"The Effects of Market Liberalization and Privatization on Chinese Telecommunications"

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**Abstract**

The Chinese telecommunications sector is undergoing fundamental changes as it moves towards liberalization. This paper examines how liberalization and privatization have affected the performance of Chinese telecommunications industry. We identify greater liberalization with increases competition as measured by reductions in industrial concentration and privatization with deceases in state equity-ownership in firms. With a new panel dataset of thirty-one Chinese provinces from 1998 through 2007, we examine the effects of reforms on prices and subscription levels of both of mobile and fixed line telecommunications operators within both the mobile and fixed line platforms. We find large gains in market performance from decreased concentration among mobile providers not for fixed-line service. The evidence on the effects of state-ownership is similarly mixed. We then estimate substitution patterns between these telecommunications platforms and find evidence of consumer substitution between the fixed and mobile platforms for subscription, but not usage.

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## I.      Introduction

The growing trend toward privatization and market liberalization evident in other

countries and other sectors are also evident in Chinese telecommunications. The

telecommunications reforms reflect changes in technology that might mitigate the reliance on

government interventions and affect our understanding of the effects of these interventions.

Specifically, the natural monopoly hypothesis applied to telecommunications may be

undermined by changing technology that has both expanded the boundaries of

telecommunications industry and blurred the distinctions between communications and

information processes (Sharkey, 1982; Spiller and Cardilli, 1997; Noll, 2000). At the same time,

property rights theory stresses that in state-owned enterprises (SOEs), the public's owners have

only weak property rights (Alchian, 1965; Alchian 1969; Furubotn and Pejovich, 1972). Weak

property rights can reduce the incentive of owners to monitor and discipline management

performance, increase a manager's consumption of job perquisites, and lower the firm's

productive efficiency. Since the 1980s, the introduction of competition, breaking up or

unbundling monopolies, and the privatization of state-owned telecommunications operators have

become the main themes of telecommunications sector reform in developing countries. These

reforms have occurred during a period of falling telecommunication prices, significant expansion

of telecommunications networks and substantial improvements in productivity. This study

attempts to uncover evidence that suggests that some of these effects are causal.

Several recent cross-country econometric studies have examined the effect of telecommunications reform on sector performance, especially for developing countries. Ros (1999) examined the effect of privatization and competition on network expansion and efficiency during 1986-1995 in the 110 countries, including developed countries. He found that countries with majority privatized Public Telecommunications Operators (PTOs) have higher mainline penetration and more mainlines per employee. While competition was not found to affect network expansion, it was found to positively affect efficiency. Wallsten (2001) explored the effect of privatization, competition and regulation on telecommunications performance in 30 African and Latin American Countries from 1984 through 1997. He found that competition was significantly correlated with increased mainline penetration, connection capacity, payphone penetration, and lower local calling prices. Privatization alone, however, was associated with few benefits, and was negatively correlated with connection capacity. Fink et al. (2003) analyzed the impact of policy reform in basic telecommunications on sector performance in 86 developing countries over the period 1985 to 1999. They found that countries with complete liberalization have higher teledensity – telephone lines per 100 population – and higher labor productivity relative to those with no or only partial reform. Both privatization and competition improved performance and the latter reinforces the former. Wallsten (2004) investigated the impact of exclusivity rights of newly privatized telecommunications firms in developing countries. Exclusivity rights tended to increase price and reduce both investment and penetration. As a result, turning a public monopoly into a private monopoly may not necessarily generate the improvements reformers had envisioned. In addition, introducing competition after privatizing incumbent operators led to fewer mainlines per population compared to a simultaneous introduction of the two policies. Li and Xu (2002, 2004) suggest that privatization and

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competition were important factors in the development and expansion of both fixed and mobile telecommunications. Full privatization, which gave private owners control rights, contributed substantially to improving the allocation of labor and capital, expanding service output and network penetration, and increasing labor and total factor productivities. But partial privatization, which retained the state's control rights, had no significant impact. In summary, the majority of studies consider that competition on its own, and complementarities between competition and privatization, are positively correlated with telecommunications industry performance. The relationship between privatization and industry performance, however, is more tenuous.

Although there has been much cross-country empirical research on the effects of competition, privatization and regulation on the telecommunications sector, very little cross-sectional empirical work in one country has been performed. Potential strengths of within country studies are that the units of analysis are more likely to share common political and economic institutional structures, participants are more likely to share a common language and cultural setting, and data collection is more likely to generate similarly defined variables.

China is a particularly interesting country in which to study the impact of differing progress of telecommunications industry reforms across regions. Chinese telecommunications industry growth performance has been impressive, but economic conditions, and the development of China's telecommunications industry in particular, vary substantially across regions. Generally, the eastern and coastal areas have developed more quickly and carried out telecommunications reform earlier than central and western areas (Fang and Yen, 2006). In addition, with respect to the decentralization of the Chinese economy and of policy-making, regional governments have been given different degrees of discretion in setting economic policy (Cao et al., 1999). For instance, Guangdong has been at the forefront of pro-market reforms with

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China Mobile Guangdong Branch being the first to incorporate and go public on the NYSE (New York Stock Exchange) and the HKSE (Hongkong Stock Exchange) in 1997. To the extent that the cross-province level analysis of telecommunications sector reform impacts industry performance measures in countries that are large and feature local discretion and in which the progress of reforms differ by region, China is an excellent country in which to conduct such an analysis. On the other hand, with an inclination for gradual reform that concedes government control to market processes only on an incremental basis, China's experience may not be representative of other developing countries.

Over the past decade or more, all Chinese provinces have experienced some level of market liberalization and privatization reforms. One reform is the divestment of incumbent monopoly state-owned enterprise (SOE) units so as to develop conditions conducive to workable competition. Another is promoting the raising of capital by SOEs by selling equity on private exchanges. Finally, new regulations were adopted to separate the regulation and operation functions of the Ministry of Information Industry (MII). No empirical studies, so far, have been conducted to study how these processes have influenced China's telecommunications industry (Fang and Yen, 2006).

This paper examines the separate effects of privatization and competition as components of telecommunications sector reform on market performance in China. In doing so, we have assembled a new panel of data that provides separate measures of the level of competition and private ownership in the telecommunication sector in thirty-one Chinese provinces over the period 1998-2007. The aim of the analysis is to improve our understanding of the determinants of performance improvements in telecommunications sectors in China and thereby contribute to the design of better reform programs.

The paper is organized as follows. Section 2 discusses Chinese telecommunications sector reform and describes the specific competition and privatization reforms. Section 3 discusses the relevant economic theory to generate a number of research hypotheses. Section 4 then presents a model used to test these hypotheses. Section 5 describes data sources. The results are presented in Section 6. The last part of the paper, Section 7, summarizes and discusses the main conclusions.

## II.     Telecommunications Reform in China

Some of the reforms of Chinese telecommunications from the 1990s were deliberate choices while others appeared to have merely ratified emerging technological, competitive and political realities. With developments in wireless technology especially, market penetration benefited from the technological advantages of scalable investments as well as rivalry from multiple providers. Entry into the World Trade organization (WTO) led the Chinese government to open the telecommunication industry to Western capital, primarily through participation in state-owned enterprises (SOEs). At the same time, large increases in demand by both residential and business customers brought about by growing incomes and productivity would have stressed the telecommunications infrastructure without the investment that the reforms permitted. Reform was considered necessary to increase the telecommunications capacity required by economic development in other sectors. Whatever their source, Chinese liberalization and privatization reforms tended to advance the spread of more telecommunication services to more consumers and do so faster than any other time in history.

Serious reforms in competition and ownership rules were implemented to liberalize and partially privatize the Chinese telecommunications sector in the late 1990s. Since then, industry concentration, as measured by the Hirshman-Herfendahl Index (HHI) , for mobile and fixed services combined fell from 10,000 to about 6,000 and average state ownership fell from 100% to 80%. During this period, the telecommunication industry grew at a remarkable pace. In 1998, the average teledensity was only 11.2 telephone sets per 100, and the total number of mobile telephones was only 23.9 million. By the end of 2007, teledensity had reached 62.8 sets, and the number of mobile phone subscribers had climbed to half a billion. As measured by the combined number of fixed and mobile telephone subscribers, China became the largest communications market in the world by 2003 (Low and Johnston, 2005).

It is unclear how much of the impressive Chinese telecommunications industry growth was due to market reforms rather than growth associated with general improvements in the Chinese economy. Our analysis attempts to uncover the effects of specific reforms independent of these other factors. We control for these general economic effects when we relate policy reforms measures to changes in industry performance. Our results are consistent with improved performance and consumer benefits from the transition toward market liberalization and privatization.

*Competition reform*

Competition reform in Chinese telecommunications followed three general stages. Figure 1 indicates the major changes from 1994 through2007. The first stage (1994-1997) was considered to be less than fully successful. Before 1994, the telecommunications sector remained

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highly centralized, monopolized, and closed to foreign investment. In 1994, China began to undertake reforms to change the monopoly structure. Government control over the telecommunications industry was slightly relaxed with the introduction of the much smaller China Unicom (CU) and Jitong and the termination of Ministry of Posts and Telecommunications (MPT)'s monopoly. These two firms had the backing of the Ministry of Electronics Industry (MEI) but domestic competition from China Unicom was hampered by interconnection arrangements with the MPT (Wu, 2009). China Unicom was only able to capture one percent of the total telecommunications market in 1998 and thus likely imposed only modest competitive pressure on China Telecom. Our analysis focuses on developments that occurred after this period.

The second stage (1998-2001) was characterized by the breaking up of China Telecom and the shaping of duopoly competition in the mobile phone service market. The Chinese government created the Ministry of Information Industry (MII) in March 1998 to separate the regulatory and operational functions of the MPT as well as to respond to changes in technology and reforms in administration. In 1999, the MII launched a major restructuring effort by splitting China Telecom into three state owned companies and reinvigorating China Unicom. The three companies emerging from China Telecom were: China Telecom (CT) for fixed-line business; China Mobile (CM) for mobile phone business; and China Satellite (CSAT) for satellite communications. Thus, China Mobile was separated from China Telecom and was in direct competition with China Unicom. Additionally, China Netcom emerged in 1999 with the backing of the Chinese Academy of Sciences to provide high speed Internet backbone capacity. Still, China Telecom continued to have a near monopoly on fixed services, by far the dominant form of subscription at the time.

In the third stage (2002-2007), two main competitors in the fixed phone service were introduced to the Chinese telecommunications industry. In 2002, China Telecom was split along regional lines. China Netcom and Jitong merged to form the China Netcom Communications Group Corporation to provide operations covering the northern 10 provinces. Operations in the twenty-one southern provinces retained the China Telecom name and operated as a separate entity. These two fixed line providers can enter each other's provinces to compete for fixed services. Railcom, which had been part of the Ministry of Railways, also began to provide fixed services in all provinces but obtained only a small market share. Finally, China Union offered some fixed phone service, but only in Tianjin, Chongqing, Sichuan and was able to garner only small market shares in these three provinces.

As the above indicates, from 1998 onward, the opportunities for competition changed significantly. The degree of competition differs across the thirty-one provinces as the different opportunities have evolved. There is considerable variation in the year that new companies established branches in the various provinces. For example, China Unicom started to operate its Beijing operations in 1994 and its Xinjiang operations in 1998, while Hainan operations were not set up until 2001. Consequently, our identification strategy exploits the variation in the pace of reform across provinces.

*Ownership Structure Reform*

Unlike most developing countries, privatization in China did not lead to companies being completely privately run. Instead, China sought foreign investment for the telecommunications sector through the listing equity shares in SOEs on public exchanges rather than through full

privatization or through introducing foreign private firms. The Chinese government has

repeatedly made statements that the telecommunications sector is one that entails sensitive

national security interests. In the incomplete institutional and the inefficient competition

environment, the government feared that a telecommunications sector controlled by private or

foreign companies could lead to reduced social welfare. Instead, the telecommunications sector

adopted partial privatization, in which some of the government's stake in an SOE is sold to

investors through a public share offering, rather than full privatization commonly using by other

developing countries (e.g., in Russia, Eastern Europe, Latin America, and South Africa). The

existing literature has focused more on the more common full privatizations rather than the

partial privatization we investigate here.

Inefficiencies in SOEs are often attributed to a lack of managerial autonomy, soft budget

constraints and severe agency-incentive problems (Groves et al., 1994; Qian, 1996; Qian and

Roland, 1996). The Chinese government consciously sought partial separation of the government

from management through partial privatization. In this way, private investors would have little

influence on key strategic decisions but managers' desires to attract capital could influence

managerial incentives. It was envisioned that, in order to secure private financing, more

opportunities, and job promotion, managers would focus more on efficiency rather than political

considerations.

In September 1997, China Telecom listed the two most profitable mobile branches in

Guangdong and Zhejiang on the Hong Kong and New York capital markets. By 2004, 23.5% of

the equity of these branches was privately owned while the remainder was still held by the state.

China Mobile was formally established in 1999 and subsequently had public listings for six

provincial branches. Operations in other provinces were also listed in the ensuing years. By

2004, all thirty-one provincial branches of China Mobile had been listed on capital markets in the Chinese mainland. In all, ownership by the public grew to 24.2% (China Telecom Annual Report, 1997-2008). Another mobile firm, China Unicom, listed 12 provincial branches on NYSE and HKSE in 2000. By 2005, 30 provincial branches had been listed and public investors owned 47.4% of shares in the company (China Unicom Annual Report, 2000-2005). In November 2002, the shares of China Telecom listed the four networks in Guangdong, Jiangsu, Shanghai, and Zhejiang on NYSE and HKSE, raising $1.5 billion. The last public listing company is China Netcom. In 2004, six provincial branches' shares were listed on the NYSE and HKSE. In 2005, all provincial branches of China Telecom and China Netcom went public with non-state-owned shares of 22.2% and 25.6% (CTAR 2000-2005 and CNAR 2004-2005). In this fashion, the privatization of SOEs in Chinese telecommunications sector proceeded on an "act after trial" process and from coastal to western provinces.

## III.    Conceptual Framework

This section generates the hypotheses as to the impacts of competition and ownership reform on service prices, subscription levels and usage of the mobile and fixed operators, which are then tested empirically in the next section.

*Hypotheses on Competition*

A wealth of studies finds that more competition usually leads firms to choose lower prices that generate increased output levels. In telecommunications, early studies focused on the US experience (Kahai, 1996; Kasserman et al, 1999; Ward, 1999). These invariably find more efficient markets from increased competition. Walsten, (2001) found that emerging competition

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in Africa and Latin America led to lower prices. Li and Xu's 2004 study of telecommunications sectors around the world found that increased competitive pressure contributed to substantial growth.

In the existing industrial organization literature, competition also plays a significant role in improving management and in stimulating market efficiency. Barry and Joseph (1983), Hart (1983) and Ros (1999) indicate that a competitive market allows the owners of a firm to more easily obtain information from which to infer managerial effort. This mechanism would lower information costs independently of whether the state or private firms owned the assets. In market economies, mangers face added incentives from better contracts and a more fluid market for managerial talent that will tend to improve firm performance. During the transition period, with relatively more government involvement, political factors greatly influenced incentives to promote and compensate labor in China. Therefore, the incentive of SOE mangers comes not only from economic incentives in better contracts, but also from the possibility of promotion to a administrative positions. In order to obtain preferred positions, with greater compensation, benefits, power, and prestige, the provincial telecommunications SOE managers formed political promotion championships under the pressure of competition. This sort of internal competition may lead to improved performance.

In addition, Hayek (1945), Alchian and Kessel (1962), Williamson (1963), Leibenstein (1966) and MacNamara (1992) indicate that competition was a mechanism for stimulating allocative, technical and internal efficiencies in the market. As a result, it is to be expected that competition will lead to higher labor productivity in Chinese telecommunications sector. Moreover, a portion of the lower costs may be passed through in the form of lower fixed and

mobile phone prices, or higher quality, thus increasing demand. These mechanisms suggest that competition will be correlated with telephone subscription levels. Therefore, we have:

**Hypothesis 1**: Competition reform (decreasing the industrial concentration) leads to lower prices for fixed and mobile telephone service.

**Hypothesis 2**: Competition reform (decreasing the industrial concentration) increases the quantity demanded for fixed and mobile telephone service.

*Hypothesis on Ownership Structure*

The form of ownership can have significant effects on manager behavior and firm performance because changes in property rights alter the incentive structures faced by decision-makers (North 1990; Levy and Spiller 1996). Stronger incentive structures in contracts for management induce changes in managerial behavior and, thus, improves company performance (Alchian, 1965; Niskanen, 1971; Sheilfer and Vishny, 1994; and Boycko et al , 1996). On the one hand, SOEs have weak property rights that could reduce management diligence and, thus, reduce productive performance. The SOEs are subject to soft budget constraints (Kornai, 1979, 1980) that directly influence efficiency through their effects on the expectations of SOEs' managers (Maskin and Xu, 2001). Therefore, the partial privatization telecommunications may have helped reduce the distortions arising from a soft budget constraint usually associated with state ownership and strengthen enterprises' incentives to minimize costs and increase productivity.

Privatization in developed countries, either completely or partially, will tend to turn a SOE into a privately-owned company. However, the ownership structural reforms for Chinese telecommunications SOEs were a process of Share Issue Privatization (SIP), using public listing as a way of divesting some of the government's ownership in SOEs (Megginson and Netter, 2001) while retaining ultimate governmental control. Some research has found that privatization leads to lower prices through the expansion of the network or improved labor productivity (Ros 1999, Li and Xu 2002, Fink et al. 2003). Other research has shown that privatization has a weak effect or is uncorrelated with industry performance (Gutierrez and Berg 2000, Bortolotti et al. 2002; Wallsten 2001, 2004). Moreover, Newberry (1991) noted that privatizing monopolies could be especially problematic. These conflicting results suggest that the results of privatization on industry performance are far from certain. Moreover, the form of privatization in Chinese telecommunications through partial SIP has been little studied. Therefore, we test:

**Hypothesis 3**: Ownership reform (Decreasing the share of state-owned equity) leads to lower prices for fixed lines and mobile operators.

**Hypothesis 4**: Ownership reform (Decreasing the share of state-owned equity) leads to greater subscription and usage demand for fixed lines and mobile telephones.

*Limitations*

Two market innovations over the period under investigation complicate the empirical analysis below. First, Voice over Internet Protocol (VOIP) became increasingly popular especially for international toll calls. While difficult to measure, by 2006, IP calls could possibly have accounted for half of all such calls (Wu, 2009, p. 124). Since these calls are largely

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unmonitored, most are likely not measured in our data. Second, fixed line operators without

mobile licenses introduced a wireless local loop option, called "the Little Smart," that allowed

for limited mobility within a city. These are counted as fixed lines in the data but are perhaps

more similar to mobile phones. This option made up about 10% of all subscriptions by 2006

(Wu, 2009, p130).

## IV.    Empirical Methodology

We address the effects of state-ownership and competition by examining their effects

with each of the fixed and mobile platforms separately. Specifically, we estimate the effects of

the percentage of state ownership share and the Herfindahl Index on multiple measures of prices

and output.

Our privatization hypotheses are that private ownership will be associated with more

efficient production and better incentives to pursue profit-maximization rather than some other

social objective. If so, higher values of the state-ownership percentage will be associated with

higher prices and lower quantities demanded. Similarly, our competition hypotheses are that, in

more competitive markets, firms cannot extract as great of profits from supra-competitive pricing

and must operate efficiently in order to remain viable. If so, higher values of our measure of

concentration, the Herfindahl Index, will be associated with higher prices and lower quantities

demanded.

We implement our tests be estimating parallel reduced-form price and quantity equations

for both the fixed and mobile telephone platforms. Specifically, for each platform, we estimate:

$$\ln P_{it} = \delta_i^P + \delta_t^P + \beta^P X_{it} + \gamma_1^P SOFrac_{it} + \gamma_2^P Herf_{it} + \varepsilon_{it}^P$$
$$\ln Q_{it} = \delta_i^Q + \delta_t^Q + \beta^Q X_{it} + \gamma_1^Q SOFrac_{it} + \gamma_2^Q Herf_{it} + \varepsilon_{it}^Q$$

(1)

where $\delta_i$ and $\delta_t$ are fixed province and year effects respectively, the $X_{it}$ represent time-varying provincial variables measuring income per capita and the fraction of the population living in urban areas, and $SOFrac_{it}$ and $Herf_{it}$ are our measures of state-ownership and concentration. Fixed province and year dummies are necessary because of profound differences in the level of development across provinces and to capture the robust rate of development over time. These two-way fixed effects imply that parameter identification is coming only from differences in within-province variation.

The parameters of interest are the $\gamma$'s, the coefficients of the State-Ownership fraction and Herfendahl Indexes. Hypothesis 1, indicates that $\gamma_2^P$, measuring the effect of industry concentration on prices, should be positive. Likewise, under hypothesis 2, $\gamma_2^Q$, measuring the effect of industry concentration on quantities, will be negative. Under hypothesis 3, $\gamma_1^P$, measuring the effect of state-ownership on prices, should be positive. Likewise, under hypothesis 4, $\gamma_1^Q$, measuring the effect of state-ownership on quantities, will be negative. Because state ownership and market concentration are likely to be co-determined along with these market outcomes, we treat them as endogenous and use as instrumental variables the values of *SOFrac* and *Herf* for fixed and mobile service from the five nearest provinces. Decision makers for one province may be determining the level of these variables based institutional settings similar to nearby provinces and on what they observe from experiences in nearby provinces. If so, the values of these variables from neighboring provinces would not affect prices and output directly but only through how they affect their counterpart variables in this province.

## V.    Data

Equations (1) are empirically estimated using panel data for 31 provinces in China over the period from 1998 to 2007. We have collected a balanced panel of 310 province-year sample observations from three primary sources. Firstly, the macroeconomic data comes from the National Bureau of Statistics of China. Secondly, the industry data are from the Ministry of Information Industry of China (MII). Thirdly, the firm specific data were gathered from each firm's annual reports. Table 1 reports summary statistics for the variables used here in levels and in their natural logarithms.

The National Bureau of Statistics of China provides a number of province level variables measuring investments, education, income, urbanization and so on. Most of these variables either differ substantially across provinces or differ substantially over time but usually not both. Thus, for most variables, their effects would likely be captured by our fixed province and year dummies. Some do represent meaningful time-variation across provinces over this time period. However, much of this variation is not likely to substantially affect the telecommunications sector. Because of our limited data sample size, we have settled on just three measures to include in our analysis: GDP per capita, population and the percent of the population living in urban areas.[1] The meteoric growth of the Chinese economy has not been evenly distributed across all regions and could affect subscription and usage decisions. Likewise, while China is rapidly becoming a more urban country, there has been a general migration from the western countryside to the eastern cities implying that there are substantial differences in the rate of urbanization across regions. Changes in urbanization could affect both the demand for communication as well

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[1] Eight values of the urbanization variable had to be interpolated to keep from dropping observations.

as the costs of provision.

The industry data that we use include revenues, subscribers, and minutes of use for both fixed and mobile service in each of the 31 provinces over the ten year period. We use these to construct or price measures Average Revenue per User (ARPU) as revenue divided by subscribers and Average Revenue per Minute (ARPM) as revenue divided by the volume of minutes. Figures 2 and 3, depicting the averages across provinces, indicate how these measures have evolved over time. While there has been substantial growth in both subscribers and calling volumes, mobile service overtook fixed service sometime around 2003. There is some decline in fixed service price measures, both ARPU and ARPM, but there has been a considerably greater decline for the mobile measures. The mobile price measures fell to one-half to one-third their initial values. Again, the mobile price measures appear to have matched those for fixed service around 2003.

Telecommunications firms' annual reports provide information by province on sales and the shares held privately and those held by the state. We use this information to construct our concentration and state-ownership percentage measures. The changes in the averages of these measures over time are depicted in figure 4. Note that while both measures decline over the sample, they decline more for mobile service than for fixed service. Finally, we use our knowledge of China's geography to identify the five nearest neighboring provinces for each province as indicated in Table 2. This is used to construct our instrumental variables, the average Herfindahl Index and state-ownership fraction for both fixed and mobile service over these five provinces in that year.

**VI.    Results**

Table 3 reports regression results of estimating equations (1) for the mobile platform for both subscription and usage. These estimates are from a Two Staged Least Squares (2SLS) panel estimator. Neighboring province fixed and mobile concentration and state-ownership measures are used as instrumental variables. Since the model is over-identified, the Sargon statistic of over-identification of the instrumental variables can be calculated. In all cases, we cannot reject the null of valid instruments at confidence levels of less than 10%. Observations are weighted by the province population and calculated standard errors are robust to heteroskedasticity.

Table 3 describes our results for mobile telephone operators and provides some support for our hypotheses. For both subscription and usage, a higher Herfindahl Index is associated with significantly higher prices as measured by both ARPU and ARPM (hypothesis 1). Likewise, a higher Herfindahl Index is associated with lower quantities as measured by the subscription rate and the minutes used (hypothesis 2). These results are consistent with the competition theory. That the effects on price and quantity are in opposite directions suggests that our estimator is identifying movement along a demand curve and not just changes in demand. We view this as evidence that increasing competition in mobile telecommunications is fundamental mechanism for improving market performance.

In table 3, state-ownership is associated with increases in ARPU (hypothesis 3) and decreases in subscriptions (hypothesis 4) but neither effect is significantly different from zero. The same pattern emerges for ARPM and usage, however, this time these effects are estimated to be significantly different from zero at the 5% confidence level. This result indicates that the SIPs may improve the mobile telecommunications' performance. There are a few possible explanations for this result. First, although the Chinese state remains the dominant shareholder in Chinese telecommunications carriers with private shareholdings limited to "merely portfolio

investment" (Roseman, 2005), the general principles of the capital market, especially the stock

market score board as an indicator of industrial performance, plays a significant role in shaping

the priorities of China's mobile telecommunications development (DeWoskin, 2001). Secondly,

SIPs must satisfy capital markets' concerns for the separation of government administrative

management from enterprises' operation and management. Therefore, SOEs will be

"corporatized" to be managed in a commercially viable manner. The "corporatization" of

telecommunication SOEs also improves mobile telecommunications' efficiency. Finally, the

SIPs' private equity market offerings raised a large amount of money, which accelerated

development of mobile telecommunications.

Table 4, reproducing the above for fixed line service, presents much more ambiguous

results. State ownership is estimated to *reduce* fixed service price measures and the effect is

significant for ARPU. Likewise, state ownership is estimated to significantly *increase* fixed call

volume. This might be consistent with pursuing a universal service goal by subsidizing prices

and raising prices only under profit pressure from private equity partners as in many developed

counties. However, there is little evidence that this was the case in China.[2] From 1978-1995, the

telecommunications adopt a high pricing paradigm. Early subscribers subsidized the build out of

infrastructure by paying extraordinarily high fees. Since 1997, with repeated market demand for

better services and lower rates, the MII slashed service fees and reformed the structure of the

telecommunications industry. Before listing fixed telecommunications carriers on equity

markets, the government greatly reduced fixed telephone fees. The results for concentration,

indicating that concentration *increases* telephone subscriptions is also contrary to our hypothesis

but consistent with our hypothesis, concentration appears to *decrease* telephone usage. The

concentration effects on the fixed service price measures are consistent with our hypothesis but

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[2] We are grateful to an anonymous referee for pointing this out.

are not significant.

The coefficient estimates suggest large effects from liberalization and privatization, at least for mobile services. A one standard deviation decrease in the mobile Herfindahl Index (0.155) is associated with a mobile price decrease of more than 50% and a two-fold increase in subscribership or four-fold increase in calling volume. Because the implicit demand elasticity is thus between -0.8 and -1.8, this would lead to a reduction in deadweight loss due to imperfect competition of 12-35% of revenue. Similarly, a one standard deviation reduction in the state-ownership fraction (0.129) is associated with a reduction in mobile ARPM of up to 17%. Under the assumptions of the constant elasticity of demand implicit in our empirical specification, this magnitude of a price change would result from an 8% reduction in marginal costs, possibly the result of better oversight of management decisions due to non-state owners. While the magnitudes of these welfare gains are large for mobile telephone providers, there do not appear to be similar effects in the fixed line telephone segment.

## VII.    Conclusion

The Chinese experience with telecommunications has many features that make it an interesting candidate for study. While the institutions within this setting may not generalize to other settings, the sheer size of this market makes it difficult to ignore. The pace of economic growth implies that many of the changes are compressed in time relative to less dynamic economies. Thus, it is possible to observe larger adjustments to market characteristics within a technology's viable lifespan. The reforms appear to have been consistently applied and their implementation can be measured using simple measures, here the Herfindahl Index and percent state-ownership.

Our empirical examination of Chinese telecommunications performance, with some discrepancies, does depict a general picture of how these telecommunications markets have evolved. First, mobile service has become the dominant platform for service. Over our sample, mobile calling volume went from less than half to almost three times that of fixed service. Second, growing income levels contributed to this shift. Higher income is estimated to be associated with increased demand for mobile service and decreased demand for fixed service. Third, a significant portion of the mobile price reductions are due to greater within mobile platform competition. Fourth, there is some evidence that the movement toward private versus state ownership also contributed to this transition. Privatization is associated with lower mobile usage prices and higher usage levels. However, it is associated with higher fixed prices and reduced fixed demand.

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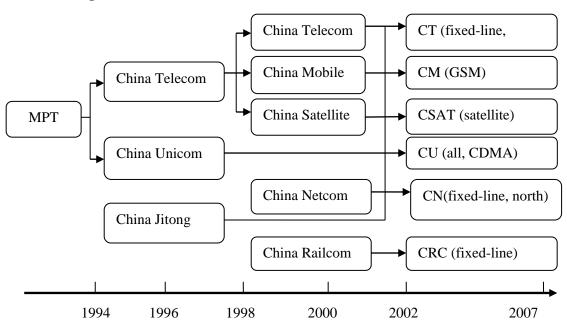
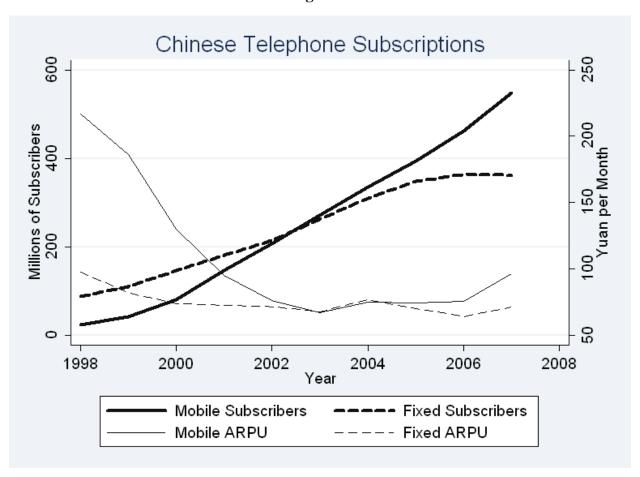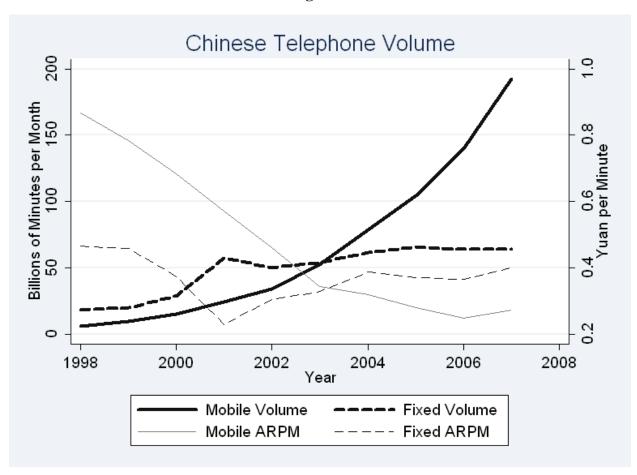**Figure 1**. 1994-2005 liberalization of the Telecommunications Sector in China
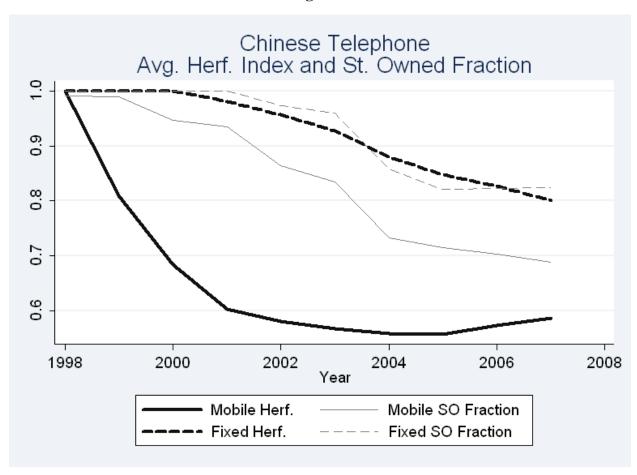
**Figure 2**



Chinese Telephone Subscriptions

**Figure 3**



Chinese Telephone Volume

**Figure 4**



Chinese Telephone
Avg. Herf. Index and St. Owned Fraction

**Table 1.** Summary Statistics

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| Fixed ARPM (Yuan/Minute) | 0.381 | 0.097 | 0.171 | 0.787 |
| Fixed Monthly ARPU (Yuan/Year) | 943 | 362 | 482 | 2,884 |
| Fixed Subs/100 Popul. | 7.686 | 6.870 | 0.059 | 37.431 |
| Fixed Monthly Minutes (Billions) | 18.709 | 18.915 | 0.199 | 121.883 |
| Fixed Herfendahl Index | 0.920 | 0.090 | 0.574 | 1.000 |
| Fixed State Owned Fraction | 0.930 | 0.086 | 0.747 | 1.000 |
| Mobile ARPM (Yuan/Minute) | 0.475 | 0.253 | 0.164 | 1.861 |
| Mobile ARPU (Yuan/Year) | 1,259 | 644 | 557 | 4,804 |
| Mobile Subs/100 Popul | 8.077 | 10.159 | 0.012 | 78.421 |
| Mobile Minutes (Billions) | 25.447 | 36.590 | 0.053 | 308.200 |
| Mobile Herfendahl Index | 0.658 | 0.155 | 0.500 | 1.000 |
| Mobile State Owned Fraction | 0.851 | 0.129 | 0.661 | 1.000 |
| GDP per capita | 4,909 | 3,289 | 1,611 | 19,650 |
| Urban Share | 0.428 | 0.167 | 0.179 | 0.989 |
| Ln Fixed ARPM | -0.997 | -0.256 | 1.766 | -0.240 |
| Ln Fixed ARPU | 6.794 | 0.314 | 6.177 | 7.967 |
| Ln Fixed Subs/Popul | 1.582 | -1.117 | 2.830 | 3.622 |
| Ln Fixed Minutes | 2.465 | -1.079 | 1.613 | 4.803 |
| Ln Mobile ARPM | -0.874 | -0.508 | 1.810 | 0.621 |
| Ln Mobile ARPU | 7.040 | 0.420 | 6.322 | 8.477 |
| Ln Mobile Subs/Popul | 1.307 | -1.486 | 4.465 | 4.362 |
| Ln Mobile Minutes | 2.313 | -1.574 | 2.947 | 5.731 |
| Ln GDP per capita | 8.352 | 0.502 | 7.385 | 9.886 |
| Ln Urban Share | -0.915 | 0.36 | -1.722 | -0.011 |

Summary statistics for 31 provinces from 1998 through 2007.

**Table 2.** The 5 nearest provinces from one province

| Province | The 5 nearest provinces | | | | |
|---|---|---|---|---|---|
| Beijing | Tianjin | Liaoning | Shanghai | Jiangsu | Shandong |
| Tianjin | Beijing | Liaoning | Shanghai | Jiangsu | Shandong |
| Hebei | Shanxi | Henan | Jilin | Heilongjiang | Hubei |
| Shanxi | Hebei | Henan | Jilin | Heilongjiang | Hubei |
| Inner | Shaanxi | Xinjiang | Gansu | Ningxia | Sichuan |
| Liaoning | Beijing | Tianjin | Shandong | Jiangsu | Shanghai |
| Jilin | Heilongjiang | Hebei | Shanxi | Henan | Anhui |
| Heilongjiang | Jilin | Hebei | Henan | Shanxi | Anhui |
| Shanghai | Jiangsu | Zhejiang | Shandong | Fujian | Guangdong |
| Jiangsu | Shandong | Zhejiang | Shanghai | Fujian | Tianjin |
| Zhejiang | Shanghai | Fujian | Jiangsu | Guangdong | Shandong |
| Anhui | Jiangxi | Hebei | Henan | Hunan | Hubei |
| Fujian | Guangdong | Zhejiang | Jiangsu | Shanghai | Hainan |
| Jiangxi | Anhui | Henan | Hubei | Hunan | Hebei |
| Shandong | Beijing | Jiangsu | Tianjin | Liaoning | Shanghai |
| Henan | Hebei | Shanxi | Hubei | Anhui | Hunan |
| Hubei | Hunan | Anhui | Jiangxi | Shanxi | Henan |
| Hunan | Hubei | Henan | Anhui | Jiangxi | Hebei |
| Guangdong | Fujian | Zhejiang | Shanghai | Jiangsu | Hainan |
| Guangxi | Sichuan | Chongqing | Yunnan | Guizhou | Tibet |
| Hainan | Guangdong | Zhejiang | Jiangsu | Fujian | Shanghai |
| Chongqing | Sichuan | Yunnan | Gansu | Guizhou | Shaanxi |
| Sichuan | Chongqing | Guizhou | Shaanxi | Yunnan | Gansu |
| Guizhou | Sichuan | Yunnan | Guangxi | Qinghai | Chongqing |
| Yunnan | Guangxi | Guizhou | Sichuan | Tibet | Chongqing |
| Tibet | Sichuan | Qinghai | Xinjiang | Yunnan | Gansu |
| Shaanxi | Gansu | Ningxia | Chongqing | Inner | Sichuan |
| Gansu | Shaanxi | Ningxia | Qinghai | Sichuan | Inner |
| Qinghai | Gansu | Ningxia | Sichuan | Tibet | Xinjiang |
| Ningxia | Inner | Qinghai | Xinjiang | Gansu | Shaanxi |
| Xinjiang | Tibet | Qinghai | Ningxia | Inner | Gansu |

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**Table 3.** IV Estimates of the Effect of Herfindahl Index and

State-Ownership on Chinese Mobile Telephone Prices and Output

| | Subscription | | Usage | |
|---|---|---|---|---|
| | Ln ARPU | Ln Subs/Pop | Ln ARPM | Ln Minutes |
| Mobile Percent State-Owned | 0.261 | -0.597 | 1.450 | -1.873 |
| | (0.763) | (0.438) | (0.619)* | (0.863)* |
| Mobile Herfindahl Index | 5.384 | -4.759 | 5.624 | -10.164 |
| | (2.547)* | (1.913)* | (1.997)** | (3.565)** |
| Ln GDP per capita | -0.681 | 0.389 | -0.120 | 0.966 |
| | (0.292)* | (0.389) | (0.277) | (0.567)+ |
| Ln Percent Urbanized | -0.149 | 0.051 | -0.298 | 0.381 |
| | (0.114) | (0.113) | (0.140)* | (0.194)* |
| R Squared | 0.547 | 0.668 | 0.645 | 0.905 |

Fixed effects for year and province are included but not reported. Robust standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%

**Table 4.** IV Estimates of the Effect of Herfindahl Index and

State-Ownership on Chinese Fixed Telephone Prices and Output

| | Subscription | | Usage | |
|---|---|---|---|---|
| | Ln ARPU | Ln Subs/Pop | Ln ARPM | Ln Minutes |
| Fixed Percent State-Owned | -2.370 | -0.459 | -2.585 | 1.604 |
| | (0.842)** | (0.714) | (1.753) | (0.701)* |
| Fixed Herfindahl Index | 2.942 | 3.538 | 6.060 | -2.985 |
| | (2.091) | (1.736)* | (5.251) | (1.779)+ |
| Ln GDP per capita | -0.041 | -0.642 | -0.152 | 0.100 |
| | (0.237) | (0.186)** | (0.355) | (0.172) |
| Ln Percent Urbanized | -0.045 | 0.112 | 0.171 | 0.020 |
| | (0.076) | (0.080) | (0.156) | (0.072) |
| R Squared | 0.317 | 0.187 | 0.681 | 0.791 |

Fixed effects for year and province are included but not reported. Robust standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%