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When to invest in high speed rail

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ABSTRACT

This paper starts by a general review of the costs and benefits of high speed rail, of how they are measured in cost–benefit analysis and of the circumstances in which benefits may be expected to exceed costs. Two approaches are taken to the latter; first, examining models in which values of key parameters are varied to see in what circumstances benefits exceed costs, and secondly looking at the limited evidence from ex post studies, mainly for France and Spain. We then turn to British experience of the appraisal of HS2 – the proposed line linking London to Birmingham, Manchester and Leeds. It is concluded that the main factors determining economic success for high speed rail projects are construction costs, value of time saving per passenger and traffic volume and degree of congestion of existing transport networks. The biggest uncertainty regarding the case for high speed rail surrounds the possibility of wider economic benefits.

Contents

1. Introduction

High speed rail (HSR) is usually regarded as comprising services operating at 250 kmph or more, and these speeds invariably require construction of new purpose built lines, although high speed trains may run at up to 200–225 kmph on upgraded existing lines. According to UIC, by 2013, a total of 21,472 km of new high speed lines had been built worldwide. China had the largest network at 9867 km, whilst Japan, France and Spain all had over 2000 km. There are plans for a further major expansion, with the

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European Commission calling for a trebling of the kilometres of high speed line in Europe by 2030. Yet high speed rail is an enormous investment, and it is necessary to consider very carefully in what circumstances such an outlay is justified.

The first such line, the new Tokaido line in Japan, was clearly built with the twin aims of giving large time savings (and thus competing effectively with air transport) and relieving capacity constraints on the existing railway line. These were also clearly the motives behind the construction of the first TGV line from Paris to Lyons in France. But since then, wider motives have appeared, including reducing carbon emissions by diverting traffic from air and road, and promoting economic regeneration and growth. The first part of this paper will consider at a general level the costs and benefits of high speed rail, and evidence to date on what determines their magnitude. We then examine evidence on the circumstances in which benefits will exceed cost, drawing both on theoretical modelling exercises and on ex post studies of actual schemes.

We will then consider specifically the current debate on high speed rail in Britain. The large volumes of existing rail traffic, and the ability to serve many of the main cities of Britain with a single line splitting into two branches, appear to make Britain an ideal country for high speed rail. However, the proposed line from London to the North, HS2, has proved very controversial. The final section of this paper draws conclusions.

2. Costs and benefits of high speed rail

2.1. Introduction

The principal costs and benefit of HSR are listed in Table 1. Section 2.2 discusses costs, Section 2.3 patronage and revenue, Section 2.4 time savings, Section 2.5 rail capacity benefits, Section 2.6 diversions from other modes and Section 2.7 wider economic benefits.

2.2. Costs

Table 2 summarises construction costs of high speed rail in Europe and Asia. It will be seen that there is a considerable range both within and between countries. Obviously there are many factors influencing this including differing labour and land costs, whether the line is designed for both freight and passenger trains or passenger only and whether the line uses slabtrack or traditional ballasted track. But particularly significant factors are the degree to which new stations have to be constructed and the length of tunnelling needed (either because of the terrain or to alleviate environmental problems (SDG, 2004). For instance of the estimated construction cost of HS2 Phase 1 in Britain, over 40% comprises station and tunnelling costs (HS2, 2012). This is because a substantial amount of tunnelling is planned, particularly in order to get into central London, and either new or substantially extended stations are required. By contrast, in many European cities (such as Paris) high speed trains have generally been accommodated in existing stations without major extensions and accessed these on the surface. One reason for this is that suburban trains have been redirected into underground routes across city centres releasing surface capacity for high speed rail.

Table 1
HSR costs and benefits.

Costs	Benefits
Capital costs	Revenue
Operating costs	Time savings (beyond those recovered in higher prices)
External costs	Release of capacity on existing rail routes
Loss of tax revenue (from traffic diverted from road to rail)	Diversion from other modes – reduced congestion, accidents and environmental costs
Opportunity cost of public sector funds	Induced traffic
	Wider economic benefits

Table 2
Construction costs of high speed rail (2005 prices).

	Euros m per route km
China	5.7–18.8
Belgium	16.1
France	4.7–18.8
Germany	15–28.8
Italy	25.5
Japan	20–30.9
Korea	34.2
Spain	7.8–20
Taiwan	39.5

Source: Derived from Campos et al. (2009) Graph 1.3, except China, which is from Wu et al. (2014).

Given these high costs, it is obviously sensible to ask whether the costs may be reduced by using upgraded conventional tracks for all or part of the network. Much will depend on what already exists and whether it has spare capacity. For instance, in Japan the existing lines were metre gauge with many curves and gradients and not easily upgraded for high speed operation. In Spain, existing lines were broad gauge and difficult to upgrade for high speeds, but the decision to build a new network of standard gauge lines has limited through running to the conventional network to trains capable of changing gauge. Even in parts of Europe, where the existing lines were much more suitable, upgraded lines are not usually used for more than 200 kmph (although 225 kmph might be feasible with new cab signalling). A further consideration is capacity; if lines upgraded for higher speeds have to accommodate existing trains at lower speeds (e.g. freight or regional passenger trains), the increased spread of speeds will actually lower capacity.

What is more common is to build new lines where demand is strongest and capacity most scarce but to use existing lines elsewhere. The French TGV network has been developed along these lines, with new tracks being built for the trunk haul into Paris but trains proceeding to a host of destinations on the old network (some of these destinations are now on extensions of the high speed network). The German ICE network uses upgraded conventional lines for much of its distance with new lines largely confined to overcoming bottlenecks.

In terms of operating cost, it appears that high speed trains are no more expensive than conventional trains when the capital cost of the vehicles is taken into account. Whilst energy consumption and maintenance costs are higher than for conventional trains, high speed means staff and rolling stock can achieve much higher utilisation rates than conventional rail, offsetting the increased costs (Civity, 2013).

Of the external costs of high speed rail projects, noise, global warming and loss of amenity through land take and visual intrusion are the major issues. Noise costs and loss of amenity can be minimised at the expense of additional capital cost, ultimately by tunnelling.

Of these costs greenhouse gases has proved particularly contentious. Other things being equal, energy consumption rises rapidly with speed, particularly at speeds above 300 kmph, so high speed trains may be more energy intensive than conventional trains. Moreover the higher speeds will induce additional traffic that has not simply diverted from other modes. Offsetting this is the fact that high speed trains typically run at much higher load