HIGH SPEED RAILWAY PRODUCTIVITY: A GLOBAL STUDY AND POTENTIAL FOR THE US NORTHEAST CORRIDOR

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Executive Summary

The privatization of the Japan National Railway (JNR) in 1987 made an impact beyond that nation’s borders. The conversion of JNR from government management to private-sector operations, inspired (or sparked) reforms in European rail systems, such as vertical separation, in which multiple public and private parties are responsible for owning and operating rail infrastructure, sometimes in a competitive manner.

This report summarizes research on the effects of reforms set in motion in the 1980s on the business productivity of JNR and Europe’s railways. To evaluate the effects of privatization on JNR, and vertical separation in European systems, we examine the performance of high speed rail (HSR) lines, focusing initially on Tokaido Shinkansen in Japan and Paris-Lyon in France, two lines that introduced the latest technology at the time of construction and that have been profitable subsequently. For the Tokaido Shinkansen line, we utilize multi-factor productivity (MFP) analysis to discover that the most significant source of productivity gains since privatization was related to capital utilization. There was insufficient data to perform a similar analysis on the impact of vertical separation on Paris-Lyon, and in fact, prior research had difficulty showing the effects of vertical separation quantitatively. Instead, we turn to Swedish railway data, from which we conclude that even small market competition correlates more strongly with increased productivity than the style of vertical separation.

Finally, as a result of observation and analysis of Japanese and European systems, we propose a model for a potential HSR system in the United States’ Northeast Corridor (NEC), between Boston and Washington, DC. To ensure the success of this future NEC HCR, we recommend the introduction of private sector funds, and competitive private sector operators.
1  **Japanese Railway Reform and Productivity**

Japan National Railway (JNR) initiated the commercial operation of the world’s first high speed rail line known as Tokaido Shinkansen between Tokyo and Osaka in October of 1964, and introduced the global passenger railway industry to a new era.

During the construction term of Tokaido Shinkansen line, politicians realized that the HSR project could stimulate local job markets and economics. So JNR planned the construction projects of Tokaido and Sanyo Shinkansen, Japan’s second HSR, and the government approved them. Then in 1970, the government passed the *Act for Construction of Shinkansen Railway Across the Country*. This act fundamentally changed the process of HSR planning and construction in Japan. After the act, responsibility for planning, adjustment, and construction order was transferred to a political sector under the Minister of Transportation. However, the financial and demand risks remained with JNR.

Just after the act passed, the Japanese government approved new HSR projects: Tohoku and Johetsu Shinkansen. These HSR construction costs were financed by the JNR’s loan from the national budget. In 1972, the Minister of Transportation ordered JNR to start the construction of the two new lines. The new construction jeopardized the financial health of the existing railway. In contrast, revenue exceeded operating expenses in the 1950s and 1960s. Figure 1 shows the transition of financial results in JNR. After the Act for Construction of Shinkansen Railway Across the Country was passed in 1970, the annual deficit of JNR increased by about six times from 1970 to 1975 due to the construction costs of Tohoku and Joetsu Shinkansen high speed rail lines.
In the early 1980s, the huge amount of JNR’s annual deficit was a very hot political issue. In 1981, the Nakasone administration set up a study group, the Ad Hoc Commission on Administrative Reform, to address the deficit and propose changes to the JNR.

On July 26, 1985, the commission submitted a final proposal to the administration describing specific reforms. It suggested that on April 1, 1987, all JNR’s business rights be taken over by a newly created JNR Settlement Corporation, and that six passenger railway companies—JR Hokkaido, JR East, JR Central, JR West, JR Shikoku, and JR Kyushu—take over geographically differentiated areas of passenger railway business. The commission also suggested a new entity, JR Freight, to take charge of the nationwide freight business.

The administration forced JNR to transfer more than 90,000 employees to other government-owned companies, such as post service and telephone business, by April 1, 1987. Then, each new railway company could then hire an appropriate number of employees.

The commission also proposed the new railway companies JR East, JR Central, and JR West assume JNR’s 20.6 trillion yen deficit, and that the government bear the burden of an additional 16.7 trillion yen. The total national burden amounted to a total of 37.3 trillion yen.

Source: Ministry of Land, Infrastructure, Transport and Tourism web page
(about $263 billion in 1987 dollars). In response to these proposals, the government passed the Act of the JNR Reform in December 1986, and JNR was required to comply.

After the JNR privatization, the Ministry of Land, Infrastructure, Transport and Tourism (MLITT) was required to reach agreement with operators, JR East, JR Central, and JR West, and local governments to start any HSR projects. In addition, the local governments were required to finance roughly one-third of total construction costs. The financial responsibility of operators for the HSR projects became much smaller than before 1987. Although JRs needed to finance initial construction costs for those parts of HSR that they would operate, the burden was offset by profits from the new HSR.

**Tokaido Shinkansen Productivity Analysis**

After understanding the history of the railway, we sought to analyze its productivity before and after reform. Productivity is a ratio of what is produced (outputs) divided by what was required for production (inputs). For the Tokaido Shinkansen, our outputs are revenue and passenger-km (For example, a train travelling five kilometers with 100 passengers yields 500 passenger-km.). Our inputs are personnel expense, non-personnel expense, and capital related expense. This report gathered data of Tokaido Shinkansen from the JNR Year Book (from 1964 to 1987), White Book of Transportation (from 1964 to 2010), Suda (1994), Kasai (2009), Central Japan Railway Fact Sheet (2010), JITI Statistics data of railway (2010). Unfortunately, some of the data between 1983 and 1986 were not available.

The passenger-km data for Tokaido Shinkansen from 1964, its opening year, to 2010 are in Figure 2.
Passenger-km increased from 1964 to 1974 because of the new entry effect—the period during which passengers recognized HSR as useful and convenient compared to alternative modes of transportation. Although generally increasing over the analysis period, JNR lost passenger-km from 1974 to 1978 due to ticket prices, which increased more than 40% when adjusted for inflation. JNR continued to increase revenue from Tokaido Shinkansen between 1974 and 1978 even though JNR had lost passenger-km at the same time (see Figure 3).
The Japanese government required JNR to increase prices and thus revenues from Tokaido Shinkansen to fund continued construction of the HSR network (Nam 2009). Indeed, JNR extended the HSR line to Okayama in 1972 and Hakata in 1976, which was named the Sanyo Shinkansen line. After its construction, JNR was also required to construct Tohoku and Joetsu Shinkansen. To capitalize the cost of the new HSR line’s infrastructure, JNR was forced to use cross-subsidization. The actual revenue of Tokaido Shinkansen increased consistently from 1964 to at least 1983. After 1986, the slope of the line decreases, indicating the start of market saturation.

Before evaluating productivity, we also needed input data: personnel expense, non-personnel expense and capital related expense. Figure 4 shows the personnel expense of Tokaido Shinkansen, which consistently increased from 1964 to 2000.

Figure 4: Personnel Expense (millions of Yen)

After privatization in 1987, JR Central had a strong incentive to operate Tokaido Shinkansen line with more appropriate staffing levels, and began decreasing personnel expenses after 2000.

Non-personnel expenses include energy cost, maintenance cost, and other operating costs,
shown in Figure 5.

**Figure 5: Non-Personnel Expense (millions of Yen)**

Interestingly, the increasing pace of the non-personnel expense during JNR operation (1964-1986) and during JR Central operation (1987-present) looks approximately similar. We can say that the industrial reform effect for the non-personnel expense part was very limited. JR Central is a railway infrastructure owner and the railway operator, but it is not a vehicle or parts supplier and must buy electricity from electrical power companies. Thus, it was difficult to control or reduce non-personnel expenses even after 1987.

Capital-related expenses include interest payments for debt, depreciation of the infrastructure and vehicles, and taxations, as shown in Figure 6.
An explanation is needed for the significant gap between the JNR term and JR Central term. The amounts of capital-related expense paid by JNR and those paid by JR Central (after 1987) are very different. The actual construction cost of Tokaido Shinkansen, 380 billion Yen, was capitalized by JNR. The price paid by JR Central to take over the infrastructure was 5.2 trillion Yen, about three times as much as the original construction cost adjusted for inflation.

The government decided that JR Central, JR East, and JR West would take over the infrastructure of Japanese HSR lines from the HSR holding company. They allocated the debt to each JR in accordance with the current value of each HSR line, not the actual construction cost of each HSR line. 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 the entire Japanese HSR network. Thus, after the privatization of the Japanese railway in 1987, the payment for the capital-related expense of Tokaido Shinkansen increased sharply. When this debt distribution was decided, the Japanese government owned 100% of JR Central’s stock, and JR Central could not reject the government’s proposal.

After assuming the 5.2 trillion Yen debt from the HSR holding company, JR Central was
very concerned about the interest rate of the debt because of its significant contribution to total expenses. JR Central reduced the average interest rate over time through loan refinancing as shown in Figure 7. JR Central successfully decreased its average interest rate from about 6.5% to 3.5% between 1992 and 2010.

Figure 7: Average interest rate of the debt in JR Central (%)

It should be noted that prior to privatization, the 1987 White Book issued by the Department of Transportation indicated the interest payment rate paid by JNR was fixed at 8%. Because JNR was a government-owned organization, which borrowed from the public treasury, JNR did not have a strong incentive to reduce the interest rate on its debt.

After gathering outputs and inputs, we calculated multi-factor productivity (MFP) for the Tokaido Shinkansen line. The details of the methodology and calculation can be found in the full MIT Master of Science in Transportation thesis from which this summary report was generated: “High Speed Railway Productivity: How Does Organization Restructuring Contribute to HSR Productivity Growth?” (Sakamoto 2012). Our methodology was similar to previous research, most notably the work done by Cowie (2001) analyzing the effect of the UK railway privatization.

From our output and input data, Figure 8 shows Tokaido Shinkansen’s cumulative MFP.
Figure 8: Passenger-km and revenue based MFP (%)

The blue line shows the revenue-based productivity; its output metric is revenue.

The red line shows the passenger-km based productivity; its output metric is passenger-km. In the first several years, passenger-km based and revenue-based MFP increased rapidly. This was due to the new entry effect. During this first decade, JNR could acquire new passengers easily. In the passenger-km based MFP after 1974, growth stagnated. After the industrial reforms launched in 1987, the revenue-based MFP and passenger-km MFP increased moderately. Table 1 shows the annual average growth of each MFP.

Table 1: Annual average growths of MFPs (%)

<table>
<thead>
<tr>
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<th>From 1975 to 1984</th>
<th>From 1987 to 1996</th>
<th>From 1997 to 2006</th>
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<tbody>
<tr>
<td>Passenger-km MFP</td>
<td>0.11</td>
<td>1.74</td>
<td>1.39</td>
</tr>
<tr>
<td>Revenue MFP</td>
<td>-0.27</td>
<td>0.48</td>
<td>0.89</td>
</tr>
</tbody>
</table>

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%. After privatization, JR Central achieved more than 1% annual growth in passenger-km based productivity, and achieved a positive growth in the revenue based productivity. These results suggest that the railway industrial reform initiated in 1987
contributed to the effective management and more robust productivity of JR Central’s Tokaido Shinkansen.

As Figure 8 shows, both passenger-km and revenue-based MFP increased after privatization. But we need to find what factor or factors contributed to increase the MFP after the industrial reform. We calculate single factor productivity to analyze which change of input had a strong impact on productivity. Figure 9 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.

Figure 9: Single factor productivity (%)

Figure 9 shows that capital-related-passenger-km and capital-related-revenue productivity have consistently increased after the industrial reform. JR Central had a strong incentive to reduce the capital-related expenses and did so effectively. After 1999, JR Central succeeded in increasing the personnel-passenger-km and personnel-revenue productivity slightly. In 1999, the government released some of JR Central’s stock to the market. The privatization effect and pressure from the market to improve the management cost, effectively motivated this
improve personnel-passenger-km and personnel-revenue MFP. Since 1987, JR Central has lost non-personnel passenger-km and non-personnel-revenue productivity as it has been unable to control the costs of energy, maintenance parts, and other items supplied by other industries.

In conclusion, Japanese railway privatization has improved the productivity of Tokaiso Shinkansen. This improvement is mainly attributed to capital expense reduction after 1987 and, less significantly, the reduction of personnel expense since 1999.

2 European Railway Reform and Productivity

According to the International Union of Railway (UIC), the Pompidou administration decided to introduce HSR in France in 1974, following the lead of the Japanese on the then 10-year old system. In 1983, France completed the first European HSR between Paris and Lyon, the cities with the first and second largest economies. Vickerman (1996) said that after the Paris-Lyon line 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 not only reduced the existing passenger’s travel time, but also induced new demand for rail between these cities.

Other developed European countries recognized the successful French investment in HSR. Germany, Italy, and Spain followed France in developing HSR in 1991, 1992, and 1992 respectively. Subsequently, all of these countries, including the European HSR pioneer, France extended their HSR networks.

While France continued to operate its traditional railway management, some countries, notably Sweden, were skeptical about the financial sustainability of traditional railway management. The national railway company of Sweden, Statens Jarnvagar (SJ), ran into financial difficulty in the 1960s and utilized cross-subsidization: the revenue for some profitable lines would cover the debt from unprofitable lines. JNR and SNCF, the French National
Railway, also used this approach, and it was the fundamental management scheme in almost all national railways around the world at that time. However, cross-subsidization forces income reallocation between urban residents and rural residents, and reduces the incentive to eliminate unprofitable lines.

To solve the problem, the Swedish government approved an Act of Transportation Policy in 1976 that legally differentiated between profitable lines, described as part of the “business economy,” and unprofitable lines, defined as part of the “social economy” and essential to Swedish society. SJ was responsible for operating profitable lines and improving service and customer satisfaction to compete with other modes of transportation. The government, rather than SJ, carried the financial burden for unprofitable lines (Jansson, Owen and Cardenbring 1989). If the government wanted to continue operating unprofitable lines, it had to buy the operations service from SJ. This was not thought of as a subsidy but compensation for social equity service. In addition, the government allowed SJ to introduce marginal cost pricing into the profitable lines.

The Swedish government approved another Act of Transportation Policy in 1988 to introduce market competition to the business economy. According to Imashiro, the act funded Banverket (BV), the Ministry of Railway, to introduce a vertical separation management system. BV owned the entire Swedish railway infrastructure, and a bidding system was instated to decide what company would operate the lines (and potentially reduce operating expenses). This restructuring of the Swedish railway industry inspired reform throughout the European railway industry.

In contrast to Sweden’s success, France never fully achieved effective vertical separation. It “was probably one of the most reluctant countries to provide open access” (Quinet 2005). The French government founded Reseau Ferre de France (RFF) in 1996 to separate railway
infrastructure ownership from SNCF to obey the European Commission regulations. RFF took over a 20.5 billion euro debt from SNCF. However, SNCF and RFF are still almost vertically integrated. For example, RFF paid SNCF about 2.6 billion euro for its infrastructure maintenance, and received about 2.3 billion euros from SNCF as infrastructure usage fee in 2004. Although the main purpose of introducing vertical separation management was to improve railway industries’ management efficiency through competition, the amount of debt generated by the French railway system rose from 35 billion euros to 41 billion euros between 1997 and 2003. Additionally, SNCF exclusively operates the TGV without competition.

According to the International Railway Journal, France “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 European Union regulations, and illustrates the French government’s resistance to imposing vertical separation management on its railway systems. However, the government’s position is understandable. Unlike the case with SJ in Sweden, SNCF had social equity responsibilities and constructed a mega-TGV network with a significant investment. To pay off this 10-billion-plus euro investment, SNCF uses its monopoly power and maintains high prices. In Germany, the rail investment was 8 billion euros. As in France, the government passively supports a rail monopoly (Nash). In contrast, Sweden and Finland, with rail debt of approximately 1.5 billion euros and 0.5 billion euros respectively, introduced open access and vertical separation (Community of European Railways 2006 Data). From these cases, it appears that countries with smaller amounts of rail debt were open to vertical separation, while countries with a mature railway market and higher debt did not risk losing their monopoly power through vertical separation.
European Railway Productivity

This report originally sought to perform a productivity analysis for European railway reform and vertical separation; however lack of publicly available data constrained our ability (and the ability of other researchers in the field) to do so. There are several other factors complicating our analysis.

First, European countries did not introduce identical vertical separation systems. For example, Friebel et al. (2008) observed that the German national railway company, DB, capitalized a new railway infrastructure owner company as one of the affiliate companies of DB group. However, France capitalized the completely new infrastructure owning company, RFF not within the corporate family as was done in Germany. Also, the financial relationships between operators and infrastructure owners is complicated. For example SNCF pays usage fees to RFF and RFF pays maintenance fees to SNCF exclusively and data on these transactions are not available. Lastly, the European railway companies still manage passenger and freight businesses. Therefore, unlike Japan, where there is only one rail freight company separate from the passenger carriers, in Europe we cannot differentiate the personnel expense between employees who work in the passenger and freight businesses. The same issue occurs with non-personnel expense and capital expense. Thus, even though the previous research calculated the productivity of European passenger railway industry, input data was influenced by freight businesses.

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.” So in Figure 10, the productivity of Germany’s passenger railways reaches 1.00-the best score within the data. We can see how inefficient the other countries and years were compared to German productivity in 1999.
Figure 10 shows that Germany had continued improving the productivity of the passenger railway after it introduced vertical separation management in 1994, and Sweden also improved productivity after introducing vertical separation management in 1988. On the other hand, France’s productivity decreased after it introduced limited vertical separation management in 1997. These are ambiguous results. As we mentioned above, each country introduced its own separation system. As a 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’s analysis also indicated that French railway reform has had a negative impact on the rail system’s 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 [productivity gains were] the lowest of the five countries in the period from 1995 to 2001.”

Although Friebel’s research model had difficulty evaluating the effect of introducing the
vertical separation due to data availability, he suggested that the German and Swedish railway industries could improve their MFP compared to France, Italy, and Spain. Germany and Sweden, which introduced competition in the railway operation business even though the scale was very small, improved their productivity. On the other hand, France, Spain, and Italy, which did not allow the new entries to join the railway operation business, have had productivity declines (Italy recently introduced vertical separation).

3 US North East Corridor

We compiled information about HSR programs in the United States to gain some insight on an appropriate structure of the future Northeast corridor (NEC) HSR: privatization of operators, vertical separation with competition, or integrated operation by the private sector, etc. There are many important differences as well as some similarities between the US and earlier Japanese and European railways, so we need to be careful when we compare these countries.

The US does not have HSR yet. The closest railway line to the international HSR definition is the Acela Express, which runs on the NEC. The average speed is still much lower than the definition of the HSR, shown in Table 2, and it achieves its maximum speed only for a very short segment of the trip.

<table>
<thead>
<tr>
<th>Line</th>
<th>Distance (mile)</th>
<th>Weekday round trips</th>
<th>Average Travel Time</th>
<th>Average Speed (mile/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boston–NY</td>
<td>220</td>
<td>10</td>
<td>3.31</td>
<td>62.7</td>
</tr>
<tr>
<td>NY–DC</td>
<td>238</td>
<td>15</td>
<td>2.45</td>
<td>86.5</td>
</tr>
<tr>
<td>Tokaido Shinkansen</td>
<td>322</td>
<td>150</td>
<td>2.25</td>
<td>133.2</td>
</tr>
</tbody>
</table>

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

Generally speaking, there are many reasons why the US has not introduced HSR technology. For example, the US has a highly developed highway transportation system and widespread airport network. Indeed, the mode share of the US passenger railway is less than
1% shown in Figure 11. This is much lower than Japan and France: Japan at 28.7% in 2007 and France at 8% in 2000.

**Figure 11: The US Transportation Mode Share (passenger mile base)**

Additionally, the US population density is lower than the average of countries which have HSR networks and lines, shown in Figure 12. However, the NEC is quite densely settled.

**Figure 12: Comparison of the population density (person/km²)**

HSR is considered an efficient transportation mode between cities with high population densities and which are separated by a distance of about 60-400 miles. The geographic size of the US is
not appropriate for a nationwide HSR network. The US High Speed Rail Association, one of the HSR advocacy groups, discusses a nationally-scaled US HSR network picture; the network would have about 17,000 miles (23877 km) of rail. This is unlikely to be viable when one considers the low population density in many parts of the US.

We note that Germany and Japan have highly developed highway networks together with highly developed HSR networks. So this demonstrates that two high-quality surface modes can coexist, which would need to be the case in the US The French population density is lower than Germany’s. However, the French TGV network is more profitable than the German ICE network. This is because Paris serves as the hub of the TGV network and is bigger than any German city. Thus, the French TGV network has a radial structure from Paris. This suggests even though the national population density is low, if there is at least a city with a very large population, HSR can be an appropriate passenger transportation mode.

In the US, the Northeast corridor (NEC) is a 457 mile multi-track rail line between Boston and Washington DC, via New York. The NEC intercity-passenger railway service operated by Amtrak carries approximately 13 million passengers within the area annually (Amtrak 2010). This number of passengers represents 5% of all intercity trip passengers by all transportation modes on NEC. The report said that NEC is one of the 10 busiest railway corridors in the world. Along the NEC, there are enough cities with large enough populations to support high speed rail. Compared to the Tokaido Shinkansen line and the Paris-Lyon line, we can see the effective potential in NEC as shown in Figure 13.
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 fares. The business operators need enough customers who believe that the travel time reduction, improved trip time reliability (especially in bad weather) and comfort values are worth the high ticket price of HSR. This report uses the estimated city GDP to evaluate the size of the economy in each city, shown in Figure 14.

Source Data: US Census Bureau

Source Data: PricewaterhouseCoopers UK Economic
Distance between cities is also similar to the Tokaido Shinkansen. Figure 15 shows the distances and population size of the cities along Tokaido Shinkansen line, the Paris to Lyon TGV line and the 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, distances between cities within the NEC are very appropriate for HSR.

Figure 15: Distance and cities’ size on each corridor

The infrastructures of Tokaido Shinkansen and the Paris-Lyon line are exclusively owned by JR Central and RFF, the French railway infrastructure owning company, respectively. On the other hand, the infrastructure of NEC corridor has four independent public owners: Amtrak, Massachusetts Bay Transportation Authority (MBTA), Connecticut Department of Transportation (DOT), and Metro-North. Amtrak owns approximately 80%, or 363 miles of the NEC railway line. For the other part, MBTA owns 38 miles, Connecticut DOT owns 46 miles, and MTA Metro-North Railroad (MNR) owns 10 miles. These latter three operate commuter services to various cities on the NEC and proper coordination between these services is an important success factor.
4 Conclusion

The productivity of the operation management of Tokaido Shinkansen improved after JNR was divided into 6 areas and partly privatized. Based on these results, replacing Amtrak with a completely new HSR operator, with a focus only on the NEC as opposed to services all over the US, as Amtrak has now, may improve the management efficiency of a future NEC HSR.

The advantage of the private sector is that first, it can set an appropriate ticket price without or at least a minimum level of cross-subsidization. JNR was forced to use cross-subsidization to continue unprofitable railway lines, and SNCF is still using cross-subsidization to continue its “social service” parts. Generally cross-subsidization makes the operators’ management incentive weaker. We cannot determine if Amtrak is using the profit from NEC to support its unprofitable lines. The current Amtrak, a deeply subsidized public company, has fewer management incentives compared to the private operators.

Also the significant improvement of Tokaido Shinkansen’s MFP has been from the reduction of the capital related expense. Thus, this report recommends that any private sector, including the HSR operation company, should capitalize and manage the construction of the future NEC infrastructure, in whole or in part. Financing the entire NEC infrastructure by a private company is impossible in reality. However, there may be potential for some private companies to form a consortium to capitalize the NEC infrastructure.

Currently, many countries have already introduced private sectors’ funds to construct HSR infrastructure. Current Japanese HSR projects are partly financed by JRIs which are now fully privatized. Taiwan constructed the first HSR line using 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 by five Taiwanese private companies
to start the domestic HSR project. This report 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 is feasible. If there is financial difficulty in constructing an exclusive NEC HSR line, the US government might consider utilizing private funds.

Regarding vertical separation and competition among the operators, we do not have enough empirical data. Some researchers favor the Swedish public bidding system, which has improved personnel productivity. This report suggests that the future NEC HSR operators should consider public bidding and vertical separation leading the intra-modal competition for HSR.

True competition already exists among airlines and even between airports. This true competition has not emerged in HSR markets that feature cross-subsidization and national railway systems. However, NTV in Italy, which is also capitalized by some pure private companies, started true competition against Trenitalia, a former Italian national railway and still a state-owned company, beginning 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.
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