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The Case of the Japanese Mobile Telecommunications Market[†]

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Abstract

This paper explicitly incorporates network effects into the antitrust logit model, where consumers are assumed to prefer a larger network, and the growth of network is expected to countervail the effects of price increase due to mergers. For illustrative purposes, the framework is applied to the Japanese mobile telecommunications market in order to simulate and assess the welfare effects of hypothetical mergers and entry. The results suggest that the level of network integration of merged carriers and the network size of entrants appears to affect the market outcome.

Key Words: Antitrust Logit Model; Network Effects; Mergers; Entry.
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1. Introduction

The recent developments in the field of empirical industrial organization made it possible to quantitatively assess the anticompetitive effects of changes in a market structure, such as mergers. The antitrust logit model (ALM), which is analyzed in Werden and Froeb (1994) and Werden, Froeb, and Tardiff (1996), is a practical, simplified model that simulates the merger effects of a differentiated product market on prices and economic welfare based on the consumers' discrete choice theory. Nevo (2000a)—a more sophisticated study—assesses the effects of mergers among the ready-to-eat cereal producers in the US using the full random coefficients model of Berry (1994) and Berry, Levisohn, and Pakes (1995), which relaxes the assumption of the ALM on the substitution pattern among brands.[1]

On the other hand, in the case of network industries such as telecommunications, consumption externalities or network effects are important factors that characterize the market. For example, the utility derived from subscribing to a certain telecommunication service depends on the size of its network, that is, the number of subscribers to that service.[2] Ohashi (2003) investigated the role of indirect network effects in the US video cassette recorder market by using the nested logit model and revealed the importance of such effects in the technological standard competition. Therefore, for policy analyses such as assessments of proposed mergers in network industries, it is important to appropriately incorporate and assess the network effects.

This paper incorporates network effects into the ALM, where consumers are assumed to prefer a larger network, and the growth of network is expected to countervail the effects of price increase due to mergers. As an example, the framework is applied to the Japanese mobile telecommunications market in order to assess the welfare effects of hypothetical mergers and entry. However, it should be noted that the author only intends to show how important the network effects are in such markets, not to provide specific policy implications concerning the Japanese mobile telecommunications market. The following are the reasons why this paper focuses on the Japanese mobile telecommunications market. This market has grown rapidly and has become highly concentrated in the span of a decade. Further, under the new policy on radio

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[1] There are other empirical works that do not rely on the discrete choice theory: Baker and Bresnahan (1985) analyzed the US brewing industry using the residual demand approach. Hausman, Leonard, and Zona (1994) and Hausman and Leonard (1997) applied the Almost Ideal Demand System (AIDS) model to the US bath tissue and beer industries, respectively. Epstein and Rubinfeld (2001) presented another simulation framework known as the Proportionality Calibrated Almost Ideal Demand System (PCAIDS).

[2] Katz and Shapiro (1994) and Shy (2001) comprehensively summarize and review this subject.

frequency, a new entry might be admitted after an interval of over 10 years. The simulations suggest that the level of network integration of merged carriers and the network size of entrants appear to affect the market outcome.

The rest of the paper is organized as follows. The next section describes the ALM with network effects. The third section shows how the demand parameters are obtained. In the fourth section, the simulation results of the hypothetical mergers and entry in the Japanese mobile telecommunications market are presented. The concluding comments are presented in the final section.

2. Antitrust Logit Model with Network Effects

Demand Side

This paper employs the antitrust nested logit model with network effects, hereinafter ALM/NE.[3] First, the products are grouped into J+1 exhaustive and mutually exclusive sets, g = 0, 1,…, G. The set of the products in g is denoted by Γ_g. Group 0 is the outside alternative having a single element.

With regard to the demand side, each consumer is assumed to maximize his/her indirect utility by choosing brand j among J+1 alternatives:

(1) $$v_{ij} = \alpha_j + \beta p_j + \gamma \ln N_j + \zeta_{i|g} + (1-\sigma)\varepsilon_{ij} = \delta_j + \zeta_{i|g} + (1-\sigma)\varepsilon_{ij}.$$

where v_{ij} is consumer i's utility that is derived from consuming brand j that belongs to group g. ε_{ij} conforms to type I extreme value distribution; $\zeta_{i|g}$ is common to all products in group g for consumer i and has a distribution depending on σ: $0 \leq \sigma < 1$. p_j is the price of brand j, and N_j is the installed base that represents the network factor of brand j. Finally, α_j denotes the product quality of brand j, and β (<0) and γ (>0) are constant demand parameters. Although a price increase after a merger is expected to harm consumer's welfare, it is likely that the merger may improve consumer's welfare through the expansion of the network size. The present paper focuses particularly on this point. As described below, in the Japanese mobile telecommunications market, the lagged number of subscribers to each network is defined as the installed base.

In this setting, the choice probability of brand j in group g is expressed in a closed form:

[3] This model is based on the ones formulated in Werden and Froeb (1994), Berry (1994), Werden, Froeb, and Tardiff (1996), Nevo (2000a, 2000b), and Ohashi (2003).

(2) $$\pi_j(p) = \frac{\exp[\delta_j/(1-\sigma)]}{D_g^{\sigma}\sum_{g'} D_{g'}^{1-\sigma}}$$

where

(3) $$D_g = \sum_{j\in\Gamma_g} \exp[\delta_j/(1-\sigma)].$$

The probability of choosing brand j, given the choice of group g, $\pi_{j|g}$, and the probability choosing the outside alternative, π_0, are

(4) $$\pi_{j|g}(p) = \frac{\exp[\delta_j/(1-\sigma)]}{D_g},$$
$$\pi_0(p) = \frac{1}{\sum_{g'} D_{g'}^{1-\sigma}}.$$

In addition, each element of the own and cross price elasticity matrix E^p is given as follows:

(5) $$E_{ij}^p = \begin{cases} -\dfrac{\beta}{1-\sigma} p_i[\sigma\pi_{i|g} + (1-\sigma)\pi_i], & \text{if i} \neq \text{j} \in \text{g}, \\ -\beta\pi_i p_i, & \text{if i} \in \text{g, j} \in \text{g', g} \neq \text{g'}, \\ \dfrac{\beta}{1-\sigma} p_i[1-\sigma\pi_{i|g} + (1-\sigma)\pi_i], & \text{otherwise.} \end{cases}$$

On the other hand, each element of the own and cross network size elasticity matrix E^N is given as follows:

(6) $$E_{ij}^N = \begin{cases} -\dfrac{\gamma}{1-\sigma}[\sigma\pi_{i|g} + (1-\sigma)\pi_i], & \text{if i} \neq \text{j} \in \text{g}, \\ -\gamma\pi_i, & \text{if i} \in \text{g, j} \in \text{g', g} \neq \text{g'}, \\ \dfrac{\gamma}{1-\sigma}[1-\sigma\pi_{i|g} + (1-\sigma)\pi_i], & \text{otherwise.} \end{cases}$$

Supply Side

With regard to the supply side, each firm supplies some subsets, Φ_f, of the brands, and the profit of firm f is

(7) $$\Pi_f = \sum_{j\in\Phi_f} (p_j - c_j) X \pi_j(p) - C_j$$

where X denotes the potential market size that is equal to the sum of the total number of buyers of inside goods and that of the outside alternative. c_j and C_j are the constant marginal and fixed costs of production, respectively. This framework is slightly different from that of the traditional merger analysis, which does not include the choice probability or the share of outside alternative, but incorporates the aggregate elasticity of demand for the inside goods. This paper employs the potential market size as an alternative to the aggregate elasticity based on the following relationship:

(8) $\varepsilon \equiv [\partial \pi_I(\lambda p)/\partial \lambda]/[p_I/\pi_I(p)] = \beta p_I \pi_o$

where π_I (=1 − π_0) is the sum of the choice probabilities for the inside goods, and p_I is the share weighted average price of the inside goods. λ is a scalar, and the derivative is evaluated at λ = 1.[4]

Given the values of the parameters and the assumption of the existence of the pure-strategy Bertrand-Nash Equilibrium in prices, the first-order condition is expressed in a matrix form as follows:

(9) $\pi(p \mid \alpha,\beta,\gamma) + \Delta^{pre}(p \mid \alpha,\beta,\gamma,N^{pre})(p-c) = 0$

where

(10) $$\Delta_{ij}^{pre}(p) = \begin{cases} \dfrac{\partial \pi_j(p)}{\partial p_i}, & \text{if i and j are produced by the same firm,} \\ 0, & \text{otherwise} \end{cases}$$

and

(11) $$\frac{\partial \pi_j(p)}{\partial p_i} = \begin{cases} -\dfrac{\beta}{1-\sigma}\pi_j[\sigma\pi_{i|g} + (1-\sigma)\pi_i], & \text{if } i \neq j \in g, \\ -\beta\pi_i\pi_j, & \text{if } i \in g, j \in g', g \neq g', \\ \dfrac{\beta}{1-\sigma}\pi_j[1-\sigma\pi_{i|g} - (1-\sigma)\pi_i], & \text{otherwise.} \end{cases}$$

This is evaluated on the basis of the pre-change market structure.[5] Solving the first-order condition for *c*, we can estimate the marginal cost of production for each brand in the pre-change market structure. Additionally, normalizing the quality of the outside alternative as 0, the (log of) product quality for each brand is estimated as follows:

(12) $\alpha_j = \ln(\pi_j/\pi_0) - \beta p_j - \gamma \ln N_j - \sigma \ln \pi_{j|g}$.

Simulation

Using this framework, we can simulate the market outcome in the post-change market structure, that is, the market structure after mergers and entry. Let Δ^{post} be a matrix of the post-change market structure. The new equilibrium prices must satisfy the following first-order conditions:

(13) $\pi(p^* \mid \alpha,\beta,\gamma) + \Delta^{post}(p^* \mid \alpha,\beta,\gamma,N^{post})(p^*-c) = 0$.

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4 Nevo (2000a) also included the share of outside alternatives.

5 The network size is assumed to be not a strategic but a pre-determined or exogenous variable for firms.

Solving the above system of nonlinear equations with the estimated marginal cost of production and the given product quality, we can predict the post-change prices and market shares. Further, the effects of the change in the market structure on consumer surplus (CS) are assessed in terms of the compensating variation:

$$CV = \frac{\ln \sum_g (D_g^{post})^{1-\sigma} - \ln \sum_g (D_g^{pre})^{1-\sigma}}{\beta}. \tag{14}$$

On the other hand, the effects on producers' surplus (PS) are evaluated as the change in revenue. The final effects on total welfare are accessed as the sum of CS and PS.

3. Setting Demand Parameters

Relative Demand Equation

In the remaining sections of the paper, the framework is applied to the Japanese mobile telecommunications market as an example. It is noteworthy that these simulations are not meant to provide definitive implications for the Japanese mobile telecommunications market, but only to illustrate the importance of network effects in such markets.

= Figure 1 =

In Japan, there are two different mobile telecommunication technologies that are practically used: cellular phone and the personal handyphone system (PHS).[6] The Ministry of Internal Affairs and Communications (2005) reported the results of the market delineation of the Japanese mobile telecommunications market and defined the entire market as a single unit consisting of two close submarkets—cellular phone and PHS—as depicted in Figure 1. Further, the Ministry suggested that the voice transmission service and the packet transmission service (such as e-mail and mobile Internet services) should be considered as a single integrated service. Given the above definition of the Japanese mobile telecommunications market, this paper regards cellular phone and PHS as two substitutable but different service categories and groups them into two different nests. There are three carriers that provide cellular phone services: the NTT DoCoMo group, Vodafone, and KDDI—which operates two different brands, au and Tu-Ka. The NTT DoCoMo group offers PHS services as well. In 2004, KDDI sold its PHS business to the Carlyle Group and this business was renamed as WILLCOM. Another PHS

[6] Pager services have been rapidly losing their position in the Japanese mobile telecommunications market, and therefore, they have not been considered in this paper.

service provider is ASTEL; however, it plans to shrink its business in the near future. Hence, there are five carriers among the seven brands in the Japanese mobile telecommunications market. Figure 2 depicts the evolving Japanese mobile telecommunications market during the latter half of the 1990s.

= Figure 2 =

Another important issue is the definition of the network factor. With regard to voice transmission services, networks appeared compatible with each other. However, with respect to packet or data transmission services, networks were incompatible because they operated different mobile Internet service networks such as i-mode by NTT DoCoMo and EZweb by KDDI. [7] Thus, in this paper, the installed base of each brand is basically defined as the network factor or network size, although the results with the market-level installed base will also be presented for a comparison.

For the application, we have to set the values of the demand parameters, β, γ, and σ. This paper employs the estimates of the regression using the data of the dominant carrier in the Japanese mobile telecommunications market—the NTT DoCoMo group—because it is relatively easy to obtain sufficient information on this carrier. The NTT DoCoMo group consists of nine regional operating companies; each operating area can be regarded as a separate mobile telecommunications market because most of the mobile phone calls are made within a certain area. [8] Based on the ALM/NE, the relative demand function to the outside alternative of NTT DoCoMo's cellular phone services is expressed as follows:

(15) $$\ln(x_{mt}^{NTT} / x_{mt}^{0}) = a^{NTT} + \beta p_{mt}^{NTT} + \gamma \ln N_{mt}^{NTT} + Z_{t}^{NTT}\theta + \sigma \ln s_{mt}^{NTT|Cel} + u_{mt},$$

where t and m denote the time and operating area. x^{NTT} and x^{0} are the number of subscribers to NTT DoCoMo's cellular phone services and the number of non-mobile users, respectively. In this paper, the potential market size is defined as the population of each area, and x^{0} is defined as the population minus the total sum of mobile users for each operating area. Z^{NTT} is the vector

[7] However, carriers have recently begun to make their mobile Internet services compatible with others. For example, NTT DoCoMo's i-motion services, which enable users to e-mail video recordings taken by a handset, can now be received by users of other brands.

[8] According to Telecommunications Carriers Association (TCA, 2005), in 2003, more than 80% of calls were made within the same area and the corresponding ratio for time length was over 70%; the operating areas were Hokkaido, Tohoku, Kanto, Tokai, Hokuriku, Kansai, Chugoku, Shikoku, and Kyushu.

of the service characteristics of NTT DoCoMo's cellular phone services, and $s^{NTT|Cel}$ is the share of NTT DoCoMo in cellular phone users. p^{NTT} and N^{NTT} denote the price and the installed base of NTT DoCoMo's cellular phone services, respectively.

Data

For the estimation, the data is collected from various sources. This paper regards the average (monthly) revenue per user (ARPU) as the price of mobile telecommunications services. The reason why this paper focuses on the ARPU is that the Japanese mobile telecommunication carriers offer several differentiated service menus and options, but it is impossible to deal with these menus because the number of subscribers to each menu is not revealed to the public. Alternatively, this paper defines the ARPU as a price, given the assumption that the use of mobiles is the same across all users during a particular time period. Indeed, it is a very strong assumption; however, given the assumption, the ARPU reflects the average of various service menus and discount options used by subscribers. However, we cannot obtain information on the ARPU for each carrier in each operating area. Alternatively, only the ARPU in terms of the national average and annual revenues for each regional NTT DoCoMo operating company is available. These figures are made available for each fiscal year from each edition of "Terekomu Deta Buku" (Telecom Data Book), which is published by the TCA, "Joho Tushin Handobuku" (Information & Communications in Japan), which is published by InfoCom Research, Inc., and the financial reports of the respective regional NTT DoCoMo operating companies. Assuming that almost all the revenues are generated from the mobile business, the ARPU of NTT DoCoMo's cellular phone services for each regional operating company is estimated as follows:

$$\text{(16)} \qquad \text{ARPU} = \frac{\text{Total Revenue - 2,700} \times \text{\# of Subscribers to NTT DoCoMo's PHS}}{\text{\# of Subscribers to NTT DoCoMo's Cellular Phone} \times 12},$$

where the base charge for NTT DoCoMo's PHS services is set at 2,700 yen. The number of subscribers to NTT DoCoMo and other carriers in nine operating areas are downloaded from the TCA Web site in the form of a monthly data from April 1996 to March 2005. Figure 3 compares the arithmetic and weighted means of the estimated ARPU for nine areas with the actual ARPU series of the NTT DoCoMo group at the national level. On the other hand, the installed base is defined as the lag of the number of subscribers to NTT DoCoMo's cellular phone services: While the number of subscribers to each service at the end of each fiscal year (March of the following year) is regarded as the current users, the number of subscribers each April is defined as the installed base. Based on the data of current users, the share of NTT DoCoMo within each regional cellular phone market is also calculated. To control for the improvement in the business of NTT DoCoMo's cellular phone services during this time period, two dummy variables are introduced as product characteristics: the i-mode dummy, which is 1 if the year is 1999 or later and 0 otherwise, and the i-appli & 3G dummy, which is 1 if the year is 2001 or later and 0 otherwise. [9]

= Figure 3 =

Instruments

According to previous works, the price and share within the cellular phone market may be endogenously determined and correlated with the error term. For this purpose, we need the appropriate instruments. The first possible candidate is a cost-side variable that is excluded from the product characteristics. This paper uses the monthly salary of service industries in each region from "Chingin Kozo Kihon Chosa" (Basic Survey on Wage Structure). Hausman (1997) introduced another candidate, that is, prices of the product in other regional markets. The present paper employs the average prices that exclude the prices of the region being instrumented. Other variables, which represent the competition condition in each regional mobile market, are used as valid instruments, such as the Hirschman-Herfindahl Index (HHI) and the share fluctuation index (SFI). While the former index is commonly used, the latter may not be well known. The SFI was introduced by Izumida, Funakoshi, and Takahashi (2004) and used by Motohashi, Funakoshi, and Tohei (2005) in the analysis of the dynamic relationship between competition and productivity. The SFI is calculated as follows:

$$(17) \qquad SFI_{mr} = \frac{1}{J}\sum_{J}(s_{jmr} - s_{jmr-1})^2 ,$$

where s_{jmr} denotes the market share of brand j in market m in time r. Hence, the SFI may capture the dynamic aspect of competition within a market. Finally, the prices and wages are deflated by the CPI (2000 = 100.0). Table 1 reports the descriptive statistics of the regression variables.[10]

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[9] i-mode is a mobile Internet service, and i-appli is a service by which users can download and use Java applications on their handsets. These services were marketed by the NTT DoCoMo group in 1999 and 2001. 3G is the third generation technology of cellular phone services and was marketed by the NTT DoCoMo group in 2001.

[10] Since the total number of subscribers in Hokuriku is greater than the population in 2002, 2003, and 2004, the number of non-mobile users becomes negative, making it difficult to compute logs. Therefore, the number for these years has simply been excluded from the samples. Thus, the total sample size is 9 × 9 – 3 = 78.

= Table 1 =

Estimation Results

Table 2 reports the estimation results. This paper uses the generalized method of moments (GMM) as the estimation method.[11] The efficient GMM estimates of standard errors with both arbitrary heteroskedasticity and arbitrary intertemporal within-area correlation are within parentheses and those with small sample corrections are within square brackets. The first column presents the estimation of the simple logit model (σ = 0.0). The parameters are significantly estimated and show the expected signs. The Hansen J test statistic is equal to 3.790, and the assumption that the instruments are orthogonal to the error term is not rejected (p-value = 0.285).

= Table 2 =

The second column shows the results of the nested logit model. Again, all the parameters except for σ are significantly estimated and show the expected signs. The Hansen J test statistic is equal to 2.613, and the orthogonal assumption is not rejected (p-value = 0.270). The estimate of price coefficient β is negative and satisfies the theoretical requirement. The marginal effect of network factor γ is positively estimated in both the models, and thus, an increase in the network size is expected to lead to an improvement in welfare. This result is contrary to that in Iimi (2005), who could not find significant direct network effects and concluded that the network size was not a crucial factor in the Japanese cellular phone market.[12] On the other hand, Okada and Hatta (1999) found significant network effects in the mobile phone demand from 1992 to 1996. Thus, despite the controversy surrounding the network effects of the Japanese mobile services, this paper conducts the following simulations, given the presence of the network effects. While σ is not precisely estimated (p-value = 0.174 and 0.250 with and without small sample correction, respectively), it lies between 0 and 1. As described above, this paper follows the market delineation reported by the Ministry of Internal Affairs and Communications (2005) and we use the estimates of the nested logit model.[13]

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[11] For the estimation, we used the "ivreg2" command of STATA 9 proposed by C. F. Baum, M. E Schaffer, and S. Stillman.

[12] This paper added the dummies for friend and family discounts as product characteristics, which might capture a part of the network effects.

[13] The estimates of the simple logit model estimate unrealistic marginal costs for PHS services, and

4. Simulation Analysis of the Japanese Mobile Telecommunications Market

Pre-change Market Outcome

First, using this framework, the marginal costs and product qualities for each brand are estimated from the market outcome in 2003. The reason why this paper focuses on 2003 as the pre-change period is that the ARPU of NTT DoCoMo's cellular phone and PHS services, au and Tu-Ka by KDDI, and Vodafone are available from "Joho Tushin Handobuku" (Information & Communications in Japan) for this year. However, since the ARPU of WILLCOM and ASTEL is not available, this is assumed to be the same as that of NTT DoCoMo's PHS services. The number of current users and the installed base are defined as the number of subscribers in March 2004 and April 2003, respectively. The ownership structure in 2003 is as follows: NTT DoCoMo operated cellular phone and PHS services; KDDI had two cellular phone brands, au and Tu-Ka; and there were other independent carriers, Vodafone (cellular phone), WILLCOM (PHS), and ASTEL (PHS).

= Table 3 =

Table 3 presents the pre-change market outcome. The first column reports the market share; it can be seen that NTT DoCoMo captured more than half the Japanese mobile telecommunications market. The second column presents the ARPU/100. According to this column, the prices of NTT DoCoMo and au seemed to be relatively high. The third and fourth columns report the estimate of the marginal cost divided by 100 and the price-cost margin ratio. According to these columns, the carriers gained approximately 20%–30% margins from the cellular phone business and 36%–56% from the PHS business. The estimates of product quality are reported in the fifth column, which shows that NTT DoCoMo provided the highest quality cellular phone services followed by au that accounts for about three-fourths of NTT DoCoMo's cellular phone services. The ratio of the total mobile users to the population is approximately 68.6%, and the share weighted average of prices is 7,255 yen.

= Table 4 =

Table 4 reports the own and cross price elasticity matrix E^p. According to this matrix,

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some of which become negative. The simulation results are reported in the Appendix.

every own price elasticity was greater than 1.0 in absolute value, and those of au and Vodafone were relatively larger. With respect to cross price elasticity, those of NTT DoCoMo's cellular phone services and au were large, but those of the PHS services were small.[14] On the other hand, Table 5 presents the estimates of own and cross network size elasticity matrix E^N. According to this table, all the own price elasticities were smaller than 1.0 and those of au and Tu-Ka were larger than the others. In the case of cross price elasticity, those of NTT DoCoMo's cellular phone services and WILLCOM were relatively large.

= Table 5 =

Merger Simulation

To illustrate the ALM/NE, we consider a hypothetical merger among cellular phone carriers. [15] For each merger, three types of operations are considered in order to verify the importance of network effects and investigate the welfare effects of network integration. In addition, the results with the market-level network effect model will be reported for a comparison.

The first operation is the separate operation, which means that the merged brands are run as separate networks by the single merged firm. In this case, the network product is regarded as other usual differentiated products. This situation is represented only by the change in the ownership structure. The marginal costs are the same as those in the pre-merger period.[16]

The second operation is the partial integration, which means that the network is integrated but the product qualities are different. This implies that while two brands are operated and supplied as explicitly differentiated services, the different brands of a merged carrier do not

[14] The estimates of own elasticity are relatively larger than those provided in Iimi (2005) and Ida and Kuroda (2005). Iimi (2005), deemed the most comprehensive study of the Japanese cellular phone market, used monthly charge for "standard plans." Ida and Kuroda (2005) estimate the mixed logit model of the Japanese mobile demand using data from an original questionnaire and define prices as the monthly expenditure for mobile services minus the estimated calling charge from the regression of expenditure on call time and additional variables. In this paper, price may be defined as the total cost of each mobile service that should be charged to an average user.

[15] There were some actual mergers in the Japanese mobile telecommunications market during the latter half of the 1990s. However, most of them occurred among small regional operators in different areas; this generated carriers that operated nationwide and could compete with NTT DoCoMo.

[16] The efficiency gain is not considered in any of the merger simulations. If merged carriers were able to lower the production cost, we could obtain more preferable results.

encounter interconnection problems in calling, sending e-mails or images, and browsing mobile contents. This situation is represented by the change in the ownership structure and the installed base of the merged brands, which is set to the sum of the installed base of each merged brand. In this case too, the marginal costs are the same as those in the pre-merger period.

The last operation is the complete integration, which implies that brands merge to become a single identical service. This situation is represented by setting the product qualities of the merged brands to the maximum level, in addition to the change in the ownership structure and the installed base, as is the case with partial integration. Additionally, the marginal cost of the completely integrated brand is set to the maximum marginal cost value among the original brands. Finally, it should be noted that in all simulations, the PHS services are assumed to be operated separately by merged carriers because of its technological differences, and that WILLCOM is regarded as a single independent carrier since it was generated by the acquisition of the PHS business from KDDI by the Carlyle Group in 2004.

= Table 6 =

Table 6 reports the results of the merger simulation. The first four columns present the hypothetical merger between NTT DoCoMo and Vodafone, and the next four present that between NTT DoCoMo and KDDI (au & Tu-Ka). These results show similar patterns: the prices of almost all cellular phone brands increase in the post-merger period and the share weighted average also rises in response. In addition, the ratio of the total mobile telecommunications market to population shrinks in this period. The first and second panels of Figure 4 depict the welfare effects of the simulated mergers. According to these panels, CS decreases but PS increases, and the total welfare is affected in cases of separate operation and complete integration. However, in the partial integration case, the total welfare increases slightly because the increases in PS outweigh the decreases in CS.

= Figure 4 =

The final four columns and the final panel of Figure 4 report the results of the hypothetical merger between KDDI (au & Tu-Ka) and Vodafone; these show slightly different patterns. In the case of separate operation, the prices of almost all cellular phone brands increase in the post-merger period and the weighted average rises to approximately 7,456 yen. The share of mobile users in the population declines slightly to 67.4%. While CS decreases, PS increases, and the total welfare improves very slightly. In the case of partial integration, while the weighted average price increases slightly to 7,351 yen, the ratio of the number of mobile users to the population increases to 69.0%. Increasing prices lead to an improvement in both the CS and the PS and consequently enhances the total welfare. This is because the integrated installed base contributes to the improvement in consumers' welfare. On the other hand, in the case of complete integration, the average price increases to 7,654 yen, and the mobile telecommunications market shrinks in the post-merger period. In regard to the welfare effects, CS decreases and PS increases. Finally, this leads to the deterioration in the total welfare.

These results suggest that there may be mergers that improve both CS and PS when the merged carrier seamlessly integrates its brands while ensuring that the lineup of the available services corresponds to that of each component carrier in the pre-merger period. This is because in comparison with complete integration, this merger enables consumers to exploit the network effects without loss of product (or brand) variety as well as price decline due to competition among mobile carriers. The final bar chart of each panel presents the results taking the market-level installed base as the network size. According to these results, if the market-level installed base is a relevant definition of the network size, mergers among cellular phone carriers will have serious effects on the total welfare.

Entry Simulation

In July 2005, the Radio Regulatory Council submitted a report on the frequency allocation guideline released by the Ministry of Internal Affairs and Communications of Japan. According to this report, at the most, new frequencies would be assigned to two new entrants in the 1.7 GHz band and to one entrant in 2.0 GHz band. Two broadband access service providers, Softbank and e-Access, applied for entry in 1.7 GHz band, with IP-Mobile applying for entry in the 2.0 GHz band. Three months later, all the applications were approved, and they planned to begin cellular phone services by 2006 or 2007.[17] In this subsection, the hypothetical entry into the Japanese mobile telecommunications market is simulated and its welfare effects are assessed using the ALM/NE.

The following simulations consider three cases with different number of entrants and different sizes of the installed base per entrant: a single entrant with 6 million, two entrants with 3 million, and three entrants with 2 million. Hence, in each case, the total installed base of the

[17] The Ministry of Internal Affairs and Communications (2005), Nikkei Business Publications, Inc. (2005a, 2005b), Nihon Keizai Shinbun, Inc. (2005), and Sankei Shinbun, Co. (2005). In March 2006, Softbank announced its plans to acquire Vodafone and to surrender the new license.

entrants is equal to 6 million.[18] In addition, while the product qualities of the new entrants are assumed to be the mean of those of cellular phone brands, the marginal costs are assumed to be the maximum marginal cost value among the brands.[19] Hence, in the case of two or three entrants, they are completely symmetric. All the entrants are assumed to be independent carriers. The present framework allows entrants with positive network factors to appear suddenly in the post-entry period, where the network size of incumbents is unchanged; this characteristic seems to be slightly unusual. This paper intends to present a picture of the market several years later, rather than to describe the dynamic process of an entry. This simulation does not take into account the entry cost. As is the case with merger simulation, this paper also considers the results with the market-level network effects.

= Table 7 =

The results reported in Table 7 and Figure 5 suggest that with both network definitions, a new entry causes price declines, market expansions, and an increase in CS but decrease in PS, thereby improving the total welfare. For example, in the case of a single entry with brand-specific network effects, the new carrier accounts for approximately 7.3% of the market, and the average price decreases to 7,181 yen and the share of the total mobile users in the population becomes approximately 70.0%. In addition, CS increases to approximately 4.07%, but PS decreases to approximately 4.42%. The total welfare improves (approximately a 1.76% increase). Moreover, it can be seen that the welfare gain decreases as the number of entrants increases. This is because the incumbents lose their profits further, although the improvement in consumers' welfare is enhanced with an increase in the number of entrants and the former effect is larger. On the other hand, in the case of market-level network effects, the welfare gain increases as the number of entrants increases and the relative importance of welfare effects on CS and PS is reversed.

= Figure 5 =

[18] According to Sankei Shinbun, Co. (2005), the new entrants plan to achieve approximately 5 to 10 million subscribers in the near future. However, assessing the feasibility of their business plans is beyond the scope of this paper.

[19] This paper assumes that the new carriers are not superior to the incumbents with regard to the production cost.

5. Concluding Remarks

This paper conducted a simple simulation analysis of the hypothetical mergers and entry in the Japanese mobile telecommunications market using the ALM/NE for illustrative purposes. The framework explicitly incorporates network effects, where the increase in the network size is assumed to improve consumers' welfare, and enables us to predict a price change due to the change in the market structure and assess its welfare effects.

To assess the welfare effects of mergers and entry, it is important to focus on the appropriate welfare measure: the total welfare or consumers' welfare. As pointed out by Werden (1996), economists prefer to focus on the total welfare, but consumers' welfare seems to be the yardstick of antitrust enforcement. From the first viewpoint, all hypothetical mergers with partial integration will be regarded as those meant for enhancing the welfare. However, if we focus on the second viewpoint, with the exception of the merger between KDDI and Vodafone with separate operation or partial integration, the hypothetical mergers seem to harm the welfare. In the case of entry, if one pays attention to the total welfare, the single entry case will be preferred, although consumers' welfare may be improved as the number of entrants increases.

Indeed, these results depend on the assumption that consumers' preferences are reflective of the network effects on mobile telecommunication services. If such an assumption is rejected, as seen in the results of Iimi (2005), the hypothetical mergers result in cases of separate operation, with all mergers except for the one between KDDI and Vodafone decreasing the total welfare and consumers' welfare. Therefore, it is important to investigate the nature of the consumption patterns and check the validity of the network effects. With regard to application, it is assumed that the Japanese mobile telecommunications market exhibits brand-specific network effects. However, as stated in the footnote, these days, Japanese mobile carriers attempt to make their mobile Internet services compatible with those of their rivals. Further, the simulation results with market-level network effects are different from those with brand-specific network effects. If their services become perfectly compatible with each other, the analysis based on brand-specific network effects might lead to incorrect policy implications.

This analysis excluded the dynamic aspect of mergers and entry and was conducted in a static setting. As pointed out by Gowrisankaran (1999), ignoring dynamic determinants of firm behavior, such as mergers, entry/exit or investment, and the linkages between them, will lead to incorrect conclusions. Moreover, network effects will shed light on another important dynamics of consumer behavior because the timing of adoption or switching among brands is likely to be intertemporally affected by the change in the market structure and the network size. In order to deal with such problems, we need a completely dynamic model of mergers, where firms' and consumers' behavior are endogenously determined. This remains an issue to be dealt with in future studies.

Finally, it should be noted that the simulation results depend heavily on model assumptions such as the nest structure, price definition, potential market size, and parameter values used in the simulation, some of which are poorly estimated. Therefore, we have to take note of the precision of the simulation. In addition, Crooke, Froeb, Tschantz, and Werden (1999) show that the curvature of the assumed demand system significantly affects the predicted price increase. Hence, the results of this study should be compared with the simulation results based on other types of demand systems. However, at the same time, Werden and Froeb (2002) proposed the ALM as a practical, quick, and easy tool for merger simulation. Therefore, given these limitations, the framework will be a benchmark for policy analysis in network industries.

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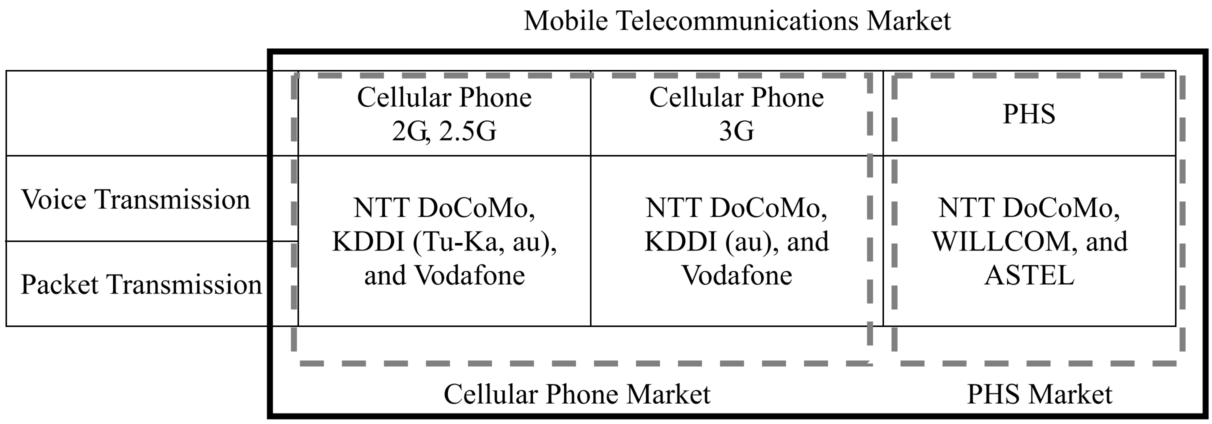
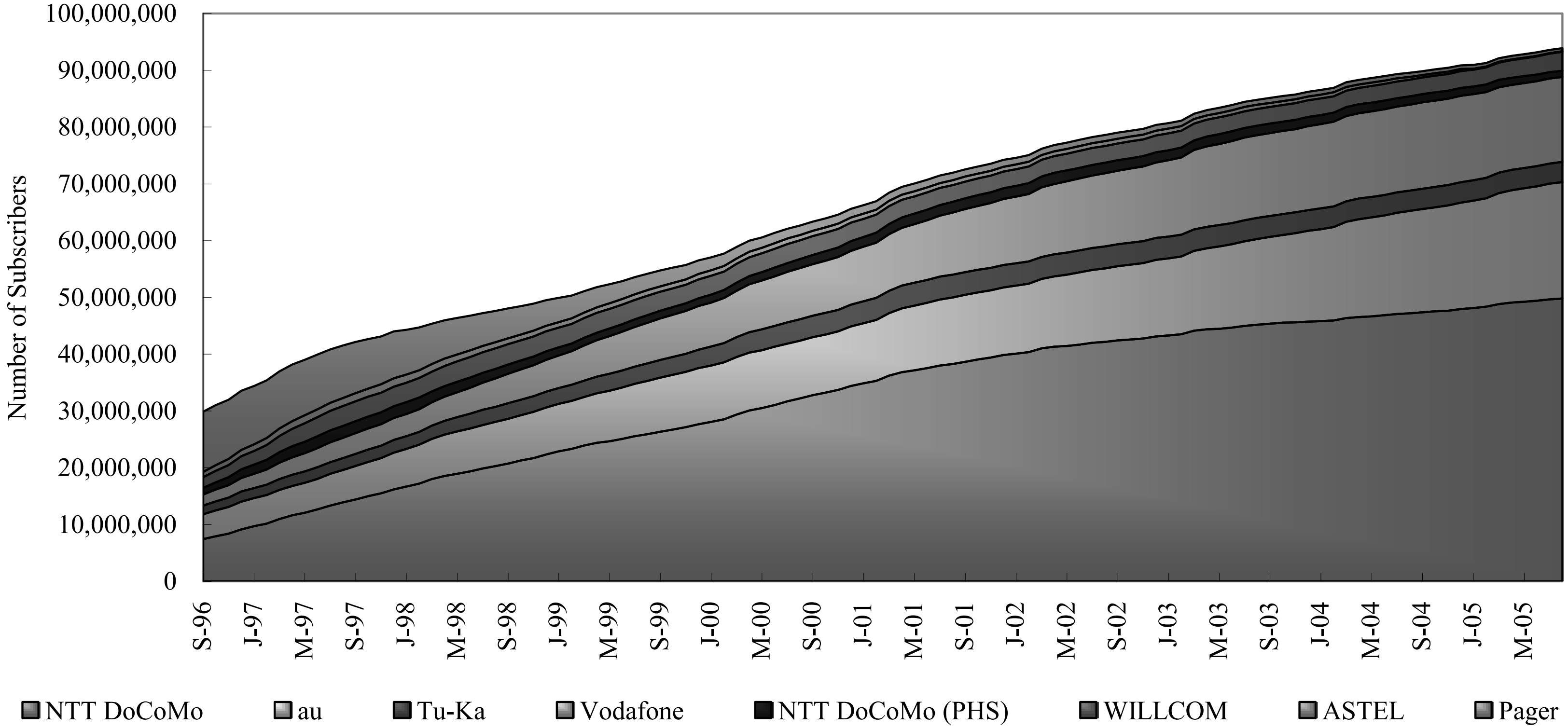
Figure 1: Delineation of the Japanese Mobile Telecommunications Market



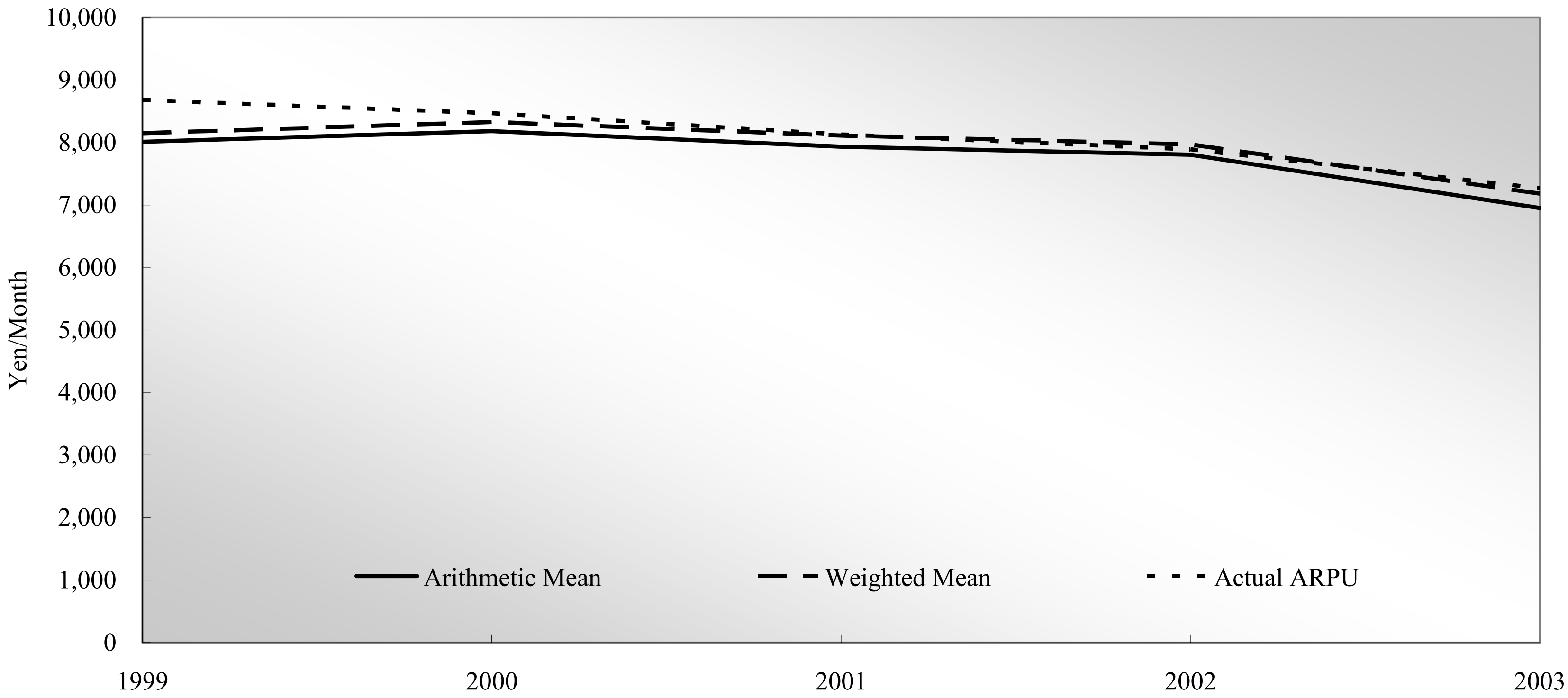
(NOTE) This is based on Figure 4-4-7(1) of the report presented by the Ministry of Internal Affairs and Communications (2005).

Figure 2: Evolution of the Japanese Mobile Telecommunications Market



(NOTE) This is based on the figures obtained from the TCA Web site, and the series are prepared, based on the carriers operating in 2005.

Figure 3: Arithmetic and Weighted Means of the Estimated ARPU and the Actual ARPU Series of NTT DoCoMo



(NOTE) The acutal ARPU series is provided at the national level, and the arithmetic and weighted means are those of the estimated ARPU for nine areas.

Table 1: Descriptive Statistics of Regression Variables

Variables	Obs.	Mean	Std. Dev.	Min	Max
ln(Number of NTT Cellular Phone/Number of Non-Mol	78	-1.245	0.679	-2.872	1.688
ln(Share of NTT in the Cellular Phone Market)	78	-0.578	0.154	-1.441	-0.368
Price/CPI	78	83.462	8.241	60.492	107.918
ln(Installed Base)	78	14.412	1.129	11.712	16.763
Monthly Salary/CPI	78	2.905	0.190	2.577	3.283
Average Price in Other Areas	78	83.323	7.528	70.539	101.112
HHI/10000	78	0.343	0.059	0.210	0.482
SFI/100	78	0.769	1.952	0.002	10.352

(NOTE) CPI is normalized as 2000 = 100.0, and the installed base is the lag of the number of subscribers to NTT DoCoMos cellular phone services. The average price is the mean of the prices excluding those in the region being instrumented. For more details, please see the text.

Table 2: Estimation Results of NTT DoCoMo's Demand Function

	Logit	Nested Logit
Price: β	-0.03457	-0.03259
	(0.00187) a	(0.00303) a
	[0.00204] a	[0.00332] a
Installed Base: γ	0.19431	0.15378
	(0.05345) a	(0.05764) a
	[0.05823] a	[0.06322] b
i-mode Dummy: θ_1	0.22919	0.25412
	(0.03929) a	(0.04284) a
	[0.04280] a	[0.04699] a
i-appli & 3G Dummy: θ_2	0.22106	0.27161
	(0.07589) a	(0.08597) a
	[0.08267] b	[0.09430] b
Share of NTT DoCoMo Given the Choice of a Cellular Phone: σ		0.60416
		(0.44432)
		[0.48736]
Constant: a	-1.42161	-0.68647
	(0.85293) c	(0.96197)
	[0.92912]	[1.05516]
Instruments:		
Log of Monthly Salary in Service Industries	Yes	Yes
Average Price in Other Area	Yes	Yes
HHI/10000	Yes	Yes
SFI/100	Yes	Yes
Hansen J Statistics	3.790	2.613
Degree of Freedom	3	2
p-value	0.28508	0.27078
Number of Observation	78	78

(NOTE) The estimation method used is the GMM. The efficient GMM estimates of standard errors with both arbitrary heteroskedasticity and arbitrary intertemporal within-area correlation are within parentheses and those with small sample correction are within square brackets. a, b, and c denote significance at the 1%, 5%, and 10% levels, respectively. For the estimation, the "ivreg2" command of STATA 9 proposed by C. F. Baum, M. E. Schaffer, and S. Stillman was used.

Table 3: Pre-change Market Outcome

	Share	Price	MC	PCM	Quality
1 NTT DoCoMo	0.532	78.900	56.455	0.284	1.675
2 au (KDDI)	0.195	74.400	59.583	0.199	1.146
3 Tu-Ka (KDDI)	0.042	50.200	35.383	0.295	0.331
4 Vodafone	0.172	69.400	55.819	0.196	0.920
5 NTT DoCoMo (PHS)	0.018	34.300	16.119	0.530	0.029
6 WILLCOM	0.033	34.300	15.236	0.556	0.034
7 ASTEL	0.007	34.300	21.887	0.362	0.023
Market Outcome					
Total Users/Population	0.686				
Average Price	72.558				

(NOTE) These are the results of the fiscal year 2003. Prices and marginal costs (MC) are divided by 100. For more details, please see the text.

Table 4: Pre-change Price Elasticity Matrix

	1	2	3	4	5	6	7
1 NTT DoCoMo	-3.543	3.352	3.352	3.352	0.996	0.996	0.996
2 au (KDDI)	1.157	-5.345	1.157	1.157	0.344	0.344	0.344
3 Tu-Ka (KDDI)	0.167	0.167	-4.220	0.167	0.050	0.050	0.050
4 Vodafone	0.955	0.955	0.955	-5.110	0.284	0.284	0.284
5 NTT DoCoMo (PHS)	0.015	0.015	0.015	0.015	-2.421	0.576	0.576
6 WILLCOM	0.027	0.027	0.027	0.027	1.049	-1.949	1.049
7 ASTEL	0.006	0.006	0.006	0.006	0.234	0.234	-2.763

(NOTE) The cell entries i and j index rows and columns, respectively. For more details, please see the text.

Table 5: Pre-change Network Size Elasticity Matrix

	1	2	3	4	5	6	7
1 NTT DoCoMo	0.200	-0.189	-0.189	-0.189	-0.056	-0.056	-0.056
2 au (KDDI)	-0.069	0.319	-0.069	-0.069	-0.021	-0.021	-0.021
3 Tu-Ka (KDDI)	-0.015	-0.015	0.374	-0.015	-0.004	-0.004	-0.004
4 Vodafone	-0.061	-0.061	-0.061	0.327	-0.018	-0.018	-0.018
5 NTT DoCoMo (PHS)	-0.002	-0.002	-0.002	-0.002	0.314	-0.075	-0.075
6 WILLCOM	-0.004	-0.004	-0.004	-0.004	-0.136	0.253	-0.136
7 ASTEL	-0.001	-0.001	-0.001	-0.001	-0.030	-0.030	0.358

(NOTE) The cell entries i and j index rows and columns, respectively. For more details, please see the text.

Table 6: Post-merger Simulation Results

	NTT DoCoMo Vodafone				NTT DoCoMo au & Tu-Ka (KDDI)				au & Tu-Ka (KDDI) Vodafone			
	Separate	Partial	Complete	Market Level	Separate	Partial	Complete	Market Level	Separate	Partial	Complete	Market Level
Market Share												
1 NTT DoCoMo	0.538	0.515	0.616	0.608	0.536	0.489	0.632	0.619	0.562	0.526	0.597	0.625
2 au (KDDI)	0.262	0.250	0.264	0.265	0.106	0.143	-	-	0.192	0.193	0.336	0.302
3 Tu-Ka (KDDI)	0.052	0.049	0.052	0.057	0.021	0.051	-	-	0.038	0.069	-	-
4 Vodafone	0.081	0.120	-	-	0.266	0.248	0.292	0.302	0.146	0.153	-	-
5 NTT DoCoMo (PHS)	0.019	0.018	0.019	0.020	0.020	0.018	0.021	0.023	0.018	0.017	0.019	0.020
6 WILLCOM	0.040	0.039	0.040	0.042	0.044	0.042	0.046	0.047	0.037	0.035	0.040	0.043
7 ASTEL	0.008	0.008	0.008	0.009	0.009	0.009	0.009	0.010	0.007	0.007	0.008	0.009
Price												
1 NTT DoCoMo	82.795	83.740	82.635	82.212	85.217	86.741	86.474	85.735	80.100	78.680	81.630	83.040
2 au (KDDI)	75.590	75.314	75.640	75.736	88.345	89.869	-	-	76.974	78.039	76.055	75.343
3 Tu-Ka (KDDI)	51.390	51.115	51.440	51.536	64.144	65.669	-	-	52.774	53.839	-	-
4 Vodafone	82.159	83.104	-	-	70.885	70.568	71.351	71.546	73.210	74.274	-	-
5 NTT DoCoMo (PHS)	35.140	35.448	35.091	34.933	35.719	36.193	35.135	34.893	34.522	34.067	34.694	35.118
6 WILLCOM	33.498	33.555	33.493	33.379	33.615	33.688	33.518	33.387	33.385	33.279	33.399	33.416
7 ASTEL	34.236	34.204	34.289	34.315	34.112	34.039	34.267	34.302	34.342	34.345	34.343	34.302
Market Outcome												
Total Users/Population	0.658	0.664	0.657	0.650	0.640	0.648	0.628	0.622	0.674	0.690	0.658	0.642
Post-change Average Price	75.965	76.721	75.889	75.375	77.634	78.500	78.076	77.346	74.562	73.517	76.540	77.153
Market Share of Merged Carrier	0.638	0.653	0.635	0.628	0.682	0.702	0.654	0.943	0.375	0.415	0.336	0.645

(NOTE) "Separate," "Partial," and "Complete" denote the levels of integration. For more details, please see the text.

Figrure 4: Welfare Effects of Simulated Hypothetical Mergers

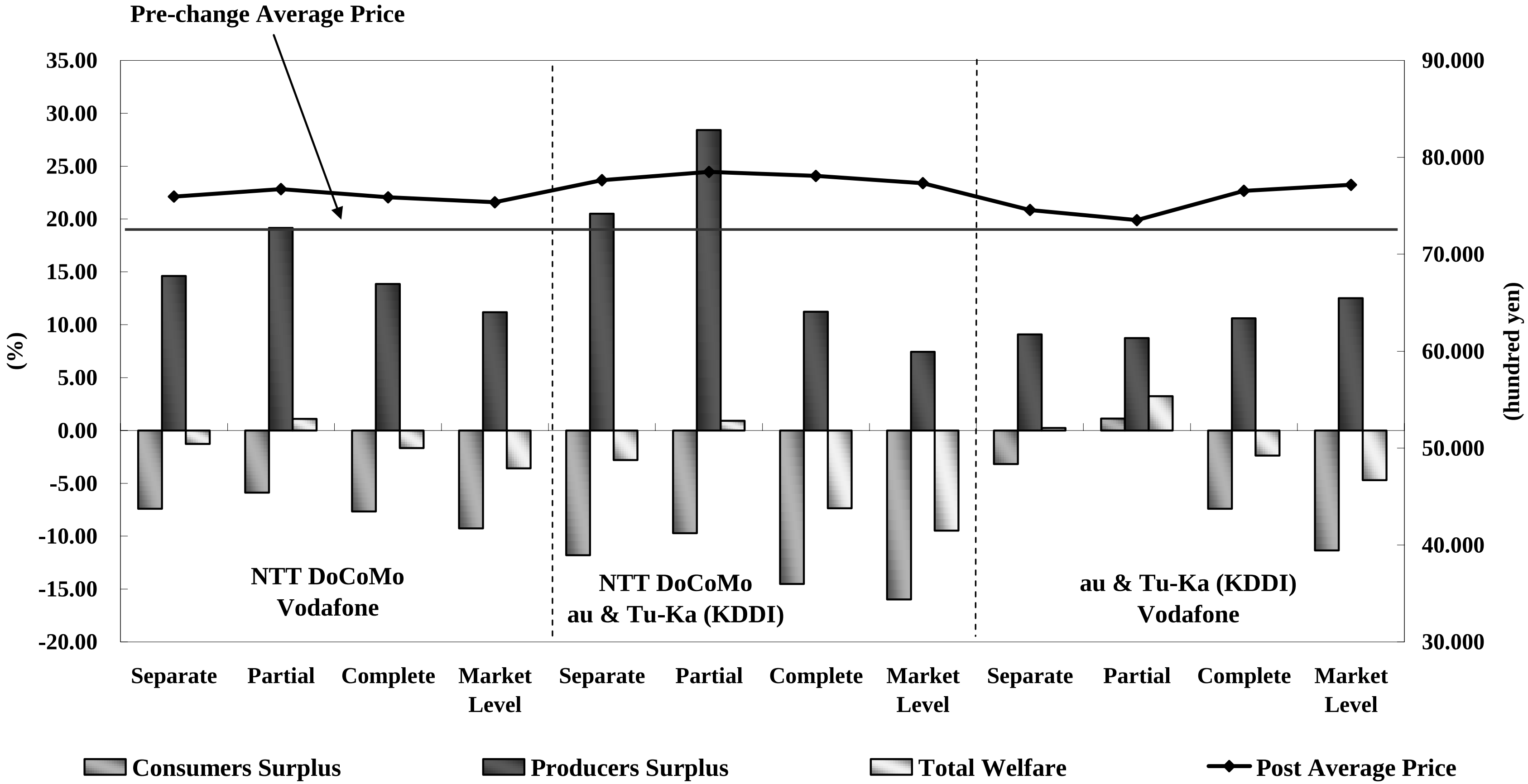
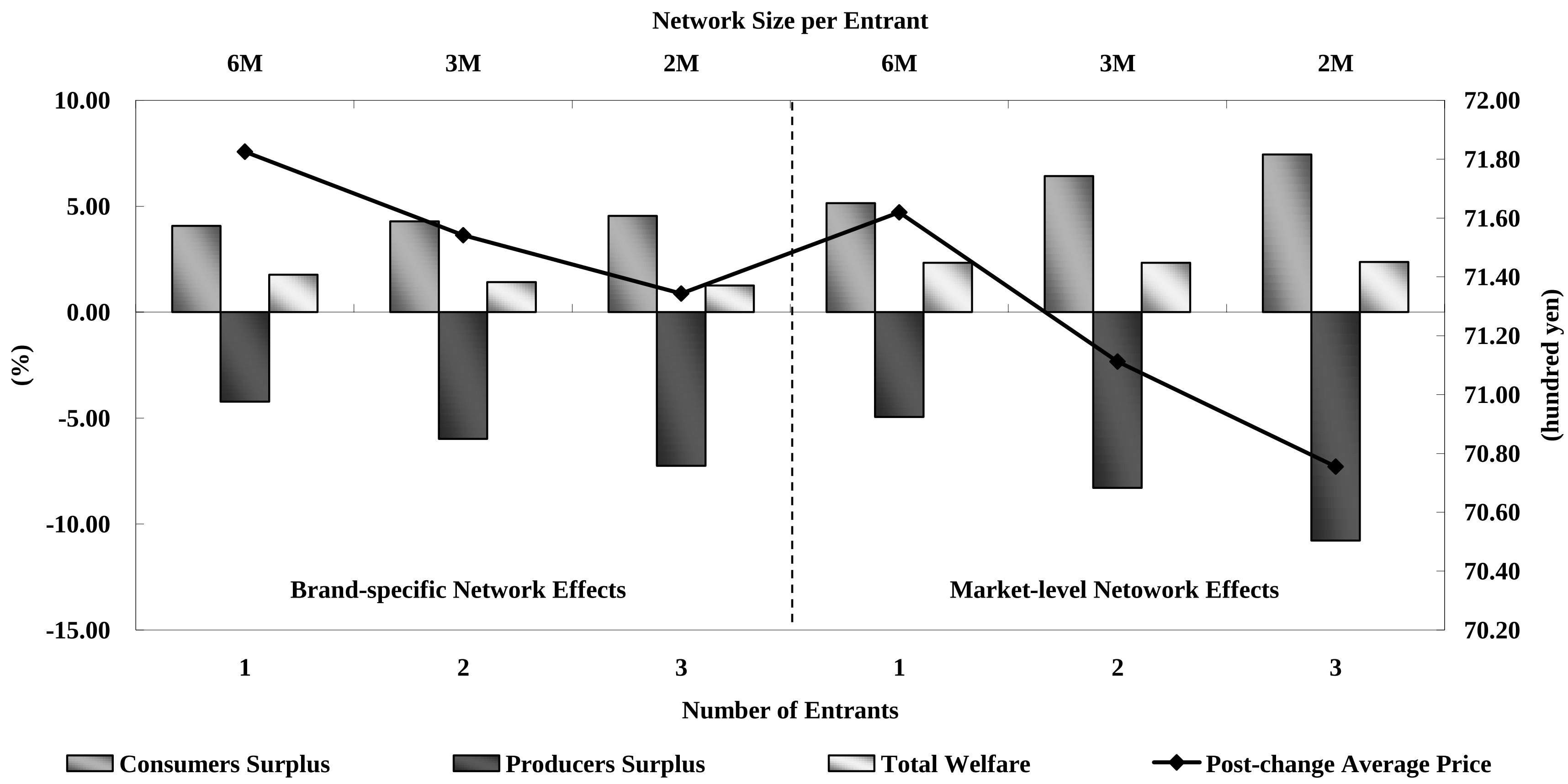


Table 7: Post-entry Simulation Results

		Brand-specific NE			Market-level NE		
	Number of Entrants	1	2	3	1	2	3
	Network Size per Entrant	6M	3M	2M	6M	3M	2M
	Market Share						
1	NTT DoCoMo	0.501	0.487	0.477	0.494	0.464	0.439
2	au (KDDI)	0.182	0.173	0.167	0.170	0.152	0.137
3	Tu-Ka (KDDI)	0.036	0.034	0.033	0.037	0.033	0.029
4	Vodafone	0.151	0.143	0.137	0.147	0.129	0.116
5	NTT DoCoMo (PHS)	0.017	0.017	0.016	0.017	0.016	0.016
6	WILLCOM	0.033	0.032	0.031	0.033	0.031	0.029
7	ASTEL	0.006	0.006	0.006	0.007	0.006	0.006
8	New Carrier 1	0.073	0.054	0.044	0.097	0.085	0.076
9	New Carrier 2	-	0.054	0.044	-	0.085	0.076
10	New Carrier 3	-	-	0.044	-	-	0.076
	Price						
1	NTT DoCoMo	77.769	77.320	76.992	77.548	76.583	75.829
2	au (KDDI)	73.892	73.720	73.598	73.714	73.367	73.112
3	Tu-Ka (KDDI)	49.689	49.516	49.397	49.511	49.167	48.911
4	Vodafone	69.108	68.995	68.914	69.042	68.808	68.637
5	NTT DoCoMo (PHS)	33.820	33.699	33.616	33.760	33.503	33.292
6	WILLCOM	33.232	33.212	33.183	33.133	33.074	33.029
7	ASTEL	34.373	34.376	34.379	34.394	34.404	34.410
8	New Carrier 1	71.852	71.618	71.509	72.142	71.994	71.886
9	New Carrier 2	-	71.618	71.509	-	71.994	71.886
10	New Carrier 3	-	-	71.509	-	-	71.886
	Maket Outcome						
	Total Users/Population	0.700	0.706	0.710	0.704	0.716	0.725
	Post-change Average Price	71.825	71.542	71.343	71.619	71.112	70.755

Figure 5: Welfare Effects of Simulated Hypothetical Entry



Appendix

Table A1: Pre-change Market Outcome (Logit)

	Share	Price	MC	PCM	Quality
1 NTT DoCoMo	0.532	78.900	32.428	0.589	0.581
2 au (KDDI)	0.195	74.400	38.905	0.477	0.227
3 Tu-Ka (KDDI)	0.042	50.200	14.705	0.707	0.027
4 Vodafone	0.172	69.400	36.596	0.473	0.169
5 NTT DoCoMo (PHS)	0.018	34.300	-12.172	1.355	0.008
6 WILLCOM	0.033	34.300	-1.195	1.035	0.013
7 ASTEL	0.007	34.300	5.225	0.848	0.004
Market Outcome					
Total Users/Population	0.686				
Average Price	72.558				

(NOTE) These are the results of the fiscal year 2003. Prices and marginal costs (MC) are divided by 100. For more detail, please see the text.

Table A2: Pre-change Price Elasticity Matrix (Logit)

	1	2	3	4	5	6	7
1 NTT DoCoMo	-1.732	0.996	0.996	0.996	0.996	0.996	0.996
2 au (KDDI)	0.344	-2.228	0.344	0.344	0.344	0.344	0.344
3 Tu-Ka (KDDI)	0.050	0.050	-1.686	0.050	0.050	0.050	0.050
4 Vodafone	0.284	0.284	0.284	-2.116	0.284	0.284	0.284
5 NTT DoCoMo (PHS)	0.015	0.015	0.015	0.015	-1.171	0.015	0.015
6 WILLCOM	0.027	0.027	0.027	0.027	0.027	-1.159	0.027
7 ASTEL	0.006	0.006	0.006	0.006	0.006	0.006	-1.180

(NOTE) The cell entries i and j index rows and columns, respectively. For more details, please see the tex

Table A3: Pre-change Network Size Elasticity Matrix (Logit)

	1	2	3	4	5	6	7
1 NTT DoCoMo	0.123	-0.071	-0.071	-0.071	-0.071	-0.071	-0.071
2 au (KDDI)	-0.026	0.168	-0.026	-0.026	-0.026	-0.026	-0.026
3 Tu-Ka (KDDI)	-0.006	-0.006	0.189	-0.006	-0.006	-0.006	-0.006
4 Vodafone	-0.023	-0.023	-0.023	0.171	-0.023	-0.023	-0.023
5 NTT DoCoMo (PHS)	-0.002	-0.002	-0.002	-0.002	0.192	-0.002	-0.002
6 WILLCOM	-0.004	-0.004	-0.004	-0.004	-0.004	0.190	-0.004
7 ASTEL	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0.193

(NOTE) The cell entries i and j index rows and columns, respectively. For more details, please see the tex

Table A4: Post-merger Simulation Results (Logit)

	NTT DoCoMo Vodafone				NTT DoCoMo au & Tu-Ka (KDDI)				au & Tu-Ka (KDDI) Vodafone			
	Separate	Partial	Complete	Market Level	Separate	Partial	Complete	Market Level	Separate	Partial	Complete	Market Level
Market Share												
1 NTT DoCoMo	0.536	0.524	0.607	0.600	0.539	0.515	0.652	0.641	0.554	0.529	0.625	0.646
2 au (KDDI)	0.235	0.227	0.257	0.257	0.138	0.161	-	-	0.189	0.195	0.294	0.268
3 Tu-Ka (KDDI)	0.048	0.047	0.053	0.055	0.028	0.045	-	-	0.039	0.054	-	-
4 Vodafone	0.108	0.132	-	-	0.216	0.206	0.252	0.257	0.149	0.157	-	-
5 NTT DoCoMo (PHS)	0.018	0.017	0.022	0.024	0.018	0.016	0.026	0.028	0.019	0.018	0.021	0.022
6 WILLCOM	0.047	0.045	0.052	0.054	0.051	0.048	0.060	0.063	0.043	0.040	0.051	0.054
7 ASTEL	0.008	0.008	0.009	0.010	0.009	0.009	0.011	0.012	0.008	0.007	0.009	0.010
Price												
1 NTT DoCoMo	83.344	84.494	84.398	83.799	85.732	87.521	87.183	86.340	79.533	78.858	81.347	81.775
2 au (KDDI)	74.375	74.227	74.816	74.773	92.209	93.997	-	-	77.712	79.077	74.448	73.601
3 Tu-Ka (KDDI)	50.178	50.047	50.617	50.549	68.012	69.794	-	-	53.499	54.873	-	-
4 Vodafone	87.511	88.664	-	-	70.101	69.950	70.588	70.633	75.403	76.768	-	-
5 NTT DoCoMo (PHS)	38.763	39.924	35.639	34.678	41.178	42.936	36.113	35.267	34.554	34.222	36.780	37.201
6 WILLCOM	28.645	28.632	28.708	28.723	28.705	28.662	28.802	28.829	28.574	28.546	28.699	28.735
7 ASTEL	34.179	34.160	34.272	34.271	34.052	33.997	34.256	34.267	34.257	34.245	34.277	34.276
Market Outcome												
Total Users/Population	0.652	0.661	0.628	0.620	0.632	0.644	0.592	0.584	0.674	0.689	0.633	0.620
Average Price	76.317	77.430	75.703	75.005	78.552	80.116	77.613	76.687	74.200	74.165	75.275	75.255
Market Share of Merged Carrier	0.662	0.673	0.629	0.624	0.724	0.737	0.677	0.926	0.378	0.406	0.294	0.668
Change (%) of												
Consumers Surplus	-8.764	-6.692	-14.651	-16.343	-13.664	-10.688	-22.601	-24.336	-3.100	0.918	-13.486	-16.503
Producers Surplus	5.197	8.665	-4.031	-6.191	6.925	12.606	-8.764	-11.467	3.274	5.567	-1.421	-2.730
Total Welfare	-2.391	0.319	-9.803	-11.708	-4.265	-0.053	-16.284	-18.461	-0.190	3.041	-7.978	-10.215

(NOTE) "Separate," "Partial," and "Complete" denote the levels of integration. For more details, please see the text.

Table A5: Post-entry Simulation Results (Logit)

		Brand-specific NE			Market-level NE		
	No of Entrants	1	2	3	1	2	3
	Network Size per Entrant	6M	3M	2M	6M	3M	2M
	Market Share						
1	NTT DoCoMo	0.475	0.444	0.420	0.468	0.170	0.390
2	au (KDDI)	0.176	0.161	0.150	0.170	0.036	0.133
3	TuKa (KDDI)	0.036	0.033	0.031	0.036	0.145	0.029
4	Vodafone	0.148	0.135	0.125	0.145	0.016	0.113
5	NTT DoCoMo (PHS)	0.015	0.015	0.014	0.016	0.034	0.013
6	WILLCOM	0.034	0.031	0.028	0.034	0.006	0.026
7	ASTEL	0.006	0.005	0.005	0.006	0.125	0.005
8	New Carrier 1	0.110	0.088	0.076	0.125	0.000	0.097
9	New Carrier 2	-	0.088	0.076	-	0.000	0.097
10	New Carrier 3	-	-	0.076	-	-	0.097
	Price						
1	NTT DoCoMo	77.261	76.303	75.537	77.108	72.932	74.573
2	au (KDDI)	73.082	72.717	72.433	72.932	48.775	72.004
3	TuKa (KDDI)	48.972	48.511	48.222	48.775	68.935	47.804
4	Vodafone	68.982	68.739	68.549	68.935	33.490	68.307
5	NTT DoCoMo (PHS)	33.557	31.664	30.888	33.490	28.422	29.969
6	WILLCOM	28.449	28.418	28.383	28.422	34.298	28.325
7	ASTEL	34.297	34.297	34.296	34.298	70.737	34.294
8	New Carrier 1	70.319	69.854	69.593	70.737	0.000	70.201
9	New Carrier 2	-	69.854	69.593	-	0.000	70.201
10	New Carrier 3	-	-	69.593	-	-	70.201
	Maket Outcome						
	Total Users/Population	0.723	0.743	0.758	0.728	0.000	0.778
	Average Price	70.930	70.286	69.835	70.805	-2.416	69.505
	Change (%) of						
	Consumers Surplus	10.894	11.447	12.078	12.405	14.340	15.936
	Producers Surplus	-0.633	-0.885	-1.087	-0.402	-0.482	-0.556
	Total Welfare	5.632	5.817	6.068	6.558	7.573	8.406