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NAGAI, Susumu / 永井, 進

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ON THE COMPETITION OF TELECOMMUNICATIONS UNDER REGULATION IN JAPAN

Susumu NAGAI

Professor, Faculty of Economics, Hosei University, Tokyo

This essay provides a general description of the present competition and regulation in the telecommunications industry of Japan and also discusses the problem in adapting relevant economic theory to the telecom industry. The telecom market in Japan has changed considerably after the deregulation in 1985, when the former public corporation, NTT, was privatised and competition was introduced under government regulation. Privatization was to change the public corporation to a private and competitive firm.

Japan's telecom market is supported by a relatively large dense base of telephone subscribers (more than 50 millions subscribers). It will be increasingly important to promote a more intensive use of the telecom network. That is, there must be a shift from extensive to intensive development, or from a concern with quantity to a concern over quality. Privatization meant more self autonomy for management, and also was a departure from the so called "soft budget constraint" (where government budgets were available to cover any deficit in the operation of the enterprise). Another side of deregulation is the introduction of competition ; of new entrants into the telecom industry.

The most simple but important new entry is a kind of "cream skimming", protected and bypassing competitors. The problem is to reconcile the public interest in the telephone network and promote efficiency through competition. The future organization of the telecom industry which has been regarded as a typical natural monopoly is very uncertain at the present moment. The government is again examining a possible reorganization of NTT and we can expect much more discussion about deregulation of the telecom market in the near future.

1. The Present Competitive Situation in Telecommunications

Since April of 1985, the telecommunications, or, "telecom" industry in Japan has changed radically. In that year, NTT which was formerly a public corporation enjoying a monopoly situation on domestic carrier service, was privatised. Competition was introduced into the telecom market, not only in the "customer premises equipment" market, and value added network market, but also for both local and trunk call market (the public switching network business). In mid 1989, there are now 49 firms in what is called "Type I" business ; firms that install their own networks and that provide various network services.

For example, there are three new common carriers (NCC) in the trunk call market, five in the local call market, two in satellite communication, two in international telecommunication, four in mobile communication service, two in marine communication and fully 29 NCCs in the pocket "beeper" business. These firms are now competing with the incumbent carriers NTT and KDD (formerly the international carrier with a monopoly position).

Among the many NCCs, three long distance firms started private line service between the two high traffic areas, Tokyo and Osaka in 1986, and general telecom

service from September of 1987. These three NCCs serving inter-exchange area, initially set their prices below those of NTT by approximately 20 percent and gained a large number of customers. Indeed, total telephone revenue for these three entrants has increased rapidly from ¥13.3 billion in 1987 to ¥65.0 billion of 1988 (these figures are for the firm's financial reporting year which is April 1 to March 31). Collectively, they have now about a 7.3% share of the total competitive trunk call market. The number of subscribers who now contracted with three NCCs grew from 0.7 mililion in September of 1987 to 7 million by September of 1989, or roughly the same number as the total subscribers in the Tokyo metropolitan area. The market share of these firms offering competitive private line service reached 18.6% in 1988. As a result, two of these three NCCs were profitable (on a current account basis) in the 1988 financial year. Market shares and financial results for these NCC's are shown in Table 1 through Table 3.

There seems to be three reasons for the rapid growth of these new common carriers. First, the NCCs have developed a least cost carrier, self-selective adapter (by which a user can in a fairly simple fashion, choose the least cost carrier among the three NCCs and NTT while placing each call), and provided it to users at no charge.

Secondly, it has become easy to interconnect the networks of the NCCs with that of NTT. When the NCCs began network service, some local switches of NTT (cross bar switching) were so old that they could not interconnect with the NCC users. NTT was forced to either add to the function of ID (of call originator) registration within local and trunk switching, or change the old type switching to

Table 1. NCC's Market Share of Long Distance Call Market between Tokyo & Osaka

(¥billion, %)

	1987	1988
TOTAL MARKET	880.0	890.0
NCCs REVENUE	13.3	65.0
NCCs SHARE	1.5%	7.3%

Table 2. NCC's Share of Private Line Market between Tokyo & Osaka

(¥billion, %)

	1987	1988
TOTAL MARKET	36.0	43.0
NCCs REVENUE	4.9	8.0
NCC's SHARE	13.6%	18.6%

Table 3. Financial Results of Three Inter-Exchange Service NCCs
fiscal 1989 (April 1 1988 to March 31 1989)

(¥million, %)

	Revenue*	Current Profit
DDI**	40,619 (87,000)	4,477 (14,500)
Japan Telecom	26,907 (72,000)	864 (3,000)
Teleway Japan	13,292 (23,000)	▼ 4,285 (1,000)
TOTAL	80,818 (182,000)	1,056 (18,500)

( ) are expected value of 1990

* These figures for revenue include payments for NTT's local network.

** Daini Denden Incorporation

new digital one. By the end of 1988, there was almost no interconnecting problem within NTT's switching system, particularly in the present service area of the NCCs.

Finally, due to a relatively cheap price in addition to an efficient self-selection (of the least cost carrier) adapter, and to the solution of interconnection problems, the three long distance NCCs have shown a very rapid growth of sales from the initiation of their service.

What has been the reaction of NTT ? Somewhat surprisingly, NTT seemed to "cooperate with", or "protect" new common carriers at first. NTT did not ask the three NCCs pay any carriers' access charge which could have been used to subsidize other deficit-making services of NTT. Moreover, NTT paid one half of the installation cost of the POI (Point of Interface) equipment to decrease the burden of infant NCCs at the expense of NTT's subcribers.

However, as competition increased, NTT has reacted with a reduction in its telephone fee structure. First of all, in August of 1987, NTT reduced the price of private lines by 10%. After this, the price of long distance calls over 320 km (the longest distance call charge) was also cut by 10% in February of 1988. In order to reduce the long distance call charge, NTT had to accept an overall decrease in their revenue requirement by ¥70 billion. (The price cut plan included the reduction in fees for services for a number of isolated islands and the reduction of total revenue requirement was ¥80 billion.) In addition to these steps, NTT further reduced the price of long distance calls, over 320 km, by another 10% in February of 1989. This time, NTT was asked by the MPT (The Ministry of Post and Telecommunications) to reduce the local call charge in order to provide additional support to the fledgling

NCCs. In response NTT reduced the local call charge, inside a 20 km area, by 10%. The total price reduction scheme calls for NTT to lose in total, ¥90 billion revenue requirement.

At the time of the latest NTT price cut, February of 1989, the NCCs also reduced their prices and maintained, on the average, 15.2% less than NTT. At the extreme, the price of the longest distance call has decreased by 30%, in comparison with the one before privatization. The history of the reduction of telephone call charges in shown in Figure 1, and a comparison of the current tarrifs between NTT and the three NCCs is shown in Table 4.

Figure 1. History of Reduction of Telephone Call Charge

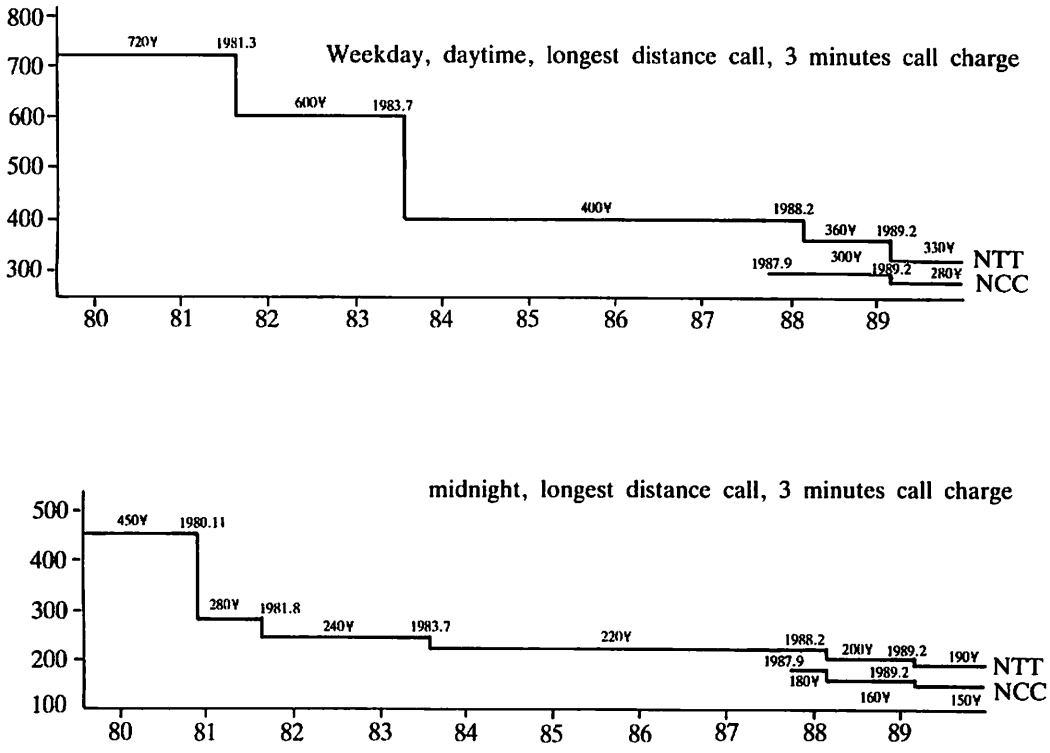


Table 4. Comparison of Telephone Call Charge between NTT and 3 NCCs.

distance (km)	current tarrif			
	NTT	DDI	JT	TWJ
meesage area	10			
adjacent	20	50	50	50
20	50	(40)	(40)	(40)
30	60			
40	90			
50				
60	120 (90)	80 (50)	80 (50)	80 (50)
70				
80	140 (90)	100 (60)	100 (60)	100 (60)
100	180 (100)	140 (70)	140 (70)	140 (70)
150				
160				
170	260 (150)	200 (110)	200 (110)	200 (110)
300				
320				
340	330 (190)	280 (150)	280 (150)	280 (150)
	Midnight 180	Midnight 140	Midnight 140	Midnight 140

a) One unit call charge is ¥10, which is 3 minutes duration.
b) figures in pareatheses are night and holiday discount rate.
c) price of three NCCs is "end-to-end" service price which includes NTT's local (message area) call charge of ¥10+¥10

2. Regulation and Competition—In the case of "Type II businesses".

In this section we will look at the present regulatory system for the telecom industry in Japan, paying special attention to the relationship between regulation and competition. In April of 1985, two new telecommunication laws (the

Telecommunications Business Law and the NTT Law) took effect. According to the Telecommunications Business Law, telecommunication carriers were divided between Type I business, which have independent lines and provide many carrier services, and Type II business, which lease private lines from Type I carriers and provide mainly value added network (VAN) services. The new law liberalized substantially Japan's telecommunications market, though Type I carriers continue to be regarded as public entities, or the public utilities, much in the same way as electric power and gas companies.

As public utilities, Type I firms are subject to considerable government regulation. The new entry of Type I carriers must be approved by the MPT which considers the overall balance between supply and demand. In a similar fashion, the exit of carriers is also controlled by the MPT. Contracted services and tariffs of Type I carriers must be approved, and further, agreement of interconnection among carriers, if necessary, requires the approval of the MPT. These requirements provide the MPT with wide-ranging power to shape the direction of the newly competitive markets.

Type II carriers are divided between "Special" and "General" Type II carriers. Special Type II carriers are those operating with 500 or more circuits, or those operating internationally. These firms must go through a formal registration process with the MPT, while the smaller General Type II carriers only need to notify the MPT of their activity.

During the process of 1982, so far as liberalization of NTT's private line is concerned, there was discussion among government. For example, in 1982, the MPT insisted that all carriers, even those which do not own transmission and switching facilities, should be regarded as public carriers, because they provide services to third parties. But this opinion was opposed at that time by MITI (Ministry of International Trade and Industry). Since then, when the Business Law was under discussion, the MPT insisted again that, from a similar point of view, special Type II carriers must be recognized and regulated as public carriers such as Type I carriers are. Further, Special Type II carriers were proposed to require the same kind of government approval as Type I carriers and to exclude foreign capital. But, this original proposal by the MPT was also abandoned because of domestic and international opposition.

The division between Type I and Type II carriers was not conducted in order to define telecommunication service differences according to basic and enhanced service.

That is a characteristic of telecom regulation in Japan. But, there are problems with this division. For example, leased circuit service is now provided by Type I carriers under strictly controlled systems, and also by the Type II carriers which can resale leased private circuit at a competitive and freely determined price. It thus became possible to have both flexible price and regulated price in the same service market. This pricing problem has led to some severe distortions in the marketing of telecom services. The same problem has occurred in VAN services. NTT provides data transmission facilities service (on-line data processing system service and communication processing service), and certainly Type II carriers also provide the same service. However, the price and operation of the former is regulated by the MPT, but that of the latter is not.

Next, we examine the situation of competition within the Type II business. Since 1985, there have been so many entrants in this sector. General Type II carriers amounted to 723 and Special Type II carriers reached 27 in July of 1989. Among the 27 Special Type II firms, 13 carriers are international VAN business carriers. In Japan, Special Type II VAN businesses are mainly off-shoot from information processing and software companies, such as Inteck Co. and Japan Information Service Co. and computer makers, such as NEC, Fujitsu, Hitachi and Oki Co. So far as international VAN business has concerned, because there are no prohibitions on the entry of foreign companies, there are now many U.S. firms, acting as the partners for a Japanese VAN company. These companies include ATT, IBM, GE, Tymnet, GTE Telenet, among others.

In contrast to the Special Type II, General Type II VAN businesses appear to have very different orientation. This large group of firms includes spinoffs from companies in the transportation business (such as Yamato System Development Co., etc.), the wholesale and retailer business, and from financial institutions. The bulk of these carriers appeared after the second liberalization of NTT's private line in 1982. The first liberalization of private line use was conducted in 1971, when not only private lines, but also publicly switched networks could be used for data transmission and the shared use of private lines was permitted. By the "shared use", we mean a close, long term relationship, such as that between manufacturers and whole-salers and among private banks. In 1982, restrictions on third party use of NTT leased circuits were substantially liberalized and small enterprise VANs were approved as a temporary measure.

The general process of deregulating data communications has been in response to strong pressure for entry from computer related industries and others in the telecommunications business. This pressure was first applied by a single company that constructed its own on-line information processing system through leased circuits from NTT in order to rationalize internal office work and, among its affiliated subsidiaries. Pressure for liberalization grew as information processing network systems were needed not only within a single company but among different enterprises.

The introduction of small enterprise VANs meant that company managers, even in small enterprises, in the retail-wholesale and transportation industries have become more sensitive to the value of information. These industries could find new business opportunities through the deregulation of the telecommunications marketplace. However, full scale VAN business had to wait until 1985 when changes came in NTT as a monopoly.

One of the biggest changes in this sector came in July of 1988 when NTT Data System Co. was formally separated from its parent company, NTT. For the time being, all stocks (its total capital is ¥100 billion) of NTT Data System Co. are owned by NTT. NTT Data System presently has 6800 employees and its initial year's revenue amounted to ¥228.8 billion. The major business of NTT Data System is in information processing system development-NTT Data System has no manufacturing division, so it is a genuine software company. NTT Data hitherto had developed large scale public service systems, such as social insurance system, and nationwide banking systems.

Competitors of NTT Data are big manufacturers, and therefore, although it is

the largest company in the Type II business, its share of the total on-line information processing industry is only estimated to be approximately 7%. However its sale of transmission processing services which are an intrinsic VAN service, is about ¥30 billion and accounts for about 18% of the total transmission processing market.

For a long time, NTT was a monopoly which provided domestic communications processing services. But, because of rapid technological innovation since the early 1980s, the monopoly situation of NTT Data had been gradually challenged by competitors, who identified the new business opportunities in this market. The big push for deregulation in this industry has come after 1982. Since then, NTT Data has lost its status as a monopoly and has now become simply one of the major competitors. Deregulation has definitely increased competition in the computer and communication industry.

We should note, however, that while competition has formally increased in these sectors, it has also been carefully limited. For example, the customers of NTT Data are mainly government and financial institutions, and its network service is a very public one. NTT Data and other VAN carriers do not directly compete with each other for the same business. The new comers, in contrast to NTT Data, are "user oriented" firms - firms which actively seek private business customers in an increasingly competitive marketplace.

Concerning the separation of NTT Data System from the parent company of NTT, an early proposal for this was contained in the Second Ad-Hoc Commission report of 1982. It was argued that this separation was desirable, in order to strengthen the competitive nature of the market. According to the Ad-Hoc Commission, if the data processing service sector stayed with NTT, it would always have an opportunity to get information of other data service providers. This kind of advantage of the network owner over the leased line carriers seemed to constitute unfair competition. However, there was not much discussion about this specific problem, and the separation of NTT Data was really conducted for different reasons. Actually, NTT was eager for the separation, because the regulations under which it was operating were too severe to accommodate rapid technological innovation. However, whatever the reasoning at the time, we can conclude that deregulation has promoted competition in this highly advanced technology industry.

At this point, it would be worthwhile to note one of the aspects of the telecommunications industry that affects the nature of competition, the low levels of sunk or irreversible costs. In general, in the Type II sector, there seems to be rather small entry barriers, because there are very few sunk costs in this market. And if there are not so much sunk costs, and easy to make an entry, then although incumbent carrier is a kind of natural monopoly, it cannot sustain its monopolistic market power. By the terms of sunk cost, irreversible cost will be properly defined. And the higher the transaction cost (the transaction specific investment) is, the higher the irreversible cost will be. However, leased line network is a standardized investment, not a transaction specific one, so it is better defined as reversible cost factor. Computers are also "reversible assets". Therefore, in the Type II business which has started from a fusion of computers and communications, there are few sunk costs and entry is rather easy. This suggests that although the previously

dominant firm (NTT Data System) appeared to be almost a natural monopoly, its position could not be maintained indefinitely.

In the Type I telecommunications sector, contrary to the expectation of the Second Ad-Hoc Commission which originally proposed the separation of NTT, within five years of initial reform, into a main operating company that handled trunk call service and several local companies responsible for local telephone operations (this idea was gained from the AT&T divestiture) there have been many new entrants. In this sector, entry, perse, demands the construction of expensive communications networks. However, there are few costs to entry for certain firms because some NCCs were separated from a parent company which can provide market entry facilities at a minimal incremental cost.

For example, Japan Telecom whose parent company is the former Japan National Railways, could easily construct a fibre optic communications network by using the right-of-way along the bullet-train (Shinkansen) tracks. Teleway Japan which is a joint venture company of Japan Highway Public Corporation and Toyota Co., also is capable of installing a fibre optic network alongside of highways. These fortunate firms did not need to purchase their own land in order to install their network system.

3. The Nature of Competition and Government Policy in Japan

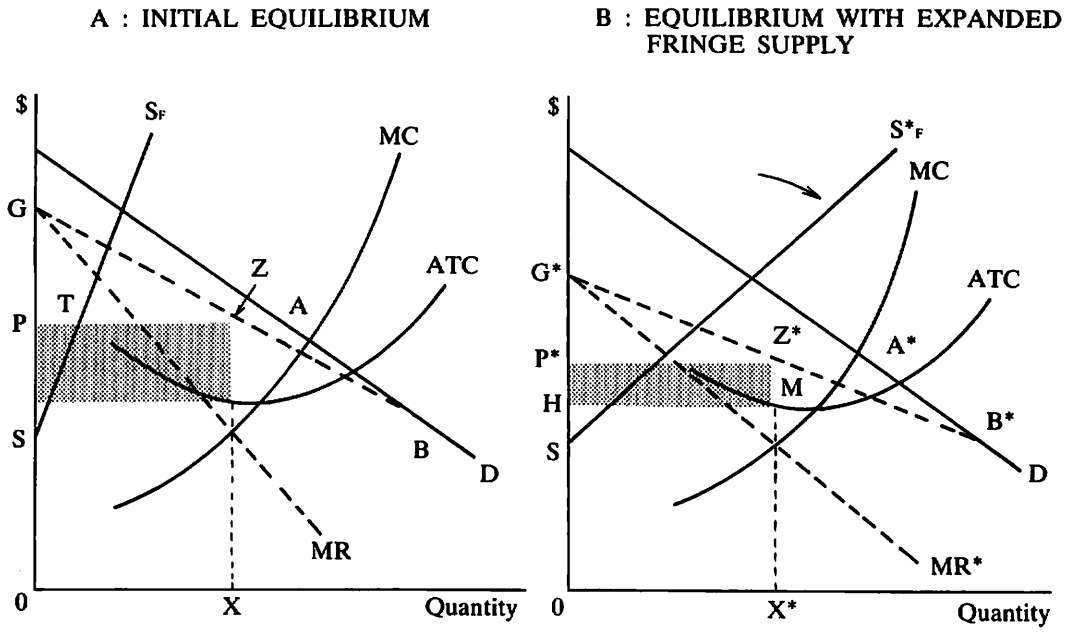
Today in Japan, there seem to be two different opinions concerning competition. And telecommunication policy has been discussed around these two view points. One opinion is that if interconnection problems will be settled down effectively, then there will be much more competition, and the NCCs will go in a larger market share. In reality, three NCCs operating in the Type I field are now broadening their service area outside of Tokyo and Osaka, and installing more POIs with NTT, and eventually could become nationwide interexchange carrieres. According to this point, increasing competition will promote efficiency of the management of NTT, and may encourage a rebalancing of the costs and charges among the different service areas (for example, local network service charges versus long distance call charges). If this scenario comes true, it probably will be necessary to further deregulate the present system, especially new entry (and exit) controls and the present rules concerning the allowable operating rate of returns.

The second opinion concerning the present condition of competition in the long distance call market is that it is like a struggle between ants and an elephant. This viewpoint focuses on NTT as a monopolistic firm, not only in its dominance of the market for long distance calls, but also its control of local networks which are said to compose an essential facility (or bottleneck) for the interexchange NCCs. According to this opinion, it will be necessary to maintain an asymmetric regulation in order to protect the infant NCCs, and if necessary, undertake a complete divestituer of NTT in order to make competition more equal.

Given this second viewpoint, it is important to evaluate the market power of NTT in the long distance telecommunication market. The present structure in this market can be described using a model of "partial monopoly". In partial monopoly, there is a big company, the dominant firm, and also a number of small fringe firms

in a market. Fringe competitors have no control over prices, but must take the price set by the dominant firm which pursues profit maximization. However, the dominant firm can only satisfy the residual demand which is the total demand minus the fringe competitors' supply. Figure 2 shows the case of a dominant firm with a growing competitive fringe. In Figure 2, D is the total demand curve, and BG is the residual demand which is the total demand minus the fringe competitors' supply curve SF, ATC, MC and MR are the total average cost, marginal cost, and marginal revenue curves of the dominant firm which sets a monopolistic price at P and earns monopolistic profit shown as the shaded rectangle. When the fringe supply expands, the dominant firm loses profits, earning only P*Z*MH in the right-hand figure. The dominant firm's market share also naturally erodes as the fringe supply expands.

Figure 2. Dominant Firm with Growing Competitive Fringe



Now let i be the dominant firm, j be the fringe competitors, E_i^d be the price elasticity of the residual demand which the dominant firm faces ; S_i the market share of the dominant firm, E_m^d the elasticity of demand of the total market and E_j the elasticity of supply of the fringe competitors. Then, the demand elasticity of the dominant firm can be written as followed.

$$E_i^d = \frac{E_m^d}{S_i} + \frac{1-S_i}{S_i} E_j$$

Given this notation, the market power of the dominant firm is defined by the

Lerner index, which is the inverse of the dominant firm's demand elasticity. The Lerner index, or the degree of monopolistic power, is higher, as the difference between the price and marginal cost becomes larger.

$$L_i = \frac{P_i - C_i}{P_i} = \frac{1}{E_i^d} = \frac{S_i}{E_m^d + E_j^s (1 - S_i)}$$

The Leaner index for a partial monopoly market, suggests three interesting results :

(1) Other conditions being given, the higher the elasticity of total demand, the smaller will be the market power of the dominant firm
(2) Other things being unchanged, the higher elasticity of supply of the fringe competitors, the higher will be the elasticity of the dominant firm's demand and the smaller will be the market power of the dominant firm
(3) The greater the market share of the dominant firm (S_i), the higher will be the market power of dominant firm.

The last proposition would seem to imply that NTT, with a large S_i would have considerable market power. However even if S_i is kept at a high level, a large value for the frige group's elasticity of supply will raise the demand elasticity of the dominant firm and reduce its market power. This conclusion has a great implication for the telecommunications industry. While it is difficult for the new common carriers which have so far entered the market to take large market share, the growth rate of their supply implies a high responsiveness to potential profits. This suggests that the elasticity of their supply is large. This leads to a higher demand elasticity and a smaller market power for the dominant carrier, even though the dominant carrier has a large market share. Growth of the fringe group's supply will force the price set by the dominant carrier closer to its marginal cost (C_i). Figure 2 shows that the monopoly profit of the shaded area decreases, with an increase in the fringe competitors' supply.

There are two reasons which reinforce the implications of the above discussion for Japanese telecommunications. First, the dominant carrier, NTT is required to provide "universal service". In practice this has meant that NTT must cross-subsidize deficit services, such as local telephone services. This obligation of the dominant firm forces NTT to react to its competitors in a very sluggish fashion. Further, the sluggishness of the dominant firm's reaction encourages the fringe competitors to increase their equipment capacity.

Second, if the fringe competitors are protected by the regulator, then it will be much easier for them to increase their supply capacity. This is a characteristic of the asymmetric regulation as it is currently produced. In 1989, NTT actually began to lose market power in the long distance call market. For example, traffic volume in the exchange office in the central business district of Tokyo has actually decreased, as shown in Table 5. This was partly because of the movement of big business users from publicly switched network service to private network communication, however, the NCC's rapid growth had also a noticeable effect.

Table 5. Growth Rates of Monthly Revenue for NTT's Dial Telephone Calls
(Compared with the previous Year)

(%)

		'87.9	'87.12	'88.3	'88.6
National Total		4.4	4.6	5.6	▲ 0.2
Tokyo district Headquarter		6.2	3.4	▲ 1.3	▲ 4.3
Chiyoda district		2.5	▲ 2.5	9.7	▲ 15.3
central office	Marunouchi	2.3	▲ 3.6	11.8	▲ 17.0
	Kanda	4.1	▲ 3.0	▲ 9.9	▲ 14.3
Kansai district Headquarter		4.9	4.1	1.2	▲ 4.3
Osaka Naka district		9.7	▲ 0.5	▲ 2.5	▲ 16.1
central office	Kitahama	11.6	▲ 5.0	▲ 12.6	▲ 27.5
	Honmachi	21.4	▲ 5.4	2.1	▲ 29.8

4. The Cross-Subsidization Problem of the Dominant Carrier

Now let us go back to the negative view point concerning competition in long distance telecommunication market. This view points to the disadvantages in the NCC's position, most prominantly because the NCCs must depend upon the monopolistic local network of NTT. If NTT increases the price of local calls, then the relative advantage of the NCCs will be directly diminished. As a result, in February 1989, NTT was pressured into reducing the price of local calls. Beyond this, the NCCs are said to have other handicaps in their competition with NTT. For example, they can not decide on the optimal location of the POIs, because they don't have sufficient information on NTT's network, such as the number of subscribers in each message area. Further, they don't know what switching equipment would be adequate for ID registration.

As a result, in early 1989s, NTT was asked to disclose more network information, and the cost and revenue associated with each disitinct telecommunications services (telephone versus telegraph, private line, mobile communication ; local versus trunk call service). This disclosure was made to encourage the handicapped NCCs and/or to discourage NTT from predatory pricing through cross-subsidization between its competitive and monopolistic businesses. These procedures are said to be a safeguard for non-structural separation requirement of NTT. These steps are probably necessary to make competition much more effective. Further steps have included the recent publications of additional network information, such as the traffic volume in each distance division, and traffic flow between different prefectures. In addition, in April of 1989, NTT disclosed its estimates of revenues and expenses by types of telephone services for the financial year of 1988.

The following are the major results of NTT's calculations ;

(1) Residential and business telephone exchange access service showed a loss of ¥290 billion, with a revenue of ¥920 billion (accounting for 20 percent of the total telephone service revenues of ¥4,700 billion) on expenses of ¥1,210 billion.
(2) Local calling services showed a loss of ¥150 billion, with revenue of ¥800 billion and expenses of ¥950 billion.
(3) Toll calling service produced a profit of ¥960 billion, with revenue of ¥2,180 billion, the largest among types of telephone services, and expenses of ¥1,220 billion.

The results of the NTT's calculation and its method of calculation were subject to considerable discussions. In particular it was suggested that the local calling service could be viewed as profitable, under an alternative method of calculation.

It is generally known that it is very difficult to distribute any common cost to different services provided by one firm. In the telecom industry, there are a great number of fixed, common costs. For example, the local network and local switching are used not only for local calls, but also for trunk and international calls. At this point we will examine the question of distributing common costs among two different kinds of products. First of all, let us assume that each product has its own constant marginal cost, C_1 and C_2. Then we can write the total cost of production for both products as :

$$TC = F + C_1X_1 + C_2X_2 \qquad (1)$$

Here, F is a fixed common cost and X_1, X_2 are the level of each production for each service, for example, the level of traffic. If we distribute a common cost fully in terms of the quantity of each product, then the ratio of the cost distribution could be written as follows :

$$f_1 = \frac{X_1}{X_1 + X_2}, \quad \text{and} \quad f_2 = \frac{X_2}{X_1 + X_2} \qquad (2)$$

$$\text{so, } f_1 + f_2 = 1$$

We can therefore determine the price of each product by its FDC (Fully Distributed Costs).

$$P_1 = \frac{f_1F}{X_1} + C_1 \qquad P_2 = \frac{f_2F}{X_2} + C_2 \qquad (3)$$

In this case, of course, total revenue (TR) is equal to total cost (TC).

$$TR = P_1X_1 + P_2X_2 = f_1F + C_1X_1 + f_1F_2 + C_2X_2 = TC \qquad (4)$$

Price setting in terms of FDC distributes a common cost so as to balance total costs and revenues.

However, pricing by FDC does not satisfy the efficiency criteria for resource allocation, because the optimal price must be equal to the marginal cost. In our case, the optimal price of each products would be written as followed :

$$P_1^* = C_1 \qquad P_2^* = C_2 \qquad (5)$$

Then, total revenue is less than total cost by the fixed cost.

$$TR = P_1^*X_1 + P_2^*X_2$$
$$TR - TC = -F \qquad (6)$$

It follows from this that under strict marginal cost pricing the firm cannot recover its fixed costs, unless the deficit is covered by an external subsidy.

A firm which must produce two kinds of complementary products, without incurring a deficit, must raise one of both prices above marginal costs. The price which maximizes consumer surpluses under the constraint of balancing total costs and revenues is called Ramsey pricing. The constraint is written as follows :

$$P_1X_1 + P_2X_2 = C_1X_1 + C_2X_2 + F \qquad (7)$$

The consumer surplus is written as follows :

$$\int_0^{X1} P_1(X_1)dX_1 + \int_0^{X2} P_2(X_2)dX_2 - C_1X_1 - C_2X_2 - F$$

In order to maximize this consumer surplus subject to the break-even constraint, it is necessary to introduce the Lagrangen equation (L), and set the first differentials of this equation, with respect to the variables, X_1, X_2, λ, to zero.

$$L = \int_0^{X1} P_1(X_1)dX_1 + \int_0^{X2} P_2(X_2)dX_2 - C_1X_1 - C_2X_2 - F$$
$$+ \lambda(P_1X_1 + P_2X_2 - C_1X_1 - C_2X_2 - F) \qquad (8)$$

$$\frac{dL}{dX_1} = P_1 - C_1 + \lambda P_1 + \lambda X_1 \frac{dp_1}{dx_1} - \lambda C_1 = 0 \qquad (9)$$

$$\frac{dL}{dX_2} = P_2 - C_2 + \lambda P_2 + \lambda X_2 \frac{dp_2}{dx_2} - \lambda C_2 = 0 \qquad (10)$$

$$\frac{dL}{d\lambda} = P_1X_1 + P_2X_2 - C_1X_2 - C_2X_2 - F = 0 \qquad (11)$$

From (9) and (10), we can deduce the following two equations.

$$\frac{P_1 - C_1}{P_1} = \frac{\lambda}{1+\lambda} \cdot \frac{1}{\varepsilon_1} \qquad (12)$$

$$\frac{P_2 - C_2}{P_2} = \frac{\lambda}{1+\lambda} \cdot \frac{1}{\varepsilon_2} \qquad (13)$$

Here, ε_1, ε_2 are price elasticities of demand for each of the product.

$$\varepsilon_1 = \left| \frac{P_1}{X_1} \cdot \frac{dX_1}{dp_1} \right|, \qquad \varepsilon_2 = \left| \frac{P_2}{X_2} \cdot \frac{dX_2}{dp_2} \right|$$

The term $\frac{\lambda}{1+\lambda} = k$ is called the Ramsey number. The ratio of the difference between the price and the marginal cost of each products to the price, is equal with Ramsey number divided by the own price elasticity of demand. As a result, the larger the price elasticity of demand, the smaller is the difference between the price and the marginal cost (and vice versa).
From the price-cost difference equations, we can determine the prices of both products.

$$P_1 = \frac{1}{1 - \frac{k}{\varepsilon_1}} \cdot C_1 \qquad P_2 = \frac{1}{1 - \frac{k}{\varepsilon_2}} \cdot C_2 \qquad (14)$$

Therefore, total revenue is written as follows and it must be equal to the total cost.

$$TR = P_1X_1 + P_2X_2 = \frac{1}{1 - \frac{k}{\varepsilon_1}} C_1X_1 + \frac{1}{1 - \frac{k}{\varepsilon_2}} C_2X_2$$

$$= C_1X_1 + C_2X_2 + F \qquad (15)$$

Above all, in the case of Ramsey pricing, we can distribute the common cost to both products as follows :

$$F = \frac{k}{\varepsilon_1 - k} C_1 X_1 + \frac{k}{\varepsilon_2 - k} C_2 X_2 \qquad (16)$$

Now let's illustrate by graph how to distribute the common cost between two products, assuming the demand function to be linear. In FIGURE 3, if we plot Ramsey price P_1^R, P_2^R on each demand curves, then the price elasticity of demand at each price P_1^R, P_2^R is written as followed.

$$\varepsilon_1 = \frac{A_1E_1}{A_1D_1} \qquad \varepsilon_2 = \frac{A_2E_2}{A_2D_2} \qquad (17)$$

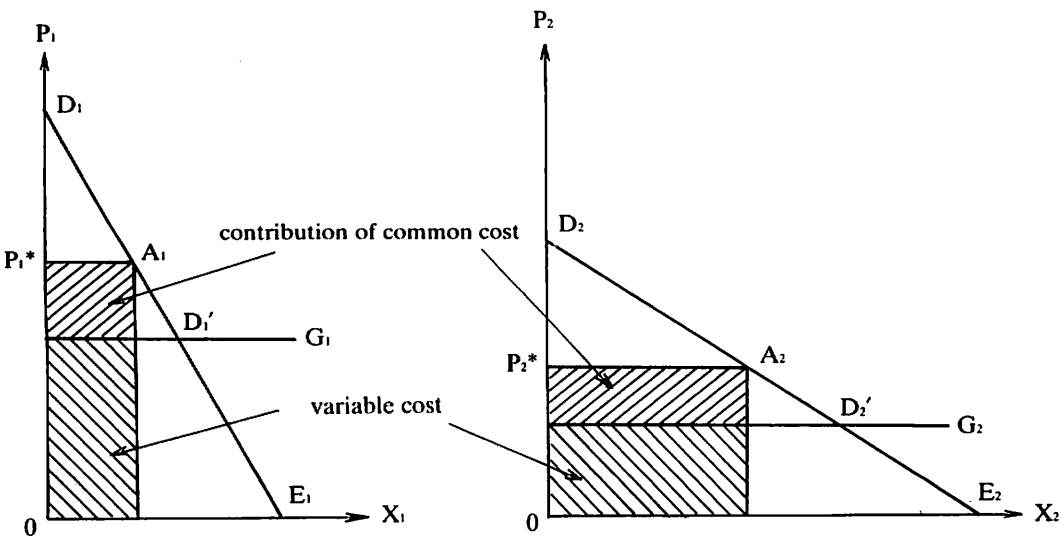
And, the differences between the price and the marginal cost of each product are as shown below.

$$\frac{P_1^R - C_1}{P_1^R} = \frac{A_1D_1'}{A_1E_1}, \qquad \frac{P_2^R - C_2}{P_2^R} = \frac{A_2D_2'}{A_2E_2} \qquad (18)$$

We can also show the Ramsey number (k) in FIGURE 3, as follows :

$$k_1 = \frac{P_1^R - C_1}{P_1^R} \cdot \varepsilon_1 = \frac{A_1D_1'}{A_1D_1}$$
$$k_2 = \frac{P_2^R - C_2}{P_2^R} \cdot \varepsilon_2 = \frac{A_2D_2'}{A_2D_2} \qquad (19)$$

Figure 3.



Because the Ramsey price requires that the Ramsey numbers of both products to be equal, the following relation can be derived.

$$\frac{A_1D_1'}{A_1D_1} = \frac{A_2D_2'}{A_2D_2} \qquad (20)$$

As a result, we can set up a Ramsey price in each product market so as to keep the above relation, and the distribution of any common costs is determined as shown in Figure 3.

Ramsey pricing is, however, second best price (in terms of resource allocation) and it is not necessarity fair price. For example, if we assume that two products have the same characteristic in production, and that the cross-elasticity of both products in the two markets are zero (perhaps we have one product which can be sold either in the domestic or in the international market), then the Ramsey pricing becomes simply a typical price discrimination. From the Ramsey pricing and $C_1 = C_2$, we can introduce the following equation.

$$P_1(1-\frac{k}{\varepsilon_1}) = P_2(1-\frac{k}{\varepsilon_2}) \qquad (21)$$

But from a situation of ordinary price discrimination, we can deduce the next equation.

$$P_1(1-\frac{1}{\varepsilon_1}) = P_2(1-\frac{1}{\varepsilon_2}) \qquad (22)$$

From these two relationships, (21) and (22), we can see that Ramsey pricing is a kind of price discrimination, and the common cost contribution is determined by the customer's ability to pay. That is, the lower the elasticity of demand is, the higher is the contribution to common costs. As a result, it can be said that Ramsey pricing does not necessarily lead to fair pricing. Let's take an extreme example. If one product faces a purely competitive market (that is infinite elasticity of demand), and the other product is sold in a monopoly market, then the total common cost must be allocated fully to the latter product.

$$P_1 = C_1, \qquad P_2 = \frac{F}{X_2} + C_2 \qquad (23)$$

Next we test at first if this kind of Ramsey price is predatory or not, and secondly if this Ramsey price is subsidy free or not. As the price of the first product P_1 is equal to the marginal cost, and also to the average variable cost, then P_1 is not a predatory price. Secondly in order to check on the existance of cross subsidization, we must estimate the incremental cost (avoidable cost) and the stand

alone cost. In our case, the stand alone cost of the second product is $F+C_2X_2$, then the incremental cost the first product becomes C_1X_1. And as the incrimental cost of C_1X_1 is equal to revenue of P_1X_1, therefore there is no subsidy from the second product to the first one. And the first product's price P_1 in competitive market is above all subsidy free price. Generally speaking, if the first price is less than its incremental cost and the second price is more than stand alone cost, then we can say the existence of cross subsidization between these two products.

From the above discussion, we can conclude that a dominant firm such as NTT may tend to shift its price structure to a kind of Ramsey pricing in order to cope with the emergence of a competitive market, but the NCCs and sometimes the government may regard this as "unfair". Although the dominant firm is likely to try to rebalance the costs, that is, to distribute more parts of the common cost to the monopolistic service such as local network service (telephone exchange access and local calling service), new competitors and regulator urge for the dominant firm to distribute more common cost to the competitive service price such as long distance call charge, and less common cost to the monopolistic service price in order to reduce their access charge to the firm.

This discussion concentrates on the supposition that Ramsey pricing may not yield an equitable price structure or an equitable distribution of common costs. The fully distributed cost (FDC) method described earlier is often seen as a more fair pricing system than Ramsey pricing. There are however many kinds of FDC. The one discussed above used traffic volume as a distribution indicater, but there are many other alternative distribution schemes. Some people even sugget using the level of revenue, although this distribution indicater itself depends upon the price which is to be determined. This kind of distribution can very well be internally inconsistent.

There is of course no unique solution to the problem of fair and subsidy free distribution of common costs. FDC must be used in financial disclosure statement and is conducted using accounting conventions. However, it is not really suitable for price determination which is now operating under the present regulation. There is a contradiction between the price regulation by the FDC and the price determination in competitive market. More competition in telecommunications market will lead to reexamination of present price regulation system.