

Deregulation or Market Competition, Which Has Larger Effect on Japanese ADSL Development: Panel Data and AHP Analyses

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Abstract

When Japan started ADSL (Asynchronous Digital Subscriber Line) services, the U.S. and Korea had already one million subscribers, and thus Japan lagged behind those other two countries. In 2003, however, Japan's ADSL subscribers exceeded those of the U.S. and Korea. The reasons can be summarized as follows: (a) deregulations including competition policy; (b) competition among ISPs; (c) technological developments, and (d) others. Deregulations include the following examples: (i) collocation rules; (ii) disclosure of ADSL capacity information; (iii) unbundling; and (iv) charges for dry copper and interconnection. New entrants with extremely new charges, such as Yahoo! BB, are examples of (b). An example of (c) is ADSL connection speed; the services currently offered to subscribers are 50Mbps. Other reasons include new technological developments related to e-mail, such as digital content.

This paper heuristically analyzes the degree to which above four factors contributed to ADSL growth in Japan. We present concrete quantitative figures of the factors' contributions from 2001 to 2004, measured by AHP (Analytical Hierarchal Process) and Panel Data Analysis. The former is based on the decision-making process of managements of major ADSL carriers, and thus it is an approach from microeconomic view. The latter, however, deal with the industry as a whole, and it is an approach from industry, or macroeconomic view. By examining these two approaches, we analyze whether these two approaches are consistent each other. A single approach may contain some defect or bias, but to compare with results obtained by two methodologies confirm results with each other and this leads to some insight for further research.

I. INTRODUCTION

Accompanying recent technological development, industrial transformations have been taking place in the Japanese telecommunications market in advance of the rest of the world. These transformations can be summarized as: (a) a shift from fixed to mobile telephones; (b) the prevalence of broadband such as ADSL and FTTH; (c) voice over IP (Internet telephony); and (d) new competition in local call markets. The number of mobile telephone subscribers has already exceeded that of fixed telephones, and the number of Internet users is now the second largest in the world, after the U.S. Above all, broadband access such as ADSL (Asynchronous Digital Subscriber Line) has recently shown a remarkable increase, with ADSL representing more than 14.2 million subscribers, and Japan has taken a worldwide lead in FTTH, with 8.0 million subscribers at the end of December 2006. Japan has been the first country to experience this transformation.¹⁾

The environments of the Japanese ADSL market were not initially favorable: the ADSL service in Japan was introduced later than in Korea, U.S. and other countries, which caused Japanese ADSL penetration to lag behind. This was considered a symbol of Japan's delay in embracing the so-called IT Revolution. Since then, however, a lot of effort has been made by both private and public sectors to catch up. Among these were efforts to promote competition in the market, including deregulations in the following areas: (i) unbundling; (ii) collocation rules²⁾; (iii) disclosure of ADSL capacity information; and (iv) charges for dry copper³⁾ and dark fiber⁴⁾ for interconnection. Because of these deregulations, new entrants emerged in the market, with Yahoo! BB is representing a typical example.⁵⁾ When Yahoo! BB entered the market, it offered almost half charges of others. Since then, fierce price competition has been in effect.⁶⁾ In addition to charges, competition occurred in various services. It was Yahoo! BB that started free services such as offering modem, on-site installment, and a three month initial trial.

Generally speaking, technological development is extremely so important in the telecommunications industry and the ADSL market is no exception. Connection speed has constantly increased, and currently stands at around 50Mbps. Heavy users of the

Internet switched from ISDN to ADSL. The development of digital contents is another factor that has served to promote ADSL. Through ADSL, large volume of attached files such as pictures can be transmitted.

Much previous works are not found in analyzing the development of ADSL services not only in Japan but also in other countries. The reasons are clear. ADSL services are so new that enough data are not available for the traditional econometric analysis. Thus, most of papers such as, Eisner and Waldon [2001], Ida and Kuroda [2006], Kridel, et al. [2001], Okada, Ohashi, Noguchi and Sunada [2006], Sidak, Robert, and Singer [2002], Tanaka, Yazaki, and Murakami [2004], and Taylor [2002] make use of Discrete Choice Model such as Conjoint Analysis which was developed since 1980s, and their main objectives focus on forecasting of the Broadband (ADSL) market based on data obtained by the survey of subscribers. Because of the limitation of data and the analytical methodology, it is difficult to capture the essence of Broadband (ADSL) growth, especially how deregulations or market competition contributed its growth, or which one has stronger effect, deregulation or market competition.⁷⁾

By considering above problems, in order to estimate the economic effect of the factors, we adopt more concise methods. The methodologies we utilize in our analysis are AHP (Analytical Hierarchal Process) and Panel Data Analysis. These two methodologies are entirely different, since the former is a microeconomic approach based on managerial decision-making process, and the latter a macroeconomic approach based on data of the industry level. By using the same data on ADSL, we analyze whether two approaches are consistent each other. A single approach may contain some defect or bias, but to compare with results obtained by two methodologies confirm results with each other and this leads to some insight for further research.

The paper consists of six sections. In section 2 we show development of Japanese ADSL growth and policies to promote it. In section 3, our first analytical methodology, that is, AHP is presented. The estimation of demand function and consumers' surplus are calculated, and the method to derived economic effect of policies and other factors are discussed. Section 5 analyzes how these four factors have contributed to ADSL growth, and shows exact monetary evaluations. Panel data estimation is formulated in

section 6. The comparison of two approaches is compared in the last section.

II. ADSL DEVELOPMENT AND ITS FACTORS

2.1. Data

The economic effects of four factors in this paper are expressed in terms of consumer demand; this estimation requires us to estimate the demand function of the ADSL services. The relevant data from FY 2001 through August 2004 were obtained from the Ministry of Internal Affairs and Communications (MIC).⁸⁾

In Figure 1, ADSL charges, which are converted to Yen per Mbps unit, are shown on the left axis. The various drops in these charges, at beginning of 2002, the beginning at of 2003, and August 2003, are thought to be results of factors such as deregulations, competitions, and technological developments. On the other hand, the rate of its increase in the number of new ADSL subscribers, increased until the end of 2002, and then decreased gradually. Before the end of 2002, three sharp increases in new subscriber's number were observed -- before June 2001, from September 2001 to January 2002, and from October 2002 to January 2003. We thus attempt to identify relative contribution of the various factors to these periods of new subscriber's increase.

2.2. Implementations and Events of Factors

The important events that are commonly thought to be associated with the increase of the ADSL subscribers are presented in the following timeline:

1999

December Experimental connection in MDF started.

2000

September Revision of Telecommunications Business Law enforcement rule
(Introduction of regulations concerning unbundling in subscriber's line)

September Revision of Telecommunications Business Law Enforcement Rule
(Establishment of regulations regarding collocation)

December Admission of line sharing and dry copper connection charges

2001

- February NTT East and West started making the ADSL modem terminal.
- April Revision and enforcement of Telecommunications Business Law Enforcement Rule and connection fee rule
(Unbundling of dark fiber)
- June Enactment of notification
(Stipulation of information on collocation be disclosed free of charge)
- September Yahoo! BB started its services.
- November Inauguration of the Telecommunications Business Dispute Settlement Commission
(The mediation and arbitration became possible.)

2002

- April Yahoo! BB started BB Phone (IP phone) services.
- August Yahoo! BB started the two-month' free trial campaign.
- October Edion formed a business tie-up with Joshin Denki.
(Tie-up with the general merchandising store)

2003

- May So-net started its ADSL connection services
(Appearance of 1Mbps low-priced service)
- June OCN started its ADSL connection services
(Appearance of 1Mbps low-priced service)
- July NTT started 24Mbps connection services.

2004

- August NTT started 47Mbps connection services.

III. AHP ANALYSIS

3.1. AHP Approach

AHP (Analytic Hierarchy Process) attempts to give people's decision-making a numerical value.⁹⁾ For example, when making a purchase, on what basis does a consumer decide? A consumer consider factors such as the price, performance and design of various alternatives, then make a decision based on his/her own criteria.

AHP formulates the mechanism of such decision making. It allows us to give numerical value to vague parts of people’s decision making, with possible application to wide array of fields. An individual makes a decision based on his/her own criteria. Normally, not only one but several evaluation criteria exist, and these often conflict with each other. In a consumers’ decision-making process, the “problem” of what to choose comes first, followed by several “alternatives”. AHP attempts to comprehend the process of the decision making, assuming that there are some “criteria” relating the specific “problem” and the “alternatives”. Thus, AHP’s approach is to construct an individual’s decision making according to the hierarchic structure.

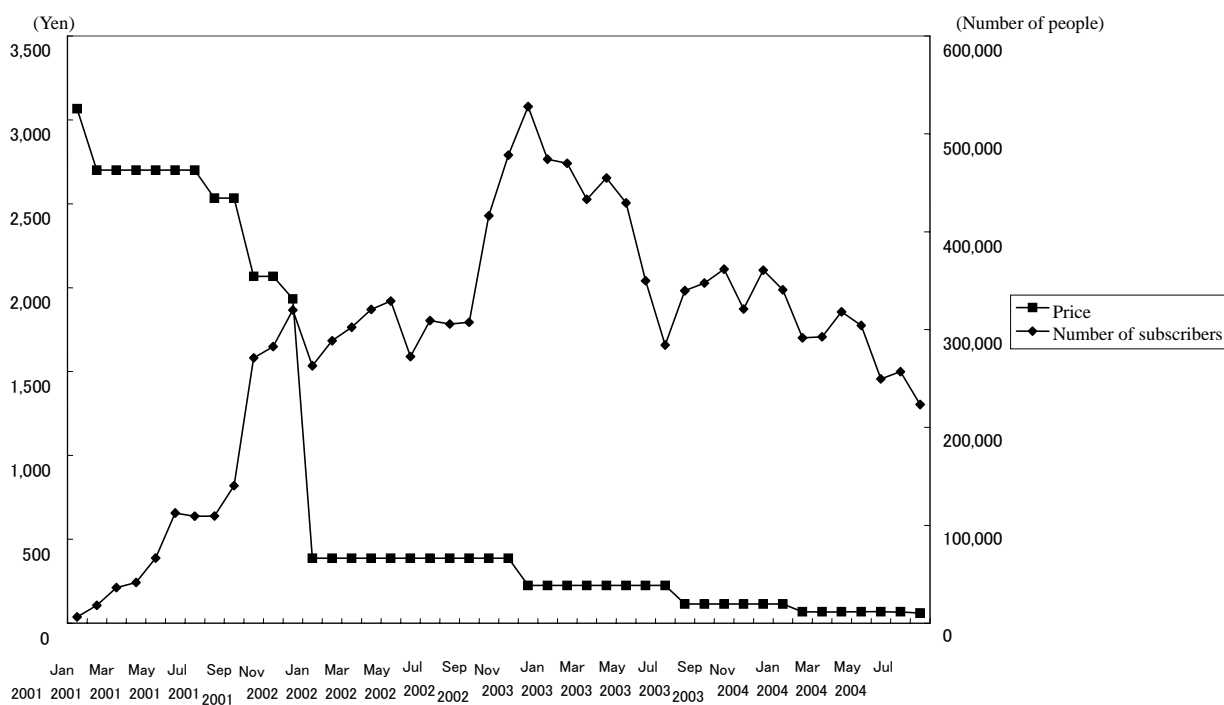


Figure 1. Transition in number of new ASDL subscribers and price per 1 Mbps
 Source: Ministry of Internal Affairs and Communications (MIC)

In this paper, we break down the main factors that boosted ADSL development into the following four; deregulation, competition, technology, and others (enhancement of content). Then we evaluate the relative importance and the degree of concrete contribution of each factor for each fiscal year from 2001 to 2004, where data exist.

3.2. ADSL Demand Function

For the sample period, we take the 44 periods from January 2001 when NTT started its DSL services, to August 2004 when it stopped the announcing of month-end subscriber numbers. We present all variables on a logarithm scale in order to stabilize the variable

In this case, the demand for services is regarded as the ADSL connection services of one month, if sign-ups and cancellations during the month are disregarded. The number of ADSL contracts at each month-end, which was announced from Ministry of Internal Affairs and Communications, is assumed to be the amount of the demand. For charges, we take the connection service charges for a month at the month-end, to ensure consistency with the demand. The data comes from the change in monthly fees for Flet's ADSL connection services. We calculated the fee in terms of Yen per 1 Mbps, so as to compensate for the effect of across-the-band improvement of connection speed. In addition, we adjusted Yen values by the Consumer Price Index for each year.

As for the income, we broke down the seasonal adjusted Quarterly GDP into values per month. Then we applied the moving-average method for the three quarters to convert to monthly data. However, with GDP data obtained in this way, the change is extremely small; thus, there is a possibility that the data may show multicollinearity with the constant term. Therefore, we removed the constant term from the estimate equation. The estimation result is as follows:

$$\ln(\text{number of contracts}) = -1.150 * \ln(\text{price}) + 2.027 * \ln(\text{GDP}) \quad (1)$$

(-12.73) (39.28)

No. of obs. = 44, $R^2 = 0.7964$, Adj. $R^2 = 0.7915$, D.W. = 0.238

The coefficient of price is negative, while that of income is positive, which shows they fill the sign condition significantly.

3.3. Estimation of Consumers' Surplus

Based on the demand function we estimated above, we found the increment of consumers' surplus as follows:

First we estimate the theoretical number of contracts from charges in each month, in which we fixed the GDP as that of the standard month to remove influence from the change in GDP. Note that when estimating the theoretical number of contracts, we omitted the normalization by Consumer Price Index. In addition, since the ADSL contracts are basically for the long term, we can consider the change in consumers' surplus relative to the yearly base. We can also see this through comparison with the annual sales. We estimate the consumers' surplus with the fixed annual price (12 times the price of the standard month), because, if there is no price change, the annual price would be 12 times charges of the standard month.

With the number of contracts and the charges we presumed as described, we estimated the increment of consumers' surplus by using a trapezoid approximation on the numbers in each month. See Table-1 for the result of this estimation.

Table-1 Increment of consumers' surplus

(million yen)

Fiscal Year	Increment of consumers' surplus
2001	31,285 (US\$2,844,000)
2002	7,071 (US\$642,800)
2003	18,458 (US\$1,678,000)
2004 (-Dec.)	2,137 (US\$194,300)
Total	58,951 (US\$5,359,000)

If March 2001 is set as the standard month, we can say that the consumers' surplus increased by 59,000 million yen.

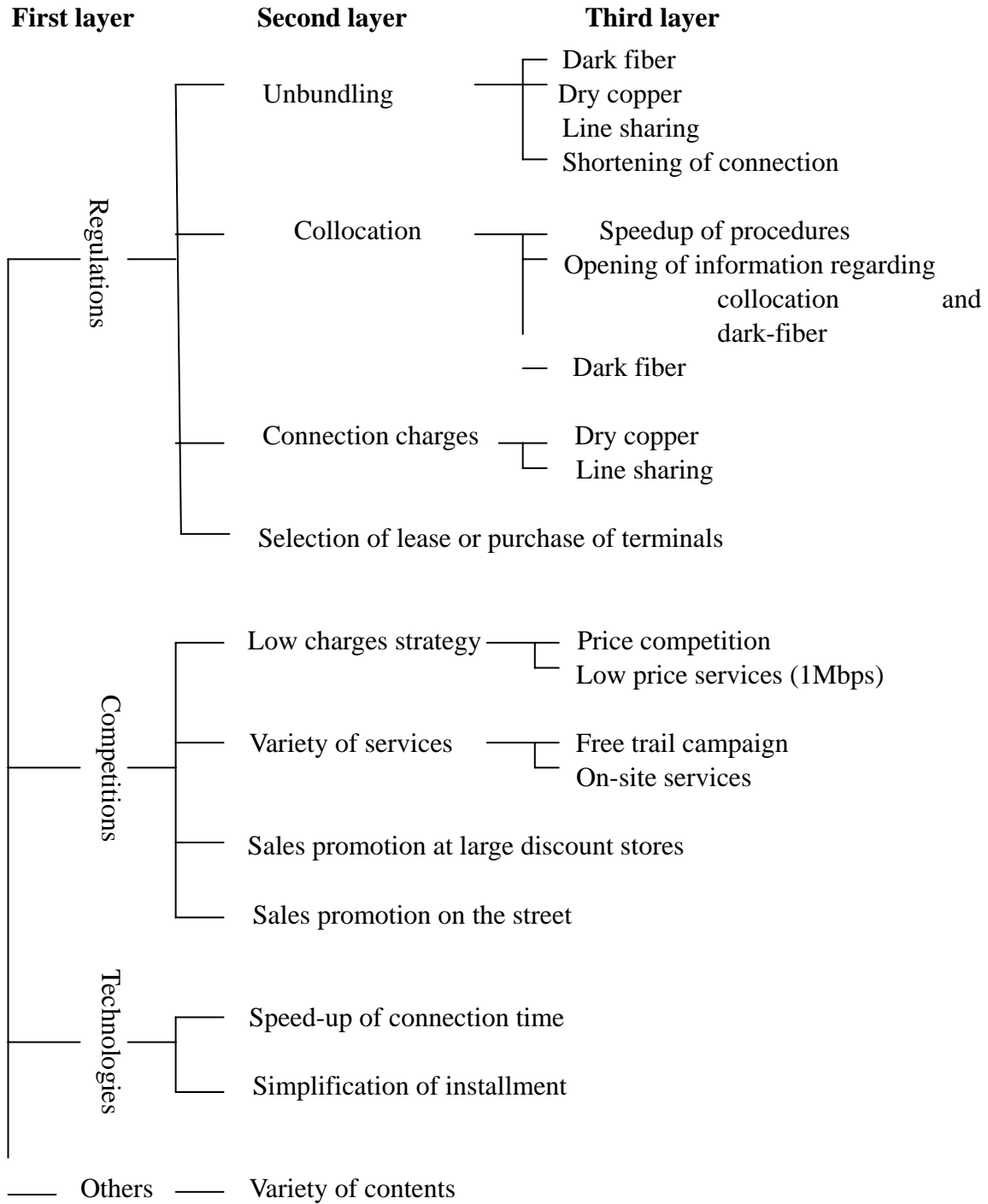
3.4. Layers of Factors

We categorize the above mentioned factors into four groups: (a) deregulation factors; (b) competition factors; (c) technological factors; and (d) other factors. These consist of factors of the “first layer”. For each first-factor, by observing policy implementations, market competition, and technological trends, we can identify more detailed sub-factors. For example, sub-factors of (a) include detailed policy measures related to (a-1) unbundling, (a-2) collocation, (a-3) connection charges, and (a-4) selection of lease or purchase of terminals. A number of sub-factors are also found for each of the other two factors (see Table 2 below). These make up the “second layer” of factors. Again, for each sub-factors, we can find more detailed factors. For (a-1) unbundling, detailed deregulations dealt with (a-1-1) dark fiber, (a-1-2) dry copper, (a-1-3) line sharing, and (a-1-4) connection shortening. These sub-factors consist of the “third layer”. The list of all sub-factors and the hierarchy of factors, are shown in Table 2.

In order to apply for our AHP analysis, we need pair-wise comparisons of all the factors in each layer. In the pair-wise comparisons questionnaire, ISPs were asked to choose a number from $1/9$, $2/9$, $3/9$, $4/9$, $5/9$, $6/9$, $7/9$, $8/9$, 1 , 2 , 3 , 4 , 5 , 6 , 7 , 8 , 9 . If they choose 1 , equal importance is placed on two factors. $1/9$ (9) implies that it factor is the least (most) important compared to another in the pair.

We asked ISPs to evaluate all the factors on 1st, 2nd and 3rd layers in Table 2. However, the relative importance of those on the 3rd layer factors turned out to be extremely low, so we will discuss only the 1st and 2nd layers in this paper.¹⁰⁾

Table 2 Layers of Questions in AHP Analysis



3.5. Weight of Each Provider

ADSL market share is indicated in Table 3. 80 – 96% of the ADSL market was occupied by the four main providers throughout the sample period. Therefore, for the AHP analysis, we asked only these four providers to assess the relative importance of factors. We then summed the score obtained from the four providers' replies, and calculated the importance of each factor. We must thus obtain the weight of each provider. For these weights we used the share of each provider for that that fiscal year. There is a small amount of market share occupied by other small providers; however, to simplify our calculation, the total market share is divided among the four major providers for the purpose of weighting.¹¹⁾

Table 3 Market hare of ISPs in the ADSL Market

	2001FY	2002FY	2003FY	2004FY
NTT	40.3	36.5	36.5	37.5
NTT East	21.4	20.4	20.4	20.6
NTT West	18.9	16.1	16.2	16.9
Yahoo! BB	20.3	33.6	35.7	35.0
eAccess	10.5	13.5	13.4	13.7
ACCA Networks	9.2	11.7	10.4	9.5
Others	19.7	4.7	3.9	4.3

Source: MIC

IV. RESULTS OF AHP ANALYSIS

4.1. Results of AHP Analysis

The results of the AHP analysis are summarized as Table 4 and Table 5. In Table 4 we see the largest absolute value of the economic effect is attributed to deregulation in FY 2001, at 10,298 million yen (US\$936,180), which corresponds with the fact that deregulations were implemented sequentially from the beginning of ADSL history. In

the 4 years total, deregulation is the second biggest factor at 17,266 million yen (US\$1,569,600), with competition in the first place at 23,510 million yen (US\$2,137,273).

Table 4 Contribution of each factor

(million yen)

Factor	2001	2002	2003	2004	Total
Deregulation	10,298 (\$936,180)	1,019 (\$92,630)	5,477 (\$497,791)	472 (\$42,910)	17,266 (\$1,569,600)
Competition	13,740 (\$1,249,910)	3,304 (\$300,364)	5,640 (\$512,727)	820 (\$74,545)	23,510 (\$2,137,273)
Technology	5,068 (\$460,072)	1,241 (\$112,818)	5,409 (\$491,727)	646 (\$42,182)	12,364 (\$1,124,000)
Other	2,180 (\$98,182)	1,777 (\$161,545)	1,931 (\$175,545)	192 (\$17,455)	6,080 (\$552,727)
Total	31,285 (\$2,844,090)	7,071 (\$642,818)	18,458 (\$1,678,000)	2,137 (\$194,427)	58,951 (\$5,359,182)

Note) The totals at the bottom are numbers of the consumers' surplus from Table-1. They do not necessarily correspond with the totals of the factors by each year.

Now let us study the percentage of each factor to the consumers' surplus in each year, which is denoted in Table 5. Deregulation accounted for 32.29% in FY 2001, 14.41% in FY 2002, 29.67% in FY 2003, and 22.09% in FY 2004. The effect was largest in FY 2001. Regarding competing factor, its percentage was at its maximum in FY 2002 when Yahoo! BB started its services.

Table 5 Contribution of each factor (%)

Factor	2001	2002	2003	2004
Deregulation	32.92	14.41	29.67	22.09
Competition	43.92	46.73	30.56	38.65
Technology	16.20	17.55	29.30	30.23
Other	6.97	25.18	10.46	8.98

In these results, the effect of deregulation seems to be slightly smaller than expected by the actual change in the market. The reasons can be summarized as follows:

- (i) The system developments which were essential in ADSL services such as dry copper, line sharing and collocation were implemented in FY 2000. The providers surveyed here possibly included those initial three deregulation factors as given in their answers, which include only year from 2001.
- (ii) Deregulations continued in FY 2001 and FY 2002 when the ADSL services has spread considerably, but charges decreased at the same time, as seen in Figure 1. Therefore, the providers were not able to clearly separate the effect of deregulations.
- (iii) The time when deregulations were implemented is the most distant from the time the providers were required to evaluate in the questionnaire, and there is a possibility that their memory was inaccurate.

We also note some relations between deregulations and competition. Competition often progresses nearly simultaneously with the regulations that enabled that competition. Also, providers will request further deregulations even as competition progresses. In such cases, the questionnaire survey cannot effectively separate the two factors. There is a possibility that, faced with this choice, the providers assigned greater importance to competition, which stands out in their recent memory. These considerations may reflect the limits of the AHP, analysis which depends on the providers' subjective responses.

5.2. Economic Effects of Specific Deregulations

Now we discuss the economic effects of factors in the second layer, which are more specific than those in the first. Let us demonstrate the results of various deregulation factors. Deregulation contained four sub-factors in the second layer: “unbundling,” “collocation,” “connection charges,” and “selection of lease or purchase of terminals”. To analyze these factors, the four ISPs were asked their weights for each in pair-wise comparisons. Again, we use the AHP analysis to determined weights.

Their economic impacts of these are summarized in Table 6.

When we look at each specific deregulation policy, we see that the effects are almost equal in the four-year totals, with little variation in numbers for unbundling, collocation, and connection charges (see Table 7). The conclusion that these three deregulation policies had similar effects is not clear, since it is possible that the ISPs could not distinguish the effect of each policy, and thus ended up giving similar points for each.

Table 6 Contribution of each deregulation policy

(millions yen and thousand UD\$)

	2001	2002	2003	2004	Total
Unbundling	3,449.1 (\$313.6)	285.0 (\$25.9)	1,639.4 (\$149.0)	148.3 (\$13.5)	5,521.8 (\$502.0)
Collocation	3,441.2 (\$312.8)	397.8 (\$36.2)	1,651.0 (\$150.1)	148.3 (\$13.5)	5,638.3 (\$512.6)
Connection fee	2,864.9 (\$160.4)	286.3 (\$26.0)	1,732.0 (\$157.5)	148.3 (\$13.5)	5,031.5 (\$457.4)
Purchase of terminals	542.5 (\$41.1)	49.9 (\$4.5)	455.1 (\$40.5)	27.4 (\$2.5)	1,074.9 (97.7)

Table 7 Contribution of each deregulation policy (%)

Factor	2001	2002	2003	2004
Unbundling	33.49	27.97	29.93	31.40
Collocation	33.42	39.04	30.14	31.40
Connection fee	27.82	28.10	31.62	31.40
Purchase of terminals	5.27	4.90	8.31	5.80

These results come from the subjectivity of the AHP analysis. To analyze this issue further, we must employ other methods of analysis in support of the AHP analysis.

V. Panel Data Analysis and its Results

5.1. Model

In this section, Panel Data Analysis is applied for four ADSL service providers bb using the same data as AHP analysis. In estimation, the following estimation is formulated.

$$\ln(\text{Subscriber}_{it}) = \beta_0 + \beta_1 \ln(\text{price}_{it}) + \beta_2 \ln(\text{GDP}_t) + \sum_j \beta_3^j \text{dummy}_{it}^j + u_{it}$$

Where Subscriber_{it} : number of ADSL subscribers, price_{it} : monthly charges of ADSL, GDP_t : monthly GDP, and dummy_{it} : dummy variable of factors, which take “0” before their implementations, “1” when they were implemented, and “0” after their implementations. The list of deregulations and events of factors utilized as dummy variables in estimation is as shown in Table 8.

5.2 Result of Estimation

In estimation, the equation takes a linear form in logarithms, and in order to take care of the endogenous problem regarding price, the instrumental variables estimation is adopted. We apply the Hausman Test for selecting either a fixed effect model or a random effect model, and since the null hypothesis was rejected at the 10% level, the former was selected. As seen in Table 9, signs of price and GDP coincide what theory suggests. Price elasticity of demand is about 0.46, and it is not so elastic. Dummy variables which indicate factors to promote ADSL growth are significant at the 1% level except d1, d6, and d9. Among them, d2 (Enforcement Rule and connection fee rule: unbundling of dark fiber in April 2001) has the largest value, and d5 (Yahoo BB started its service in September 2001) is followed.

Table 8 List of Dummy variables

time	dummy	event
Dec.2000	d1	Admission of line sharing and dry copper connection charges
Apr.2001	d2	Revision and enforcement of Telecommunications Business Law Enforcement Rule and connection fee rule
Jun.2001	d3	Enactment of notification
Sep.2001	d4	YahooBB started its service
Aug.2002	d5	Yahoo! BB started the two-month' free trial campaign
Sep.2001(Yahoo,e-Access)	d6	8Mbps service started
Aug.2002(Yahoo)	d7	12Mbps service started
Jun.2003(NTT,ACCA)	d8	24~26Mbps service started
Dec.2003(NTT)	d9	40Mbps service started

Table 9 Result of estimation (fixed effect IV regression)

Dependent variable: Subscriber of ADSL						
	Coef.	Std.Err.	z-value	p-value		
price	-0.4635	0.1021	-4.54	0.000	***	
GDP	14.4544	4.0703	3.55	0.000	***	
d1(Admission of line sharing)	0.6867	0.5442	1.26	0.207		
d2(Unbundling of dark fiber)	1.5998	0.2954	5.42	0.000	***	
d3(Enactment of notification)	1.1704	0.2669	4.38	0.000	***	
d4(YahooBB started its services)	1.2913	0.2914	4.43	0.000	***	
d5(YahooBB started free trial campaign)	0.6919	0.2414	2.87	0.004	***	
d6(8Mbps services started)	0.0914	0.1812	0.50	0.614		
d7(12Mbps services started)	0.6720	0.1549	4.34	0.000	***	
d8(24Mbps services started)	0.5412	0.1584	3.42	0.001	***	
d9(40Mbps services started)	0.1651	0.1297	1.27	0.203		
constant	-162.9671	49.7249	-3.28	0.001	***	
R-square	within	0.9091				
	between	0.4140				
	overall	0.7922				
Number of obs.		234				
Number of groups		4				

Where ***, **, and * indicate significant at the 1%, 5%, and 10% level.

VI. CONCLUSION: COMPARISION OF TWO APPROACHES

Let us discuss the results obtained by two approaches. Effects of factors are measured in terms of consumers' surplus, that is, money terms in AHP, while a panel data analysis measures effects in terms of the number of subscribers. As units are different, we cannot compare directly. We measure each factors by its percentage among total effects. According to this, we can compare effects of factors in each year except 2004, when there is no dummy variable which is significant.

Table 10 Comparison between AHP analysis and Panel Estimation

Order	2001		2002		2003	
	AHP	Panel Estimation	AHP	Panel Estimation	AHP	Panel Estimation
1st	Competition	Deregulation (Unbundling)	Competition	Competition	Competition	Technology
2nd	Deregulation	Competition	Technology	Technology	Deregulation	
3rd	Technology	Deregulation (Collocation)	Deregulation		Technology	

According to the above estimation by a panel data method, in FY 2001, d2: Revision and enforcement of Telecommunications Business Law (April), and d3: Enactment of notification (Stipulation of information on collocation be disclosed free of charge) (June), d5: Yahoo! BB started its services (September), and d6: 8Mbps service started (December) are larger coefficients. Among them, d2 and d4 are significant at less than 1%. The result of AHP, which is shown in Table 10, tells that Competition factors are most important. The result of a panel, on the other hand, shows that d5: Yahoo! BB started its services, which is major factor of competition, is smaller than d2: Revision and enforcement of Telecommunications Business Law, which represent deregulation. It seems that strength of these two factors is not the same order in two models. This is due to the difference in timing of two factors, that is, d2 was implemented in April, while d5 started in September, and this may cause the orders of

strength in two models.

In FY 2002, according to a panel analysis, d5: Yahoo! BB started the two-month' free trial campaign, which is a factor of Competition, and d7: 12Mbps service started, which is a factor of Technology are significant at less than 1% level. Moreover, the former is slightly larger than the latter. In sum, in 2002 a panel analysis shows that Competition has larger effect than Technology. These result is just coincides with those obtained by AHP.

In FY 2003, variables such as d8: 24~26Mbps service started is significant, which is a factor of Technology, and there is no other significant factor. d8, however, has the smallest coefficient, and we can say it has only limited effect. AHP analysis shows that Technology has third largest effect next to Competition and Deregulation. From these, it can be said that two approaches are significant with each other in FY 2003.

In comparison with two approaches, we conclude that they are almost consistent with each other. Especially, we pointed out that AHP may underestimate the effect of deregulations because of timing of events, that is, most of deregulations were implemented early stage of the time period and thus respondents of each ADSL providers may not recall those events well. With the help of a panel data analysis, this is not the case, but deregulations actually had limited effect in that period.

AHP and panel analyses are conducted independently, which is not the reason to compare with each other. As a result this leads to some ambiguous interpretations of the analyses. A panel model here needs more elaborations in such a way to analyze how four factors affect individual ADSL providers. If we succeed in this, then in the microeconomic level, two approaches can be compared with each other.

ACKNOWLEDGEMENT

This paper is based on Tsuji [2005a], Tsuji and Tomizuka [2006], and Akematsu [2007]. Comments on these earlier versions given by participants in the conference, and Professor Y. Kasuga, Kobe University, and M. Fukushige, Osaka University are highly appreciated. The Financial support from Japan Society for Promotion of Sciences and from Ohkawa Foundation for Information and Telecommunications to the first author is gratefully acknowledged. Thanks are due to officials of MIC, especially Mr. Kimura and Mochizuki, and Cabinet Office, government of Japan for providing data and other supports, and ADSL providers who accepted in long interviews for AHP.

NOTES

- 1) See Tsuji [2004], [2005b] in more detail.
- 2) ADSL is required to connect to local subscriber's line, which is owned by NTT locals. ISPs have to install ADSL equipment at NTT's telephone offices. The NTT locals have advantages as incumbent operators. Moreover, NTT had a strategy to promote ISDN instead of ADSL, and claimed that the latter disturbed the former. Thus, it took a time to settle this technological problem, and it is said that this made delay in starting Japanese ADSL services. Almost all deregulations regarding ADSL were related to restrict NTT locals to enforce fair competition.
- 3) The charge of dry copper is calculated by historical costs, not by long-run incremental costs. NTT locals claim that those are set too low to cover actual costs. But it is true that ADSL development became possible because of this, as we can analyze in this paper (see Tsuji [2005] in more detail)
- 4) The charge of dark fiber is based on the long-run pricing, that is, the time period of pricing is set to be several years and future demand for optical fibers will be increasing. Again, NTT locals claim that the charge is too low to cover actual costs.
- 5) Regarding the business strategy of Yahoo! BB, extensive analysis can be found in Tsuji [2003], for example. ADSL services were the company's first business in the telecommunications market.
- 6) Even Yahoo! BB has been suffering negative profit from the beginning. It is only recent that its profit turned to be positive.
- 7) Tanaka, Yazaki, and Murakami [2004] makes an attempt to derive the supply function of the ADSL market by using annual data of subscribers, but the number of

years are just several.

- 8) There are thus 44 sample data. After August 2004, MIC published only quarter data. This restricts our analysis from FY 2001 to August, 2004.
- 9) For AHP, refer to Saaty [1980] and [1986], for example.
- 10) Regarding the consistency of their answers, which can be confirmed by the transitivity test, it met our requirements.
- 11) When we asked ISPs to reply to our questionnaires, they asked that their replies should be confidential, since they were related to their business activities. In this paper, therefore, we do not present their scores related to pair-wise comparisons of factors.

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