# High speed rail in the Midwest

*Herbert Baer and Donna Vandenbrink*

For years, Amtrak has struggled to attract passengers on its routes in the Midwest, using technology developed half a century ago. During the same time, foreign railroads were developing new passenger rail systems that could profitably compete with air travel. Two of these systems, the French TGV and the Japanese Shinkansen, reach speeds of 160 mph, while the British HST operates at 125 mph.

The success of these systems, together with the apparent interest of American policymakers in promoting further investments in passenger rail service, has sparked a number of recent proposals for high speed rail systems throughout the nation, including the Midwest.[1] This interest is based largely on high speed rail's success in dramatically decreasing travel time between cities. Unfortunately, these systems are expensive to build—as much as 3.5 billion dollars—making their financial viability questionable. This article summarizes a larger study which analyzes high speed rail's economic prospects in three Midwestern corridors—Detroit to Chicago, St. Louis to Chicago, and Milwaukee to Chicago. Three technologies are analyzed: High Speed (125 mph); Very High Speed (150-160 mph); and Super Speed (250 mph). Combining the technologies and the corridors creates nine specific projects for examination.

Support from policymakers and private investors for high speed rail projects in the Midwest and elsewhere in the U.S. must await development of better estimates of capital costs, the size and timing of the projected revenues, and the extent of any secondary social benefits. Existing feasibility studies for projects throughout North America provide a wealth of detailed information on the costs and/or revenues of systems with different speeds, frequencies, and markets. However, a review of these studies indicates that they fail to explain how these factors interact to affect the cost, ridership, pricing, and profitability of high speed rail systems.

Like earlier feasibility studies, this study develops measures of the costs and revenues of high speed rail. But the study does not generate any new data; it is, in fact, based entirely on the existing body of high speed rail data.

It differs from existing studies in three ways. First, it attempts to explain the interaction between speed and frequency on the one hand, and costs and revenues on the other. Second, it compares competing technologies rather than intensively studying a single technology. Third, it attempts not only to provide bottom line answers, but also to identify the factors which are critical to the profitability of high speed rail systems.

## Corridor choices

Experience suggests that successful high speed rail corridors should be between 250 and 500 miles in length, be heavily populated, have relatively high population densities, and, of less importance, have areas of population density distributed along the entire route.

Three Midwest rail corridors fill some or all of these requirements and are especially suitable for analysis: Detroit to Chicago, St. Louis to Chicago, and Milwaukee to Chicago. These three corridors allow us to consider the cost and profitability of high speed rail service in a number of different environments.

The Detroit-Chicago corridor is relatively long and urban. It covers a distance of a little under 300 miles and it includes the five larger metropolitan areas of Gary, Indiana, and Kalamazoo, Battle Creek, Jackson, and Ann Arbor, Michigan. This corridor contains over 13 million people and is the third most populous rail corridor served by Amtrak.

---

Herbert Baer and Donna Vandenbrink are economists at the Federal Reserve Bank of Chicago.

[1] Studies in the Midwest include Detroit to Chicago by Transmode, Inc. [2], Milwaukee to Chicago by Budd Co. [3] and Cleveland, Columbus, and Cincinnati by Dalton, Dalton, Newport [4]. For a more general overview of high speed rail technologies, see [5].

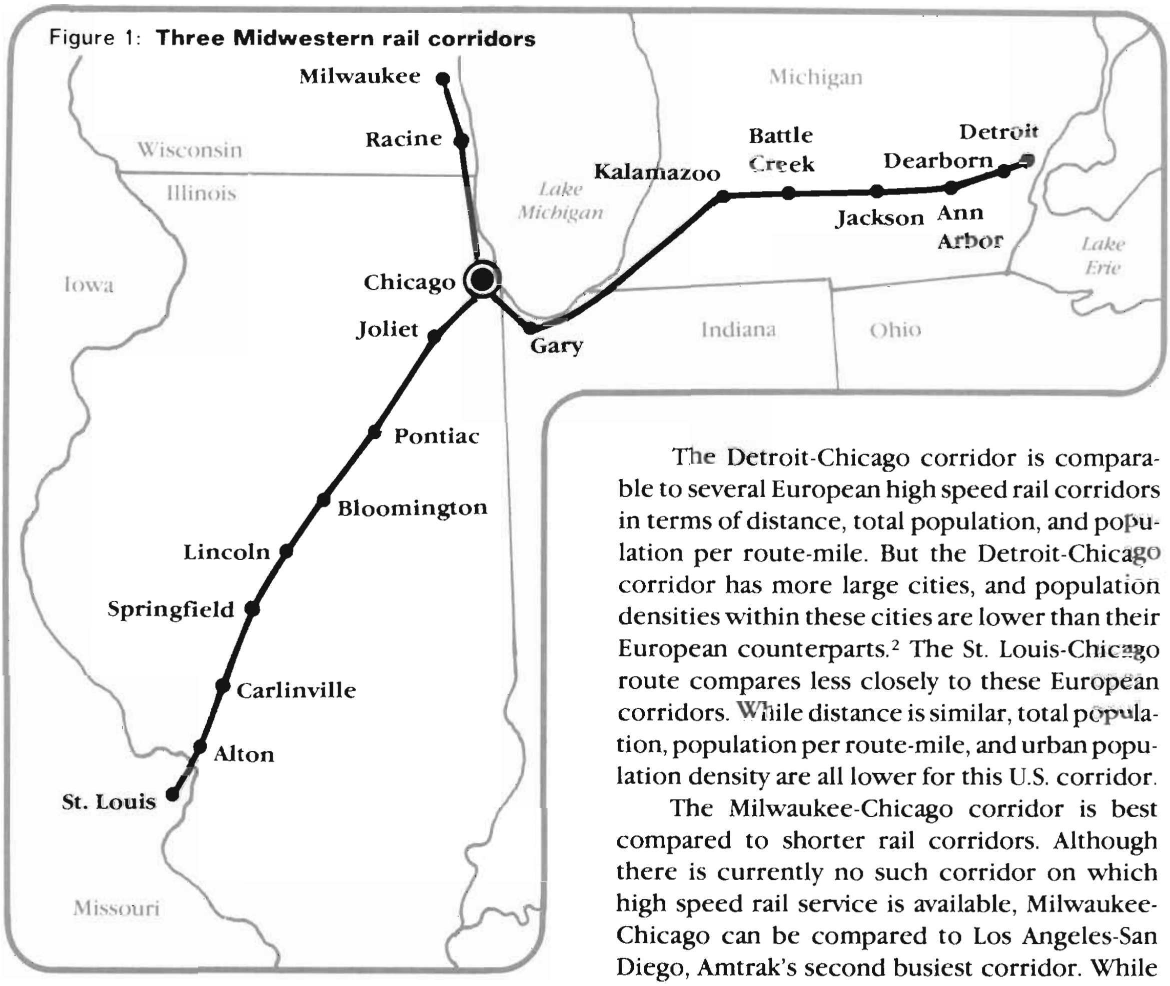

Figure 1: **Three Midwestern rail corridors**

The distance from St. Louis to Chicago is also just under 300 miles, but population in this corridor is more sparsely distributed than between Detroit and Chicago. The population in the St. Louis-Chicago corridor is about 9 to 10 million, and it is more highly concentrated at the two end points.

The Milwaukee-Chicago corridor presents a different case. It serves a population of almost 9 million, similar to that located in the St. Louis-Chicago corridor, but it covers a distance of just under 90 miles, making a dense concentration of potential travelers. In addition to the Milwaukee and Chicago metropolitan areas, this corridor includes the cities of Kenosha and Racine, Wisconsin.

The Detroit-Chicago corridor is comparable to several European high speed rail corridors in terms of distance, total population, and population per route-mile. But the Detroit-Chicago corridor has more large cities, and population densities within these cities are lower than their European counterparts.[2] The St. Louis-Chicago route compares less closely to these European corridors. While distance is similar, total population, population per route-mile, and urban population density are all lower for this U.S. corridor.

The Milwaukee-Chicago corridor is best compared to shorter rail corridors. Although there is currently no such corridor on which high speed rail service is available, Milwaukee-Chicago can be compared to Los Angeles-San Diego, Amtrak's second busiest corridor. While total population in the Milwaukee-Chicago corridor is lower, population per route-mile and urban population density are both higher. However, the short distance between Milwaukee and Chicago limits the demand for higher speed technologies.

## Technology choices

The term "high speed rail" encompasses a wide range of speed capabilities. We distinguish three types of high speed rail services according to the maximum commercial speed of the technology: High Speed (HS) covers trains capable of

---

[2] Population density in this sense is measured as the number of people living within a given distance from a station.

reaching speeds of 120-125 mph; Very High Speed (VHS) includes those with a top speed of 150-160 mph; and Super Speed (SS) refers to trains which can reach speeds of 250 mph or higher.

Characteristics of our hypothetical High Speed technology are drawn from experience with the Amtrak Metroliner service in the Northeast Corridor (ultimately designed to function as a High Speed train) as well as the British High Speed Train (HST) inaugurated in 1976. The characteristics of our Very High Speed technology are based primarily on the French TGV technology in operation since October 1981.[3] The characteristics of our Super Speed technology are based on data for the German Transrapid-06 magnetic levitation technology, which is still undergoing development for commercial application. Vehicles for each technology are shown in Figures 2, 3, and 4.

Courtesy: GM Electromotive

Figure 2: **Amtrak's Metroliner engine**

Courtesy: TGV-US

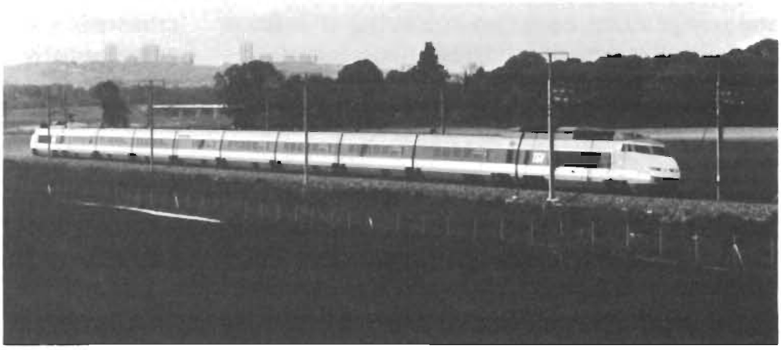

Figure 3: **The French TGV, a Very High Speed Train**

Courtesy: Budd Co.

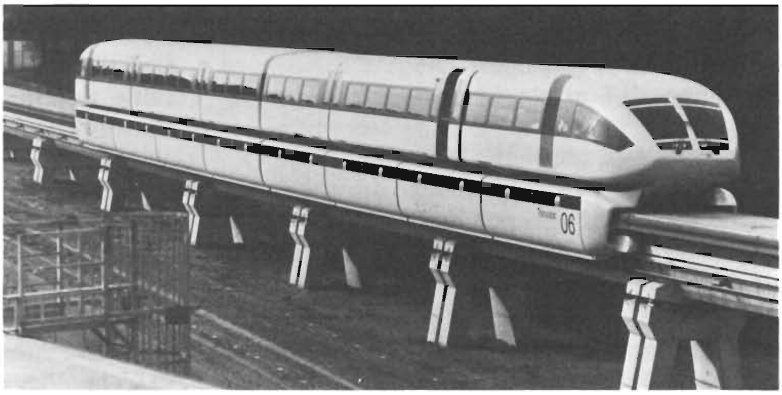

Figure 4: **The Transrapid-06, an experimental Super Speed maglev train**

### High Speed and Very High Speed: Metroliner and TGV

The Amtrak Metroliner and the French TGV represent successive developments in the application of the conventional steel-wheel-on-rail technology.

---

[3] This technology seemed more suited to the Midwestern transportation environment than the highly capital-intensive Shinkansen technology.

Speeds of 125 mph can be achieved without any fundamental changes in this vehicle technology. The major impediments to reaching service speeds of 125 mph with conventional rail passenger technology are the condition of the existing track and roadbed and the logistics of sharing right-of-way with low speed freight and passenger trains. Therefore, the implementation of the Metroliner-HS option focuses on improvements in track, roadbed, and signalling and control systems. The Metroliner equipment itself is essentially no different from that used for other intercity passenger service.

In contrast, the TGV represents the state of the art in steel-wheel-on-rail technology. The TGV vehicles were designed from the ground up to combine the best components from existing rail technologies and to incorporate the latest advances in aerodynamics, stability, and braking. Each TGV train has a fixed number of cars with one power car at each end of a string of articulated coaches. Adjacent coaches in the middle of the train share a single set of wheels, which are located under the articulated segments. This design reduces aerodynamic resistance and the number of axles, and increases passenger comfort. The lighter weight and higher speed resulting from these design improvements enable the TGV to climb steeper grades than other passenger trains. This permits savings in roadbed excavation and tunnel construction. The reduced weight of the TGV also reduces track maintenance costs. On the other hand, the operator's ability to adjust train capacity to demand patterns is limited because cars cannot be added readily.

### Super Speed: Transrapid-06 Maglev

The use of magnetic levitation (maglev) and electromagnetic propulsion to provide contactless vehicle movement makes the Transrapid-06 (TR-06) technology radically different from either the Metroliner or the TGV. The underside of the TR-06 carriage (where the wheel trucks would be on a conventional car) wraps around a guideway. Magnets on the bottom of the guideway attract magnets on the "wraparound," pulling it up towards the guideway. This suspends the vehicles about one centimeter above the guideway. Changes in the polarity of other magnets in the guideway cause the vehicles to move forward or backward.

Maglev technology obliterates the familiar distinction between track and rolling stock in propulsion. Power-generating equipment is relocated from the conventional locomotive to the underside of each car and to the track and guideway structure of the TR-06.

The fact that the TR-06 is designed to wrap around an elevated central guideway rather than to move on ground-level track has both advantages and disadvantages. The guideway is incompatible with existing track and stations, and must be newly constructed and electrified. However, the elevated guideway can be adapted to varied terrain with much less excavation and construction than are needed to lay ground-level track. The maglev technology promises dramatic increases in speed, but it has not yet been proven commercially feasible. At present it is employed in only one commercial application, a low-speed people mover at Birmingham Airport in the United Kingdom. Although high-speed prototypes are already operating, it will be perhaps another 5 to 20 years before the technology can be made commercial in high-speed applications.

### The impact on travel time

Speed is an appropriate characteristic by which to distinguish the many alternative high speed technologies, since it helps determine both rail demand and costs. On the demand side, differences in travel time affect the competitiveness of rail with respect to other modes of travel. Table 1 shows how travel times in the three Midwest corridors vary with the maximum speed of the rail technology. The travel time between Detroit or St. Louis and Chicago is between five and five and a half hours according to the current (1983) Amtrak schedule. The HS technology would reduce travel time to three-and-one-half hours; the VHS technology would bring the time down to a little under three hours; and with the SS technology the trip could be made in under two hours. Similarly, the current one-and-one-half hour trip between Milwaukee and Chicago

**Table 1**
**The effect of technology on rail travel times in three Midwest corridors**

| | Rail travel time between: Detroit and Chicago (minutes) | St. Louis and Chicago (minutes) | Milwaukee and Chicago (minutes) |
|---|---|---|---|
| Current Amtrak service | 333 | 320 | 89 |
| High Speed | 216 | 208 | 58 |
| Very High Speed | 176 | 170 | 45 |
| Super Speed | 110 | 106 | 29 |
| Distance (in miles) | 279 | 282 | 85 |

could be made in under an hour with the HS technology, in 45 minutes with the VHS technology, and in only a half-hour with the SS technology. It is easy to imagine that the reductions in travel time offered by the new high speed technologies might significantly enhance the attractiveness of rail travel in these Midwest corridors.

However, the potential demand for these travel-time savings must be weighed against the costs of implementing the various technologies. Differences in maximum attainable speed create different engineering, technological, and construction parameters that in turn affect the cost of a rail system. For example, Super Speed service with the magnetic levitation technology requires the construction of a new guideway structure along the entire route. High Speed service, on the other hand, can be implemented with improvements to existing rail rights-of-way without significant new roadbed construction.

## An analytical framework

There are many yardsticks which could be used to evaluate these nine projects. Profitability is one such measure, and in this study we compare projects by focusing on the net present value of current and future profits (losses) that would be realized if fares and frequencies were chosen to maximize total profits.

We chose this profit maximization criterion for three reasons. First, by focusing on the profit maximization (loss minimization) scenarios, we hoped to establish the circumstances under which the rail improvements could be made without governmental subsidies. Where we find that a subsidy would be necessary, our results also indicate the minimum subsidy required by each project. Second, since only a profit-making project would be able to attract private investment, our analysis points out the circumstances in which private participation in high speed rail development is most likely. Finally, breaking even under private profit-maximizing behavior is, in the absence of any negative externalities, a sufficient condition for a project to be socially desirable, although it is not a necessary condition. Social welfare would be maximized by setting railfares equal to long-run marginal social cost and providing a lump sum subsidy to the rail service operator. When a project fails this break-even test, a second more complicated test is needed to determine social desirability.[4]

A profitability analysis requires information on revenues (R), operating expenses (OE), capital outlays (K), the risky "real" (inflation-adjusted) interest rate (r), and the rate at which ridership (and hence revenues and operating expenses) are expected to grow over time (g). This information is combined to compute each project's net present value using the formula:[5]

$$NPV = \frac{R-OE}{r-g} - K$$

Outlays were estimated using actual and projected cost data for the High Speed and Very High Speed options and projected cost data for the Super Speed option. The passenger response to changes in speed, frequency of service, and rail fares was estimated using two intercity travel

---

[4] In this test, price is set equal to long-run marginal social cost. If, at these prices, revenues plus the weighted sum of consumers' surplus exceeds the project's costs then the project should be built and operated with government subsidies. Because this test requires knowledge of society's welfare function, it is best made by politicians and not economists.

[5] This formula ignores the presence of taxes. However tax effects are of secondary importance. A more detailed treatment would take account of income taxes including interest deductions, depreciation deductions, and investment tax credits. Our analysis indicated that taking these factors into account would have changed the absolute value of a project's net present value, but not its sign.

demand models—one developed by the firm of Peat, Marwick, Mitchell and Co., the other developed by Transmode, Inc.[6]

Profits are maximized by varying both rail fares and service frequency. Service frequencies affect revenues, operating expenses, and capital outlays. An increase in the frequency of service raises capital outlays by increasing the portion of the route which must be double tracked so that trains moving in opposite directions may pass one another.[7] It also increases the number of vehicles needed for smooth operation of the system. An increase in frequency raises operating expenses by increasing labor, maintenance, and fuel expenses. Finally, an increase in frequency raises revenues by improving the availability of rail service. This is particularly important when there are fewer than 12 trains a day. The impact of increases in rail fares is principally confined to revenues.[8]

The following two sections summarize the results of our analysis, focusing first on capital outlays and then on overall profitability.

## Capital costs

Rail projects are highly capital intensive. Our most expensive project required a capital outlay of $3.6 billion. The annual costs of financing the physical structure and construction outlays are often twice annual expenditures for operation and maintenance of the rail service. Track-related expenditures can account for over 70 percent of total capital outlays. Since these capital outlays are large—often exceeding a billion dollars—it becomes important to build only the minimum amount of track needed for smooth operation of the service. The amount of double track is the chief variable under the control of the designer. Limiting the amount of double tracking can reduce total capital outlays by as much as 80 percent below the outlays needed for a fully double-tracked system. Whether or not such savings will ultimately generate greater profits depends on the nature of passenger demand. Nevertheless, it is important to understand that this option is available.

Faster speeds and more frequent service both affect the amount of double tracking. Higher speeds increase the amount of double track needed for two trains to safely pass each other. Increases in service frequency increase the number of times trains must pass each other. The more times this occurs, the greater the portion of the route that will be double tracked. Other factors such as terrain and current track condition are also important to track-related expenditures but were ignored in our study.

The results of our cost analysis are shown in Table 2. These may be summarized as follows.

- Capital costs increase at an increasing rate with decreases in travel time. Going from the High Speed option to the Very High Speed option causes costs to increase by 95 percent but reduces travel time by 25 percent. Going from the Very High Speed option to the Super Speed option increases capital costs by an additional 110 percent but only leads to a 60 percent reduction in travel time.

- Because the number of trains per day is a principal determinant of the amount of track required, the frequency of service for which the system is designed can have a significant effect on its capital costs. In particular, going from 6 to 24 trains per day can increase the capital costs of the project by as much as 66 percent.

- Once the system is completely double tracked, the marginal costs of running another train fall dramatically.

- While changes in frequency are costly, their impact on capital cost is much less than changes in speed (technology). Holding the number of trains constant, moving from High

---

[6] Details of the Peat-Marwick-Mitchell model may be found in [7]. Details of the Transmode model may be found in [2] and an unpublished report. Both models are summarized in [1].

[7] It is assumed that once 60 percent of the route is double tracked (70 percent for the Super Speed option) the costs of switching and control make it desirable to double track the entire route.

[8] Fare increases could also reduce the vehicle component of capital cost. However, this is such a small part of total capital costs that it is ignored.

**Table 2**
**Cost estimates for three Midwest corridors**
*($ millions)*

| | Detroit-Chicago | | | | St. Louis-Chicago | | | | Milwaukee-Chicago | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Trains per day | 6 | 8 | 12 | 24 | 6 | 8 | 12 | 24 | 6 | 8 | 12 | 24 |
| **High Speed System** | | | | | | | | | | | | |
| TOTAL CAPITAL COST | 575 | 612 | 832 | 904 | 570 | 606 | 830 | 902 | 168 | 204 | 218 | 289 |
| Annual O&M Cost | 24 | 32 | 47 | 97 | 24 | 32 | 47 | 97 | 7 | 10 | 15 | 29 |
| **Very High Speed System** | | | | | | | | | | | | |
| TOTAL CAPITAL COST | 1151 | 1261 | 1682 | 1738 | 1149 | 1260 | 1689 | 1745 | 309 | 309 | 420 | 543 |
| Annual O&M Cost | 30 | 39 | 60 | 119 | 31 | 40 | 60 | 120 | 9 | 12 | 18 | 37 |
| **Super Speed System** | | | | | | | | | | | | |
| TOTAL CAPITAL COST | 2417 | 3042 | 3548 | 3612 | 2421 | 3046 | 3562 | 3636 | 590 | 590 | 590 | 1126 |
| Annual O&M Cost | 29 | 38 | 57 | 114 | 29 | 38 | 57 | 114 | 9 | 12 | 18 | 36 |

NOTE: O&M = operating and maintenance.

Speed to Very High Speed or Very High Speed to Super Speed tends to about double costs.

## Profitability

As the reader can see from Table 2, service frequency is important in determining the capital costs of a high speed rail system. Armed with this result, we will now switch our focus from costs to profitability. In order to analyze profitability for each of the three technologies in each of the three corridors, we chose the rail fare and frequency of service which maximized project net present value.[9] In doing so, we assumed that, given the frequency of service, the cost of serving an additional passenger was zero.

In computing these present values we took into account two environmental factors: the rate of growth in passenger revenues (g) and the decision-maker's real discount rate (r). These two factors will obviously have an impact not only on project profitability but also on the characteristics of the profit-maximizing project. Changes in these factors are most likely to have an effect when annual operating and maintenance expenditures are small relative to capital costs, as is the case with the SS option.

The choice of appropriate rates of discount and growth is always plagued with uncertainty. However, discussions with a number of rail specialists led us to conclude that the real rate of discount should be at least 6 percent per year.[10]

Table 3 presents the results of our analysis using demand forecasts based on the Transmode model. Table 4 presents our results using the Peat-Marwick-Mitchell model. These results may be summarized as follows:

- Product pricing plays an important role in the ultimate profitability of a project.
- The High Speed option is generally more profitable (less unprofitable) than the Very High Speed option.

---

[9] Because in the Peat-Marwick-Mitchell model the demand for passenger rail services had a price elasticity less than one, any project could be made profitable by raising fares high enough. To overcome this problem we developed what we felt would be a reasonable set of fares. We used these fares to obtain forecasts of demand and revenues from the Peat-Marwick-Mitchell model (see Table 4). These fares were generally higher than the fares suggested by the Transmode model.

Both forecasts assume that business travelers pay 80 percent more than nonbusiness travelers.

[10] Based on discussions with British Rail and Amtrak. Private rail firms appear to employ a higher rate—somewhere between 11 and 16 percent.

### Table 3
### Characteristics of profit-maximizing high speed rail projects based on the Transmode Model

| | Detroit-Chicago | | | St. Louis-Chicago | | | Milwaukee-Chicago | | |
|---|---|---|---|---|---|---|---|---|---|
| | High Speed | Very High Speed | Super Speed | High Speed | Very High Speed | Super Speed | High Speed | Very High Speed | Super Speed |
| Present value *(million dollars)* | | | | | | | | | |
| when r − g = .06 | 105 | -346 | -1202 | -7 | -474 | -1333 | -128 | -272 | -413 |
| .05 | 241 | -185 | -959 | 107 | -339 | -1115 | -120 | -265 | -378 |
| .04 | 445 | 56 | -595 | 277 | -137 | -544 | -108 | -254 | -325 |
| .03 | 785 | 459 | 13 | 561 | 201 | -245 | -88 | -235 | -237 |
| .02 | 1465 | 1264 | 1228 | 1130 | 876 | 844 | -48 | -198 | -60 |
| Capital cost *(million dollars)* | 575 | 1151 | 2417 | 575 | 1149 | 2421 | 168 | 309 | 590 |
| Frequency | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 12 |
| Optimal price as a percentage of current price | 120% | 140% | 180% | 120% | 140% | 180% | 190% | 220% | 130% |

### Table 4
### Characteristics of profit-maximizing high speed rail projects based on the Peat-Marwick-Mitchell model

| | Detroit-Chicago | | | St. Louis-Chicago | | | Milwaukee-Chicago | | |
|---|---|---|---|---|---|---|---|---|---|
| | High Speed | Very High Speed | Super Speed | High Speed | Very High Speed | Super Speed | High Speed | Very High Speed | Super Speed |
| Present value *(million dollars)* | | | | | | | | | |
| when r − g = .06 | -345 | -734 | -1181 | -586 | -1151 | -1888 | -118 | -234 | -90 |
| .05 | -222 | -629 | -694 | -590 | -1141 | -1781 | -108 | -159 | 10 |
| .04 | -125 | -471 | 35 | -595 | -1139 | -1621 | -92 | -122 | 160 |
| .03 | 38 | -207 | 1251 | -603 | -1143 | -1355 | -47 | -59 | 410 |
| .02 | 395 | 319 | 3683 | -620 | -1435 | -392 | 67 | 100 | 910 |
| Capital cost *(million dollars)* | | | | | | | | | |
| when r − g = .06 | 575 | 1261 | 3612 | 570 | 1149 | 2421 | 168 | 309 | 590 |
| .05 | 612 | 1261 | 3612 | 570 | 1149 | 2421 | 168 | 309 | 590 |
| .04 | 612 | 1261 | 3612 | 570 | 1149 | 2421 | 204 | 309 | 590 |
| .03 | 612 | 1261 | 3612 | 570 | 1260 | 2421 | 289 | 309 | 590 |
| .02 | 832 | 1261 | 3612 | 570 | 1260 | 3562 | 289 | 420 | 590 |
| Frequency | | | | | | | | | |
| when r − g = .06 | 6 | 8 | 24 | 6 | 6 | 6 | 6 | 6 | 12 |
| .05 | 8 | 8 | 24 | 6 | 6 | 6 | 6 | 8 | 12 |
| .04 | 8 | 8 | 24 | 6 | 6 | 6 | 8 | 8 | 12 |
| .03 | 8 | 8 | 24 | 6 | 8 | 6 | 12 | 8 | 12 |
| .02 | 12 | 8 | 24 | 6 | 8 | 12 | 12 | 12 | 12 |
| Price as a percentage of current price | 160% | 180% | 200% | 160% | 180% | 200% | 160% | 180% | 200% |

- The profit maximizing rail option in our three Midwest corridors most often involves only modest increases in frequency from the existing 3 to 5 trains per day operated by Amtrak. This optimal frequency is generally far below the levels provided in France, Great Britain, or Japan.

- Several high speed rail projects did appear to have the ability to be profitable, but only if the public sector discount rate of 6 percent were applied. If the rates used by private rail companies were applied, none of these projects would appear to be profitable.

Our findings concerning the importance of product pricing are, we believe, novel. We found that profit-maximizing pricing of new rail service could raise revenues by as much as 45 percent. Considering the sensitivity of profitability to pricing, it is surprising that few previous studies have spent much time addressing this issue. Profit-maximizing pricing can make it possible to conserve on expensive track by trading off lower fares for lower frequencies (and longer waiting times). Rail service also lends itself to various forms of price discrimination which make it easier to break even. For instance, promotional fares can permit the filling of off-peak trains which, given the track in place, can be relatively cheap to run. Finally, pricing which reflects the improved travel times available at higher speeds will make it more likely that the project will be able to break even.

Our conclusion concerning the relative profitability of High and Very High speed rail options is a direct outcome of the relatively small increase in ridership together with the doubling of construction costs created by moving from the lower speed option to the higher speed one.

Our result concerning the optimal number of trains per day for high speed rail service in the Midwest requires more discussion. The number of trains per day suggested by our models is far below the number observed in countries currently operating high speed rail systems. The French run 18 TGV trains a day in each direction between Paris and Lyon and an additional 14 TGV trains which use the system but do not stop at Lyon. The British run 20 trains per day in each direction between London and Newcastle. Finally, the Japanese run 79 Shinkansen trains each day in each direction on their Tokyo-Osaka route.

There are three possible explanations for the divergence between our results on frequency and existing overseas practice. First, the transportation environment in the American Midwest differs radically from that in France, Great Britain, or Japan. Population density is often cited as a major difference between the United States and foreign countries. However, it is not the density measured as population per route-mile which differs, but population per square mile at the end-points; European towns are typically more compact than American towns.[11] There are other differences in the transportation environment which also appear to be important. Cars cost more to purchase and operate abroad. In particular, gasoline is almost twice as expensive in these three countries as it is in the United States. Also, public transportation (primarily rail) is generally less expensive abroad than in the United States. Finally, European and Japanese incomes, and hence values of time, are lower than in the United States. All these factors tend to increase the demand for rail service and reduce the demand for other modes.

Second, all three foreign high speed rail projects were undertaken because of heavy demand for existing service. Demand and frequent service go hand in hand. However, excess demand is not a problem in any of the Midwest routes we examined.

Finally, the foreign rail companies may be pursuing a policy of welfare maximization rather than profit-maximization. When dealing with projects which have large fixed costs (we can view the single track between two points as the fixed cost and any additional track as a variable cost), economic efficiency is achieved not by maximizing profits or attempting to break even,

---

[11] There are exceptions to this rule. They generally occur where an American city is situated next to a body of water or a mountain range. In these cases population densities may be higher than in European cities of comparable size. However, the number of people living within a given distance of downtown is still generally lower.

but by setting price equal to the long-run marginal social cost of an additional unit of service. Such a policy would obviously entail much higher service levels than would a policy of attempting to maximize profits.

## Conclusion

We find that some high speed rail projects in the Midwest may be profitable under some circumstances. Taking social benefits into account would increase the number of projects which society would find attractive. However, the reader should realize that profitable projects involve relatively few trains per day (six to twelve), assume that a "no frills" system is constructed, and assume that a "public sector" discount rate is employed. None of these projects is likely to be profitable if capital costs run out of control or if the difference between the real rate of interest and the annual growth in rail demand exceeds 6 percent per year.

Of the three technologies studied, the profitability results for the Super Speed magnetic levitation technology are the most difficult to interpret. The technology's relatively low projected operating costs make it ideally suited for highly traveled corridors.[12] Its high speed also permits it to economize on track construction in relatively short corridors. Unfortunately, on such corridors, access-egress time usually becomes important in generating riders and revenues, making it desirable to have many stops. However, frequent stops rob the system of much of the travel time savings obtained through higher speeds. The SS option presents special problems for forecasting. Cost estimates are a problem since the technology has never been placed in service commercially or built on a commercial scale. In addition, the range of travel times permitted by this option is so far removed from actual experience that the validity of our forecasting models becomes debatable. Nevertheless, the two models disagree on the profitability of the SS option in only one instance—between Milwaukee and Chicago—and even this disagreement diminishes once we take interest costs during construction into account.[13]

Our capital cost estimates are generally on the conservative side. If we have underestimated the amount of track realignment required for the High Speed or Very High Speed system, it is unlikely that any of the projects would be profitable. A decision to build an overly sophisticated system or an unexpected lengthening of the construction process would have a similar effect. Finally, more accurate assessment of the uncertainties involved in predicting revenues and construction costs (particularly in the Super Speed case) may decrease the attractiveness of these Midwest projects.

---

[12] See Table 2.

[13] See [1] for details.

## References

[1] Baer, Herbert, William Testa, Donna Vandenbrink, and Bruce Williams. *High Speed Rail in the Midwest: An Economic Analysis.* Chicago: Federal Reserve Bank of Chicago, 1984.

[2] Foster, Adrian and Metcalf, Alex. *Michigan High Speed Intercity Rail Passenger Development Study: Market Analysis.* Prepared for Michigan Department of Transportation, Bureau of Urban and Public Transportation. London: Transmark, 1981.

[3] *Milwaukee to Chicago Maglev System: Feasibility Study: Final Report.* Prepared for Henry Reuss, et al., by Budd Company Technical Center. Fort Washington, Pa: Budd Company, 1982.

[4] *Ohio High Speed Intercity Rail Passenger Program: Executive Summary.* Prepared for the Ohio Rail Transportation Authority, by Dalton, Dalton, Newport. Cleveland: Dalton, 1980.

[5] U.S. Congress. Office of Technology Assessment. *U.S. Passenger Rail Technologies.* Washington: 1983.

[6] U.S. Congressional Budget Office. *Federal Subsidies for Rail Passenger Service: An Assessment of Amtrak.* Washington: 1982.

[7] *Variations in Travel Forecasts for Improved High Speed Rail Services in the Northeast Corridor.* Final Report prepared for the U.S. Department of Transportation, Federal Railroad Administration, by Peat, Marwick, and Mitchell and Company: Springfield, Va: National Technical Information Service, 1973.