecture fiscal situation is good, the county government fiscal situation is passable, and township and village fiscal situation is very difficult (Lu Xueyi, 2005). According to a survey conducted by the Agriculture Ministry, the debt of township and villages is 325.9 billion yuan. One researcher has concluded that the Agriculture Ministry has underestimated the debt of township and villages, which may reach as much as 600-900 billion yuan across the country (Lu Xueyi, 2005). On average, each township and village has a debt of about 2.98 million yuan and each village about 200,000 yuan. In Xiang Yang county of Hubei Province, each township and village level government owes 24.11 million yuan, and each village owes 1.6 million yuan.

[3] In terms of the current identity registration system, rural people make up 72.6%.

## 2. INFRASTRUCTURE DEVELOPMENT

### 2.1 General Situation of Infrastructure

The aggregate stock of infrastructure in the PRC is larger than that of most countries in the world, but the per capita stock is lower than the world average (Table 7). In such areas as the provision of transport and communication, it is even lower than low-income countries.

The rural households face a worse infrastructure than do urban households. In 2002, water facilities cover 92% of households in cities compared with 68% in countryside, with a 24-point difference between them. Drainage systems cover 69% households in cities, compared with 29% in the countryside, a 40-point difference. Coverage by water supply and drainage systems in rural China is 5 and 25 percentage points lower than the world average, respectively, and 12 and 35 percentage points lower than the average of middle-income countries. The situation for the drainage system was even worse, being one percentage point lower than even low-income countries (Changxin, 2006).

**Table 7. International Comparison of Infrastructure Service Provision**

| | Electricity | Telecommunication | | Transportation | | Coverage | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| PRC | 1379 | 499 | 73 | 1.4 | 0.05 | 77 | 44 |
| Low income countries | 358 | 72 | 24 | 3.0 | 0.13 | 65 | 41 |
| Middle income countries | 1720 | 485 | 90 | 7.0 | 0.40 | 89 | 79 |
| High income countries | 9503 | 1309 | 545 | 4.3-17.3** | 0.36-0.53** | 99 | 99-100** |
| World average | 2456 | 471 | 139 | 6.7 | 0.33 | 80 | 64 |

Source: World Bank, 2005; Goicoechea and Estache, 2005.
Note 1: * 2002 data for PRC, per capita level from 1997 to 2002 for other countries
Note 2: ** Smaller number represents the level of non-OECD rich countries, bigger number represents the level of OECD countries.

(1) Electric power (kilowatt hours/per capita) (2003)
(2) Number of Telephone and mobile phone (per 1000 persons) (2004)
(3) Number of users using network (per 1000 persons) (2004)
(4) Density of highway (kilometers/1000 persons) (2002)*
(5) Density of railway (kilometers/1000 persons) (2002)*
(6) Water supply (%) (2002).
(7) Drainage (%) (2002)

We roughly classify infrastructure into three kinds: pure productive infrastructure, pure living infrastructure and mixed productive and living infrastructure. Pure productive infrastructure refers to infrastructure that provides service only for production, such as land irrigation systems. Pure living infrastructure refers to infrastructure that provides a service only for the improvement of living conditions, such as drinking water systems, gasoline, marsh gas, and broadcast and television networks. Some infrastructure provides services to both production processes and living processes. Roads, railways, environmental protection and maintenance facilities, electricity system, and telecommunication systems belong to this type.

Rural collectives took responsibility for rural irrigation systems before 1978. Following rural reform, rural collectives played little role in the provision of irrigation systems and most small

and middle-sized projects are invested in by peasants themselves, unless it is big enough and requires investment by the government. Rural irrigation systems should not be regarded as public infrastructure.

Most marsh gas projects in rural area are small in size, and mainly serve as rural living infrastructure. They are usually built and used by individual households with some financial support from the government, and thus have few external effects.

Rural telephone lines are usually built by state-owned enterprises. They can be seen as infrastructure that facilitates both production and consumption. As it is a nationalized system it is difficult to identify which part is made particularly for rural areas. The number of telephone sets in rural area is seen as a proxy for the development of rural communications. The number of rural telephone sets grew very rapidly from 1.466 million in 1990 to 110.692 million in 2005, growing at a rate of 19.5% (Table 8).

Electric infrastructure can be regarded as productive and living infrastructure. Rural electricity consumption grows as high as 10.98% (table 8), even faster than household income and production. Since the purpose of commercial companies providing electric infrastructure is to earn profits, its attribute as a public good is discounted.

**Table 8: Proxy of Rural-Related Infrastructure**

| Year | Rural electricity consumption (100 million kwh) | Irrigated land (mu) | Number of rural telephone (10,000 sets) |
|---|---|---|---|
| 1978 | 262.4 | 72683.0 | 89.6 |
| 1982 | 410.9 | 66265.3 | 98 |
| 1985 | 517.7 | 66054.1 | 107 |
| 1988 | 736.4 | 665638.5 | 110.4 |
| 1990 | 874.2 | 711046.5 | 146.6 |
| 1995 | 1655.9 | 739218.0 | 807 |
| 2000 | 2420.3 | 807304.5 | 5171.3 |
| 2005 | 4375.5 | 825439.5 | 11069.2 |
| Growth | 10.98% | 9.4% | 19.5% |

In the *China Statistical Yearbook*, roads are classified into six types: expressways, class 1, class 2, class 3, class 4, and substandard. Expressways can be classified into three kinds, two-way 4-lanes, two-way 6-lanes, and two way 8-lanes. Generally, a one-kilometer section of expressway costs about 20 million yuan in plain areas, and as much as 70 million yuan in mountainous areas; first class road with 25 meter wide costs about 5 million yuan per kilometer; a class 2 road with a width of 12-17 meters costs 1-1.5 million per kilometer; a class 3 road with a width of 8 meters costs 0.7-0.8 million yuan; and a class 4 road with a width of 7 meters costs 0.5 million yuan per kilometer. There are two kinds of village roads according to the standards for new village building. The first, with a width of 3.5 meters, 20 centimeters of sand and 20 centimeters of thick cement, costs about 0.12 million yuan. Some local official and ordinary people feel that such roads are too narrow for two cars or buses to pass. The other type has a width of 6 meters, with 20 centimeters of sand and 20 centimeters of cement, costing about 0.24 million yuan. For the same cost as a one-kilometer section of expressway, and 80-kilometer village road can be built. The cost per kilometer of expressways in Beijing is as much as 100 million yuan. The expenditure for a one-kilometer section of expressway in Beijing is enough to build 500 kilometers of village roads. The utility of a one-kilometer section of expressway to the people of Beijing might be negligible, but a 500-kilometer village road could completely change the appearance of a

middle-sized county, and thus its utility to the county would be significant. This tells us that the benefit of reallocating fiscal budget from developed regions to undeveloped regions may be huge. If more public structure investment were made in rural area for low standard roads, and if the government could change its viewpoint toward achievement, reduce projects that demonstrate achievement and increase projects that are beneficial to civilians, the goal of developing the countryside could be realized more rapidly.

Different kinds of roads have different financing sources and different implications for people and enterprises. In the PRC, there is an expression that "the official produces numbers, and numbers produce the official; the bigger the number, the bigger the official," (Kanamori and Zhao, 2004). This refers to the tendency among Chinese officials to adopt an incorrect perspective of achievements, pursue a high economic growth rate and neglect economic efficiency. The wrong perspective on achievement leads government officials to build higher standard roads rather than lower standard roads. Table 9 shows that expressways, class 1, class 2, class 3, and class 4 roads, by kilometer, grew at respective rates of 24.5%, 19.4%, 12.7%, 5.3% and 3.5%. It is obvious that the growth of higher standard roads has been much faster than that of lower standard roads.

High standard roads and low standard roads differ in that the former usually connect cities and are toll roads, whereas low standard roads usually connect counties or townships and are free. Compared with the high standard roads, the low standard roads have greater externality and public goods features.

Of course, it is impossible to deny the possibility that high standard road building provides some officials with greater opportunities to embezzle public resources.

**Table 9. Development of Roads Infrastructure (By Kilometer)**

| Year | Express | Class1 | Class2 | Class3 | Class4 |
|---|---|---|---|---|---|
| 1982 | | 669.9 | 15,665 | 115,249 | 419,149 |
| 1985 | | 1019.833 | 21,194 | 128,541 | 456,286 |
| 1988 | 1065.75 | 3465.5 | 32,949 | 159,376 | 503,126 |
| 1990 | 1892.25 | 3,343.286 | 41,599 | 167,040 | 511,848 |
| 1995 | 4,434.93 | 10,685.38 | 84,910 | 207,282 | 606,841 |
| 2000 | 18,196.38 | 20,805.43 | 152,672 | 276,672 | 750,267 |
| 2001 | 20,131.18 | 26,114.5 | 177,759 | 308,626 | 800,665 |
| 2005 | 42,467.39 | 39,753.82 | 246,440 | | |
| Growth | 24.20% | 19.40% | 12.70% | 5.30% | 3.50% |

(Source: *China Statistical Yearbook*)

**2.2 Village Appearance and Village Level Infrastructure**

Now let's look into the primary materials acquired directly from a typical village survey, which was made by one of the authors last year. We find that currently new village building faces three challenges.

The first challenge is the "San dui" or "Three piles," referring to the phenomenon of piles of straw, dung, and soil being placed disorderly throughout villages.

The second challenge is the “San luan” (or “Illegal charges, illegal penalties and illegal apportions,” referring to the conduct of some local government agencies that collect money illegally from peasants, but use the money for personal benefit or for the benefit of the staff of the agency. This aggravates the burden of rural people and leads to extensive social dissatisfaction. Some rural people have even organized themselves to petition higher authorities for help. Street protests and demonstrations in front of government buildings are not uncommon.

The third challenge is the “San wu nong min” (or “Peasants with three lacks.” This term has appeared frequently in the Chinese media in recent years, and refers to those peasants who have neither land, jobs, or social security.” It has been reported that the number of such peasants may be no less than 40 million (Lu Xueyi, 2005).

To further understand the current situation of rural infrastructure, a few photographs taken by the authors can give readers a first impression of some Chinese villages. Figure 2 is an irrigation system that has collapsed and is poorly maintained. In Figure 3 we see garbage dumped along a riverside. Figure 4 shows dunghills placed alongside the roadside of a village. It is obvious that the current rural infrastructure and environments are worsening to some extent, and that rural infrastructure is not simply a problem of money, though money is important. Before economic reform and at the early stage of reform, rural households were even poorer than today, but the environment was better. Since the Chinese economy is growing at an annual rate of 9% and government revenue has doubled every five years since 1990, poor rural infrastructure should not be attributed to a lack of money. Behind these pictures lie an uneven distribution of income between rural and urban residents, government revenue allocations between the central and rural governments, poor rural collective management, and poor public awareness and daily habits regarding environment protection.

**Figure 2. A Collapsed Irrigation System**

**Figure 3. Garbage Dumped along a Riverside**

**Figure 4. A Pile of Dung near a Village**

To understand the perspectives of rural households on the current rural infrastructure, we sent 133 questionnaires to interviewees in Laiyang, Shandong province. One of the questions was “Are you satisfied with the environment of the village?” Of the interviewees, 118 or 88.7% chose “No,” and 11.3% chose “yes.” This indicates that most respondents were dissatisfied with the rural environment. Another question regarded their attitude toward the behavior of throwing garbage and spitting. No interviewees responded that this kind of habit or behavior was good. From this we can see that most rural people are not satisfied with the current situation and village management. There is much room for improvement.

When Interviewees were asked, “Who will you depend on to support your expenditures when getting old (multiple choices)?” 101 or 76% of respondents chose “children”; 61 or 46% “social security”; 15 or 11% chose “bank deposit” and 9 or 7% chose “retirement pension.”

Regard the interest of rural people in social security, the question was “Do you plan to join a security plan”? Of the interviewees, 91 replied “yes,” accounting for 70%; 39 replied “no,” accounting for 30%. Only 19 or 14% of the interviewees responded, “I have already joined rural healthcare insurance.”

There are also huge rural-urban gaps in educational opportunities. Each university in the PRC sets in advance a quota of the number of students to be recruited from different provinces or regions. This leads to a difference in opportunities for students in different regions. For example, there are 97 million people living in Henan province. Peking University and Tsinghua University, the two most prestigious universities in the PRC, recruit 171 students from that province. In contrast, there are only 16 million populations in Beijing municipality, but 851 students were admitted into Peking University and Tsinghua University.

Students in Beijing had a 30 times greater opportunity than students in Henan (http://edu.people.com.cn/GB/4193759.html).

Peasants constitute the largest social group in the PRC, but are treated as the weakest group. The root reason rests with the unreasonable institutional arrangement. Rural and urban people enjoy different democratic rights. For example, in rural areas 880,000 persons elect one delegate to the National People's Congress, while in urban area 220,000 persons have one delegate. In other words, an urban resident enjoys four times the voting power of a rural person. This arrangement clearly discriminates against rural people. The situation is the opposite in Japan. Rural Japanese have 3-4 times the voting power of urban Japanese. Accordingly, Japanese farmers enjoy preferential treatment. Though it might be unrealistic to immediately even voting power between rural and urban people in the PRC, it is indeed necessary to increase the voting power of rural people step by step and finally eliminate it.

More importantly, under the current system, leading government officials are not directly elected by the people. Some do not consider their power to be granted by ordinary people, but by senor officials, and think they need do good deeds only for senior officials and not for ordinary people. As a result, the interests of ordinary people are not easily reflected in the legislated process and government administrative practices. Recently, an article titled "Democracy Is a Good Thing" argued that the importance of democracy has been recognized. If the democratic system was developed more rapidly and perfectly, and if major officials were selected by the people and placed under the supervision of the people, peasants would be strongest group in the PRC.

Rural people don't enjoy the same welfare treatment as urban people in terms of social security or health insurance. The current minimum living security line and minimum wage rate are designed especially for urban households and are not applicable in rural areas. In addition, the social security system has not been established in rural areas. Rural people cast doubts on the reliability of the social security system, as many cases of misuses of social security funds have been reported around the PRC. For example, it is reported that 7 billion yuan of social security funds were illegally used in 2006. Not long ago, the former top leader of Shanghai municipality government was arrested for making illegal use of social security funds. On the other hand, Chinese rural people have been used to an absence of social security for thousands of years (http://www.zgjrw.com/News/2006125/ Finance/ 753854894500.html).

### 2.3 Importance of Collectives in Rural Infrastructure

Historically, under the people's commune system adopted in countryside before 1978, the collective economy played a vital role in providing and maintaining infrastructure. Rural village and township governments took full responsibility for all rural public events, including the provision, maintenance, management and organization of infrastructure. For example, the government sector organized villagers to pave and maintain roads using compulsory labor or paying them workpoint in return. Roads and water irrigation and other infrastructure were maintained quite well in terms of the economic development level at that time.

However, with marketization, this efficient system for rural infrastructure building and maintenance was broken, and no new efficient system has been set up. After the replacement of the rural collective economy with the individual economy, village governments have found themselves with little money to invest into rural infrastructure; on the other hand, because of the lack of an efficient management and supervision system, even if there is money, it is not necessarily used where rural people need it most. All around the country, money is wasted on projects. A large part of the public budget is wasted in governmental achievement projects, embezzled, or goes directly into individual's pockets.

From the viewpoint of the relationship between central and local governments, the uneven national fiscal revenue is also responsible for a worsening of rural infrastructure. Since most public financial resources are concentrated in the central government, local governments have no money to invest in infrastructure. Village governments are unable to take responsibility for rural infrastructure building and maintenance. On the other hand, the government prefers to spend more on urban than rural infrastructure, and on big infrastructure projects than small ones.

## 3. MODELING THE ROLE OF INFRASTRUCTURE AND RURAL DEVELOPMENT

We assume that a rural economy is composed of government and households. Each household plays two roles, as both consumer and producer. As producer, it employs capital, labor and other factors to produce goods and maximize its profit. As consumer, it divides its disposable income into consumption and savings to maximize its lifetime utility. Under traditional utility theory, utility is determined by goods consumption only, and there is no position for infrastructure variables. The utility function adopted here involves proxy variables for infrastructure, to embody the external effect of infrastructure in the production of private goods.

The government sector is assumed to impose taxes on output and provide public infrastructure using government revenue. Since public infrastructure has an external effect on both utility and production, each household enjoys the virtue of public infrastructure, but does not have to bear the cost. Of course it is likely that some tax revenue is consumed for corruption or as transaction costs.

The assumptions adopted here differ from those in some other models in that public capital is not treated as an independent factor of private production and go directly into the individual production function, but producers and consumers passively accept its external effect on production and consumption.

### 3.1 Production of Goods

As a producer of private goods as well as consumer, the representative household conducts production using labor, capital and the external effect of public infrastructure. We allow the service flow of infrastructure instead of infrastructure itself to go directly into production function with labor-augmented Cobb-Douglass technology, denoted by:

$$Y_{it} = F(L_{it}, K_{it}, K_{gt}) = A(K_{it})^{1-\alpha}(K_{gt}L_{it})^{\alpha} \quad (1)$$

Where $Y_{it}$ is the output of private goods at time t by producer i, $L_{it}$ is the number of laborers employed at time t by producer i, and $K_{gt}$ is a service flow provided by public infrastructure. Formula (1) captures the effect of public infrastructure over production.

Private capital accumulation is subject to the dynamic constraints

$$\dot{K}_{it} = (1-\tau)Y_{it} - \delta K_{it} - C_t \quad (2)$$

Where $\tau$ represents the tax rate imposed on private output, and $\delta$ is the depreciation rate of private capital. Formula (2) indicates that the increase of private capital equals after-tax income minus the depreciation of previous capital stock minus consumption.

### 3.2 Consumption of Goods

As stated above, household utility is determined by both consumption and the spillover effect of service flows of public infrastructure. Thus, we denote the utility function of a representative household by

$$U = U(c_t, K_{gt}) = Log(c_t K_{gt}) \tag{3}$$

Where $c_t$ denotes the consumption of a representative household at time t; and $K_{gt}$ denotes the service provided by the stock of public infrastructure. The marginal substitution elasticity of utility relative to consumption is assumed to be 1. It is clear that consumer's utility increases with public infrastructure stock $K_{gt}$.

### 3.3 Provision of Infrastructure

For simplicity, we assume that there is no other function of government and focus only on its function to provide public infrastructure. Most public infrastructure is provided by the government and used by consumers and producers without any direct payment. Therefore, the production function of newly produced infrastructure (infrastructure flow) at time t is represented by:

$$I_{gt} = \sum_i A_g \tau Y_{it} = N A_g (1-\varphi)\tau Y_{it} \tag{4}$$

,

The infrastructure stock dynamic transition is assumed to be subject to

$$\dot{K}_{gt} = I_{gt} - \delta_g K_{gt} \tag{5}$$

Where part of government tax revenue (with ratio $\varphi$) is seen as the costs of corruption and embezzlement, etc. $\varphi = 0$ means no corruption and all government tax is efficiently used in infrastructure construction; $\varphi = 1$ means all tax is wasted and no infrastructure is formed. $N$ is the number of producers paying tax. $A_g$ is a technology that transfers government expenditure into infrastructure. $\tau Y_{it}$ is total tax used in infrastructure production and $\delta_g$, infrastructure depreciates with rate.

Rewriting (1), (2), (4) and (5) in intensive form, we have

$$y_{it} = A(k_{it})^{1-\alpha}(K_{gt})^{\alpha} \tag{1}'$$

$$\dot{k}_{it} = (1-\tau)y_{it} - (\delta + n)k_{it} - c_t \tag{2}'$$

$$I_{gt} = NL_{it} A_g [(1-\varphi)\tau y_{it}] \tag{4}'$$

$$\dot{K}_{gt} = NL_{it} A_g [(1-\varphi)\tau y_{it}] - \delta_g K_{gt} \tag{5}'$$

The lowercase letters $y_{it}$, $k_{it}$, $c_t$ in (1)', (2)', (4)', and (5)' are per capita variables, representing output, consumption and capital respectively, corresponding to aggregate

output, consumption and private capital in (1), (2), (4), and (5). $L_t = NL_{it}$ is total population employed by all producers. The growth rate of the number of laborers employed is assumed to remain unchanged over time.

### 3.3.1 Optimal Problem of Individual Households

Assuming an individual household regards public infrastructure as a predetermined variable, then the optimal problem of a household can be written as

$$\begin{aligned}\max_{c(t)} V(0) &= \max_{c(t)} \int_0^{\infty} U(c_t, K_{gt}) e^{-(\rho-n)t} dt \\ &= \max_{c(t)} \int_0^{\infty} Log(c_t K_{gt}) e^{-(\rho-n)t} dt\end{aligned} \tag{6}$$

Subject to:

$$\dot{k}_{it} = (1-\tau)A(k_{it})^{1-\alpha}(K_{gt})^{\alpha} - (\delta + n\ )k_{it} - c_t \tag{7}$$

Based on the maximum value principle, the Hamilton function corresponding to this optimal problem can be written as

$$\begin{aligned}H(t, k_{it}; c_t) &= e^{-(\rho-n)t} Log(c_t K_{gt}) \\ &+ \mu(t)\left[(1-\tau)A(k_{it})^{1-\alpha}(K_{gt})^{\alpha} - (\delta + n_p)k_{it} - c_t\right]\end{aligned} \tag{8}$$

Where, $c_t$ is a control variable and $k_{it}$ a state variable, then the first order conditions for the optimal problem are

$$\frac{\partial H}{\partial c_t} = e^{-(\rho-n)t} / c_t - \mu_t = 0 \tag{9}$$

$$\frac{\partial H}{\partial k_{it}} = \mu_t\left[(1-\alpha)(1-\tau)A\ (k_{it})^{-\alpha}(K_{gt})^{\alpha} - (\delta + n\ )\right] = -\dot{\mu}_t \tag{10}$$

Taking the derivative with respect to time t on both side of equation (9), we obtain

$$\dot{\mu}_t = -\left[\frac{\dot{c}_t}{c_t} + (\rho - n)\right]\mu_t \tag{11}$$

Substituting $\dot{\mu}_t$ in (11) into (10) and then making some adjustments, we have

$$\frac{\dot{c}_t}{c_t} = \left[(1-\alpha)(1-\tau)A\left(\frac{k_{it}}{K_{gt}}\right)^{-\alpha} - (\delta + \rho)\right] \tag{12}$$

Since $y_{it} = A(k_{it})^{1-\alpha}(K_{gt})^{\alpha}$, and $\frac{y_{it}}{k_{it}} = A(k_{it})^{-\alpha}(K_{gt})^{\alpha}$, the private capital dynamic transitional state equation (2) can be written as

$$\frac{\dot{k}_{it}}{k_{it}} = (1-\tau)A(k_{it})^{-\alpha}(K_{gt})^{\alpha} - (\delta + n) - \frac{c_t}{k_{it}} \tag{13}$$

Equation (12) together with (13) constitutes an equation group that describes the transitional dynamic state. It is clear that the growth rate of an individual household's consumption will increase with public infrastructure. In a steady state, each variable grows at constant rate, then we have $k_{it}$ and $c_t$ is constant, or $\frac{\dot{k}_{it}}{k_{it}} = 0$ and $\frac{\dot{c}_t}{c_t} = 0$ from (12), $\left(\frac{\dot{c}_t}{k_{it}}\right)^{\bullet} = 0$ from (13). Therefore, in steady state we have

$$\frac{c_t}{k_{it}} = (1-\tau)A_p(k_{it})^{-\alpha}(K_{gt})^{\alpha} - (\delta + n), \tag{14}$$

and

$$\left[(1-\alpha)(1-\tau)A(k_{it})^{-\alpha}(K_{gt})^{\alpha} - (\delta+\rho)\right] = 0. \tag{15}$$

From (15), individual capital stock and consumption at time t follows:

$$k_{it}^{*} = \left[(1-\alpha)(1-\tau)A/(\delta+\rho)\right]^{\frac{1}{\alpha}} K_{gt} \tag{16}$$

and

$$c_t^{*} = \left[\left[(\delta+\rho)/(1-\alpha)\right] - (\delta+n)\right]\left[(1-\alpha)(1-\tau)A/(\delta+\rho)\right]^{\frac{1}{\alpha}} K_{gt} \tag{17}$$

It is clear that $\left[(\delta+\rho)/(1-\alpha)\right] - (\delta+n) > 0$ (because $\rho > n$ ) and equation (16) and (17) imply that public infrastructure has a positive effect on steady state per capita consumption and capital accumulation. Given the current circumstance where the PRC macro economy is suffering from weak consumption in rural areas, it is helpful to strengthen infrastructure building to boost investment and consumption, ceteris paribus.

Equation (16) tells us that consumption growth is positively related to the expansion of the infrastructure building and private technical level, but negatively related to the tax rate, capital depreciation rate and time preference rate. The more the investment in infrastructure or the higher the infrastructure capital accumulation, the lower the tax rate, capital depreciation rate or time preference rate, and the higher the steady state consumption.

From the viewpoint of the individual household, it would be possible for a producer to produce to the point where the marginal product surpasses marginal cost if public infrastructure is over invested, which make producers earn more than a normal profit.

The statement above resolves the issue of the impact of infrastructure on private consumption and investment. However, how to decide the size infrastructure is not yet clear. The authors believe this issue should be left to government and be reflected in the goals of government. In addition, since taxation aims to provide household with infrastructure, the government should also decide the level of tax revenue.

### 3.3.2 Optimization Problem of Government

We assume that the government as a social planner pursues the maximization of the welfare of the whole society. In addition, the government knows about the producer's production and consumer's utility function, both of which are influenced by the capital stock of public infrastructure. The government also knows about the constraints faced by producers and consumers, transitional equation and public infrastructure capital accumulation process. In its decision, the government has already taken into consideration the external effects of infrastructure on individual production and consumption, that is, external effects of infrastructure are internalized in government decisions. The optimal problem facing households is as follows:

$$\begin{aligned} \max_{c(t)} V(0) &= \max_{c(t)} \int_0^{\infty} U(c_t, K_{gt}) e^{-\rho t} dt \\ &= \max \int_0^{\infty} Log(c_t K_{gt}) e^{-\rho t} dt \end{aligned} \tag{20}$$

Subject to the constraints

$$\dot{k}_{it} = (1-\tau)A(k_{it})^{1-\alpha}(K_{gt})^{\alpha} - \delta k_{it} - c_t \tag{21}$$

$$\dot{K}_{gt} = NL_i A_g (1-\varphi)\tau A(k_{it})^{1-\alpha}(K_{gt})^{\alpha} - \delta_g K_{gt} \tag{22}$$

According to the maximum value principle, the Hamilton function corresponding to this problem can be written as

$$\begin{aligned} H(t,k_{pt},K_{gt};c_t) &= e^{-\rho t}Log(c_tK_{gt}) \\ &+ \mu(t)\left[(1-\tau)A(k_{it})^{1-\alpha}(K_{gt})^{\alpha} - \delta k_{it} - c_t\right] \\ &+ \nu(t)\left[NL_iA_g(1-\varphi)\tau A(k_{it})^{1-\alpha}(K_{gt})^{\alpha} - \delta_g K_{gt}\right] \end{aligned} \quad (23)$$

$c_t$ and $K_{gt}$ are control variables and $k_{it}$, $K_{gt}$ are state variables. $L = NL_i$ is a variable that does not change over time t. The first order conditions for the optimal problem are

$$\frac{\partial H}{\partial c_t} = e^{-\rho t}/c_t - \mu_t = 0 \quad (24)$$

$$\begin{aligned} \frac{\partial H}{\partial k_{it}} &= \mu_t\left[(1-\alpha)(1-\tau)A(k_{it})^{-\alpha}(K_{gt})^{\alpha} - \delta\right] \\ &+ \nu_t\left[(1-\alpha)NL_iA_g(1-\varphi)\tau A(k_{it})^{-\alpha}(K_{gt})^{\alpha}\right] \\ &= -\dot{\mu}_t \end{aligned} \quad (25)$$

$$\begin{aligned} \frac{\partial H}{\partial K_{gt}} &= e^{-(\rho-n)t}/K_{gt} + \mu_t\left[\alpha(1-\tau)A(k_{it})^{1-\alpha}(K_{gt})^{\alpha-1}\right] \\ &+ \nu_t\left[\alpha NL_iA_g(1-\varphi)\tau A(k_{it})^{1-\alpha}(K_{gt})^{\alpha-1} - \delta_g\right] \\ &= -\dot{\nu}_t \end{aligned} \quad (26)$$

$$\begin{aligned} \frac{\partial H}{\partial \tau} &= -\mu_t\left[(1-\alpha)A(k_{it})^{-\alpha}(K_{gt})^{\alpha}\right] \\ &+ \nu_t\left[(1-\alpha)NL_iA_g(1-\varphi)A(k_{it})^{-\alpha}(K_{gt})^{\alpha}\right] \\ &= 0 \end{aligned} \quad (27)$$

Taking the derivative of both side of equation (26), we obtain

$$\dot{\mu}_t = -\left[\frac{\dot{c}_t}{c_t} + \rho\right]\mu_t \quad (28)$$

Rewriting (25), we have

$$\mu_t\left[\frac{(1-\alpha)(1-\tau)y_{it}}{k_{it}} - \delta\right] + \nu_t\left[\frac{(1-\alpha)NL_iA_g(1-\varphi)\tau y_{it}}{k_{it}}\right] = -\dot{\mu}_t \quad (29)$$

Rewriting (26), we have

$$\mu_t\left[\frac{\alpha(1-\tau)y_{it}}{K_{gt}} + \frac{c_t}{K_{gt}}\right] + \nu_t\left[\frac{NL_i\alpha A_g(1-\varphi\tau y_{it}}{K_{gt}} - \delta_g\right] = -\dot{\nu}_t \quad (30)$$

Substituting $\dot{\mu}_t$ in (28) into (29) and making some simple adjustment, we obtain

$$\frac{\mu_t}{\nu_t} = -\left[\frac{(1-\alpha)NL_iA_g(1-\varphi)\tau y_{it}}{k_{it}}\right] \Big/ \left[\frac{(1-\alpha)(1-\tau)y_{it}}{k_{it}} - \frac{\dot{c}_t}{c_t} - \delta - \rho\right] \quad (31)$$

On the other hand, according to (27) we obtain

$$\mu_t = \nu_t\left[NL_iA_g(1-\varphi)\right] \quad (32)$$

Substituting (32) into (31), we have

$$\frac{\dot{c}_t}{c_t} = \left[\frac{(1-\alpha)y_{it}}{k_{it}} - (\delta+\rho)\right] \quad (33)$$

Since $\mu_t = \nu_t\left[NL_i A_g(1-\varphi)\right]$, formula $\frac{\dot{\mu}_t}{\mu_t} = \frac{\dot{\nu}_t}{\nu_t}$ holds, and (30) can be simplified as

$$\frac{\dot{c}_t}{c_t} = NL_i \alpha A_g (1-\varphi)\left(\frac{y_{it}}{K_{gt}} + \frac{c_t}{K_{gt}}\right) - (\delta_g + \rho) \tag{34}$$

From (33) and (34), we obtain

$$\frac{(1-\alpha)y_{it}}{k_{it}} = NL_i \alpha A_g (1-\varphi)\left(\frac{y_{it}}{K_{gt}} + \frac{c_t}{K_{gt}}\right) + (\delta - \delta_g) \tag{35}$$

or

$$\frac{(1-\alpha)y_{it}}{k_{it}} = NL_i \alpha A_g (1-\varphi)\left\{\left(\frac{y_{it}}{k_{it}}\right)\left(\frac{k_{it}}{K_{gt}}\right) + \left(\frac{c_t}{k_{it}}\right)\left(\frac{k_{it}}{K_{gt}}\right)\right\} + (\delta - \delta_g) \tag{36}$$

The dynamic transition of the system and optimal tax rate are determined by transitional equations (21), (22), and (34) and equation (36). However, the steady state of consumption growth and capital growth and infrastructure capital growth cannot be seen directly from these equations. We rewrite (21), (22) and (34), to find their steady state and obtain dynamic transitional equations regarding variables $\frac{k_{it}}{K_{gt}}$, $\frac{c_t}{k_{it}}$ and $\tau$. Since

$$\frac{\dot{k}_{it}}{k_{it}} = (1-\tau)A\left(\frac{k_{it}}{K_{gt}}\right)^{-\alpha} - \delta - \frac{c_t}{k_{it}} \tag{37}$$

$$\frac{\dot{K}_{gt}}{K_{gt}} = NL_i A_g (1-\varphi)\tau A\left(\frac{k_{it}}{K_{gt}}\right)^{1-\alpha} - \delta_g \tag{38}$$

$$\frac{\dot{c}_t}{c_t} = (1-\alpha)A\left(\frac{k_{it}}{K_{gt}}\right)^{-\alpha} - (\delta + \rho) \tag{39}$$

Introducing variable $\eta = \frac{k_{it}}{K_{gt}}$ and $\chi = \frac{c_t}{k_{it}}$, we have

$$\frac{\dot{\eta}}{\eta} = \frac{\dot{k}_{it}}{k_{it}} - \frac{\dot{K}_{gt}}{K_{gt}} = (1-\tau)A\eta^{-\alpha} - \chi - LA_g(1-\varphi)\tau A\eta^{1-\alpha} + \delta_g - \delta \tag{40}$$

$$\frac{\dot{\chi}}{\chi} = \frac{\dot{c}_t}{c_t} - \frac{\dot{k}_{it}}{k_{it}} = A(\tau - \alpha)\eta^{-\alpha} - \rho + \chi \tag{41}$$

According to (34) and (39), we have

$$\frac{(1-\alpha)y_{it}}{k_{it}} = L\alpha A_g (1-\varphi)\left\{\left(\frac{y_{it}}{k_{it}}\right)\left(\frac{k_{it}}{K_{gt}}\right) + \left(\frac{c_t}{k_{it}}\right)\left(\frac{k_{it}}{K_{gt}}\right)\right\} + (\delta - \delta_g) \tag{42}$$

or

$$(1-\alpha)A\eta^{-\alpha} = L\alpha A_g (1-\varphi)\left(A\eta^{1-\alpha} + \eta\chi\right) + (\delta - \delta_g) \tag{43}$$

At the steady state, both $\dot{\chi} = 0$, $\dot{\eta} = 0$, $\dot{\tau} = 0$ and (43) are satisfied. The steady state of the system is satisfied by equation (44), (45) and (46):

$$(1-\tau)A\eta^{-\alpha} - \chi - LA_g(1-\varphi)\tau A\eta^{1-\alpha} + \delta_g - \delta = 0 \quad (44)$$

$$A(\tau-\alpha)\eta^{-\alpha} - \rho + \chi = 0 \quad (45)$$

$$(1-\alpha)A\eta^{-\alpha} = L\alpha A_g(1-\varphi)\left(A\eta^{1-\alpha} + \eta\chi\right) + (\delta - \delta_g) \quad (46)$$

These three equations determine variables $\eta$, $\chi$ and $\tau$, the steady state consumption growth, capital growth and economic growth. From Equation (44) and (45), we derive

$$(1-\alpha)A\eta^{-\alpha} - LA_g(1-\varphi)\tau A\eta^{1-\alpha} + \delta_g - \delta - \rho = 0 \quad (47)$$

Taking the derivative of $\eta$ with regard to tax rate in (47), we obtain

$$\left.\frac{d\eta}{d\tau}\right|_{\tau=\tau^*} = -\left.\frac{LA_g(1-\varphi)\tau A\eta^{1-\alpha}}{\alpha(1-\alpha)A\eta^{-\alpha-1} + (1-\alpha)LA_g(1-\varphi)\tau A\eta^{-\alpha}}\right|_{\tau=\tau^*} < 0 \quad (48)$$

$$d\left(\frac{\dot{c}_t}{c_t}\right) \Big/ d\tau > 0 \quad (49)$$

(49) Indicates that the growth rate of consumption increases with an increasing tax rate around the steady state. Unlike the neoclassical model in which the growth rate of individual consumption and other concerned variables finally stops, this model shows that consumption growth is endogenous and can be sustainable.

### 3.4 Implications of the Models

The external effect or learning by investing effect of infrastructure has been frequently discussed in the literature, but it has seldom been modeled into a general equilibrium framework. Therefore, in this paper we have created an endogenous growth model of three sectors that highlight the effect of infrastructure on economic growth.

Unlike the neoclassical model in which per capita consumption and economic growth finally stop at a steady state, this newly developed model states that externalities of infrastructure on production and consumption make it possible to sustain long-run economic growth. Unlike the neoclassical model in which long-run growth is either exogenously determined or left unexplained, the model here also says that sustainable growth may be outcome of government behavior. The model also demonstrates that a scale effect of population should be taken into consideration when developing infrastructure, in order for infrastructure to develop its role. In addition, it shows that management costs, corruption and other factors that might damage the efficiency of translating tax into infrastructure has an important role in long-term economic and consumption growth.

## 4. EMPIRICAL STUDY ON THE ROLE OF INFRASTRUCTURE

### 4.1 Definition of Variables and Data Sources

There are 31 provinces (or autonomous regions) in the PRC. Among them, Hainan Province was once one of the prefectures of Guangdong Province. In April 1984, Hainan was made into a special administration region at the second session of the Sixth Chinese National People's Congress, still under the control of Guangdong Province. In March 1988 it was announced that Hainan Special Administration Region would be a new province independent from Guangdong. In 1997, it was announced that Chongqing, a big city formerly in Sichuan Province, would become the fourth municipality. Because of the separation of Chongqing from Sichuan and Hainan from Guangdong, data for Sichuan before 1997 and from Guangdong before 1988 are not comparable with later data. To make the data historically comparable, we integrate the data of Hainan with those of Guangdong and the data of

Chongqing with those of Sichuan, using the name of Guangdong and Sichuan. Following the integration, there are 29 provinces in our study.

As a country with 9.6 million square kilometers of land and 56 nationalities, there are huge differences in climates and terrains among regions. To embody the interregional difference, we further classify the 29 provinces (or autonomous regions) into four regions, that is, Eastern China, Central China, Western China, and Northeastern China. Eastern China includes Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong; Central China includes Anhui, Jiangxi, Henan, Hubei, Hunan, Shanxi; Western China includes Inner Mongolia, Guangxi, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang; Northeastern China includes Liaoning, Jilin, Heilongjiang.

The data used in this study are collected by province and by year. We updated the data to 2005 based on the data applied in Research Report 138 of the International Food Policy Research Institute dated from 1952 to 2001 by Fan et al (2005).[4] Unless specially indicated, all data used are from official publications of the PRC's statistical agency, the National Bureau of Statistics. For the purpose of this study, we only use those data that are associated with the rural economy, including agricultural GDP, agricultural labor, geographical land area, sown land area, fertilizer use, rural telephone numbers, and length of highways by different classes at the principal level between 1978 and 2005. Rural income and rural consumption data and GDP data from other sectors are also collected and edited in order to better understand the effects of public infrastructure.

Important variables used in the production function include: (1) agriculture output (GDP); (2) agriculture inputs such as land, rural physical capital stock, labor; (3) infrastructure proxy variable such as rural human capital or education level, length of roads, electric power infrastructure, and telecommunications. From the consumption side, rural household income and consumption are also needed for the empirical study. Now let us give a detailed explanation about the variables used in the empirical study.

**Agriculture GDP** is the most important source of rural income, but we have to recognize that there is no exact concept of agriculture GDP in the *China Statistical Yearbooks*. Nevertheless, the yearbooks report two concepts in association with agriculture output. One is value added of farming, which reflects only grain, vegetables, oil-bearing production, and a few other variables, which can be viewed as within the narrow concept of agriculture. The other is value added of primary industry, which combines the value added from farming, forestry, animal husbandry, and fishery, and can be seen as within the broad concept of agriculture. Agriculture GDP reported in Fan (2005) refers to primary industry GDP. We continue to apply this classification.

**The agriculture capital stock** is a concept that is closely related to agricultural GDP. The *China Statistical Yearbooks* report capital formation of the agricultural sector (primary industry), industrial sector (secondary industry) and service sector (tertiary industry). Using the same methods used by Fan et al (2005), we estimate and update the agriculture capital stock time series up to 2005. Our method is to estimate the capital depreciation rates using the consecutive data of capital stock prior to 2001 at first and then use the capital formation data reported in *China Statistical Yearbooks* from 1997-2001 and the formula $K_t = I_t + (1-\delta)K_{t-1}$ to estimate capital stock after 2001. In computing capital stock, the capital depreciation rates after 2001 have to be predetermined. We use the depreciation rate between 1997 and 2001 as a proxy for the depreciation rate of capital stock after 2001. Real term capital formation is derived after deflating the nominal capital formation. Once the depreciation rates, nominal capital formation, and capital stock for 2001 are available, the

[4] As a macroeconomic consultant, one of the authors Zhijun Zhao made some contributions to the data collection in 2002.

capital stock between 2001 and 2005 can be derived. Fertilizer used, sown land area and machinery power, which are important inputs of agriculture production, are computed in agriculture investment or capital stock. Therefore, these inputs do not appear in the production function.

**Land** is another important productive factor. There are different land classifications. We use sown land area instead of total arable land as the input, because only sown land plays an actual role in agricultural production. Regarding the quality of land (similar to human capital relative to number of workers), we think that qualitative differences have been reflected in investment, because an increase in investment in agriculture improves the quality of land.

**Agricultural labor** here refers to the number of workers employed in primary industry or the broad agriculture sector, which can be found in the *China Statistical Yearbook* for various years. This concept is similar to simple labor in Marxist economics.

**Human capital**, as an index of the quality of labor, can be seen as a relative concept. Hence, educated rural Chinese have more human capital than uneducated ones and literate people have more human capital than illiterate people. There are different types of indices that reflect the educational level in rural areas. Data available in this regard include ratio of rural population with high school education, average length of schooling of rural population and ratio of rural illiteracy. We put these separately into a regression and see their impact. More importantly for this study, rural education can be seen as a typical infrastructure, because it is provided by government, is basically free[5] and is productive.

**Roads, telecommunication, and electricity** are important factors with potential effects on agricultural production, rural household income and consumption.

As mentioned above, roads in the PRC are classified into six types. We further classify them into three types: high standard roads, low standard roads, and substandard roads.[6] High standard roads include expressways, class 1, and class 2 roads. Low standard roads include class 3 and class 4 roads. Substandard roads are built by rural collectives. We do not think that they should be considered as public infrastructure with external effects on rural production and consumption. Therefore, our empirical study does not consider substandard roads.

**Rural electricity consumption** can be viewed as a proxy of the electricity infrastructure development index. The number of telephones is viewed as a proxy for the development of the rural telecommunications as stated by Fan.

Unlike education and low standard roads, which are provided by government for free, electricity and telecommunication infrastructure are basically investments by monopolistic stated-owned enterprises and are not free, but are expensive even according to some developed countries' standards.

### 4.2 Model and Variable Selection

The production function adopted here is Cobb-Douglass type production function, which can be turned into a linear double logarithm form of production function. This type of functional form is proper and has clear economic implications. Thus, the parameters are easy to interpret (Fan 2005; and Fuss, McFadden, and Mundlak 1978). Fan et al (2005) run regressions with fixed effects on both cross-sectional dummies and time period dummies

[5] China implements nine years of compulsory education.
[6] Here the length of substandard roads is not reported, because, first, most of them are formulated historically or built by collectives rather than depending on investment; and second, road measurement standards have changed with time and are not comparable historically.

based on panel data. Though this method is thought to be able to capture long-run co-integration among variables and the R-squared statistic in regressive results is usually high, most regression equations are derived from the linearization of non-linear equations, thus they could at best be seen as localized co-integration. In addition, residual terms are usually highly correlated and not stationary. When conducting the same regressions repeatedly (Fan et al, 2005), the residual term is found to be not stationary and highly correlated. Therefore, we don't think that this method is well supported by standard statistical theories. Actually, it is better to run regressions between level variables to reflect static relationships, and to run regressions between growth variables to reflect dynamic relationships as implied in modeling efforts. To eliminate the residual correlation and reflect the cross-section variations, we adopt a double logarithm functional form with fixed effects across section or time series, and sometimes run autoreggressions when we find autocorrelation between residual terms.

An intensive double log agriculture production function with a first order auto regression can be written as

$$\begin{aligned}&\log(GDPR1?/AL?)_{it}\\&=\alpha+\alpha_i+\alpha_t+\beta_1\log(C1?/AL?)_{it}+\beta_2\log(SOWN?/(GAREA?*AL?))_{it}\\&+\beta_3\log(LSROAD?/AL?)_{it}+\beta_4\log(HSROAD?/AL?)_{it}\\&+\beta_5\log(ELEC?/AL?)_{it}+\beta_6\log(RTR?/AL?)_{it}+\beta_7\log(ILLITE)+\mu_t\end{aligned} \tag{75}$$

Rural consumption is impacted by rural income and various infrastructures.

$$\begin{aligned}&\log(RCONS?)_{it}\\&=\alpha+\alpha_i+\beta_1\log(RINCOME?)_{it}\\&+\beta_2\log(LSROAD?/AL?)_{it}+\beta_3\log(HSROAD?/AL?)_{it}\\&+\beta_4\log(ELEC?/AL?)_{it}+\beta_5\log(RTR?/AL?)_{it}+\beta_6\log(ILLITE)+\mu_t\end{aligned} \tag{76}$$

Where, $\alpha$ is constant, $\alpha_i$ denotes cross sections fixed effects subject to $\sum_i \alpha_i = 0$ and $\alpha_t$ denotes periodic fixed effects. If a high correlation is found between the residuals $\mu_t$ in equation (75) and (76)), we further try regressions with $\mu_t$ following the AR process:

$$\mu_t = \gamma_0 + \gamma_1\mu_{t-1} + \Lambda + \gamma_p\mu_{p-1} + \varepsilon_t \tag{77}$$

Where, $\varepsilon_t$ is a white noise process and $E(\varepsilon_t) = 0$.

Similar empirical studies are also conducted in industrial GDP and service GDP. The definition of variables in (75) and (76) is described in table (10):

**Table 10. Definition of Variables**

| Variable | Unit | Definition |
|---|---|---|
| AL? | 10,000 people | Agricultural labor |
| ELEC? | 100 million kilowatts | Rural electricity consumption |
| GAREA? | 10,000 square kilometers | Geographic area |
| GDPR1? | 100 million yuan, base year 1980 | Real agricultural GDP |
| GDPR2? | 100 million yuan, base year 1980 | Real industrial GDP |
| GDPR3? | 100 million yuan, base year 1980 | Real service GDP |
| C1? | 100 million yuan, base year 1980 | Capital stock of agriculture |
| C2? | 100 million yuan, base year 1980 | Capital stock of industry |
| C3? | 100 million yuan, base year 1980 | Capital stock of service |
| SOWN? | 10,000 mu | Sown areas to crop |
| HSROAD? | Kilometers | Length of high standard roads |
| LSROAD? | Kilometers | Length of low standard roads |
| RTR? | 10,000 sets | Number of rural telephones |
| ILLITE? | Percent | Rural illiteracy rate |
| RINCOME? | Yuan, base year 1980 | Rural per capita income |
| RCONS? | Yuan, base year 1980 | Rural per capita consumption |
| TPOP | 10,000 people | Number of total population |

### 4.3 Empirical Results and Their Implications

Table 11 lists the results of the pooled regression of per capita agricultural GDP growth with fixed cross-sectional and time period effects for 29 provinces. The dependent variable of the model is growth of agricultural GDP and the regressive variables are growth of per capita capital stock, sown land area, low standard and high standard roads and the number of rural telephone sets. It looks quite good in term of the R-squared statistic and Durbin-Watson statistic. The results show that per capita capital stock, sown land area, low standard roads and rural telephone sets have significant positive effects on agricultural GDP growth at the 5% significance level, while electricity infrastructure and high standard roads have no significant impact on agricultural GDP growth.

**Table 11. Regressions of Per Worker Agricultural GDP Growth**

| | Nationwide | | Nationwide | |
|---|---|---|---|---|
| Variable | Coefficient | t-statistic | Coefficient | t-statistic |
| C | 0.054929 | 15.01173** | 0.056839 | 18.02220** |
| D(LOG(C1?/AL?)) | 0.080556 | 3.286792** | 0.082985 | 3.410620** |
| D(LOG(SOWN?/AL?)) | 0.737180 | 15.50016** | 0.749925 | 16.23918** |
| D(LOG(ELEC?/AL?)) | 0.025825 | 1.215339 | | |
| D(LOG(LSROAD?/(GAREA?*AL?))) | 0.037769 | 2.795896** | 0.038891 | 2.892477** |
| D(LOG(HSROAD?/(GAREA?*AL?))) | -0.000475 | -0.086348 | | |
| D(LOG(RTR?/AL?)) | 0.023986 | 2.876430** | 0.024332 | 2.921185** |
| R-squared | 0.719119 | | 0.718339 | |
| Durbin-Watson | 2.071312 | | 2.058693 | |

Note: A statistic marked with "**" is significant at the 5% level. "C1?/AL?" refers to agricultural capital stock divided by agricultural labor; the meaning of variable D(LOG(C1?/AL?)) is the logarithm of agriculture capital stock divided by agriculture labor. Other variables can be given similar explanations.

Table 11 does not show the effects of education on agriculture GDP, as data from 2001 and 2005 are unavailable. To determine the role of education in rural development, we use data

and conduct regressions with educational variables from 1983-2000. We first put years of schooling of rural population and ratio of rural population with high school education into the equations, but find no significant effect on per capita agriculture GDP growth. We then put the rural illiteracy rate and repeat the computation process (see Table 12). As a result, we find a significant negative effect of illiteracy, at the 1% level. Significant effects on per capita agricultural GDP growth are also found for capital stock, sown land area, low standard and high standard roads and the number of rural telephone sets. These findings indicate that it does not matter whether a rural person is educated for five or eight years. What matters is if he or she enjoys elementary education or is rescued from illiteracy. In addition, neither the growth of high standard roads or electricity show any significant effect on agricultural GDP growth.

**Table 12. Pooled Regression of Per Labor Agricultural GDP Growth (Fixed cross section and periodic effects are not reported)**

| | Nationwide | | Nationwide | |
|---|---|---|---|---|
| Variable | Coefficient | t-statistic | Coefficient | t-statistic |
| C | 0.143489 | 4.040965** | 0.137399 | 3.90074** |
| D(LOG(C1?/AL?)) | 0.238790 | 4.541069** | 0.229987 | 4.44416** |
| D(LOG(SOWN?/AL?)) | 0.798619 | 11.22381** | 0.732407 | 9.92025** |
| D(LOG(ELEC?/AL?)) | -0.01671 | -0.698451 | | |
| D(LOG(LSROAD?/(GAREA?*AL?))) | 0.027867 | 1.917654* | 0.026174 | 1.81501* |
| D(LOG(HSROAD?/(GAREA?*AL?))) | -0.00624 | -0.669381 | | |
| D(LOG(RTR?/AL?)) | 0.018262 | 2.051270** | 0.015483 | 1.73912* |
| LOG(ILLITE?) | -0.03414 | -2.714004** | -0.03386 | -2.7153** |
| R-squared | 0.774470 | | 0.776812 | |
| Durbin-Watson | 2.092522 | | 2.120013 | |

Note: A t-statistic with "**" is significant at the 5% level and a statistic with "*" is significant at the 10% level.

Since different regions of the PRC are in different development phases and there are tremendous differences in weather and geographic conditions, infrastructures have different effects across regions. However, we cannot identify interregional difference from Table 11. To find such differences, we run regressions of agricultural GDP regarding various inputs respectively for the four different regions (see Table 13). We find that capital stock shows a significant positive effect in the eastern and northeastern regions and insignificant effects in the other two regions; sown area of land shows positive effect in east, middle, and west regions, and insignificant effect in northeast region. Rural telecommunications system shows a negative significant effect in middle region[7], in other regions the effect is not significant. Positive (negative) effects of the literacy rate (illiteracy rate) are found in the eastern, central, and western regions, and insignificant effects are found in the northeastern region. Finally, in the interregional comparative studies, we do not find significant effect of roads, either high standard or low standard.

[7] Telecommunications in terms of the number of telephone sets largely involves consumption goods, and perhaps has a dominant substitution effect over the income effect, and then shows a negative or insignificant effect on rural GDP.

**Table 13. Regressions of Per Labor Agricultural GDP Growth**

| | Eastern | | Central | | Western | | Northeastern | |
|---|---|---|---|---|---|---|---|---|
| Fixed effect | Cross section and time series | | Time series | | Cross section and time series | | Time series | |
| Variable | Coefficient | t-statistic | Coefficient | t-statistic | Coefficient | t-statistic | Coefficient | t-statistic |
| C | 0.171 | 2.91** | 0.234 | 4.80** | 0.353 | 2.91** | 0.032 | 0.881 |
| D(LOG(C1?/AL?)) | 0.361209 | 3.556722** | -0.088813 | -0.758356 | 0.145863 | 1.450647 | 1.228907 | 3.347071** |
| D(LOG(SOWN?/AL?)) | 0.716076 | 5.073966** | 1.325225 | 5.743744** | 0.354436 | 2.475365** | -0.064681 | -0.174793 |
| D(LOG(LSROAD?/(GAREA?*AL?))) | -0.008124 | -0.083531 | 0.014974 | 0.765321 | 0.058736 | 0.705716 | -0.122824 | -0.668162 |
| D(LOG(HSROAD?/(GAREA?*AL?))) | -0.002959 | -0.127110 | -0.012271 | -0.733228 | 0.003784 | 0.233646 | 0.031763 | 0.645185 |
| D(LOG(RTR?/AL?)) | 0.009188 | 0.796425 | -0.175572 | -3.267676** | 0.024673 | 1.509676 | -0.029764 | -0.279291 |
| LOG(ILLITE?) | -0.048033 | -2.007954** | -0.046817 | -2.948637** | -0.098221 | -2.642294** | -0.016173 | -1.225327 |
| R-squared | 0.911344 | | 0.636215 | | 0.499616 | | 0.938530 | |
| Durbin-Watson stat | 1.86088 | | 1.797836 | | 2.255637 | | 1.906913 | |

Note: A t-statistic with "**" is significant at the 5% level and a statistic with "*" is significant at the 10% level.

Using more information available after 2000 we update the data to 2005 and run regressions for regions where the illiteracy rate fell once again. The empirical results are reported in Table 14. It shows that capital stock and sown land area demonstrate a positive effect on agricultural GDP growth in every region. Positive effects of low standard roads on agricultural GDP growth are present in the eastern region, while high standard roads show no significant effect on agricultural GDP in any region, indicating that the current policy that encourages investment in high standard roads is not favorable for rural development and may cause the gap between rural and urban areas to expand further. A significant negative effect of the rural telecommunications system is found in the central region.

**Table 14. Regressions of Per Worker Agricultural GDP Growth**

| | Eastern | | Central | | Western | | Northeastern | |
|---|---|---|---|---|---|---|---|---|
| Fixed effect | Cross section and time series | | Time series | | Cross section and time series | | Time series | |
| Variable | Coefficient | t | Coefficient | T | Coefficient | t | Coefficient | T |
| C | 0.072001 | 12.14560** | 0.076926 | 6.133563** | 0.041718 | 8.538166** | 0.033848 | 1.554764 |
| D(LOG(C1?/AL?)) | 0.114658 | 2.750520** | 0.079735 | 1.667142** | 0.109784 | 2.131155** | 0.640186 | 3.354242** |
| D(LOG(SOWN?/AL?)) | 0.757689 | 9.538101** | 0.938262 | 5.982970** | 0.370837 | 4.077667** | 0.726401 | 4.212330** |
| D(LOG(LSROAD?/(GAREA?*AL?))) | 0.108454 | 2.449642** | 0.012516 | 0.708272 | -0.020689 | -0.457077 | -0.266243 | -1.663834 |
| D(LOG(RTR?/AL?)) | 0.011533 | 0.960377 | -0.117519 | -2.442370** | 0.023258 | 1.667600 | 0.003159 | 0.035998 |
| R-squared | 0.868568 | | 0.641572 | | 0.458267 | | 0.927828 | |
| Durbin-Watson stat | 1.835899 | | 2.241401 | | 1.992706 | | 1.979469 | |

Note: A t-statistic with "**" is significant at the 5% level and a statistic with "*" is significant at the 10% level.

If high standard roads have an insignificant effect on agricultural GDP growth, why do governments at various levels focus their attention on such roads? One of the reasons may be that high standard roads mainly connect middle and large cities and contribute more to industrial GDP and the urban economy. To confirm this, we also run regressions of the effects of road infrastructure on industrial GDP and service GDP (see Table 15). For neither high standard nor low standard roads infrastructure is there a significant effect on service sector GDP growth, but a significant effect of low standard roads is found on industrial GDP in the eastern, central and western regions. Significant effects of high standard roads are found only in the western region.

**Table 15. Effect of Road Infrastructure on Per Capita Industrial GDP Growth**

| Fixed effects | Cross section only | | Cross section and time series | | Cross section only | | Cross section and time series | |
|---|---|---|---|---|---|---|---|---|
| | Eastern | | Central | | Western | | Northeastern | |
| Variable | Coefficient | t-Statistic | Coefficient | t-Statistic | Coefficient | t-Statistic | Coefficient | t-Statistic |
| C | 0.098 | 12.12** | 0.096 | 8.064** | 0.061 | 8.229** | 0.080 | 16.36** |
| D(LOG(C2?/TPOP?)) | 0.064 | 2.409** | 0.288 | 1.764* | 0.257 | 5.034** | 0.021 | 0.779 |
| D(LOG(LSROAD?/(GAREA?*TPOP?))) | 0.097 | 2.206** | -0.008 | -0.659 | 0.263 | 4.040** | 0.100 | 1.019 |
| D(LOG(HSROAD?/(GAREA?*TPOP?))) | 0.017 | 0.596 | 0.010 | 1.008 | 0.052 | 3.795** | 0.009 | 0.317 |
| AR (1) | 0.402 | 5.388** | | | 0.338 | 4.580** | | |
| R-squared | 0.397 | | 0.842 | | 0.324 | | 0.814 | |
| Durbin-Watson stat | 1.797 | | 1.775 | | 1.949 | | 1.850 | |

Note: Statistics marked with "*" are significant at the 10% level and statistics marked with "**" are significant at the 5% level.

Regarding the effects of various types of infrastructure on per capita consumption in rural areas, the results are listed in Table 16. Here we put level rather than growth data in the regression equation, because standard consumption theory states that the relationship between level variables and residual terms should be proven stationary, and various kinds of

statistics are good enough through autoregression adjustment. Table 16 shows that the rural income always has significant effects on per capita consumption in both national data and regional data. Income is the most important determinant of rural consumption in terms of its high elasticity coefficients. From Table 16, we also see that electricity infrastructure has a significant impact on consumption in the central and northeastern regions, and insignificant effects in the eastern and western regions.

A significant effect of low standard roads on consumption is found in the eastern and northeastern regions, but not in other two regions. High standard roads don't show any significant effect on consumption, so it is not reported here. This result is consistent with our intuition. On one hand, high standard roads that mainly connect big cities together are not very useful for agriculture; on the other hand, most high standard roads are not free public goods, so they are too expensive for rural people and firms to consume. Thus, they do not fit with the pace of local economic development and the needs of rural development. In our field study, we found very few automobiles running on some expressways in the western regions indicating that the investment may not be efficient. In addition, since the land in the West is large but sparsely populated, it may not be clear how the spillover effect promotes consumption. In contrast, since economies in the eastern and northeastern regions are more advanced and the lands are more densely populated, it is easier to bring into effect the scale effect of infrastructure.

Like in previous regression results, telecommunications in term of the number of telephone sets[8] is found to have a small negative effect on consumption in central China, but to have an insignificant effect in the east, west and northeast. If telecommunication expenditure is seen as a part of permanent consumption, we guess that the negative effects of telecommunication on consumption may rest with the relatively low development stage of rural China. At a time when rural households are not sufficiently rich, a permanent expenditure on telecommunications may reduce expenditure on other items, leading to a negative effect of expenditure on telecommunications.

**Table 16. Pooled Regressions of Rural Per Capita Consumption**

| | Eastern | | Central | | Western | | Northeastern | |
|---|---|---|---|---|---|---|---|---|
| Variable | Coefficient | t-statistic | Coefficient | t-statistic | Coefficient | t-statistic | Coefficient | t-statistic |
| C | 2.068 | 6.5195** | 2.3556 | 6.3484** | 1.28345 | 5.98961** | 4.05614 | 4.16195** |
| LOG(RINCOME?) | 0.651 | 13.903** | 0.6498 | 16.4163** | 0.75537 | 20.9131** | 0.43148 | 3.88236** |
| LOG(ELEC?/APOP?) | | | 0.0895 | 2.9389** | | | 0.17383 | 1.9844** |
| LOG(LSROAD?/(GAREA?* APOP?)) | 0.133 | 3.6591** | | | | | 0.37607 | 2.09865** |
| LOG(RTR?/ APOP?) | | | -0.063 | -3.1178** | | | | |
| AR(1) | 0.673 | 7.9972** | 0.3226 | 2.62035** | 0.56008 | 7.84524** | 0.33361 | 1.8017* |
| R-squared | 0.982779 | | 0.968226 | | 0.936018 | | 0.906894 | |
| Durbin-Watson | 1.884617 | | 1.773869 | | 2.012413 | | 2.044569 | |

Note: all the regression coefficients are significant at the 5% level.

In Table 17 we list the results of a regression of three sectors' per capita GDP growth with regard to road infrastructure, each with fixed cross section and time series effects. A significant effect of per capita capital stock on GDP growth is found for each sector. A

[8] It must be recognized that the number of telephone sets does not necessarily provide a comprehensive picture of rural telecommunications, since it does not include mobile phones, which have developed rapidly in the past several years.

significant effect of low standard roads on GDP growth is found for the agricultural sector and industrial sector, but not the service sector. A significant effect of high standard roads on GDP growth is found only for the industrial sector, but not the agricultural sector or service sector. It seems that the service sector and agricultural sector have received insufficient focus and attracted little investment. These results seem to be in line with the government's industrialization policies.

**Table 17. Sector Per Capita GDP Growth and Road Infrastructure**

| | LOG(GDPR1?/TPOP?) | | LOG(GDPR2?/TPOP?) | | LOG(GDPR3?/TPOP?) | |
|---|---|---|---|---|---|---|
| Variable | Coefficient | t-Statistic | Coefficient | t-Statistic | Coefficient | t-Statistic |
| C | 0.047 | 19.09** | 0.087 | 31.788** | 0.076 | 16.283** |
| D(LOG(C1?/TPOP?)) | 0.122 | 5.352** | | | | |
| D(LOG(C2?/TPOP?)) | | | 0.125 | 5.238** | | |
| D(LOG(C3?/TPOP?)) | | | | | 0.341 | 6.844** |
| D(LOG(LSROAD?/(GAREA?*TPOP?))) | 0.036 | 2.885** | 0.028 | 2.239** | 0.014 | 0.973 |
| D(LOG(HSROAD?/(GAREA?*TPOP?))) | 0.007 | 1.271 | 0.024 | 3.337** | 0.002 | 0.161 |
| R-squared | 0.470001 | | 0.621291 | | 0.424955 | |
| Durbin-Watson stat | 2.071869 | | 1.686617 | | 1.879572 | |

Note: D(LOG(C?/TPOP?)) represents the capital stock corresponding to each industrial sector.

In summary, we have conducted a range of empirical studies to determine the impacts of a variety of production factors and types of infrastructure on rural development nationwide and by region. The empirical results show that agriculture capital stock and sown land area are in all cases two important determinants of agriculture production from both nationwide and regional aspects. Input variables have different impacts in different regions. This may be related to geographical differences among regions.

Rural education, as an important public infrastructure, plays a positive role in agriculture nationwide and in all regions but the northeast. This may be because northeastern China is the biggest agricultural area, and rural people there have been better educated and the problem of illiteracy has been basically resolved.

Empirical studies also show that illiteracy rate matters for rural people. Outside of the northeast, primary education needs to improve further. Though the PRC has already adopted a compulsory education law, the law has not been well implemented in some regions.

Nationwide and in some regions, low standard roads show a positive effect on agricultural GDP growth and industrial GDP growth. However, the positive impact of high standard roads is seen only in the industrial sector. This situation corresponds to the PRC's industrialization strategy and ignorance of rural people's interests and rights.

Another important finding of this paper is that infrastructure has important implications on consumption, as indicated in theoretical analysis. Although we cannot directly and precisely compute the effects of infrastructure on consumer's utility, we do know from our theoretical analysis that infrastructure and consumption, and infrastructure and production, should be optimally combined to realize the goals of producers and consumers. These points have been demonstrated at least in some regions if not all. For example, electricity infrastructure has positive effects on rural consumption in central and northeastern China; low standard roads have a positive effect on consumption in eastern and northeastern China.

## 5. IMPLICATIONS FOR RURAL DEVELOPMENT

One of the important characteristics of rural China is its large population and small land area, and rural Chinese have to cultivate their limited lands intensively in order to produce sufficient grain to satisfy the food demand of the PRC's population of 1.3 billion. Intensive cultivation has almost exhausted the potential of agriculture development. It is estimated that in the best harvest year, one mu land can produce as much as 370 yuan or so on average from planting three major crops, and that each peasant can earn about 1,480 Yuan (about US$200) from these two mu, assuming that each year has two harvest seasons.

This judgment is strengthened by the fact that the weight of rural household income from agriculture in total income is falling and that the weight of rural household income from non-agricultural sources is going up. Therefore, in the long run, the only way to provide wealth for rural Chinese is urbanization or allowing more and more people to leave the land.

However, urbanization is a long process and it is difficult for rural households to increase their revenue sharply in the short run. However, the living standards of rural Chinese can be promoted by mobilizing the PRC's rich human as well as financial resources. This will require rural Chinese and their government to shift their attention away from income alone and toward both income and the improvement of the quality of the living environment. We suggest that realistic measures should be taken to mobilize unemployed human resource on one side, and on the other side, urbanization and corresponding institutional arrangements should be made to match new village construction and beautify the village environment. Let peasants enjoy a high quality of life.

Specifically, institutional reform should be carried out in the following aspects: privatization of rural collective land, nationwide unification of the residential registration system, establishment of rural democracy, establishment of an agency system for rural collective environmental protection and maintenance, implementation of a basic compulsory education law and equalization of opportunities for higher education.

### 5.1 The Scale Effect of Population and Infrastructure

Theoretical analyses indicate that there is a scale effect of population on infrastructure. To bring the scale effect into play, populations have to reach a certain size; otherwise, infrastructure will not be used efficiently. Rural populations, and especially those in the western area, are widely scattered. It is very expensive to build infrastructure to connect scattered villages. The expressways in some western regions exceed needs. Infrastructure should be built to facilitate rural residents migration from a scattered state to a relatively concentrated state in order to promote the efficiency of infrastructure. Correspondingly, the resident registration system should be reformed to allow rural residents to migrate easily to regions with good infrastructure. Our empirical study shows that the construction of inexpensive and low standard roads has a positive effect on the growth of agricultural GDP and consumption. Thus, road infrastructure development should match the level of economic development.

Many high standard roads in the PRC are financed by bank loans. They are not free and the fees collected cover the loan interest. They cannot be seen as public goods and have little externality. Low standard roads are totally free for rural household users and thus have larger externality. Therefore, it is advised that more government budget should be spent on low standard road projects.

### 5.2. Education and Rural Development

Compulsory education can be seen as the biggest infrastructure for the rural population. According to our empirical study, literate rural people perform much better than illiterate people in their agricultural activities. This also implies that elementary education is enormously important for rural people who engage in agriculture. However, the PRC's educational law is not well implemented. Excessive illegal charges are levied in many regions, and some families cannot afford the charges and must take their children out of school. Considering this, nine years of compulsory education has to be guaranteed.

### 5.3 Infrastructure Financing and New Village Building

"The biggest problem facing new socialist village building is money." This expression was frequently heard during our field study. However, statistics show that a great amount of rural financial resources is left unused or lent to cities. It seems that the banking sector is reluctant to make loans to rural households and enterprises. Therefore, rural infrastructure cannot rely on loans from state commercial banks.

Rural infrastructure cannot be created by peasants themselves either, because most villages have no businesses or enterprises and have no money to spend on infrastructure. On the other hand, since peasants have made contributions to urban and industrial development for 50 years by selling cheap agriculture goods, it is time for the urban economy and industrial sector to give something back to agriculture and peasants. Therefore, channels for financing rural infrastructure should be expanded to central government transfers, local government budgets, and social donations. Another practical way would be to mobilize existing barren land and unused residential land.

First, based on cost/benefit analysis, the benefit of reallocating fiscal resources from developed regions to undeveloped regions, from high standard roads to low standard roads, might be huge. If the government sector changes its viewpoint on achievements, cut projects that are meant to demonstrate achievements, and increases projects that benefit civilians, the goal of developing the countryside could be realized more rapidly. Hence, more fiscal budget should be provided to rural infrastructure, and transfers from the central and provincial governments to lower governments should be strengthened in the short run. In the long run, the tax system should be reformed so that local governments can collect more tax revenue directly and take more responsibility for building infrastructure. This will not only promote the enthusiasm of local governments, but also reduce the costs of the taxation and fiscal budget transfer process. More importantly, it can reduce the corruption costs incurred in the long reallocation process from the central to local governments. Of course, since local government governance is suspicious, the supervision and control system and other matching systems have to be reformed or strengthened before further decentralization can be pursued.

The second way to fund rural infrastructure is to mobilize social financial resources. After economic reform, many rural people left their hometowns to pursue higher education and work or start businesses. Some of them should be willing to make a contribution to their hometown in one way or another. Local governments should encourage them to donate money to hometown construction projects. For example, a village could erect monuments to commemorate those who made contributions to village construction, or introduce certain favorable tax treatments, e.g., tax exemptions for donations, as is done in the US as well as other developed countries, including Japan, to give incentives to those who make donations.

The third way would be to encourage a flow of urban capital to rural construction through marketization. The biggest problem facing new village building is the shortage of money; the biggest advantage of villages is the abundant and cheap labor and unused land. Meanwhile,

urban residents face two problems. One is excessive liquidity, which has created a bubble in the stock and property markets, putting severe pressure on ordinary urban residents; the other is serious pollution, which makes many cities unsuitable for inhabitation. Some urban people would prefer to reside in rural areas where the air is cleaner. Therefore, positive action should be taken to channel urban resources to serve new village building. Should unused rural land be privatized and marketized, and if urban funds can be introduced into new village construction, rural people could enjoy the benefits of the appreciation of land, and improvements in the rural environment.

### 5.4 Limited Land Privatization Reform

In the reform during the past 30 years, state-owned enterprises have been reformed from pure state or collectively owned enterprises to privately owned ones. State-owned property assets have also been privatized. Following the rapid reform of stated-owned enterprises and privatization of public housing, the price of land has soared. With private land ownership, landowners can get huge benefits from the soaring price of land. Landowners can use revenue from land sales to improve living standards and rural infrastructure. Soaring land prices would also enable them to buy houses in cities, pushing forward urbanization.

However, Chinese peasants today are unable to benefit from selling land, but easily suffer from the loss of their land, becoming landless, jobless peasants with no social security. Under the current land system, peasants own rural land indirectly. They are only endowed with a usufruct of 30 years. This system gives the local government enormous power over land, and local governments often abuse this power for personal interests. For example, they may nullify a land contract before it expires. Rural land must be sold at a low price to the local government, or can be confiscated. However, the government can resell it at a high price. As a result, considerable benefits from the huge price difference become government extra-budgetary revenue. In addition, corruption and the impingement of the interests of peasants result from collusion between government officials and merchants.

The current land ownership system is also responsible for a deterioration of the natural environment. Under the collective ownership system, trees are cut in a disordered way and without planting afterwards, and the soil is left deserted. If land were privatized, trees would be replanted immediately after being cut.

Therefore, it is urgent to return land ownership to peasants, and build a perfectly free land market under which land can be freely and orderly traded, transferred, and leased.

From the perspective of peasants, the benefits of land privatization would be enormous: First, if governments need land, they would have to buy it from peasants at a reasonable market price. After paying the necessary tax, all revenues from the sales, transfer, or lease of the land would be owned by the peasants themselves. This would lead to an increase in rural household income. Peasants would become richer and able to invest in infrastructure. Second, since government would lose the ability to confiscate land at a low price, it would lose the expectation of earning money from land and corruption would be reduced. Third, urbanization would be stepped up. More peasants or farmers would become rich enough to afford houses or apartments in cities and would finally become citizens. Finally, land privatization would have a positive impact on the allocation of labor resources. At present, many able rural Chinese have no room to develop their talents in the countryside and have to go outside to find better opportunities; as a result, what are left are mostly old, disabled men and women. After privatization, land could be concentrated in the hands of skilled farmers, and land could be used efficiently and scientifically, giving skilled farmers more room to develop the countryside.

One might argue that if rural land were privatized and opened for trade, more peasants would sell their land and become landless and jobless people with no social security, leading to social instability. Actually, this worry is unfounded. No peasant would want to become a "peasant with three lacks." In fact, this concept does not exist in countries where the land has been privatized. It is just the current land system of the PRC that produces this problem.

In addition, the wisdom of rural people should not be underestimated. Even if rural land were privatized and peasants endowed with the right to sell land freely, it would mean that the rights and interest of peasants were protected, but would not mean that peasants had to sell their land. We believe that peasants weight the costs and benefits when deciding to sell, transfer or lease land. Only when the revenue from selling the land is larger than the cost of keeping it is it sold.

Some may also argue that if land is privatized, arable land will be easily transferred to industrial use, leading to a decline of arable land and threatening the future food supply. In fact, privatization is not unlimited in any country in the world. It does not mean that the landowner has unlimited power or rights. The nation can still regulate the use of land. For example, it can make regulations stating that arable land can be traded but that its use cannot be changed.

In any case, the privatization of land ownership is feasible. By privatizing rural land, the land would be prevented from illegal infringement. Peasants could share the benefits of privatization, urbanization and industrialization. Therefore, rural land privatization would bring great benefits to rural Chinese.

### 5.5 The Permanent Resident Registration System and Urbanization

The resident registration system legislates whether rural Chinese can enjoy the same treatment and opportunities as urban people. Therefore, the current system, which discriminates against rural people, has to be changed and a nationally unified resident registration system should be implemented. Once a peasant loses his or her land due to land confiscation, he or she should not be seen as a peasant, but as unemployed worker covered by social security and unemployment insurance. Peasants who sell their land should be required to pay a large part of the revenue as social security payments recorded in their personal account. Enterprises that employ peasants should enjoy the same treatment as those employing urban residents in terms of pension, medical insurance, housing accumulation funds, and unemployment insurance.

### 5.6 Rebuilding Collective Government

The role of the village collective organization before 1978 is controversial. On one hand, it discouraged hard work, but on the other it indeed played an important role in the building and maintenance of rural infrastructure. The advantage of the collective economy is its strong ability to mobilize resources for the production of public goods. After 1978, the old collective organization was destroyed; meanwhile, some positive functions of collectives, in areas such as cooperative medical treatment and the building of public infrastructure were lost. Today, rural collective organizations need rebuilding in order to work, along with government investment in rural infrastructure, to mobilize redundant rural labor resources.

Since the PRC has essentially eliminated all agriculture-related tax and fees, village government expenditures have to be decided by upper level government. Therefore, there is a need to rebuild village management organizations and decide the number of village governments, their responsibilities, obligations and benefits. It is important to have village expenditures covered under a unified government budget, have the salaries of village cadres covered by government budgets, and make efforts to build and perfect a rural grassroots

democratic system and bring every action of village government under the supervision of villagers.

### 5.7 Establishing Organizations to Maintain the Village Environment

To maintain a clean environment in rural areas, the government's attention should be focused not only on new infrastructure building, but also on the maintenance of infrastructure. Our suggestion in this regard is to extend the function of environmental sanitation organizations from urban areas to the countryside. Since there are a huge amount of rural laborers working at low wages, it would not be very expensive to mobilize rural laborers to clean villages. Wang Fang is a village with over a thousand villagers in Huxian County, Shaanxi province. This village established a team of two workers who were given responsibility for keeping the village clean. The village made a contract with a tractor driver to move garbage to a designated place. The total cost per year for the cleaning is 10,000 Yuan, including 6000 yuan as salaries for two workers, and 4000 yuan for tractors for moving garbage to a designated place.

The PRC has a total of 640,139 villages. If each village spent 10,000 yuan, the total outlays for the country would be just 6.4 billion yuan. This is not a large figure compared with the government budget of nearly 4,021 billion yuan. Thus, we do not think that the government fiscal budget would have any trouble financing the maintenance of the rural environment. It would be quite worthwhile to spend 6.4 billion and realize the objective of cleaning 640,139 villages in return.

### 5. 8 Democratic Systems: The Institutional Insurance of Rural Development

Democracy, transparency and media freedom play an important role in rural infrastructure development. We suggest strengthening the rural democratic system to prevent corruption, which harms the interests of rural populations. We propose letting rural people themselves select village heads and supervise the head, thus promoting the efficiency of fiscal resources. Though it might be unrealistic to immediately equalize voting power between rural and urban people in the PRC, it is indeed necessary to increase the voting power of rural people step by step.

## 6. CONCLUSION

This paper contributes to the economic literature in three aspects. First, it reviews rural development and infrastructure development in the People's Republic of China since 1978, and gives readers an intuitive impression of Chinese rural development and infrastructure. Second, it creates an endogenous growth model that incorporates infrastructure with both a productive and utility-enlarging function, helping to analyze the relationship between rural development and infrastructure. Third, it carries out an empirical study on the relationship between rural development and infrastructure based on theoretical model and pooled data from 29 provinces.

In reviewing the process of rural development and infrastructure development, we find that early on, rural households enjoyed the fruits of the reform of the rural household contract responsibility system, and then with the declining effect of that system and the launch of urban and enterprise reform and the open door policy, experienced a relatively stagnant period of rural development, under which the rural per capita income increased a much slower rate than urban income, worsening the income gap between rural and urban households. We also find that there is inconsistency between rural infrastructure and rural economic development: while rural households were getting richer, rural infrastructure and the rural living environment were getting worse in many regions. During urbanization and

industrialization, a great number of farmers lost their land and jobs. Some took to the street to protest or appealed to higher authorities for help. Unpaid rural workers reportedly had to ask for help from premier Wen Jiabao to get their unpaid salaries. Social harmony and political stability were severely undermined. Behind these phenomena were the distorted institutional arrangements for the land ownership, household registration system, and democratic systems.

Under the newly developed model, the external effect of infrastructure on both production and consumption makes long-run economic growth possible. The model also demonstrates that a scale effect of population should be taken into consideration in infrastructure building and urbanization. In addition, the efficiency of the government's translation of tax into infrastructure is found to play an important role in economic growth. In addition to long-run endogenous growth, infrastructure investment also leads to a structural change in income and consumption.

Considering years of schooling, the high school population rate and illiteracy as proxy indices for educational infrastructure, we find that only illiteracy is statistically significant in agriculture production in the western regions. This implies that it doesn't matter how many years a peasant is educated. What matters is if illiteracy is eliminated. We also find that different types of roads have different effects on agriculture. Low standard roads have a positive effect on agricultural GDP growth and industrial GDP growth, but high standard roads only have a positive effect on the industrial sector. Regarding the implications of infrastructure on consumption, we find that electricity infrastructure has positive spillover effects on rural consumption in central and northeastern PRC, and that low standard roads have a positive spillover effect on consumption in the eastern and northeastern regions.

Since agriculture is almost running out of potential, it is difficult for rural Chinese to be better off without leaving their farmland. Therefore, the future of rural development in the long run is not in agriculture, but in the acceleration of urbanization. Since urbanization is a long process, it is important to mobilize labor and financial resources in the short run. Therefore, it is urgent to carry out rural reform in the following aspects: privatization of rural collective land, implementation of a nationwide unification of the residential registration system, expansion of rural democracy, strengthening and rebuilding of agencies for the protection and maintenance of the rural collective environment, implementation of the basic compulsory education law and the equalization of opportunities for higher education.

**References**

Ahmed, R. And Donovan, C. 1992. Issues Of Infrastructure Development: A Synthesis Of The Literature. Washington, DC: International Food Policy Research Institute.

Arrow and Kurz 1970. "Public Investment, the Rate of Return and Optimal Fiscal Policy," John Hopkins University, Baltimore, MD.

Aschauer, David Alan and Greenwood, Jeremy 1985. "Macroeconomic effects of fiscal policy." Carnegie-Rochester Conference Series on Public Policy 23: pp. 91-138.

Aschauer D. A., 1988. "The Equilibrium Approach to Fiscal Policy." *Journal of Money, Credit, and Banking*, Vol. 20, Pp. 41-62.

Aschauer D. A., 1989a. "Is Public Expenditure Productive?" *Journal of Monetary Economics*, Vol. 23, Pp 177-200.

Aschauer D. A., 1989b. "Public Investment and Productivity Growth in the Group of Seven,"

*Economic Perspectives*, Vol. 13, 17-25.

Aschauer D. A., 1989c. “Does Public Capital Crowd Out Private Capital?” *Journal of Monetary Economics*, Vol. 24, Pp 171-88.

Aschauer, David A., 1990b. “Why is Infrastructure Important?” in Alicia H. Munnell, Ed. 24(2), pp. 171-88.

Asian Development Bank, Japan Bank for International Cooperation, World Bank, 2005, “Connecting East Asia: A New Framework for Infrastructure.”

Barro, R. J. 1989. “A Cross-Country Study of Growth, Saving and Government,” National Bureau of Economic Research Working Paper No. 2855, February.

Barro, R., 1990. “Government Spending in A Simple Model of Endogenous Growth,” *Journal of Political Economy* 98, pp.103-125.

Baxter, M. and King, R. G., 1993. “Fiscal Policy in General Equilibrium,” *American Economic Review*, Vol. 83, Pp. 315-34.

Bhalla, A. S. 2002. “Sino-Indian Growth and Liberalization: A Survey,” *Asian Survey*, Vol. 42, No. 3, pp. 419-439.

Chenery, H.B., 1979. *Structure Change and Development Policy*, New York: Oxford University Press.

Chenery, H.B., Robinson, S. and Syrquin, M., 1986. “Industrialization and Growth: A Comparative Study,” Washington: World Bank.

Da Silva Costa Et Al.1987. “Public Capital, Regional Output, and Development: Some Empirical Evidence,” *Journal of Regional Science* 27, pp. 419-437.

De La Fuente, A. and A. Estache, 2004, Infrastructure Productivity and Growth: A Quick Survey, Washington DC, WBIGF.

Deno, Kevin T., 1988. “The Effect Of Public Capital On U.S. Manufacturing: 1970-1978,” *Southern Economic Journal* 55, Pp.400-411.

Dixit, Avinash K. and Joseph E. Stiglitz (1977). “Monopolistic Competition and Optimism Product Diversity,” *American Economic Review*, 67, 3, (June), 297-308.

Evans, Paul, and Georgios Karras, 1993. “Is Government Capital Productive? Evidence from a Panel of Seven Countries,” *Journal of Macroeconomics*, Mar.

Fan, Shenggen and Connie Chan-Kang 2005. “Road Development, Economic Growth and Poverty Reduction in China,” Research Report 138, International Food Policy Research Institute Washington, DC.

Futagami, K. Y., Mortia, Y. and Shibata, A. 1993. “Dynamic Analysis of an Endogenous Growth Model with Public Capital,” *Scandinavian Journal of Economics*, Vol. 95, Pp. 607-25.

Gramlich, Edward M. 1994. “Infrastructure Investment: A Review Essay,” *Journal of Economic Literature* Vol 32, No. 3. Pp. 1176-1196.

Helms L.Jay, 1985, The Effect of State and Local Taxes on Economic Growth: A Time Series

Cross Section Approach, The Review of Economics and Statistics 67 (April), 574-82.

Holtz-Eakin, 1994, "Public-Sector Capital and Productivity Puzzle," *This Review* 76, pp.12-21.

Hulten, Charles R. and Schwab, Robert M., 1991. "Is There Too Little Public Capital? Infrastructure and Economic Growth," American Enterprises Institute Discussion Paper, Feb.

Jorgenson, Dale. 1991, "Fragile Statistical Foundations: The Macroeconomics Of Public Infrastructure Investment." American Enterprises Institute Discussion Paper, Feb. 1991.

Kanamori, Toshiki and Zhijun Zhao, 2004. "Private Sector Development in the People's Republic of China," Asia Development Bank Institute, Tokyo.

Lin Justin Yifu, 2002. "China's Urban Development and Rural Modernization," *Beijing Daxue Xuebao* (Peking University Bulletin), No. 4.

Lu, Xueyi, 2005. *A New View on Agriculture, Village and Peasants*, Social Sciences Academic Press (Chinese).

Lucas, Robert E., Jr., 1988. "On the Mechanism of Economic Development," *Journal of Monetary Economics*, 22, 1 July, 3-42

Mead, J.E., 1952. "External Economies and Diseconomies in A Competitive Situation," *Economic Journal* 62: 54-67.

Munnell, Alicia H., 1990a. "Why Has Productivity Growth Declined? Productivity and Public Investment," *New England Economic Review*, Jan. /Feb., Pp.3-22.

Munnell, Alicia H., 1990b. "Is There A Shortfall in Public Capital Investment?" ED.: Alicia H. Munnell. Conference Series No. 34. Boston: Federal Reserve Bank of Boston.

Munnell, Alicia H., 1992. "Infrastructure Investment Affects Regional Economic Performance?" *Journal of Economic Perspectives*, Fall 1992, 6(4), pp. 189-198.

Stern, Nicholas, 1991. "The Determinants of Growth," *Economic Journal*, 101, Pp. 122-133.

Stern, Nicholas, 1989. "The Economics of Development: A Survey," *Economic Journal*, Vol. 99, Pp. 597-685.

Rathner, Jonathan B., 1983. "Government Capital and the Production Function For U.S. Private Output," *Economics Letters* 13: 2-3, Pp. 213-227.

Reynolds, J., 1983. "The Spread of Economic Growth to the Third World: 1850-1980," *Journal of Economic Literature*, Vol. 21, pp. 941-80.

Romer, Paul M., 1986. "Increasing Returns and Long-Run Growth," *Journal of Political Economy*, Vol. 94, Pp. 1002-37.

Solow, Robert M. (1957). "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics*, 39 (August), 312-320.

Tatom, John A. 1991a. "Should Government Spending on Capital Goods Be Raised?" *Fed. Res. Bank of St. Louis Rev*., Mar. /April. 1991a, pp. 3-15. 1991

Tatom, John A. 1993. “Paved with Good Intentions: The Mythical National Infrastructure Crisis,” Policy Analysis, Cato Institute, Aug. 12, 1993.

Thomas, J. 1991. “Informal Economic Activity,” Hemel Hempstead: Harvester Wheat Sheaf.

Turnovsky, S.J., 1995. *Method of Macroeconomic Dynamics*, Cambridge, MA: MIT Press.

Turnovsky, S.J. and Fisher, W.H., 1995. “The Composition of Government Expenditure and Its Consequences for Macroeconomic Performance,” *Journal of Economic Dynamics and Control*, Vol. 19, Pp. 747-86.

Wang, 2006. “Perspective of Imbalance in Investment Structure” semi-monthly talk No.15. (in Chinese).

Wanmali Sudhir and Islam Yassir, 1995. “ Rural Service, Rural Infrastructure, and Regional Development in India. “*Geographical Journal*, Vol. 161, No. 2, Pp. 149-166.

Wanmali Sudhir and Islam Yassir, 1997. “Rural Infrastructure and Agriculture Development in Southern Africa: A Centre-Periphery Perspective,” *Geographical Journal*, Vol. 163, No. 3, Pp. 259-269.

Zhou, T. 2001. “Corruption in Public Investment and Economic Growth,” Reform of Economic System, March/April.

Zhu, L. 1990. “The Impacts of Public Engineering in the Economic Growth of Poor Rural Region, Employment, and Social Services: A Typical Survey of the Implementation of Relieving People by Project Policy in 1980s,” *Economic Research Journal* (In Chinese).

Changxin, 2006. “The role of infrastructure in economic growth,” Working Paper, Institute of Economics, Chinese Academy of Social Sciences.

Http://Edu.People.Com.Cn/GB/4193759.Html).
Http://Www.Zgjrw.Com/News/2006125/Finance/753854894500.Html).