Market pricing is essential on high speed lines

The world has watched with awe, and more than a little envy, as China has leapt to the top of the high speed league table by operating at up to 350 km/h on the Wuhan – Guangzhou route. However, on other routes Chinese Railways has decided to run trains at a somewhat slower 300 km/h for reasons of cost, although faster services may be possible in the future. So what happened? Did CR just figure that they could run a bit faster, set a new record and give another boost to national prestige? Or did they calculate the costs and benefits of different options? Now that CR has experience of high speed operation, it has learned that running fast is not cheap, as track wear and power consumption go up exponentially.

China is not the first country to build high speed lines, and not the first to face the dilemma of how fast to run its trains. The problem is that in aiming to recover its costs CR still uses tariff-based pricing, setting fares according to the distance travelled. In other countries such as France and the UK, operators have adopted market pricing, charging higher fares to travel in the peaks and for flexible tickets which enable passengers to change their travel plans at the last minute. Much lower fares are offered to people who book in advance, travel outside peak hours and buy non-refundable tickets.

Experience shows that market pricing attracts more passengers, increasing revenue and reducing the need for subsidy. Charging higher fares to time-sensitive travellers has made it easier to justify the large investment required for higher speeds and more frequent services. In contrast, the continued use of tariff pricing in Germany and Japan has not achieved the same passenger growth rates, with higher average fares and operators apparently less inclined to increase speeds or service frequencies.

Chinese practice

On the flagship Beijing – Shanghai route, CR runs 25 high speed G class trains each way every day. A few make only one intermediate stop with an overall journey time of 4 h 48 min, but most make eight or nine stops and take almost 6 h. CR still operates a few slower D trains taking 8 h to 9 h and three overnight services. Fares are set by the national tariff (Table I). For most domestic passengers, the difference between the D and G fares is equivalent to a full day’s pay, a high price to save 3 h or 4 h. Price-sensitive travellers, migrant workers, students and even middle-class families prefer the cheaper trains, but these sell out as soon as tickets are available. So many are forced to pay for the faster, higher-priced G trains. Lower-income passengers, for whom the fare is more important than the journey time, complain of being ‘high speeded’. Unfortunately, the 6 h journey time is not short enough to compete with air, and most business travellers would still rather fly, even at twice the G fare. The result is that China’s high speed trains are too expensive for the ordinary traveller, who actually does not care very much about speed, and yet too slow, and arguably too cheap, for the time-sensitive traveller.

CR does not disclose detailed data, but it seems that its G trains are running on average half-full. At the busiest times they are full, but there are plenty of seats during the middle of the day, or the middle of the week. There seems little doubt that China’s high speed rail network is a wise investment, as it will encourage compact and sustainable development and should also release capacity on the conventional network for freight. Fares at current levels will cover operating costs, and perhaps pay off some of the enormous capital debt that has been incurred. But unless CR adopts market pricing, experience in other

**REVENUE** In an international comparison of fares policy, Michael Schabas* argues that half of the potential benefits of the Chinese high speed rail network are being wasted without market pricing.

The world has watched with awe, and more than a little envy, as China has leapt to the top of the high speed league table by operating at up to 350 km/h on the Wuhan – Guangzhou route. However, on other routes Chinese Railways has decided to run trains at a somewhat slower 300 km/h for reasons of cost, although faster services may be possible in the future. So what happened? Did CR just figure that they could run a bit faster, set a new record and give another boost to national prestige? Or did they calculate the costs and benefits of different options? Now that CR has experience of high speed operation, it has learned that running fast is not cheap, as track wear and power consumption go up exponentially.

China is not the first country to build high speed lines, and not the first to face the dilemma of how fast to run its trains. The problem is that in aiming to recover its costs CR still uses tariff-based pricing, setting fares according to the distance travelled. In other countries such as France and the UK, operators have adopted market pricing, charging higher fares to travel in the peaks and for flexible tickets which enable passengers to change their travel plans at the last minute. Much lower fares are offered to people who book in advance, travel outside peak hours and buy non-refundable tickets.

Experience shows that market pricing attracts more passengers, increasing revenue and reducing the need for subsidy. Charging higher fares to time-sensitive travellers has made it easier to justify the large investment required for higher speeds and more frequent services. In contrast, the continued use of tariff pricing in Germany and Japan has not achieved the same passenger growth rates, with higher average fares and operators apparently less inclined to increase speeds or service frequencies.

**Chinese practice**

On the flagship Beijing – Shanghai route, CR runs 25 high speed G class trains each way every day. A few make only one intermediate stop with an overall journey time of 4 h 48 min, but most make eight or nine stops and take almost 6 h. CR still operates a few slower D trains taking 8 h to 9 h and three overnight services. Fares are set by the national tariff (Table I).

For most domestic passengers, the difference between the D and G fares is equivalent to a full day’s pay, a high price to save 3 h or 4 h. Price-sensitive travellers, migrant workers, students and even middle-class families prefer the cheaper trains, but these sell out as soon as tickets are available. So many are forced to pay for the faster, higher-priced G trains. Lower-income passengers, for whom the fare is more important than the journey time, complain of being ‘high speeded’. Unfortunately, the 6 h journey time is not short enough to compete with air, and most business travellers would still rather fly, even at twice the G fare. The result is that China’s high speed trains are too expensive for the ordinary traveller, who actually does not care very much about speed, and yet too slow, and arguably too cheap, for the time-sensitive traveller.

CR does not disclose detailed data, but it seems that its G trains are running on average half-full. At the busiest times they are full, but there are plenty of seats during the middle of the day, or the middle of the week. There seems little doubt that China’s high speed rail network is a wise investment, as it will encourage compact and sustainable development and should also release capacity on the conventional network for freight. Fares at current levels will cover operating costs, and perhaps pay off some of the enormous capital debt that has been incurred. But unless CR adopts market pricing, experience in other...
countries suggests that load factors will never be much above 50%. CR will struggle to justify the cost of running trains fast enough to attract business travellers, and those who do use rail will often find it hard to get a seat. Half the benefits of high speed will be wasted.

**Tariff vs market pricing**

Traditional distance-based pricing seems fair and is simple to administer. It worked well for railways before they faced road and air competition. But on most routes today, operators struggle to find a fare that will generate sufficient revenue to cover costs and yet still attract passengers. A high fare will generate more revenue from those who are willing to pay it, but many potential passengers will travel less by rail, or simply won’t travel at all. If the fare is set very low, more will travel. But at busy times the trains will be overcrowded. And the railway will lose money, because traffic will not have grown enough to make up for the fare cut.

A new high speed line creates capacity that tariff pricing simply cannot sell. Business trips are mostly at the beginning and end of the day. But it doesn’t make sense to let expensive trains sit idle through the day, and some travellers want flexibility to change their plans. Fixed-formation trainsets operating at fixed intervals are overcrowded at peak times, but have plenty of empty seats in the middle of the day. Average load factors of

<table>
<thead>
<tr>
<th>Revenue €/year</th>
<th>Load factor %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>1.0</td>
<td>20</td>
</tr>
<tr>
<td>1.5</td>
<td>40</td>
</tr>
<tr>
<td>2.0</td>
<td>60</td>
</tr>
<tr>
<td>2.5</td>
<td>80</td>
</tr>
<tr>
<td>3.0</td>
<td>100</td>
</tr>
</tbody>
</table>

Fig 1. This graph of a hypothetical HSR route shows loadings and revenue with tariff pricing, for each hour of the day. Trains are heavily loaded in the morning and evening, but load factors fall to about 20% in the middle of the day.

**Table I. Comparison between G and D trains**

<table>
<thead>
<tr>
<th></th>
<th>G trains</th>
<th>D trains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top speed</td>
<td>350 km/h</td>
<td>225 km/h</td>
</tr>
<tr>
<td>Beijing-Shanghai fare</td>
<td>RMB 518 (€57)</td>
<td>RMB 302 (€33)</td>
</tr>
<tr>
<td>Journey time</td>
<td>5 – 6 hours</td>
<td>8 – 9 hours</td>
</tr>
</tbody>
</table>

On September 20 at 13:30 CET

we will unveil a new evolution in bolt security.

For years, designers have struggled with how to secure bolts against stresses from multiple fronts, including vibration, dynamic loads, settlement and relaxation. Now, there’s one solution for all your bolt securing needs.

50% or less are typical.

If you are going to lose money anyway, it is probably better to at least carry plenty of passengers at low fares. Many passengers will benefit, which may persuade the government to make up the difference through subsidy, as is the case for most metros. But CR’s long-distance trains have, until now, been financially self-supporting. And the Chinese government’s appetite for paying operating subsidy seems limited, especially for high speed services which compete with profitable (and still state-owned) airlines.

When setting tariff prices, you start with the costs, and try to spread them across the total number of passengers. But in setting market prices, you start with the passenger, trying to charge each one as much as they are willing to pay. Different passengers have very different values of time. A business traveller trying to get home to read her child a bedtime story may be willing to pay quite a premium to save even half an hour, especially if her employer is actually paying the fare. A student going home for the holidays will have planned the trip long in advance, may not care much about an extra hour or three and will travel at an inconvenient time if it means they can pay less.

Of course, nobody willingly pays a higher fare. Railways, like airlines, have developed techniques to segment the market, charging more for trips in peak hours and imposing restrictions on when or how tickets can be purchased, changed or refunded. In this manner market pricing can sell the capacity of a high speed route so that expensive capital investment is not wasted.

**TGV: high speed for all**

When conceiving its first high speed line between Paris and Lyon, SNCF aimed to attract business travellers by offering a 2 h journey time competitive with air. Previously, SNCF had charged supplements on top of distance-based fares for its prestigious express trains such as *Le Mistral*, and critics said it was building the new line for the ‘elite’. The French national operator surprised them by charging the same fares on its high speed line as on the rest of the network. The slogan was ‘travel at 260 km/h for the price of 160 km/h’. SNCF correctly forecast that traffic and revenue would double after the line opened, so the cost per passenger actually fell.

In 1993, when it opened its third high speed line from Paris to Lille, SNCF introduced market pricing and yield management, whereby prices are continuously adjusted to match expected and actual demand. With the objective of maximising total revenue, higher fares are charged for busy trains, usually in the morning and evening peaks, and for tickets purchased at the last minute. Much cheaper fares are available to passengers who book well in advance and travel during the middle of the day.

For the 800 km from Paris to Marseille, advance-purchase fares can be as low as €25 (€0.03 per km), while a seat bought at the last minute for a shorter route like Paris – Lille can be as much as €78 (€0.35 per km). Travellers know they can get a good fare if they book in advance. They also know that, if they are willing to pay more, they can usually just turn up at the station and get a seat on the next train.

As passengers became used to buying cheap advance tickets, the government allowed SNCF to raise the top
fares well above inflation. The difference between the highest and lowest fares is about 10:1, similar to the range found on airlines. The cheapest tickets are non-refundable and cannot be changed, while mid-price tickets are usually non-refundable but can be used on a different train for a fee.

SNCF’s TGV services operate at a substantial profit, covering all operating and maintenance costs. The capital investment in the first high speed line between Paris and Lyon was paid off within a decade. Newer lines have required capital subsidy, but with operating surpluses still paying a significant share. Load factors are about 80%, and traffic has grown by 30% over the past decade.

**InterCity first into profit**

Market pricing was introduced more gradually in the UK, but with much the same results. From the 1960s, the erstwhile national operator British Rail developed a network of fast, frequent long-distance services offering air-conditioning, onboard catering and reserved seats, which it marketed as InterCity. Although not considered true high speed services because the top speed is only 200 km/h on conventional infrastructure, InterCity and its descendants have proved competitive with driving or flying, especially into central London where roads are badly congested and parking is very expensive.

In the 1970s BR split the long-distance market with higher-priced open fares and cheaper off-peak tickets. It later took advantage of emerging computer technology to introduce advance purchase fares. Since privatisation in the 1990s, train operating companies have developed the range of fares further, making use of the internet and mobile phones for ticket retailing, but still within a government-regulated framework.

The range of fares available today is often perceived as unnecessarily complex, and in an attempt at standardisation three categories were introduced to provide some clarity for passengers: Anytime, Off-Peak and Advance.

As the name suggests, Anytime (open) fares can be used on any train at any time. They range from £0.25 to £0.40 per km in standard (second) class. Fares for first class are usually 50% or 60% higher, up to £0.65 per km, and the fully-flexible £140 Anytime single fare from London to Manchester is actually similar to the price of an air ticket.

Off-Peak fares are typically half the price of Anytime fares, and discounted long-distance fares have encouraged passengers to travel outside peak hours. This can help to reduce rolling stock requirements, and thus leasing costs, while people who really need to travel in the peaks can be reasonably sure of getting a seat, even at the last minute.

Business travellers know they can go to a station, put a credit card into a ticket vending machine and get on the next train, as there are usually two and sometimes up to four trains an hour on the principal long-distance routes. With Anytime and Off-Peak fares, seat reservations are optional. While many still book a seat, it seems sensible to let passengers take the risk of having to stand if they want maximum flexibility. Off-Peak tickets are aimed at people travelling on personal business who want the flexibility to change their plans at the last minute but are willing to avoid peak hours in return for saving money.

In fact, BR’s strategy was so
successful that, on some routes, the single morning and afternoon peaks were transformed into double peaks, with overcrowding becoming a problem on the trains just before and after the peak fare restriction (Fig 2).

Nevertheless, BR found it still had plenty of empty seats which it could not sell even at the lower Off-Peak fares. From the 1980s it began to offer Advance fares. These are only available with advance purchase, and are for a specific seat on a specific train. They are non-refundable and cannot be changed. Initially, most Advance tickets were purchased by phone, with tickets sent by post. Now, most are purchased on the internet, and collected from self-service machines at stations.

A range of Advance fares is offered, the price depending upon when you book and how busy the train is expected to be. The cheapest fare can be as little as £0.04 per km. The quotas for each fare are adjusted, sometimes automatically, based on expected demand. Thus if a major football match is scheduled, the cheapest fares will not be offered because every seat can be sold at a higher price.

Rail privatisation also saw fares regulation placed on a formal basis by the UK government. For longer distances, increases in Off-Peak fares must not exceed a cap linked to the rate of inflation, while on commuter routes the Anytime fare is similarly regulated. Enjoying wide freedom to set other fares, most TOCs have raised first class prices, but have also increased the range and availability of discounted fares.

Advance tickets can now be purchased on the internet up to the night before travel, for one-way trips, for

---

**Fig 3.** After privatisation, train companies began using the internet to offer advance fares even for travel in peak hours. Availability is carefully controlled so that there is always space for passengers paying much higher ‘anytime’ fares. In this hypothetical example, trains are now 40% loaded even in the middle of the day, while average load factors have increased to 80%.
travel in first class and even on trains in peak hours (Fig 3). These fares are not always very cheap. Advance fares in peak hours are usually more expensive than the Off-Peak fare. The TOCs have also introduced one-way Off-Peak fares that are more expensive than Advance fares but offer flexibility to use any train. This allows passengers to mix and match to achieve the best combination of price and flexibility.

The increasing availability of cheap fares since privatisation is proof that they generate more total revenue. Otherwise, the profit-driven private operators would not offer them. There are sometimes complaints that rail fares in the UK are ‘too complicated’. Of course, the same complaint is made about mobile phone tariffs and air fares. New fares have only been developed to attract more passengers onto the trains, to generate more revenue from them, and to reduce the need for subsidy. Operators believe that any forced simplification of the fares structure would result in fewer people travelling by rail, and the UK railway requiring more support from the taxpayer.

From the published financial data it is evident that most long-distance routes in the UK recover their full operating costs, including train leasing, track access charges paid to Network Rail. Many now generate large surpluses that are paid to government. Load factor data is harder to find, but on inter-city services from London it is believed to be about 70%. Passenger traffic on the national network has grown by more than 40% over the past decade (Figs 4 and 5), and perhaps half of this is due to market pricing.

On a typical route carrying 50000 passengers a day, a 10 min reduction in journey time might attract an additional 1000 business passengers who would otherwise fly or drive. At a fare of £140 each, this would generate £42m each year in extra revenue, which might support capital investment of £400m. With tariff pricing the revenue increase, and the potential investment that could be funded, is much lower.

With time-sensitive passengers paying high fares in return for speed and frequency, UK operators have been able to justify continued service improvements on a commercial basis. Since 1995, the journey time from London to Manchester has been reduced from 2 h 50 min to 2 h 10 min, while service frequency has increased from one to three trains an hour.

**DB sticks to the tariff**

In 2002 DB attempted to introduce a new fares system for its long-distance services based on airline practice, with key managers joining the railway from Luhtansa. However, the transition was not managed well. The new system was not considered user-friendly, and passengers seemed unconvinced of the benefits it was meant to offer. After many complaints, DB was forced by the government to revert to a tariff system, with fare increases subject to approval by the federal parliament.

DB’s Normalpreis fares on its ICE services travelling at up to 320 km/h, are about €0·30 per km, similar to Off-Peak fares in the UK but valid on any train. Slightly lower fares are charged for travel on IC services, even on those routes where ICE trains operate at conventional speed. As there is no reduction for off-peak travel and seat reservations are optional, overcrowding is common on peak trains.

Regular users can purchase a BahnCard which offers a 25% or 50% discount on Normalpreis fares upon payment of an up-front annual fee. In effect, a BahnCard 50 brings the fare down to about €0·15 per km. The concept is understandably very popular with passengers, but less so with DB. Although the cards encourage customer loyalty, they make overcrowding even worse.

DB does now offer Sparpreis advance purchase tickets at a discount of 50% or 75% (€0·15 or €0·075 per km). These are only available until three days before travel on trains where DB is certain there will be empty seats. However, the relative attraction of these tickets is reduced because of the availability of the BahnCard.

Generally, service quality at stations and on trains operated by DB is similar or better than that experienced in the UK or France. Most stations have been modernised and there are excellent connections with local public transport. But train frequencies and average speeds are often not so good. On main routes DB only operates one or two trains/h, where similar routes in the UK would have three or four. DB does operate at up to 300 km/h, but the actual high speed sections are usually less than 200 km in length. Even ICE trains spend most of their time running on conventional infrastructure at a maximum speed of 160 km/h, with frequent and fairly leisurely station stops.

The highest fares in Germany are about two-thirds the level charged in the UK, so DB’s ‘reward’ for attracting more high-value passengers by cutting journey times or increasing service frequencies is similarly reduced. Indeed, DB has decided that its new fleet of IC trains will have a top speed of only 249 km/h.

Overall, passenger traffic has grown more slowly in Germany than in France or the UK, at rate of 10% per decade despite many service improvements and a stronger underlying economy. There seems little doubt that traffic and revenue would increase if DB introduced market pricing, to the benefit of both railway and taxpayer. It would also provide stronger incentives to run faster and more frequent services. But it would also be complicated and controversial, and since the 2002 debacle, DB has not suggested it.

**Don’t rock the boat**

Tariff pricing also remains the norm in Japan, with fares set per km depending upon the type of train used, although Shinkansen fares are based on tariff-km rather than strict.
High speed services in Japan all apparently operate at a profit, but only the main Tokyo – Nagoya – Osaka route has repaid its cost of construction. Serving one of the densest and richest corridors in the world, the railways’ revenue is about ¥1.5tr with a net income of ¥133bn.

Although the main JR companies were privatised by stock market flotation around 10 years ago, government approval is still required for any fare increase. Yet since privatisation no increase has been requested. The Japanese yen has been deflating, so fares have gradually been increasing in real terms anyway.

Certainly, overcrowding could be alleviated and more off-peak business attracted with market pricing. But raising peak fares would require government permission, even if this were linked with a cut in off-peak fares. Traffic and revenues would both increase, but the government might wake up and ask for a slice of the cake, as it does in the UK. So there seems little incentive to rock the boat.

JR Central is now preparing to build the Chuo Shinkansen, a 500 km/h maglev with a capital cost in excess of ¥5tr. The railway’s motives are unclear, as it is hard to see the forecast 10% increase in revenue ever repaying this investment. Perhaps JR Central prefers to be seen as ‘reinvesting’ its profits, even on something that makes little commercial sense, because otherwise the government might try to capture them through fares regulation or taxation.

Market pricing works

European experience shows that traffic, revenue and profit can all be increased with market pricing. Business travellers pay eye-watering fares for walk-on convenience on routes with three or four trains per hour. Leisure passengers fill trains through the day at lower fares.

With market pricing, being ‘high speeded’ would be something to welcomed by China’s price-sensitive passengers. Many could end up paying less, perhaps even less than the D fares. Time-sensitive travellers would be able to get a seat, at a higher price, and to travel when they need to. CR would find it worthwhile to run more frequent services, perhaps even at 350 km/h, at least on the flagship Beijing – Shanghai high speed line.