

**Assessing the Significance of  
Telecommunication Deregulation  
on the Growth of Japan's Mobile  
Phone Market**

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Working Paper No. 6  
January 2001

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## **ABSTRACT**

This paper analyzes the development of Japan's mobile phone market. Specifically, it focuses on the regulatory reforms of Japan's mobile communication sector and their impact on the growth of the market. The analysis based on a monopolistic competition model shows that the deregulation policies perform an essential role in fostering the rapid expansion of Japan's mobile phone market. Using quarterly data from 1991 to 1999, the paper tests the significance of the telecommunication deregulation on both the price and the demand of mobile phone services. The empirical results suggest that the significant price declination and the rapid growth of mobile phone market in the last decade were largely attributed to the regulatory reforms, which abolished the entry barriers, phased out the mobile phone rental system, and simplified the mobile communication rate setting procedure. In addition, the demand curve of mobile phone service was estimated. The estimated demand function indicates that the demand for mobile phone service is highly price elastic. The price elasticity was as high as 6.4 and decreased to 2.1 by 1999 as the market became saturated.

## 1. Introduction

Telecommunications had been a highly regulated industry in many countries. The nature of increasing return to scale associated with telecommunications granted legitimate excuses for governments to accommodate monopolistic status of the industry through various regulations. Inappropriate regulations, however, can impose substantial costs and inefficiencies on firms, sectors, and the economy as a whole. These costs can arise from inefficient allocation of resources, excess rents accruing to capital/labor, little incentive for technological innovations (Blondal and Pilat, 1997). Hausman, et al, (1997) estimated that the lengthy regulatory delay on the introduction of cellular services by the Federal Communication Commission would cost American consumers \$50 billion per year. On the other hand, as the regulations were abolished, market forces and competition would result in low costs, shrinking monopolistic rents, technological innovation, high productivity, and market expansion, benefiting the economy as a whole. For instance, the breakup of AT&T in 1984 generated billions of dollars of economic efficiency gains annually for the U.S. economy (Hausman, Tardiff, and Belinfante, 1993). Recognizing the importance of competition for the development of telecommunications and the inefficiency of the state-monopoly, many industrialized countries moved forward to liberalize their telecommunication market in the early 1980s (Waverman and Sirel 1997, Spiller and Cardilli 1997). Being troubled by low efficiency and rising debts of state-owned enterprises, the Japanese government followed the same fashion, starting to liberalize its telecommunication market in 1985 by privatizing NTT and opening all segments of its telecommunication market to competition. The overall progress of the telecommunication deregulation has been slow. After a long time political debate, NTT, the domestic telecommunication monopoly, was finally broken into two holding companies: NTT East and NTT West in 1999. The liberalization of Japan's mobile phone market, nonetheless, has proceeded far ahead of the liberalization in conventional domestic and international services. As the entry barriers were abolished, many new common carriers (NCC) entered the mobile communication market subsequently. By the end of 1999, there exist 30 mobile phones carriers in operation, among which 21 belong to NCC and the rest nine carriers are regional operators of NTTDoCoMo. The competition in Japan's mobile phone market is the fiercest in the world. The intensified competition has been driving the price of mobile

phone service down significantly. Offering free mobile phones to new customers has evolved as a common marketing strategy employed by carriers to lure new subscribers. Additionally, the competition greatly stimulates technological innovation in mobile phones. Low price and multi-functionality of mobile phones attract more and more users. By the end of March 2000, there were about 51 millions mobile phone subscribers in Japan (TCA, 2000), implying that there were 41 mobile phone subscribers for every one hundred Japanese residents. Besides the exponential growth of mobile phone subscribers, the revenue of mobile communication sector also grew remarkably. Though mobile phone service is relatively new compared with conventional fixed phone services, its total revenue, however, accounted for more than 36 percent of whole telecommunication industry's revenue in 1998 (TCA, 2000). Mobile communication sector has been a shining spot of the sluggish Japanese economy.

The purpose of this paper is to identify major factors driving enormous growth of Japan's mobile phone market. In order to achieve the objective, it primarily concentrates on the liberalization process of Japan's mobile phone market, examining to what extent deregulation policies have contributed to the remarkable growth. Moreover, the paper attempts to estimate the demand curve of mobile phone services, analyzing the sensitivity of mobile phone demand to prices. As both fiscal and monetary policies failed to pull Japanese economy out of the long lasting recession, the Japanese government has been seriously engaging in liberalizations on its tightly regulated sectors, particularly telecommunication and financial markets. It is expected that the deregulation policies would revitalize Japanese economy through intensified competition and structure changes. Empirical studies on the achievement of Japan's mobile phone market and the importance of deregulation policies would provide valuable information for assessing the success of these policies.

## **2. Changing Policy Environment**

The Deregulation of Japan's mobile communication market started with the liberalization of Japan's telecommunication market in 1985. According to the major achievements of the regulatory reforms, we can divide the deregulation process into two phases. The first ranged from 1985 to 1994. In the first phase, breaking the monopoly of NTT and opening the mobile phone market to new carriers was the main theme of the process. The second phase started in 1994. Abolishing mobile phone

leasing system and liberalizing mobile communication call rates dominated the agenda of the second phase.

The history of Japan's mobile phone market can be traced back to car phone services, which started in 1979. Due to limited service areas and the size of terminal units, the market expanded relatively slowly. By 1985, there were merely 40,000 subscribers. Regulation restricting new entries into the market also hindered the growth of the mobile phone market. From the beginning of mobile phone service, NTT was the only designated provider. It had monopolized the market until 1987. Because of the bureaucratic management of NTT, the absence of competition in Japan's telecommunication market, as well as the concern over rising government debt, the Japanese government was determined to liberalize its telecommunication market in 1985. The telecommunication liberalization initially focused on privatizing NTT and allowing new companies to enter telecommunication markets. "Telecommunication Business Law" and "NTT Private Corporate" were ratified to regulate the deregulation process. The first one governs the market liberalization, specifying the conditions for offering telecommunication services and authoring the Ministry of Post and Telecommunication (MPT) to regulate the new entries of telecommunication carriers. The second one governs how NTT should be privatized (Sato and Steven, 1989). As a consequence, the mobile communication market was liberalized in 1986. NCCs have been granted permissions to enter the mobile phone market where incumbent NTT had been dominant. IDO, a joint-venture of TOYOTA Co, TEPCO and Teleway Japan Co. is the first NCC entering Japan's mobile phone market. It launched mobile phone service in 1988. In the following year, another NCC, DDI Cellular Group entered the market and started to provide mobile phone services. To further facilitate the competition in Japan's mobile phone market, NTT spin off its mobile phone sector from its main business, establishing NTTDoCoMo in 1992. The separation is also part of the telecommunication deregulation plan. NTT DoCoMo was then divided into 9 regional companies in the subsequent year. By 1993, there were 15 NCCs serving in mobile communication market. Their total sales reached 220.9 billion Yen, 36 percent of total mobile phone market (JETRO, 1998)

In 1994, Japan's mobile phone market entered a new era when Customer Owned and Maintained (COAM) system was introduced. COAM system replaced mobile phone leasing system, under which Japanese consumers could not purchase mobile phones but rent them from service carriers. The adoption of COAM system

significantly reduced the threshold for Japanese consumers accessing mobile phone services. Under the leasing system, subscribers had to pay a lump sum deposit (e.g. 100,000Yen for customers of NTT DoCoMo), and a hefty monthly rental fee, which could be as high as 15,000 Yen. The adoption of COAM system automatically abolished the deposit and rental charges. Consequently, the initial investment for accessing mobile phone service decreased sharply. By purchasing phone sets, Japanese consumers are able to avoid expensive monthly charges. Moreover, COAM system stimulates not only the demand for mobile phone services but also the demand for mobile phone sets. The rising demand motivates Japanese manufacturers to innovate on their technology and to produce mobile phones that are attractive to consumers. As a result, small, light, long battery life, and low-priced mobile phones have dominated Japan's mobile phone market. Two more carriers, Digital Phone Group and Tu-Ka Group, entered the mobile phone market in the same year. The entrance of Digital Phone Group signal the beginning of digital mobile phones, which provide better voice quality and privacy protection than analog cellular phones.

Facing rapid technology progresses and intensified competition triggered by new entries, Japanese mobile phone carriers feel the need to have more flexibility and freedom on determining mobile communication rates so as to compete with their rivals. However, Mobile communication rates were regulated by "Telecommunication Business Law." The law required that all Japanese type I carriers (the carriers which install telecommunication lines facilities on their own to provide telecommunication services) should calculate call rates based on "full cost principles." The "full cost" consists of operating costs, depreciation, taxes, profit margin, etc. For any rate changes, type I carriers should obtain approvals from MPT, which would examine whether proposed new rates were based on the "full cost principle" and their fairness to consumers. The rate setting mechanism outlined by the law undoubtedly complicates the calculation process and discourages the efficiency improvement in telecommunication service sector. Under the "full cost principles", telecommunication providers lacked of incentives to reduce costs because all costs would be covered by call rates. In addition, it took long waiting period to obtain the approval for new call rates due to complicated calculation and bureaucratic procedures. Therefore, further liberalization was needed to facilitate price competition. In December 1996, the requirement for the authorization of MPT regarding to mobile communication rate changes was abolished and replaced with

prior notification system. The change substantially enhances the freedom and flexibility of mobile carriers in determining their call rates. Mobile phone carriers have reduced their charges frequently since then. For instance, from 1996 to 1997, in just one year, NTTDoCoMo cut its three minutes call charges four times. The rate was reduced to 100 Yen from 190, representing a 47 percent reduction (TCA, 1998). The adoption of the prior notification system for rate setting greatly intensifies the competition in mobile phone market. Reducing call rates and providing cheap service packages have become the primary strategy of mobile communication carriers competing for new subscribers.

### **3. The Dynamic Growth**

The events outlined above represent major components of the deregulation in Japan's mobile phone market. The favorable environment cultivated by the liberalization has unambiguously boosted the remarkable growth of Japan's mobile phone market. The rapid expansion of Japan's mobile phone market can be characterized by rising new entries, drastic price reduction, and exponential growth of subscribers. As entry barriers are gradually removed, more and more new players jumped into the mobile communication market. The number of new carriers surged significantly. By the end of 1999, there were 21 NCCs providing mobile communication service. It is an astonishing progress compared with the status before 1988 when there was only one provider, NTT. Measured by their revenues, the market share of NCC expanded substantially. They gained 41 percent of mobile communication market while NTT DoCoMo share shrank to 59 percent in 1997. The dominance of NTT DoCoMo mitigated significantly and the market concentration ratio dwindled. The rising number of carriers has transferred Japan's mobile communication market one of the most competitive telecommunication markets in the world. The new entries not only terminated the monopoly of NTT but also promoted the competition, which has been driving the robust growth of the sector. From 1990 to 1997, the total revenue of the mobile communication sector had sustained almost 50 percent annual growth rate, much higher than the overall growth rate of Japan's telecommunication sector, 8.9 percent. The total revenue of mobile phone service rose to 3.3 trillion Japanese Yen in 1997, more than 13 times higher than in 1990 (see table 1).

**Table 1. Revenue and Growth Rate: 1990-1997**

	1990	1991	1992	1993	1994	1995	1996	1997
Mobile Phone Revenue (Billion Yen)	246.9	339.7	466.5	608.0	873.2	1,418.7	2,355.4	3,267.9
Growth Rate in Mobile Sector (%)	82	38	37	30	44	62	66	39
Growth Rate in Type I Carriers (%)	6.6	4.7	4.9	6.0	7.4	12.5	15.0	13.9

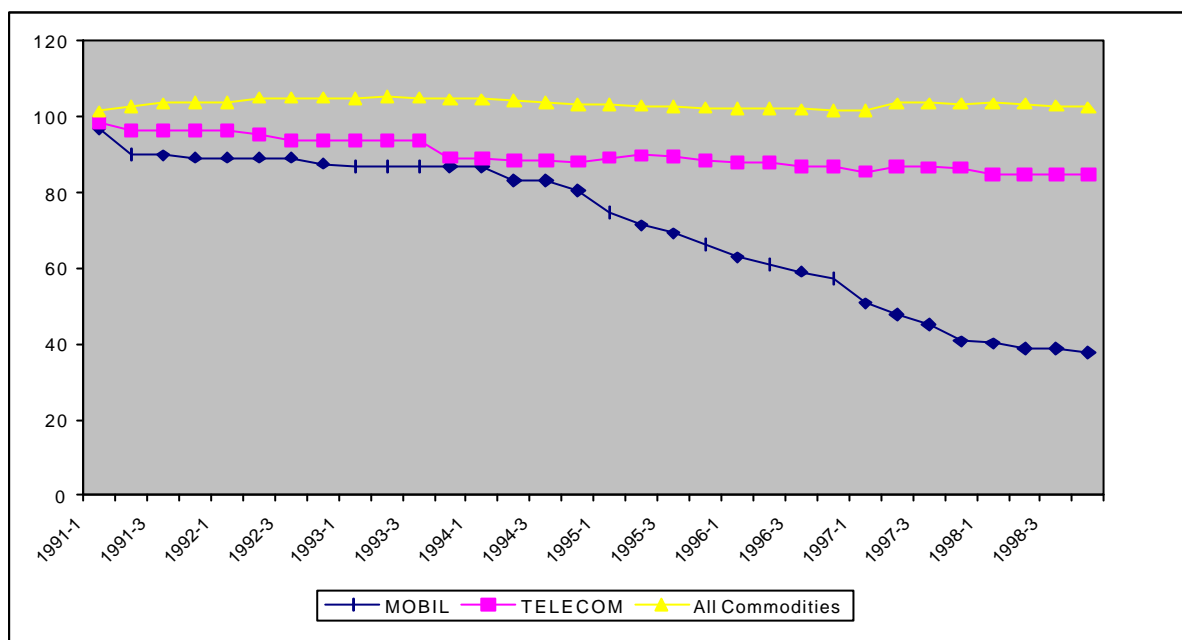
Source: Statistics of Ministry of Post and Telecommunication in 1999

The intensified competition fostered by the deregulation effectively squeezes abnormal profits of mobile communication carriers, and compels them to improve their efficiency by cutting costs. The sharp declining price of mobile phone service in the last ten years is the direct consequence of competition and efficiency improvement. In Japan, mobile phone service charges usually consist of three basic fees: subscription fee, basic monthly fee, and call charge. The deregulation, especially the implementation of COMA system and the adoption of the prior notification system for call rates, has created a favorable environment for the reduction of mobile telecommunication service fees. To compete with NTT DoCoMo and to attract more subscribers, NCCs gradually lowered their basic monthly fees to 4,600 Yen in 1998 from 8,500 Yen in 1994 (TCA, 1999). The call rates were also cut substantially. For instance, by the end of 1999, NTT DoCoMo had reduced the charge of a three-minutes to 80 Yen, only one third of the call charge in 1991. The most notable change is the elimination of subscription fees. In 1997 all carriers abolished subscription fee, a one-time charge for initiating mobile phone service and handling applications. The subscription fee used to be 8,400 Yen in 1995 for NTT DoCoMo customers (MPT, 2000). The elimination of subscriber fees simplified mobile telecommunication fee structure and trimmed down the cost of mobile phone services to a large extent. Illustrating the declining trend of mobile communication costs, we depicted quarterly price index of mobile phone service, along with the price index of all telecommunication services and the price index of all commodities in figure 3.1 for the period of 1991 to 1998. While the general price had been flat during the period because of the sluggish Japanese economy, the mobile phone service price index showed an unequivocal downward trend. It dropped to 37.7 in the last quarter of 1998, more than 60 percent lower than that of 1990. The decrease, nonetheless, was not evenly distributed during the period. Before 1994, the price index only fell 20 percent. More than 50 percent reduction occurred after 1994. Unambiguously, the significant



reduction in mobile communication costs should be credited to the introduction of COAM system and the prior notification for call rate setting.

**Figure 1. The Quarterly Price Indexes of Mobile Phone Service, Telecommunications, and all Commodities (1990=100)**



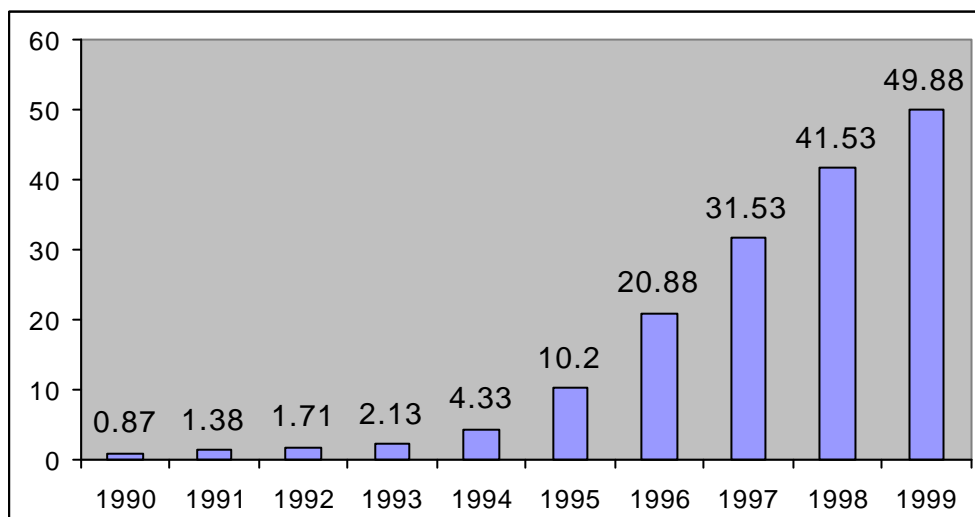
Source: Bank of Japan, The Monthly Report of Price Indexes (various issues).

Like deregulation in any sectors, Japanese consumers are big winners of the deregulation. The growing supply associated with declining prices makes mobile phone service affordable for more and more Japanese consumers. The number of mobile phone subscribers has experienced an exponential growth since 1990. By 1994, the number of subscribers surged to 4.33 millions, more than 500 percent higher than in 1990. During the period of 1993 to 1996, the number of subscribers almost doubled every year. By the end of 1999, there were almost 50 millions subscribers (see Figure 2).

It would be biased if we exclusively credited the flourish of Japan's mobile phone market to deregulation policies. Undoubtedly, technology innovations in mobile telecommunication accelerate the market expansion too. NTT DoCoMo started its digital service for cellular phones in 1993. In the subsequent year, Digital Group, the first NCC providing digital cellular phone, also launched digital service for mobile communications. The availability of digital cellular phones enhances the speed and capacity of cellular phone handling data transmission, thus making possible for fax and internet services. The technology superiority of digital cellular phones

expands mobile communication beyond its conventional voice service and increases features of cellular phones. Multiple function phones attract more and more consumers. By the end of 1999, the transformation from analog to digital cellular phones almost completed while less than one percent of mobile phone subscribers used digital cellular phones in 1994. Unambiguously, advances in technology and price reduction have generated a positive feedback cycle, which has allowed the production of cheaper, smaller, and multifunction handsets, these have been well received by consumers, whose demand is at the same time are enormously increasing. The evolution from analog to digital cellular phone has stimulated the growth of Japan's mobile phone market and transferred mobile communication to a necessity from a luxury commodity.

**Figure 2. The Number of Mobile Phone Subscribers**



Source: Association of Telecommunication, Annual Statistics 2000.

In summary, the telecommunication deregulation combined with the technological progress in mobile communications pro-competition policy have cultivated the exponential growth of Japan's mobile phone market in the last decade. These factors together have been driving the growth of the market. As a positive feedback, the rising demand further strengthens the competition and boots technology innovation. Due to the difficulty of measuring the technological advance in mobile phones, this study solely focus on the contribution of the deregulation to the growth of Japan's mobile phone market. In the next section, we will employ a monopolistic model to illustrate the role of the telecommunication liberalization in the process of the market expansion.

#### 4. A Model of Mobile Phone Demand under Monopolistic Competition

Currently there are 30 mobile phone carriers operating in Japan's mobile market. Technically speaking, the services offered by all carriers are highly substitutable for one another. If a carrier raises its service charge, its customers will switch to other operators. Moreover, the major regulatory reform in 1986 abolished entry barriers and made it easy to enter and exit the market. Hence, the market is highly competitive. To cope with the intensified competition, mobile phone operators often differentiate their offers by features of mobile phone sets, choices of services, etc. Mobile phone services offered by different carriers are not identical as in perfectly competitive market. Therefore, Japan's mobile phone market can be classified as a market with monopolistic competition.

Suppose that the whole mobile phone sector faces the demand

$$D_t = D(P_t) \quad (1)$$

where  $P_t$  indicates the average price charged by all mobile phone carriers, and  $D_t$  denotes the corresponding demand for mobile phone services at the given price. The demand is measured in terms of the number of mobile phone subscribers. As for each individual mobile phone carrier, the demand for its service is stipulated as

$$Q_{it} = D_t \{1/n_t - \alpha(P_{it} - \bar{P}_t)\} \quad (2)$$

where  $Q_{it}$  is the number of subscribers contracted by a typical mobile phone carrier,  $n_t$  represents the number of mobile phone carriers,  $P_{it}$  measures the price charged by the carrier itself, and  $\alpha$  is a constant measuring the sensitivity of the market demand to its price.  $\bar{P}_t$  indicates the average price charged by its competitors. The individual demand function suggests that all carriers would have same market share  $D_t/n_t$  if they charge the same prices. A mobile phone carrier charging more than the average of other firms would end up with a smaller market share, charging less a larger share. The demand function can be derived from the utility function in Salop's (1979) study about monopolistic competition.

In the monopolistic competition, mobile phone carriers are assumed to take each others' prices as given. In other words, each carrier ignores the possibility of

that if it changes its prices other carriers will also change theirs. If each carrier treats price  $P_t$  as given, the marginal revenue of a typical carrier can be derived as

$$MR_{it} = P_t - Q_{it} / (aD_t) \quad (3)$$

Now, we turn to define cost curves of the mobile phone carriers. It is well known that fixed costs for setting up telecommunication network account for major part of total costs. The industry generally shows increasing return to scale. Their average cost decreases as more customers served. Therefore, the cost function of a typical carrier is defined as

$$C_{it} = F + Q_{it}c_{it} \quad (4)$$

where  $F$  denotes fixed cost and  $c_{it}$  indicates marginal cost. The marginal cost is assumed being independent of  $Q_{it}$ , the number of subscribers, but maybe varying over time. The rational for time-varying marginal cost is that technological progresses and policy changes would affect the marginal cost. For instance, the price of mobile phone sets has declined sharply because of technology innovation, reducing the cost of mobile phone users substantially. With the introduction of COAM system in 1994, monthly rental fees and hefty deposits charged by mobile phone carriers were abolished completely. The reform unambiguously reduced the marginal cost of subscribing mobile phone services. Regard to the cost function and the demand function, it is straightforward to derive the price charged by a typical mobile phone carrier. Profit-maximizing carriers will set marginal revenue equal to their marginal cost. That is

$$MR_{it} = P_t - Q_{it} / (aD_t) = c_{it} \quad (5)$$

If all carriers charge the same prices  $P_t$ , each will contract  $Q_t = D_t/n_t$  mobile phone subscribers. Substituting this into equation (5) and rearranging the equation yield

$$P_t = c_t + 1/(an_t) \quad (6)$$

Equation (6) indicates that the price charged by an individual carrier depends on its marginal cost and the number of mobile phone carriers in operation. As the number

of mobile phone carriers increase, the price charged by each carrier will decrease. The negative correlation between the price and the number of carrier is a direct result of intensified competition, forcing mobile carriers to lower their prices. For a given number of carriers, the price charged by a mobile phone carrier will move in the same direction as its marginal cost. The carrier with low marginal cost tends to set relatively low price for its service. Since the demand of mobile phone service is a decreasing function of prices, it is straightforward to construct an unequivocal relationship between mobile phone demand and the two variables: marginal cost  $c_t$  and the number of carriers  $n_t$ . Substituting (6) into total industrial demand function  $D(p_t)$  obtains

$$D_t = D(c_t + 1/\alpha n_t) \quad (7)$$

Since  $dD_t/dP_t < 0$ , we should have  $dD_t/dc_t < 0$  and  $dD_t/dn_t > 0$ . Equation (7) shows that the demand for mobile phone depends on the number of mobile phone carriers and the marginal cost of providing mobile phone service. The demand for mobile phone would rise if the marginal cost declines. Similarly, as more and more carriers enter the market, the demand will increase too. As argued before, the substantial increase of mobile phone carriers is mainly attributed to the liberalization of mobile phone market, allowing NCC to enter the market. The regulatory reform brought to an end for the monopoly of NTT and opened the market to NCC. Hence, the number of carriers  $n_t$  measures the intensity of the telecommunication liberalization. As for the marginal cost, the monthly rental fee used to be a major component of mobile phone users' expense. The introduction of COMS system automatically phased out the monthly fees and reduced the cost of mobile phone users. The reform of call rate setting mechanism also reduced substantially the transaction fees of lowering price. Actually, as an immediate response to the switch from the authorization to prior notification for call rate changes, all carriers abolished their one time subscription fee in 1997. Therefore, the regulatory reforms fundamentally changed the structure of marginal cost of mobile phone service and opened the door of the mobile phone market to new common carrier, leading to substantial increase of new entries. Pertaining to the theoretical results of the model, we could reach a conclusion that the deregulation implemented by the Japanese government successfully introduced the competition mechanism to the market, causing continuous declination of mobile

phone service prices, and eventually driving the rapid growth of mobile phone demand.

## 5. The Estimation of the Deregulation Impacts

The model outlined in the above section provides framework for empirical investigations about the impact of the deregulation on the growth of Japan's mobile phone market. To examine the significance of the deregulation on the price of mobile phone services, we first estimate the following regression model, which is derived from equation (6),

$$P_t = a_0 + b_1 n_t + b_2 z_1 + b_3 z_2 + e_t$$

where  $P_t$  is mobile phone service price, measured by quarterly price index. The price index is compiled by Bank of Japan.  $z_1$  and  $z_2$  are two dummy variables.  $z_1$  takes value one for periods after 1993 and zero otherwise. It represents the introduction of COAM system. The other dummy variable  $z_2$  is designed to indicate the change of call rate setting system in 1996, which granted mobile phone carriers further freedom and flexibility to alter call rates. It equals to zero for the quarters before 1996, one otherwise. The estimation employed the data covering the periods of the first quarter of 1991 to the last quarter of 1999. The sample size is 36. Table 4 reports all estimates. All reported estimates include correction for autocorrelation. The correction is implemented by applying Newey-West method (Newey and West, 1987).

**Table 4: The Estimation of the Deregulation Impact on the Price of Mobile Phone Service**

Variable	Coefficient	Std. Error
$c$	105.6960	6.567
$N_t$	-1.460*	0.580
$Z_1$	-9.020*	5.366
$Z_2$	-24.221*	4.930
Sample size	36	
Adjusted R-squared	0.941	
Durbin-Watson stat	0.675	

\* Significant at 5%.

As reported in table 4, the coefficient of  $n_t$ , the number of carriers, is negative and statistically significant, suggesting that new entries would drive down the overall price of mobile phone service. It is consistent with the theoretical expectation of the

model. The coefficients of both dummy variables are also negative and significantly different from zero at 5 percent significance level. According to the definition, both variables take value one for after reform periods. The significance shows that, the regulatory reforms, introduction of COAM system and abolishment of call rate approval system, effectively gave rise to the price reduction of mobile phone services. Since the demand for mobile phone is a decreasing function of price, we can conclude that the deregulation contributed significantly to the growth of the mobile phone demand.

To further examine the impact of deregulation on the demand directly, we estimate another regression model

$$\log(D_t) = \mathbf{a}_0 + \mathbf{b}_1 n_t + \mathbf{b}_2 z_1 + \mathbf{b}_3 z_2 + \mathbf{e}_t$$

The right side independent variables are the same as before. The dependent variable is the number of mobile phone subscribers in logarithm. The regression model is derived based on equation (7), indicating that the marginal cost and the number of mobile phone carriers would affect the demand. Table 5 presents all estimates. The results are consistent with the regression, in which the price was employed as the dependent variable. According to the estimation, the coefficient of independent variable the number of mobile phone operators is positive and statistically significant, indicating that mobile phone demand would increase as new carriers enter the market. Similarly, the coefficients of the two dummy variables are also positive and significantly different from zero. It implies that the introduction of COAM system and the adoption of prior notification system for call rate setting substantially boosted the demand of mobile phone service. The empirical result is consistent with our analysis on the interaction between the deregulation and the development of Japan's mobile phone market. As we argued the three independent variables represents the major components of the deregulation implemented in Japan's mobile communication market. Hence, the empirical results unambiguously show that the deregulation has achieved its objective and facilitated the growth of the market successfully.

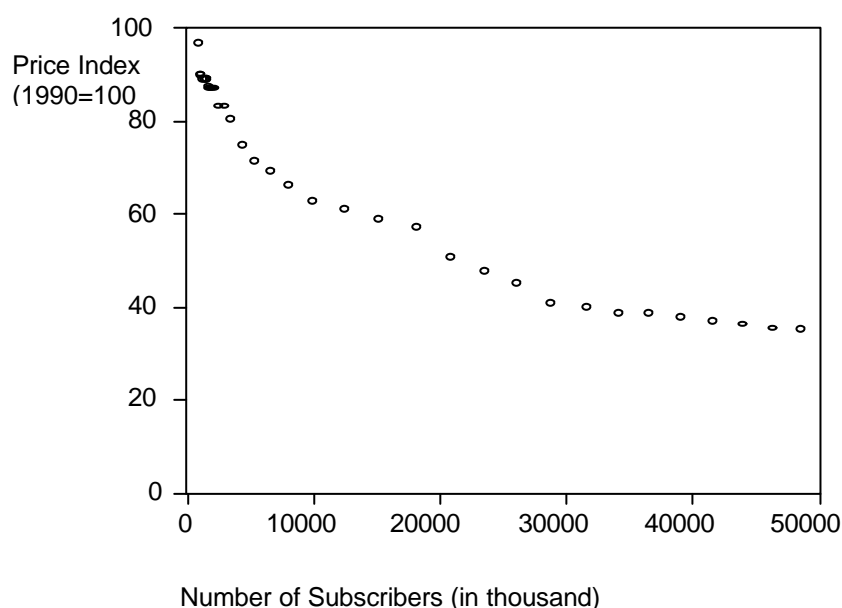
**Table 5: The Estimation of the Deregulation Impact on the Demand of Mobile Phone**

Variable	Coefficient	Std. Error
$C$	5.801*	0.434
$N_t$	0.130*	0.038
$Z_1$	0.596*	0.332
$Z_2$	1.161*	0.300
Sample size	36	
Adjusted R-squared	0.948	
Durbin-Watson stat	0.720	

- significant at 5%.

In modeling the mobile phone demand, we defined the demand for mobile phone as a function of single independent variable price. The rationale for the simplicity is that Japan's national income per capita was almost flat from 1991 to 1999<sup>1</sup>, in a sharp contrast to the exponential growth of mobile phone demand. The change of the income could not explain the variation of the mobile phone demand. Therefore, the income is not included as an independent variable explaining the mobile phone demand. The empirical observation on the correlation between the income and the number of mobile phone subscribers shows that these two variables are not correlated. Further the scatter-diagram (figure 3) intuitively shows that price could be the only major variable determining the demand. It outlined a distinctive pattern between the price movement and the number of mobile phone subscribers. The pattern could be described by an exponential function, in which price is an independent variable.

**Figure 3. Price vs. Demand**



<sup>1</sup> Japan's GDP per capita was 3,736, 000 Yen in 1991, 3,893,000 Yen in 1999. *White Report on Japanese Economy 2000*.



For validating the assumption on the mobile phone demand, the number of mobile phone subscribers was regressed on the price. Table 6 presents the estimated demand curves by two different methods: OLS and nonlinear estimation with first order autocorrelation. The variances of OLS estimates were also computed by Newey-West method. According to the estimation, the coefficient of price is positive and highly significant at a one percent significance level. The Durbin-Watson statistics of OLS is very low, indicating potential autocorrelation. To correct the problem, the demand function was re-estimated by including first order autocorrelation. Compared with the OLS estimation, the coefficients of price changed substantially. However, the single independent variable still provided 99 percent explanatory power to the variation of the mobile phone demand. Hence, the specification errors in modeling the demand function, at most, are negligible. The estimated demand curve indicates that continuous declination of mobile phone services, which was resulted from the deregulation, was the primary factor driving the growth of the mobile phone market. The estimated demand function also provides insightful information on the sensitivity of the demand to the price. With regards to the estimates, the price elasticity of the demand of mobile phone service can be derived as

$$E_t = 0.064P_t.$$

The elasticity is not constant but price dependent. It shows that the mobile phone demand was highly elastic when it was very expensive. For instance, the elasticity in 1990 is estimated at about 1.9 while the elasticity in 1999 is only 0.67. The declining elasticity over time can be explained as follows: as more and more Japanese subscribe mobile phone service, the growth rate of mobile phone users naturally tends to shrink. In addition, the price reduction at low level would generate relatively smaller impact on the demand than at high level, because the declining price gradually approaches the reservation price of majority consumers. The historic data also supported the conclusion. The mobile phone subscribers grew more than 100 percent before 1996, much higher than the growth rates in the last few years. Due to the limit of technical data, the technology progress of mobile phone is not considered in the study. It is the major pitfall of the empirical investigation.

**Table 6: The Estimation of Mobile Phone Demand**

$$\log(D_t) = \alpha_0 + \beta P_t + e_t$$

Variable	OLS		Estimation with AR(1)	
	Coefficients	Std. Error	Coefficient	Std. Error
$C$	13.102	0.142	26.480	34.49
$P_t$	-0.064*	0.002	-0.019*	0.006
Sample size		36		35
R-squared		0.987		0.998
Durbin-Watson stat		0.326		0.695

- significant at 1 percent.

## 6. Conclusions

Japan's mobile phone market had experience remarkable growth in the last decade. It emerged as the most robust sector of the slumping Japanese economy. Further, the growth of the mobile communication sector exceeded the growth of conventional communication sectors. With more than 51 millions mobile phone subscribers, mobile phones have become a necessity and reached ordinary Japanese consumers. In order to answer why Japan's mobile communication sector has been immune of the decade long economic recession and grown rapidly, this paper studies the development of Japan's mobile phone market. In particular, it focuses on regulatory reforms of the mobile communication sector and their impact on the growth of mobile phone demand. The analysis based on a monopolistic competition model shows that deregulation policies perform an essential role in fostering the rapid market expansion of Japan's mobile phone services. Using quarterly data from 1991 to 1999, we tested the significance of the deregulation on both the price and the demand of mobile phone. The empirical results suggest that the significant price declination and the rapid growth of mobile phone market in the last decade were largely attributed to the regulatory reforms, which abolished the entry barriers, phased out the mobile phone rental system, and simplified the mobile communication rate setting procedure. In addition, the demand curve of model phone was estimated. The estimated demand function indicates that mobile phone demand is highly price elastic. The price elasticity was as high as 6.4 and decreased to 2.1 by 1999 as the market became saturated. Since the regulatory reforms are one of the major driving forces behind the rapid expansion of mobile communication market in Japan, the empirical results

indicat that deregulation could be an effective strategy to revitalize the sluggish Japanese economy.

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