UNIVERSAL SERVICE AND NETWORK EXTERNALITIES IN TELECOMMUNICATIONS

------ FROM AN ECONOMIC PERSPECTIVE IN CHINA

by

CHANGZHENG (AVIVA) LI

B.A., Beijing Normal University, 2001

M.A., University of Guelph, 2002

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS, ASIA PACIFIC POLICY STUDIES

in

INSTITUTE OF ASIAN RESEARCH

We accept this thesis as conforming

to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

April 2004

Library Authorization

In presenting this thesis in partial fulfillment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the head of my department or by his or her representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

CHANGZHENG LI — Name of Author *(please print)*

20/04/2004 — Date (dd/mm/yyyy)

Title of Thesis:

UNIVERSAL SERVICE AND NETWORK EXTERNALITIES IN TELECOMMUNICATIONS: FROM AN ECONOMIC PERSPECTIVE IN CHINA

Degree: M.A., Asia Pacific Policy Studies Year: 2004

Department of Institute of Asian Research

The University of British Columbia
Vancouver, BC Canada

ABSTRACT

Current universal service policy in the telecommunications industry aims to provide available, affordable and accessible telecommunications services to all citizens. The economic rationale of this policy is network externalities. Network externalities refer to the benefit of all users in a network derived from a subsequent network expansion. To maximize network externalities, three network expansion approaches are investigated: improving penetration rates, the market structure and interconnection. Current universal service policy is primarily focused on the first approach, while the importance of the market structure, interconnection and their interaction in network expansion is often neglected. As the economic perspective is concerned, network externalities are the ultimate concern in the provision of universal service. The dynamics of these three network expansion approaches determines the effects of network expansion and the outcome of universal service. This paper applies the logic of network externalities to investigate the dynamics of these three network expansion approaches and their policy implications in developing countries' provision of universal service. Explicit funding and allocating mechanisms to improve penetration rates and a market structure with symmetrically vertical-integrated competition are recommended. As well, the importance of economic growth in relation to telecommunications development is presented.

CONTENTS

LIST OF FIGURES

ACKNOWLEDGEMENTS

This thesis could not have been written without the assistance and support of numerous individuals. My research took place at the Institute of Asian Research at the University of British Columbia. I am grateful to the stimulating environment for academic research at the Institute.

I would like to thank my advisors, Dr. Pitman B. Potter and Dr. Ilan Vertinsky for their valuable guidance and advice. Dr. Potter, the Director of the Institute of Asian Research, also provided an Infrastructure Policy Scholarship through the generosity of Power Corporation of Canada for my first-year research in infrastructure policy. I am also indebted to Dr. Vertinsky, the Director of Centre for International Business Studies, Sauder School of Business, who extended my knowledge in both economics and business regimes and provided me with favorable insight into China's telecommunications industry.

As well, the staff at the main office of the Institute were helpful in ensuring my studies were both pleasant and rewarding.

Finally, I would like to thank my family, Spooner family and friends in both Canada and China for their ongoing encouragement and assistance. Deep appreciation goes to my family in Beijing, China, and Matthew Spooner.

Introduction

Universal service has been an essential element of economic, social and political debates on regulatory reforms in the telecommunications industry. In different countries, universal service policy is defined differently. The commonly recognized definition is to provide available, affordable and accessible telecommunications services to all citizens.[1] Other than its focus on equality and voter targets from social and political perspectives, the economic rationale of universal service policy is the presence of network externalities.[2] Katz and Shapiro (1994) define network externalities as the consumption utilities arising from the number of other agents consuming the same good. Network externalities in the telecommunications industry can be explained as the increased network value derived from network expansion, which benefits all consumers in the network.[3]

Under the current technological development and liberalized policy environments in developed countries, extensive research has been conducted to uncover the policy implications of network externalities in universal service in the telecommunications industry. Laffont and Tirole (2000) argue that network externalities are no longer the forefront of universal service debates. The existence of well developed telecommunications networks in developed countries and the internalization of

---

[1] Universal service policy usually refers to local fixed phone services. Detailed categorization of telecommunications service markets is discussed in Chapter I.

[2] Political economy analysis claims that universal service obligations are kept in place to preserve some cross subsidies that benefit particular groups of voters (Valletti, 2000). Network externalities in principle, can be either positive or negative. The discussion that follows will focus on the positive network externalities. Therefore network externalities refer to positive network externalities in this discussion, unless otherwise mentioned.

[3] Crandall and Waverman. (2000).

operators are in part responsible for this argument.[4] However, the importance of network externalities in the telecommunications industry depends upon the maturity of the technology, the market structure and the level of penetration.[5] As an economic feature of the telecommunications industry, network externalities, are extremely significant in developing countries. These countries often suffer from less advanced technology, an inefficient market structure and low penetration rates. Research on network externalities in developing countries presents policy implications for universal service in the telecommunications industry. Such research, however, has not been fully explored. This paper aims to fill this gap and presents China as a case study to examine the implications of network externalities in universal service policy in developing countries.

1. Categorization of Network Externalities

In the telecommunications industry, network externalities can be categorized into both direct and indirect effects.[6] Direct network externalities refer to the benefits to all consumers in the network derived from the network expansion due to either an additional consumer or the improvement of physical network infrastructure.[7] Improving penetration rates and interconnecting across networks are two major vehicles to maximize direct network externalities. By increased penetration rates, more and more consumers are able to connect to and raise the value of the network. Interconnection, on the other hand, sets up effective communication links across networks and enables one

[4] Laffont and Tirole. 2000: 230.
[5] Panzar. (2000).
[6] Katz and Shapiro. (1994).
[7] Crandall and Waverman. 2000: 24.

service provider's customers to communicate with another service provider's customers.[8] The corresponding inter-network expansion benefits all consumers in the networks.

Indirect network externalities explain the network benefits derived from the introduction of complementary goods and services in telecommunications markets.[9] These have the effect of vertically expanding the network, thus increasing the value of the network. Interconnection across various categories of services (e.g., fixed and mobile phone services) allows consumers in one network to enjoy other networks' telecommunications services. As well, a vertically integrated market structure integrates different services in one network while indirectly maximizing network externalities.

Therefore, improving penetration rates, interconnection and the market structure are three major approaches to expand networks and maximize network externalities in the telecommunications industry. The current definition of universal service policy focuses solely on improving penetration rates. The importance of two other key approaches, interconnection, the market structure and their interaction, is often neglected. As network externalities are the ultimate concern of universal service from an economic point of view, the operation and interaction of these three network expansion approaches determine the effects of network expansion and the outcome of universal service policy. This paper will expand the extent of the current concept of universal service and emphasize on the dynamics of these three approaches and the resulting policy implications on universal service.

---

[8] China Unicom Co. Ltd. Available at *http://www.chinaunicom.com.hk/en/tech/terms.html.* Visited on Mar.28th, 2004.

[9] Katz and Shapiro. (1994).

2. Network Expansion Approaches

Ubiquity and uniform price constraints are generally applied to improve penetration rates. In practice, the costs to access telecommunications networks are different due to individual circumstances. Urban areas are considered low-cost areas with high population densities, while rural and remote areas suffer high-costs to access networks. Ubiquity and uniform pricing ensure affordability and avoid geographic discrimination in the provision of telecommunications services. However, this averaging pricing system masks the difference in actual costs and consumer preferences, thereby distorting the cost-oriented price system and the market structure. The corresponding funding and allocating mechanisms to support these price constraints further enhance this distortion. Ubiquity and uniform pricing are traditionally financed by an implicit cross subsidy system to charge above-costs for 'profitable' services to subsidize 'unprofitable' (below-cost pricing) services. This system is sustainable under a monopoly market structure. Due to economies of scale and scope, the telecommunications industry was traditionally considered as a natural monopoly, whereby a monopoly company with a unified network was able to cross subsidize internally.[10]

Rapid technological development and a more liberalized policy environment have generated powerful forces for deregulation in the telecommunications sector. Economies of scale, which natural monopoly is based upon, have become less

[10] Normative natural monopoly refers to an industry where industry average cost of production is minimized when there is a single producer. Church and Ware. 2000: 752. Economies of scale exist if long-run average cost declines as the rate of output increases. *Ibid*: 54-58.

significant. As a consequence, the market is opening up to competition.[11] A competitive market structure requires greater transparency in pricing and competitive-neutral funding and allocating mechanisms to improve penetration rates. An implicit cross subsidy system distorts the pricing system and causes "cream skimming" in a competitive market structure. Consequently, it is replaced by explicit funding and allocating mechanisms, which subsidize the obligations out of the pricing system and are more competitively neutral. While both mechanisms induce a welfare loss due to the price constraints, explicit mechanisms are more desirable in a competitive market structure.

The relationship between improving penetration rates and the market structure is controversial. As demonstrated, priority is placed upon pricing and the supporting funding and allocating mechanisms. Ubiquity and uniform pricing, and the accompanying funding and allocating mechanisms distort the price system and the market structure. This is particularly significant in a competitive market. A competitive market, in turn, requires transparency in pricing and competitively neutral funding and allocating mechanisms.

As well, the interaction between improving penetration rates and interconnection focuses on pricing. Interconnection access pricing becomes even more complicated when taking into account ubiquity and uniform pricing constraints. In the trade-off between the market structure and interconnection, the market structure determines the incentives and strategies of companies to interconnect. A vertically integrated market structure is favorable for network expansion. However, an asymmetrically vertical-

[11] Due to the large sunk costs of network infrastructure, competition in basic telecommunications services is often shown as an oligopoly structure.

integrated market structure induces the integrated company to dis-interconnect. The outcome of interconnection on the other hand, determines companies' relative competitive advantages in the market.

From an economic rationale, maximizing network externalities is the ultimate concern of universal service policy. Network externalities are derived from network expansion. Therefore, the dynamics of these three network expansion approaches determines the effects of network expansion and the outcome of universal service policy.

3. Universal Service in China

China is presently establishing an initial nation-wide telecommunications network. Simultaneously, the country's telecommunications industry is undergoing dramatic market restructuring. Deregulation of China's telecommunications industry commenced in 1993.[12] The market structure has shifted gradually from China Telecom's monopoly in all services to a relatively competitive market. Currently, a low degree of competition in fixed phone services exists between China Telecom and China Netcom.[13] Meanwhile, considerable competition exists in mobile phone services between China Mobile and China Unicom, and further competition is exhibited in value-added services.[14] As illustrated, different service categories are segmented, whereby virtually no vertically integrated companies exist. In the past, interconnection was a contentious issue due to the vertically asymmetric market structure between China Telecom and China Unicom. This tension was in part reduced in 1999, as a result

[12] More discussion on China's telecommunication reforms in Guan (2003).
[13] China Telecom and China Netcom refer to China Telecom Group and China Network Communications Group, respectively.
[14] China Mobile and China Unicom refer to China Mobile Group and China United Telecommunications Corporation, respectively.

of the break-up of China Telecom's integrated market position.

Accompanied with technological development, deregulation in China's telecommunications industry has brought remarkable expansion in network infrastructure and substantial improvements in productivity. In the 1990s, universal service policy was aimed at "One family, One telephone" in urban area and telephone services in every rural administrative village.[15] At the end of 2003, the overall penetration rate in fixed phone services was 20 percent, while the urban residential penetration rate was 16 percent.[16] At the same time, in rural areas, 89 percent of administrative villages had access to fixed phone services.[17] As illustrated, the overall penetration rate in fixed phone services is still low, particularly in residential phone services. As well, telecommunications development is imbalanced among regions and between urban and rural areas. It is imperative to promote universal service in China to improve penetration rates and alleviate these disparities.

The current universal service policy was traditionally financed through the internal cross subsidy system by the monopoly company China Telecom and through government revenues. However, the increasing degree of competition in the telecommunications industry has threatened the viability of this implicit cross-subsidy system. In 2001, China announced that it would establish Universal Service Funds (USFs). This represents explicit funding and allocating mechanisms to fulfill universal

---

[15] Li and Wang. (2003).

[16] 16 percent is an estimated number. Ministry of Information Industry. Available at *http://www.mii.gov.cn/mii/hyzw/tongji/yb/tongjiyuebao200312.htm.* National Bureau of Statistics of China. Available at *http://www.stats.gov.cn/tjsj/ndsj/index.htm.* Visited on Mar.30th, 2004. Modified by author.

[17] 89 percent of administrative villages (not the percentage of village population) had access to fixed phones. Natural village accession rate was lower than that of administrative villages. Ministry of Information Industry. Available at *http://www.mii.gov.cn/mii/hyzw/tongji/yb/tongjiyuebao200312.htm.* Visited on Feb.20th, 2004.

service obligations, constituting a milestone in the telecommunications reforms in China.

This paper examines the implications of network externalities in universal service policy in developing countries. The operation and interaction of three network expansion approaches, improving penetration rates, the market structure and interconnection are investigated. Explicit funding and financing mechanisms to improve penetration rates and a symmetric market structure with vertically integrated competition are recommended. In the first chapter, theoretical review is conducted on the concepts of universal service and network externalities. Empirical studies are reviewed based on the experience of the United States, by far the most aggressive country in telecommunications regulatory reforms. The second chapter discusses the dynamics of the three network expansion approaches and their implications on universal service policy. The current state of telecommunications development in China will be addressed in the third chapter. National, regional and urban-rural teledensity and disparities are revealed. As well, interconnection conditions and market structure transformation are discussed. The final section analyzes the current universal service policy in China and the implications of the operation and interaction of the three network expansion approaches. In conclusion, two policy recommendations are proposed regarding universal service in China under the dynamic national and international telecommunications environments.

Chapter I - Universal Service and Network Externalities

The telecommunications market can be categorized into both basic and enhanced segments as illustrated in Figure 1.[18] The basic telecommunications market, according to the flexibility of facilities, can be further divided into fixed and mobile phone markets. According to the connection distance of phone calls, basic telecommunications market can also be divided into local and long distance phone markets. Enhanced services, on the other hand, include value added and internet services, etc.

The current concept of universal service policy aims to provide available, affordable, and accessible telecommunications services to all citizens. The telecommunications services in this objective often refer to local fixed phone services.[19] From social and political perspectives, the focus of universal service policy is on equality, income redistribution and voter targets. However the concept of universal service was originally developed from the presence of network externalities. The economic rationale presents that the ultimate concern of universal service is to maximizing network externalities.

---

[18] Armstrong (1997) distinguishes the network operation and service provision companies in the telecommunications industry. As service provision companies are often based on network operation in basic telecommunications services, this categorization is not emphasized in this discussion.

[19] With rapid technological innovations, alternative options other than fixed networks are available. "Technology neutral" is often applied to reach the "availability" goal of universal service. Whereby telecommunications service providers can apply different technologies to connect with consumers in high-cost areas. Mobile phones and satellite applications are logical substitutes to fixed phone lines in high-cost areas with a lower population density or geographical barriers. The concept of universal service policy, traditionally prioritizing local fixed phone penetration rates, has been broadened in some countries, to also include mobile phone services.

1.1 The Historical Concept of Universal Service

Universal service was first introduced into the telecommunications industry in AT&T's 1907 annual report in the United States.[20] Contrary to the current emphasis on "equal access" for all citizens, the origin of universal service stems from the issue of "interconnection" across different networks. In the United States, AT&T had held a monopoly in telecommunications services until 1894 when Bell Company's last technical patent for local telephone service expired.[21] Consequently, numerous independent telecommunications companies entered the local phone service market and increased their market shares substantially. The resulting competition between AT&T and independent companies contributed to the expansion of the telecommunications networks across the country.[22] Despite network compatibility, interconnection between AT&T and independent companies' networks was a contentious issue. As the only service provider in the long distance phone market, AT&T denied the connection of long distance calls originated from independent company subscribers. In the meantime, AT&T's telephone calls could not go through independent companies' networks. As a result, telephone networks were fragmented into the "dual service", by AT&T and independent companies.[23] In this environment, the concept of universal service was first introduced in AT&T's slogan "One system, One Policy, Universal Service" in its 1907 annual report.[24] The company's objective was to promote a nation-wide unified

---

[20] Mueller. (1997).
[21] Crandall and Waverman. (2000).
[22] Mueller. (1997).
[23] *Ibid.*
[24] *Ibid.*

telephone network to maximize network externalities.[25] In 1913, interconnection between AT&T and independent companies was achieved.[26] From this point onwards, telephone calls could originate and terminate through different networks.

From a historical perspective, the inherent concern to the original concept of universal service was to maximize network externalities in the telecommunications industry.

1.2 Network Externalities

1.2.1 Concept of Network Externalities

Modern literature defines network externalities (or effects) as the change in the benefit or surplus that an agent derives from a good when the number of other agents consuming the same kind of good changes.[27] Leibenstein (1950) illustrates network externalities as the corresponding higher elasticity in demand curves when consumers derive positive value from an increase in the size of the network. Price elasticity of demand measures the sensitivity of the change in quantity demanded by a change in price. Whereby, in this case, the proportional change in quantity demanded becomes larger than the proportional change in price due to network expansion. On the other hand, network externalities can also be presented as the upward shift of the demand curve from an increase in size of the network. In Figure 2, the demand curve slopes downwards, but shifts upwards from D to D* when the network expands. At the same price level P, consumers demand more, as shown by quantity demand Q* being larger

[25] Crandall and Waverman. (2000).
[26] The Justice Department and AT&T reached an agreement in 1913 known as the Kingsbury Commitment. Under the settlement, AT&T would allow independent companies to interconnect with its system. Horwitz, 1989: 100-101.
[27] Cave, *et al.* 2002: 77.

than Q.

Liebowitz and Margolis (2002) model the optimal network size under open access conditions as illustrated in Figure 3.[28] This explains network externalities from both the consumer and supplier sides, with N representing the number of users in the network. PB is the private benefit of network participation that any user enjoys and is the maximum amount that any user would be willing to pay for access. Its upward slope reflects the presence of positive network externalities (or effects, dPB/dN>0). MB is the marginal benefit to the network due to network expansion (e.g., an additional user). As demonstrated by the positive network externalities, MB is greater than PB, in that, the private benefit of network participation increases with N.[29] MC is the marginal cost of serving network participants. Its upward slope reflects the characteristic of telecommunications networks that the increase in participation often requires connection with customers who are increasingly difficult to connect with.[30] The optimal network size is shown as N*, where the marginal benefit of network participation is equal to the marginal cost. In an open access network, where private ownership is highly fragmented, each agent enjoys the benefits PB and faces costs MC. The equilibrium network size is Np, which is less than the optimal network size, N*. At Np, a welfare loss occurs due to marginal benefit (MB) being greater than marginal cost (MC).

---

[28] Figure is adapted from Liebowitz and Margolis. (2002).

[29] TB = N * PB and MB = dTB / dN = PB+N*(dPB/dN), where TB is the total benefits. Due to positive network externalities, dPB/dN>0, therefore MB>PB.

[30] Kahn (1998) argues that in conventional public utility industries, marginal cost with respect to network size increases as networks get large, because marginal customers eventually are those that are more distant or otherwise more difficult to serve.

1.2.2 Categorization of Network Externalities

Network economists categorize externalities into both direct and indirect effects.[31] Direct network externalities are generated due to additional users or physical expansion of telecommunications infrastructure (e.g., horizontal interconnection).[32] In this context, the value of a network rises as the number of users increases; whereby, an additional connection to the system increases the benefit of the network to all users.[33] Assuming networks are compatible, Economides (1996) defines direct network externalities as the 2n potential new goods (or links) by the provision of a complementary link to the existing network. In respect to telecommunications as a two-way network, there are n(n-1) potential goods (or links) in an n-component network. An additional (n+1)th customer provides direct externalities to all other customers in the network by adding 2n potential new goods (or links).[34] The early 1900s case of AT&T introducing universal service to promote interconnection provides a noteworthy example. With interconnection between networks, customers of both AT&T and independent companies could originate and terminate phone calls through different networks. Prior to the adoption of interconnection, A and B amounts of customers existed in AT&T and independent companies' networks, respectively. Interconnection had the effect of expanding both networks. For example, in AT&T's network, A*A links expanded to (A+B)*(A+B), with an increase of B*B+2A*B links. The net gain for

---

[31] Katz and Shapiro (1994)
[32] Horizontal interconnection refers to interconnection across networks in the same service category (e.g., interconnection between local fixed network A and B).
[33] Crandall and Waverman. (2000)
[34] (n+1)*n-n*(n-1)=2n.

the society from this interconnection was 2A*B links.[35]

On the other hand, indirect network externalities are "market mediated effects", in which complementary goods and service are more readily available or lower in price arising from an increase in users consuming the good or service.[36] For example, introduction of a new service or good (e.g. value added services) would expand the network vertically.[37] This can also be explained from the supplier side as economies of scope. Economies of scope exist if it is cheaper to produce two output levels together in one plant rather than produce similar amounts of each good in single-product plants.[38] As a result, a vertically integrated market structure, providing various services under one network, and interconnection across networks of different services (e.g., fixed and mobile phone services) maximize network externalities indirectly.

From the categorization of network externalities, improving penetration rates, a vertically integrated market structure and interconnection are three main approaches to achieve network expansion. As previously discussed, the ultimate concern of universal service is to maximize network externalities, which are derived from network expansion. Consequently, it is important to investigate the operation and interaction of these network expansion approaches. Their dynamics determines the effects of network expansion and the outcome of the provision of universal services.

---

[35] (A+B)*(A+B)-(A*A)-(B*B)=2A*B.
[36] Liebowitz and Margolis. (2002).
[37] Katz and Shapiro. (1994).
[38] Church and Ware. 2000:54-58.

Chapter II Dynamics of Network Expansion Approaches

Improving penetration rates, the market structure and interconnection are three main approaches to expanding networks and maximizing network externalities in the telecommunications industry. How they operate and interact with each other determines the outcome of universal service policy. In this chapter, the dynamics of these three network expansion approaches and their policy implications on universal service are investigated.

Current universal service policy aims to provide affordable, available and accessible telecommunications service to all citizens. As demonstrated, improving penetration rates constitutes the main priority. Generally, ubiquity and uniform pricing are applied to fulfill this universal service obligation. These price constraints are designed to provide relatively uniform prices to all consumers, regardless of the cost variations in the provision of services. This averaging price system masks the difference in actual costs and consumer preferences. Further distortions on the price system and market structure arise from the funding and allocating mechanisms supporting these price constraints. Therefore, pricing and corresponding funding and allocating mechanisms are essential issues in the pursuit of improving penetration rates.

The dynamics of improving penetration rates, the market structure and interconnection is illustrated in Figure 4. In the triangle of the interaction of these approaches, the trade-off between improving penetration rates and the market structure is contentious. On one hand, the pricing and the supporting funding and allocating mechanisms have a strong impact on the competitive incentives and strategies of telecommunications companies. Price constraints distort the pricing system and the

market structure. Simultaneously, the introduction of a competitive market structure forces a cost-oriented pricing system and requires a competitive-neutral funding and allocating system to achieve the objectives of improving penetration rates.

Aside from the relationship discussed above, the other two layers of interactions are significant in network expansion. The trade-off between improving penetration rates and interconnection also concentrates on pricing. Access pricing in interconnection is even more complicated considering ubiquity and uniform pricing constraints. In the trade-off between the market structure and interconnection, the market structure affects the incentives and strategies of companies to interconnect. A prime illustration is the negative impact of a vertically asymmetric market structure on interconnection. The interconnection outcome, on the other hand, influences companies' competitive advantages in the market.

2.1 Improving Penetration Rates

2.1.1 Ubiquity and Uniform Pricing

Regulators often apply universal service obligations (USOs) to incumbent service providers to achieve the objectives of improving penetration rates. This entails restrictions on their prices and geographic coverage. Ubiquity and uniform pricing pose as the general constraints. These requirements force service providers to offer services at a geographically uniform price to all customers although the costs to provide services vary substantially across regions.[39]

This averaging pricing constraint ignores the heterogeneity in cost and demand

[39] Valletti. (2002).

conditions, thereby distorting the pricing system.[40] In practice, the costs to access the telecommunications network are differentiated according to individual circumstances. Population density, to some extent, determines the costs to access networks. Urban areas, with a higher population density, appear to be inherently low-cost, while rural and remote areas bear high-cost to access networks. Network externalities demonstrate that all users in the network benefit from network expansion. However, this benefit is at the network aggregate level, its marginal impact on individuals is differentiated. For example, the benefit derived for consumer (A) as a result of network expansion due to a friend or a stranger joining is different.[41] If his/her friend and the stranger are both from a high-cost area, it is inefficient for consumer A to share the same burden (high costs to connect) from their joining. As a result, average pricing masks the difference in actual costs and individual benefits from network expansion. Moreover, consumers' preferences to connect to networks are differentiated. Therefore, ubiquity and uniform pricing have the effect of distorting the pricing system.

Based on economies of scale, the telecommunications industry was traditionally considered as a natural monopoly. As a result, a monopoly market structure was deemed most cost-efficient. Taking ubiquity and uniform pricing into account, Economides and Himmelberg (1995) argue that a monopolist who is unable to price-discriminate will support a smaller network and charge higher prices over perfectly competitive firms. Ubiquity and uniform pricing (or a price cap) restrict the incumbent service provider to price discriminate.[42] From this point of view, in order to reach an optimal network size

---

[40] Panzar. (2000).
[41] Crandall and Waverman. (2000).
[42] Price cap refers to the maximum average price of the services under regulation. This is often applied to ensure the affordability of telecommunications services. Non price discrimination means that a firm

and pricing system, a competitive market structure is not necessarily more inefficient than a monopoly. The discussion above illustrates that a distorted pricing system has a strong impact on the market structure. The corresponding funding and allocating mechanisms to support this pricing scheme further distort the pricing system and the market structure.

2.1.2 Funding and Allocating Mechanisms

Traditionally, ubiquity and uniform pricing were supported by an implicit cross subsidy system between "profitable" and "unprofitable" services. Telecommunications companies charge above-cost on profitable services (e.g., long distance and business phone services) to subsidize the discounted (charge below-cost) local qualifying telephone services (e.g., local service to low income and high-cost customers).

Presently, the efficiency loss arising from the funding and allocating mechanisms to improve penetration rates is under intense debate. Price elasticity of demand is of important consideration in this discussion. Local fixed phone service appears to be a necessary good, and has a low price elasticity of demand. Meanwhile, long distance phone service presents a more luxurious good and has a higher price elasticity of demand. Taylor (1994) demonstrates that the price elasticity of demand in the United States for local phone service is -0.02, and for long distance service ranges from -0.75 to -1.0.[43] This extremely low price elasticity of demand for local phone

---

cannot appropriate the entire consumer surplus using nonlinear tariffs: a firm has to offer the same utility to different consumers, thus marking it less aggressive (though competition for low-cost consumers would otherwise cause huge losses on high-cost users). The combination of ubiquity and price uniformity brings additional sources of inefficiency. Valleti. (2000) and Chone *et al.* (2000).

[43] Crandall and Waverman (2000) estimated this price elasticity of local service ranged from -0.006 to -0.17, while most of the more recent estimates well below -0.1.

services along with the comparatively high price elasticity of demand for long distance usage illustrates the efficiency loss from raising the price of high elasticity services to subsidize low elasticity services. Artificially raising the price corresponds to a decline in the quantity demanded for long distance phone services, which is larger than the quantity increased in local phone services due to the discounted price. As a result, the welfare gain from local phone service is less than the loss from long distance phone services. Consequently, the cross-subsidy system causes a net welfare loss.

Due to large sunk costs in network infrastructure, a monopoly was traditionally considered the most cost-effective market structure for the telecommunications industry.[44] In defense of this argument, the importance of economies of scale has been emphasized. An implicit cross-subsidy system is sustainable under a monopoly market structure, as a monopoly company is able to subsidize internally. In the case of the United States, up to 1982 AT&T occupied 80 percent and 97 percent of local and long distance phone markets, respectively.[45] Its uniform pricing was achieved through the internal cross subsidies between local and long distance phone services.

Recent rapid technological development has reduced the costs of construction and operation of telecommunications networks. As a result, the benefit of economies of scale has declined in significance. This contributes to the transformation of the market structure towards a more fragmented ownership of telecommunications networks. As well, technological innovations have provided more options and alternatives in telecommunications services; whereby the significance of consumer preference differentiation has risen. A more liberalized policy environment has also contributed to

[44] Sunk costs refer to non-recoverable fixed costs.
[45] Ou Yang. 2000: 156.

the increasing degree of competition in the telecommunications industry. The movement towards a competitive market structure enhances the demand to reform the implicit funding and allocating mechanisms in improving penetration rates.

Chone (2000) explains this situation in three dimensions. First, inefficient entry distorts the market structure. Due to the high profitability arising from the distorted pricing system, inefficient service providers will enter the market and even survive. Secondly, the profit-driven new entrants will focus on higher price-cost disparity phone services (high-price and low-cost local phone services, e.g. services in urban areas). As a result, some consumers (less profitable high-cost area consumers, e.g., rural and remote area consumers) will be excluded from phone services. Consequently, the development of the telecommunications sector will become increasingly unbalanced. The goal of penetration rates will not be achieved and may even decline. Thirdly, the incumbent service provider's internal cross subsidy base will erode because of the decline of their market shares in profitable services due to the "cream skimming" operations of non-incumbent service providers. The incumbent service providers will then be unable to finance its universal service obligations by an implicit cross subsidy system.

Therefore, the traditionally implicit funding and allocating mechanisms to improve penetration rates distort the cost-oriented pricing system and cause "cream skimming", which disadvantages the incumbent service providers. This scenario is not sustainable under a competitive market structure.

A competitive market structure requests greater transparency in pricing corresponding to actual costs and competitive neutrality in the funding and allocating

mechanisms to improve penetration rates. Consequently, competitive-neutral and explicit funding and allocating mechanisms are produced, in which subsidies are out of price system and collected from taxes on targeted telecommunications revenues. In the United States, Universal Service Funds (USFs) were established in 1983. Later, the Telecommunications Act of 1996 culminated in financing of universal service from direct taxation. Presently, the gross costs of universal service obligations are estimated through forward-looking cost models. Funds are collected from the taxes levied on end-user revenues in interstate telecommunications services. This tax ratio (percentage) is revised four times a year (quarterly) and increases or decreases depending on the needs of the universal service programs.[46] As of the first quarter of 2004, the contribution factor is 8.7%.[47]

This layer of relationship between improving penetration rates and the market structure focuses on pricing and supporting funding and allocating mechanisms. Economists have long been critical of these mechanisms in improving penetration rates. Due to price constraints, welfare loss is unavoidable. Through explicit funding and allocating mechanisms, subsidies are out of the direct price system. As a result, explicit funding and allocating mechanisms provide greater transparency in pricing and competitive neutrality, compared to implicit measures; thereby more sustainable in a competitive market structure.

2.2 Interconnection and Market Structure

Interconnection, in both horizontal and vertical dimensions, is another approach

[46] This percentage is also known as the contribution factor.
[47] Federal Communications Commission. Available at *http://www.fcc.gov/wcb/universal_service/quarter.html*. Visited on Feb. 5th, 2004.

to expand the network. Economies of scale in production led to a natural monopoly market structure in the telecommunications industry.[48] A monopoly market structure reduces the costs from increased production, simplifies the standardization process, and provides the basis for uniform nationwide connectivity. However, with the market structure shifting towards greater competition, interconnection provides communications links across networks and ensures uniform connectivity. This in turn expands the networks substantially in a competitive market structure.

In most countries, interconnection is regulated as a mandatory obligation for all telecommunications service providers, of which access pricing is the most salient factor. Extensive research has been conducted into access pricing. Due to the practice of "cream-skimming", marginal pricing is considered less desirable.[49] The trade-off between interconnection and improving penetration rates further complicates access pricing. Interconnection pricing on the other hand, is significant in improving penetration rates.

The trade-off between interconnection and the market structure often occurs in vertical interconnection. This entails interconnection among local, long distance and mobile networks, and value-added services. The market structure determines the incentives and strategies of companies to interconnect. As discussed previously, a vertically integrated market structure is favorable for network expansion. However, an asymmetrically vertical-integrated market structure distorts the outcome of interconnection. AT &T and independent companies' struggling with interconnection presents a prime example. Domon and Ota (2001) present the various market structures

[48] Liebowitz and Margolis. 2002: 87-88.
[49] Armstrong. (1997).

of the telecommunications industry in Figure 5, ranging from complete integration to full competition. In partial integration, A and I represent AT&T and independent companies, respectively. AT&T is integrated in local and long distance phone services. Meanwhile, independent companies only provide services in the local phone market. Due to the advantage of an integrated market structure, AT&T could simply refuse to interconnect with independent companies and bottleneck long distance phone services. Or they could charge a significantly high interconnection fee to squeeze independent companies' profits and market shares in the local phone market. After the introduction of universal service and the application of interconnection, AT&T bought up smaller service providers and became the monopoly service provider in local telephone service until 1984.[50] This market result verifies the negative impacts of the asymmetrically vertical-integrated market structure on interconnection, and the impacts of the interconnection outcome on companies' relative competitive advantages in the market.

In conclusion, from an economic rationale, maximizing network externalities is the ultimate concern of universal service policy. These network externalities are derived from network expansion. This chapter has examined the operation and interaction of three main network expansion approaches, improving penetration rates, the market structure and interconnection. The most controversial trade-off in these relationships is between the pursuit of improving penetration rates and the market structure. Generally, to improve penetration rates, ubiquity and uniform pricing are applied. This average pricing system is traditionally supported by implicit funding and allocating mechanisms. Distortions of the pricing system and the market structure in a competitive market structure occur as a consequence of "cream-skimming" arising from the implicit

[50] AT&T's integrated market position was finished in 1984. Wilson. (2000).

cross-subsidy system. This corresponds to competitive disadvantages for incumbent companies. A competitive market structure, on the other hand stimulates greater transparency in pricing and competitively neutral funding and allocating mechanisms. In response, pricing and the supporting funding and allocating systems are the prime focus.

As well, the other two layers of trade-offs are significant in network expansion. In the pursuit of improving penetration rates, price constraints complicate access pricing in interconnection. Regardless, interconnection access pricing is an important factor in improving penetration rates. A vertically integrated market structure expands the network indirectly. However, an asymmetrically vertical-integrated market structure will affect companies' incentives and strategies to interconnect. On the other hand, the interconnection outcome determines in part the relative competitive advantage across companies.

As illustrated, the operation and interaction of these three approaches determine the effects of network expansion and the outcome of universal service. While network externalities are the ultimate concern, universal service is a dynamic concept. The implications of the operation and interaction of network expansion approaches differentiate according to the circumstances of individual country. Chapter III and IV will present the case of China to apply the understanding of the dynamics of network expansion approaches and to investigate policy implications arising from universal service in developing countries.

Chapter III - Telecommunications Development in China

It is the intention of this paper to apply the understanding of network externalities on universal service policy in developing countries' telecommunications industries. Following the discussion of the dynamics of network expansion approaches in universal service policy in Chapter II, Chapter III will investigate their policy implications for China. The present state of China's telecommunications development regarding penetration rates, the market structure and interconnection are reviewed.

China constitutes one of the largest and fast growing telecommunications markets in the world. As a developing country, China is currently in the process of establishing nation-wide networks, while experiencing a transformation of its market structure. In the last decade, dramatic developments in telecommunications services have occurred. Reforms of telecommunications commenced in 1993.[51] Subsequently, accompanied with rapid technological development, deregulation has brought extensive expansion of telecommunications networks, considerable improvements in productivity and a shifting market structure towards greater competition.

By the end of 2003, the overall telephone penetration rate was 41 percent with the ratio of villages with access to a fixed phone at 89 percent.[52] Teledensity disparities among regions and between urban-rural areas are significant. The eastern region enjoys double the penetration rates of its central and western counterparts.[53] Overall urban area

---

[51] Guan. (2003).

[52] Overall penetration rates include both fixed and mobile phones. 89 percent of administrative villages (not the percentage of village persons) had access to fixed phone. Natural Village accession rate was lower than that of administrative villages. Ministry of Information Industry, China. Available at *http://www.mii.gov.cn/mii/hyzw/tongji/yb/tongjiyuebao200312.htm.* Visited on Feb.20th, 2004.

[53] All analysis is limited to mainland China only. Eastern region (10): Beijing, Tianjin, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan; Central Region (9): Hebei,

penetration rates are more than twice than that of rural areas, as well as residential phone penetration rates. Consequently, promoting universal service and reducing disparities in telecommunications development across regions and between urban-rural areas is an essential objective of telecommunications policies in China.

Generally, universal availability, affordability and accessibility are promoted in universal service to improve penetration rates. Assistance is granted to individual households to connect to public telecommunications networks. In developing countries with insufficient telecommunications networks, universal service often refers to universal access policy. Contrary to prioritizing individual household and residential phone penetration rates, emphasis of universal access policy is placed on the provision of reasonable means of access to publicly available telephones.[54] Often this is achieved through pay phones, community telephone centers, etc.

In the1990s universal access policy was aimed at promoting "One family, One telephone" in urban areas and telephone services in every rural administrative village in China.[55] Traditionally, this policy was funded by the implicit cross subsidy system of China Telecom and through government revenues. Until 1993, China Telecom held a monopoly in the telecommunications market. Competition was introduced in 1993. In response, the market structure has shifted towards embracing greater competition. Presently, there are five active service providers in basic telecommunications services, specializing in fixed or mobile phone markets.

Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hube and Hunan. Western Region (12): Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunan, Xizang, Shanxi, Gansu, Qinghai, Ningxia and Xinjiang. *Ibid.*

[54] Intven and Tétrault. (2000).

[55] Li and Wang. (2003).

3.1 Telecommunications Development

3.1.1 Overall Telecommunications Development

In the last ten years, China has experienced a rapid rate of urbanization. Figure 6 highlights the economic growth (GDP per capita) and urban population rates in China from 1990 to 2002.[56] As a result of drastic economic reforms, GDP per capita has grown significantly. From the 1990 level of 1,634 Yuan GDP per capita grew five times to 7,908 Yuan in 2002. Concurrently, urbanization of populace increased from 26 percent in 1990 to 38 percent by the end of 2001. This corresponds to more than an eleven percentage point increase in the level of urbanization. Until 1998, the urban population rate increase had lagged behind economic growth rates. This demonstrates slower rural-area economic development compared to overall economic growth. From 1999 to 2001, the pace of urbanization sped up. The increase in the urban population rates is now parallel to the economic growth rates.

Set against the backdrop of the high rates in economic growth and urbanization, the telecommunications industry is undergoing rapid development. Figure 7 highlights the growth of penetration rates with respect to economic growth (GDP per capita).[57] As demonstrated, the ratios of penetration rates growth versus economic growth were larger than 1, with the exception of public phone penetration rates in 2001. This illustrates the outpacing of the growth in the telecommunications sector over economic

---

[56] Data Sources: IMF. *International Financial Statistics.* Available at http://pacific.commerce.ubc.ca/ifs/ifs/newdata.html . Visited on Mar.2nd, 2004. National Bureau of Statistics of China. Available at *http://www.stats.gov.cn/tjsj/ndsj/index.htm.* Visted on Mar.2nd, 2004. Modified by author.

[57] {[Penetration Rate]t/[Penetration Rate](t-1)}/{[GDP per capita]t/[GDP per capita](t-1)}. Wauschkuhn. (2000). Data Sources: Ministry of Information Industry. Available at *http://www.mii.gov.cn/mii/hyzw/tjxx.html.* Visited Feb.20th, 2004. National Bureau of Statistics of China. *http://www.stats.gov.cn/tjsj/ndsj/index.htm.* Visited on Mar. 21st, 2004. Modified by author.

growth. Fixed phone penetration rates remained relatively stagnant ranging from 1.0 to 1.2, growing in accordance with economic growth. Internet and Mobile phone services witnessed the fastest growth, with average ratios near 2 and 3.5, respectively. Surprisingly, internet services dropped from 3.5 in 2001 to 1.4 in 2002. However, public phones were the only area where growth lagged behind hikes in GDP per capita, with a ratio of 0.9 in 2001. Since1994, the overall growth ratios of public phone penetration rates have fallen. This presents a lower priority on the improvement of public phone penetration rates over other areas.

Figure 8 outlines the actual penetration rates by services from 1990 to 2003.[58] In the last ten years, both fixed phone and mobile phone penetration rates have expanded dramatically. As evident in Figure 7, the growth in mobile phone services have surpassed fixed phone services. This trend is also demonstrated in Figure 8. At the end of 2003, the total number of fixed and mobile phone lines were 263.3 million and 268.7 million, with penetration rates hitting 20 and 21 percent, respectively.[59] Clearly, mobile phones have outpaced fixed phone lines. By the end of 1998, the total number of mobile phone lines was less than one third of fixed phone lines.[60] However, in October 2003 mobile phones lines exceeded the number of fixed lines for the first time and continued to grow thereafter. There are two possibilities to explain this trend. One is rapid technological development which has lowered the costs of mobile phones services and facilities substantially. This leads to greater accessibility for consumers to mobile phone services. Another explanation is the competition among profit-driven

---

[58] Data Sources: Ministry of Information Industry. Available at *http://www.mii.gov.cn/mii/hyzw/tjxx.html.* Visited Feb.20th, 2004. National Bureau of Statistics of China. *http://www.stats.gov.cn/tjsj/ndsj/index.htm.* Visited on Mar. 21st, 2004. Modified by author.

[59] *Ibid.*

[60] 1.91/7.00=0.273<1/3.

telecommunications companies. Mobile phone services tend to be more profitable over fixed phone services.[61] Consequently, investments are intensified in mobile phones over the fixed phone market. As a priority of universal service access policy, public phone penetration rates have increased marginally over the years. In addition, between 1999 and 2001 the use of Internet, a new technology, has expanded considerably.

As demonstrated above, the overall development of telecommunications services, in terms of penetration rates, has been significant. However this development is imbalanced, as evident in the disparities across eastern, central and western regions and between urban and rural areas.

3.1.2 Regional Imbalanced Telecommunications Development

Figure 9 highlights the regional disparity in fixed phone and mobile phone penetration rates from 1998 to 2003.[62] Penetration rates in all regions have increased significantly. However, the gap between the eastern region and other regions remains considerable. The eastern region constitutes the most developed area with penetration rates more than twice that of the western region. In the fixed phone market, the western region is the least developed, while the central region is slightly higher. At the same time, growth of mobile phone market in the western region has outpaced that of the central region, nearing the level of penetration rates of the latter by 2003. Dramatic development of the eastern region's economy exceeded that of both the western and

---

[61] Local fixed phone and mobile phone service revenues are 32 percent and 47 percent of total telecommunications revenues in 2003. Revenue per phone line: (Mobile: 47/268.7=0.17}>{Fixed: 32/263.3=0.12}. Ministry of Information Industry. *Telecom Statistics Monthly Report, December 2003.* Available at *http://www.mii.gov.cn/mii/hyzw/tjxx.html.* Visited on Feb.20th, 2004. Modified by author.

[62] Ministry of Information Industry. Available at *http://www.mii.gov.cn/mii/hyzw/tjxx.html.* Visited Feb.20th, 2004. National Bureau of Statistics of China. *http://www.stats.gov.cn/tjsj/ndsj/index.htm.* Visited on Mar. 21st, 2004. Modified by author.

central regions. The disparity in regional fixed and mobile phone penetration rates reflects the unevenness in regional economic growth.

Figure 10 contrasts regional penetration rate growth versus economic growth from 1998 to 2001.[63] Despite the large regional disparity in penetration rates as illustrated in Figure 9, the ratio of regional penetration rate growth versus economic growth underlines a moderate disparity across regions. The western region had the highest ratio in both fixed and mobile phone services at 1.8 and 6.1, respectively. Meanwhile, the central and eastern regions were close to national averages in both fixed and mobile phones. The comparison of different regional patterns indicates that regional economic disparity has a strong bearing on the difference of regional penetration rates. Figure 11 highlights regional disparity in economic growth. Evidently, the eastern region experienced the highest economic development, while western and central regions only reached half that of the level of the eastern region. This disparity is significant and has been widening substantially since 2000. As discussed above, levels of economic development play an important role in improving penetration rates in China. The positive correlation between telecommunications and economic development must be considered in universal service policy.

3.1.3 Urban-Rural Imbalanced Telecommunications Development

Disparity of telecommunications development in urban-rural areas is also evident. Figure 12 compares the urban-rural disparity in fixed phone penetration rates

[63] Due to the limitation in data sources, only 1998 and 2001 data are available. The growth rates are per three year calculated from 1998 and 2001 data. *Ibid.*

from 1990 to 2003.[64] A pervasive gap in penetration rates exists between urban and rural fixed phones services, as well as in residential phones services. At the end of 2001, urban and rural fixed phone penetration rates were 22 percent and 9 percent, respectively. Incidentally, urban and rural residential phone penetration rates were 17 percent and 8 percent, respectively. The gap in fixed phones penetration rates is larger than that of residential phones partly due to urban areas' stronger business function. As well, Figure 12 presents a slight converging trend between urban and rural residential phone penetration rates since 1998.

Figure 13 correlates the urban rural penetration rates versus economic growth from 1990-2002. Since1994, rural penetration rates have grown faster than that of urban areas in fixed phone services. The same trend was evident in residential phone services. Two reasons can explain this situation: first the outcome of universal service policy and secondly that penetration rates in some urban areas have reached high levels whereby the potential for further growth is relatively low. Rural areas, however, have the potential to improve penetration rates considerably. In summary, while the disparity between penetration rates in urban and rural areas in fixed phone services remains high, growth trends illustrate a narrowing of the gap between the two.

3.2 Telecommunications Deregulation

Deregulation of China's telecommunications sector commenced in 1993. The market structure has shifted away from China Telecom's monopoly in all services towards an increasing degree of competition. In fixed phone services, a low degree of competition has opened up between China Telecom and China Netcom, both

[64] *Ibid.*

geographically monopolistic companies. In mobile phone services, China Mobile and China Unicom compete with each other. Meanwhile, value added services has witnessed the fullest extent of competition. However, World Economic Forum (2002) rated China's telecommunications sector as an insufficient competitive market, in terms of providing services with high quality, infrequent interruptions and low prices.[65] Improving the efficiency and effectiveness of the competition is the next focus on the deregulation.

Wauschkuhn (2000) and Guan (2003) have examined the process of deregulation in China extensively. Figures 14 and 15 highlight the market structure transformation process in China. China Telecom formerly fell under the jurisdiction of the MPT (Ministry of Posts and Telecommunications).[66] Until 1993, the company had held a monopoly in all telecommunications markets and played the role as both a regulator and a service provider.[67] As a consequence of the absence of competition, the price-elasticity of demand to telecommunications services was very low. In 1993, this situation came to an end when the market started opening up to competition.

3.2.1 1993-1998

China Unicom and Jitong were established in 1993 as competitors to China Telecom.[68] This signified the first step of deregulation towards competition in China's telecommunications industry. China Unicom was licensed to provide fixed phone services in limited regions and mobile phone services. Jitong, however, did not focus on

---

[65] Dutta, *et al.* 2003: 285.
[66] Guan. (2003).
[67] Before 1993, the MPT was the monopolistic telecommunications participant in China.
[68] *Ibid.*

basic telecommunications to end users. Instead, it focuses on satellite, microwave and cable connection from huge data networks.[69] Due the dual responsibility of China Telecom, the company held a natural competitive advantage over China Unicom. As a result, effective competition between these two companies failed to develop. Technically, China Telecom continued to enjoy its position as a monopoly in the fixed phone market. In 1994, China Telecom was disconnected from the MPT.[70] Consequently, the dual responsibility of China Telecom in the provision of telecommunications services ended. The MPT became a single-function regulator and China Telecom a service provider. This partly released the competitive disadvantages of China Unicom.

Other than China Telecom's natural advantage in competition due to its dual responsibilities, the market structure played an important role in competition in the mobile phone market between China Telecom and China Unicom. This partly reflects the historical experience of AT&T and independent companies in the early 1900s. As demonstrated by Figure 15, from 1993 to 1998 China Telecom was a vertically integrated company, occupying a monopoly in fixed phone service and a significant portion of mobile phone services. Meanwhile, China Unicom concentrated wholly in the mobile phone market. This asymmetric market structure resulted in a bottleneck in the fixed phone services. As China Unicom has a negligible portion of inputs in interconnection, China Telecom could easily foreclose China Unicom's connection by denying them access to the fixed phone network. This asymmetric market structure placed China Unicom at a severe competitive disadvantage and decelerated its

[69] Ure. (1995)
[70] Guan. (2003).

expansion growth considerably. Only in 1999 when China Telecom's vertically integrated market position was broken up did the issue of interconnection between China Telecom and China Unicom get resolved. This case enhances the understanding of the trade-off between the market structure and interconnection in network expansion. The market structure affects companies' incentives and strategies to interconnect. The outcome of interconnection does, on the other hand, influence companies' competitive advantages.

3.2.2 1999-2002

In 1998, the MPT was replaced by the new Ministry of Information Industry. A subsequent expansion of regulatory authority regime from post and telecommunications grows to include information industry.[71] In 1999, China Telecom's vertical integration in fixed and mobile phone markets was dismantled. As a result, Mobile phone, satellite and paging services were separated from fixed phone services. Afterwards, China Telecom concentrated on the provision of fixed phone service, with the newly established China Mobile and China Satellite companies assuming control of mobile phone and satellite services from China Telecom, respectively. Guoxing paging service from China Telecom merged into China Unicom. At this time, Guoxing Paging was three times of the size of China Unicom.[72] Evidently, the former asymmetric market position of China Telecom and China Unicom was significant prior to 1999. Reforms in 1998 and 1999 established the market structure foundation for subsequent full

[71] MII consisted of MPT, Ministry of Electric Industry (MEI), the network Division of the Ministry of Broadcasting, Film and Television, and the regulatory authority scattered in other governmental developments. Guan. 2003:23.
[72] Wauschkuhn (2000)

competition in China's telecommunications industry.

In 1999, China Netcom was established and licensed to provide fixed phone services. In the following year, China Railcom was founded and licensed to provide fixed phone services along the railway lines. However by this time, China Netcom, China Railcom and China Unicom have occupied a small share of the fixed phone market, with China Telecom continuing to enjoy a monopoly status.

3.2.3 2002 up to the Present Time

In 2002, China Telecom was further broken up into two geographic entities. The first of these two was named China Telecom Groups, maintaining fixed phone business in Southern provinces (21 provinces). The second entity merged into China Netcom and held business in northern China (10 provinces). In addition, both companies were licensed to provide services in each other's service regions.

As a result of the restructuring, the telecommunications industry is presented as a "5+1" model in Figure 14, with five basic telecommunications companies (marked as *) and one satellite company (marked as #). In fixed phone services, four companies compete with each other: China Telecom, China Netcom, China Railcom and China Unicom. By the end of 2003, their corresponding market shares by customers are 62.7, 34.7, 2.5 and 0 percents, respectively.[73] As highlighted, China Telecom and China Netcom are substantially monopolistic in their designated regions, while China Railcom and China Unicom hold a small portion of the market share. Although China Telecom and China Netcom maintain dominant market positions in their geographic regions, the

[73] ChinaNex Telecom Guide. *Company Profile. http://www.chinanex.com/company/index.htm.* Visited on Mar.29th, 2004.

horizontal break-up of China Telecom indicates the regulatory incentives to induce competition in the fixed phone market.

In mobile phone services, China Mobile and China Unicom compete with each other across the country. At the end of 2003, their market shares by customers were 61.7 and 27.9 percents, respectively.[74] China Telecom and Netcom entered the mobile phone market with a small but increasing portion of market shares by providing local mobile services "Little Wizard".[75] By the end of 2003, "Little Wizard" services have had more than 10 percent of the mobile phone market.[76]

3.2.4 Alternative Competitors

Technological innovation has diminished the distinction among image, data and voice transmission. This provides the potential to break up the boundaries of broadcasting, information technology and telecommunications industries. As a consequence, cross-industry entry has been facilitated. The convergence of information technology and telecommunications industries has been processing smoothly. The institutional convergence into the new Ministry of Information Industry in 1998 illustrates this reality. Telecommunications development has increasingly depended on technological innovations. For instance, IP telephony, has been broadly accepted and applied as a long distance solution in telephone services. As well, Electricity and

---

[74] *Ibid.*

[75] "Little Wizard" local mobile phone service is basically a more powerful cordless telephone service based on fixed –line networks and can be used for local wireless communication and roaming services between base stations. (Guan 2003: 31-32). Due to the lower service charge, China Telecom and Netcom "Little Wizard" customers has reached more than 10 percent of total mobile phone subscribers by the end of 2003. ChinaNex Telecom Guide. *Company Profile. http://www.chinanex.com/company/index.htm.* Visited on Mar.29th, 2004.

[76] ChinaNex Telecom Guide. *Company Profile. http://www.chinanex.com/company/index.htm.* Visited on Mar.29th, 2004. Modified by author.

broadcasting industries are potential cross-industry competitors.

In conclusion, with the onset of deregulation since 1993, overall telecommunications development in China has been significant. Of particular, importance is regional and urban-rural gaps in telephone penetration rates. It is imperative to improve penetration rates and alleviate these disparities. China's telecommunications industry has shifted from a monopoly towards a more competitive market structure. In response the significance of the corresponding interconnection across competing networks has risen. With the understanding of the evolution and development of China's telecommunications industry, Chapter IV will investigate the dynamics of network expansion approaches and their implications in China's universal service policy.

Chapter IV - Universal Service Policy in China

The previous chapter examined the evolution and development of China's telecommunications industry. This chapter will discuss the operation and interaction of network expansion approaches in China and investigate their policy implications on the provision of universal service in developing countries. Consequently, this chapter will seek to answer two sets of questions:

1) What is the optimal market structure to maximize network externalities in China? What is the interaction with other approaches?
2) What are the optimal ways to improve penetration rates? What is the interaction with other approaches to maximize network externalities?

4.1 Market Structure

4.1.1 Feasibility of Competition in Telecommunication Markets

National income has a tendency to place constraints on the upper level of penetration rates in developing countries. In addition to this income constraint (GDP per capita) on the consumption of telecommunications services from the consumer side, a shortage of supply often plays an important role in the existence of low penetration rates in developing countries.

Due to economies of scale, the telecommunications industry was traditionally considered as a natural monopoly. Huge sunk costs and capacity constraints are generally the entry barriers to the industry. Technological development is credited for reducing substantially the costs of network construction and operation. Within the framework of a liberalized policy environment, a competitive market structure

flourished in the telecommunications industry. Xu (2000) argues whether competition is practical to improve penetration rates in China. This argument is in part supported by examining the case of the United States. Before the break-up of AT&T in 1984, the penetration rate was 46%. The achievement of this penetration rate was attributed to AT&T's position as a monopoly. However, this argument overlooks the competition between AT&T and independent companies in the early 1900s, which is partly responsible for the improvement of this penetration rate.[77] Due to the segmented "dual service" market as previously discussed, independent companies focused their services in rural areas, which built up initial network connection to high-cost areas of the country.[78] In response the penetration rates were improved significantly in this time period. The contribution of the competition to increase penetration rate demonstrated that competition is not necessarily impractical in improving penetrations rates.

Armstrong (1997)'s research on the exhaustion of economies of scale in the telecommunications industry also criticizes the natural monopoly argument in network expansion. His argument proposes that the extent to which a natural monopoly exists is likely to be limited when supply capacity has been exhausted. This is particularly significant in developing countries, which are at lower economic and technological development levels compared to their developed country counterparts. In the case of China, an insufficient supply of telecommunication networks is one of the reasons for low penetration levels. In 1999, 71 percent of fixed phone capacities were reached,

---

[77] Mueller (1997)

[78] Segmented "dual service" market was discussed previously in the originating of universal service concept in Chapter I.

while residential capacities occupies at 81 percent.[79] At the same time, ratios for automatic and digital capacities were 100 and 99.90 percent, respectively. The capacity ratios indicate the potential increase in fixed and residential phone lines, and tight capacity in automatic and digital facilities. In 1999, total telecommunications investment in China reached US$ 19,100 millions. Consequently, investments per person and per main line were US $15.1 and US$ 176, respectively. These figures were far lower than the world averages of $33 and $210, respectively. In retrospect, the exhaustion of economies of scale may have occurred due to the capacity and investment constraints of the former monopoly company, China Telecom. In this circumstance, a competitive market structure rather than a monopoly is more efficient in the presence of network expansion.

Critics of a competitive market structure in China's telecommunications industry often focus on the concerns over network duplication. Similar to other network infrastructure industries, the telecommunications industry requires enormous sunk costs in order to establish network infrastructure. Duplication of network facilities distorts resource redistribution in society. As a result, avoiding duplicating facilities, particularly the fixed costs of network systems has been an important element of the natural-monopoly argument in fixed phone service regulatory reforms.[80] The corresponding policy implication for regulators presents an entry barrier for competing companies.

The potential of interconnection among networks acts to circumvent this obstacle. Mandatory interconnection among service providers uses existing network

---

[79] Source of capacity and investment data: International Telecommunication Union (ITU). *World Telecommunication Indicators (2000/01)*. Geneva.
[80] Spulber. 2002: 487.

elements and competes without the duplicated construction. Furthermore, with rapid technological innovation, competition can also be easily attained by cross-industry entry without duplication of networks. As previously discussed, potential competitors based on existing networks through railway lines, electricity transmission lines and broadcasting networks can enter the market and provide telecommunications service. China Railway is a prime example. The company provides telecommunication services along the railway using their preexisting internal telecommunications networks. As well, Cable TV networks, in principle, are capable to transmit telecommunications signals through its broadcasting network infrastructure. However, the broadcasting industry has traditionally fallen under strict control by the Chinese central government. As a consequence, regulators have few incentives to integrate these two industries.[81] Under the circumstances, the outlook of broadcasting networks' entry into the telecommunications sector remains obscure.[82]

From the discussion above, duplication of network facilities is not a necessary consequence of a competitive market structure. When economies of scale have been exhausted, competition is to some extent more efficient than a monopoly. This in turn helps alleviate concerns over supply by monopoly companies.

4.1.2 Vertically Integrated Market Structure

As previously discussed, a vertically integrated market structure expands networks vertically and indirectly maximizes network externalities. From the perspective of network externalities, a symmetrical market structure with vertical-

[81] Guan. 2003: 33-39.
[82] *Ibid.*

integrated competition is most favorable.

As previously illustrated, interconnection difficulties happened between both AT&T and independent companies, and between China Telecom and China Unicom. These difficulties originated from the existence of a vertically asymmetric market structure. In a two-way interconnection, the integrated party provides both direct services for end users and the intermediate services for the other party to reach the end users.[83] Figure 16 illustrated this situation. China Telecom provides direct services for their user C to reach user A and intermediate services in B-A period for China Unicom user D to reach user A. As demonstrated, China Telecom has more inputs in this interconnection, attributing to their competitive advantages over China Unicom. Consequently, China Telecom would be in position to refuse interconnection or increase the interconnecting fee in order to squeeze China Unicom's market share and profits. Therefore a vertically asymmetric market structure harms the interconnection outcome and limits network externalities.

The vertical break-up of China Telecom in 1999 eliminated the vertically asymmetric market structure. Current competition is segmented into different services, as previously highlighted in Figure 15. In principle, China Unicom is the only fully licensed company in both fixed and mobile phone services. However, its share of the fixed phone market is neglected.[84] The current relatively asymmetric market framework is favorable for interconnection. However, from the point of view of maximizing network externalities vertically, the current market structure is less desirable. The vertically segmented structure limits the benefits from complementary

[83] Domon and Ota. (2001).
[84] The market shares of fixed phone service providers are shown in Chapter III.

telecommunications services. Therefore, symmetrically vertical-integrated competition is recommended. The resulting implication for China is to fully license telecommunications companies in both fixed and mobile phone services, rather than the segmentation in services. The corresponding symmetrically vertical-integrated competition will maximize the benefits from interconnection and complementary services.

4.2 Improving Penetration Rates

4.2.1 Implicit and Explicit Mechanisms

In order to fulfill the objectives of increasing penetration rates, ubiquity and uniform pricing are applied in China. Traditionally these were financed by an implicit cross-subsidy system, operated internally by China Telecom through its monopolistic market position. Regardless of the onset of deregulation in the industry from 1993 until 2002, China Telecom remained the only incumbent service provider. Open access introduced competition in "profitable" services, i.e., mobile and long distance services. With a distorted pricing system in place, competitors eroded China Telecom's market shares in "profitable" services significantly. Consequently, the financing sources of cross subsidies were threatened. The abolishment of the initial connection fee in 2001 further erodes the maintenance of cross subsidizing. In 1999, the initial connection fee was US$ 226, the 6th most expensive connection fee in the world.[85] This fee represented an important component of the funding basis for the implicit cross subsidy system. The combination of competition in "profitable" services and the elimination of initial connection fee induced insufficient financing sources to fund and allocate

[85] ITU. *World Telecommunication Indicators (2000/01)*. Geneva

resources for universal service obligations in China. Subsequently, the viability of maintaining the implicit cross-subsidy system fell sharply. Since China's accession to the WTO in 2001, foreign investments have gradually entered into both basic and enhanced telecommunications services. This will amplify the negative impact of "cream skimming" in profitable services and intensify the asymmetric burden (universal service obligations) for incumbent service providers.[86]

From the discussion above, implicit funding and allocating mechanisms have distorted the price system and spawned inefficient market outcome in China. Under insufficient subsidies, uneven development of telecommunications has become more significant with the fear of some consumers facing exclusion from networks. Consequently, in the current competitive market structure, an implicit cross subsidy system has been unable to fulfill the objectives of improving penetration rates. A competitive market structure stimulates a transparent pricing system and competitive-neutral funding and allocating mechanisms to improve penetration rates. The accession to WTO further enforces these requirements.

WTO basic telecommunications agreement on universal service states:

"Any Member has the right to define the kind of universal service obligation it wishes to maintain. Such obligations will not be regarded as anti-competitive per se, provided they are administered in a transparent, non-discriminatory and competitively neutral manner and are not more burdensome than necessary for the kind of universal service defined by the Member."[87]

---

[86] In 2002, China Telecom geographically broke up. China Telecom and China Netcom became the incumbent service providers for universal service obligations in southern and northern China, respectively.
[87] World Trade Organization. *"Negotiating Group on Basic Telecommunications"* (April 24, 1996) Available at *http://www.wto.org/english/news_e/pres97_e/refpap-e.htm*. Visited on Mar. 27th, 2004.

In 2001, China announced that it would establish a system of Universal Service Funds (USFs). This represents an explicit system to fulfill universal service obligations, constituting a milestone in China's telecommunications reform agenda. Further regulation on the application of this policy has yet been revealed.

Based on other countries' experience, Universal Service Funds are collected from taxation on targeted telecommunications revenues. The amount of this subsidy depends on the varying costs to provide services to high-cost areas and low income customers. Tax-based explicit funding and allocating mechanisms are more competitively neutral and transparent in cost-oriented pricing, thus more sustainable under a competitive market structure.

4.2.2 Allocation and Administration Costs

The efficiency and effectiveness of tax-based explicit mechanisms depend in part upon the allocation and administration costs in the collection and distribution process. In developing countries, corruption and inefficient auditing practices often exacerbates allocation and administration costs of explicit funding and allocating mechanisms very high. Under China's inefficient tax systems, applying a direct tax system to finance universal service is both socially and economically costly. Gasmi *et al* (2000) argue that in this circumstance, implicit cross-subsidies may be more attractive than explicit taxation to finance and allocate subsidies in developing countries.[88] However, as previously discussed, the incumbent service providers China Telecom and China Netcom have been unable to finance cross-subsidies due to cream skimming under a competitive market structure. The asymmetric burdens on the two companies to

[88] Gasmi *et al* 2000; Laffont, 2000

improve penetration rates for high-cost areas and low income consumers have considerably disadvantaged their competition with non-incumbent service providers. An implicit cross subsidy system distorts the pricing system and the market structure, thus rendering it unsustainable in the presence of growing competition. As a consequence, the efficiency loss from high administration and allocation costs arising from an explicit direct tax mechanism must be carefully reviewed in China. The application of such a mechanism should be combined with reforms on raising the efficiency of the general tax and auditing system.

4.2.3 Low Income Programs

High cost area and low income consumers are two target groups in improving penetration rates. Regardless of the consideration for differentiated costs in providing service, low income programs prioritize "affordability", with attention on income redistribution. However universal service policy is not designed as an income transfer program, but rather its goal is to maximize network externalities through improved penetration rates. Allowing individuals to join and remain in the telecommunications network is the optimal outcome. Low income programs often include discounted initial interconnection fees and monthly charges.[89] The funds necessary to subsidize the programs are derived from Universal Service Funds. Low income consumers are located in both high-cost (rural) and low cost (urban) areas. Unfortunately, cost-based cross subsidies have the paradox effect of making low income customers in low-cost areas worse off, while high income customers in high-cost areas better off. As prices

[89] Federal Communications Commission. *The FCC's Universal Service Program for Low-Income Consumers.* Available at *http://www.fcc.gov/cgb/consumerfacts/lowincome.html.* Visited on Mar.28th, 2004.

rise in low-cost areas, the disadvantaged low income customers in these areas are likely to leave the networks. In response, the original objective of subsidies is distorted. Rosston (2000) finds that targeted programs are cheaper and perform better than cost-based rules that pay a subsidy to all consumers in a given area, regardless of their individual needs. To improve penetration rates, funding and allocating mechanisms are preferred as a combination of explicit subsidies for high cost area customers and target programs for low income groups.

Currently, there no targeted programs for low income groups exist in China. Economic reform and development have led to the abandonment of traditional income redistribution systems. Effective income redistribution and a welfare system to prevent income disparity have yet been established.[90] As a result, it is imperative to apply low income programs to assist disadvantaged groups in connecting to and remaining in telecommunications networks.

[90] Démurger (2001)

Chapter V - Conclusion

The economic rationale of universal service policy in the telecommunications industry is based on network externalities. Network externalities are the benefits of all consumers in the network derived from network expansion. Rather than focus solely on improving penetration rates, this paper has expanded the extent of the current concept of universal service policy while emphasizing on the outcome of network expansion. Improvement of penetration rates, the market structure and interconnection are three main approaches to expanding networks in the telecommunications industry. The dynamics of these approaches determines the effects of network expansion and the outcome of universal service policy.

Ubiquity and uniform pricing are often applied in the pursuit of improving penetration rates. This averaging price system and its supporting funding and allocating mechanisms mask cost differences and consumer preferences, thereby distorting the cost-oriented pricing system. As a consequence, the market structure is subsequently distorted. In a competitive market structure, cream skimming and inefficient market entry are induced due to the distorted pricing. In this paper, the efficiency and effectiveness of implicit and explicit funding and allocating mechanisms has been investigated. Both result in a welfare loss due to the distortion of prices. An implicit subsidy system subsidizes through internal cross subsidies charging above-cost for "profitable" services to subsidize discounted "unprofitable" services. On the other hand, an explicit mechanism implies direct taxation on targeted telecommunications revenues, based on a forward-looking cost estimate for universal service obligations. The latter is

superior over the former, providing greater transparency in pricing and more competitive neutrality. Consequently, an explicit mechanism is more sustainable and favorable to improving penetration rates in a competitive market structure.

The most contentious issue facing network expansion is the trade-off between improving penetration rates and the market structure. Improving penetration rates distorts both the price system and the market structure. A competitive market structure, on the other hand, requires transparency in cost-oriented pricing and competitively neutral funding and allocating mechanisms to improve penetration rates. The underlying element in this relationship is the distorted pricing system and the supporting funding and allocating mechanisms. As well, the trade-off between improving penetration rates and interconnection concentrates on pricing. Ubiquity and uniform price constraints complicate access pricing in interconnection. Interconnection pricing on other hand, has a significant effect on the pricing system.

Current universal service policy often neglects the roles of vertically integrated market structure and interconnection on network expansion. This mode of market structure expands the network vertically through complementary goods and services. Concurrently, interconnection is responsible for linking different networks into unified networks. Ultimately, the interaction between these two approaches affects the outcome of network expansion. A vertically asymmetric market structure damages the incentives of the integrated company to interconnect. The interconnection outcome, on the other hand, determines the competitive advantages of the interconnecting companies in the market.

Universal service is a dynamic concept. Under the current national and

international economic, political and technological environments, China's universal service policy is extremely complicated. Applying the understanding of the dynamics of the network expansion approaches in China's telecommunications industry, uncovers two major policy implications.

5.1 Market structure

Among the degrees of competition, asymmetrically vertical-integrated competition is recommended in China's telecommunications industry. Competition is a feasible and more efficient market structure over a monopoly in maximizing network externalities. Aside from traditional market entry, cross-industry entries from railway lines, electrical power lines and broadcasting networks will alleviate capacity and investment burdens while avoiding network duplication. A vertically integrated market structure, with fully licensed companies in the basic telecommunications market, maximizes network externalities through complementary goods and services. The culmination of rapid technological innovation has spawned a greater amount of service options. In response, economies of scope in different services have increased in significance. Consequently, fully licensed competing companies are in favorable positions to maximize network externalities in China. Furthermore, a symmetric competitive market structure ensures the outcome of interconnection while expanding the networks.

5.2 Practice of Improving Penetration Rates

In a competitive market structure, explicit funding and allocating mechanisms to

improve penetration rates are desirable to improve penetration rates. Nevertheless in developing countries, administration and allocation costs behind a direct tax system can be extremely costly and therefore its efficiency loss should be carefully monitored. The preference for an explicit direct tax mechanism is combined with reforms in both the taxation and auditing systems.

From the dynamics of network expansion approaches, it is evident that universal service policy is not a single policy. It interacts with other telecommunications policies, such as the market structure and interconnection. Regulators must simultaneously consider all related policies in order to evaluate and target specific policy objectives. Moreover, universal service policy harbours inherent social and political implications in income redistribution and regional planning. Economic growth is recognized as playing a substantial role in the levels of penetration rates. Consequently, extensive consideration of telecommunications policy along with national development objectives is necessary to achieve a comprehensive understanding of the policy outcomes.

BIBLIOGRAPHY

Armstrong, Mark. (1997). "Competition in Telecommunications." *Oxford Review of Economic Policy*, Vol.13, No.1, 64-82.

Alexander, Donald L. (1997). *Telecommunications Policy: Have Regulators Dialed the Wrong Number?* Westport, Conn.: Praeger.

Alleman, James. (2000). "Book Review on 'Who Pays for Universal Service? When Telephone Subsidies Become Transparent'." *Information Economics and Policy*, 12, 417-421.

Aufderheide, Patricia. (1999). *Communications Policy and the Public Interest.* New York: Guildford Press.

Barnett, A. H. and David L. Kaserman. (1998). "The Simple Welfare Economics of Network Externalities and the Uneasy Case for Subscribership Subsidies." *Journal of Regulatory Economics,* 13, 245-254.

Benitez, Daniel A., Antonio Estache, D. Mark Kennet and Christian A. Ruzzier. (2002). "The Potential Role of Economic Cost Models in the Regulation of Telecommunications in Developing Countries." *Information Economics and Policy*, 14, 21-38.

Blonski, Matthias. (2002). "Network Externalities and Two-Part Tariffs in Telecommunication Markets." *Information Economics and Policy,* 14, 95-109.

Cave, Martin E., Sumit K. Majumdar and Ingo Vogelsang. (2002). "Structure, Regulation and Competition in the Telecommunications Industry." *Handbook of telecommunications economics,* Chapter 1. Amsterdam; Boston: Elsevier.

Chone, Philippe, Laurent Flochel and Anne Perrot. (2000). "Universal Service Obligations and Competition." *Information Economics and Policy*, 12, 249-259.

Chone, Philippe, Laurent Flochel and Anne Perrot. (2002). "Allocating and Funding Universal Service Obligations in a Competitive Market." *International Journal of Industrial Organization*, 1, 1247-1276.

Crandall, Robert W. and Leonard Waverman. (2000). *Who Pays for Universal Service? When Telephone Subsidies Become Transparent.* Washington, D.C.: Brookings Institute Press.

Crémer, Jacques. (2000). "Network Externalities and Universal Service Obligation in the Internet." *European Economic Review*, 44, 1021-1031.

Church, Jeffrey R. and Roger Ware. (2000). I*ndustrial Organization: A Strategic Approach.* Boston: Irwin McGraw Hill.

Démurger, Sylvie. (2001). "Infrastructure Development and Economic Growth: An Explanation for Regional Disparities in China." *Journal of Comparative Economics*, 29, 95-117.

Domon, K. and K. Ota. (2001) "Access Pricing and Market Structure." *Information Economics and Policy*, 13, 77-93.

Downes, Tom and Shane Greenstein. (2002). "Universal Access and Local Internet Markets in the US." *Research Policy*, 31, 1035-1052.

Dutta, Soumitra, Bruno Lanvin and Fiona Paua (Ed.). (2003). *The Global Information Technology Report.* New York; Oxford: Oxford University Press.

Economides, Nicholas. (1996). "The Economics of Networks." *International Journal of Industrial Organization,* 14, 673-699.

Falch, Morten and Amos Anyimadu. (2003). "Tele-Centres as a Way of Achieving Universal Access—the Case of Ghana." *Telecommunications Policy*, 27, 21-39.

Fink, Carsten. Aaditya Mattoo and Randeep Rathindran. (2003). "An Assessment of Telecommunications Reform in Developing Countries." *Information Economics and Policy*, 15, 443-466.

Gasmi, F., J.J. Laffont and W.W. Sharkey. (2000). "Competition, Universal Service and Telecommunications Policy in Developing Countries." *Information Economics and Policy*, 12, 221-248.

Guan, Scott Yunxiang. (2003). *China's Telecommunications Reforms: from Monopoly towards Competition.* New York: Nova Science Publishers.

Holler, Manfred J. (1999). *On the Regulation of Telecommunications Markets.* Helsinki: United Nations University, World Institute for Development Economics Research.

Horwitz, Robert B. (1989). *The Irony of Regulatory Reform: the Deregulation of American Telecommunications.* New York: Oxford University Press.

Hudson, Heather E. (2001). "Book Reviews on 'Who Pays for Universal Service? When Telephone Policies Become Transparent'." *Telecommunications Policy*, 25, 373-377.

Intven, Hank and McCarthy Tétrault. (2000). *Telecommunications Regulation Handbook,* Module Six. World Bank. Washington D.C.

Li, Mingzhi and Jin Wang. (2003). *China's Telecommunications Universal Service in a Competitive Environment.* UNU/WIDER Project Conference on Spatial Inequality in Asia, United Nations University Centre, Tokyo.

Laffont, Jean-Jacques and Aké N'Gbo. (2000). "Cross-Subsidies and Network Expansion in Developing Countries." *European Economic Review*, 44, 797-805.

Laffont, Jean-Jacques and Tirole, Jean. (2000). *Competition in Telecommunications.* Cambridge, Mass., MIT Press.

Liebowitz, S.J. and Stephen E. Margolis. (2002). "Network Effects." *Handbook of telecommunications economics,* Chapter 3. Amsterdam ; Boston : Elsevier.

Liebowitz, S.J. and Stephen E. Margolis. (1994). "Network Externality: An Uncommon Tragedy." *The Journal of Economic Perspectives,* Vol.8, No.2, 133-150.

Leibenstein, H. (1950). "Bandwagon, Snob, and Veblen Effects in the Theory of Consumer's Demand." *Quarterly Journal of Economics,* 64,183-207.

Kahn, Alfred E. (1988). *The Economics of Regulation: Principles and Institutions.* Cambridge, Mass.: MIT Press.

Katz M.L. and C. Shapiro. (1994). "Systems Competition and Network Effects." *Journal of Economic Perspectives,* 8, 93-115.

Kennard, William E. (1999). *Connecting the Globe: A Regulator's Guide to Building a Global Information Community.* Available at *http://www.fcc.gov/connectglobe/.* Visited on March 8th, 2004.

Majumdar, Sumit K. (2000). "With a Little Help from My Friends? Cross-Subsidy and Installed-based Quality in the U.S. Telecommunications Industry." *International Journal of Industrial Organization*, 18, 445-470.

McElhinney, Stephen. (2001). "Telecommunications Liberalization and the Quest for Universal Service in Australia." *Telecommunications Policy*, 25, 233-248.

McLarty, Taunya L. (1998). "Liberalized Telecommunications Trade in the WTO: Implications for Universal Service Policy." *Federal Communications Law Journal,* December, 51, 1, 1-59.

Mueller, Milton L. (1997). *Universal Service: Competition, Interconnection, and Monopoly in the Making of the American Telephone System.* Cambridge, Mass., MIT Press and Washington, D.C.: AEI Press.

Noam, Eli M. and Wolfson, Alex J. (1997). *Globalism and Localism in Telecommunications.* New York: Elsevier.

Ou Yang, Wu. (2000). *Deregulating Telecommunications in the United States.* Beijing: China Friendship Press.

Onwumechili, Chuka. (2001). "Dream or Reality: Providing Universal Access to Basic Telecommunications in Nigeria?" *Telecommunications Policy*, 25, 219-231.

Panzar, John C. (2000). "A Methodology for Measuring the Costs of Universal Service Obligations." *Information Economics and Policy*, 12, 211-220.

Parsons, Steve G. (1998). "Cross-Subsidization in Telecommunications." *Journal of Regulatory Economics*, 13, 157-182.

Riordan, Michael H. (2002). "Universal Residential Telephone Service." *Handbook of telecommunications economics,* Chapter 10. Amsterdam ; Boston : Elsevier.

Rodini, Mark, Michael R. Ward and Glenn A. Woroch. (2003). "Going Mobile: Substitutability between Fixed and Mobile Access." *Telecommunications Policy*, 27, 457-476.

Rosston, Gregory L. and Bradley S. Wimmer. (2000). "The 'State' of Universal Service." *Information Economics and Policy*, 12, 261-283.

Shaw, James. (2001). *Telecommunications Deregulation and the Information Economy.* Boston: Artech House.

Schement, Jorge R. and Scott C. Forbes. (1999). "The Persistent Gap in Telecommunications: Toward Hypothesis and Answers." *Competition, Regulation, and Convergence: Current Trends in Telecommunications Policy Research.* Gillett, Sharon E. and Ingo Vogelsang. (ed.) Mahwah, NJ: Lawrence Erlbaum.

Sorana, Valter. (2000). "Auctions for Universal Service Subsidies." *Journal of Regulatory Economics*, 18:1, 33-58.

Spulber, Daniel F. (2002). "Competition Policy in Telecommunications." *Handbook of telecommunications economics,* Chapter 3. Amsterdam; Boston: Elsevier.

Strover, Sharon. (2003). "The Prospects for Broadband Deployment in Rural America." *Government Information Quarterly*, 20, 95-106.

Taylor, Lester D. (1994). *Telecommunications Demand in Theory and Practice.* Boston: Kluwer Academic Publishers.

Ure, John. (1995). "Telecommunications in China and the Four Dragons". *Telecommunications in Asia. Policy, Planning and Development.* Hong Kong: Hong Kong University Press. 11-48.

Valletti, Tommaso M. (2000). "Introduction: Symposium on Universal Service Obligation and Competition." *Information Economics and Policy*, 12, 205-210.

Valletti, Tommaso M., Steffen Hoernig and Pedro O. Barros. (2002). "Universal Service and Entry: The Role of Uniform Pricing and Coverage Constraints." *Journal of Regulatory Economics*, 21:2, 169-190.

Vogelsang, Ingo and Bridger M. Mitchell. (1997). *Telecommunications Competition: the Last Ten Miles.* Cambridge, Mass.: MIT Press; Washington, D.C.: AEI Press.

Wauschkuhn, Markus. (2000). "Telecommunications and Economic Development in China." *Asia Pacific Dynamism 1550-2000.* London: Routledge.

Wheatley, Jeffery J. (1999). *World Telecommunications Economics.* London: Institute of Electrical Engineers.

Winston, Clifford. (1998). "U.S. Industry Adjustment to Economic Deregulation." *The Journal of Economic Perspectives*, Vol.12, No.3, 89-110.

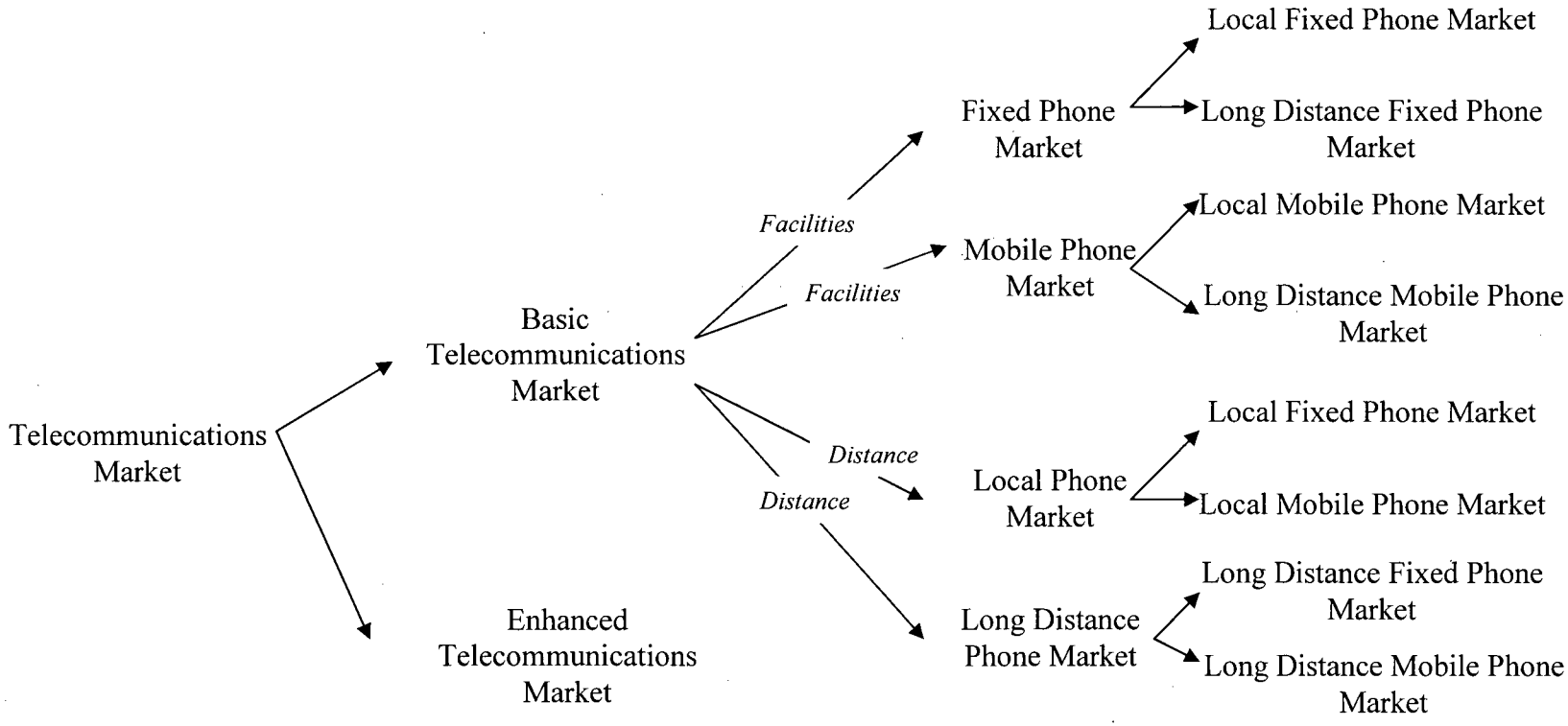
Wolak, Frank A. (1996). "Can Universal Service Survive in a Competitive Telecommunications Environment? Evidence from the United States Consumer Expenditure Survey." *Information Economics and Policy*, 8, 163-203.

Xu, Yan. (2000). "The WTO and Its Effects on the Chinese Telecommunications Industry." Paper presented at Telecom Asia Policy and Development Summit of International Telecommunication Union, Hong Kong, December 4-9, 2000.

Yannelis, Demetrius. (2001). "On the Simple Welfare Economics of Network Externalities." *International Journal of Social Economics,* Vol. 28, Issue 4, 344-348.

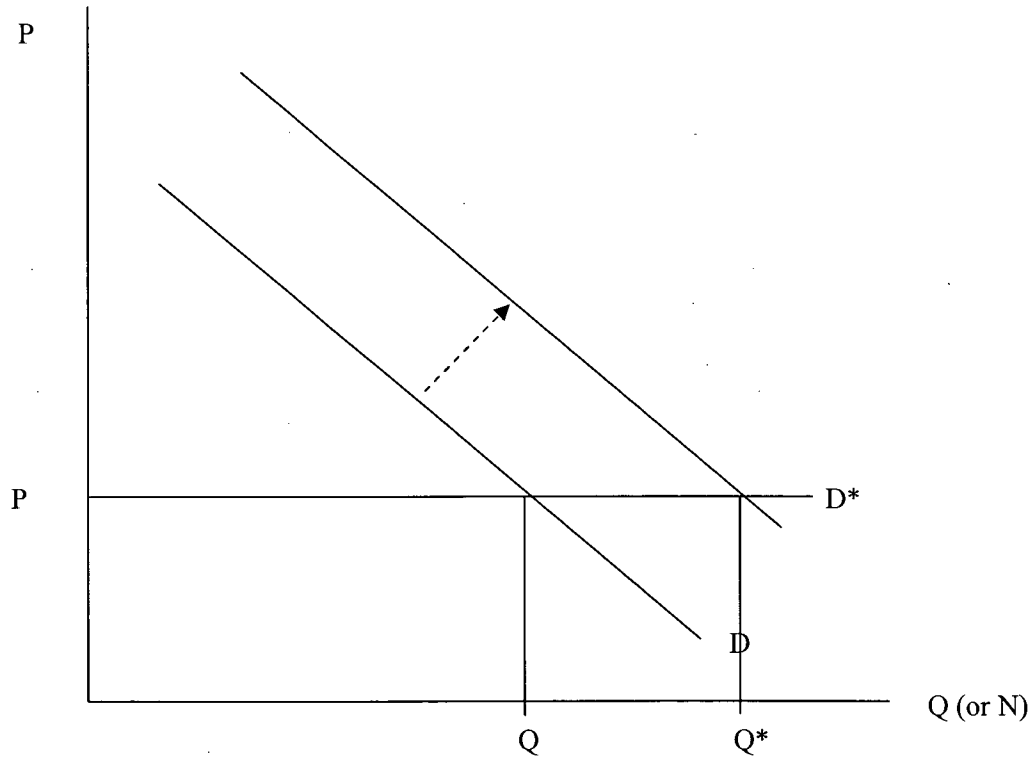
APPENDIX:

Figure 1: Telecommunications Market Overview



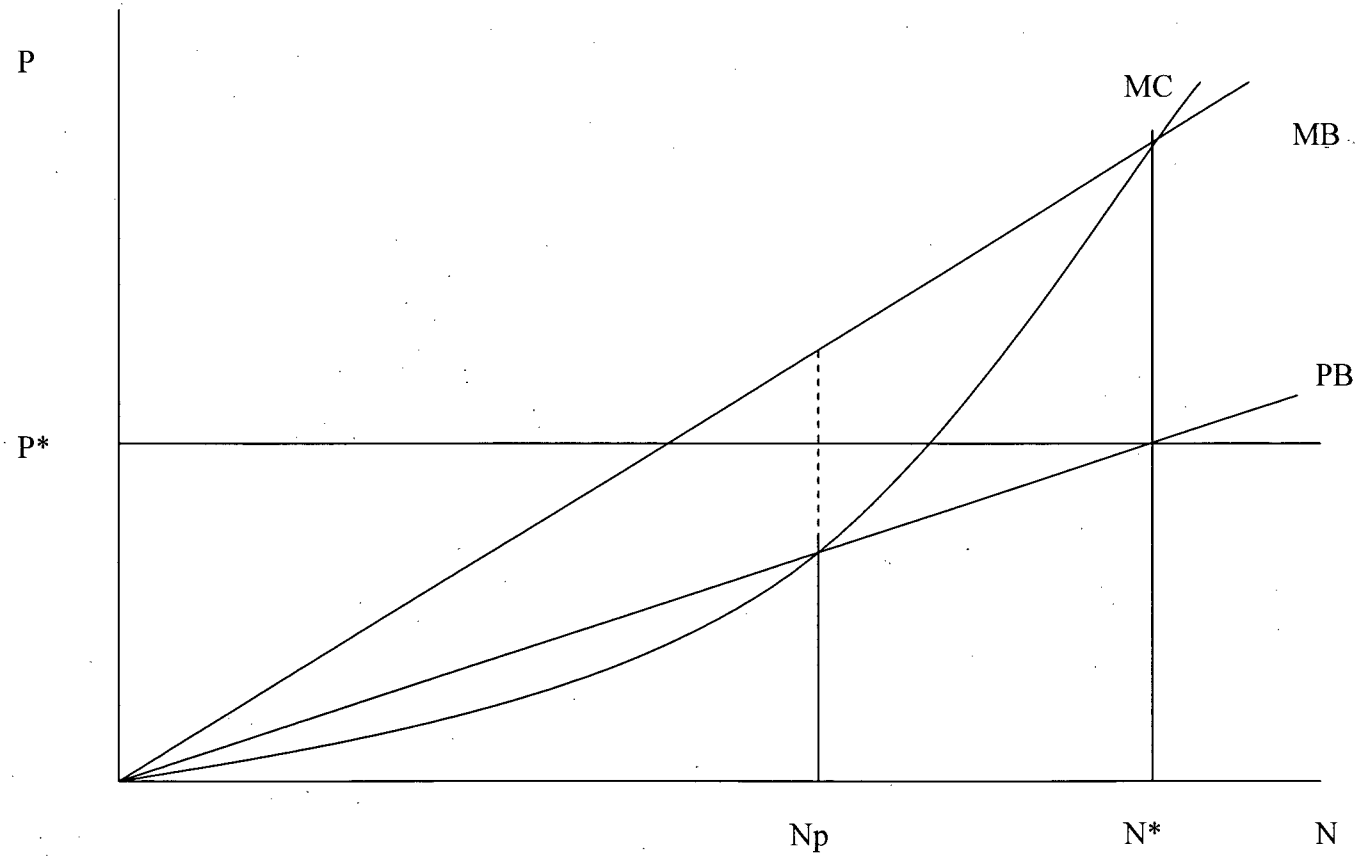
APPENDIX:

Figure 2: Demand Curve with Network Externalities



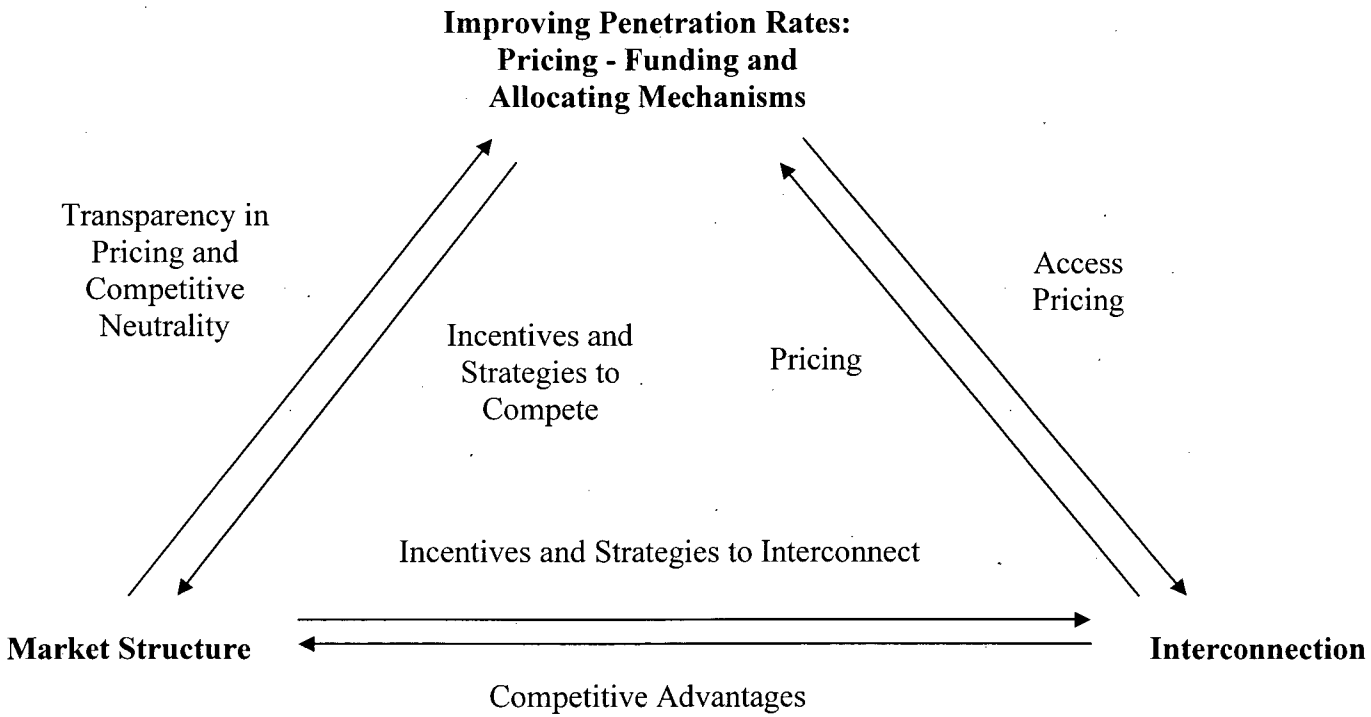
APPENDIX:

Figure 3: Optimal Network Size



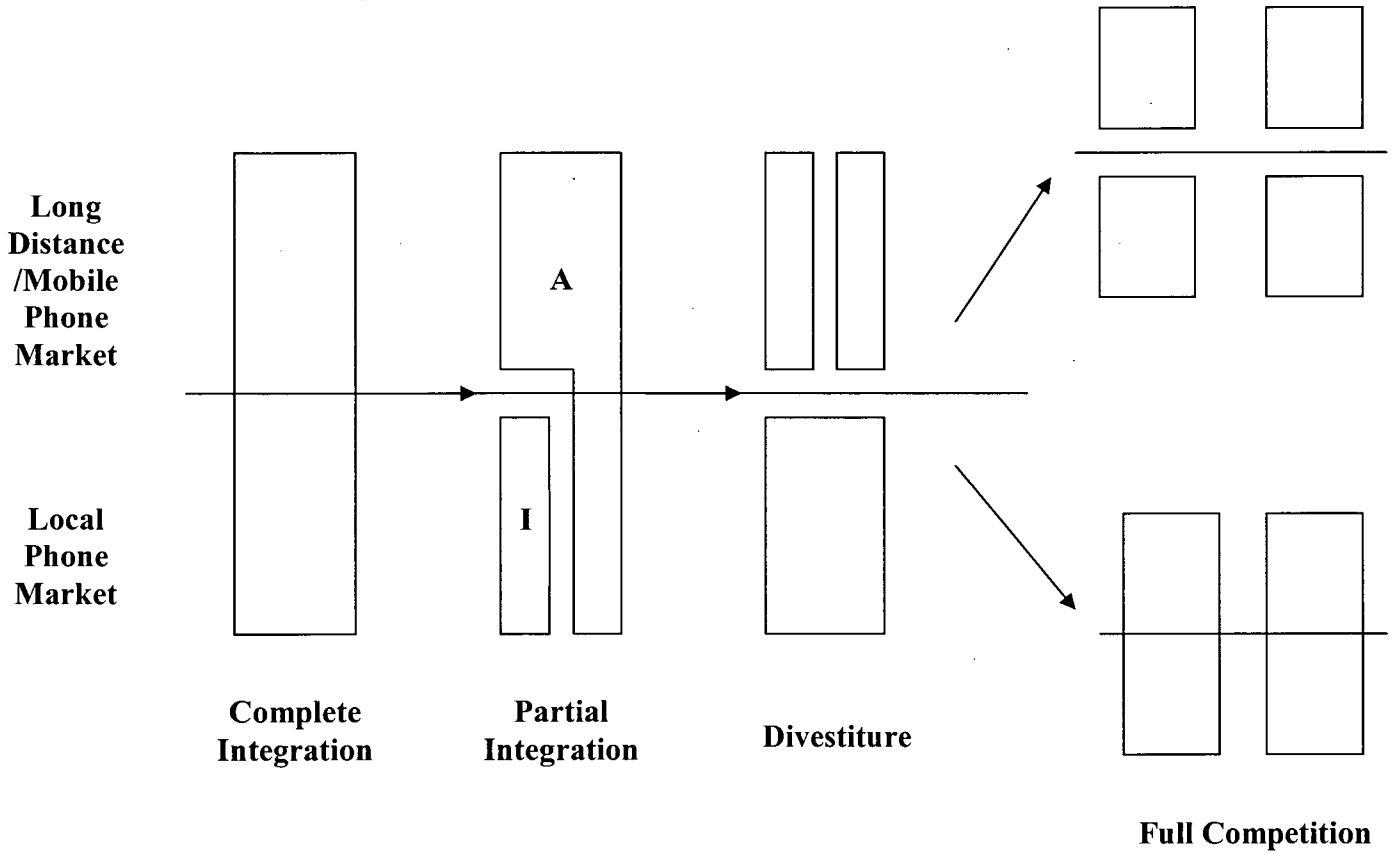
APPENDIX:

Figure 4: Dynamics of Network Expansion Approaches



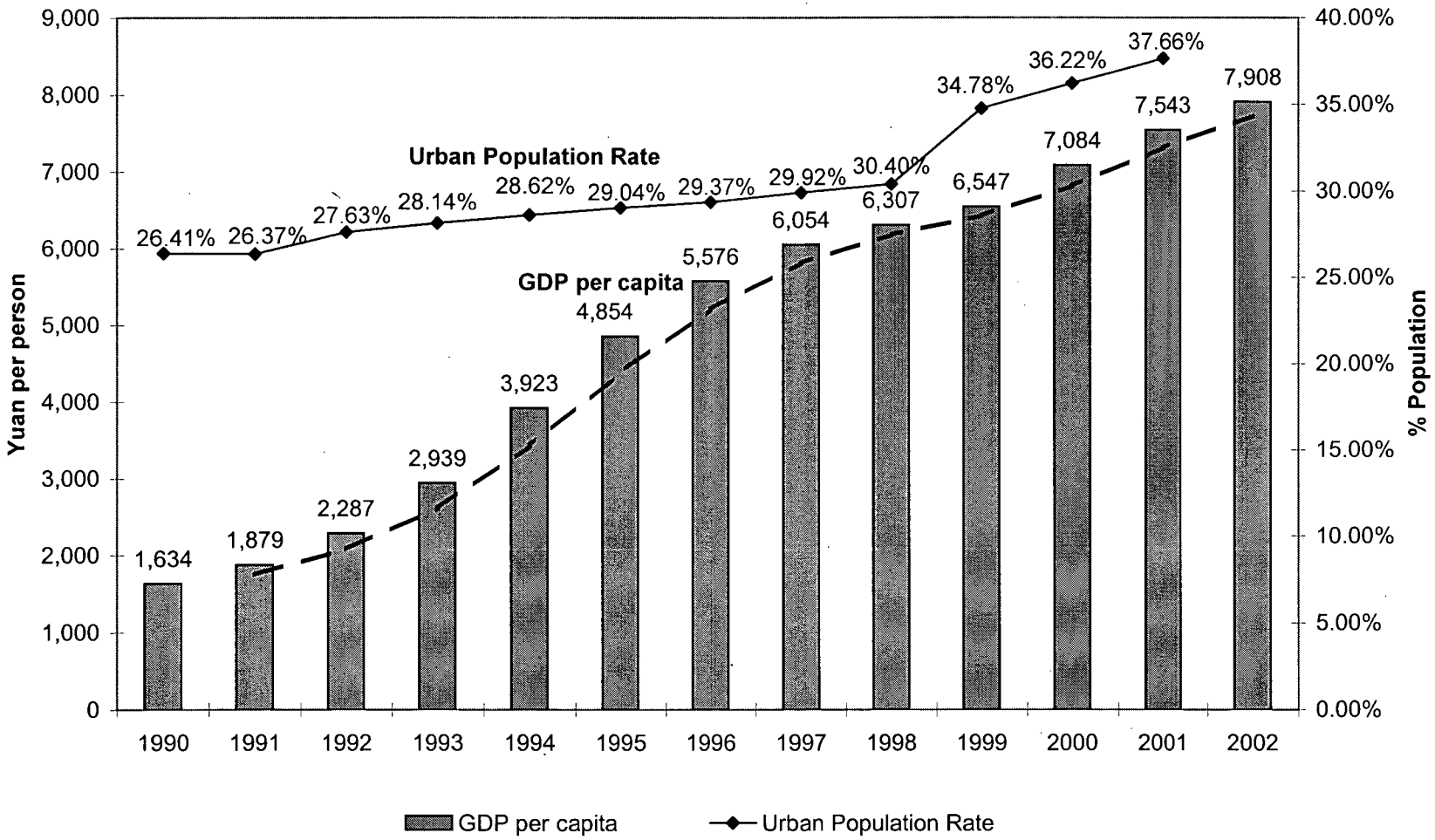
APPENDIX:

Figure 5: Interconnection and Market Structure



APPENDIX:

Figure 6: Economic Growth and Urbanization, China, 1990-2002



APPENDIX:

Figure 7 : Penetration Rates Growth vs. Economic Growth, China, 1990-2002

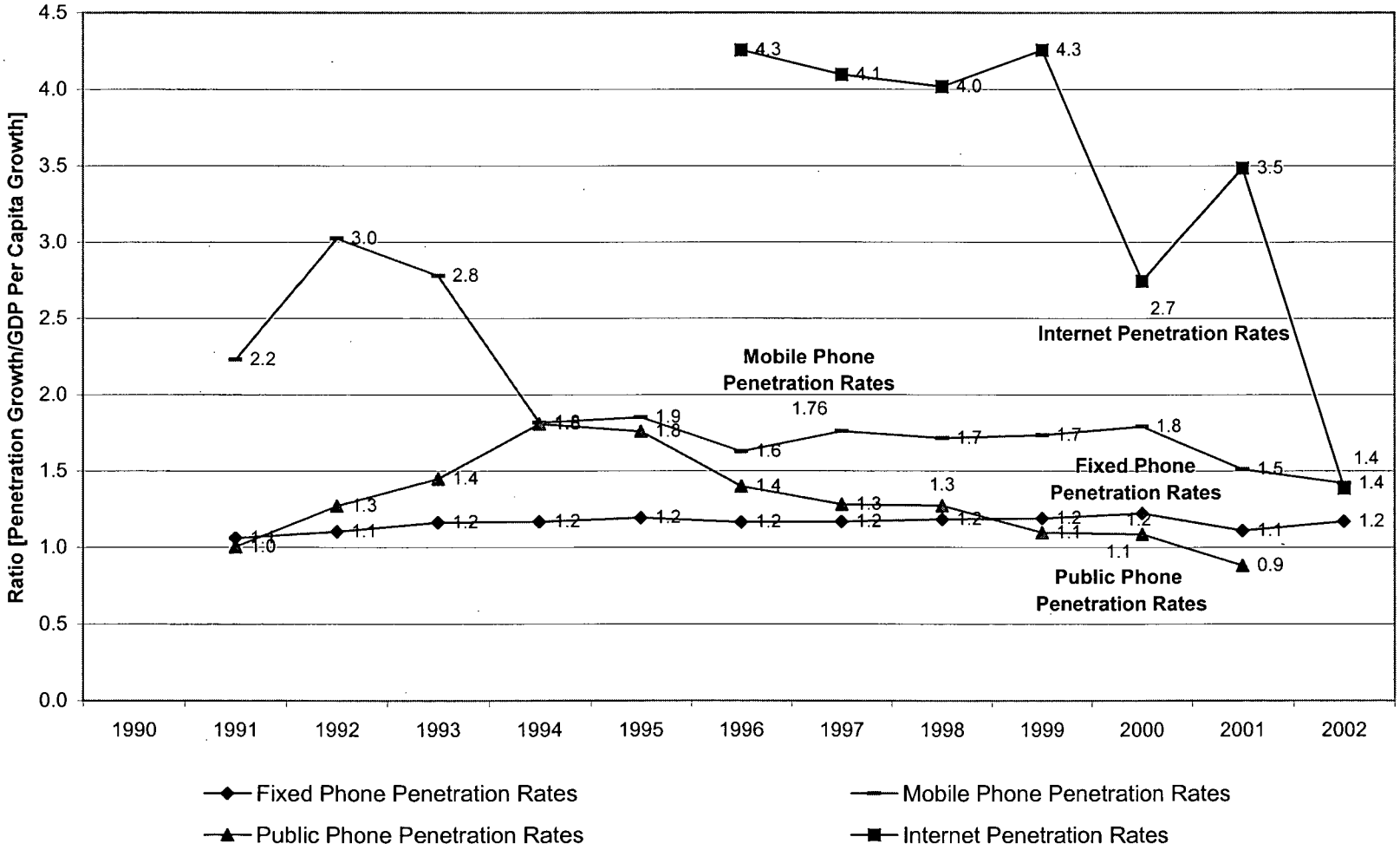


Figure 8: Telecommunications Service Penetration Rates, China, 1990-2003

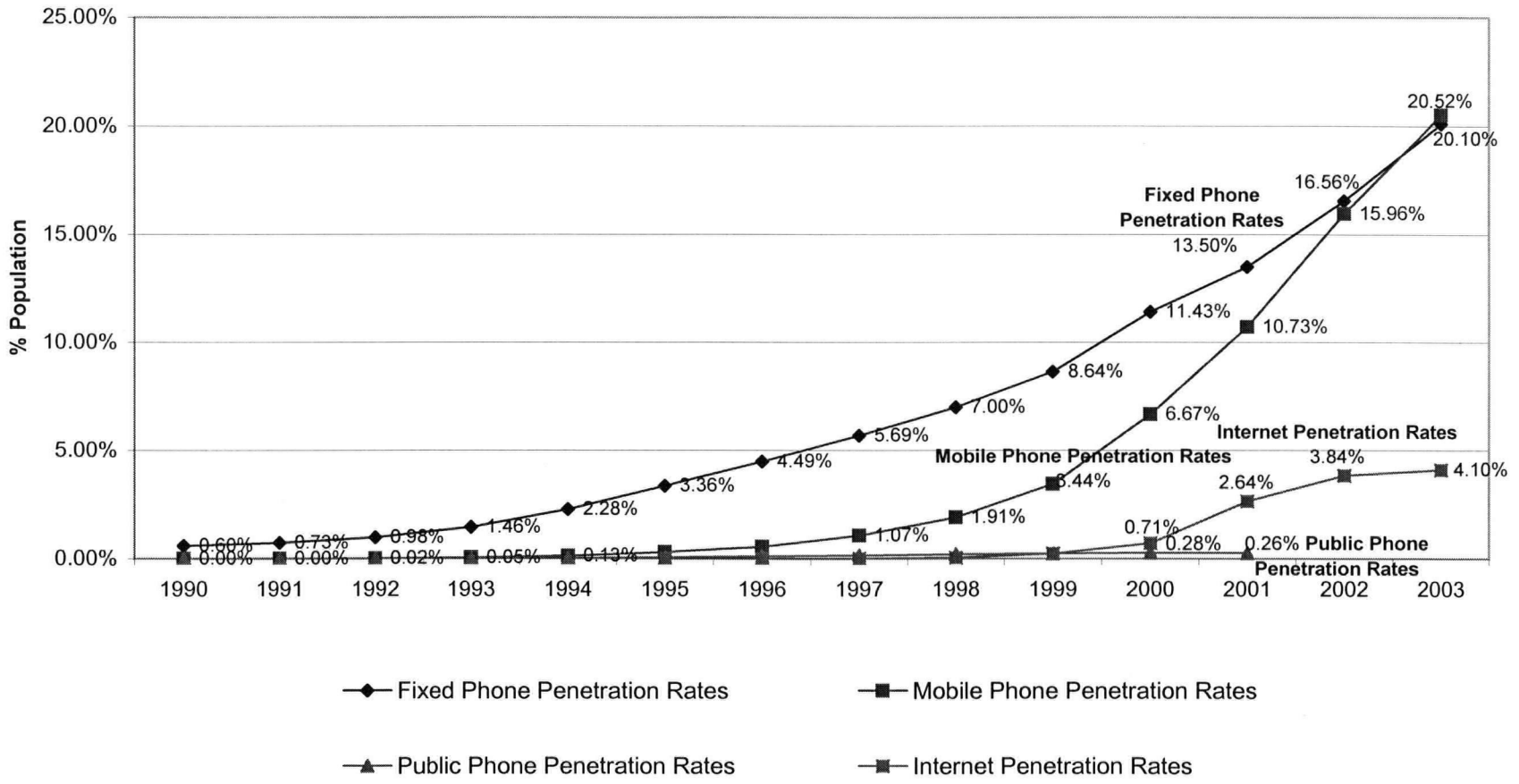


Figure 9: Regional Disparity in Fixed and Mobile Phone Penetration Rates, China, 1998-2003

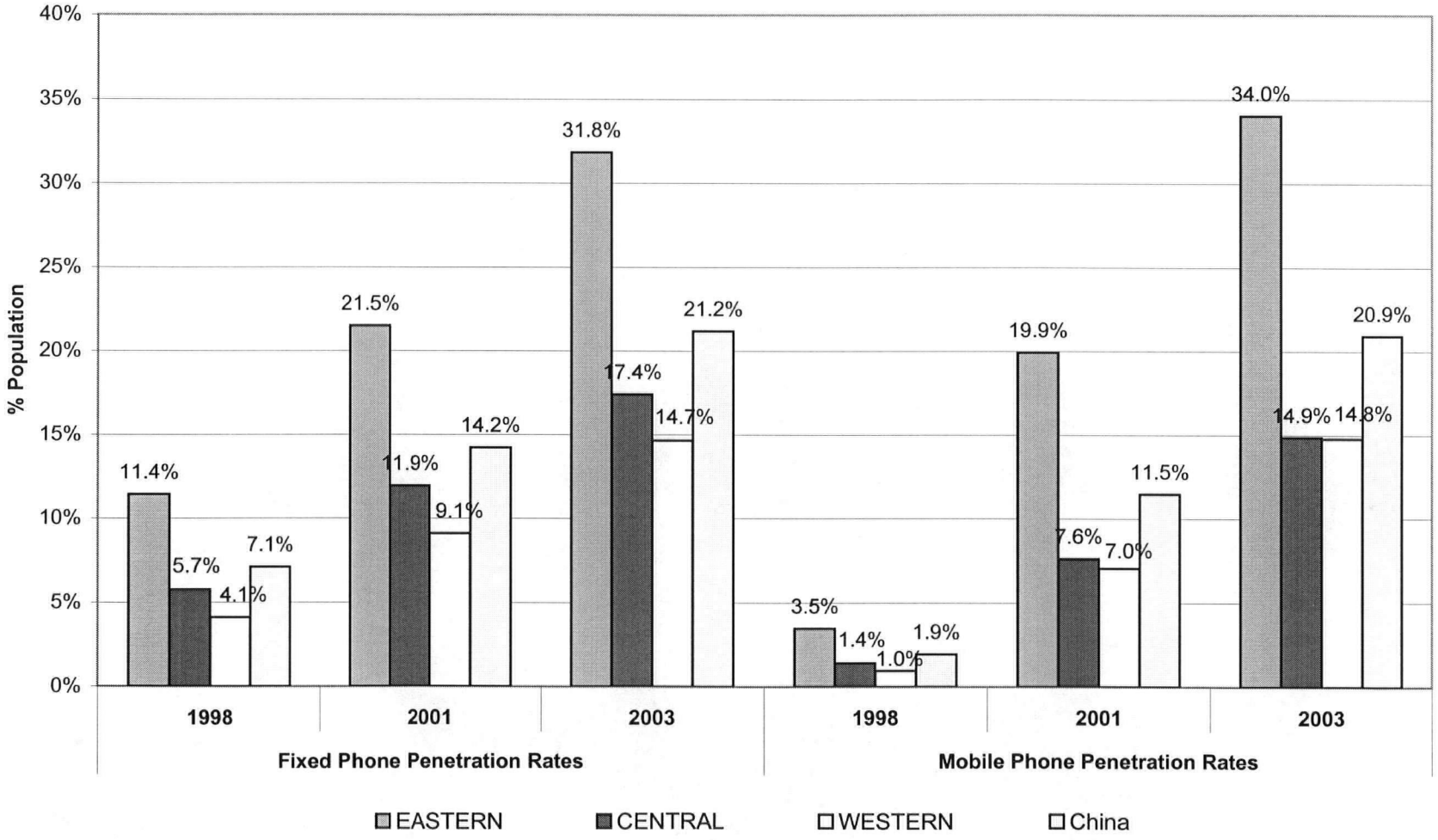
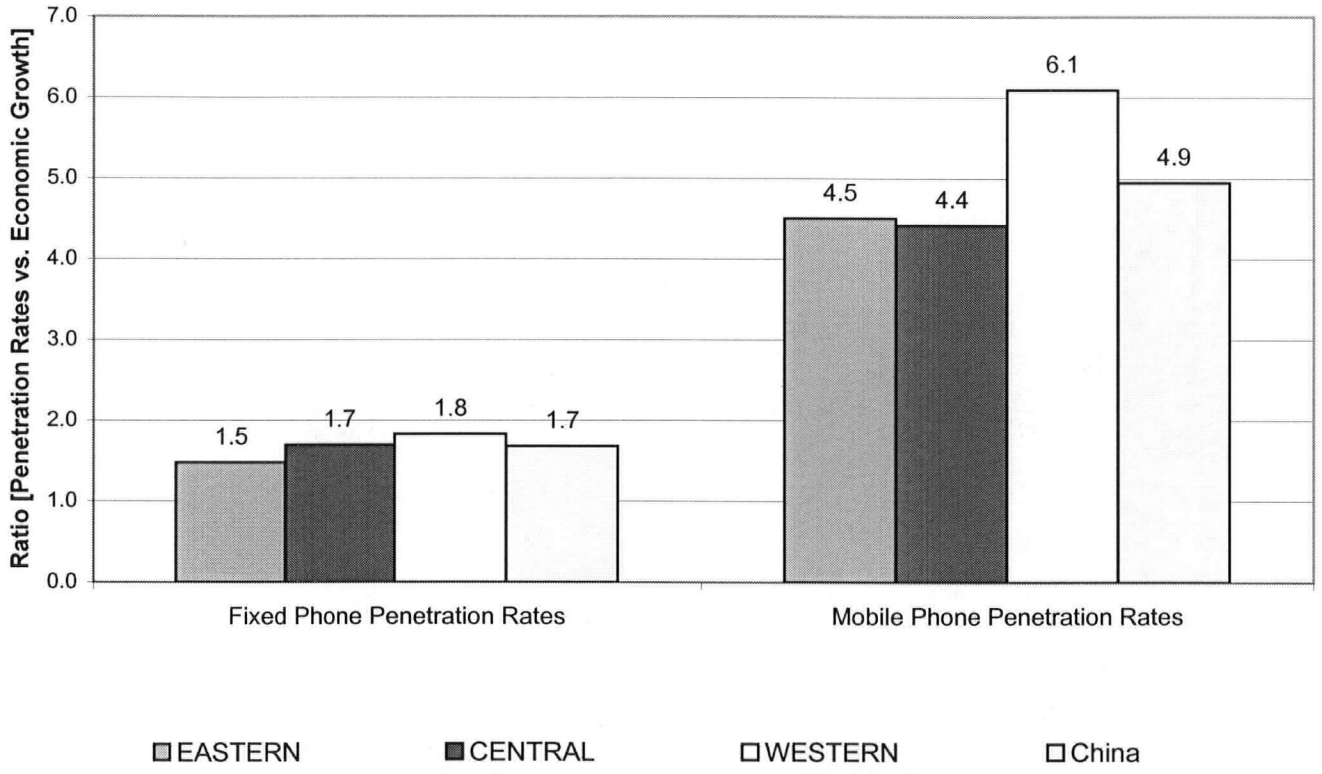


Figure 10:Regional Disparity [Penetration Rates Growth vs. Economic Growth, China, 1998-2001



APPENDIX:

Figure 11: Regional Disparity in Economic Growth, China, 1998-2001

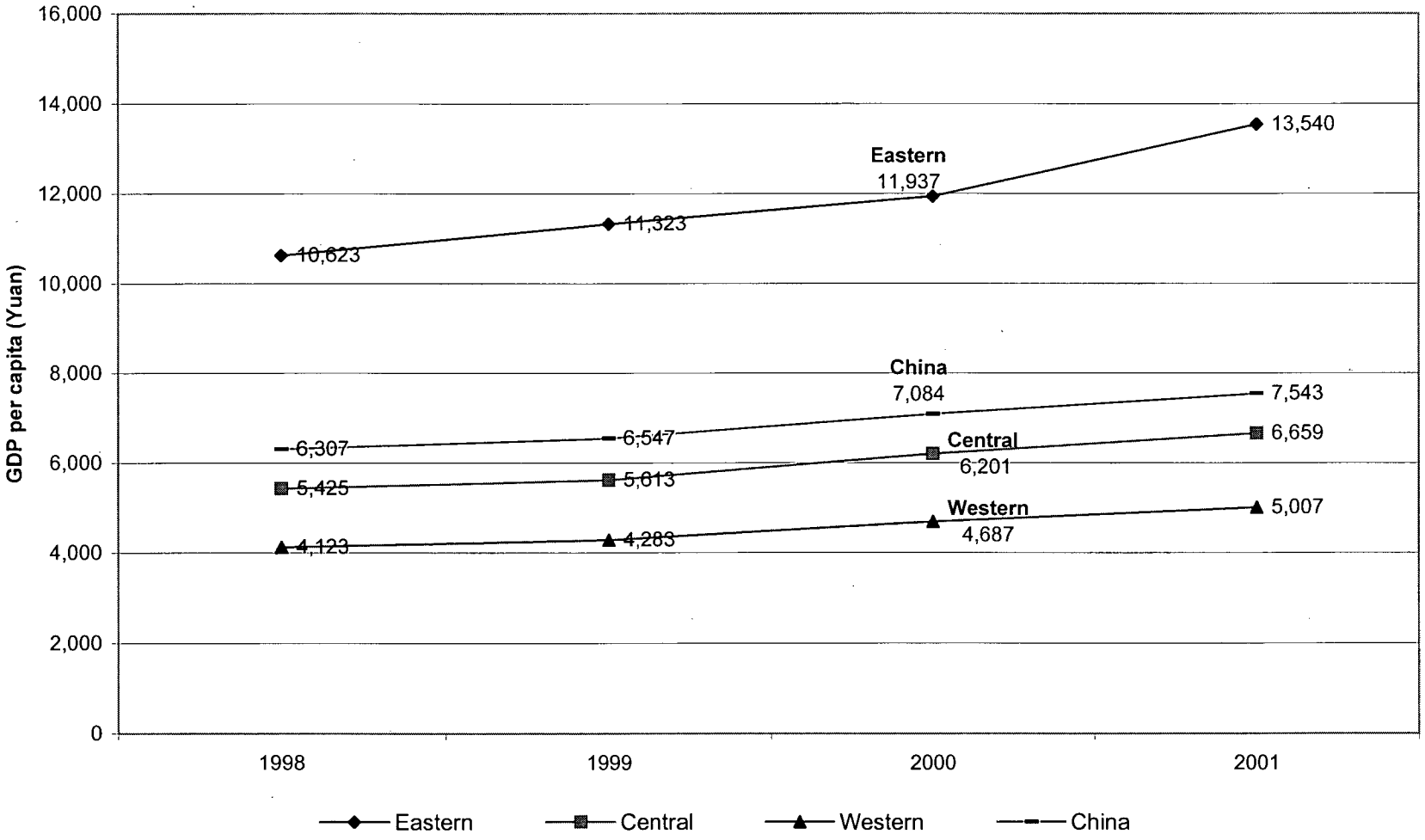


Figure 12: Urban Rural Disparity in Fixed Phone Penetration Rates, China, 1990-2003

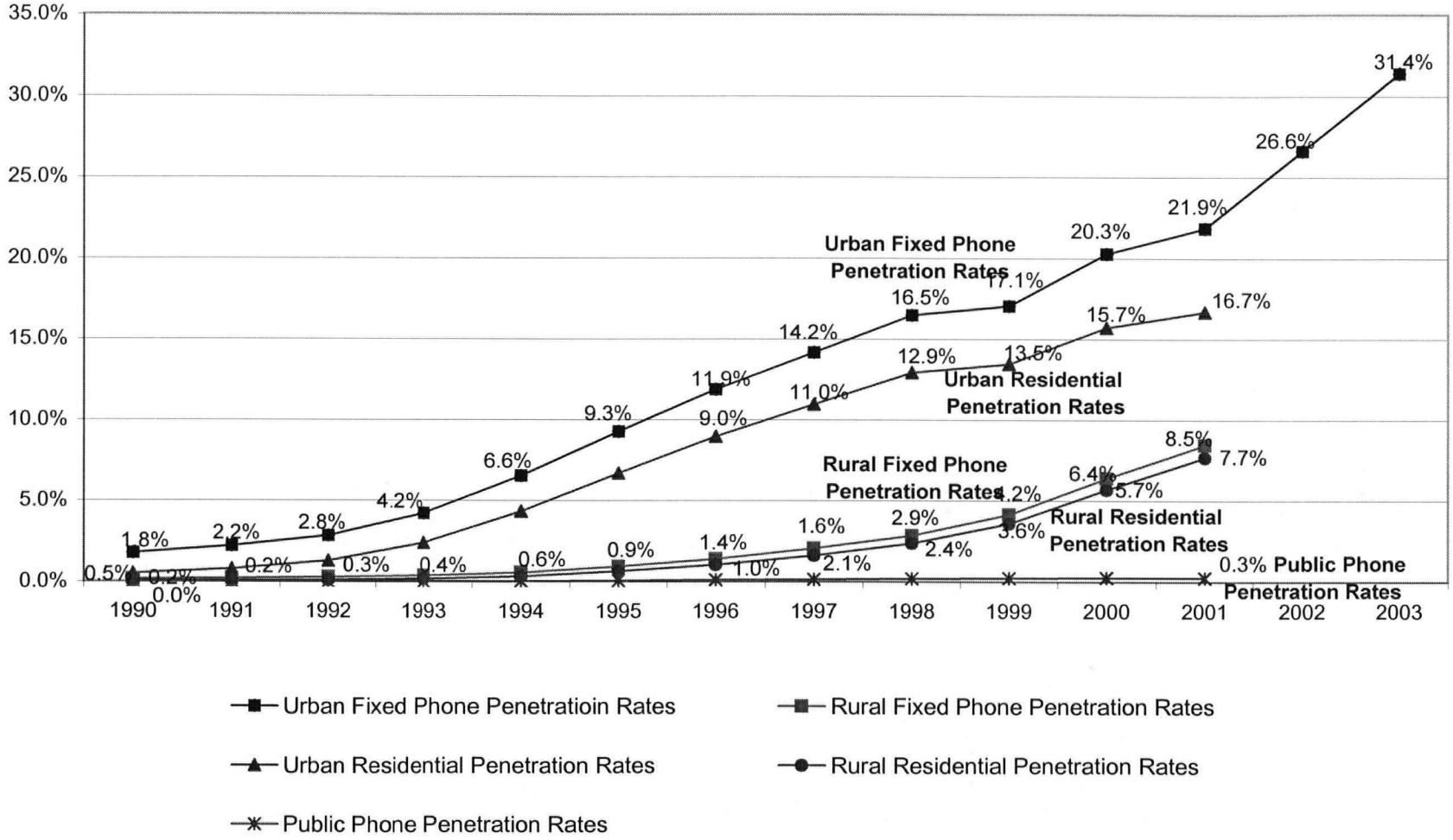
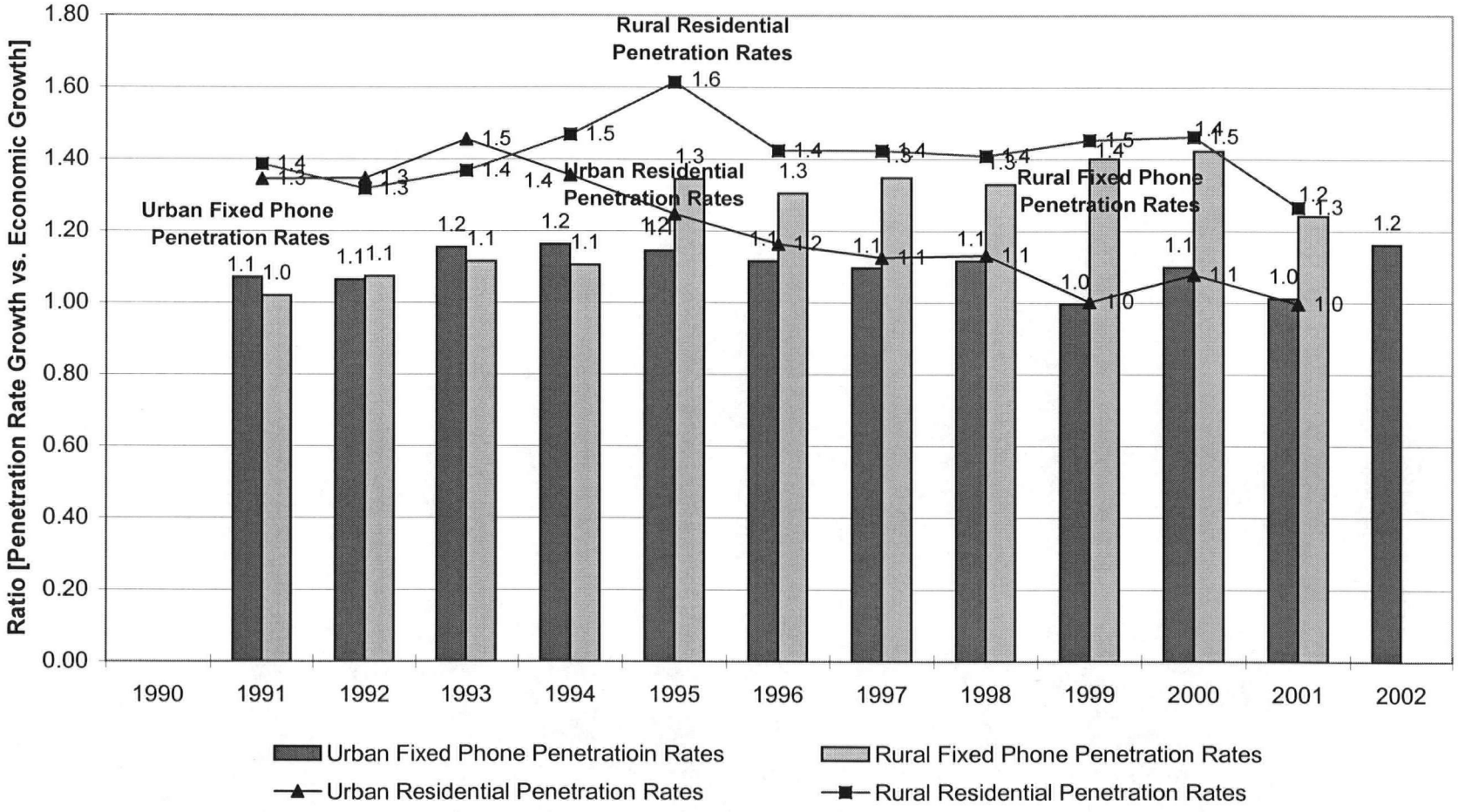
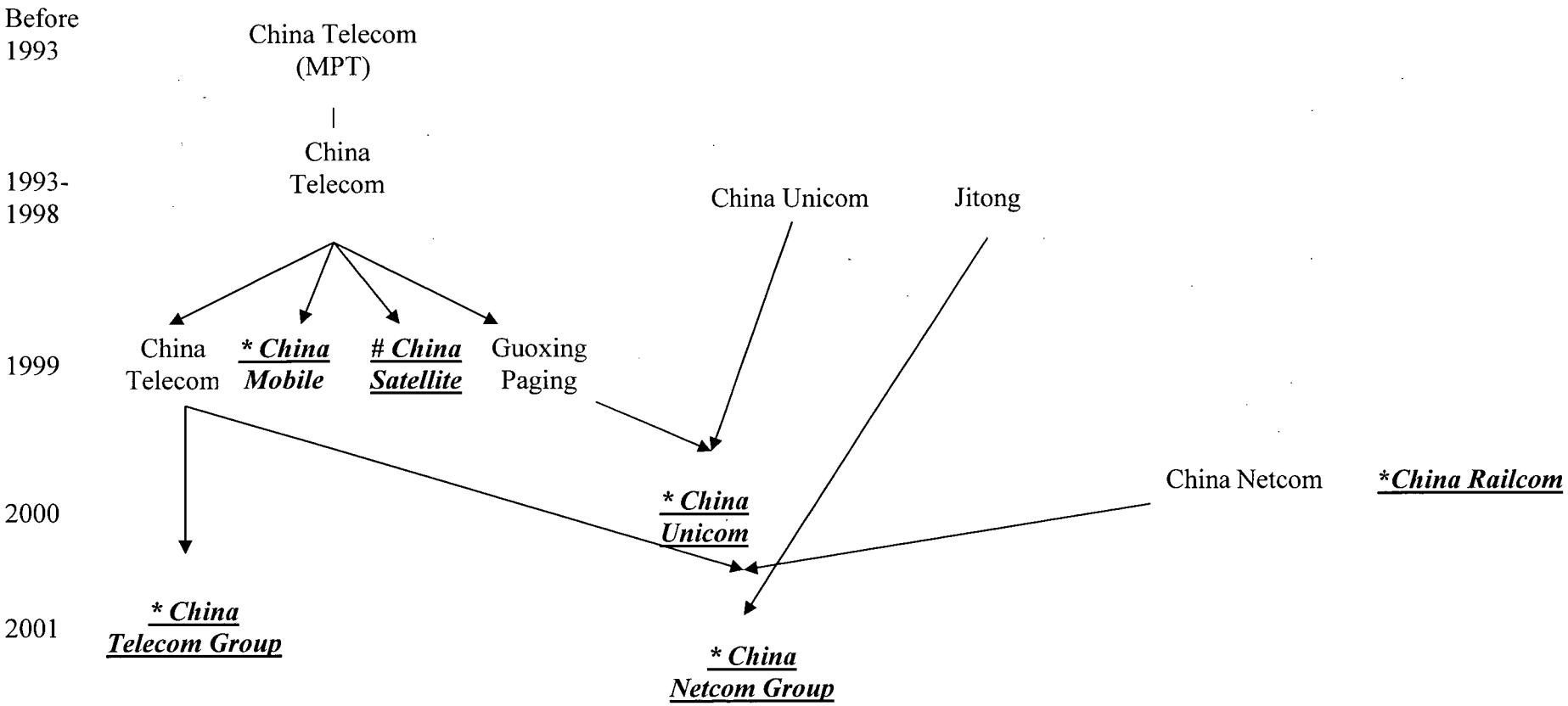


Figure 13: Urban Rural Disparity [Penetration Rates Growth vs. Economic Growth], China, 1990-2002



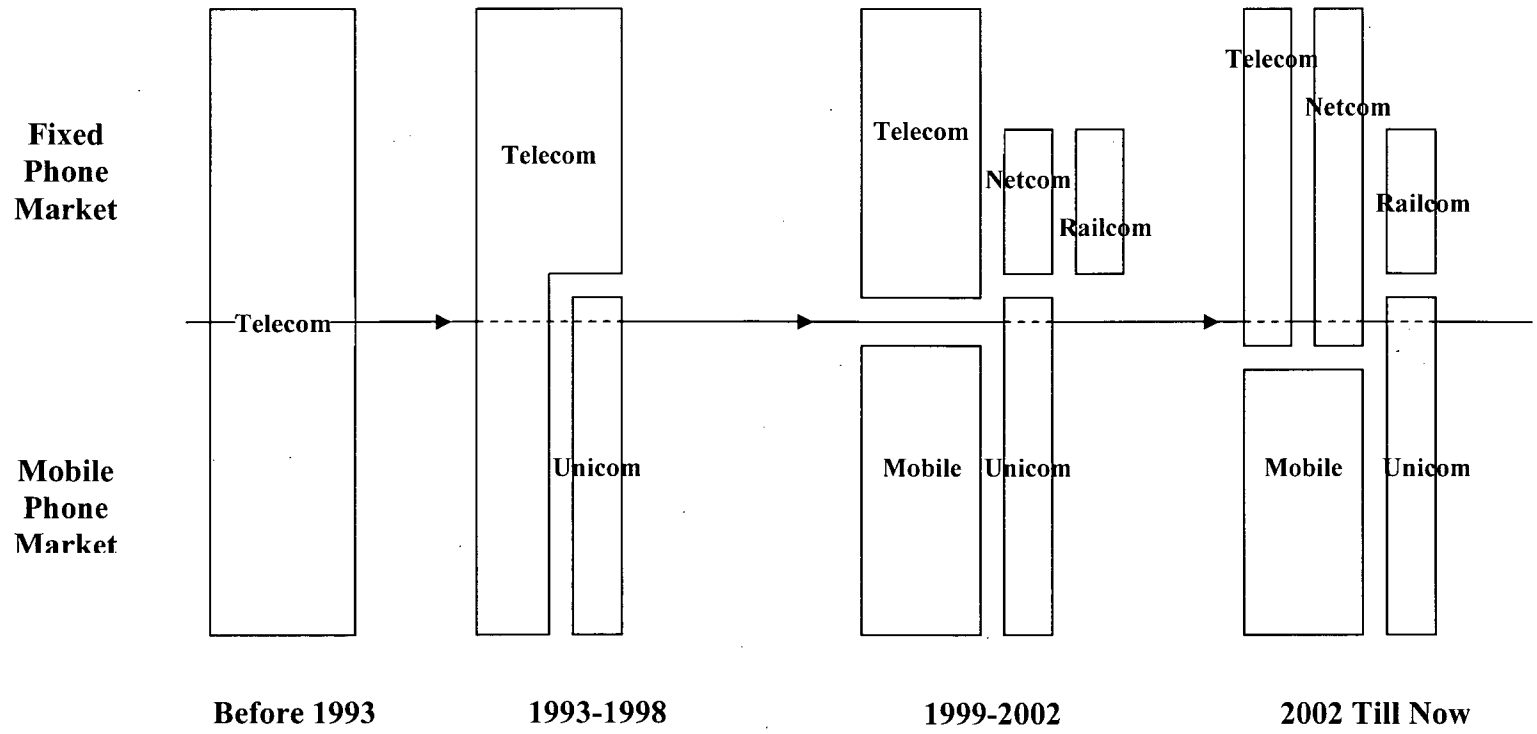
APPENDIX:

Figure 14: Restructuring Process in China's Telecommunications Market



APPENDIX:

Figure 15: Transformation of Market Structure in China



APPENDIX:

Figure 16: Interconnection in China