High Speed Railway Productivity:
How Does Organizational Restructuring Contribute to HSR Productivity Growth?

By

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Bachelor and Master of Engineering, Hokkaido University, 2005

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Abstract

The institutional reform of Japan National Railway (JNR) in 1987 has been considered as a great success. After the Japanese railway reform, European countries introduced vertical separation management. However, the question whether the new companies' railway business has been improved by the privatization and vertical separation is still not well known.

To evaluate the effect of the privatization and vertical separation, this thesis applied "productivity analysis". First, we set Tokaido Shinkansen and the Paris-Lyon line as our research object because that these lines introduced the latest technology when it had been constructed. This means the technological development which increases the productivity has been very limited. Second, these lines have been profitable railway lines for a long time.

This thesis used multi-factor productivity (MFP). We set passenger-km and revenue as output separately, and personnel, non-personnel, and capital related expenses as input data. As a result, this thesis found that the JNR privatization has contributed to increase MFP of Tokaido Shinkansen after 1987.

This thesis reviewed the previous research. As a result, we figured out that their research model has difficulties showing the effect of introducing the vertical separation. From the Swedish railway data, we judged even the small market competition has more relationship with increased productivity than the style of vertical separation.

We believed that the future NEC HSR should introduce private sector's funds, and be operated by private sectors with competition within operators.

Thesis Supervisor: Joseph M. Sussman

Title: JR East Professor of Civil & Environmental Engineering and Engineering Systems

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List of Abbreviation

HSR	High speed railway
TFP	Total factor productivity
MFP	Multi factor productivity
JRCentral	Central Japan Railway Co.
JR East	East Japan Railway Co.
JR West	West Japan Railway Co.
JRC	Central Japan Railway Co.
NEC	Northeast corridor
JNR	Japan National Railway
JRTT	Japan Railway Construction Transportation and Techology Agency
MITI	Ministry of International Trade and Industry
JITI	International Transportation Institute
EPR	Expenditure per revenue
PPR	Profit per revenue
EPD	Number of personnel per operation-km
IBRD	International Bank for Reconstruction and Development
SJ	Statens Jarnvagar
BV	Banverker
EC	European Commision
NTV	Nuovo Transpori Viaggiatori
CN	Canadian National Railway
CP	Canadian Pacific Railway

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Chapter 1

Introduction

This thesis has a main research objective and some suggestions for the potential US high-speed railway (HSR) from the main research result. The main part is whether the railway industrial reforms -privatization in Japan and introducing vertical separation in Europe- have contributed to improve the productivity of their railway. After that, we suggested what type of management structure could be appropriate for the future Northeast corridor (NEC) HSR. For judging these problems, this thesis applied productivity analysis.

As Kasai (2007), said the reform of Japan National Railway (JNR) in 1987, known as privatization, has been considered a great success. The abandonment of unprofitable lines, layoff of excess personnel, and permitting the newly privatized railway companies to do the non-railway businesses, which had been forbidden before the reform, have contributed somewhat to the increase in new private railway companies' profits. On the other hand, whether the new companies' railway operation managements, which were taken over from JNR, have been improved by the new private railway companies is still not well known empirically. Chapter 2 explains what actually happened before and after the Japanese railway industrial reform and why the government needed to privatize JNR.

About 10 years after the Japanese reform, European countries had also introduced the new railway management structure, known as vertical separation. Fig 1.1 shows the image of vertical separation.

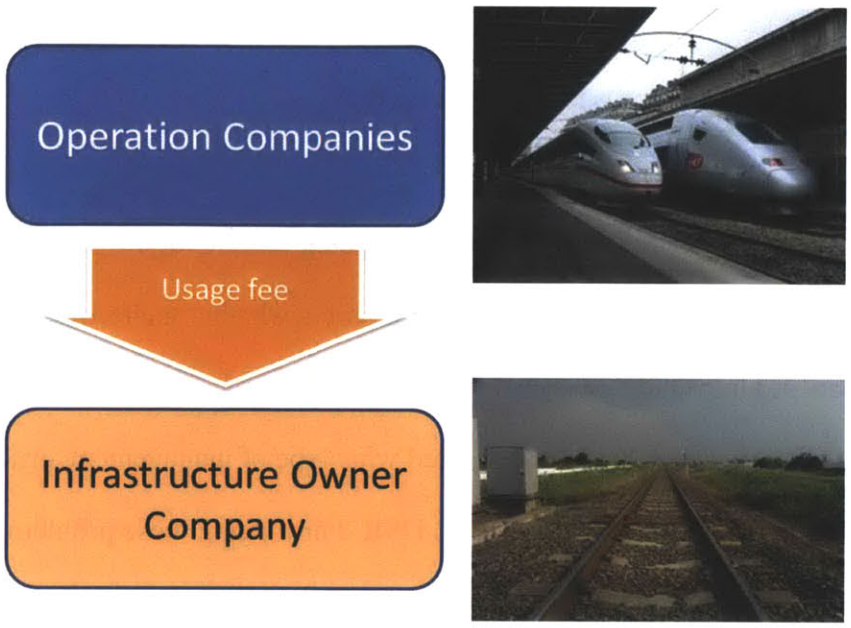

Fig 1.1 Image of vertical separation

The original idea of introducing the vertical separation was to stimulate the competition among the railway operators. It is, however, difficult to say that the current European railway industry has developed that competition. Each country introduced its own vertical separation systems, this makes the definition and analysis of the European vertical separation management difficult. Chapter 3 explains the European railway reform in detail.

For evaluating the effect of the privatization and introduction of the vertical separation in the railway industry, this thesis applies productivity analysis. Chapter 4 explains what productivity is by introducing the historical important previous research of Solow, Krugman, Trethwaym Oum, and Cowie. We set Tokaido Shinkansen and the Paris-Lyon line as our research objects. This was because the Tokaido Shinkansen line and the Paris-Lyon line introduced the latest technology when these were constructed. This means the technological development which could increase the productivity after the institutional reform has been very limited. In addition, Tokaido Shinkansen and the Paris-Lyon line were a profitable railway line even when JNR and pre-reformed SNCF operated these.

This thesis applies the *multi-factor productivity* (MFP). We set passenger-km and revenue as output separately, and we set personnel, non-personnel, and capital related expenses as input data. This research scheme is definitely different from previous research, which set the number of the personnel and the total length of their railways as input data. After we obtained the results of MFP, we also applied the *single factor productivity* (SFP) analysis. As the result of the SFP, we could see what type of expenses had a significant impact on the MFP growth. Data of Tokaido Shinkansen and Paris-Lyon line are shown in Chapter 5, and the data analysis procedure is shown in Chapter 6.

In addition, this thesis reviews some previous research evaluating the European vertical separation by productivity analysis. We determined that the previous research had significant difficulties analyzing the effect of the introducing the vertical separation management because of lack of data. Chapter 6 also shows the previous research's data graphs and conclusions.

This thesis finds that the JNR privatization has contributed to an increase in MFP for Tokaido Shinkansen after 1987. Furthermore, this thesis shows that the most significant source of the increased MFP is the capital related expense. Although an object of this thesis was to show whether the vertical separation management in European countries has improved the railway industries' productivity, not enough data were available. Thus, this thesis uses the previous findings about the productivity analysis of European railway as one of the sources in the analysis. As a result, we found that their research models had difficulties showing the effect of introducing the vertical separation. From the limited Swedish and German data, we judged even the small market competition, rather than the type of the vertical separation, has stronger relationship with increased productivity.

Chapter 7 compiled the information about the US high speed railway project, especially Northeast

corridor (NEC) HSR project. There are several reasons why the US has not yet introduced HSR into their transportation system. However, generally people may agree with the idea that NEC has a good potential to be the first HSR line in the US. This thesis analyzes the current NEC situation to suggest the appropriate industrial management structure to implement the NEC HSR.

As conclusion, this thesis suggests that the NEC HSR should introduce the private sectors' management and capital into the construction and management of its infrastructure by analysis with the Tokaido Shinkansen. Although also the well regulated competition among the future HSR operators could be recommended, it is still difficult to judge whether the competition among the operators on an infrastructure could increase the entire productivity.

As a first step, in the next chapter, this thesis discusses the detail of Japanese railway industrial reform.

Chapter 2

Japanese Railway Industrial Reform

2.1 Introduction

When JNR started the commercial operation of the world first HSR, known as Shinkansen, on October 1964, Tokaido Shinkansen between Tokyo and Osaka, passenger railway industry opened the door of the new era. Since then, the Japanese HSR line has continued extending. According to Japan Railway Construction Transportation and Technology Agency (JRTT), Japan now has 2387.7 km (1492.3 mile) of HSR. Table 2.1 shows the history of the expansion Japanese HSR.

Table 2.1 Japanese HSR extension history

	Distance (km)	Opening Year
Tokyo-Shin Osaka	515	1964
Shin Osaka-Okayama	161	1972
Okayama-Hakata	393	1975
Omiya-Morioka	466	1982
Omiya-Nigata	270	1982
Ueno-Omiya	28	1985
Tokyo-Ueno	4	1991
Takasaki-Nagano	125	1997
Shin Yashiro-Kagoshima	128	2004
Morioka-Shin Aomori	194	2011
Hakata-Shinyashiro	121	2011

Source: Visual Railway (2011)

There were several reasons why Japan has been eager to construct new HSR lines. Takatsu (2007) compiled the advantages of HSR in Japan;

1. Shortened passenger travel time
2. Capacity

3. Frequency
4. Safety
5. Punctuality
6. Environmental thoughtfulness

The first is the shortened travel time; HSR has been able to reduce people's travel time between two or more large cities. Takatsu shows one example that "Hokuriku Shinkansen from Takasaki to Nagano cut the time required to travel from Tokyo to Nagano by more than 50% from 2 hours 56 minutes to just 1 hour 23 minutes".

The second is capacity; Takatsu's report said that the latest HSR trains operated in the Tokaido line can accommodate as much as 1323 passengers. He said this number is more than "twice the capacity of a Boeing 747".

The third is frequency; Central Japan Railway Company (JR Central), the current operator and infrastructure owner of the Tokaido Shinkansen line, reported that more than 300 trains run in a day on the Tokaido line in FY2006. Takatsu also said that the Shinkansen minimum headway is just 3 minutes with an average of 15 runs per hour.

Fourth is regarding safety; not a single accident involving loss of life has occurred since Japanese HSR began the operation in 1964.

The fifth is punctuality; JR Central reported that the average delay per service of Tokaido Shinkansen is 36 seconds in FY2005. Japan International Transportation Institute (JITI) said that

Japanese airline's average delay per service is roughly 3 minutes. This gap can be a strong advantage for HSR.

The sixth is environmental thoughtfulness; with the increasing attention for the global warming, HSR is now considered as a more energy efficient and environmentally thoughtful transportation mode than automobile and airline transportation. Takatsu reported that the amount of CO_2 emission per passenger-km from the Tokaido Shinkansen is now about 16% of air transportation and 11% of automobile transportation. Of course the amount of CO_2 emission depends on the production of the electric power for HSR.

For the several reasons mentioned above, HSR is the transportation mode of recognized standing in Japan. Japanese Ministry of International Trade and Industry (MITI) showed the new growth strategy which exhibited that HSR has a great potential to be a profitable export product.

However, it was not an easy task to continue constructing HSR and establish its high status as a great transportation mode. The official web page of the Ministry of Land, Infrastructure, Transport and Tourism (MLITT) reported that JNR, completely government owned company which previously owned and operated all of Japanese HSR until 1987, almost went through bankruptcy, and the original HSR construction project, which was defined by Act for Construction of Shinkansen Railway Across the Country (1970), had been delayed several times and abandoned partly.

Understanding what actually happened in the management of the operation and construction of the Japanese HSR and why JNR was divided and privatized can help us to understand the problems in the current US passenger railway industry and potential future HSR project.

2.2 Before Tokaido Shinkansen Line

Japan National Railway Chronology (1995) issued by Japanese Railway Statistics Foundation shows the data of passenger-km of passenger railway service and ton-km of freight railway service from 1875 to 1995. Imashiro (1999) compiled some of these data, shown in Fig 2.1.

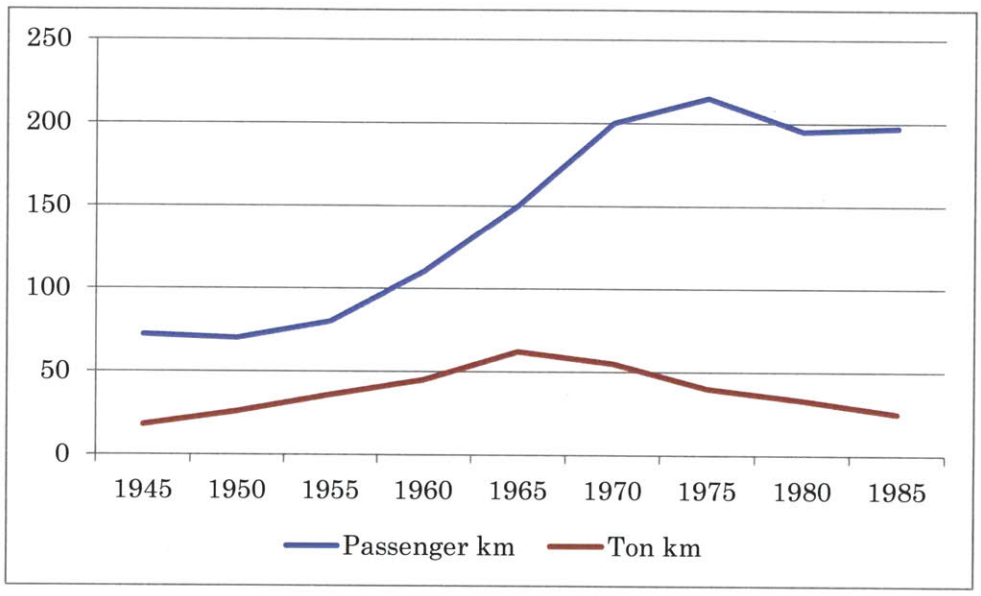

Fig 2.1 Passenger km and ton km operated by JNR (billion)

Source: Imashiro (1999)

JNR had operated both passenger railway service and freight railway service. After World War II, JNR's passenger-km and ton-km had increased through 1965 with the developing postwar economy. After 1970, ton-km, freight traffic volume had been decreasing constantly, as contrasted with still increasing passenger-km. Imashiro also compiled the data from Railway Statistics Annual Data issued by Japanese Ministry of Transportation, current MLITT.

Table 2.2 shows the JNR's financial health level between 1950 and 1980 by the ratio of operating

expenditure per revenue (EPR), profit per revenue (PPR), and the number of personnel per operation km (EPD) From the data table, Imashiro concluded that JNR's financial status was good until 1960. At least between 1950 and 1960, the revenue of JNR had exceeded their operating expenditure. Also they had received profits from their business until 1960.

Table 2.2 Transfer of the finance indexes of JNR

	EPR(%)	PPR(%)	EPD(%)
1950	97.9	3.5	23.9
1960	98	1.3	21.9
1970	113.5	-0.1	22
1980	133.8	-34	19.4

EPR=(operating expenditure)/(revenue)
PPR=(current profit)/(revenue)
EPD=(number of employee)/(operating km)

Source: Imashiro (1999)

On the other hand, after 1970, JNR's operation expenditure had exceeded its revenue, and the profit had gone negative. Generally specialists, including Ministry of Transportation, said that the biggest reason for JNR bankruptcy was the problem of excess personnel. However, it is not correct in a narrow sense. As Table 2.1 shows, the number of personnel per operation km had been decreased from 1950 to 1980.

If new railway lines which had been constructed after 1970 could have same level of EPR as the lines which had been already operated before 1970, they would not have run into financial difficulty. From these points, we can say that the railway lines, including HSR lines, constructed after the 1970s had not earned enough revenue compared to the existed lines.

2.3 Tokaido Shinkansen

Suda (1994) reported what actually happened to the construction project of the Tokaido Shinkansen line from the late 1950s to the early 1990s. Even before the project was started, JNR had realized that the rapidly increasing passenger demand for Tokaido local line between Tokyo and Osaka would be a serious problem soon. The Annual Transportation Report Book issued by Ministry of Transportation in 1956 said that "even though Tokaido line was just 2.9% (569.5 km) of total railway length in Japan, it carried 26% (36.2 billion passenger km) of total passenger km and 23% (13.1 billion ton km) of total ton km in 1955…So, there was no room to increase frequency".

As the first action of JNR for this problem, Suda said that JNR formed a research group to study the problem. Takatsu said that there were two plans. One was to improve the frequency in the existing local line by expanding its gauge from narrow (1067mm) to standard (1435mm). This is because they expected if they would expand the gauge, they could make their railway operation speed faster.

The other was the "bullet train project": constructing the exclusive line for only high speed passenger railway. Suda said that finally the CEO of JNR Sogo and Executive Chief Engineer Shima decided in 1957 with their strong leadership to construct the new exclusive bullet train, named Shinkansen, between Tokyo and Osaka.

On March 1959, the government approved the budget for the project. Suda explained that the project finance scheme was that the government loan the money to JNR for constructing HSR annually as long term indebtedness, and JNR pay it back from the revenue from the new line.

Even though JNR decided to construct new dedicated line for high speed passenger train and the

government approved the first year budget for it, this fact would not guarantee the total project success. Suda mentioned that the biggest problem was one year budget system in Japanese Diet.

Nam (2009) also said that it was difficult for JNR to pass the long term project budget bill through Congress. Nam explained that then JNR's budget had to be approved by Minister of Transportation and Minister of Finance every financial year. In addition, then Japan was in a period of inflation. The inflation ratio is shown in Fig 2.2.

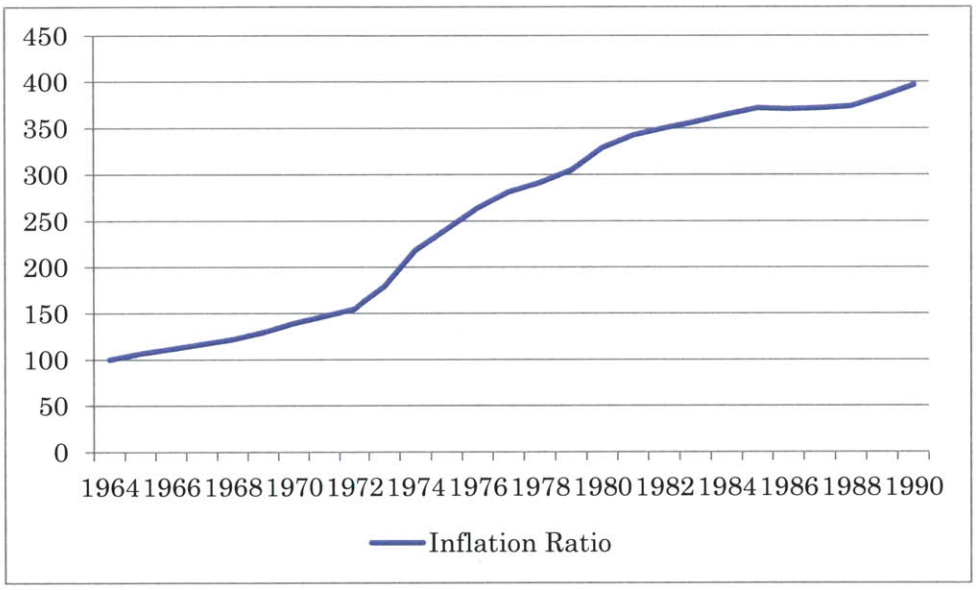

Fig 2.2 Japanese Inflation transfer (1964=100)

Source: Bank of Japan

Under such a rapid inflation, estimating the total project cost was very difficult. Sogo and JNR's HSR project team actually estimated the probability of budget shortfall after the project would start (indeed the total project cost was much higher than they estimated in FY1959). Then, Minister of Finance, Sato, one of the strong supporters of the HSR project among politicians, raised the idea that

JNR would take out a loan from the International Bank for Reconstruction and Development (IBRD), known as World Bank.

According to Takahashi (2000), Sato suggested that even if the entire government was reappointed, the agreement between the government and IBRD would guarantee the completion of the project. Indeed, the article of agreement between IBRD and JNR required the government's guarantee of completing the project. In 1961, JNR and IBRD signed an agreement with the financial loan program. Takahashi explained the details; total amount of the loan was $80 million, annual interest was 5.75%, and reimbursement term was 20 years. Later, JNR completely paid off the loan from World Bank in 1981.

After JNR received the loan from IBRD in 1961, the HSR project went well. Table 2.3 shows the construction terms and distances of the first HSR projects in each country. Compared to the other countries, short time span of Japanese HSR construction is outstanding.

Table 2.3 Comparison between the first HSR projects in each country

	Japan	France	Germany	Spain	Italy	Korea	Taiwan	China
The year of the full opening operation in each first HSR	1964	1983	1991	1992	1992	2004	2007	2008
The first line name	Tokaido-line	Southeast-line		Seville-line	Direttissima	KTX		
Cities between	Tokyo-Osaka	Paris-Lyon	*Mannheim-Stuttgart *Hannover-Wurzburg	Madrid-Seville	Firenze-Roma	Seoul-Pusan	Taipei-Kaohsiung	Beijing-Tianjin
*German case started two standoff HSR constructions simultaneously								
construction period	1959-1964	1976-1983	1973-1991	1987-1992	1970-1992	1992-2004	1999-2007	2005-2008
Construction term (years)	5	7	15	5	22*	12	15	3
* The first Italian HSR construction terms were devided into three stages First stage has 150km (1970-1981) Second stage has 74km (1981-1984) Third stage has 24km (1984-1992)								
First HSR line length (km)	515	417	426	471	248	330	345	120

Source: UIC data web page

The average annual construction length of Tokaido Shinkansen was more than 100 km. This is the longest in the data shown in Table 2.3. Of course the construction pace depends on some factors, such as geological formations and construction technology level. However, the guaranteed budget from the government and World Bank might support the trouble-free construction of Tokaido Shinkansen. As evidence, Miura showed, after JNR had run into financial difficulty in the 1980s, JNR needed much longer term to construct Tohoku Shinkansen, the average annual construction length of Tohoku Shinkansen was about 45 km.

JNR started the commercial operation of Tokaido Shinkansen line on October 1 1964. Fig 2.3 shows the line map of Tokaido Shinkansen.

Fig 2.3 Line map of Tokaido Shinkansen

Source: JR Central

In FY1964, Tokaido Shinkan line carried 3.9 billion passenger-km and 10.7 billion passenger-km in FY 1965. From the first operation year, its speed, punctuality, comfort, and safety were highly appreciated by passengers. After the opening year, JNR had increased the number of passengers in Tokaido Shinkansen line every year until 1974. On the other hand, the path to the JNR bankruptcy had already started in 1964.

2.4 Beginning of the JNR financial crisis

In FY1964, the opening year of Tokaido Shinkansen, JNR posted first-ever loss in its long history. Imashiro mentioned that after 1964, JNR had carried on the deficit operation until 1987, year of the reform of JNR. The web page of MLITT shows the reasons for JNR bankruptcy. The first is motorization. Fig 2.4 and 2.5 show the mode share changes between transportation modes in passenger and freight.

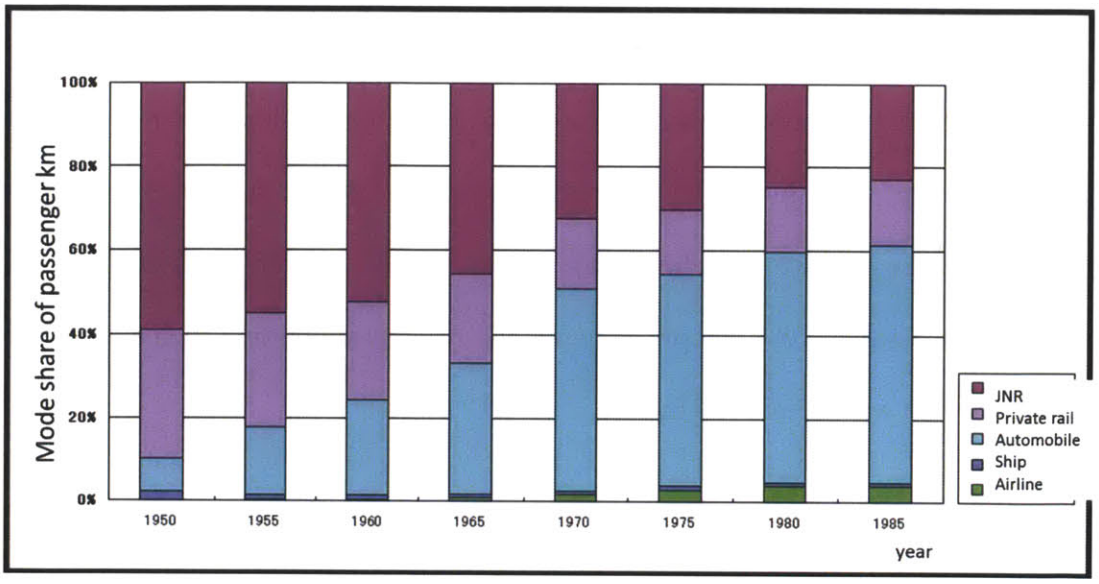

Fig 2.4 Mode share of passenger travel

Source: MILTT web page

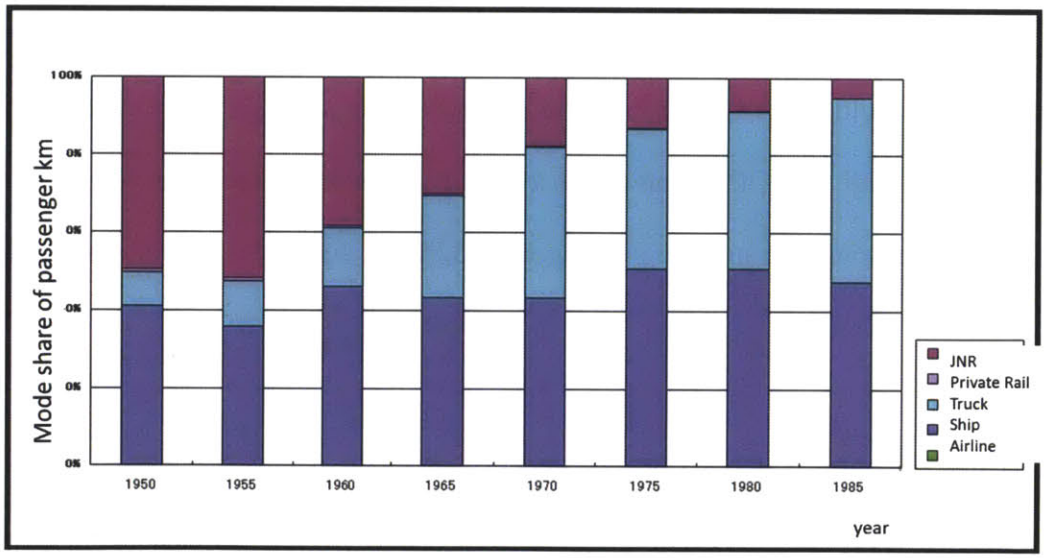

Fig 2.5 Mode share of freight

Source: MILTT web page

From 1960 to 1970, passenger transportation mode share of JNR had been reduced from about 55% to 35%. At the same time, the share in the individual automobile had been increased from about

25% to 50%. The freight business of JNR had also same problem as its passenger business. JNR had lost more than 20% freight transportation mode share from 1960 to 1970. Imashiro mentioned that it was difficult to get a receptive attitude from tax payers to cover the deficit made by JNR, especially by its freight sectors because just two years before the reform of JNR, in 1985, JNR mode share in freight transportation was less than 10%. People were not happy about supporting such a tiny mode share transportation system with taxpayer's money.

Along with the problem of the decreasing passenger and freight mode share, JNR also had problems in their management. The web page of MLITT said that JNR did not have the authority to make decisions about their ticket price and freight service price at all. If they needed to change the passenger ticket and freight prices, it was required to change the act in Diet. And indeed, the government of that time was unwilling to increase the prices because they worried about increasing the public transportation cost could cause further inflation. However, this policy actually furthered the financial crisis in JNR later. After 1974, JNR had increased the passengers' ticket prices to cover the vast amount of deficit. This process accelerated the passengers and freight customers to avoid using the service of JNR.

MLITT explained that the reason why it happened was that JNR did not have an independent management. JNR was restricted in its service price decision making process, its authority of top personnel issue, and its investment planning process by administrations and Congress. As a result, the relationship between JNR management and several labor unions in JNR was problematic. Indeed Kasai mentioned that there was almost no productive negotiation between JNR's labor unions and JNR management sector because there were too many constraints in the decision making process of JNR. Thus, Akiyama (2004) mentioned that these labor unions planned strikes to win concessions not from

the JNR management but from the administration in the 1970s many times. However, these strikes accelerated loss of the passengers using JNR services as a result.

2.5 Law of HSR

Even before the opening year of Tokaido Shinkansen, JNR already had planned to expand the line from Osaka to Hakata. Japan National Railway History (1995) said that the administration approved the construction project in 1965. As shown in Table 2.1, JNR started the commercial operation between Osaka and Okayama in 1972. Finally the line between Okayama and Hakata was opened in 1975. Fig 2.6 shows the line map of Sanyo Shinkansen line, between Osaka and Hakata.

Until the construction of Sanyo line, the projects had followed the original investment idea that JNR needed to increase the main line's capacity to respond to the increasing passenger demands. However, after the accomplishment of the construction of Sanyo line, Japanese HSR project would have been almost controlled by the government without JNR's cost revenue analysis.

Fig 2.6 Line map of Sanyo Shinkansen

Source: JR West web page

Kado (2001) discussed this change in detail. During the construction term of Tokaido Shinkansen line, politicians had realized that the HSR project could stimulate local job markets and economics. Actually, after the administration approved the first HSR project, a lot of HSR lobbies had appeared and spread throughout Japan. In response, the government passed Act for Construction of Shinkansen Railway Across the Country in 1970. This act fundamentally changed the process of the HSR planning and construction.

Before the act, JNR had planned the construction projects of Tokaido and Sanyo Shinkansen, and the government just approved the projects. However after the act, planning, adjustment, and construction order had been under the control of Minister of Transportation. This means that, after the act, Japanese HSR project had been controlled by political sector. However, the financial and demand risks had remained in JNR.

Just after the act passed, Congress approved the new HSR projects, Tohoku and Johetsu Shinkansen. These HSR's construction costs were financed by the JNR's loan from the national budget. On November 13 1972, Minister of Transportation ordered JNR to start the construction of the two new lines.

After these construction projects started, the financial condition of JNR went into a tailspin. Table 2.4 shows the construction costs of each Shinkansen line.

Table 2.4 Data of each HSR construction cost and length

	Length (km)	Construction Cost (billio Yen)	cost per km (billion Yen)
Tokaido	515	330	0.64
Sanyo	553.7	910	1.64
Tohoku	469.5	2660	5.36
Johetsu	269.5	1630	6.05

Source: Kasai (2009) and MILTT web page

The construction cost of Tohoku Shinkansen per km was almost eight times as much as the Tokaido Shinkansen. Kado mentioned the two reasons for such a high cost. The first is that Ministry of Finance cut down the budget of annual Shinkansen project in 1975. This budget cut affected the delay of the project, and the delay also had increased the total construction cost. As shown in Table 2.3, Tokaido Shinkansen had been constructed in 5 years. On the other hand, Tohoki shinkansen had needed 11 years even the length was slightly shorter than Tokaido Shinkansen.

The second is the negativeness for the project in JNR. Indeed, the CEO of JNR, Isozaki explained that "the current HSR projects, Tohoku and Johetsu Shinkansen, would be unprofitable lines" in Congress on May 1973. Fig 2.7 shows the transition of financial balance in JNR. After the Act for Construction of Shinkansen Railway Across the Country was passed in 1970, the annual deficit of JNR had gone up by about six times from 1970 to 1975 by the construction costs of Tohoku and Joetsu Shinkansen.

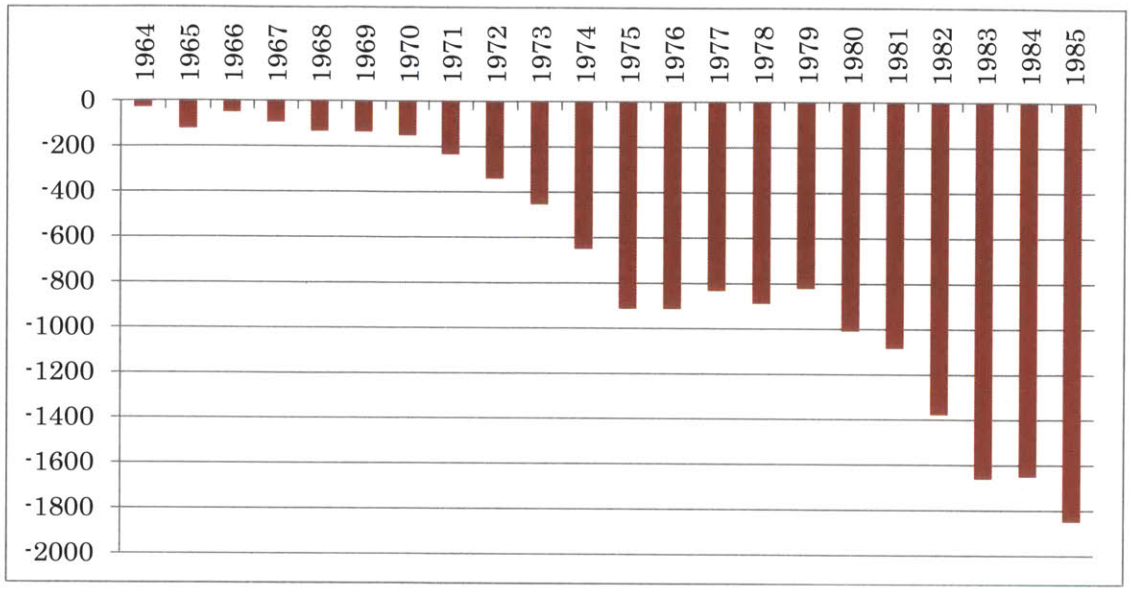

Fig 2.7 Annual deficit of JNR

Source: MILTT web page

Although the deficit had not come only from the HSR construction projects but also from unprofitable local lines and freight business, the steep increasing in this term shows how much the construction of these HSR, Tohoku and Johetsu Shinkansen, had been financial burden to JNR.

2.6 Reform of JNR

In the early 1980s, the huge amount of annual deficit in JNR was a very hot issue in Diet. Ministry of Transportation annual reports in 1981 said that Nakasone administration set up the study group, Ad Hoc Commission on Administrative Reform, which would powerfully advance the reform of JNR. In 1982, the study group issued the Opinion to the Reform of JNR. Conclusively the reform of JNR was done in line with it. This was the first official opinion which required JNR to be privatized and divided. While, on the other hand, JNR also delivered its reform plan by itself in the same year.

JNR's reform plan said that JNR should be a special company wholly owned by the government and keep it as one national railway company. However, the reform plan from JNR was not approved by customers and politicians. Kasai (2007) discussed this topic. He said this was because JNR already made some reform plans from the late 1970s, and all of these already failed then. Indeed that reform plan, issued in 1982, was the fifth attempt. Eventually, the administration chose the idea from the study group. It might be that the opinion from the study group was more rational. The opinion had divided the JNR's problems into two parts; its institutional structure and its size of management. And each part had four more detailed explanations.

1. Institutional Structure
    1.1 Intervention from the outside of JNR
    1.2 Loss of its authority
    1.3 Problematic relationship with labor unions
    1.4 Constraints in its business field
2. Management Area Size
    2.1 Inappropriate branch size
    2.2 Standardized management
    2.3 Cross subsidization
    2.4 No competitive consciousness

Source: web page of MLITT

In the institutional structure, the study group pointed out four problems. The first was that JNR management was likely to be affected from outside of its management. As this thesis will explain in Section 2.7, the CEO of JNR had been chosen by the government. It was almost impossible to reject the construction offer from government sectors.

The second was JNR management sector already lost its management authority after the government passed Act for Construction of Shinkansen Railway Across the Country in 1970, which defined that the decision whether any new HSR line would be construct would be decided by Ministry of Transportation.

The third was the problematic relationship with labor union. As this thesis mentioned above, Although several labor unions had struck many times between 1970 and 1980, the management sector of JNR could not negotiate with them because they did not have almost any decision making power.

The fourth was strict constraints in its business area; JNR's business field was strictly constrained by Japan National Railway Act, and they could do only railway business and subordinate businesses of railway, such as ferry operation between the main island and Hokkaido.

In the management area size, they also pointed out four problems. The first was inappropriate branch size. In some areas, some branches had to manage the urban area and countryside area. Actually there were characteristic difference between management of urban area and countryside area. But the JNR's branch size just ignored the difference.

The second was the standardized management in the different areas which had different economic situations. This means JNR used the single-price system in their all area. In addition, JNR had used the same compensation package in all their management area, even though the countryside employees' amount of work was much smaller than the amount of works of employees in urban areas.

The third was the unreasonable cross subsidization. Indeed, the cross subsidization had happened

between passenger and freight, urban area and local area, and profitable and unprofitable HSR. Saito (2001) explained that generally micro economists teach us that the cross-subsidization could reduce the efficiency of management of almost all industries because it reduces the management incentive from especially profitable part of business.

The fourth was no competitive consciousness in each branch. This means a profitable branch used to lose their incentive easily because any unprofitable branches used to use the revenue from the profitable branch as cross subsidy. Whether working in profitable blanch or unprofitable blanch, there was no difference in their salaries.

After the study group showed the problems of JNR, the administration accelerated the reform of JNR with its strong leadership. Kasai (2007) said that, first, the Nakasone administration changed the CEO of JNR from Nisugi, who supported the reform idea from JNR side, to Sugiura who was supported by the Nakasone administration.

Second, the administration passed the Act on Temporary Measures Concerning the Reform of Japan National Railway in on May 1983. In addition, to promote the reform of JNR and oversee the actual reform of JNR, the administration set up the Administration Committee of JNR Privatization on June 10 1983. On July 26 1985, the committee submitted the final proposal to the administration. It suggested that on April 1 1987, all JNR's business rights would be taken over by JNR Settlement Corporation, and six passenger railway companies, JR Hokkaido, JR East, JR Central, JR West, JR Shikoku, and JR Kyushu would take over the each area of passenger railway business, and JR Freight would take over the nationwide freight business Fig 2.8 shows the business area of the each passenger railway company.

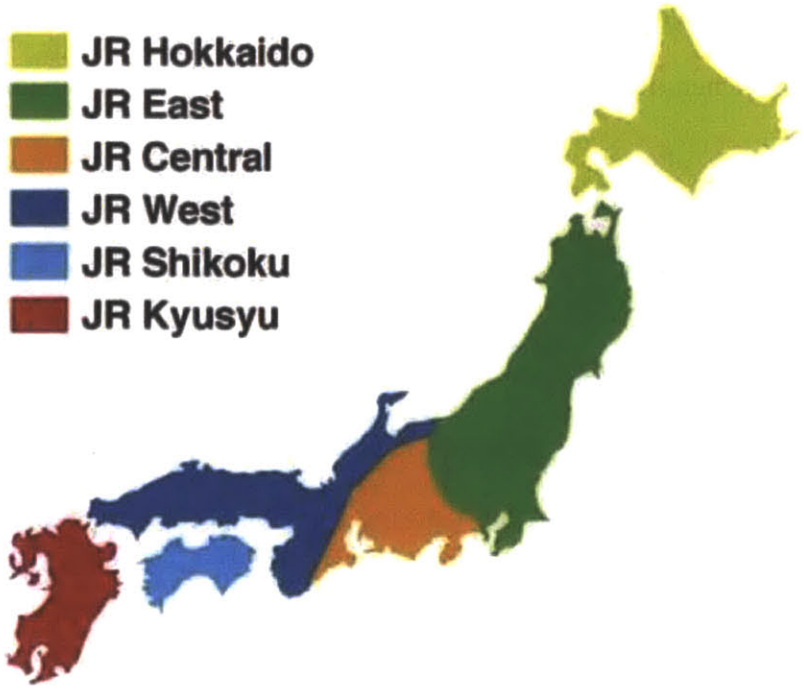

Fig 2.8 Japanese current railway business area map

Source: JR East

Third, the administration forced JNR to transfer more than ninety thousand employees to the other government owned companies, such as post service and telephone business, by April 1 1987, and each new railway company could employ the appropriate number of employees.

Fourth, 20 .6 trillion yen deficit, made by JNR, would be taken over by the new railway companies, JR East, JR Central, and JR West, and 16.7 trillion yen would be taken over by the government budget, national burden, of totally 37.3 trillion yen (about $263 billion in the currency exchange rate at the time). After the order, the government passed Act of the Japan National Railway Reform on December 1986 that forced JNR to follow the suggestion.

Kasai explained the part of JNR divided scheme more in detail. Correctly we cannot say that JNR

was divided into JRs because JNR could not sort its employees to JRs in a legal way. This was because they were public officers who had been protected from layoff. That was the reason JNR had an excess personnel problem. Thus, the administration set up JNR Settlement Corporation which took over all of the JNR personnel, and the new JRs employed the number of personnel they actually needed. As mentioned above, the fact that JNR was government owned company had made the reform of JNR difficult until just before the privatization.

2.7 Law amendment for JRs

The biggest change that happened in 1987 was the regulation reform. Before 1987, JNR was mainly regulated by Japan National Railway Act (JNR Act). The act was abolished in 1987, and the new act, Japanese Passenger Railways and Freight Railway Company Act (JR Act) came into effect. Nam compiled the difference between those two acts, and the differences are shown in table 2.5. Generally the new act approved JRs to have management flexibility, and JRs were independent from the influence of government sectors.

Table 2.5 the differences between two acts

Act	JNR Act	JR Act
Selection of board members	Appointed by Ministry of Transportation (appointive system)	Approved by Ministry of Transportation (approved system)
Budget process	Required to get permission from Ministry of Transportation, Finance, and Congress annualy	Obligated to submit annual financial statement
Revising fee	Need to revise act	need to get permission from Ministry of Transportation
Personnel	Public officer	Private company's staff
Business Area	Restricted only in railway business	Basically free

source: Nam(2009)

There were four main points of differences. The first is the procedure of selecting board members; in JNR Act, the CEO had been chosen by the administration. And their compensation was determined by the act. This part had accelerated the government's intervention. On the other hand, JR Act says that the JRs need to get permission about their selecting of board members. This means the appointive system in JNR Act was revised to be the approval system.

The second is budget making process; JNR Act had required JNR to submit its budget plan to Ministry of Transportation annually, and Ministry of Transportation had needed to negotiate with Ministry of Finance. After that, the budget plan had to be approved in Congress. When JNR wanted to issue its bonds, they need the permission from Ministry of Transportation. Conversely in JR Act, almost all budget planning processes is same with the other private railway companies, even though JRs still needed the permission from Ministry of Transportation when they issue the company bonds and new stocks.

The third is the service price revising process; in JNR Act, when JNR wanted to revise its ticket fee and freight service price, the revising plan needed to pass Diet because JNR's ticket fee had been regulated by Public Finance Act. While in JR Act, it said that JRs need to get permission from Ministry of Transportation. This means the process was changed from that had been required to revise the part of act to that was required to get permission. Actually since JR Central started the new special HSR service, which only stop at Nagoya between Tokyo and Osaka, JR Central has charged the extra cost for the express service.

Fourth is the position of personnel; JNR Act defined that the personnel of JNR were public officers. Thus, their position had been guaranteed by Public Corporation and National Enterprise Labor

Relations Act (1950). Thus, JNR almost had not had the right to shed them. On the other hand, now each JR's employees are just staff of private companies in JR Act.

The fifth is the constraint in their business areas; JNR Act had strictly regulated its business areas. JNR could manage only railway business. This means JNR had been forbidden to manage almost all non-railway business even though they had lot of potentials. Conversely JR Act required Ministry of Transportation to accept JRs' new businesses if their business plan is rational. Currently there are almost no constraints about the JR's business filed. For example, JR East had managed the affiliate company which did the automobile sales.

As mentioned above, we can say the biggest change in 1987 was deregulation. The new JR Act relaxed a lot of regulations which were set by JNR Act. However, is that privatization? Then, what is the privatization? This topic is discussed in Section 2.9.

2.8 HSR Holding Company

As explained in the previous section, a lot of regulations were changed between before and after April 1st 1987. Above all, introducing the vertical separation management, one company or government sector owns transportation infrastructure, and the other company or government sector manages the operation of the railway by using the infrastructure, in HSR operation by HSR Holding Company was the most complicated and still controversial topic. Aida (1992) mentioned about what was the role of this company and what actually happened around the Japanese vertical separation management.

HSR Holding Company was funded by the government on the basis of Act of HSR Holding Company. The holding company had owned every HSR infrastructure, and they leased it to JR East, JR

Central, and JR West. The holding company had received the usage fee from the three JRs. The holding company took over the JNR deficit of about 8.1 trillion yen. The HSR usage fee was dedicated to pay it back. Imashiro mentioned the each company's ratio of the usage fee was about JR East (Tohoku and Johetsu Shinkansen) 30%, JR Central (Tokaido Shinkansen) 60%, and JR West (Sanyo Shinkansen) 10%.

This ratio was definitely different from the actual construction cost shown in Table 2.4. Imashiro concluded that HSR Holding Company undertook a role that redistributed HSR profits from Tokaido Shinkansen to Tohoku and Johetsu Shinkansen. Indeed, the ratio of HSR passenger was JR East 20%, JR Central 50%, and JR West 22%. That ratio is closer with the ratio of usage fee than the construction cost ratio.

At the same time, Act of the Japan National Railway Reform also demanded the government to open JRs' stock to the public after the market would recognize that each JR had enough financial stability. Obermauer (2001) mentioned that although 1987 was generally recognized as the privatization year of JNR, still the government owned all JRs' stocks then. If the meaning of privatization is that previously government owned company would be owned by private sectors, then JR East, JR Central, and JR West were not privatized in 1987, and the rest of JRs, JR Hokkaido, JR Kyushu, JR Shikoku, and JR Freight, are still not privatized in 2012. When the government started preparing for the offering of stock to the public, the presence of HSR Holding Company was regarded as an obstacle.

Kasai explained that why the holding company would be the obstacle; the CEO of Tokyo Stock Exchange contested the validity of the stability of usage fee. Indeed, the contract between JRs and HSR Holding Company said that the term of leasing was thirty years. However, they did not explained that the forward markup and what they would have to do after the contract would be expired in 2017. Eventually, the government decided to abolish the vertical separation management system, and they sold

each HSR infrastructure to JR East, JR Central, and JR West in 1991. Table 2.6 shows the amount of each payment for HSR infrastructure.

Table 2.6 Aount of money for buyout of each HSR infrastructure

		Buyout fee (billion Yen)	Ratio
JR East	Tohoku and Johetsu	3094	34
JR Central	Tokaido	5096	56
JR West	Sanyo	1001	11
Total		9100	100

Source: MILTT web page

Imashiro also mentioned that just after the buyout, the financial indexes of JR East, JR Central, and JR West dropped off, shown in Table 2.7.

Table 2.7 Financial indexes after 1987

		1987	1990	1993
EPR (%)	JR East	81.1	83.9	78.1
	JR Central	91.3	87.9	64.8
	JR West	90.6	86.5	85.9
PPR (%)	JR East	4.5	8.1	5.2
	JR Central	7	11.7	5.8
	JR West	1.1	9.8	5.8

EPR=(operating expenditure)/(revenue)
PPR=(current profit)/(revenue)

Source: Imashiro (1999)

However, after we calculated the productivity of Tokaido Shinkansen's management, we found that the ownership of HSR infrastructure by the operator, known as integrated management, has contributed to increase MFP of Tokaido Shinkansen, shown in Chapter 6.

2.9 Definition of Privatization

The significant difference between Japanese and EU vertical separation management was their intents. As this thesis discussed in Chapter 3, EU originally intended to stimulate the competition within HSR operators to improve passengers' benefit and operators' management efficiency. On the other hand, the role of Japanese HSR Holding Company was just to redistribute the revenue from the highest profitable line, Tokaido Shinkansen, to the lower profitable lines.

Kasai explained that after the government and JRs cleared the obstacle, the government cashed out part of JR East's stock in 1993, JR West in 1996, and JR Central 1997. Since 2001 on the eve of completing privatization, JR East, JR Central, and JR West no longer have been under the regulation in JR Act. Now they are just regulated by Railway Business Act which regulates all Japanese private railway companies. Finally, the government cashed out the rest of JR East's stock in 2002, JR West in 2004, and JR Central in 2006, shown in Table 2.8

Table 2.8 Process of the privatization

Year	Event
1987	JNR's business right was taken over by JNR settlement corporation. HSR infrastructure was taken over by HSR holding company New 6 passenger railway companies and a freight railway company started their businesses
1991	HSR holding company was deactivated
1993	The government released the part of JR East's stocks
1996	The government released the part of JR West's stocks
1997	The government released the part of JR Central's stocks
2001	JR East, West, and Central was released from JR Act
2002	All JR East stocks were released into the market
2004	All JR West stocks were released into the market
2006	All JR Central stocks were released into the market

Source: Kasai (2007)

As this thesis mentioned above, even though the JNR was recognized to be privatized in 1987 generally, it is not correct. At least when JNR was privatized depends on what is privatization. Starr (1988) defined and categorized privatization. He said that privatization is very "ambiguous" word. However, the most important point is "ownership" of the organization. Obermauer set the five levels in the railway ownership and Table 2.9 shows that. She defined that the complete privatization means the companies' almost all stocks should be owned by private sectors or individual stock owners, level 5.

Table 2.9 Levels of ownership of passenger railway companies

Levels		Railway Companies
Level 1	State-owned companies without commercial statutes	None
Level 2	State-owned companies with commercial statutes	Luxembourg Railways, Irish Railways, Portuguese Railways, Danish State Railways, Austrian Federal Railway, RENFE, SNCF, SNCB
Level 3	Joint-stock companies, majority state owned	JR Freight, JR Hokkaido, JR Kyushu, JR Shikoku, DB, Trenitalia,
Level 4	Joint-stock companies, majority privately owned	None
Level 5	Fully privately owned joint-stock companies	JR East, JR Central, JR West, TOCs in the UK, Italo

Source: Obermauer (2001)

At this point, JR East was entirely privatized in 2002, JR West was in 2004, and JR Central was in 2006.

2.10 HSR construction scheme after 1987

Until the entire privatization, each JR (JR East, JR Central, and JR West) have been still stuck in constraints by the public sector's control, such as the system of HSR Holding Company and JR Act. From this point of view, how to alleviate the intervention from the public sectors has been significant issue to JRs. Especially, the project of new HSR construction, which needs huge capital cost, was a very

sensitive topic to each JR. Thus, the government revised Act for Construction of Shinkansen Railway Across the Country. MLITT shows the construction financial scheme in its official web page. Fig 2.9 shows the image of the financial scheme.

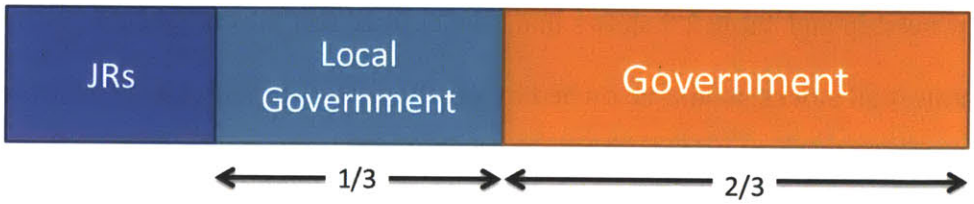

Fig 2.9 Current HSR finance Scheme

Source: web page of MLITT

After the revision of the act, MLITT has been required to make an agreement with operators, JR East, JR Central, and JR West, and local governments to start any HSR projects. In addition, the local governments have to finance about roughly one third of total construction costs. The financial responsibility of operators for the HSR projects became much smaller than before 1987. Although JRs needs to finance the part of initial construction cost of HSR which they would operate, the burden is suppressed less than the profit from the new HSR.

Imashiro mentioned that the new financial scheme increased the burden of local governments and decrease the burden of operators. However, he also concluded that the taxpayers have recognized that HSRs have contributed to their social benefits very well over a long period of time since 1964. From this point of view, JNR going bankrupt was a great lesson about "who should finance the social infrastructure." Indeed, almost the same thing happened in EU countries in the 1990s and 2000s. The first HSR in France and Germany were completely financed by their national railway companies, SNCF

and DB. However, each country already introduced the public money to continue constructing their HSR network. This thesis explains more detail about it in Chapter 3.

2.11 Conclusion of Japanese railway reform

As this thesis shows above, the financial situation of JNR in the 1950s and early 1960s were good. After 1964, JNR had been deficit-ridden company until 1987, reform year. The deficit was mainly from the imposed financial burden when the government had continued constructing uneconomic, but socially important, HSR lines. Simultaneously JNR's management had been restricted in many areas, and they did not have a withdrawing right from any railway businesses.

It is difficult to say that JNR had failed its business alone. In addition, HSR lines, which were one of the reasons that compounded JNR's financial difficulty, are appreciated as the great transportation mode nowadays, as this paper mentioned at the beginning. Imashiro explained that the JNR reform and new HSR finance scheme were constructed through the great "tried and error" processes, which acquaint taxpayers and politicians with what they need to distinguish public sector's and private sector's role, responsibility, and risk.

In the next chapter, this thesis discusses what actually happened in Europe, especially France, after Sweden introduced vertical separation management in their railway management in 1988.

Chapter 3

Europe / France

3.1 Introduction

When JNR lost its transportation mode share in the 1970s, as shown in Chapter 2, the European passenger railway transportation also lost its mode share too. This is explained in detail in Section 3.2. At the same time, the success of the Japanese HSR, Tokaido Shinkansen, made the European railway industries recognize that HSR could be the main transportation mode in the next several decades.

According to the International Union of Railway (UIC) web page, the Pompidou administration decided to introduce HSR in France in 1974, ten years after the opening of Tokaido Shinkansen. Finally, in 1983, France completed the first European HSR between Paris, the capital city of France, and Lyon, the city which has the second largest economy. In general, the Paris-Lyon line has been highly appreciated as a successful investment.

Vickerman (1996) said that after the Paris-Lyon line's operation was started, travel time was reduced from around four hours to two hours, and "total rail passengers on the corridor increased from 12.5 million in 1980 to 22.9 million in 1992, 18.9 million being TGV passengers." This suggests the TGV Paris-Lyon line has not only reduced the existed passenger's travel time, but also created the new demand of passengers between these cities.

We can say that the other developed European countries also recognized the French investment in HSR as a significant success. This is evidenced by the fact that Germany, Italy, and Spain have followed France in developing HSR. Germany started its first line in 1991, Italy in 1992, and Spain in 1992.

Subsequently, all of these countries have continued to extend their HSR networks. We can say that HSR has been one of the most important passenger transportation modes in Europe. On the other hand, the development of HSR networks has almost exclusively happened domestically, not as international transportation, in which one train operation crosses the national borders.

Nash (2004) said that although the European railway industry has had a profitable international passenger railway market, they could not manage its operations well. This problem has been because each country's railway industry was owned by each government, and they had independent regulations, signal systems, and requirements for staff, including for licenses. Thus, the process of unification of railway management structure in Europe has not progressed well.

On the other hand, European Union (EU) has wanted to improve the European railway industries' management efficiency. Thus, they forced European countries to introduce vertical separation, which could lead the competition within the railway operators, as discussed in Section 3.5 in detail. However, although EU originally expected the vertical separation management to stimulate the operators' competition, it has not happened well. This chapter explains what has actually happened in European passenger railway industry, and discusses what the obstacles to introduce the effective competition in the railway operations market.

3.2 Before HSR

Historically each European country had owned each national railway company, *Deutsche Bahn AG* (BD) in Germany, *Société Nationale des Chemins de fer Français* (SNCF) in France, *Ferrovie dello Stato S.p.A.* (SF) in Italy, *Red Nacional de los Ferrocarriles Españoles* (RENFE), and so on. Their national railway systems started in the early 20th century. According to the SNCF annual report (2010),

SNCF was founded in 1938 when the previous national railway company, *Chemin de Fer,* amalgamated the other five private railway companies.

In the 1970s, SNCF lost its transportation mode share gradually due to the increasing motorization just as happened in Japan. From 1970 to 2000, French railway industry lost about two percent transportation mode share. Table 3.1 shows the mode share transformation from 1970 to 2000.

Table 3.1

Change of French transportation mode share (passenger km %)

	1970	1980	1990	2000
Auto (%)	81.7	82.45	83.94	85.05
Bus (%)	6.34	6.67	5.78	5.41
Tram & Metro (%)	1.64	1.35	1.36	1.21
Railway (%)	10.32	9.53	8.93	8.35

Source: The Public Purpose (2004)

The motorization happened not only in France but also in all European countries. On average, the European railway industry lost about four percent mode share from 1970 to 2000. Fig 3.1 shows the change of passenger transportation mode share in the European Union.

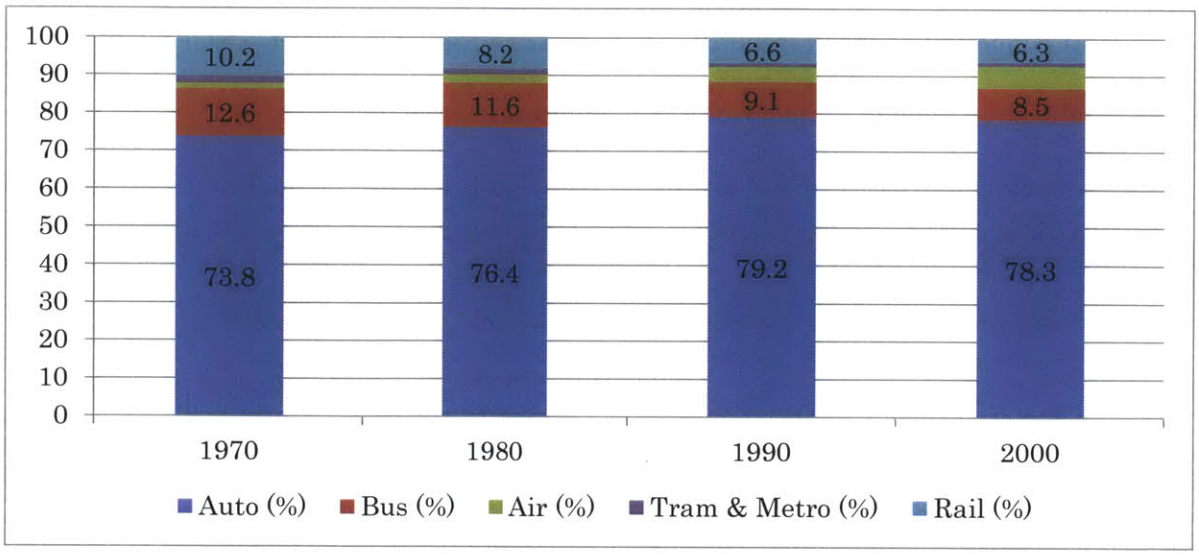

Fig 3.1 Transfer of Passenger transportation mode share in EU

Source: Nash (2004)

On the other hand, the demand on the most congested intercity passenger line in Europe, which was between Paris and Lyon, was reaching capacity. Vickerman explained that the fundamental rationale for constructing the new HSR line between Paris and Lyon was to improve "the inadequacy of capacity on certain critical stretches of line where only two tracks were in operation."

As this thesis already showed in Chapter 2, this rationale was the same with Japanese Tokaido Shinkansen. Vickerman said that French national railway company, SNCF, started to negotiate with the French government to allocate the enough budget to the HSR project between Paris and Lyon.

3.3 Paris-Lyon line

As described above, the idea for constructing the new line between Paris and Lyon to increase its transportation capacity was developed by SNCF in the early 1970s. At that time Japan already had had more than five years HSR operation experience. So it was reasonable that SNCF planned to construct

HSR in the most congested corridor. According to Miura and Akiyama (2008), SNCF conducted in-depth research about Tokaido Shinkansen's technology, operation planning, profit ratio, and so on. They decided to call their HSR TGV and started the TGV project. In 1974, the Pompidou administration approved the new HSR project.

In the financing of construction cost, we can see the commonality with Tokaido Shinkansen. Vickerman said that "TGV Paris-Lyon was financed entirely by SNCF on the basis of an expected minimum 12% financial rate of return". This means SNCF originally believed that the TGV Paris-Lyon line would have a positive outcome on the finances of SNCF. They had constructed the almost exclusive HSR line between Paris and Lyon from 1976 to 1983. The meaning of "almost" is that TGV system uses the common lines with local railway operations near the station areas to reduce the initial construction costs, in costly urban areas.

This is the biggest technical difference from Tokaido Shinkansen, which runs on the completely exclusive line and the platforms in the stations. In 1981, SNCF started the limited operation between St. Florentin and Lyon (301km). Two years later, in 1983, they started the full TGV operation between Paris and Lyon (417km).

The first European HSR, the Paris-Lyon line, has been appreciated as a significant new transportation mode which has potential to be profitable. Vickerman said that the actual financial rate of return has been higher than SNCF expected. After this success, SNCF accelerated to extend its TGV network. Vickerman also explained that the success of the Paris-Lyon line in terms of both traffic and revenue confirmed the citizens' view that investing in HSR would be an appropriate choice, not only for SNCF but also for all citizens. Table 3.2 shows the HSR construction pace in each European country

from 1981 to 2002.

Table 3.2 Expansion of the European HSR networks (km)

	1981	1982	1983	1988	1990	1995	1996	1997	1998	1999	2000	2001	2002
Germany							434	434	486	491	510	510	687
Spain						377	377	377	377	377	377	377	377
France	301	301	417	417	667	1124	1147	1147	1147	1147	1147	1395	1395
Italy							237	259	259	259	259	259	259

Source: Union International des Chemins de Fer

Transportation Policy Journal, internet news site, said that "from its TGV service, SNCF has made significant profits, which have reached 900 million euro annually in recent years, much of which has been used to cross-subsidize losses on slower intercity trains serving smaller cities...and regional rail." SNCF has been using the same approach with JNR to continue the operation of unprofitable local and intercity lines.

Quinet also said that "the most profitable TGV lines have already been built and that the future ones will be less profitable." This means that SNCF and the French government have intentionally used cross-subsidization to spread TGV network, with subsidies from the Paris-Lyon line to the construction costs of the other unprofitable or less-profitable TGV lines. The entire TGV network map is shown in Fig 3.2.

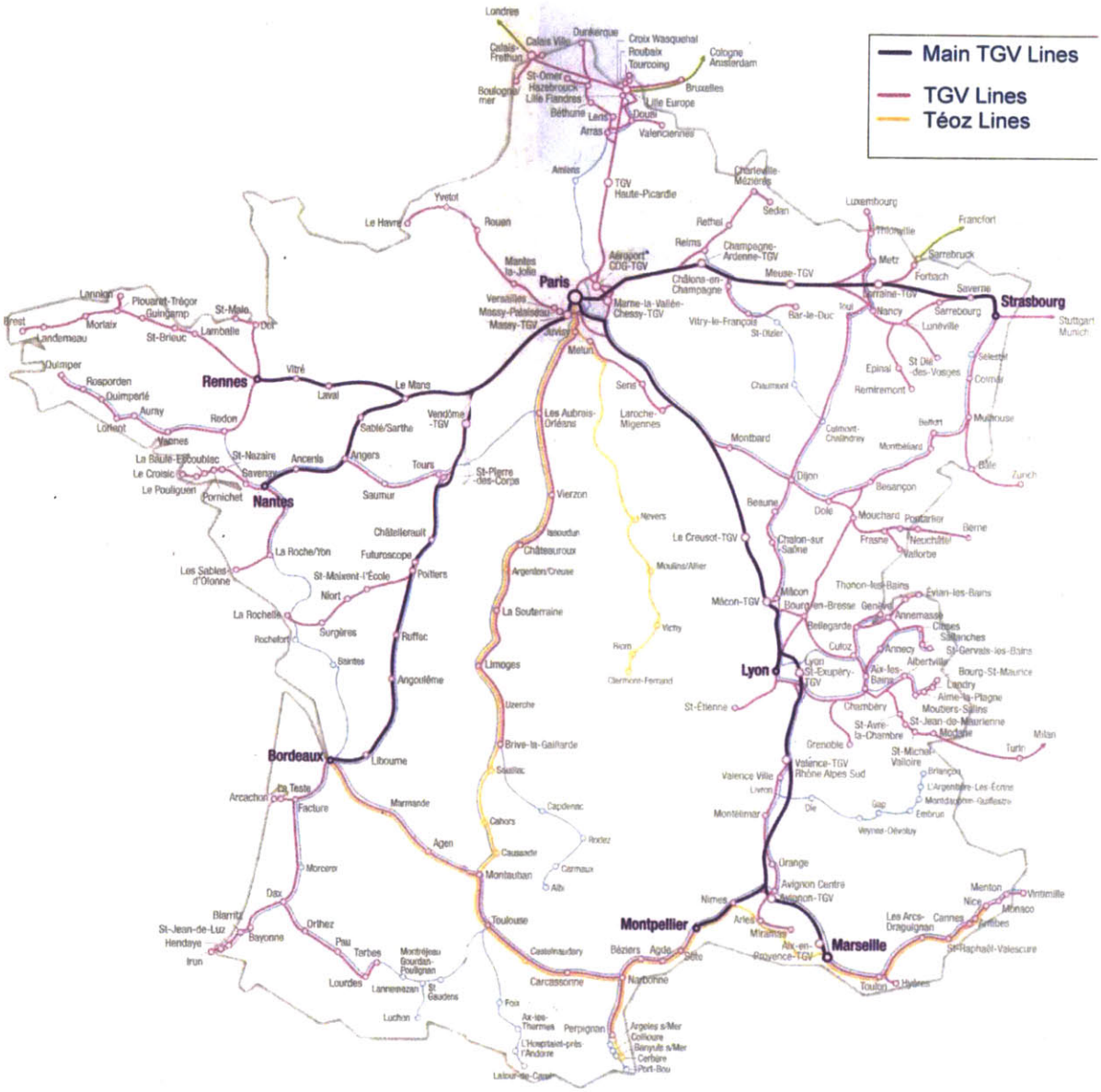

Fig 3.2 French TGV Network

Source: Parisbytrain.com

3.4 Public view of SNCF and TGV project

The finance scheme of French TGV project introduced public money from the second TGV line, TGV Atlantic, between Paris and Le Mans. Vickerman said that the French government paid for 30% of total construction costs in the line. This was because the government understood that construction of

TGV could contribute to developing the regional economy. This part was completely different from the Japanese case: however JNR, rather than the government, had financed HSR infrastructure until JNR was reformed in 1987, as explained in Chapter 2 in detail. As shown in Table 3.2, SNCF had continued extending its TGV network energetically with financial support from the government.

On the other hand, in the 1990s, after they constructed three more TGV lines since the Paris-Lyon line, the Atlantic line in 1989, the Rhone-Alpes line in 1992, and the Northern Europe line in 1993, SNCF was heavily in debt. Table 3.3 shows the amount of railway debt in European countries.

Table 3.3 Railway debt in Europe in 1997

		Railway Debts (Million Euro)	Railway Debt in % GDP
Austria	OBB	2892	1.7
Belgium	SNCB	3539	1.8
Netherland	NS	2807	1.0
France	SNCF	28731	2.6
Germanny	DB, AG	5795	0.3
Italy	FS	42067	4.9
Spain	RENFE	8140	2.0

Source: Mercer Management Consulting (1998)

Although Vickerman said "SNCF regards its TGV investment as hugely profitable taken on their own", continuing constructing the TGV network had made its debt (mainly loans from the government) large. Quinet (2005) said that a significant amount of the debt was mainly from the investment in new lines between the 1980s and 1990s, and "that large investments had been made in the first three high-speed rail lines during this period." We can say that the financial situation of SNCF and the reason of its significant amount of debt in 1997, shown in Table 3.3, were very similar to JNR in the early 1980s.

Even though the amount of debt in SNCF was significant, politicians, citizens, and SNCF did not think that SNCF was almost bankrupt like JNR. This was because SNCF was considered as the public organization which should achieve social equity in France. Indeed, SNCF's management has been originally supported by the subsidies from the government and other state bodies.

Henry and Quinet (1998) shows that the ratio of subsidies to their total income was about 32% in 1994. Quinet also explained the people's feeling for SNCF. He said that "the concept of public service is deeply rooted in French attitudes. It is extensively defined in French legislation: there is a special body of laws for public service and special courts to interpret them. The French view public service as a tool not just to address the basic needs and failures of markets, as seen from an economic point of view, but also to achieve equity or distribution goals." For this reason, SNCF had the political support to continue extending TGV network even with significant amount of debt.

3.5 Birth of vertical separation management

While France had continued its traditional railway management system, some countries were skeptical about the sustainability of the traditional railway management. Sweden was one of these. According to Uekusa (1991), the national railway company of Sweden, Statens Jarnvagar (SJ), had run into financial difficulty in the 1960s. Then SJ had survived with subsidies from the government and states. In addition, SJ had used cross-subsidization: the revenue for some profitable lines would cover the debt from unprofitable lines.

As shown above already, JNR and SNCF also used this approach, and it was the fundamental management scheme in almost all national railways around the world at that time. However, generally speaking that cross-subsidization forces the income reallocation between urban residents and rural

residents, and reduces the incentive from national railway companies, which should rationalize its unprofitable lines.

To solve the problem, the Swedish government approved Act of Transportation Policy in 1976. Jansson, Owen and Cardenbring (1989) explained the important parts of the act. The act differentiated legally between the lines which had profitability and the lines which did not have profitability but had necessity for the society. SJ would have a responsibility to operate profitable lines. On the other hand, SJ would be absolved of responsibility for operating unprofitable lines. Instead of SJ, the go/no-go decision for the unprofitable lines would be under the government's responsibility.

If the government or state governments wanted SJ to continue operating these unprofitable lines, they had to buy the operation service for the unprofitable lines from SJ. This means that even though the government had still paid money to SJ, this was not subsidy but compensation for the social equity service by SJ. In addition, the government allowed SJ to introduce the marginal cost pricing system into the profitable lines.

Now all railway industries appreciate this act as an epoch-making experiment. Nilsson (1988) explained that the act differentiated between "business economy and social economy". In fact, almost all national railway companies and the governments who were owners of these companies misunderstood the role of railway industry until then. These public sectors mixed up the business economy with the social economy in their national railway companies historically.

In the business economy, which was represented by the profitable lines in Sweden, SJ had responsibility to earn revenue to improve its service and customer satisfaction to compete with other

transportation modes. On the other hand, in the social economy, which was represented by the unprofitable lines, SJ could not discontinue these operations even though these operations were quit unprofitable because people believed that SJ had a responsibility for the social equity. We can say that Act of Transportation Policy in 1976 differentiated these two roles clearly. Then, the remaining concern was how the government would introduce the principle of market competition into the business economy.

The Swedish government approved the Act of Transportation Policy in 1988 to solve the remaining problem. According to Imashiro, the act funded Banverket (BV), Ministry of Railway, to introduce the vertical separation management system: SJ would have to participate in the bidding if the other railway operators also want to operate any railway line, and BV owns all Swedish railway infrastructure. This means BV has to open the all railway operation market to any other candidates who want to operate any railways on BV's infrastructure. The government and state governments have to solicit bids to decide operators.

Indeed, in 1990 three states collectively funded the new railway company, BK-Tag, because these three states realized that the amount of payment for the SJ's service in their states was not reasonable. Geukler (1991) said that BK-Tag started the 500 km operation in 1991 instead of SJ. In addition, Fujioka (1992) mentioned that in some "social business" lines, the local government could reduce the operation cost by about twenty to thirty percent by the bids.

As mentioned above, two acts approved by Sweden in 1979 and 1988 made great impacts on European railway industry. Traditionally, the national railway companies had two roles in their services; the first is the competitive transportation service against any other transportation modes. The second is

the social equity service. In the first role, railway companies have to compete against automobile, bus, and sometimes airline transportations. Then, they have to improve their service quality to keep or increase the number of customers, and they should introduce the marginal social pricing system. In this role, national railway companies were exposed to the market competition.

On the other hand, they did not discontinue social equity services even though these would probably have been unprofitable. This was because people believed that they had public responsibility. However, the social business aspect had reduced national railway companies' market competition power in business economy area by cross-subsidization.

In Sweden, the first act differentiated the first and second roles. SJ would have the responsibility only for the first role, and the public sectors took over the responsibility of the second role. In the second act, which was approved in 1988, SJ got relief from the responsibility of the infrastructure management. However, instead of this, SJ came under the principle of market competition in all domestic railway lines. This restructuring of the railway industry, which happened in Sweden, has been appreciated generally and recognized as vertical separation management. This new management structure inspired EU to feel the necessity of restructuring of European railway industry.

Rivera and Trujillo (2004) showed the example of how Swedish railway restructuring was more thorough compared to German one, shown in Table 3.4. German reform is shown in the next section. Table 3.4 said that before Sweden introduced the vertical separation management with competition, they needed more than 8 times operating staff as much as Germany. However, after they introduced the competition, Sweden just needs the half number of operating staffs of Germany needs, even though Germany also introduced the vertical separation management and minimal competition in their operation

market.

Table 3.4 Analysis of reform in two European countries (annual average rate of growth in %)

	Pre reform	Post reform
(Train km)/(Train operating staff)		
Sweden	0.45	10.15
Germany	3.98	5.73

Source: Rivera-Trujillo (2004)

Rivera and Rtujillo judged the operation efficiency difference between Germany and Sweden came from the degree of the competition in their operators' market.

3. 6 Role of European Union

As shown in the previous section, the vertical separation introduced in Sweden inspired EU and the other European countries. This was because the European railway industries, both passenger and freight, noticed that the vertical separation management could be a key to solving the chronic problem in the international railway transportation mode in European countries, and it could achieve the open access; all railway infrastructure is opened to all railway operators.

According to Nash (2004), the railway industry had the serious border problem compared to automobile and airline transportation. Nash said that when one passenger or freight railway operation would pass the border, they had to clear several problems.

First, passengers had to switch trains at the border city because sometimes each country used an independent signal system. Second, each country had an independent train drivers' license system. The

operators sometimes needed to change train crews at the borders. Third, the national railway companies could deny the access request from the other railway companies who want to use their infrastructure. This was because they owned infrastructure, and there was not unified regulation about international railway operations.

The national railway company could charge unreasonable railway usage fee to the new entries. Nash said that although the EU of course noticed this problem before Sweden introduced the vertical separation management, and they noticed that vertical separation management could make open access possible, they could not reconcile the conflicting interests of different countries concerning the open access.

However, after the success of vertical separation management in Sweden, Introducing the vertical separation management and open access became the realistic policy. European Commission (EC), executive body of EU, adopted *1893/91 Council Regulation of 20 June 1991 Amending Regulation* (1991). This regulation required the governments to absolve their national railway companies from the obligation of unprofitable public service. Shortly after that, EC also adopted *91/440/EEC Council Directive of 29 July 1991 On the Development of the Community's Railways* (1991).

First, this directive stipulated the national railway companies to separate their management from their governments. Second, the national railway companies were forced to divide the railway operations from the management of railway infrastructure. The regulation and directive showed that EU concluded that the vertical separation management could accelerate the open access, and the open access could be a good catalyst for the international freight and passenger railway operations. This happened three years after Sweden introduced the vertical separation management.

By following these regulations, each country started the restructuring of their railway industries. However, the speed of the restructuring process and final organizational structure were different. The first case was Germany. According to Link (2004), after the reunion of German in 1990, the government amalgamated Deutsche Bundesbahn (DB), former West German national railway company, and Deutsche Reichsbahn (DR), former East German railway company. The name of new unified national railway company was DBAG, a public limited company with share capital owned by the German federal government completely, in 1994. Nash (2009) said that Germany was the first country which opened their passenger railway operation market for new entries after EC forced member countries to introduce the vertical separation management.

However, Nash also pointed out that DBAG still holds both the operation company, DB Bahn, and the infrastructure management company, DB Netz, in one organization. The German federal government just separated them within the group holding company. Indeed, Link said that DBAG remains very dominant. She said that this was because organizational arrangements favor the incumbent. She showed that the new entries had just got eight percent of train km in the regional railway services, not in the HSR operation market.

As mentioned above, German passenger railway business, especially HSR operation market, was still monopolized by the former national railway company. And this not only happened in Germany but also happened in France, Italy, and Spain. This thesis explains, in the next chapter, why these countries which have large railway market, especially France, did not want to introduce the open access.

3.7 French Reform

Quinet explained that "France was probably one of the most reluctant countries to provide open

access." This section explains why the French government does not appreciate the EC regulations. Quinet talked about the French railway reform. The French government founded *Reseau Ferre de France* (RFF) in 1996 to separate the railway infrastructure ownership from SNCF to obey the EC regulations. Then, RFF took over 20.5 billion euro debt from SNCF. However, Quinet showed several evidences that they, SNCF and RFF, are still almost vertically integrated. First, RFF offered the infrastructure maintenance jobs to SNCF. Indeed, RFF paid about 2.6 billion euro for its infrastructure maintenance jobs to SNCF, and also received about 2.3 billion euro from SNCF as infrastructure usage fee in 2004.

RFF does not need to open its infrastructure maintenance market to other than SNCF. Second, RFF has only about five hundred employees to manage French nationwide railway infrastructure. On the other hand, SNCF still has the infrastructure division. They can negotiate about the maintenance fee and infrastructure usage fee exclusively. In fact although the main purpose to introduce vertical separation management was to improve railway industries' management efficiency, the amount of debt from the railway system rose from 35 billion euro to 41 billion euro between 1997 and 2003.

Quinet said that the half of this debt was from new TGV infrastructure investment financed mainly by RFF, and SNCF has operated TGV on the new and existing lines exclusively. Quinte said that no new entry has come into French railway operation industry. He explained the reason for this that there are too much complicated relationship and legal contracts between the French government, SNCF, and RFF.

Now the French government released the information that they are planning to reunify SNCF and RFF. International Railway Journal said that "The government plans to unify the operation of the

national rail network by bringing together functions currently carried out by French Rail Network (RFF) and French National Railways (SNCF)." This action is counter to EU regulations. This means the French government officially showed that they were not willing to introduce the vertical separation management into SNCF.

Putting aside the morality of French rebel stance to the vertical separation, quitting it would make sense for them. Quinet said this is because the current assumed vertical separation would produce the transaction cost within SNCF and RFF.

Quinte also expresses understanding partly for the French policy. He said that originally the national railway, SNCF, had a responsibility to achieve the social equity. Hence, SNCF constructed a mega-TGV network with a significant investment. Now SNCF has to earn the revenue from the network to pay back the debt with its monopoly power. However, if SNCF would accept any new entry operators in the operation of TGV, SNCF would probably lose its monopoly power and high profit. Nash explained that German and France already have invested significant amount of money in their HSR infrastructure.

Now they have to recover the costs by the revenue from these HSR. Thus, the idea of the open access to HSR is almost "cherry picking" for them, said by Nash. The French and German governments also support the monopoly of DB and SNCF passively. Community of European Railway shows how much each government had paid for each railway infrastructure by 2006. French spending on rail infrastructure was 10.1 billion euro, and German was 8 billion euro. On the other hand, Sweden was 1.5 billion and Finland, which also already introduced the open access, was 0.5 billion euro, shown in Table 3.5

Table 3.5 State Financial Support to Rail

2006 Data	State spending on rail infrastructure (in million euro)	Track length (km)
France	10100	52820
Italy	5126	23193
Germany	8001	64219
Finland	1415	13496

Source: Community of European Railway (2006)

From this data, we can say that the relatively small countries that have the small railway market and small amount of debt from the railway infrastructure were willing to introduce the vertical separation. On the other hand, the countries that already have the mature railway market and significant amount of debt from the railway infrastructure were passive to introduce the vertical separation management. This is because that the vertical separation management might give the operators of small countries chances to join the large market, and oppositely it might give the countries that have mature railway market risk of losing its market, and monopoly power in the market, by the new entries.

As shown above, the real market competition that EC expected has not happened yet in European HSR industry. On the other hand, some new completely private railway operators, such as Veolia and Nuovo Transpori Viaggiatori (NTV) are now planning to join the HSR operation market. Furthermore, SNCF contribute to these projects.

3.8 Competition in HSR market

In contradiction to the current French and German domestic market, some new competition is going to happen in the European HSR operation market. Nash said that in Italy, NTV is trying to enter into the HSR operation business between Napoli to Rome from April 2012. Interestingly, SNCF

capitalized 20% of NTV. On the other hand, the former Italian national railway company, Trenitalia, made a contract with Veolia, the private transportation company, to incorporate to operate the HSR between Paris and Brussels, and London and Strasbourg.

However, Nash concluded that "it is doubtful as to the extent of potential new entry elsewhere." The first reason is that European countries still have some different management structures respectively. This is because they could not unify the management system. Table 3.7 shows the organizational structure in Europe.

In addition, EU could not force these former national railway companies to be privatized. Nash pointed out that this was one of the fundamental reasons why EU has been failing to introduce the true competition. These national railway companies still have obligation to do "social service". Thus, they need their monopoly power in their profitable lines to continue the cross-subsidization. Nash concluded that just introducing the vertical separation management was not enough to stimulate the competition within the operators.

Table 3.6

Rail Organization in Western European Railways in 2004

Country	Degree of Separation of Infrastructure from Operation	Degree of Competition	Main Operator	Infrastructure
Belgium	Only accounting separation	None	SNCB state owned	SNCB state owned
France	Institutional separation	None	SNCF state owned	RFF state owned
Germany	Organizational separation	All markets	DV AG Vertically integrated railway divided into groups and divisions	DB Nets AG state owned
Italy	Organizational separation	Freight and regional passenger service	FS state owned	RFI state owned
Spain	Institutional separation	None	RENFE state owned	ADIF state owned

Note: The term institutional separation is used to denote totally separate institutions; Organizational separation is used where infrastructure and operation are separate subsidiaries of the same holding company.

Source: Nash and Rivera-Trujillo (2004)

The other reason why actually true competition did not happen in European HSR operation market is that some infrastructure owning companies, RFF in France, DB nets in Germany, and ADIF in Spain, are charging too high an infrastructure usage fee to operators. According to International Transportation Forum (2005), RFF charged much higher infrastructure usage fee to SNCF to operate the TGV network than the estimated marginal cost of it. The reason why RFF set such a high usage fee is that just they want to eliminate the competition from the TGV network.

3.9 Conclusion

As mentioned above, the competition within operators in HSR market has not happened yet at least in France. This is because fundamentally France believes that the open access idea is not fair to the countries that already have the mature passenger railway market, especially HSR network. On the surface level, although French passenger railway industry introduced the vertical separation

management technically, there is no real competition. In addition, German, Spain, and Italy, countries which have HSR networks and large debt from these, also still monopolized their HSR operation market by their former national railway companies. Chapter 6 introduced the previous research which analyzed whether introducing the vertical separation management contributes to improve the productivity of entire French railway operation management by SNCF.

In the next chapter, this thesis explained the history of productivity analysis and how this thesis set our research objectives and why our research objectives are appropriate to evaluate the effect of the railway industrial reforms.

Chapter 4

Productivity

4.1 Introduction

When people evaluate an industry or company, there are several indices, such as revenue, profit, and total capitalization. On the other hand, the previous research which analyzed the industrial reforms, including privatization, deregulation, and price freedom, applied productivity analysis. Especially *multi-factor productivity* (MFP) or *total-factor productivity* (TFP) have been used effectively to evaluate the effect of these industrial reforms.

Although people often use the words productive or nonproductive to explain job quality and efficiency, the academic meaning of "productivity" is very different from such a general meaning. So we need some steps to understand what the academic meanings of productivity and multi-factor productivity (MFP) are. In this chapter, we show an intuitively understandable example of the introductory level productivity definition.

4.2 Single factor productivity

The most commonly used example of introductory level productivity analysis is one that evaluates the factory's labor efficiency. In this example, imagine a small factory in arbitrary year 1. The factory employed five workers, and they produced 100 widgets in that year. In the next year, year 2, the factory added five employees, and they produced 200 widgets. It is intuitive. Twice the number of employees could produce twice the amount of widgets. However, at the same time, the labor productivity growth of the factory is 0. The formula is

$$\Delta P = \left\{ \left(\frac{stuffs_{year2}}{employees_{year2}} \right) \Big/ \left(\frac{stuffs_{year1}}{employee_{year1}} \right) \right\} - 1 \quad (1)$$

Where ΔP is the change of productivity from year1 to year2.

In actual numbers,

$$\Delta P = \left\{ \left(\frac{200}{10} \right) \Big/ \left(\frac{100}{5} \right) \right\} - 1 = 0 \quad (2)$$

In the next year, year 3, the factory also employed new 5 workers. In this year, they produced 330 widgets. If we could estimate from the past data the amount of widgets that would be produced by fifteen employees in year 3, our calculation result might be 300 widgets. However, we can intuitively understand that this gap between our estimation and the actual result sometimes may happen. At that time, the growth of labor productivity is

$$\Delta P = \left\{ \left(\frac{stuffs_{year3}}{employees_{year3}} \right) \Big/ \left(\frac{stuffs_{year2}}{employee_{year2}} \right) \right\} - 1 \quad (3)$$

In actual numbers,

$$\Delta P = \left\{ \left(\frac{330}{15} \right) \Big/ \left(\frac{200}{10} \right) \right\} - 1 = 0.1 \quad (4)$$

The result of equation (4) means that the factory got 10% labor productivity growth from year 2 to year 3. The important thing we need to know is that there was no definition of each year's productivity. We cannot know the productivity of the factory in year 1, year 2, and year 3. We can only know that the productivity growth between year 1 and year 2, and between year 2 and year 3 in this case. The general

function of the factory's labor productivity in this case is

$$\Delta P = \left\{ \left(\frac{stuffs_{yearT}}{employees_{yearT}} \right) \Big/ \left(\frac{stuffs_{yearT-1}}{employee_{yearT-1}} \right) \right\} - 1 \quad (5)$$

Where year T is an arbitrary year, T-1 is a year before year T

For the next step of analyzing productivity, we want to know why the productivity of the factory improved from year 2 to year 3. Of course there were a lot of candidates of sources of improved, and usually multiple sources work simultaneously. For example, if the factory introduced a role limitation working system, one employee works in only one role, his or her degree of maturity in the job could be increased. Then, the factory could get the productivity growth without new financial input.

This is completely positive productivity growth because there was no other increased input. On the other hand, if the factory introduced the new expensive machines to increase the amount of output, widgets, we have to consider the new cost from the machines. Then, we need to consider *multi-factor productivity*.

In this case, in year 2, if the salary of each employee was $50,000, the total personnel expense the factory paid was $500,000. In year 3, if the salary was not changed, the total personnel expense the factory paid was $750,000. In addition, the factory needed to pay for the depreciation of the machines. It was $100,000, and they also needed to pay $50,000 for the maintenance of the machines. Then, the total cost the factory paid in year 3 was $900,000. In this case, the economic productivity change of the factory from year 2 to year 3 was

$$\Delta P = \left\{ \left(\frac{330}{900000}\right) \Big/ \left(\frac{200}{500000}\right) \right\} - 1 = -0.08333 \qquad (6)$$

The result of the equation (6) shows that the factory lost its productivity by about 8.3%, after they introduced the new machines, even though their amount of widgets produced was increased.

As shown in the above examples, the single factor productivity analysis shows the intuitively understandable equation and result. It was useful to check the simple relationship with "input", the number of laborers, and "output", the number of the widgets they produced in this case. On the other hand, there are more complicated cases which have the multiple inputs we need to consider in the real world. The next section shows how previous research was developed productivity analysis.

4.3 Developing history of MFP analysis

As shown in the previous section, sometimes single factor productivity, which has an input index and an output index, cannot explain the reality we need to know. This is because many industries need multiple inputs to produce an output. Thus, even though the analyzing process could be more complicated, researchers prefer to use MFP analysis.

Actually, previous research called their research TFP, even though they dealt in single output. For the avoidance of confusion, this thesis defined that MFP has multi input data and single output data, and TFP has multiple input data and multiple output data.

Solow (1957) made significant progress in the MFP research field. His research field was national

gross domestic products (GDP) growth, and he was interested in what kind of factors could increase the national GDP. Solow said that there were two factors which could be input indices. The first is labor, and the second is capital. The importance of the two factors is easy to understand. If one country increased the number of people who could work, the country could increase their GDP. If they increased the total capital they have, the country may also increase their GDP.

However, the same thing happens in the national GDP growth with the factory example shown in Section 4.1. This means that even if one country exactly doubled their capital investment and labor population respectively, the GDP might not be doubled exactly because of what Solow called "technological change."

Solow said that the technological change includes "any kind of shift". He also showed some examples of "any kind of shift", such as "improvements in the education of the labor force". This means that if one country increased their GDP without increased labor or capital, this increased GDP was from "technological change".

Solow defined the fundamental TFP function. First, he set "the aggregate production function" as

$$\mathrm{Q} = A_{(t)} f(K_t, L_t) \tag{7}$$

Where K is capital input, L is labor input, t is time, and A is accumulated effect of shifts over time

When we differentiate the equation (7) totally with respect to time and divide by Q, we obtains

$$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + A\frac{\partial f}{\partial K}\frac{\dot{K}}{Q} + A\frac{\partial f}{\partial L}\frac{\dot{L}}{Q} \tag{8}$$

Dot above the variables indicates time derivatives (e.g.$\dot{Q}$), which is $\frac{dQ}{dt}$

Now Solow defined that $w_k = \frac{\partial Q}{\partial K}\frac{K}{Q}$ and $w_l = \frac{\partial Q}{\partial L}\frac{L}{Q}$ as the relative share of capital and labor.

When we substitute in the above equation, we have the following results:

$$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + w_k\frac{\dot{K}}{k} + w_l\frac{\dot{L}}{L} \tag{9}$$

Solow said that $\frac{\dot{A}}{A}$ represents the technological change. By this equation, Solow surveyed what were the main factors of the US GDP growth.

Now empirically, Solow concluded that the "Gross output per man hour doubled" from 1909 to 1949 in the USA, and he estimated that "87.5 percent of the increase was attributable to technical change and the remaining 12.5 percent to increase use of capital." This was a surprising result that almost all increased output was from technological change, not from labor or capital increasing. However, most researchers have agreed with the result.

Due to Solow's achievement, research about GDP growth with TFP has become active. On the other hand, the productivity function developed by Solow was just an arbitrary function. Thus, researchers introduced Cobb-Douglas production function to apply it to analyze their research objectives.

$$\mathrm{f}(K_t, L_t) = K_t^{\alpha} L_t^{1-\alpha} \tag{10}$$

Where α is an arbitrary variable.

When we take the natural logarithms in the equation (10),

$$\ln Y_t = lnA_t \cdot K_t^{\alpha} \cdot L_t^{1-\alpha} \tag{11}$$

And differentiating the function above with respect to t

$$\frac{\partial}{\partial t} lnY_t = \frac{\partial}{\partial t} lnA_t + \alpha \ln K_t + (1-\alpha)\frac{\partial}{\partial t} lnL_t \tag{12}$$

$$\ln\left(\frac{Y_t}{Y_{t-1}}\right) = \ln\left(\frac{A_t}{A_{t-1}}\right) + \alpha \ln\left(\frac{K_t}{K_{t-1}}\right) + (1-\alpha)\ln\left(\frac{L_t}{L_{t-1}}\right) \quad (13)$$

$$\ln\left(\frac{A_t}{A_{t-1}}\right) = \ln\left(\frac{Y_t}{Y_{t-1}}\right) - \alpha \ln\left(\frac{K_t}{K_{t-1}}\right) - (1-\alpha)\ln\left(\frac{L_t}{L_{t-1}}\right) \quad (14)$$

Then, $\left(\frac{A_t}{A_{t-1}}\right)$ represents the growth of productivity between year (t-1) and year t.

After that, many researchers have applied the equation to analyze the transportation industries' productivity. This thesis adopted the equation (15) defined by Cowie (2001) that was developed to analyze the effect of the reform in the UK passenger railway industry.

$$\ln\left(\frac{\mathrm{TFP}_k}{TFP_l}\right) = \ln\left(\frac{y_k}{y_l}\right) - \sum_{j=i}^{N} S_j \ln(x_{jk}/x_{jl}) \quad (15)$$

"Where N is the number of inputs. S_j indicates the cost share of input x_j between year k and l, and y is output."

For example, again imagine a small railway operation company in 2010. The company paid \$1 million to the personnel costs, \$1 million to the non-personnel costs, such as electrical power, diesel fuel, and maintenance costs, and \$3 million to their depreciation. In 2010, they had 100 million passenger-km. In the next year, 2011, the company purchased the several new vehicles and employed new personnel because they believed the number of passengers was increasing. So the company paid \$2.3 million to the personnel costs, and paid \$ 1.5 million to the non-personnel costs, and \$ 4 million to their depreciation. In 2011, indeed, the company had 140 million passenger-km. For the sake of shorthand, this thesis abbreviated million. In this case, the actual numbers in equation (15) are

$$\ln\left(\frac{\mathrm{TFP}_{2011}}{TFP_{2010}}\right) = \ln\left(\frac{140}{100}\right) - \left\{\left[\frac{2.3}{(2.3+1.5+4)}\right] \times \ln\left(\frac{2.3}{2}\right) + \left[\frac{1.5}{(2.3+1.5+4)}\right] \times \ln\left(\frac{1.5}{1}\right) + \left[\frac{4}{(2.3+1.5+4)}\right] \times \ln\left(\frac{4}{3}\right)\right\} =$$

$$0.0697 \ldots \quad (16)$$

The result of equation (16) shows that the railway operation company improved their *total factor*

productivity by 6.97% from 2010 to 2011.

4.4 Importance of productivity growth

Generally speaking, the most valuable research about GDP growth was done by Krugman (1994), and his result of the research showed why analyzing productivity growth was important and what we can say from the result. Krugman made a prediction in his famous research paper that the incredible pace of Asian countries' GDP growth would come to a halt soon because their GDP growth was almost completely from the rapidly increased capital input and labor input, not from the productivity growth.

The economists in Western Europe and US had been concerned about the other countries' economic growth during two different periods. The first time was in the 1950s, and the concern was about socialist countries, especially USSR economic growth. The second one was in the 1990s about East Asian countries and the region, such as Singapore, Taiwan, South Korea, and Hong Kong. The first time, some people believed that the rapid growth of Soviet Union's GDP would become a danger to the US.

They also believed that the planned economy in the Soviet Union could overwhelm the market economy in the Western Europe and the US. However, it turned out that it was a needless fear. The Soviet Union could not continue its high GDP growth after the 1960s.

Krugman concluded that this was because the GDP growth of the Soviet Union in the 1950s depended almost completely on the rapid increased capital and labor inputs. Practically, it is impossible to continue GDP growth which is enhanced by only increased inputs. This is because that each country has a limitation of the available supplies of capital and labors. After the market was saturated, they could

not increase their GDP without technological change.

On the other hand, the technological change almost does not have any physical limit. Nakajima (2001) showed an interesting example of this. When the mailing service had been developed in Japan, the industry had increased the number of employees and invested capital in the new post offices and so on. However, even though their market had been expanded, their productivity growth was very low because the mailing service company had very small technological improvement during the expansion phase. They are still using manpower to deliver any mails in the last part of their logistics chain.

On the other hand, the technological change in the internet industry has been significant and rapid. Just ten years after the specialists started using e-mail, people can send e-mail without any limit in the number of mails, and people also send pictures and sometime voice mail and movies via e-mail. This improvement has come not only from the capital and labor investments but also from the technological changes, such as the high speed internet and high performance personnel computers.

Krugman concluded that we could not continue expanding our economy if the economic growth just relied on the increased input. Thus, after Kim and Lawlence (1994) pointed out that East Asian countries growth had been enhanced almost completely by the increased input, Krugman predicted that the growth of these countries would be halted soon. Indeed, his prediction was correct. Taiwan, Hong Kong, Singapore, and South Korea, in which the countries Kim and Lawlence showed that their economic growth have relied only on the increased input, lost their high GDP growth ratio between 1997 and 1998, shown in Fig 4.1.

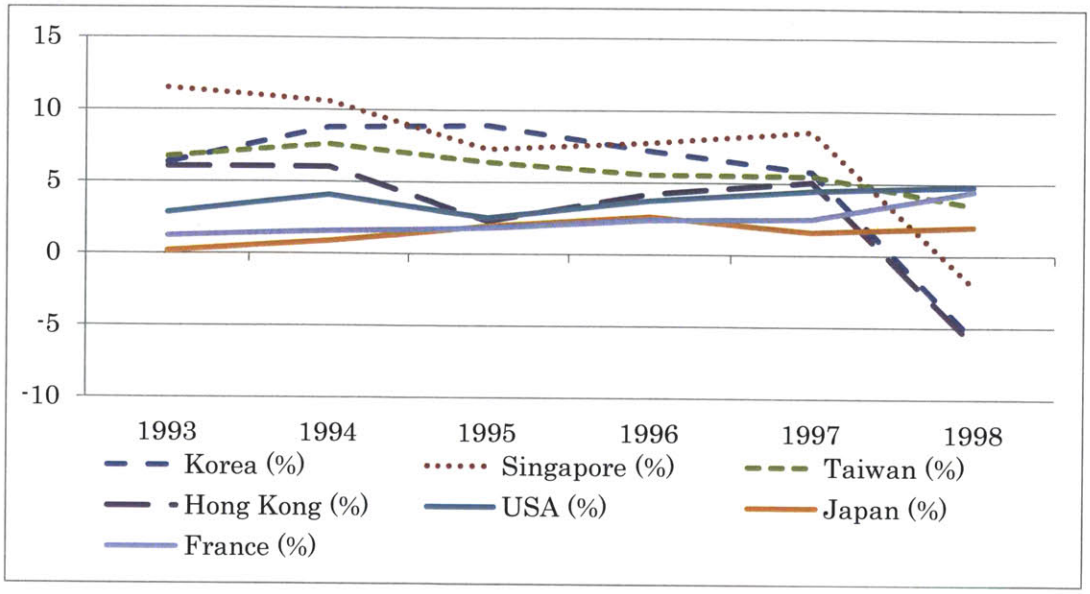

Fig 4.1 National GDP growth ratio

Source: World Bank

Fig 4.1 shows that developing countries and area, Korea, Singapore, Taiwan, and Hong-Kong lost their GDP from 1997 to 1998 steeply. On the other hand, the US, France, and Japan continued to increase their GDP constantly.

From the result, Krugman said that if we want to continue economic growth, we need to improve productivity. This is because although the increased input could increase the output, it would not be a sustainable growth. This is because there are physical limits of the increased input. On the other hand, there is almost no limit in the technological change. Thus, productivity growth analysis is very important for industrial viability, especially very mature industries.

As shown above, originally Solow pointed out that there are "residual" between input, labor and capital, and output, GDP, and he call the residual "technological change". Later, the researchers call

"technological change" productivity or "Solow residual". However, these words, technological change, productivity, and Solow residual, were still too ambiguous. These words include a lot of sources. The previous research had been trying to define which actual sources could improve the productivity. This thesis provided a review of previous research about the MFP and TFP analysis of the transportation industry.

4.5 Productivity analysis in transportation

After Solow's contribution to the productivity analysis, many economic researchers have developed the MFP and TFP analysis. Some of these introduced TFP to analyze the inefficiency of the regulated market. Indeed, although the inefficiency in the regulated economy compared to the unregulated market economy was intuitively credible, there were not enough empirical examples.

Capron and Noll (1971) said that "the performance of regulated industries falls far short of the ideal and even of a reasonable target for public policy. But they (general researchers) also agree that only in a few exceptional instances can the inadequacy of the performance be clearly documented." Thus, the first goal for the economists was to find two cases, one regulated and the other almost unregulated. The significant example was the comparison between the US and Canadian freight and passenger railway industries.

Caves, Christensen, and Swanson (1981) used the example to evaluate the inefficiency in the regulated market. In their research, the Canadian railway industry represented the market economy, and the US railway industry represented the regulated economy.

The two cases need to have enough common parts, such as market size, objectives, and market

peaks and troughs to do a reasonable comparison. This means we cannot compare the productivity between a company in the internet technology industry and a company in the infrastructure industry to evaluate the inefficiency in the regulated market. Even though the information technology company could represent the unregulated market and the infrastructure company could represent the regulated market, the background of these companies would be too different.

However, the background of the Canadian and the US railway industry was enough alike, and almost the only important difference between these two was the market regulation. To demonstrate the inefficiency in the regulated market, they chose Canadian Pacific (CP), Canadian National (CN), Santa Fe (SF), and Southern Pacific (SP) railroads as the research objects.

Caves et al. explained that the railway industries had substantial monopoly power in the 1920s, before World aor II. The government needed to give attention to the industries because they were likely to use the monopoly power to decide service prices. Thus, they were substantially regulated by the governments at that time. However, they lost a lot of transportation mode share since the 1930s because of the motorization and competition from trucks and water carriers.

Their research said that "in the United States the railroads' share of freight ton-miles supplied by rail fell from 78 percent in 1945 to 60 percent in 1955. The share in Canadian fell from 74 percent in 1944 to 61 percent in 1956." As the data shown above, these industries had lost these monopoly powers in the transportation industry.

However, Cave et al. said that the solutions which the US and Canadian government took were completely different. In Canada, the government had relaxed the regulation, especially pricing regulation,

in the Canadian railway industry. This was because that the competitors of the railway industry, such as trucking and water carrier industries were really unregulated industry. The government might believe that deregulating the railway industry to increase its competitive power. In other words, the government wanted to introduce the market competition to the entire transportation market, and "level the playing field".

On the other hand, the US government had regulated the competing industry more, similar to the railway industry. Concretely speaking, the government expanded Interstate Commerce Commission (ICC) regulation into the trucking industry in 1935 and into the water carriage industry in 1940. Cave et al. explained that the regulation expansion was "largely as an attempt to protect the railroads."

Thus, Cave et al. hypothesized that the Canadian railway industries' productivity had to be higher than the US railway industries'. They applied TFP analysis. They set "(1) ton-miles of freight, (2) average length of freight haul, (3) passenger-miles, and (4) average length of passenger trip" as output data, and they set "(1) labor, (2) fuel, and (3) equipment and materials" as input data. The important difference from our research model is that they applied TFP, not MFP because, then, freight railway industries in the US and Canada had also operated passenger railways. This means they had two output indices, passenger-km and ton-km. The result of their calculation clearly said that the Canadian railway industries' TFP had been higher than the US railway industries', shown in Table 4.1.

As Table 4.1 shows, although CN and CP had lost output between 1956 and 1963, they had also reduced their input. Thus, they could keep positive TFP growth during the period. Since 1963, CN and CP's output had been positive even though they had almost completely reduced their input. On the other hand, although SF and SP's input growth ratios were slight or negative, their output growths were also

slight. Caves et al. explained that the difference was due to the deregulated pricing in Canadian railway industry. Also Heaver and Nelson (1977) said that CN and CP set up "Traffic Research Department", which was expected to analyze the competitive market. Indeed, the departments gave CN and CP pricing techniques to compete with mainly trucking industry.

Table 4.1 Comparison of U.S. and Canadian railroads

	Aggregate input				Aggregate output			
year	CN	CP	SF	SP	CN	CP	SF	SP
1956-1963	-2.8	-3.6	-1.3	0.3	-1.1	-2	0	3.4
1963-1974	0.3	-0.6	-0.1	0.7	4.6	2.7	0.8	1.1
1956-1974	-0.9	-1.8	-0.6	0.5	2.4	0.9	0.5	2

	Total factor productivity			
	CN	CP	SF	SP
1956-1963	1.8	1.7	1.4	3.1
1963-1974	4.3	3.3	1	0.4
1956-1974	3.3	2.7	1.1	1.4

(percent per year)

Average annual rate of growth of inputs, outputs, and total factor productivity for Canadian National (CN), Canadian Pacific (CP), Santa Fe (SF), and Southern Pacific (SP) Railroads

Source: Caves et al. (1981)

As a conclusion, Caves et al. said that the Canadian policies, which gave CN and CP pricing freedom and forced them to face the market competition, improved TFP of the Canadian railway industry. This research consolidated the new survey area of TFP so that researchers could evaluate the effects of deregulation, policy change, and reform of industry by MFP and TFP. In their conclusion, Cave et al. made the prediction that the productivity of the US railway industry would increase after 1980. This was because the US government also gave the US railway industry greater pricing freedom in the Impact of the Staggers Rail Act (1980).

Indeed, Tretheway, Waters and Fok compared the MFP growths between the US freight railway industry and the Canadian freight railway in the 1980s. The reason why they researched only the freight

industry was that the all US interstate passenger railway businesses were taken over by Amtrak in 1971. Thus, they set only "ton-mile" as output. The result of MFP growth of the US freight railway industry between 1981 and 1988 was higher than the CN and CP's, shown in Table 4.2.

Table 4.2 MFP growth: US-Canada rail industry comparison 1981-88

TFP growth percentage 1981-88		
US	CN	CP
5.2	4.6	3.5

Source: Tretheway et al.

After the comparison between the regulated and unregulated market economy in the railway industries, Caves, Christensen, and Tretheway (1982) applied TFP analysis to evaluate the effects of deregulation in the US airline industry. In November 1978 President Carter signed the Airline Deregulation Act. Before the act, the US airline industry had been highly regulated. There was a high entry barrier for the new companies. Thus, the existing airline companies had enjoyed the oligopoly market. The act enabled new entries into the industry, and gave the airline industry more pricing freedom.

Thus, the trunk airline companies, which had enough market shares, could not continue their monopoly power in the market. Indeed, Cave et al. said although the trunk and local airline companies had higher TFP between 1976 and 1980 than from 1970 to 1975, the average of TFP growth in the local airline companies after the deregulation was 6.3%. This was higher than the trunk airline companies' average, 4.9%, shown in Table 4.3.

Table 4.3 Average growth in airline productivity (percent per year)

Airline	1970-1975	1976-1980
TRUNKS		
United	1	6
American	2	3
TWA	2	6
Pan American	2	7
Eastern	2	5
Delta	2	4
Northwest	6	4
Western	4	3
Continental	2	1
Braniff	1	5
Total Trunks	2.6	4.9
LOCALS		
Allegheny	4	6
Airwest	8	8
Frontier	4	5
Ozark	2	5
Piedmont	2	7
Texas International	1	14
Total Locals	4	6.3
Combined	2.8	5.1

Source: Caves (1982)

As shown above, TFP can be very useful to evaluate the efficiency of reform in various transportation industries although sometimes researchers faced the problem of data availability. Oum, Tretheway, and Waters (1992) constructed the productivity analysis scheme in the transportation sector. First, they defined what kind of "cases" we can evaluate with productivity analysis. They showed eight cases. The previous research shown in this chapter analyzed two cases. One is "the relationship between productivity and pricing policy", and the other is "comparing performance of firms/industries under alternate public policy regime, e.g. regulation and/or government ownership."

In addition, Oum et al. decomposed the sources of increased TFP. They showed ten sources of

productivity gains. Oum et al. said that regulated companies and public sector often use the cross-subsidies, and "they may be simply lazy, or otherwise not motivated to control costs." Thus, usually industrial reform aimed to eliminate the inefficiency from the cross-subsidies, low motivation for the revenue, and public sectors' low motivation for the management efficiency; public sectors are not under pressure from stock holders.

The previous research described in this chapter evaluated the effect of "elimination of technical inefficiencies" as Oun et al. defined, and this thesis will also evaluate this effect by using MFP analysis in Chapter 6. Any deregulations may be able to "eliminate the technical inefficiencies" in the transportation industries. However, Oum et al. alerted that these sources could overlap. This means if the producticity growth in one case had more than two sources, we might not count one of the sources. Even if our research cases showed the significant MFP growth, it might be very difficult to say which factor contributed to the result of MFP growth. Thus, when we want to evaluate only the source, "elimination of technical inefficiencies", we need to scrutinize the object, and know what actually happened in the industry and why the other sources were limited.

Generally speaking, even though there are difficulties in the logic, productivity research about the efficiency of the deregulation has been well. This is because it is reasonable to conclude that the deregulation and pricing freedom improved the productivity of the transportation industry. On the other hand, there are a few researchers who denied the effect of the deregulation on improved productivity. One example is Martland (2011). He concluded that the contribution of the US freight railway industry's increased TFP by deregulation was very limited. He pointed out that other factors, such as technological advance, new labor agreement, improved logistics system, and developed management system have contributed to TFP growth more than deregulation. Of course, he also acknowledged that the US freight

railway industry had improved its TFP after deregulation. However, he said that the indications of TFP growth had already begun before deregulation.

Martland decomposed the TFP growth into the expected sources which contributed to the increased TFP in the US freight railway industry. He concluded that the most significant factor was fuel efficiency. He said that this source, "increased quality of inputs", made significant impact on TFP. Indeed, the US freight railway industry improved an average revenue ton-miles per gallon (RTM/gallon) from 188 to 373 between 1966 and 1995, and "another 20% gain had been achieved by 2008." The significant contribution was achieved by the improved vehicle technology and new logistics system, not by deregulation. Martland said if RTM/gallon remained at the same level as the level in 1966, TFP would also remain at the same level as in 1966.

Of course Martland's conclusion is not the only final conclusion about the importance of the deregulation in the US freight industry. However, his counterargument at least alerted us that we have to carefully select the research object and need to know what actually happened. As Martland pointed out, even if we could find the TFP growth in one industry which was deregulated, we could not determine that the growth came only from the deregulation, industry reform, or privatization easily.

Thus, when we would set the research object to analyze the effect of any industrial reform, such as vertical separation in European railway industry and dividing and privatization in Japanese railway industry, if the object had too much large scale, we could not evaluate the effect well. For instance, as shown in Chapter 2, we should not compare the MFP of JNR and MFP of all new JRs to evaluate the reform of the Japanese railway industry. This is because JR Hokkiado, JR Shikoku, JR Kyushu, and JR freight are not privatized yet. These non-privatized companies are under the preferential taxation system,

guarded by the JR law, and subsidized.

We also should not compare all national railway industries in Europe between before and after they introduced vertical separation. This was because one country, such as Sweden, was really eager to introduce it with competition. On the other hand, other countries, such as France, Spain, and Italy, might be passive as shown in Chapter 3. Thus, using total or average MFP growth in European railway industry to evaluate the efficiency of introducing vertical separation management does not make sense. So we need to optimize the object scale to evaluate the effect of the alternative policy regimes. In other word, we need the objectives to evaluate the effect of these reforms.

4.6 Objective of research

This thesis studies the effect of the reform in Japanese and French railway industries. As shown in Chapter 2, Japanese government privatized JNR "partly", and European Commission forced French railway industry, SNCF, and the government to introduce vertical separation management and open access. As this thesis explained above, when we research the effect of these management structure changes, we need research objectives. If we set too large scale industry as our research objectives, we cannot eliminate the effect from manifold changes, such as technology development, demand change, and introduction of IT. To evaluate the effect of these two reforms, we chose the highest profitable HSRs, Tokaido Shinkansen line and the Paris-Lyon TGV line, in each country. The reasons why we narrowed down the object scales to only these are that these lines:

i. have been very profitable
ii. are using the latest technology since the beginning of the operation
iii. almost exclusively used by HSR, no local trains and freights
iv. have enough long management terms before and after the reforms.

About i, as shown in Chapter 2 and 3, Tokaido Shinkansen line and the TGV Paris-Lyon line have been profitable; at least JNR and SNCF planned these lines to be profitable lines. Thus, fundamentally JNR, JRC, and SNCF have continued to put enough inputs into these lines. This is because they expected to get enough output back from the inputs. This is considerably a healthy economic activity.

About ii, Tokaido Shinkansen and the TGV Paris-Lyon line introduced the latest technology in these vehicle, signal system, and infrastructure. Indeed, JRC had used the proto-type HSR vehicle until 2008, and SNCF is still using the proto-type HSR vehicle. These HSRs are moved by electrical power, not fossil fuels such as freight railways and airlines. Of course they have also improved technology in their HSR. However, the degree of technological change in these HSR is very limited.

About iii, these lines have been used by only the passenger HSRs. Even though JNR, JRC, and SNCF have improved their operation plans, this degree was much smaller than developed logistics system which was introduced by freight and airline industries. For these reasons, this research chose the two HSR lines to evaluate the industrial reforms, privatization and vertical separation in Japan and France.

About iv, we cannot evaluate the reform effect just from a year data after the industry was reformed. This is because the amount of the transportation industries' output, such as passenger-km, ton-km, and revenue, could be influenced the economic situation of the countries, gas prices, and indefinable reasons. However, if we could analyze the enough long term data before and after the reform, these external factors would be reduced significantly.

In the next chapter, we shows the input data and output data of Tokaido Shinkansen and the

Paris-Lyon line, which we used, with some analysis. In Chapter 6, we applied these data to the productivity function we adopted.

Chapter 5

Data of Tokaido Shinkansen and Analysis

As shown in Chapter 4, for calculating productivity, we need input and output data. We chose passenger-km and revenue as two separated output data respectively, and personnel expense, non-personnel expense, and capital related expense as input data. This means each output has three inputs. We call our productivity result passenger-km based productivity and revenue based productivity separately; both are *multi-factor productivity* (MFP), one output and multiple input. This thesis gathered data of Tokaido Shinkansen from Japan National Railway year book (from 1964 to 1987), White book of Transportation (from 1964 to 2010), Suda (1994), Kasai (2007), Central Japan Railway Fact Sheet (2010), JITI Statistics data of railway (2010).

Fig 5.1 shows the passenger—km of Tokaido shinkansen from 1964, opening year, to 2010. The data shows that the passenger km had been sometimes decreased, such as from 1974 to 1978.

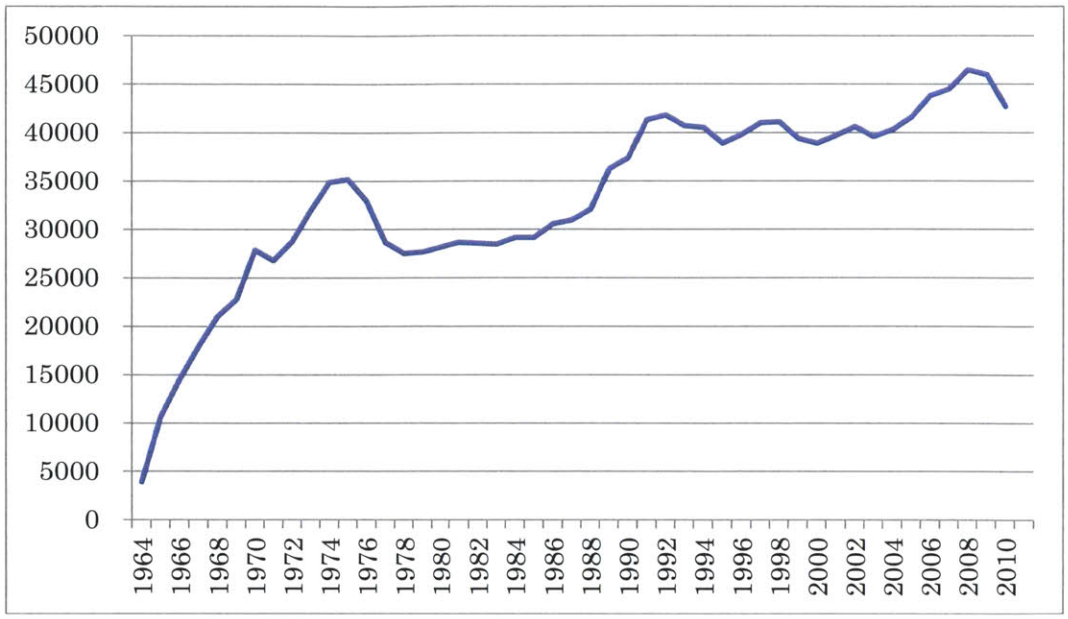

Fig 5.1 Tokaido Shinkansen Passenger-km (million km)

We can say that naturally the passenger km had increased from 1964 to 1974 because of the new entry effect. JNR lost the passenger km between 1974 and 1978. This was because that JNR had increased the ticket price of Tokaido Shinkansen at the same time. Fig 5.2 shows the change of the ticket price. The blue graph shows the actual ticket price change between Tokyo and Osaka, and the red graph shows the adjusted ticket price by Consumer Price Index (CPI) which is released by Japan National Bank.

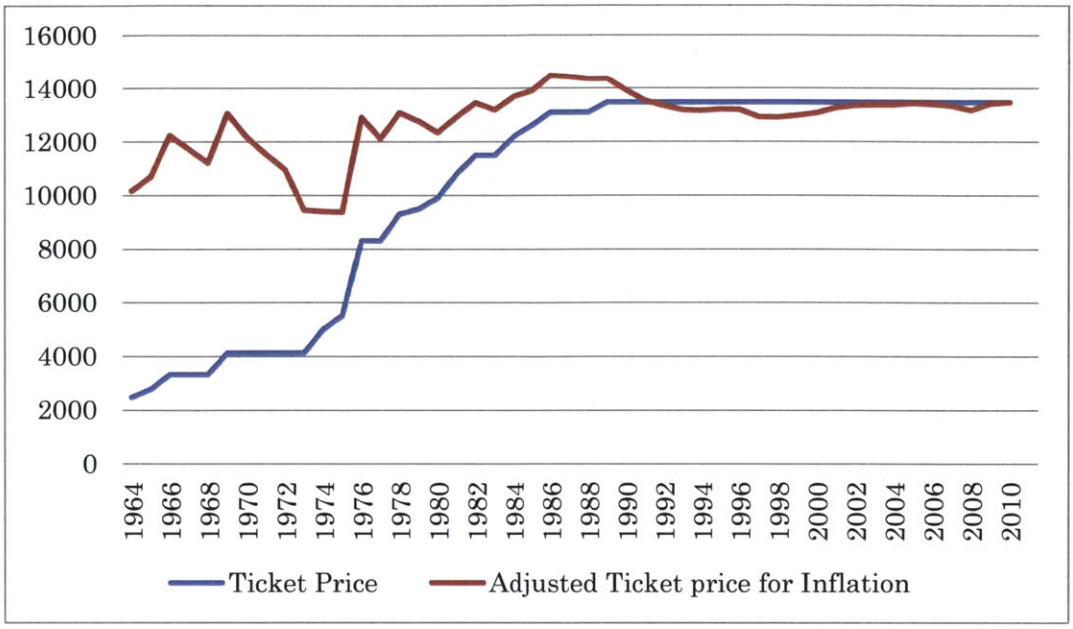

Fig 5.2 Ticket Price between Tokyo and Osaka (Yen)

The actual ticket price had increased more than 100% from 1974 to 1978. Even the ticket price adjusted for inflation had increased more than 40% at the same time. Nam (2009) explained that the reason why JNR had increased the ticket price was that the Department of Transportation required them to do it. As we already discussed in Chapter 2, JNR's ticket prices had been decided very politically, and JNR did not have the power to reject the request from the government to increase the ticket prices. The Department of Transportation wanted JNR to earn more money from Tokaido Shinkansen because they wanted to continue constructing the HSR network.

Indeed, JNR extended the HSR line to Okayama in 1972 and Hakata in 1976, named Sanyo Shinkansen line, shown in Fig 2.6. After the construction of Sanyo Shinkansen, JNR was also forced to construct Tohoku and Joetsu Shinlansen, shown in Fig 5.3. JNR had to capitalize the cost of the new HSR line's infrastructure. This means JNR had been forced to use the cross-subsidization to continue the construction of the HSR network, as explained in Chapter 2 in detail.

Fig 5.3 Tohoku, Joetsu and the other Shinkansen lines

Source: Densha de Japan (2010)

One of the reasons why JNR lost passenger-km between 1974 and 1978 was the rapid increased in ticket price. As a result, JNR had continued the high level income revenue from Tokaido Shinkansen between 1974 and 1978 even though JNR had lost passenger-km at the same time.

Fig 5.3 shows the revenue from Tokaido Shinkansen. It shows that the revenue increasing pace of Tokaido Shinkansen is gradual.

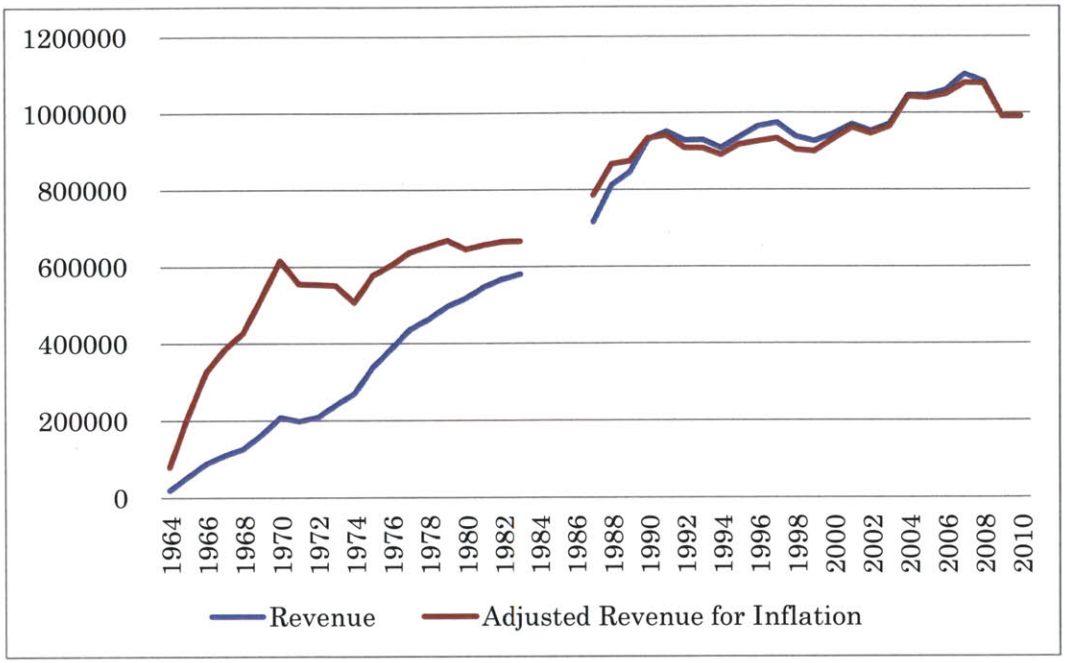

Fig 5.3 Revenue from Tokaido Shinkansen (millions of Yen)

The actual revenue of Tokaido Shinkansen had increased constantly from 1964 to at least 1983. On the other hand, the increased pace of the revenue after the JNR reform had been slower. We estimated that the market of Tokaido Shinkansen is going to be saturated. Thus, JR Central has to increase their productivity. This is because even if JR Central increased the input to increase the output, its effectiveness is very limited. Unfortunately, the data between 1983 and 1986 were not available.

We also needed the input data. As we said above, we set three input data. Fig 5.4 shows the personnel expense of Tokaido Shinkansen. The personnel expense had increased from 1964 to 2000 constantly.

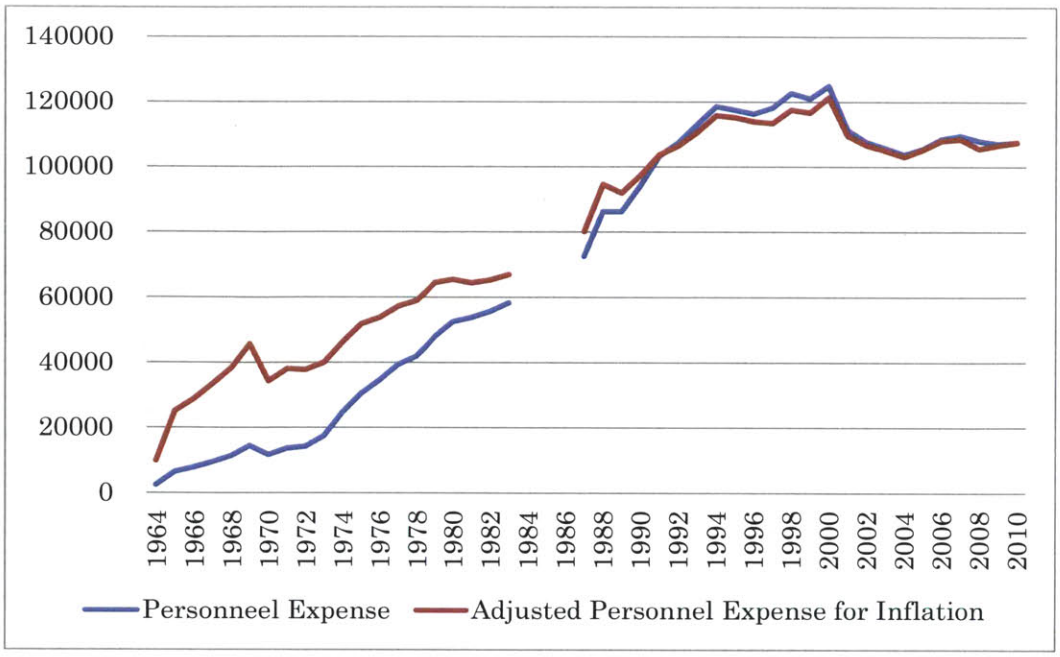

Fig 5.4 Personnel Expense (millions of Yen)

On the other hand, after 2000, JR Central has decreased its personnel expense. After 1987, JR Central has strong incentive to operate Tokaido Shinkansen line with an optimal personnel expense.

The next input data are non-personnel expense which includes energy cost, maintenance cost, and other operation costs, shown in Fig 5.5.

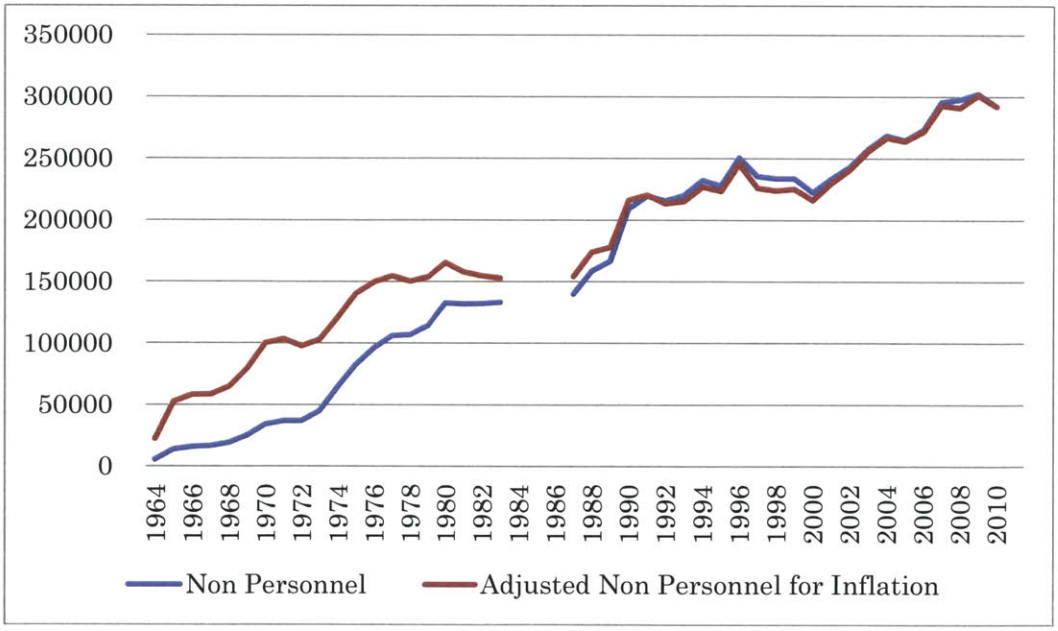

Fig 5.5 Non-Personnel Expense (millions of Yen)

Interestingly, the increasing pace of the non-personnel expense between the JNR operation, from 1964 to 1986, and the JR Central operation, from 1987 looks approximately similar. We can say that the industrial reform effect for the non-personnel expense part was very limited in the HSR operation. This might be because that they have to purchase almost all vehicles and maintenance parts from the other industries. JR Central is a railway infrastructure owner and the railway operator, but they are not a vehicle or parts supplier, and they need to buy electrical energy from electrical power companies. Thus, it is very difficult to control or reduce the non-personnel expense even after 1987.

The third input data are capital related expense which includes interest payment of debt, depreciation of the infrastructure and vehicles, and taxations. As shown in Fig 5.6. We need to explain about the significant gap between JNR term and JR Central term.

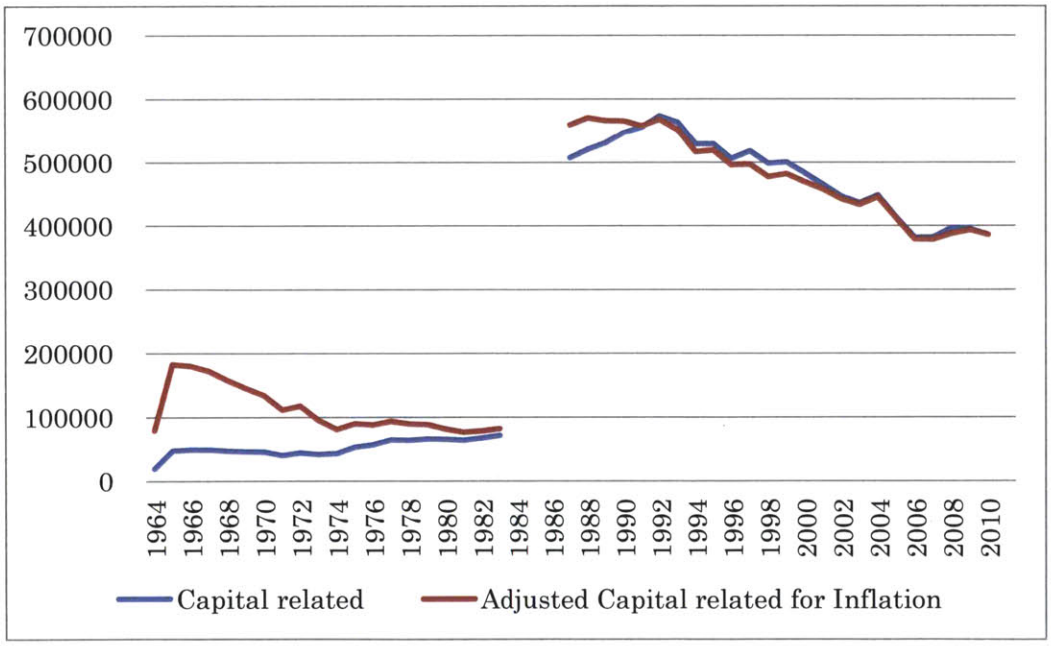

Fig 5.6 Capital related expense (millions of Yen)

The amounts of capital related expense which JNR had paid and the one which JR Central has paid are very different. This was because the actual construction cost of Tokaido Shinkansen which was capitalized by JNR, 380 billion Yen, and the price which was paid by JR Central to take over the infrastructure, 5.2 trillion Yen, are very different. This is about three times as much as the original construction cost adjusted for inflation. As this thesis said in Chapter 2, the government decided that JR Central, JR East, and JR West would take over the infrastructure of Japanese HSR lines from the HSR holding Co., they allocated the debt to each JR in accordance with the current value of each HSR line, not actual construction cost of each HSR line.

This means even though the actual construction cost of Tokaido Shinkansen was the cheapest among Japanese HSR lines, JR Central took over about 60% of total construction cost of Japanese HSR network. Thus, after the Japanese railway industrial reform in 1987, known as privatization, the payment for the capital related expense of Tokaido Shinkansen jumped up. This was very unfair trade for JR Central. However, when this debt distribution was decided, Japanese government owned 100% of JR Central's stocks. Thus, JR Central could not reject any proposal from the government.

After they took over the 5.2 trillion Yen debt from the HSR holding company, JR Central seriously care about the interest rate of the debt. This is because the amount of the interest payment is significant in the total expense of Tokaido Shinkansen management. JR Central has tried to reduce the average interest rate of the debt by the loan refinancing. Fig 5.7 shows the average interest rate of debt which JR Central has paid. JR Central achieved decreasing their average interest rate of debt from about 6.5% to 3.5% between 1992 and 2010.

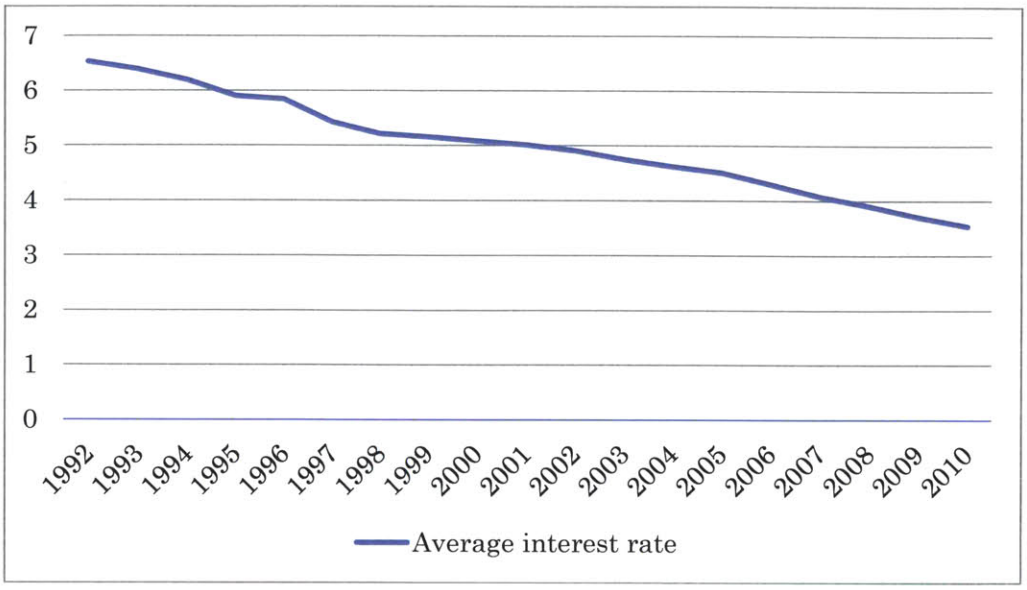

Fig 5.7 Average interest rate of the debt in JR Central (%)

On the other hand, the white book (1987) issued by the Department of Transportation said that the interest payment rate which had been paid by JNR had been almost fixed in 8%. This might be because JNR did not have strong incentive to reduce the interest rate of their debt. JNR was the government owned organization and they had borrowed from the public treasury. In Chapter 6, we show the calculation result of MFP and analysis for it.

In the next chapter, this thesis calculate MFP by using the data which shown in this chapter. After the calculation, this thesis analyzes the effect of the railway industrial reforms.

Chapter 6

MFP

6.1 Analysis of Tokaido Shinkansen

As explained in Chapter 4, we applied MFP to analyze the effect of the Japanese and European, mainly French, railway reform. The MFP equation we adopted is

$$\ln\left(\frac{\mathrm{TF}P_k}{TFP_l}\right) = \ln\left(\frac{y_k}{y_l}\right) - \sum_{j=i}^{N} S_j \ln(x_{jk}/x_{jl}) \qquad (15)$$

"Where N is the number of inputs. S_j indicates the cost share of input x_j between year k and l, and y is output."

The equation was used by previous research. The most valuable research which applied the equation was done by Cowie (2001), he analyzed the effect of the UK railway privatization by the equation.

From the data in Chapter 5, we calculated the year to year MFP of Tokaido Shinkansen management. Fig 6.1 shows the result. Fig 6.2 shows the cumulative graph of Tokaido Shinkansen's MFP.

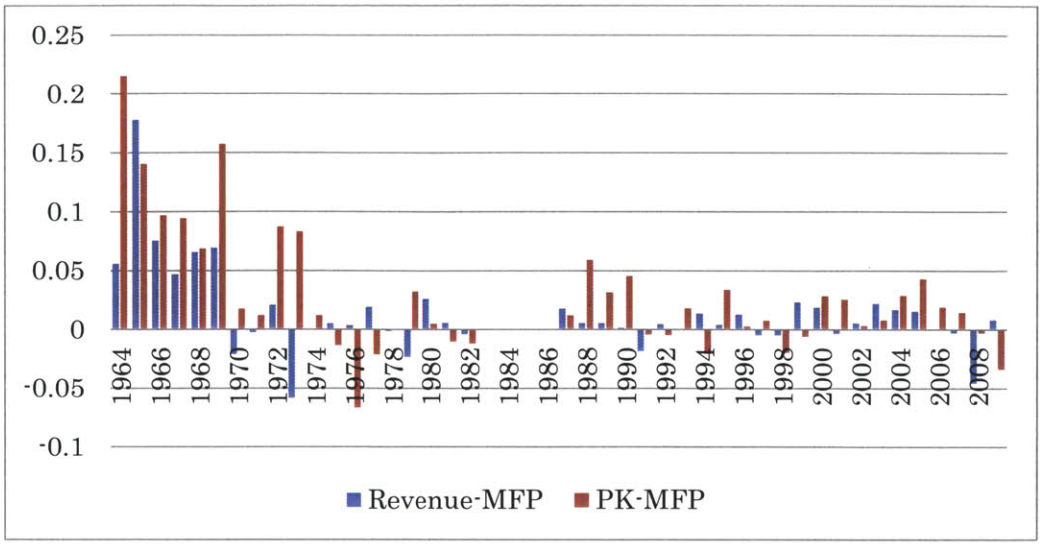

Fig 6.1 Year to year revenue and Passenger-km MFP (%)

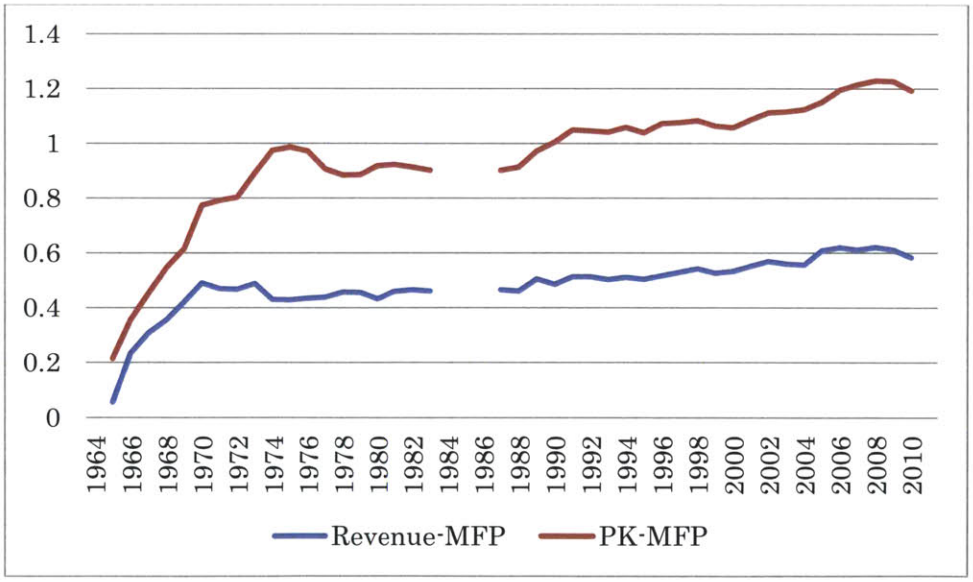

Fig 6.2 Passenger-km and revenue based MFP (%)

The blue graph shows the revenue based productivity; its output is revenue. The red graph shows the passenger-km based productivity; its output is passenger-km. In the first several years, passenger-km based and revenue-based MFP had increased rapidly. As explained in Chapter 5, we judged this was from the new entry effect: the time passengers have been recognizing the HSR as useful and convenient

transportation mode even compared to the alternative modes. During this first decade, JNR could get new passengers easily. However, in the revenue based TFP, after 1970, the growth ratio had been zero or sometime negative until the reform in 1987. Also in the passenger km based MFP, after 1974, the growth ratio had been negative. After the industrial reform in 1987, the revenue based MFP and passenger-km MFP both has been increased moderately. Table 6.1 shows the annual average growth of each MFP.

Table 6.1 Annual average growths of MFPs (%)

	From 1975 to 1984	From 1987 to 1996	From 1997 to 2006
Passenger km MFP	0.11	1.74	1.39
Reenue MFP	−0.27	0.48	0.89

From 1975 to 1984, before the privatization, JNR's average growth of revenue based productivity was negative, -0.27%, and the average growth of the passenger km based productivity was 0.11%. On the other hand, after the privatization, JR Central has made more than 1% annual growth in passenger-km based productivity, and positive average in the revenue based productivity.

We can say from the result that the railway industrial reform in 1987 contributed the JR Central's Tokaido Shinkansen management.

6.2 Decomposed single factor productivity

As Fig 6.2 shows, Passenger km based and revenue based multi-factor productivity both have been increased after the privatization. The next question is what kind of the factor or factors contributed to increase the MFP after the industrial reform. Now we calculated single factor productivity to analyze which change of input had a strong impact on the MFP. Fig 6.3 shows the six single factor productivity graphs, personnel-passenger-km, personnel-revenue, non-personnel-passenger-km,

non-personnel-revenue, capital related-passenger-km, and capital related-revenue productivity.

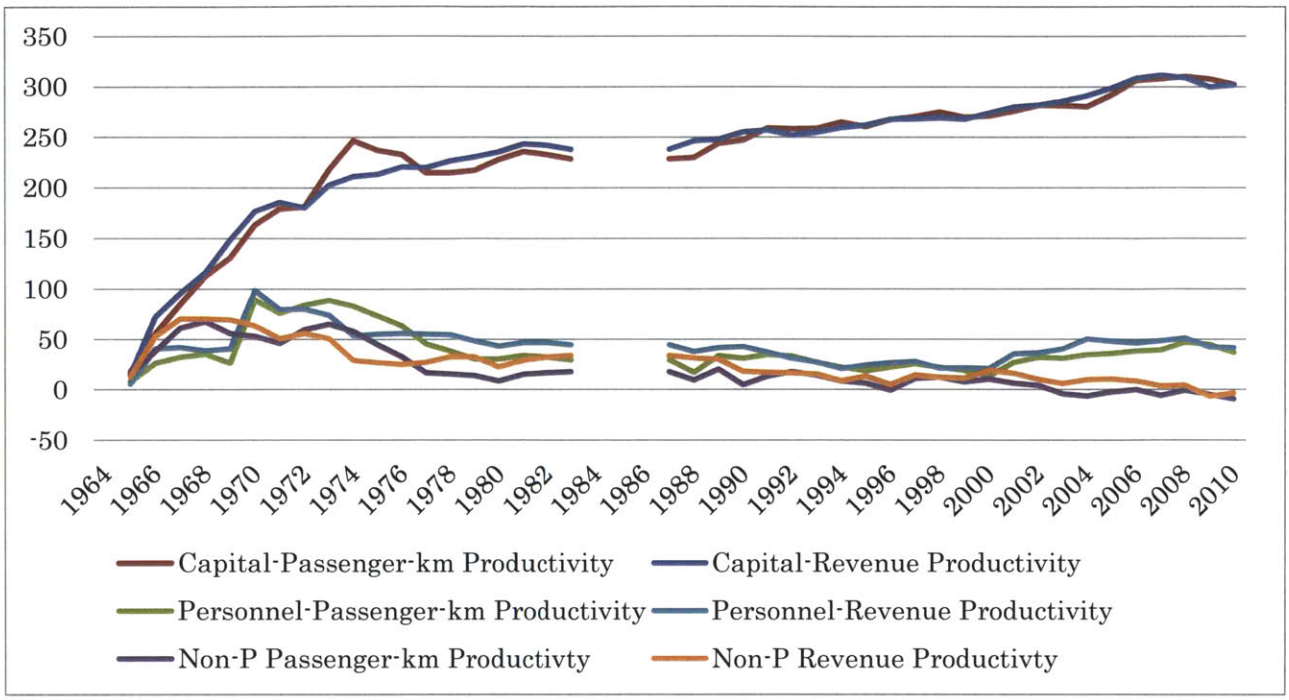

Fig 6.3 Single factor productivity (%)

Fig 6.3 shows that capital related-passenger-km and capital related-revenue productivity have been increased after the industrial reform constantly. As shown in Fig5.6, JR Central is very eager to reduce the capital related expense after the industrial reform, and they could do. This was because the amount of payment for the capital related expense is significant for JR Central's management. We can say that JR Central has a strong incentive to reduce the capital related expenses.

In addition, after 1999, JR Central has been also succeeded in increasing the personnel-passenger and personnel-revenue productivity both slightly. As shown in Chapter 2, in 1999, the government released the part of JR Central's stocks to the market. We judged that the privatization effect, pressure from the market to optimize the management cost, has improved personnel-passenger-km and

personnel-revenue MFP.

On the other hand, even after 1987, privatization, JR Central has lost non-personnel passenger-km and non-personnel-revenue productivity. As we judged in Chapter 5, JR Central has difficulty improving non-personnel based productivity because JR Central cannot control the price of energy, maintenance parts, and anything which has been supplied by the other industry to JR Central.

As conclusion, the Japanese railway reform, which was started from 1987 known as dividing and privatization, has improved the productivity of Tokaiso Shinkansen. This improvement has been from the continuing capital expense reduction after 1987 and the reduction of personnel expense from 1999.

6.3 TFP of French railway industry

This thesis also tried to calculate the multi-factor productivity of the French first HSR, the Paris-Lyon TGV line. However, the particular line's data is not available. Instead of calculating the Paris-Lyon line's MFP, this thesis reviewed the previous research about European Railway reforms, known as the vertical separation. Evaluating the effect of introducing the vertical separation management is more difficult than Japanese case. There are many complicated factors.

First, the European railway industrial reform did not happen all together, and did not introduce the same vertical separation system. As examples, Friebel et al. (2008) said that German national railway company DB capitalized new railway infrastructure owner company as one of the affiliate company of DB group. On the other hand, as we explained in Chapter 3, the French government capitalized the completely new infrastructure owning company, RFF. Thus, there were some railway reform styles within the vertical separation in European countries. Table 6.2 shows the types of separation of

infrastructure from operators and years when they introduced it.

Table 6.2 types of separation of infrastructure from operators

	Organizational separation within a company	Full institutional separation
Austria	From 1997	
Belgium	From 1998	
Denmark		From 1997
Finland		From 1995
France		From 1997
Germany	From 1994	
Italy	From 1998	
Netherland	From 1995	
Portugal		From 1997
Spain	From 1996	
Sweden		From 1988

Source: Friebel (2003)

Second, the European railway companies still manage the freight railway business. This means we cannot differentiate the personnel expense between staffs who work in the passenger railway business and staffs who work in the freight railway business. It's the same with non-personnel expense and capital expense. Thus, even though the previous research calculated the TFP of passenger railway industry, input data they adopted was influenced by freight business.

Third, the current financial relationship between operators and infrastructure owner companies is too complicated to apply our MFP model. As mentioned in Chapter 3, for example, SNCF has paid the railway usage fee to RFF, and RFF paid the maintenance fee to SNCF exclusively, and these data are not available. Thus, finding the correct data of the non-personnel expense which includes the maintenance cost and the capital related expense is very difficult. Indeed, Friebel et al. chose passenger-km as output,

and route-km and the number of staff as input data. Quinet (2005) also calculated the TFP of European large countries' railway industry. Quinet set passenger traffic and freight traffic as output, and rolling stock, infrastructure stock, and labor as input. His research was TFP, more than two output indices. However, he did not show the data he used, and he did not explain how he figured out the complicated relationship between SNCF and RFF.

Friebel et al. used "efficiency" to explain the effect of introducing the vertical separation in European countries. They said "the efficiency measure takes the value 1 (or 100%) for the country with the highest performance." This means in the Fig 6.4, Germany's passenger railway productivity in 1999, which is the best within the data, is 1.00. We can see how inefficient the other countries and years were compared to German productivity in 1999.

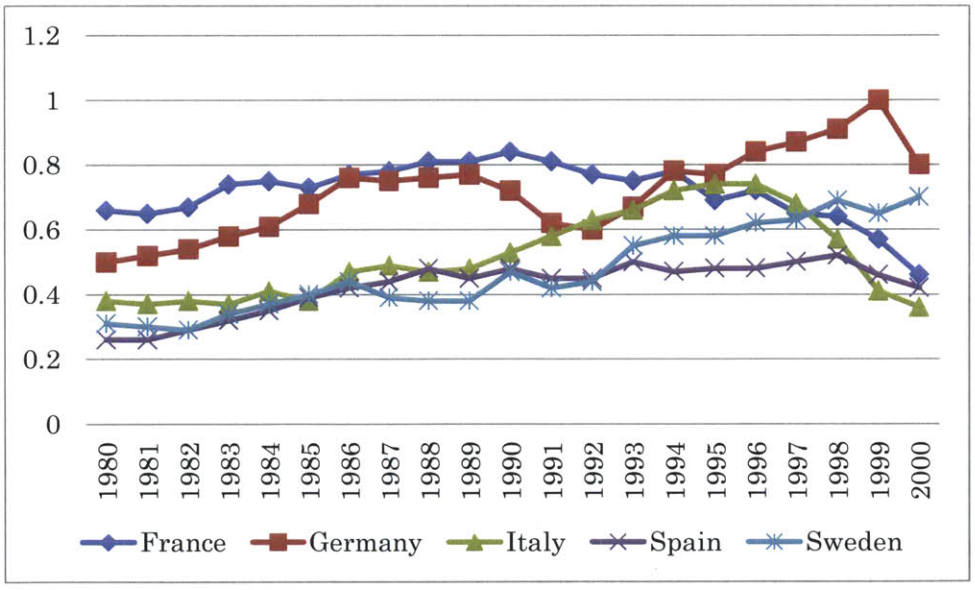

Fig 6.4 Productivity of passenger railways in Europe

Source: Friebel (2003)

Fig 6.4 shows that Germany had continued improving the productivity of the passenger railway after they introduced the vertical separation management in 1994, and Sweden had also improved the productivity after they introduced it in 1988. On the other hand, France, Spain, and Italy had reduced productivity after they introduced the vertical separation management. This is the very ambiguous result. This is because as we mentioned above, each country introduced the very characteristic separation system. As conclusion, Friebel et al. said that "building the reform of network industries on a one-size-fits-all model of separation of infrastructure from operations may not be a fruitful way to enhance productivity."

Quinet also calculated the productivity of European railway industry. He showed the only data graph, Fig 6.5.

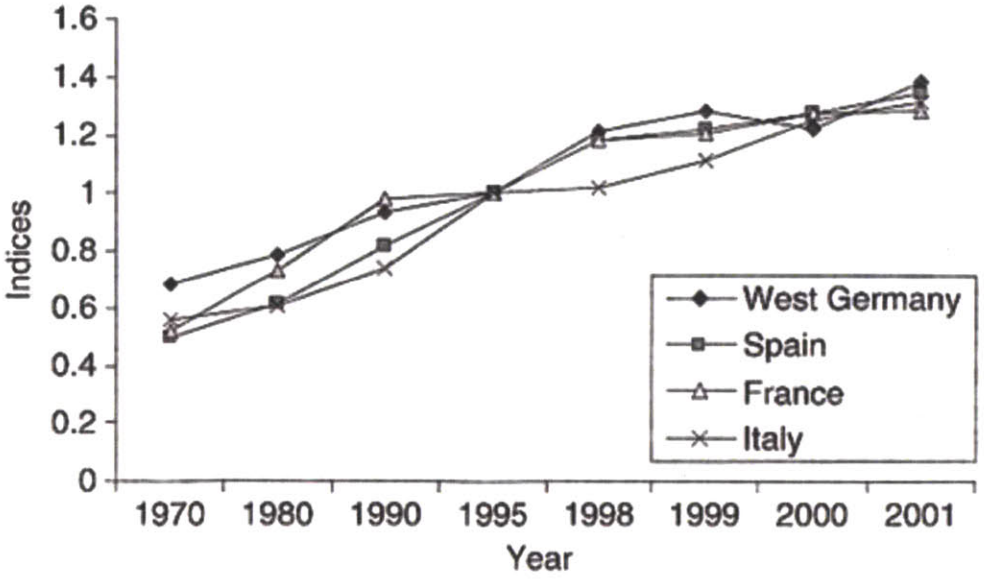

Fig 6.5 TFP of European Railway industry, 1995=1

Source: Quinet (2005)

The result of Quinet is slightly different from the result of Friebel. However, Quinet also said that

the French railway reform in 1996 has made a negative impact on their productivity. He said that "the rate of railway productivity growth in France was comparable to or better than the rates in Germany, Sweden, Italy, and Spain during the period from 1980 to 1995 but was the lowest of the five countries in the period from 1995 to 2001."

As we said above, the research of Quinet and Friebel was seriously constricted by data availability. Thus, Friebel used route-km and the number of staff as input data, and Quinet used TFP which included freight business data. Indeed, these data were not enough to evaluate the industrial reform, effect of introducing the vertical separation. This is because the railway industry could reduce the number of staff and reduce the route-km if they would abandon the local line services which had very small number of passenger-km. However, these are not from the effect of introducing the vertical separation management; these were just the effect from the layoff and abandonment of tracks.

Although Friebel's research model had a difficulty to evaluate the effect of introducing the vertical separation, at least he figured out that the German and Swedish railway industries could improve their MFP compared to France, Italy, and Spain as shown in Fig 6.4.

Germany and Sweden, which introduced the competition in the railway operation business even the scale was very small, had improved their productivity. On the other hand, France, Spain, and Italia, which did not allow the new entries to join the railway operation business, have lost their productivity. From these data, we can at least say that the European railway industries' productivity has a relationship with the degree of competition.

In the next chapter, this thesis shows the current US HSR program and problems, and this thesis

tries to suggest the future appropriate management structure of NEC HSR.

Chapter 7

The US HSR Project

7.1 Introduction

In this chapter, we compiled information about the US HSR programs to gain some insight on the appropriate structure of the future Northeast corridor (NEC) HSR: privatization of operators, vertical separation with competition, or integrated operation by the private sector. There are many common problems between the US and earlier Japanese and European railway industries, and also there are significant difference between them. So we need to be careful when we compere these countries with the US.

First, we present the reasons why the US has not introduced the HSR technology, unlike Japan and European countries. Since 1964, when the JNR started the operation of Tokaido Shinkansen, several developed countries have continued to expand their HSR networks. However, to be precise, there is no common definition of "high-speed" that all of these countries share. Several previous research papers determined that high speed means the maximum train speed is at least 150 mile per hour and the trains run almost always at more than 120 miles per hour. According to this definition, currently six countries have HSR networks and five countries have HSR lines, shown in Table 7.1.

Even though there is no rigorous distinction between networks and lines, this thesis roughly defined that HSR network has a radial structure or at least a main line and some branch lines. On the other hand, HSR line has almost only main line.

Table 7.1 HSR network and line around the world

Countires which have HSR network	First line open year	length (km)	countries which have HSR line	First line open year	length (km)
France	1981	1893	Belgium	1998	120
Italia	1981	866	UK	2003	113
Germany	1988	881	Netherlands	2008	120
Spain	1992	1585	Korea	2004	330
Japan	1964	2405	Taiwan	2007	345
China	2007	4175			

Source: UIC

However, the US does not have HSR yet. Although the closest railway line to the HSR definition is the Acela Express which runs on NEC, the average speed is still much lower than the definition of the HSR, shown in Table 7.2, and also it achieves its maximum speed for a very short segment of the trip. General information about current NEC is explained in Section 7.5 in detail.

Table 7.2 operation frequency and travel time on NEC and Tokaido Shinkansen

Line		Distance (mile)	Weekday round trips	Average Travel Time	Average Speed (mile/h)
NEC	Boston-NY	220	10	3:31	62.7
	NY-DC	238	15	2:45	86.5
Tokaido Shinkansen	Tokyo-Osaka	322	150	2:25	133.2

Source: NEC IMP (2010) and JR Central Fact Sheet (2010)

Generally speaking, there are many reasons why the US did not introduce HSR technology. For example, the US already had a highly developed highway transportation system and widespread airport network instead of HSR network. Indeed, the mode share of the US passenger railway is less than 1% shown in Fig 7.1. This is much lower than Japan and France, Japanese 28.7% in 2007and France 8% in 2000, shown in Chapter 3: Japan, and Chapter 4: France.

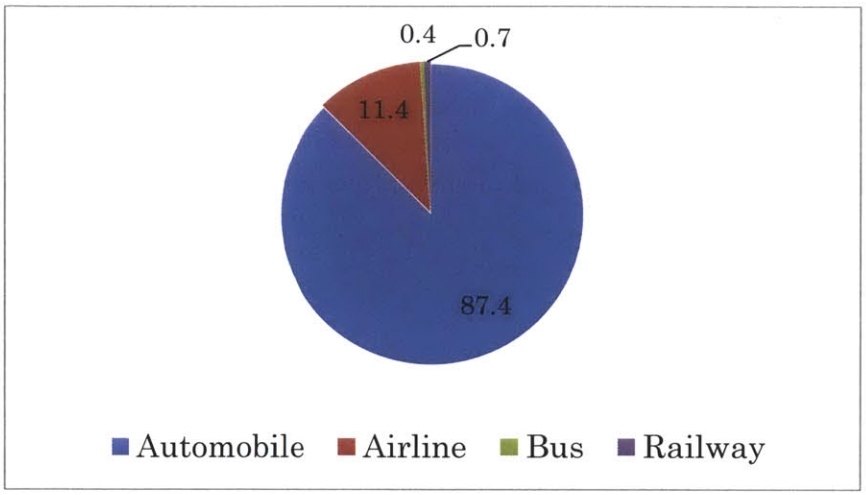

Fig 7.1 The US Transportation Mode Share (passenger mile base)

Source: Bureau of Transportation Statistics

Thus, improving and expanding the existing highway and airport network has been considered a better idea for the almost all US citizens and politicians. In addition, the US population density is lower than the average of countries which have HSR networks and lines, shown in Fig 7.2.

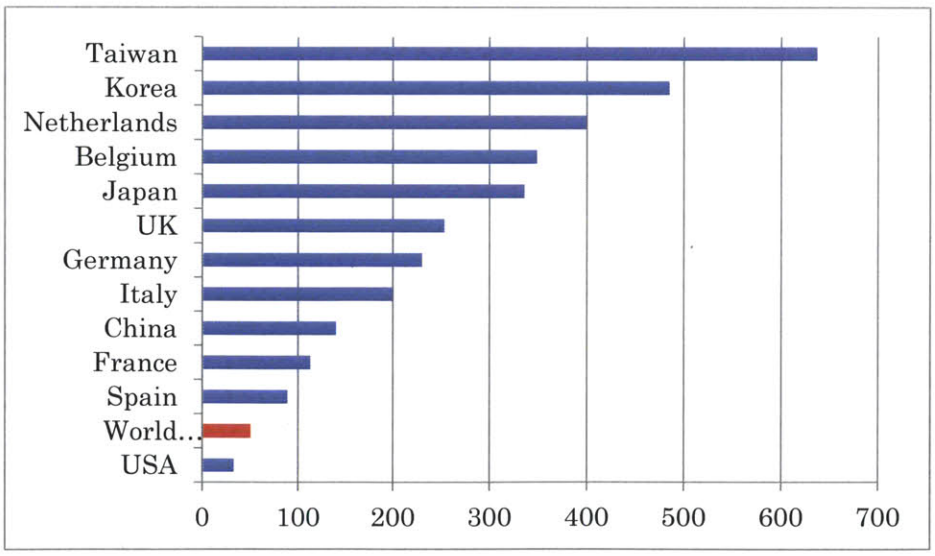

Fig 7.2 Comparison of the population density (person/km^2)

Source: United Nation Department of Economic and Social Affairs

Generally, HSR is considered the efficient transportation mode between the cities that have high population density and the distance between these two cities is between about 100 km and 700 km. This is because the high initial construction cost of HSR requires high passenger demand to cover the debt from its construction.

In addition, the US geographic scale is much bigger than the countries which have already introduced the national HSR network. Fig 7.3 shows the Japanese HSR network and Fig 7.4 shows the French HSR network. Japanese HSR, Shinkansen, network has 2387.7 km railway lines, and French HSR, TGV, network has 1895 km. Generally, HSR has an advantage against airline and automobile transportation in the trip distance between 100 km and 700 km. If the travel distance is less than 100 km, automobile transportation may be the first choice, and if the travel distance is more than 700km, passenger may prefer to use airline to reduce their travel time. The country size of Japan and France are very appropriate for the HSR.

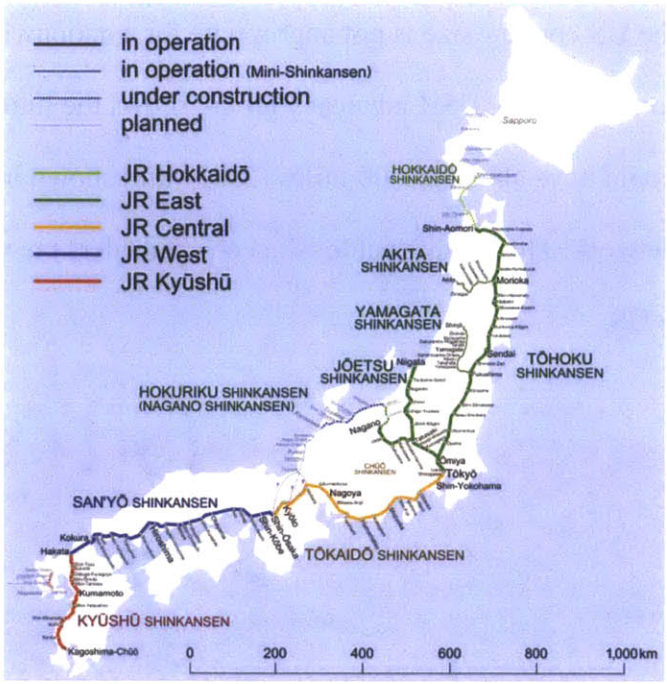

Fig 7.3 Japanese HSR network

Source: Ministry of Land, Infrastructure, Transport and Tourism

Fig 7.4 French HSR network

Source: SNCF

On the other hand, the US country size is not appropriate for a nationwide HSR network. The US High Speed Rail Association, one of the HSR advocacy group, shows the future US HSR network picture, and the network would have about 17,000 miles (23877 km) shown in Fig 7.5. This is 10 times as long as Japanese HSR network. This is unfeasible when one considers the very low population density in many part of the US.

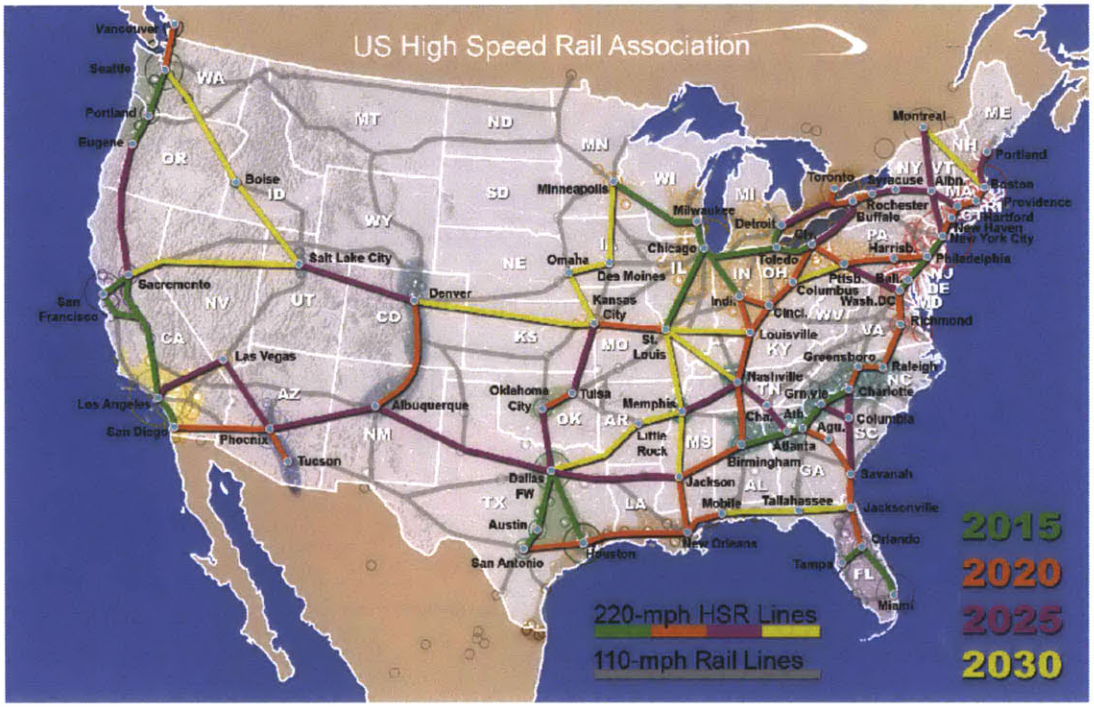

Fig 7.5 Future US HSR network drawn by US HSR Association

Source: US HSR Association

However, there are also counterarguments to these reasons why the US does not have HSR at all. First, Germany and Japan have the highly developed highway networks as well as highly developed HSR networks, and at least NEC has enough population and density. As Fig 7.1 shows, the French population density is lower than Germany's one. However, generally speaking, the French TGV network is more profitable than the German ICE network. This is because France has Paris as the hub of TGV

network. Paris is bigger than any German city. Thus, the French TGV network has the radial structure from Paris. This suggests even though the national population density is very low, if there is at least a city which has the very large population size, HSR can be an appropriate passenger transportation mode.

The current environment surrounding the US HSR project is very political. This thesis does not discuss the political conflict around the HSR project in detail. This thesis, however, discusses why the US HSR program has not been done at all.

7.2 Conception of the US HSR

In April 2009, US Department of Transportation (2009) and President Obama declared Vision for High Speed Rail in America. This was the first US nationwide HSR program. The President also allocated $8 billion to the project from the fund of *American Recovery and Reinvestment Act* (ARRA), which had $787 billion in total. In December 2009, Congress approved the suggestion that on additional $2.5 billion would be allocated for the HSR project in FY2010. In January 2010, the Federal Railway Administration (FRA) chose 79 projects from 31 states to allocate the $8 billion fund, show in Fig 7.6.

Fig 7.6 US HSR corridor designations

Source: US DOT

The US railway industry and supporters of the HSR might have a positive feeling about the many of projects were approved then. However, because of the large number of projects, the average amount of fund each project could receive was about $130 million. This is a very small amount in the HSR world. This means that some of the projects which were approved in January 2010 were not planning to construct the world standard level HSR, which was defined in Section 7.1.

Since the second half of 2010, the US HSR projects have slowed down or partly halted. In November 2010, the Democrat party lost many seats in the House of Representatives in the midterm election, and lost its majority in the House. Subsequently, the newly elected Republican governors, Governor Walker in Wisconsin and Governor Kasich in Ohio, decided to return the fund which was allocated to the HSR project in these states. HUFF Post Chicago, internet news web site, reported that Ohio Governor "Kasich has said that the top speed of 79 miles per hour (about 126 km per hour) on the

proposed Ohio project is too slow and questioned whether enough people would ride it." This slow speed has been a major concern about the US HSR project. As the report said, originally some of the US HSR project did not expect to construct the latest world standard HSR.

However, the Obama administration did not reduce their interest of the project. President Obama declared that the US would complete by 2025 the HSR network that could be accessed by 80% of all US citizens. So his administration suggested the US would invest $53 billion in the project for 6 years, from FY2012. Of course, some of the US transportation specialist, such as Ken Orski, a former federal transportation official, opposed the project. December 6th, 2011, TFI news, internet web news source, said that Orski explained his opinion for the project: "Instead of identifying a corridor that would offer the best chance of successfully demonstrating the technology of high-speed rail, and concentrating resources on that project, the Administration has scattered its nine billion dollars on 145 projects in 32 states, and in all regions of the country."

In February 2011, a critical negative event happened in Florida. The newly elected Florida Republican Governor Rick Scott refused to accept the $2 billion HSR fund, which was from initial $8 billion fund, for the Florida project. This case had a strong impact on the total HSR project in the US. After the rejection of the project in Florida, in April 2011, Congress decided to reduce the $2.5 billion HSR fund in FY2011 to 0, and they also reduced the $2.5 billion HSR fund in FY2010 to $2.1 billion.

Several sources showed the reasons why the new Florida governor refused to accept the federal HSR fund. St. Petersburg Times, internet news web page, said that the governor showed three reasons why he rejected the HSR project.

First, Florida would have to pay from $540 million to $3 billion if the construction cost overran the expected cost. Second, the ridership was considered to be wishful thinking because the federal prediction used Amtrak's NEC case. Third, Florida would have to pay back the initial $2.4 billion federal subsidy if the HSR project failed completely. This thesis does not evaluate whether the Governor's view of the Florida HSR project is correct. However, we can at least say that the project was originally proposed by the political sectors, not from the national railway company, Amtrak.

As shown in Chapter 2 and 3, Japanese and French first HSR projects were suggested by their national railway companies, JNR and SNCF. JNR and SNCF both took the risks of construction cost, demand, and management.

However, in Florida case, as the Governor said, the state of Florida would have to take almost all risks of the HSR project. In addition, nobody knew who could be the railway operator, how much the future railway operator would pay for the usage fee, and whether the state of Florida would accept private sectors' investment in the infrastructure.

After the failure of the Florida HSR project, people might start to have negative feelings about the US HSR programs. Since 2009, the total amount of the fund that the HSR project has received was $10.1 billion, which has come from the first $8 billion from ARRA and $2.1 billion from the budget of FY2010. The fund which was returned from Ohio, Wisconsin, and Florida was re-allocated to the other projects, including NEC and the California HSR.

As shown above, introducing the entire national HSR network into the US is an unreasonable idea. However, as Taiwan and Korea, if the countries have an area which has at least high population density

cities, constructing HSR line, not network makes certain amount of sense. This thesis discusses about California HSR project, in the next section, and NEC HSR projects, in Section 7.5, which have enough population, population densities and an appropriate distances between two or more cities. We call these HSR structure "lines" in this thesis.

7.3 California case

The California HSR project is one of the projects which received the fund that was returned from Ohio, Wisconsin, and Florida. This section explores the California HSR project; the California HSR project has characteristic differences from the other US HSR projects.

In November 2008, before President Obama was inaugurated, California took the vote that would decide whether California would construct HSR, and the citizens approved "Safe, Reliable High-Speed Passenger Train Bond Act for the 21st Century", known as Proportion 1A. The act approved issuing state bonds to help constructing the HSR between San Francisco and Los Angeles, about 400 miles, of international standard HSR. This means that the California case was approved by the citizens legally. This is one of the important points of the project. This means it is difficult to easily abandon the project because the project was officially authorized.

The other important point is that the California project has been planning to construct the world standard HSR from the ground up, not just improving an existing local line. As mentioned above, several other projects have been planning to improve the existing lines.

In addition, the California case has an official authority, California High-Speed Rail Authority (CHSRA). CHSRA is a state agency that was established by the California High-Speed Rail Act in 1996.

So in the California project, the organization that has the responsibility of the project is clearer than other US projects, such as NEC HSR project, discussed in Section 7.5. This is a important character of the California case and commonality with the first Japanese and French HSR project. As explained in Chapter 2 and 3, at least Tokaido Shinkansen and the Paris-Lyon TGV line were planned and capitalized by JNR and SNCF. On the other hand, most of the US HSR projects did not have strong authorities.

7.4 The difference between the US HSR project and HSR in other countries

However, the California and the other US programs still have a fundamental difference from Japanese and French cases. The difference is that CHSRA is not a business operator or a railway operator. They have planned, organized, but they have not had financial risks, and they have not considered being the railway operator.

On the other hand, the countries which already have HSR have the business operators, such as JNR and SNCF. Also JNR and SNCF believed that their first HSR lines could earn profit for them. Thus, they had strong responsibility, interest, and obligation for the project. At the same time, they also faced the financial risks. This means even though they were public sector, these HSR projects made the investment case that they expected to get enough financial return.

If they failed to construct the profitable lines, there would be no HSR networks in Japan and France. However, as this shown in Chapter 2 and 3, these first HSR lines, Tokaiso Shinkansen and the Paris-Lyon TGV line have succeeded to be significant profitable HSR lines.

CHSRA made a modification about the budget and the project term once. Originally, they estimated that the project needed $43 billion, and the project would be completed in 2020. However,

November 2011, they revised their estimations. The new budget they are requiring is $98.5 billion, and the project term is extended to 2033. The budget they need has doubled and the term of the project was extended by 13 years. Furthermore, in April 2nd 2012, Reuters news article said that CHSRA showed their new cost of the construction plan which said they need $68.6 billion. Within less than two years, they changed the estimated construction cost twice. The California HSR project is in crisis, like the other US HSR projects.

This thesis concludes that the US HSR program has mainly three fundamental problems. First, each project's financial scheme was immature. As Florida governor complained, some projects imposed the financial risk on the states. This has not happened in the other countries. Thus, many projects have just invested the federal grant in the existing local railway lines to improve the speed a little bit, and certainly not approach world standard HSR. This is fundamentally different from the idea of Japanese and French HSR network project, shown in Chapter 2 and 3.

The second reason has a strong relationship with the first reason. As shown in Chapter 2 and 3, at least Japan and France have had nationwide national railway companies, JNR and SNCF, that could finance the first HSR lines. However, in the US, each case does not have an eligible business operator. Even now, nobody knows who will be the operator of the California HSR, and nobody knows who would take the financial risks if the project finance crashed. This means, there is no business operator who has an incentive to drive the project forward.

Third is too much spreading of funds for political reason. As explained in Section 7.1, the US DOT accepted too many projects, and some of these are not high speed passenger railway project. They were just planning to improve the existing railway infrastructure.

However, JNR had constructed only Tokaido Shinkansen line between 1959 and 1964, and SNCF had also constructed only the Paris-Lyon TGV line between 1976 and 1983. Their focused financing and construction process were completely different from the US program, as it exists today

7.5 NEC

The US most profitable and congested railway corridor, known as Northeast corridor (NEC), is a 457 mile multi-track rail line between Boston and Washington DC, via New York. Cambridge Systematics (2011) reported that the intercity-passenger railway service operated by Amtrak carries approximately 13 million passengers within the area. This number of the passengers represents 5% of all intercity trip passengers by all transportation modes on NEC. The report said that NEC is one of the ten busiest railway corridors in the world.

First, this thesis estimated the potential of the future NEC HSR. This is because there are enough big cities, which have large enough populations, along NEC. Even compared to Tokaido Shinkansen line and the Paris-Lyon line, we can see the effective potential in NEC. Fig 7.8 shows the main cities' populations along the three lines.

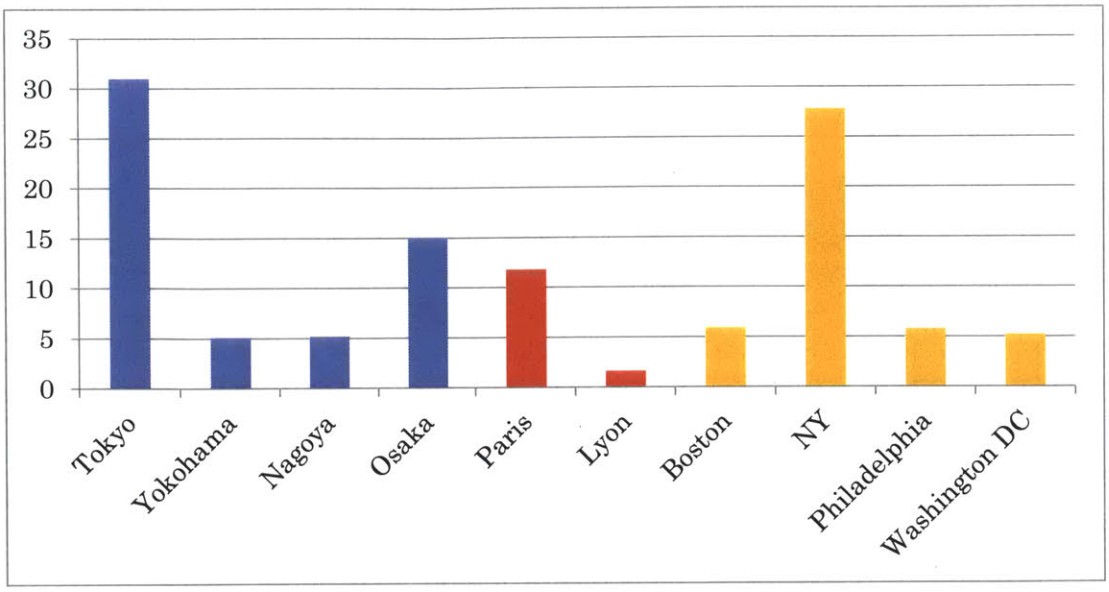

Fig 7.8 Population in the big metropolitan areas along the NEC (millions)

Source: US Census Bureau,

Besides, the economic scales of cities along the NEC are also appropriate for the HSR. Generally speaking, high initial construction cost of HSR requires a business operator to set a high ticket price. This means if the business operator wanted to succeed in the HSR business, they need enough passengers who can pay the high ticket prices. The business operators need customers who believe that the travel time reduction and comfort values are worth high ticket cost of HSR. This thesis uses the estimated city GDP to evaluate the size of the economy in each city, shown in Fig 7.9

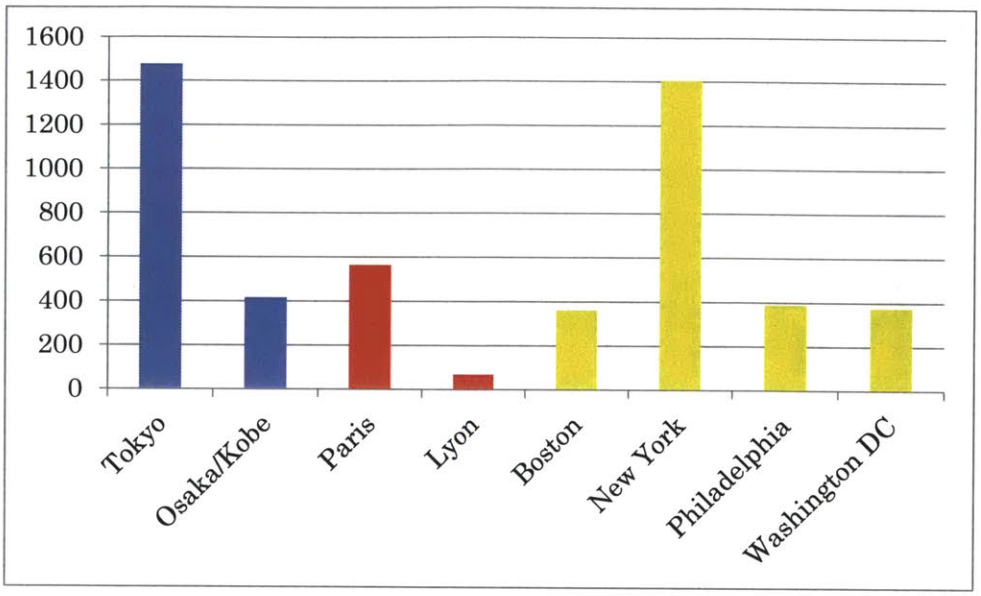

Fig 7.9 Estimated Cities' GDP ($ billion)

Source: PricewaterhouseCoopers UK Economic

Distance between cities is also similar to the Tokaido Shinkansen. Fig 7.10 shows the image of distances and population size of the cities along Tokaido Shinkansen line and NEC. The total length of Tokaido Shinkansen line is 322 miles, and the distance between Boston and New York is 220 miles, and the distance between New York and Washington DC is 238 miles. The length of the Paris-Lyon TGV line is 260 miles. From the data, each distance between cities along with NEC is very appropriate for HSR.

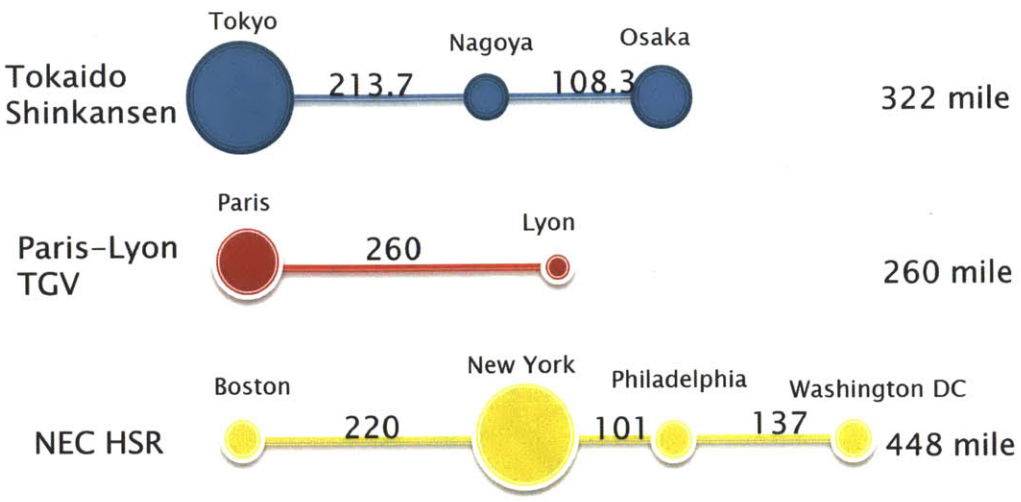

Fig 7.10 Distance and cities' size on each corridor

Source: Amtrak and JR Central web pages

The ownership of the NEC infrastructure has particular structure. Fig 7.11 shows the ownerships of each segment on the NEC and the areas of commuter railway services operating on the corridor. As discussed in Chapter 2 and 3, infrastructures of Tokaido Shinkansen line and the Paris-Lyon line are exclusively owned by JR Central and RFF, French railway infrastructure owning company, respectively. On the other hand, the total infrastructures of NEC corridor are owned by four independent public organizations, Amtrak, Massachusetts Bay Transportation Authority (MBTA), Connecticut DOT, and Metro-North. Amtrak owns approximately 80%, 363 miles of the NEC railway line. For the other part, MBTA owns 38 miles, Connecticut DOT owns 46 miles, MTA Metro-North Railroad (MNR) owns 10 miles.

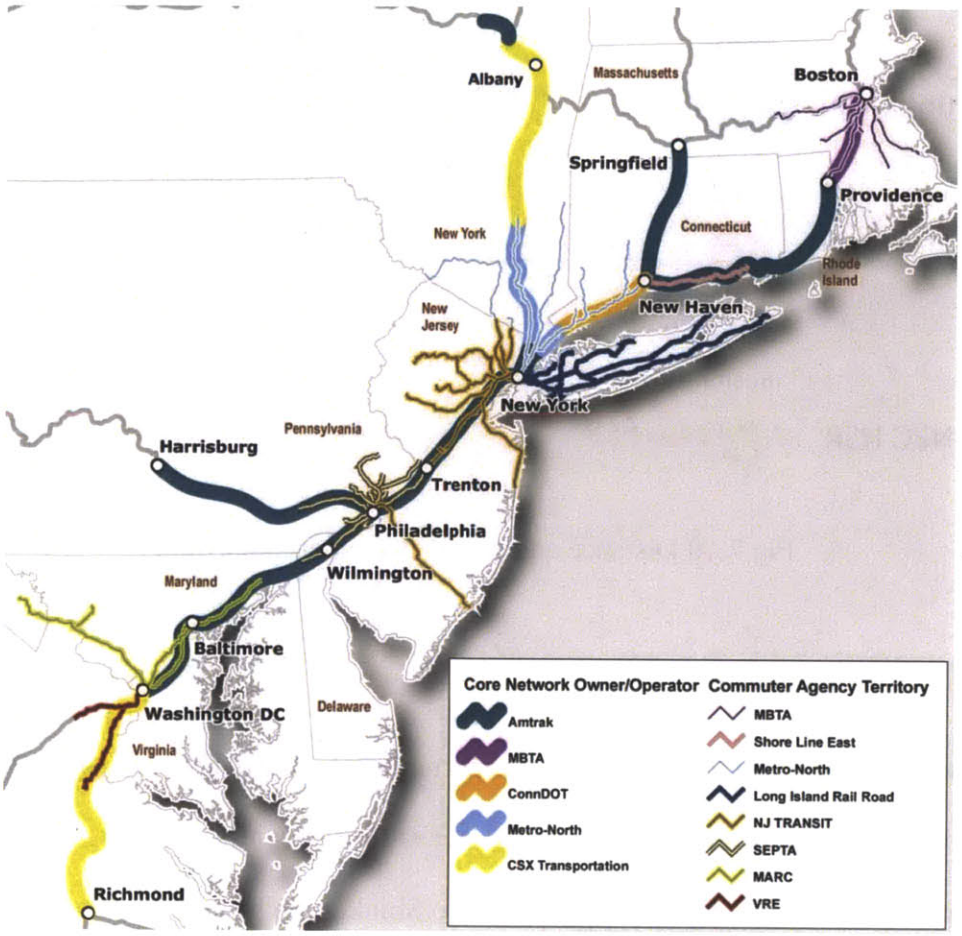

Fig. 7.11 Ownership of NEC and commuter rail operators

Source: NEC Infrastructure Master Plan

Amtrak operates two types of intercity passenger railway service on NEC, *Acela Express and Regional* between Boston and Washington DC, via New York. Amtrak National Factsheet (2010) said that these two services have annual ridership of 8.107 million and 3.219 million passengers respectively. Currently, Amtrak manages 10 daily operations of Acela Express between Boston and New York, and 15 daily operations between New York and Washington DC. Table 7.2 shows the comparison of the service frequency and speed between NEC and Tokaido Shinkansen line.

Several freight railway companies also have trackage rights on the NEC. Currently, there are Conrail Shared Assets Corporation, Providence and Worcester (P&W), Pan Am Southern, Canadian Pacific (CP), Connecticut Southern, Norfolk Southern, and CSX Transportation. They operate approximately 50 trains per day on the NEC. This is not a small number compared to the number of operations managed by Amtrak, shown in Table 7.1.

Indeed, the intercity passenger transportation operated by Amtrak is not the majority of the service in NEC. This means the major business player on NEC is short range commuter railway business. Amtrak only has 5% of total ridership. In the share of train operation, Amtrak has only 6.7 % share. This means Amtrak also recognized that the main operator on the current NEC is definitely not Amtrak, but the other short distance commuter railway operators.

Table 7.3 shows the current ridership and the number of operations by each passenger railway operator.

Table 7.3 Current ridership and daily trains

	Annual Riders (millions)	% of total	Daily Trains	% of total
Amtrak	13	5	154	6.8
MBTA	23	8.8	296	13.0
ConnDOT/SLE	1	0.3	23	1.0
MNR	49	18.8	345	15.2
LIRR	86	33.1	581	25.6
NJT	58	22.3	387	17.0
SEPTA/DelDOT	18	6.9	374	16.5
MARC	8	3.1	83	3.7
VRE	4	1.5	29	1.3
TOTAL	260		2272	

Source: NEC IMP (2010)

As shown in Table 7.3, the total ridership of MBTA, Metro-North Railroad (MNR), Long Island Railroad (LIRR), and New Jersey Transit (NJT) is more than 83% of total NEC ridership. They are basically short-distance commuter railway operators.

The Amtrak NEC master plan (2010) said that they expected that the ridership would be 23 million and the daily trains would be 210 services by 2030. However, these numbers represent only 5.6% and 6.4 % of the total ridership and daily trains, respectively, in 2030. This means Amtrak knows that the intercity passenger railway service would not be the major service on NEC, even in the future.

Fig 7.12 shows the volume of the train movement on the NEC. The main volume zones are around the big cities, Boston, New Haven, Stamford, New York, Philadelphia, and Washington DC.

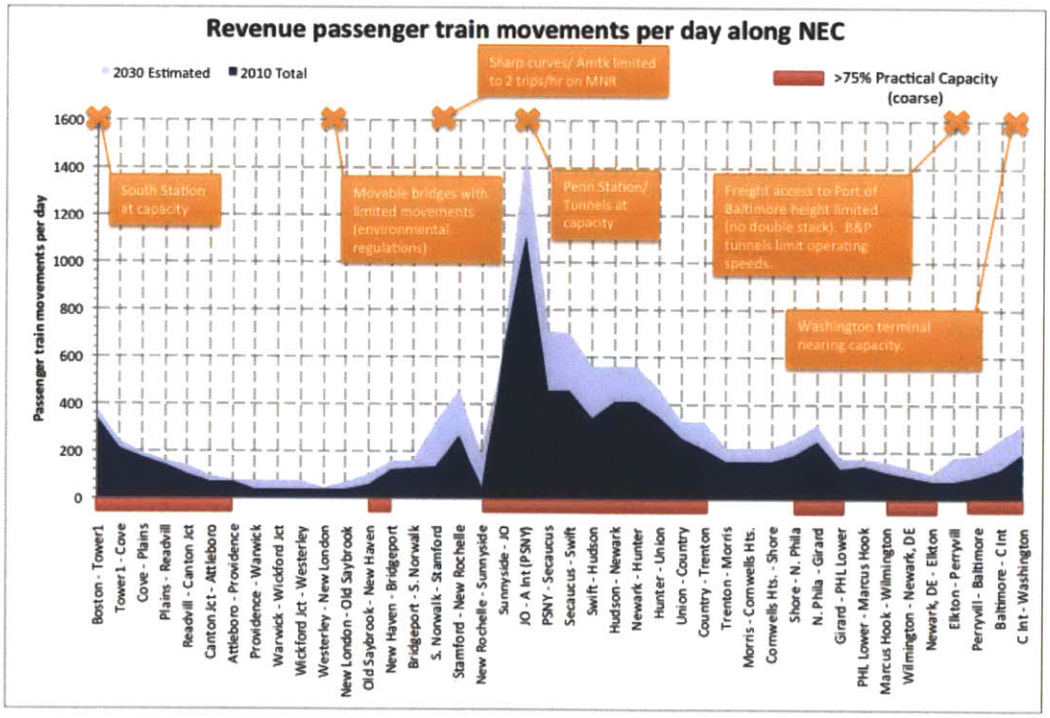

Fig. 7.12 Passenger train movements by segment of the NEC

Source: NEC IMP (2010)

Besides, Amtrak has other physical constraints in the NEC infrastructure. On the NEC, there are several movable bridges in Connecticut. During the summer months, the Connecticut Department of Energy and Environmental Protection limits the operation of Amtrak to 39 trains per weekday and 25 trains per weekend day over the five bridges in the state. The operation limited by the Connecticut regulation makes a major bottleneck in the railway service between Boston and New York. Fig 7.13 shows how many times the movable bridges were operated in 1993.

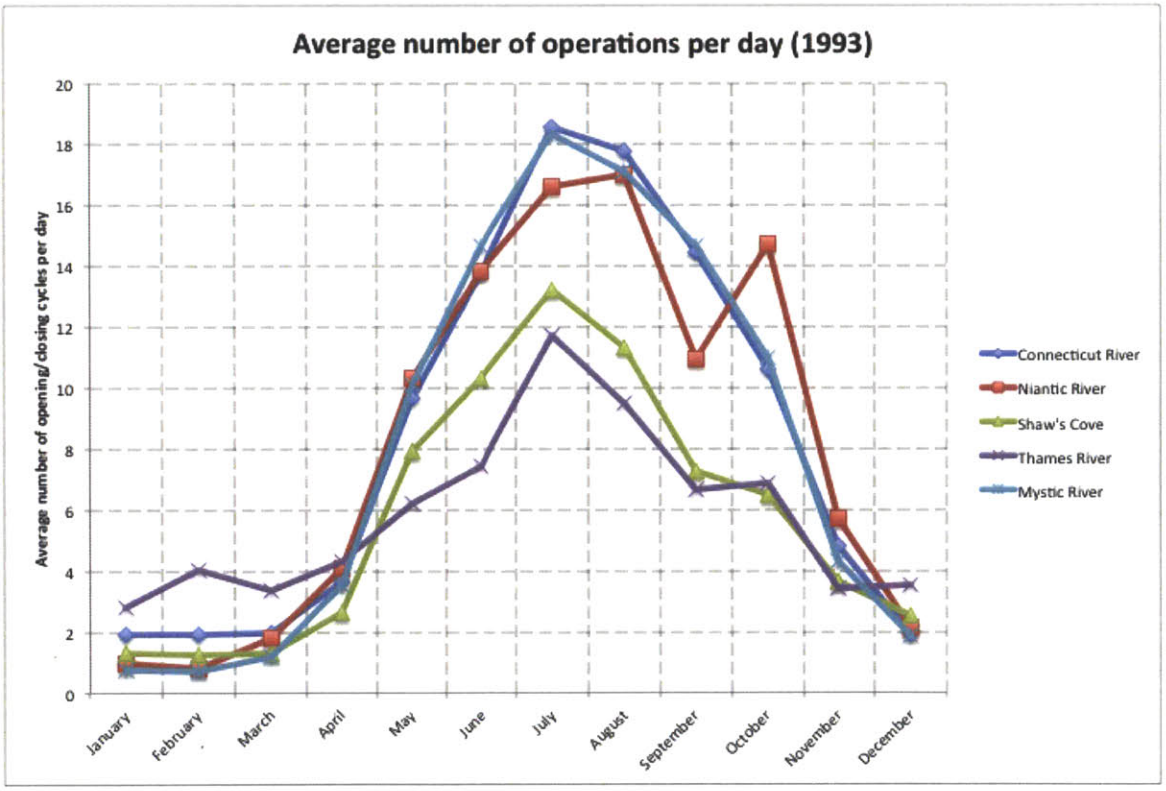

Fig. 7.13 Average number of operations per day of the five Amtrak-owned movable bridges in Connecticut, 1993

Source: FRA 1994

According to the NEC master plan, Amtrak stated that they would need $52 billion to improve the

bottleneck of the NEC. The shortened travel time between Boston and New York would be 3 hours and 8 minutes from 3 hours and 31 minutes, and the travel time between New York and Washington DC would be 2 hour and 21 minutes from 2 hours and 45 minutes. It is very difficult to evaluate the cost and benefit of the investment exactly. However, at least we can say that the amount of the fund, $52 billion, is an extraordinary amount compared to the annual subsides from FRA to Amtrak. Amtrak has received annually $1.5 billion subsidies from Federal Railway Administration (FRA), shown in Table 7.3.

Table 7.4 Federal Government Funds for FRA ($ million)

year	2008	2009	2010	2011	2012
FRA	1581	11098	39660	1860	1632
Amtrak	1325	2790	1565	1565	1418
HSR	0	8000	2100	0	0
other	256	308	295	295	214

Source: DOT

This means the Amtrak's improving NEC project required the government to invest 35 years' worth of the subsidies. Besides, the result from the gigantic subsidies would shorten the travel time about 25 minutes. The author believes that justifying the $52 billion budget just for improving the existing NEC is very difficult.

7.6 Constructing a completely new HSR on NEC

Amtrak also published "A Vision for High-Speed Rail in the Northeast Corridor" (VHSR). This paper suggested that Amtrak would construct a new exclusive HSR; only HSR vehicles run on it, and the train operation speed would be 220 miles per hour. Amtrak suggested two potential lines, southern alignment and northern alignment. The advantage of southern alignment is that Amtrak can use part of existing NEC infrastructure. On the other hand, the advantage of northern alignment is that Amtrak can

construct the new HSR along the existing highways, Interstate 84 and 91, owned by Connecticut, and Intercity 90, owned by Massachusetts. These highway infrastructures and real estate are owned by public sector organizations. The report said that if they constructed the new HSR alongside the highways, they could save some of the capital construction cost. However, the choice of the alignment need same amount of construction cost. Amtrak estimated that they need $117 billion.

"Amtrak Vision for HSR" also explained the shortened travel time in the future. The proposal paper shows the "HSR and Super HSR", Super HSR's total travel time would be shortened by reduced time of staying in the stations. Table 7.4 shows the estimated future travel time.

Table 7.5 Estimated future travel time of NEC

	Distance (mile)	HSR	Average (mile/h)	Super HSR	Average
DC-NYC	238	1:55	124.6	1:36	148.7
NYC-Boston	220	1:46	124.5	1:23	159.4
DC-Boston	448	4:06	111.7	3:23	135.5
Tokyo-Osaka	322	2:25	133.2		133.2

Source: Amtrak VHSR (2010)

From the travel times and distances, we can estimate the average travel time, shown in Table 7.5; this is close to the current speed of Tokaido Shinkansen.

Table 7.6 Expected travel time and speed by VHSR

	HSR	Average (mile/h)	Super HSR	Average
DC-NYC	1:55	124.6	1:36	148.7
NYC-Boston	1:46	124.5	1:23	159.4
DC-Boston	4:06	111.7	3:23	135.5
Tokyo-Osaka	2:25	133.2		133.2

Source: Amtrak VHSR (2010)

Although Amtrak did not mention the frequency of the services, we assume that the new HSR could have the same level of operations frequency as the Tokaido Shinkansen line.

For this exclusive new world standard HSR, Amtrak requires $117 billion. Actually estimating the future construction costs is an important and difficult problem. However, Rus (2008) compiled the survey financial data about HSR in Europe, and he said that "the average cost per km of a HSR line ranges from 9 to 40 million of euros with an average of 18." The average exchange rate between euro and dollar was about 1 euro equals $1.5. Thus, the average of European HSR construction cost per km was $27 million. Amtrak's proposal, VHSR, said they need $163 million per km to complete the HSR infrastructure on NEC. This is six times as much as the European average, and more than twice the cost of the most expensive European HSR infrastructure.

We could not find out how Amtrak estimated the total construction cost, and why the cost was 6 times as much as the European average HSR construction cost. However, from the discussion in this thesis, one possibility is there is less motivation for reducing the construction costs in Amtrak, which does not have any risk about the construction of the future exclusive NEC, might lead to increase in the construction cost.

Again, each HSR case has its own geographical problem. Thus, estimating the total construction costs from other existing HSR system is very difficult. However, if we compare the amount of an annual subsidy, about $1.5 billion, which Amtrak has been receiving, and the total construction cost, $117 billion, which Amtrak estimated, we can say the feasibility is very low. There are several reasons why the project did not make enough progress even though the potential market is huge. As this thesis already mentioned, we concluded that there is no organization which has a responsibility to the US HSR

projects. Thus, there are little incentive to promote it compared to Japanese and French cases we already explained in Chapter 2 and 3.

As shown in Table 7.4, Amtrak has been a heavily subsidized government owned company. Since the beginning, in 1971, they have continued a deficit operation in their finance. The financial statements that have been released by Amtrak annually stated that all of the railway operations by Amtrak need the subsidies, except for the NEC operation.

Train Journal (2011) said that "the NEC trains covered all their direct and indirect costs, with $61 million left over." This means Amtrak has two business constraints. One is that they need subsidies to operate the social public services. This was the original reason that the government capitalized Amtrak in 1971. The other is that they need to do competitive business on NEC. There are other transportation modes, such as automobiles and buses service on a highway and airlines. However, the current Amtrak fiscal structure might decrease the ability to achieve the appropriate management and financing for the world standard HSR project.

7.7 Conclusion: appropriate management structure in NEC

As this thesis already showed in Chapter 6, the productivity of the operation management of Tokaido Shinkansen has been improved after JNR was divided into 6 areas and partly privatized. From the result, introducing the completely new HSR operator, not Amtrak, may be able to improve the management efficiency of the future NEC HSR.

The advantage of the private sector is that first, they can set an appropriate ticket price without or at least a minimum level of cross-subsidization. As shown in Chapter 2 and 3, JNR was forced to use

cross-subsidization to continue unprofitable railway lines, and SNCF is still using cross-subsidization to continue their "social service" parts. Generally cross-subsidization makes the operators' management incentive weaker. Although we cannot determined if Amtrak is using the profit from NEC to continue their unprofitable lines, at least the current Amtrak, deeply subsidized public company, has less management incentives compared to the private operators.

Also as show in Chapter 6, the significant improvement of Tokaido Shinkansen's MFP has been from the reduction of the capital related expense. Thus, this thesis recommends that any private sector, including the HSR operation company, should capitalize and manage the construction of the future NEC infrastructure, even partly. This suggests that financing entire NEC infrastructure by a private company is impossible in reality. However, there are some feasible cases. For example, some private companies make a consortium to capitalize the NEC infrastructure.

Currently, many countries have already introduced private sectors' funds to construct HSR infrastructure. As shown in Chapter 2, current Japanese HSR project is partly financed by JRs. In Taiwan, they constructed the first HSR line by BOT, Build-Operate-Transfer. Chang (2001) explained the Taiwanese HSR case financed by BOT. He said that "Taiwan High Speed Rail (BOTHSR) developed a model for financial planning and evaluation of bidders' proposals". BOTHSR is a pure private company which was capitalized five Taiwanese private companies to start the domestic HSR project.

This thesis cannot conclude that the Taiwanese case works well because there is not enough available data. However, we can say that utilizing the private sector's funds to construct HSR infrastructure was feasible. If there is financial difficulty to construct exclusive NEC HSR line, at least the US government has to consider utilizing the private funds.

In addition, the private sector can be very eager to reduce the total construction costs. This is because they are also capitalized by private companies and individual stock holders. To satisfy them, their investment should be very rational.

About introducing the vertical separation and competition within the operator, we do not have enough empirical data. Some researchers favor the Swedish public bidding system, which has improved personnel productivity, shown in Table 3.4. Thus, this thesis suggests that the future NEC HSR operator should consider the public bidding.

True competition in the transportation field already exists in airline and automobile transportation. On the other hand, this true competition had not happened in HSR market. There are some reasons why it had not happened, for example, safety problem, cross-subsidization, and national railway system. However, NTV in Italy, which is also capitalized by some pure private companies, started true competition against Trenitalia, former Italian national railway and still state owned company, from April 28th 2012. Although there is not enough data to evaluate the effect of the true competition within the railway operators, this Italian case could be a fine test case for the future NEC. This thesis shows information of the current Italian HSR competition in the afterword that follows Chapter 8

This thesis researched about Japanese and French HSR productivity to evaluate the effect of privatization and vertical separation, and we suggested that introducing competition within the private sectors can improve the potential US HSR market well. However, each country has characteristic problems. We have to be careful about introducing the privatization and competition into the US potential HSR market even though these have improved the productivity of railway industries in some countries. In the next chapter, we show the conclusion of our research.

Chapter 8

Conclusion

This thesis mainly analyzed the effect of privatization and dividing of JNR, so-called JNR privatization, and vertical separation of SNCF by applying *multi-factor productivity* (MFP). Thus, we need to know what actually happened during the privatization of JNR and introducing vertical separation into SNCF to guarantee that our research objectives are appropriate to evaluate the effect of these railway industrial reforms. We set Tokaido Shinkansen and the Paris-Lyon lines as research objectives to evaluate the reforms.

First, this thesis introduced what actually happened in Japanese railway industrial reform, known as JNR privatization in Chapter 2, and in European railway industrial reform, known as vertical separation management in Chapter 3.

The privatization and vertical separation had been introduced in part because of the change of railway mode share in these countries. As shown in Chapter 2 and 3, in Japan and European countries, the national railway companies lost significant amount of their mode share. These national companies had an obligation to operate a number of unprofitable lines. They had been forced to use cross-subsidization to cover the deficit from these unprofitable lines.

However, after World War II, the rapid spread of motorization made continuing the cross-subsidization difficult. In the 1980s, Japan and European countries decided to reform their national railway companies. In 1987, JNR was divided into six passenger railway companies, a freight railway company, and a high speed railway infrastructure owning company. At this point, Japan introduced the vertical separation in their HSR management as well. However, the Japanese vertical separation system

was over about 4 years later, 1991. This was because the system forced JR Central, which has operated Tokaido Shinkansen since 1987, to continue the cross-subsidization to support the other JRs financially. After the Japanese vertical separation was terminated, the government began releasing JR Central's stocks from 1996 and finished releasing the stocks in 2006. Now JR Central is a completely private railway operation company which also owns Tokaido Shinkansen's infrastructure.

In Europe, although Sweden introduced vertical separation management in 1988, the countries which had large scale national railway companies, such as France, Italy, and Spain, were very slow to introduce vertical separation management. As a result, in these countries' vertical separation managements were not rigorous. For example as shown in Chapter 3, France introduced the "rhetorical" vertical separation. The French government divided RFF, railway infrastructure owner company, from SNCF, national railway company. However, Quinet (2005) noted that SNCF and RFF have a special relationship that precludes any new entries into the HSR operation.

This thesis evaluated the effect of the successive railway industrial reform in Japan by using productivity analysis. In Chapter 4, this thesis introduced the earlier important research of productivity. First, Solow (1957) developed the procedure which applied *total-factor productivity* (TFP) to analyze US GDP growth. He figured out that 87.5 % of the US GDP growth from 1909 to 1949 was from TFP growth.

This thesis also introduced the GDP growth analysis by Krugman (1994). He pointed out that the Asian countries' high GDP growth had been supported by the increasing input rather than improved TFP. So he predicted that these countries' GDP growth would slow down soon. Actually in the late 1990s, these countries GDP growth were very low or even negative.

We also discussed the research of the effect from deregulation in the transportation industries, such as the US and Canadian railways and the US airline. Tretheway (1982) showed that the Canadian railway companies' productivity had been higher than the US railway companies because the Canadian government permitted Canadian railway companies to use very flexible pricing systems. On the other hand, the US government introduced some regulations into motor vehicle industries to support the US freight railway industry. In addition, Cave (1982) showed that the US airline deregulation has improved their productivity well. We explained generally productivity analysis is recognized a good tool to analyze the industrial structure reform, in our case, privatization and vertical separation.

We applied MFP, which has a single output and multiple inputs. Passenger-km and revenue were used as output data separately, and personnel expense, non-personnel expense, and capital related expense were used as input data. We set Tokaido Shinkansen and the Paris-Lyon line as our research objectives. This was because these lines have the appropriate character to represent the effect of railway industrial reforms. First, these lines have been profitable since their opening years. This suggests the microeconomic theory works in the management of these lines. Second, these lines introduced the latest technology when these lines had been constructed. This suggests the contribution of additional HSR technology development for productivity is limited. Third, these lines have been used by only HSR. So we can eliminate the contribution of developing logistics system in freight railway industry to productivity. Fourth, these lines have more than 30 years management history. When we evaluate the effect of industrial reform, we need a reasonable time span.

Our research results showed, after 1974, Tokaiso Shinkansen's MFP growth had been negative. However, after JR Central (JRC) started its operation, Tokaido Shinkansen's MFP growth managed by JRC has been constantly positive. From the result, we determined that the Japanese railway reform,

known as the privatization of JNR, has succeeded in improving the MFP of Tokaido Shinkansen.

After we showed the results of MFP analysis, we analyzed the single factor productivity, which has a single input and a single output. The research result inducated that the capital related productivity, passenger-km-capital expense productivity and revenue-capital expense productivity, has increased significantly since the reform. We judged that the reason why JR Central has improved its productivity is that JRC has a higher incentive to reduce the capital related expense than JNR had. Since 2000, JRC has also increased their personnel expense related productivity. However, we cannot see a significant change in the non-personnel expense related productivity. At this point, additional research is still needed.

We also tried to calculate the Paris-Lyon line's MFP to evaluate the effect of introducing the vertical separation in the French railway industry. However, not enough data were available. So we reviewed the previous research about the productivity of entire French railway industry, including the freight railway. Generally, their research results showed that the vertical separation has reduced the productivity of the French railway industry. On the other hand, simultaneously, their research result determined that Germany and Sweden have improved their productivity well after introducing the vertical separation. This means that if one country introduced the competition with the vertical separation management, as Germany and Sweden did, they could improve their productivity. As we showed in Chapter 3.2, the French government slowly introduced the vertical separation because they were not willing to introduce competition into their railway industry.

However, as shown in Chapter 3.2, the French government introduced a very complicated relationship between SNCF and RFF. RFF has offered the railway maintenance jobs only to SNCF, and the decision making process of railway infrastructure usage fees paid by SNCF to RFF is opaque. The

previous research had not considered the complicated relationship between SNCF and RFF. To develop a research scheme that solves the current complicated management system in France, additional research is still needed.

From the MFP analysis of Tokaido Shinkansen and the literature review of the research of the European railway reform, we obtained two important results:

1. Privatization and dividing of Japanese railway industry has improved the productivity of the most profitable HSR, Tokaido Shinkansen
2. Introducing the vertical separation might improve the railway industries' productivity in Europe but only if they also introduced competition.

In Chapter 7, this thesis analyzed the current US HSR programs and suggests three reasons why the US HSR programs are not moving forward. The first is a problematic financing scheme. Almost all projects deeply depend on the subsidies from federal government. As shown in Chapter 2 and 3, the first Japanese and French HSR were financed by JNR and SNCF. Second, there is no large scale railway operator. This means there is no organization which drives the US HSR programs. Third, for the political reason, the federal government distributed their subsidies to the large number of programs around the US, 79 projects, and did not concentrate constructing HSR on the important corridors, such as California and NEC.

Although the entire national HSR network in the US is not a feasible project, this thesis suggests that the HSR lines in major corridors, California corridor and NEC, make a certain amount of sense. As shown in Table 7.1, some countries, such as Korea and Taiwan, introduced the HSR line. These countries connected their capital cities and the second biggest cites. So these cases could be good

examples for the future US HSR in major corridors.

From our research results, even though geographically and economically there are lot of difference between the US case and Japanese or French cases, one of the ideal management structure we suggest for consideration of the potential NEC HSR is as following, the infrastructure will be capitalized by mainly public money. However, the private sector should be in charge of managing the infrastructure, and the operation will be managed by a private company with competition. The infrastructure owning private company would take over the new exclusive HSR infrastructure financed by public sector's money.

This is because from the case of Tokaido Shinkansen, we showed that the most significant effect of the privatization has appeared in the capital related productivity. This company would manage the depreciation, taxation, and maintenance fee as expense and railway usage fee from the operator as income. This company should try to improve their infrastructure and financing scheme with diligence because they are a private company for profit. Besides, private HSR operators would try to decrease their operating costs to decrease their ticket fee if the government or the infrastructure owner company would hold the bidding; infrastructure owner company would decide the operator which would pay the highest infrastructure usage fee.

However, this is only one possibility for the future exclusive HSR in NEC. Indeed, this case has not happened yet because there are still considerable technical and financial difficulties. In addition, the private sector's success happened only in Japan. We cannot say the privatization and dividing would be the best solution in all railway industries. However, from April 28th 2012, Italo, Italian pure private railway operator, is planning to manage their HSR service on the infrastructure which is owned by the

public sector. The previous Italian national railway company, Trenitalia is also operating their HSR on the same infrastructure. This Italian case could act as a pioneer. This thesis explains current Italian HSR competition in the afterword following this chapter.

Since the Japanese government reformed the national railway company, some innovative railway reform has happened. The vertical separation introduced by Sweden has spread into the members of EU with some alterations. Now the latest social pilot program will be held in Italy. After the future research evaluate the Italian HSR case, private companies competition on the vertically separated infrastructure, we will know more appropriate HSR management structure.

Even after our research has been complicated, there are still very interesting topics remaining. Does introducing vertical separation without competition make sense? Does introducing true competition really improve productivity? Is it possible to introduce the private sectors' funds to construct the new exclusive NEC infrastructure? We hope these questions will be solved with careful numerical data analysis in the near future.

This thesis requires substantial amount of patience for readers, and here we would like to express our thanks to all of readers for your attention. We hope you find our research of value.

Afterword

HSR Competition in Italy

Introduction:

As this thesis described many times, originally, the EU wanted to stimulate competition within the HSR operators by introducing vertical separation management; that means two or more operators on the same infrastructure. Fundamentally, their idea was correct. Indeed, some countries, such as Sweden, have said that they have improved their management efficiency with vertical separation, as shown in Table 3.4. On the other hand, in the major European HSR markets, such as Germany, France, Spain, and Italy, they had continued the monopoly market by the former national railways. Besides, these HSR operators are still state owned companies, DB, SNCF, RENFE, and Trenitalia. As we explained in Chapter 3, previous research showed their vertical separation might not contribute to improve productivity, although admittedly data is limited.

However, an epoch making event is happening now in Italy. On April 28th 2012, the pure private capitalized HSR operation company, Italo, started their HSR operation business on the Italian HSR infrastructure which is owned by the public sector. Now, the former Italian national railway company, Trenitalia, has to compete against Italo to retain their market share.

In this afterword, we discuss what is happening in Italy and the fundamental question, whether the competition is fair from the viewpoints of Italo and Trenitalia.

History of Italian railway:

Before introducing vertical separation, Italian National Railway Company, so-called Ferrovie dello Stato (FS), had operated all domestic railways including HSR. In 1991, the government introduced

vertical separation management in their HSR management in compliance with the regulation of the EU. Italian government capitalized *Treno Alta Velocità SpA* (TAV), which owns Italian HSR infrastructure. The government gave a new name, Trenitalia, to the new government owned railway operator.

As this thesis mentioned in Chapter 3, even though the original purpose of introducing vertical separation management was to stimulate the competition within the operators, no actual competition had happened in Italian HSR market. However, in 2006, the pure private holding company, Nuovo Trasporto Viaggiatori (NTV), was capitalized to operate HSR in Italy as completely pure private railway operator.

NTV and Italo:

NTV is the holding company, which was capitalized by several Italian major business leaders, such as CEO of Fiat and TODS, and *Intesa Sanpaolo,* an Italian bank. Then, they said, they would operate HSR in Italy in the future, and NTV named the new HSR operation company Italo.

They postponed the day of the opening of their business. They may have gone through a lot of political conflicts. The Financial Times, February 24th 2012, reported that the CEO of Italo said that the opening day of their HSR depends on when TAV issues the business permission to Italo. Finally, Italo was accepted by TAV, and started their HSR operation between Rome, capital city of Italy, and Milano, the financial capital city of Italy on April 28th.

Reputation if Italo's service now:

Just before April 28th, some of the media was skeptical about the challenge of Italo. The Railway Gazette, April 10th 2012, said whether Italo will be able to start their HSR business deeply depended on the decision of TAV in February 2012. As shown in Chapter 3, EU did not forced member countries to

introduce the same vertical separation system. As Table 3.6 shows, there are various vertical separation managements. In Italy, the government just divided the infrastructure owner company, RFI, and railway operator, FS, but both companies are still belonging to the national railway group, Ferrovie dello Stato S.p.A. Nash (2004) called this type of separation "organizational separation".

Trenitalia's viewpoint:

As noted above, Trenitalia is a government-owned company. This thesis cannot confirm they have legal obligation to operate unprofitable railway lines as social services. However, definitely some of their railway operation businesses are unprofitable. Until Italo penetrated the HSR operation business between Rome and Milan, Trenitalia enjoyed their monopoly power in that profitabele market, and they used cross subsidization to continue operating their unprofitable railway lines. But now they have lost their monopoly power in the profitable market. The Voice of America reported that "the state-owned railway network (Trenitalia) has already lowerd its ticket prices and improved its service." So they already reduce their HSR ticket price to keep their customers. Every customer is happy about it, and people may be able to say this is the benefit from the competitive market theory.

However, can Trenitalia believe this is a competitive market? We may be able to say they have some sense that it's an unfair competition. This is because they are managing certain amount of unprofitable operations. On the other hand, Italo can manage only the profitable HSR operations. Trenitalia may think Italo is just doing cream-skimming.

NTV and Italo's viewpoint:

On the other hand, even though Italo is happy about starting their business, they may also have certain amount of instability in their business model. First, there is no rigorous regulation about the

infrastructure usage fee. Reuters reported that CEO of Italo said "we are going to pay 120 million euro for the usage fee". But perhaps TAV will raise the usage fee. They may not be able to contest it because there is no market price.

Second, the TAV can stop their business if they think Italo's business has any safety problem.

Third, theoretically, Trenitalia can get unlimited amount of subsides from the government. This is because Trenitalia is still a government owned company.

What we can learn from the case:

As mentioned above, passengers can get benefits from competition between Trenitalia and Italo now. Italo's ticket price is lower than Trenitalia, and Trenitalia is also trying to catch up with Italo's ticket price.

However, there is no guarantee this competition could be continued. This thesis suggests that the Italian government should privatize Trenitalia, or at least the HSR management department. Now Trenitalia, the government-owned company, is competing against Italo, a pure private company. This is an unbalanced competition. This is because even if Trenitalia's management system has fundamental problems, they can cover a loss by the subsidy from the government. But a balanced competition can occur between private companies. In the near future, we suspect the Italian government will face the problem.

This thesis hopes the Italian HSR competition would be the important pilot case for every country which wants to improve the productivity of its railway industry via vertical separation with competition.

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