High-Speed Railways: Do They Produce Economic Growth?

Kenneth Button

MERCATUS RESEARCH

MERCATUS CENTER
George Mason University
3434 Washington Blvd., 4th Floor, Arlington, Virginia 22201
www.mercatus.org

Kenneth Button. "High-Speed Railways: Do They Produce Economic Growth?" Mercatus Research, Mercatus Center at George Mason University, Arlington, VA, March 2017.

ABSTRACT

The debate surrounding the economic benefits of extending the US high-speed passenger rail system beyond the small stretch between Washington, DC, and New York City has abated somewhat but remains of policy interest. One of the justifications advocates cite for high-speed rail (HSR) is that it can provide important stimuli to the national and select regional economies. That argument is difficult to assess in the abstract, but it may be possible to glean some insights by studying systems that operate elsewhere. To that end, this paper examines the information available regarding the world's three largest HSR systems—those of China, Japan, and Spain. The approach is not only to look at the broad effects of those systems on the macroeconomic development of the countries involved but also to consider their more localized, regional implications. The investigation is hindered by fragmented data and data gaps, particularly gaps in data about the financial costs and opportunity costs of HSR systems. What does emerge is that, although politicians and rail enthusiasts have widely supported HSR infrastructure investment as a catalyst for economic development, academic writings abound with considerable skepticism about the economic value of such investment. Furthermore, in virtually all cases, the development argument presented in support of HSR has proved to be overly optimistic, and the anticipated economic growth effects have been minimal or even negative. Where *ex ante* justification has been for a geographical shift of economic activity—typically away from congested to economically deprived locations—the outcomes have seldom been as hoped.

JEL codes: R4, R58, O1

Keywords: high-speed railways, infrastructure, regulation, economic development, investment appraisal, subsidies, network economics, public expenditure

Release: February 2017

Supporters of extending the US high-speed rail (HSR) system beyond the small stretch between Washington, DC, and New York City continue to claim that such extension can produce significant local, and often national, economic growth. This paper examines what has happened in Japan, Spain, and China, countries that have the world's largest HSR systems. The paper focuses on the still very embryonic and fragmented evidence that is available on the narrow economic implications of investment in HSR and largely neglects other claimed potential benefits, such as advancing political cohesion, meeting a need for accessibility, or offering a more environmentally friendly alternative to other forms of transportation. This singular focus is in no way meant to decry the importance of the debates surrounding those latter topics, but the aim of this paper is to help clarify one specific area of interest rather than to indulge in what often has become a confusion of muddled arguments involving double counting and selective data.

By its nature, the topic is not easy to examine. Clear experiments allowing the distinct evaluation of the effect of HSR on economic growth do not exist, nor does any unequivocal way of defining counterfactuals to examine the implications of diverting resources from alternative uses to build HSR tracks. In addition, planning, financing, constructing, and building patronage for a new rail service takes time, and over that period many things can change. Even discussion of a new HSR link can elicit preemptive business decisions and alter related actions of local governments, making it difficult subsequently to establish a baseline against which the consequences of an HSR service can be gauged. HSR rail investments also often are part of a wider package of measures that may have been initiated anyway, making the HSR effect difficult to disentangle.

The situation is not impossible to analyze, however. By making quite conservative assumptions and disentangling, where possible, the genuine economic growth effects of introducing HSR services in situations in which investments have been made, rather than by hypothecating what may happen, analysts may glean some reasonable insights. The three national case studies examined were

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TRANSPORTATION AND ECONOMIC GROWTH

The practical question is whether any handle at all can be put on the broad economic growth effects of high-speed rail investment. A reasonable starting point when looking at any investment is to focus on the financial returns involved if the market were to make the investment. As this paper reveals, those returns often would not support investment in high-speed rail services. That is a legitimate way of considering the gains from an investment: individuals, without being coerced, are putting their own assets into a project, anticipating a financial return from it. The traditional difficulty, and one highlighted by free-market theorist Adam Smith, has been that some investments are too large for private institutions to sufficiently fund and would be unexplored without government direction. To be charitable, one could use that argument to support public financing of high-speed railways. The problem is that it does not explain HSR’s generally poor financial performance; a government investment, using Smith’s reasoning, should earn the same return as an investment by a group of private-sector investors if the latter could be organized.

The contemporary case for using public-sector money (or guarantees, for which government bears the burden of risk) is that markets are imperfect, and those imperfections tend toward suboptimally low investments. Imperfections often cited include imperfect information on the part of investors, monopoly market power of network owners, the public good elements of transportation, and the existence of negative environmental externalities. In the transportation context, publicly subsidized investment often is justified if alternative modes are underpriced, and that is the second-best argument for using public-sector financing. This paper does not reiterate the pros and cons of the plethora of such arguments that are regularly trolled through political debates. The focus of this study is on how the effects of HSR may, in general, be measured and what the implications are for economic growth.

The traditional transportation approach assumes that markets are functioning perfectly—or, at least, that the imperfections are minimal and thus can largely be ignored. That allows the effects of any investment to be measured in terms of the net benefits enjoyed by those making use of the transportation improvements. Transportation user effects include, at a minimum, time savings and direct financial returns.[1] The underlying rationale is that to extend analysis further leads to double counting. For example, including a company's additional productivity as a result of quicker travel times for its employees may simply be mirroring what has been captured in time savings or financial returns associated with the enhanced transportation system.

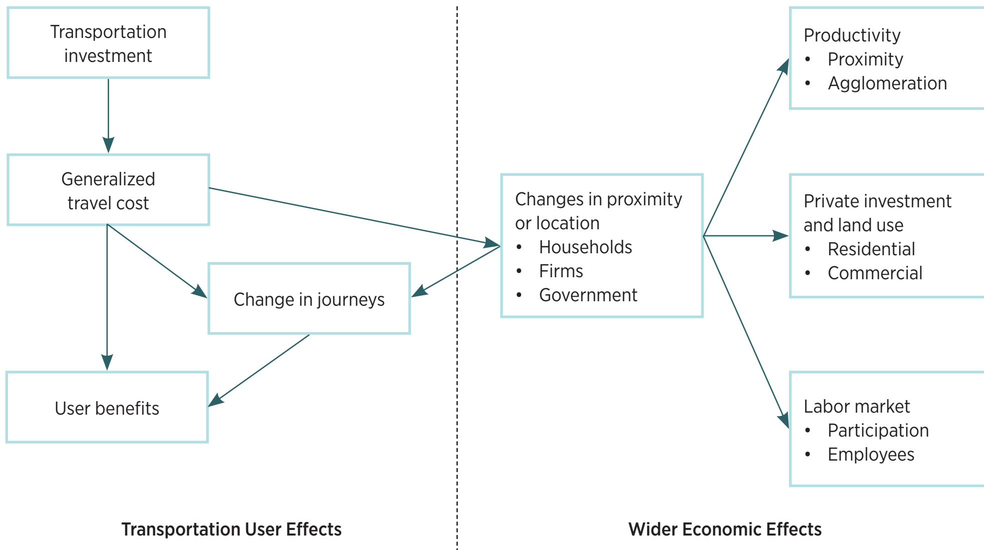
That approach, which underlies most transportation benefit-cost analysis, is, however, partial equilibrium in its orientation. It often seems to ignore wider changes that a major piece of new infrastructure may induce, for example, causing economic growth by shifting the production function in addition to moving along it.

Anthony Venables's work at the World Bank points to the possibility that better transportation brings economic agents closer together and can trigger beneficial relocation of economic activity as firms and households respond to new opportunities.[2] In figure 1, the left segment is the standard transportation benefit assessment whereby transportation investment reduces the costs of access, which generates benefits for its users. The right side shows that better transportation can also, in some circumstances, shape the effective density of economic activity, and thus productivity, in a way not fully captured in the direct effects of faster or cheaper journeys. That type of outcome often is seen as a development effect and should be distinguished from a Keynesian stimulus. The latter is about comparative statics and is concerned with shifting the economy from one level of output to another. Development effects in this context are about producing a higher, sustained increase in GDP.

Transportation improvements can, all else equal, make a different set of locations more attractive for residents, workers, and firms, inducing investment

1. Some care must be exercised in doing even this. Most HSR systems engage in price discrimination, resulting in many of the time savings benefits being captured in fare revenues.
2. Anthony Venables, "Incorporating Wider Economic Impacts within Cost-Benefit Appraisal" (Discussion Paper No. 2016-05, Organisation for Economic Co-operation and Development, Paris, 2006).

FIGURE 1. THE VARIOUS EFFECTS OF TRANSPORTATION CHANGES



Source: Anthony Venables, "Incorporating Wider Economic Impacts within Cost-Benefit Appraisal" (OECD Discussion Paper 2016-05, Paris, 2006).

and changes in land use. Those changes may generate agglomeration and productivity effects. In particular, they may allow economies of scale to be realized and gains from specialization to be reaped. Labor supply may also be changed, on the supply side, with transportation enhancement enabling greater and more efficient labor force participation. The demand side carries a caveat, however: that although jobs will be created in some places, jobs may be lost in others. Further, in most cases, much of the traffic using new transportation services, such as HSR, is transfer traffic from other modes serving the same origins and destinations. Although transportation users will gain from that change, it will cause less of a shift in resources than will HSR routes in new geographical areas. In summary, the changed transportation system will have both trade creation and trade diversion effects.

Broad estimates of the relative sizes of the transportation and wider economic implications of major infrastructure investments are, because of their diversity, difficult to make. What we do know is that, in general, they are not that large. In a meta-analysis of about 563 estimates, Melo, Graham, and Brage-Ardao found that transportation has a very small effect on productivity; a 10 percent increase in public investment leads to only a 0.5 percent increase in output.[3] When including such effects for specific investments, however, the devil lies in the details, as Venables recognizes: "Incorporating wider economic impacts in CBA [cost-benefit analysis] is challenging and has its own risks. Broadening the set of mechanisms that are studied creates the risk that bad arguments may appear to be legitimized, and that effects can be exaggerated. Studies tend to concentrate on areas where a transportation improvement expands economic activity, and to ignore areas from which this activity may have been displaced." Implicit in that concept is the very serious possibility that improvements enjoyed by the transportation users of the infrastructure and paid for by those users are double counted as wider economic benefits.

Considering the narrow HSR transportation effects, attempts have been made to define thresholds above which HSR would emerge as viable from a narrow, transportation perspective. The results are remarkably similar. Gines de Rus and Gustavo Nombela, using European engineering data combined with revenue- and time-saving benefits, conclude that the first-year patronage would have to be from 8 to 10 million passengers on a 310-mile route, generally taken as the optimal distance for HSR, to make HSR competitive with alternative transportation modes.[4] Roger Vickerman, also focusing on patronage, finds that a demand for between 12 and 15 million passengers is needed for commercial viability.[5] Those findings are also broadly in line with those of Peter Hall, who, taking a more geographical approach, found HSR viable only "between major urban agglomerations with over one million population . . . [when] such agglomerations are disposed along linear corridors, with cities spaced at approximately 125-mile intervals."[6] The Commission of the European Union reaches similar conclusions: "only exceptional circumstances (i.e., a combination based on low construction costs and time savings) may justify a new high-speed line with a passenger minimum volume of 6 million users in the initial year. With normal construction costs and standard time savings, a demand of 9 million is probably

3. Patrica C. Melo, Daniel J. Graham, and Ruben Brage-Ardao, "The Productivity of Transport Infrastructure Investment: A Meta-analysis of Empirical Evidence," *Regional Science and Urban Economics* 43 (2013).
4. Gines de Rus and Gustavo Nombela, "Is the Investment in High-Speed Rail Socially Profitable?," *Journal of Transport Economics and Policy* 41 (2007): 3–23.
5. Roger Vickerman, "High-Speed Rail in Europe: Experience and Issues for Future Development," *Annals of Regional Science* 31 (1997): 21–38.
6. Peter Hall, "High-Speed Trains and Air: Competitive or Complementary?" (paper presented at the Lake Arrowhead Transportation Symposium, 1999).

necessary."[7] If those were the criteria actually adopted, few HSR systems would ever be constructed.

THE NATURE OF HIGH-SPEED RAILWAYS

The idea that fast railways have benefits beyond those immediately enjoyed by travelers is certainly not new. A fairly typical view is that "the close relationship between railroad expansion and the general development and prosperity of the country is nowhere brought more distinctly into relief than in connection with the construction of the Pacific railroads."[8] Railway technology changes, however, and even if that view is true, its validity has varied over time.

The definition of HSR is malleable and has changed depending on the technology of the historic period being considered and the underlying politics of its context. It can also vary by country.[9] Technology is obviously a constraint to speed and has affected definitions of HSR over time. It has, for example, moved forward considerably since the opening of the first inter-city railway in 1830 between Liverpool and Manchester in England. At that time, 20 miles per hour (mph) was "high speed." Subsequent technology advances allowed operating speed to reach more than 65 mph by 1900.

Today, HSR has no global definition. It is broadly defined as a type of rail transportation that operates significantly faster than traditional rail traffic, usually using an integrated system of specialized rolling stock and dedicated tracks. Countries vary as to what "faster" means, but new lines in excess of 155 mph and existing lines in excess of 125 mph are widely considered to be high speed. Many systems, as discussed herein, exceed those minima.

Although many of the physical changes are clearly visible to anyone looking at the locomotives and carriages, many other changes extend well beyond those modes of transport and add to the costs of HRS. In terms of infrastructure, for example, because track tends to separate, the original laying of track in the 1830s on individual stone blocks—not the engine—was the main constraint on speed. Modern high-speed rail track (a) is laid on sleepers of steel or plastic to tie it together, (b) is welded to prevent cracking at joints and to allow for

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7. European Commission, *Guide to Cost-Benefit Analysis of Investment Projects* (European Commission, Brussels, 2007).
8. John Moody, *The Railroad Builders: A Chronicle of the Welding of the States* (New Haven: Yale University Press, 1919).
9. Kenneth J. Button, "Is There any Economic Justification for High-Speed Railways in the United States?," *Journal of Transport Geography* 22 (2012): 300–302.

the contraction and expansion associated with variable climatic conditions, (c) is cambered at turns to stop train displacement, (d) involves grade separation to remove junction problems, and (e) is electronically monitored to detect damage. Institutionally important, high-speed rail services use a standard gauge of track that allows for international running of trains.

High-speed rail is, in addition, an intelligent transportation system in the sense that it makes extensive use of modern information systems to monitor and control operations and to refine prices to achieve revenue targets. That capability is particularly important when the high-speed system shares infrastructure with other rail services. Without such technology, considerable constraints would be placed on speeds on both dedicated rail track and shared track, most notably the latter.

DIFFERENT FORMS OF HSR SYSTEMS

Different geography, history, economics, and political priorities mean that HSR systems differ considerably by country. Figure 2 illustrates details of the situation in Europe and East Asia (excluding some lines into the hinterland of China), highlighting not only the geography of the systems but also the engineering differences in terms of attainable speeds. A key difference in Spain's HSR and those of Japan and China is that Spain's is part of a much larger European system, whereas the East Asian systems are separate entities, unconnected to other national systems. The roles of East Asia's HSRs are thus much more oriented to the internal economies of the countries involved than to integration of economies within any larger economic block.

Geographically, Spain is in many ways like the 48 contiguous states of the United States in that it is basically rectangular in shape, with concentrations of population and economic activity at the center and in the corners. That layout is conducive to hub-and-spoke networks because of the ability to use the central location (in Spain, Madrid) as a hub

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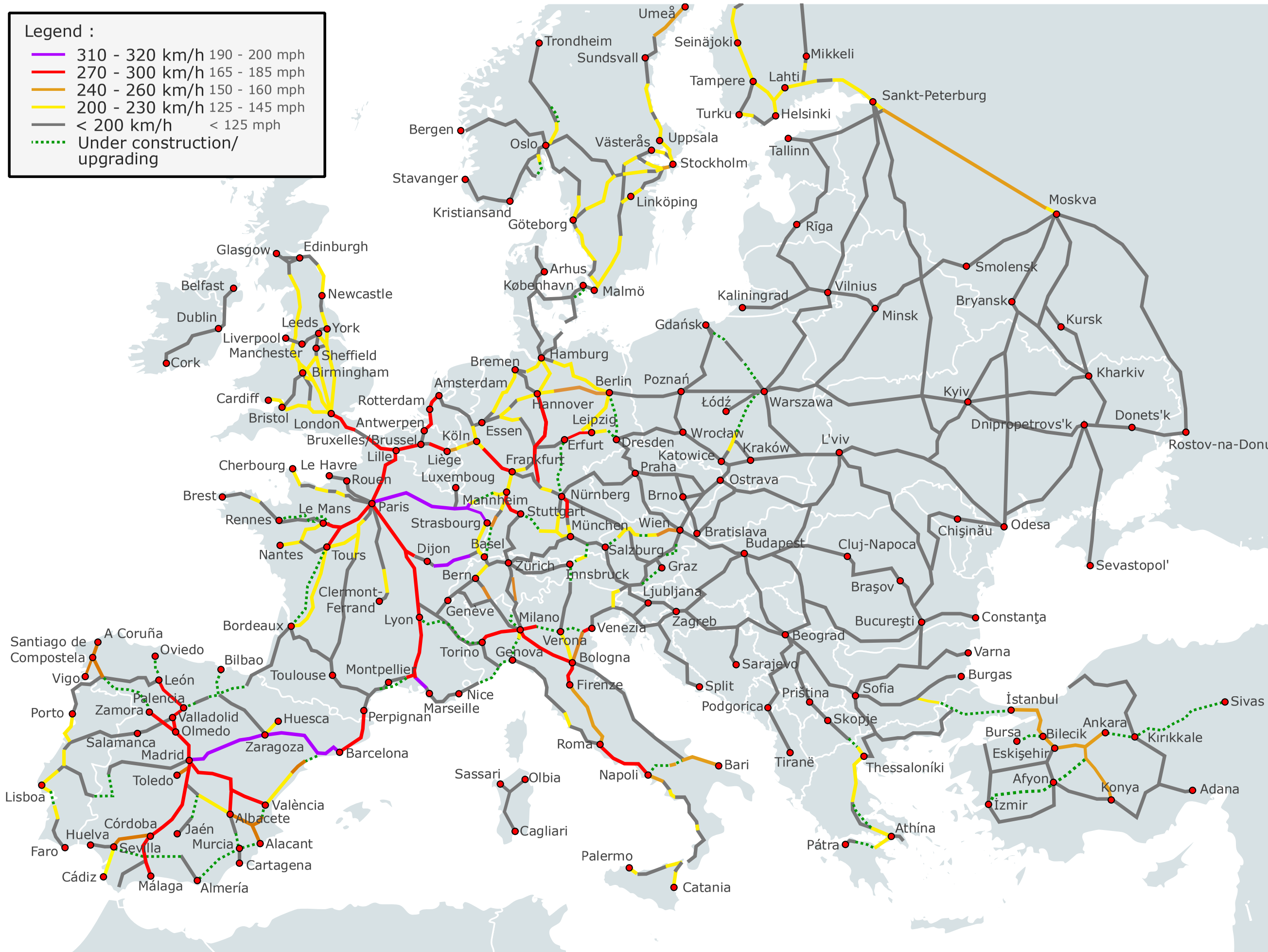
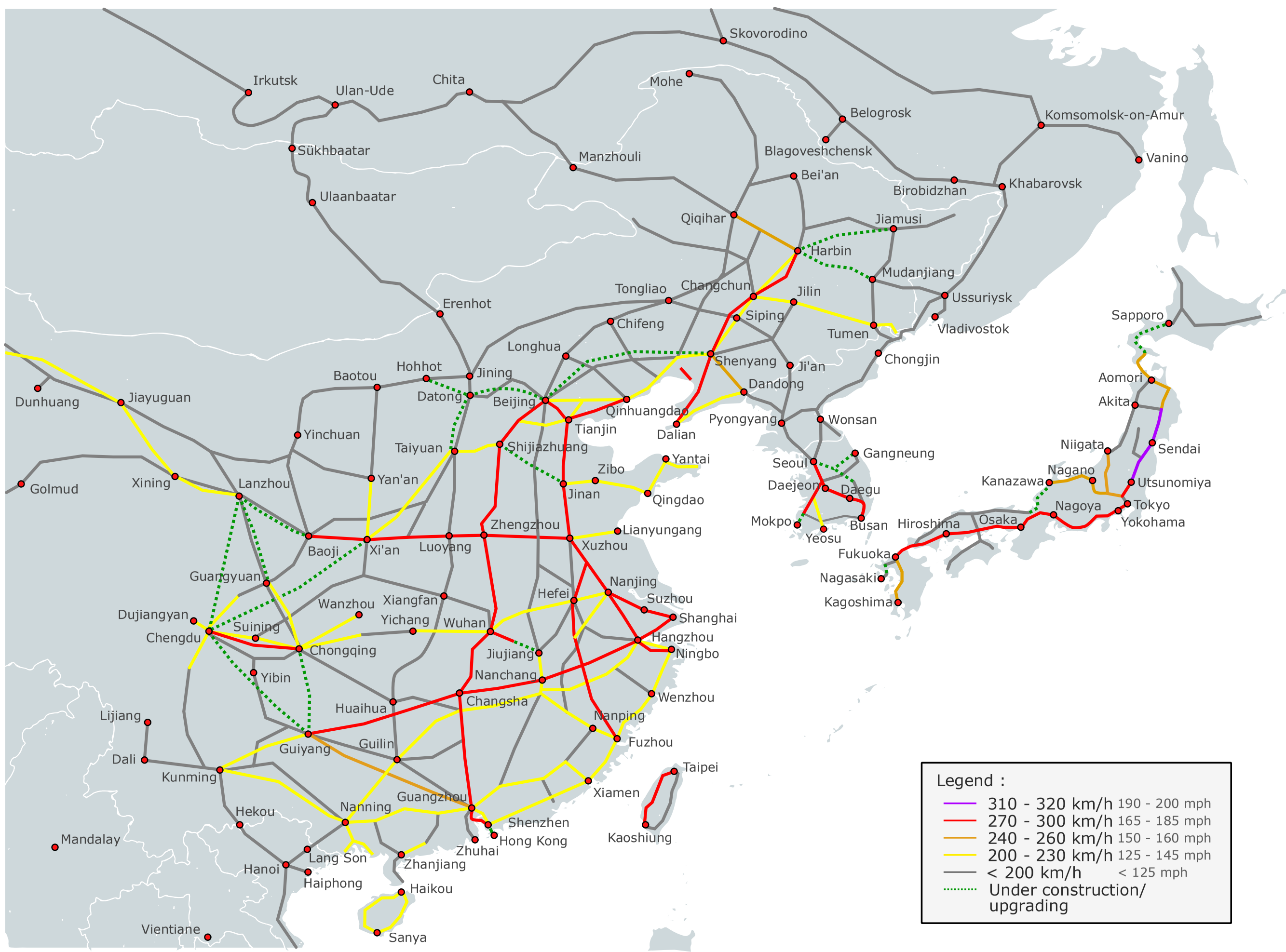
FIGURE 2. OPERATIONAL HIGH-SPEED RAIL SYSTEMS IN EUROPE AND EAST ASIA





Source: Image by Bernese media in *Wikipedia*, s.v. "High-Speed Rail in Europe," last modified February 17, 2017; image by FlyAkwa in *Wikipedia*, s.v. "High-Speed Rail in Asia," last modified January 24, 2017. These crowd-sourced maps showing regional high-speed rail systems are updated regularly.

to maximize economies of density and scope. The hub is used for interchanging passengers traveling between the various centers around the edge of the rectangular market.

In contrast, although the Tokyo metropolitan area is by far the largest city in Japan, much of the remainder of Japan's population is concentrated along its southern coast, making linear rather than hub-and spoke services more efficient. Trains pick up and drop off passengers at stations along routes to generate scope and density efficiencies. China's economy is in many ways akin to that of the European Union, with most of its activities and population bunched in a highly congested part of its geography in the southern and eastern areas of the country. Such a layout favors rail services radiating from a number of base cities as the most efficient system. Indeed, those are the patterns of services supplied by airlines, the main competitor to HSR in the three cases considered in this paper. Airlines and HSRs display similarities and differences, however. Both have the spatial economic development feature that when they do stimulate economic growth, it is around their nodal points—not along the links, which provide de facto zero accessibility to either form of transportation. Indeed, in that context, the French economist Alain Bonnafous once argued that the TGV, France's HSR system, should be seen as a low-flying Airbus. Although that is a nice, succinct analogy, the problem is not newly appreciated. About 25 years ago, geographers Klaus Spiekermann and Michael Wegener put it very simply: "High-speed infrastructure connects only important cities, but not the space in between them."[10]

But to talk of HSR "networks" as is done with airlines is often misleading; indeed, that is why the moniker "HSR systems" is used throughout this paper. Networks imply interconnectivity of a hub-and-spoke nature, with users enjoying the interoperability of being able to, in the case of HSRs, change trains to reach a variety of destinations. That is the concept underlying airline hub-and-spoke networks. To make that concept attractive, the overall time penalty of changing trains, as opposed to taking a direct service, must be relatively small in terms of both link and transfer times. Although that is often true for airlines, as we see in the following examples, it is seldom the case with HSRs. HSRs are simply not fast enough—even over links of 250 to 300 miles or so, their generally claimed optimal range—to make one-stop rail trips of about 500 miles attractive. Thus, although many national HSR systems have centroids, they seldom serve the same sort of hubbing functions found with traditional airlines. Rather, they

10. Klaus Spiekermann and Michael Wegener, "The Shrinking Continent: New Time-Space Maps of Europe," *Environment and Planning B* 21 (1994): 653–73.

have features of the radial systems with "bases" used by such low-cost airlines as Ryanair, with which they increasingly compete.

THE MAIN HSR SYSTEMS

As stated previously, China, Japan, and Spain have the three largest HSR systems by network length, although not by patronage. The three systems differ, however, in form and in their economics.

Japan

The Japanese Shinkansen system established the modern approach to high-speed rail. With some 45 million people living in the densely populated Tokyo-to-Osaka corridor, congestion on roads and railways became a serious problem after World War II, and the government began considering a new HSR service. Japan in the 1950s was a populous, resource-limited nation that—for security and economic reasons—did not want to import petroleum but needed a way to transport its millions of people between its largest cities. The country also was reluctant to give any indication that it was trying to develop military air power by building up its domestic airlines.

The original Japanese railways generally used narrow-gauge rails, but the increased stability offered by widening the rails to standard gauge promised to make very high-speed rail travel much simpler; thus standard-gauge rail was adopted for high-speed services. The Shinkansen service would provide a new alignment, 25-percent wider standard gauge, continuously welded rails between Tokyo and Osaka using rolling stock designed for 155 mph (although limited initially to 130 mph for safety reasons). It also would be built in a corridor of a length and terrain highly suited to HSR. Japan's first HSR system, the Tōkaidō Shinkansen, was opened in time for the 1964 Olympic Games.

Within three years, more than 100 million passengers had used the trains, and the HSR system reached the milestone of its first billion passengers in 1976.[11] In 1972, the line was extended 100 miles, and further construction resulted in the system's expanding to 1,626 miles by 2015, with a further 341 miles of extensions currently under construction and due to open in stages between March 2016 and 2035 (table 1). The cumulative patronage on the entire system since 1964 is

11. A billion is measured throughout on the short scale, as used by the United States (that is, 10^9), not the long scale (10^{12}) used by most of the rest of the world on the metric system.

TABLE 1. THE MAIN JAPANESE SHINKANSEN LINES

Origin/destination	Miles	Opened	Passengers in 2011 (millions)
Tokyo/Shin-Osaka	320	1964	143.0
Shin-Osaka/Hakata	344	1972–1975	64.4
Tokyo/Shin-Aomori	419	1982–2010	76.2
Ōmiya-Niigata	168	1982	34.8
Takasaki-Kanazawa	215	1997–2015	9.4
Hakata/Kagoshima-Chūō	160	2004–2011	12.1
Shin-Aomori/Shin-Hakodate-Hokuto	93	2016	

Source: Japanese Ministry of Land, Infrastructure and Transport, Rail Transport Statistics (Tokyo, 2011).

more than 10 billion people, the equivalent of approximately 150 percent of the world's current population, without a single accident-related passenger fatality.

Since their introduction, Japan's Shinkansen lines have been undergoing constant improvement that has increased not only the lines' speeds but also their length. More than a dozen train models have been produced, addressing diverse issues such as tunnel boom noise, vibration, aerodynamic drag, lines with lower patronage ("Mini Shinkansen"), earthquake and typhoon safety, braking distance, problems resulting from snow, and energy consumption (newer trains are twice as energy efficient as the initial ones despite traveling at greater speeds).

In an effort to enhance efficiency, in 1987 Japan's national railways were divided and privatized into seven for-profit companies (one being freight only). JR East, the largest by passenger numbers, does not require any public subsidy from the Japanese government. One reason for its efficiency is that JR East owns all the infrastructure on the route—the stations, the rolling stock, and the tracks—meaning that fewer management teams duplicate work. The railway also thrives because of a planning system that encourages the building of commercial developments and housing alongside the railway route. JR East owns the land around the railways and leases it; nearly one-third of its revenue comes from shopping malls, blocks of offices, flats, and the like.

Geography has influenced the rail system's development: most of Japan's 128 million inhabitants live in a few densely populated cities along the country's coastline. By linking those dense populations together—nearly 40 million people in greater Tokyo with the 20 million residents of Osaka, Kobe, and Kyoto—the railway helped to shift business patterns, making day trips between Tokyo and Osaka possible. From a purely practical perspective, other modes could likely not handle the sheer volume of traffic on the Tokyo–Osaka corridor. Many HSR customers also are from higher income brackets and are willing to pay for more expensive high-speed tickets rather than use road alternatives.

Spain

Supported by European Union (EU) and national subsidies, by 2015, Europe had added more than 3,700 miles of HSR track to the 620 miles that existed in 1990, and more construction is planned. For example, by 2017, no fewer than four new French lines will begin operations. The EU also intends to finance a $5.3 billion HSR link between Estonia, Latvia, Lithuania, and Poland. Against that background, the Spanish HSR system has developed.

In 1992, and in time for the Barcelona Olympic Games and Seville Expo '92, the Madrid–Seville high-speed rail line opened. The Alta Velocidad Española (AVE) system has subsequently been developed rapidly, with financial support from the EU. Its construction has coincided with periods of serious economic crisis, with some potential interaction between the two.[12] The Madrid-centric system grew rapidly in the early years of the 21st century (table 2), and in 2005, the Spanish government announced policy plans that by 2020, 90 percent of the population of the country would be living within 30 miles of an AVE station, irrespective of the costs or economic returns. As of 2015, the AVE had reached 1,900 miles and is now the largest system in Europe, surpassed globally only by China's.

Traffic on Spain's HSR falls well short of the volume on other major HSR systems; it is only about 5 percent of Japan's and 10 percent of France's. To become the world's second longest system, Spain has invested more than $50 billion in completed infrastructure and has allocated $1.5 billion more to lines currently under construction. That is about 4 percent of Spain's GDP, although about $11 billion has been funded over the years by grants from the European Union, and even more has been obtained by soft loans through different transfer programs. In relative terms, consulting firm A.T. Kearney found Spain's HSR to be a cheap HSR system, costing about $9.5 million per mile—a cost comparable

12. For discussions of the development of the Spanish HSR system, see papers in José M. de Ureña, ed., *Territorial Implications of High Speed Rail: A Spanish Perspective* (Farmham, UK: Ashgate, 2012); Carmen Bellet, "The Introduction of the High-Speed Rail and Urban Restructuring: The Case of Spain" (Lleida, Spain: Department of Geography and Sociology, University of Lleida, 2009); and Javier Campos, Gines de Rus, and Iñaki Barron, *A Review of HSR Experiences around the World* (Munich: Fundación BBVA, 2007). Although EU funding may be seen as an external subsidy, Spain is the fourth largest economy in the Union, thus part of the funding is de facto a transfer of Spanish funds back to Spain.

TABLE 2. THE DEVELOPMENT OF THE SPANISH HIGH-SPEED RAIL SYSTEM

High-speed rail line (by cities)	Year of coming into operation
Madrid–Córdoba–Sevilla	1992
Madrid–Guadalaja–Calatayud–Zaragoza–Lérida	2003
Madrid–Toledo	2005
Córdoba–Antegona	2006
Lérida–Tarragona	2006
Antequerra–Málaga	2007
Madrid–Segovia–Valladolid	2007
Tarragona–Barcelona	2008
Madrid bypass (Sevilla–Barcelona)	2009
Madrid–Cuenca–Valencia	2010
Cuenca–Albacete	2010
Ourense–Santiago de Compostela	2011
Santiago de Compostela–A Coruña	2011
Barcelona–Gerona–Figueres	2013
Albacete–Villena–Alicante	2013
Madrid–Segovia–Olmedo–Zamora	2015
Vigo–Pontevedra–Santiago de Compostela	2015
Valladolid–Venta de Baños–Palencia–León	2015
Sevilla–Jerez de la Frontera–Cádiz	2015

Source: Based on "Infraestructuras y estaciones: Líneas de alta velocidad," ADIF, accessed February 21, 2017, www.adif.es/es_ES/infraestructuras/lineas_de_alta_velocidad/lineas_de_alta_velocidad.shtml.

to France's and less than Germany's ($15 million per mile), Italy's ($45 million), and Japan's ($33.5 million), although land costs and geography account for a large part of the differences.[13]

Efforts have been made to develop public-private partnerships, but they have met with little success. In 2005, various parties agreed to invest in an HSR service between Perpignan in France and Figueres in Spain. It was financed with $700 million in tax funds from the governments and the EU, with the balance of $500 million as loans from a group of Spanish banks. TP Ferro, involving Eiffage (France) and ACS (Spain), was awarded a 53-year concession to build and operate the infrastructure and to be paid fees for its use. Service began in 2009, but the forecast traffic of 19,000 trains per year had reached only 800 by 2015. Receivers were called in September 2015 when debt to the banks could not be met. The two governments will take over the bankrupt project company,

13. A.T. Kearney, "Contribución de las infraestructuras al desarrollo económico y social de España," September 2015.

assume responsibility for paying the bank loans, and operate it as a binational government enterprise.

The motivations underlying the development of an HSR system in Spain seem to have little do with mobility or economic development and more to do with solidifying the political power of Madrid, from which the main lines radiate.[14] Linked to that motivation, the system also serves all the regional capitals, irrespective of their population size. Indeed, there is little evidence that any benefit-cost calculations—even in the broadest sense—were being conducted regarding the development effects of the system.

China

The Chinese "economic miracle" is generally traced to the economic reforms of 1978 that allowed more market-based activities in the country.[15] State planning for HSR began in the early 1990s, and the first line, the Qinhuangdao–Shenyang Passenger Railway, opened in 2003. By 2008, high-speed trains were running at up to 217 mph between Beijing and Tianjin as part of the infrastructure development of the Beijing Summer Olympic Games, and in 2009, trains on the new Wuhan–Guangzhou High-Speed Railway set a world record average speed of 194.2 mph for the 601-mile trip.

A collision of high-speed trains in July 2011 in eastern China, which killed 40 people and injured 195, raised concerns about safety, and a financial crisis later in the year slowed the construction of new lines. By 2012, though, the high-speed rail boom had renewed, with new lines and new rolling stock by domestic producers that had indigenized foreign technology. In December 2012, China opened the world's longest high-speed rail line, which runs 1,372 miles from the country's capital, Beijing, in the north to Shenzhen on the south coast. China had nearly 12,000 miles of high-speed rail in 2015, or about 65 percent of the world's total. The system is still rapidly expanding to create the so-called 4+4 National High Speed Rail Grid, with tentacles spreading away from the south and west to less populated regions in the hinterland of the country.

The system is heavily used (table 3), although it is expensive for passengers compared with the much slower, low-fare, conventional rail network. The fares, although low by international standards, are relatively high despite significant

14. Daniel Albalate and Germa Bel, *The Economics and Politics of High-Speed Rail: Lessons from Experiences Abroad* (Lanham, MD: Lexington Books, 2014).
15. For details of the development of the Chinese system, see Zhenhua Chen and Kingsley E. Haynes, *Chinese Railways in an Era of High-Speed* (Bingley, UK: Emerald, 2015).

TABLE 3. HIGH-SPEED PASSENGER RAIL TRAFFIC GROWTH IN CHINA

Year	Ridership (millions)	Percent change per year
2007	61.21	–
2008	127.73	+108.7
2009	179.58	+40.6
2010	290.54	+61.8
2011	440.00	+51.4
2012	486.00	+10.4
2013	672.00	+38.3
2014	893.20	+32.9

Source: Bao Xingan, "Railway Investment in 2014 to 808.8 Billion Yuan to Complete the Full Year Plan," www.CCStock.cn, January 30, 2015, http://www.ccstock.cn/finance/hongguanjingji/2015-01-30/A1422549977766.html.

operating and capital subsidies. The official line for the capital subsidies is that HSR is a quasi-public good and thus would be undersupplied without appropriate government support. About 40 to 50 percent of the system's investment financing is provided by the national government through loans from state-owned banks and financial institutions, 40 percent comes from bonds issued by the Ministry of Railway, and the remainder is provided by provincial and local governments.

The development of high-speed rail has forced the once highly inefficient domestic airlines in China to slash airfare and cancel regional flights. The effect of high-speed rail on air travel is most acute for intercity trips of less than 310 miles. By 2011, airline service had been halted on previously widely used routes, including Wuhan–Nanjing, Wuhan–Nanchang, Xi'an–Zhengzhou, and Chengdu–Chongqing. Flights on routes of more than 900 miles generally are unaffected by HSR, with competition continuing over intermediate distances. That consequence should be taken in the context of a relatively underdeveloped low-cost carrier airline market in China and subsidized HSR fares.

ECONOMIC DEVELOPMENT OUTCOMES

Rail investments are long term, and their implications for economic development are difficult to isolate in a continually changing world. Certainly, in the past skeptics have been unconvinced by the role that railways can play in economic development. Not least of those skeptics was Nobel Prize winner Robert Fogel, who famously said, "Despite its eventual ubiquity in inland transportation, despite its devouring appetite for capital, despite its power to determine the outcome of commercial (and sometimes political) competition, the railroad did

TABLE 4. HIGH-SPEED RAIL AND AIRLINE COMPARISONS ON SELECTED ROUTES

Route	High-speed rail	Low-cost airline
Barcelona–Valladolid	$83.00 (6 hours, 48 minutes)	$44.12 (1 hour, 30 minutes)
Barcelona–Santiago de Compostela	$86.00 (12 hours, 28 minutes)	$50.20 (1 hour, 55 minutes)
Barcelona–Seville	$146.00 (5 hours, 15 minutes)	$74.49 (1 hour, 50 minutes)
Madrid–Santiago de Compostela	$49.00 (5 hours, 19 minutes)	$20.64 (1 hour, 20 minutes)
Madrid–Barcelona	$83.00 (2 hours, 50 minutes)	$70.00 (1 hour, 20 minutes)

Source: Data from websites of the railways and airlines serving these routes.

not make an overwhelming contribution to the production potential of the [US] economy."[16] Added to this, since its introduction in 1830, the commercial railroad business has been prone to successive cycles of crises, as capacity has failed to be in sync with demand. So even if there were a link between economic growth and rail infrastructure, one could argue that the indicators of that link may take time to emerge. However, if serious potential were associated with HSR, then one would anticipate some positive effect quite quickly. Otherwise, a case for postponement is strong.

Academics have generally exhibited a fairly healthy skepticism over many of the *ex ante* projections regarding the development effects of HSR. In many cases, investments have provided much lower returns than forecast and, often, negative net gains. The doubts of academics concern both the level of development benefits from HSR and its geographical distribution.[17]

Focusing initially on the costs that users pay for HSR services, table 4 provides some very rough-and-ready computations of the journey times between Spanish airports and between HSR stations and the fares charged. The fare discrimination used by both modes inevitably makes anything but broad comparisons challenging. The HSR routes are selected by design to involve a change of train, vary in length, and have modal competition from low-cost air carriers. In Spain, that represents the reality. The change of train reflects that longer routes, where air services are viable, are not served by direct HSR services. The main competition is between direct air and indirect HSR services. The services listed are one-way, web-cited services accessed on July 17, 2016, for an economy trip on August 16, that begins about 9 a.m. and covers only the air or HSR part of each

16. Robert W. Fogel, *Railroads and American Economic Growth: Essays in Econometric History* (Baltimore, MD: Johns Hopkins Press, 1964).
17. For a broad survey of work in this area, see Anastasia Loukaitou-Sideris et al., "Tracks to Change or Mixed Signals? A Review of the Anglo-Saxon Literature on the Economic and Spatial Impacts of High-Speed Rail," *Transport Reviews* 33 (2013): 617–33.

trip; the costs and times of access to and egress from terminals are absent. To try to reduce some of the distortions from subsidies, the routes were selected because at least one of the airports on each route is profitable.[18]

Despite the array of caveats that must surround these data, airlines clearly can be both cheaper and faster between terminals than is HSR, thus any other advantage enjoyed by rail users because of HSR attributes will be relatively small. The implications for that conclusion are that even if HSR has development benefits exceeding those measured as transportation user gains, they will not be of any significant size.

Traffic generated by HSR services—traffic important in terms of developing agglomeration economies—has varied in magnitude but often is relatively small. In Japan, for example, 6 percent of the traffic on the Sanyo Shinkansen was newly generated, 55 percent came from other rail lines, 23 percent from air, and 16 percent from intercity bus. In other words, although HSR rail services have attracted new passengers, the diversion from other modes can be substantial. Mode switchers, although enjoying possible transportation benefits, do not produce much in the way of agglomeration economies because they are already making the same journey, and the HSR has no relocation implication for them. Among the limited details we have from China is an assessment of the Nanguang and Guiguang services that began operating in 2014 and that reduced rail travel times between their respective origins and destinations from 13 to 3 hours and from 21 to 4. The assessment found, however, that many of the travelers would have made the journey anyway—64 percent of Guiguang passengers said they would have made the trip anyway, as did 82 percent of Nanguang passengers. Of the newly generated traffic, only 15 percent of travelers using the Guiguang service and 30 percent of those using the Nanguang service were doing so for business.[19]

In some cases, of course, and for a variety of reasons (such as serious congestion at airports, as with Heathrow, London, or because the routes are suboptimally short for air travel, as with Paris to Brussels), HSR has taken market shares from airlines, although with considerable subsidies. Examples include Madrid–Seville (rail, 83 percent; air, 27 percent), Paris–London (rail, 81 percent;

18. These data clearly omit travel costs and time to and from stations and airports at both ends of the trips. Given the vast diversity of origins and final destinations of trips, to include those data would require large surveys. What is clear is that assuming that HSR has an advantage because its stations often are closer to city centers is far too simplistic. Many jobs and homes are located well away from the city centers, and access to the nearest airport—because traffic is less congested—may be easier than to a city center HSR terminal.
19. Nanyan Zhou et al., *High-Speed Railways in China: An Update on Passenger Profiles* (World Bank Report 102815, Washington, DC, 2016).

air, 17 percent), and Paris–Brussels (rail, 95 percent; air, 5 percent). Often, however, HSR simply causes a transfer from traditional railways. Between 2000 and 2011, as high-speed lines opened across the European Union, rail's overall share of passenger-miles traveled changed little, by 6.4 percent in 2011. Cars' share had barely changed, at 72.5 percent. Buses lost a percentage point, to 8.2 percent, and airlines, excluding flights to outside the EU, gained more than a point, to 8.9 percent.[20]

In terms of figure 1, all this would seem to imply that the travelers' benefits from enhanced transportation on a route, shown on the left-hand side of the figure, are not large; therefore, the wider economic spillover effects to the economy, shown on the right side, are likely to be limited.

THE EFFECTS ON REGIONAL EQUITY

High-speed rail projects often run into trouble when they are sold on a promise of promoting regional equity and reducing congestion in what are seen as overheating regions; the term *regional rebalancing* has become central to the rhetoric associated with that idea. Evidence, however, suggests the opposite can often be true. To quote economist Diego Puga, "Road and rail tracks can be used to travel both ways. A better connection between two regions with different development levels not only gives firms in a less developed region better access to the inputs and markets of more developed regions, it also makes it easier for firms in richer regions to supply poorer regions at a distance, and can thus harm the industrialisation prospects of less developed areas."[21]

The Shinkansen system, for example, delivers much of Japan's workforce to Tokyo, but, as we see later, has done little to spread employment away from the capital. In terms of overall economic growth, evidence from 1997 indicates

"The Shinkansen system . . . delivers much of Japan's workforce to Tokyo, but, as we see later, has done little to spread employment away from the capital."

20. *Economist*, "High-Speed Rail in Europe: Problems Down the Line," January 10, 2015.
21. Diego Puga, "European Regional Policies in Light of Recent Location Theories," *Journal of Economic Geography* 2 (2002): 373–406.

that HSR had not necessarily contributed to long-term regional dispersion of economic activities.[22] Although the cities served by it grew at a faster pace than did those excluded, the HSR routes had been designed taking into consideration expected growth, independently of its effects. Faster growth happened, therefore, where it was already expected even before the line was planned or built.

When the Paris-to-Rhone Alps line was introduced to France's TGV system, train travel to Paris increased by 144 percent in terms of the base of the travelers, but travel in the opposite direction grew by only 54 percent. The projection had been that the rail line would lead to a dispersion of economic activity away from the heavily congested Île-de-France. The situation was summed up by John Tomaney in evidence he gave to the UK House of Commons relating to the idea of investing in more HSR in the UK: "Following our review of the international peer-reviewed and other literature . . . there are compelling reasons to doubt whether HSR will contribute to 'rebalancing regional economies.'"[23]

From an *ex ante* assessment perspective, much of the excessive optimism that has accompanied many infrastructure projects seems to have come from a combination of serious underestimation of the final financial costs and serious overoptimism concerning the ultimate use. Although those issues are found across the board in transportation analysis, the assessment of fixed track infrastructure, including HSR, is particularly prone to flawed estimations.[24] The reasons, although partly a reflection of the technical challenges of economic forecasting in general, also seem to be the result of political bias favoring high-profile, high-cost projects, with rail projects having a particular appeal to decision makers.

From the macroeconomic perspective, the economic effects are difficult to isolate but include the following: First, HSR is a small element of any overall economy or, indeed, any national transportation system. Second, HSR rail investments, and thus their effects, appear over a number of years. Third, the counterfactual of not having HSR is difficult to define, let alone estimate. Fourth, the quality of management of HSR systems varies. Finally, the demands for transportation and its characteristics continually change.

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22. Komei Sasaki, Tadahiro Ohashi, and Asao Ando, "High-Speed Rail Transit Impact on Regional Systems: Does the Shinkansen Contribute to Dispersion?," *Annals of Regional Science* 31 (1997): 77–98.
23. Written evidence from John Tomaney, professor of urban and regional planning at University College London, *The Local and Regional Impacts of High Speed Rail in the UK: A Review of the Evidence*, House of Commons Session 2010-12, HSR-2.
24. Examples regarding costs include Bent Flyvbjerg, Mette K. Skamris Holm, and Søren L. Buhl, "What Causes Cost Overrun in Transport Infrastructure Projects?," *Transport Reviews* 24 (2004): 3–18; and of demand include Bent Flyvbjerg, Mette K. Skamris Holm, and Søren L. Buhl, "Inaccuracy in Traffic Forecasts," *Transport Reviews* 26 (2006): 1–24.

From a policy perspective, if the aim is to aid slower-growing, lower-income regions, then the best approach in many cases would be to focus on factors other than good-quality access. In the wider European context, and echoing Puga, Andrés Rodríguez-Pose and Ugo Fratesi argue,

> Since . . . roads, railways, and telecommunication systems run in two directions, a strategy strongly skewed towards specific regional characteristics that are at the root of the development of infrastructure in regions with relatively vulnerable local production structures, weak entrepreneurship levels and technological base, and an often weaker human capital endowment, may solve an important development bottleneck and reduce the infrastructural gap with the rest of the EU, but may leave these regions more exposed to competition from stronger and more technologically advanced firms in core areas. Spain provides an example of where this mechanism may already be at work. The large amount of recent investment in transport infrastructure in Objective 1 regions devoted to the construction of road and high-speed rail links between the periphery of the country and Madrid has probably helped to boost the phenomenal growth rates that Madrid has experienced in the second half of the 1990s. But it has also left many of the Objective 1 regions, whose economic prospects rail-links were supposed to increase, struggling to catch-up.[25]

GEOGRAPHICAL SPREAD OF ECONOMIC DEVELOPMENT

The low-flying Airbus effect of HSR lines on the spread of the economic success noted earlier is clear from the experiences of HSR in the three countries examined. Basically, cities not served by HSR, or those served by HSR but peripheral to central cities, will usually gain no significant benefits from HSR. That picture is fairly clear from the experiences of Japan. For example, Robert Cervero found that although the Tokyo–Osaka Shinkansan line had limited effects for employment and job movement, it did strengthen the relative economic positions of Tokyo

25. Andrés Rodríguez-Pose and Ugo Fratesi, "Between Development and Social Policies: The Impact of European Structural Funds in Objective 1 Regions," *Regional Studies* 38 (2004): 97–113. The European Union has three categories of regions, of which currently "less developed regions" receive the highest level of assistance; those areas were called Objective 1 regions in 2004.

and Osaka while weakening those of cities not served by HSR.[26] In a similar vein, Piet Rietveld and associates find that cities with Shinkansen services have enjoyed faster employment growth than those without, while Kingsley Haynes refines that view to show that employment growth in retail, industrial construction, and wholesale grew by 16 to 34 percent more than in other Japanese cities.[27]

In line with the work of Sasaki and his colleagues, cited earlier, a World Bank study found that the Japanese Shinkansen network expansion led to a limited degree of regional dispersion from developed to poorer regions. In other words, HSR has not resolved the problem of excessive agglomeration around Tokyo.[28] The problem is that, at best, only a small amount of dispersion was likely to result in Japan from its extensive HSR system. The extant local lines were working to the advantage of the more developed regions, and construction of new HSR lines from remote regions improved accessibility only to those local networks, thus adding to the already developed central regions. The outcome is akin to the "Appalachian Effect" experiences in the United States in the 1960s, when the economy of the depressed Appalachian region actually suffered by being more closely tied to the rest of the economy after extensive road infrastructure investment.[29]

Turning to Spain, the situation is similar, with the large cities served by HSR benefiting, although in Spain, more attention has been paid to both complementary investments to HSR and the implications for the economies of large intermediate cities that also enjoy HSR services.[30] At the meso level, cities with vacant or poorly utilized land around railway stations have sought to attract HSR services for local redevelopment reasons, as, for example, is the case in Ciudad Real. That situation

26. Robert Cervero, "Urban Development on Railway-Served Land: Lessons and Opportunities for the Developing World" (Working Paper UCB-ITS-VWP-2009-13, Center for Future Urban Transportation, University of California, Berkeley, 2009).
27. Pete Rietveld, Frank R. Bruinsma, and H. T. van Delft, "Economic Impacts of High Speed Trains: Experiences in Japan and France, Expectations in the Netherlands" (Research Memorandum 2001-20, Faculty of Economics and Business Administration, Free University of Amsterdam, 2001); Kingsley E. Haynes, "Labor Market and Regional Transportation Improvements: The Case of High-Speed Trains," *Annals of Regional Science* 31 (1997).
28. The use of HSR is also very much a second-best approach to excessive agglomeration that, from a theoretical standpoint, results from imperfect property rights allocations. The latter term means that potential immigrants to a city are not made fully aware of the congestion costs that their moves impose on residents.
29. "Regional Economic Impact Analysis of High Speed Rail in China: Main Report" (Report No: ACS9734, World Bank, Washington, DC, June 2014).
30. José M. de Ureña, Philippe Menerault, and Maddi Garmendia, "The High-Speed Rail Challenge for Big Intermediate Cities: A National, Regional and Local Perspective," *Cities* 26 (2009); Maddi Garmendia et al., "Urban Residential Development in Isolated Small Cities That Are Partially Integrated in Metropolitan Areas by High Speed Train," *European Urban and Regional Studies* 15 (2008). These authors examine what they see as a serious problem in Spain.

often is accompanied by supplementary public investments in site clearance and local infrastructure provision, the costs of which should be added strictly to those of the HSR itself given their complementarity in any development process. Equally, costs are involved in downgrading or closing other stations that become redundant as HSR takes traffic away from local trains. That can reduce the economic growth potential of communities where local services are reduced or lost entirely.[31]

Intermediate, second-tier cities in Spain on HSR lines, especially those within about 125 miles of a primary terminal—most notably, Madrid—have benefited. Although commuting is two way, the benefit has largely been in terms of land-use values (that are largely captured in HSR user benefits) and more refined labor markets given that those services facilitate one-hour commutes between the urban areas. As a benchmark, the average commute for residents of Madrid is 32 minutes, although the number of workers with longer commutes has been increasing. The intermediate stops on longer HSR routes, however, lengthen overall travel times for long-distance travelers.

In terms of specific industries that also tend to be geographically concentrated, the United Nations' World Tourism Organization found that the 65 million visitors to Spain in 2014 made the country's foreign tourist industry the third largest in the world, with the second largest amount of financial receipts ($65.4 billion, or about 11 percent of the country's GDP). Daniel Albalate and Xavier Fagedata, using data covering 50 Spanish provinces between 1998 and 2013, provide mixed evidence about the effect of HSR on the sector.[32] Air transportation, the main mode for long-distance tourist mobility and a strong predictor of tourists traveling to Spain, is clearly negatively affected by HSR on continental European routes.[33] However, HSR has a very weak positive direct effect on tourism within the country, although that effect is influenced by the measure of HSR accessibility adopted and the type of analysis used.

WHAT ABOUT THE COSTS?

Most studies of the economic growth implications of HSR focus largely on the gross, direct development effects and say little about the long- and short-term

31. Deike Peters and Johannes Novy, "Train Station Area Development Mega-projects in Europe: A Typology," *Built Environment* 38 (2012): 13–30.
32. Daniel Albalate and Xavier Fageda, "High Speed Rail and Tourism: Empirical Evidence from Spain," *Transportation Research Part A* 85 (2016).
33. About one-fourth of Spain's tourists come from the United Kingdom and, despite the Channel Tunnel, their number has not been affected by the HSR system.

financial costs of subsidized investment, operations, and maintenance. Further, the matter of the broader opportunity costs involved in taking resources from elsewhere to fund HSR services is almost universally neglected. Indeed, that omission is somewhat ironic because one of the oft-cited justifications for public-sector engagement is that HSR, because of market imperfections, will be underprovided in the marketplace. Stepping aside from the rather unclear picture of the environmental cost of HSR, the financial costs almost inevitably are very much higher than often claimed, and revenues less. Indeed, that is one reason HSR services such as between Shanghai and Nanjing, which opened in 2009, closed after 10 days; the Toledo–Cuenca–Albecete service in Spain closed in 2011 after having far fewer than 3,000 passengers in six months; and, more recently, as mentioned previously, the Perpignan–Figueres service went into receivership in 2016.

HSR accounting can be creative and fuzzy, but HSRs are generally accepted to be expensive to construct and to operate, although precise and complete data are hard to come by.[34] For example, the current 1,900-mile Spanish system has cost an estimated $44 billion to build and receives significant annual subsidies of between $330 million and $440 million a year. It also has enjoyed financial aid from the European Union; for example, Spain's HSR system received $8.2 billion from the European Union in 2010.[35] HSR costs also vary considerably by country and by individual project. The average infrastructure unit price of HSR in Europe is, for example, between $17 million and $24 million per mile, and the estimated cost for proposed HSRs in California is, conservatively, $35 million per mile, whereas China's investments per mile have cost between $11 million and $13 million.[36] China's considerably lower cost per mile is largely due to low land and labor costs, and it is one explanation for the rapid creation of the Chinese system.

HSRs also are not very good generators of revenue. Again focusing on Spain, a 2015 report from the Applied Economy Studies Foundation argued that "not one of the [country's high-speed lines] should have been built."[37] None of them were found to be making a profit; for example, using 50 years of projected financing data to allow for commercial rates of interest on capital costs to be

34. Valiant efforts at obtaining such data include the following: Baruch Feigenbaum, "High-Speed Rail in Europe and Asia: Lessons for the United States" (Policy Study 418, Reason Foundation, Los Angeles, 2013); and Gines de Rus, *Economic Analysis of High Speed Rail in Europe* (Bilbao, Spain: Fundación BBVA, 2009).
35. An exchange rate of €1 = $1.11 is used throughout this discussion.
36. The Chinese costs may have been lower but for large-scale embezzlement—$2.8 billion by one official and $28 million on the Beijing–Shanghai line.
37. Ofelia Betancor Cruz and Gerard Llobet, "Contabilidad financiera y social de la alta velocidad en España" (Estudios sobre la economía española 2015/08, FEDEA, 2015).

included, the Madrid–Barcelona corridor would lose an overall $4.5 billion, the Madrid–Andalusia corridor $5.49 billion, and the Madrid–Levante corridor $5.9 billion.[38] That expenditure should be set in the larger context of the Spanish transportation system, in which only 14 of the 47 state-owned, ENAIRE-run airports cover their costs, and in an economy with record of unemployment of more than 20 percent since 2009.[39] The problem is as much with the wider macroeconomic and transportation environment in which Spain has functioned as with the specifics of its HSR system.

Economic viability of HSR services and, to a large extent, their development effects depend very much on the density of traffic they carry—basically, the economies of density that can be generated. In that sense, the Japanese system clearly is largely efficient; at the other extreme, the Spanish system probably is not. Considering one million passengers per mile as a measure of traffic density, the Spanish system in 2007 had a density of only 1.7 and in 2008 of 3.44, compared with the European Union average of 15.41 and 16.22 for those years, respectively (France had a density of 25.62 and 28.08 and Germany of 17.06 and 18.16).[40]

In its two years of operation, the Beijing–Tianjin Intercity Railway in China delivered more than 41 million rides but at a high cost. The line cost more than $3 billion to build and involves $270 million in annual operating costs, including $90 million in interest on its $1.5 billion of loans. In 2008, its first year of operation, the line carried 18.7 million riders and generated $165 million in revenues, a loss of $105 million, and in the second year it carried 22.3 million passengers, reducing losses to $75 million. On that basis, and because of the fare strategy being adopted, the rail line would have to carry 33 million riders a year to recover costs. That volume of traffic is not likely to occur in many places outside China and is considered in the context of China's construction costs, which are on the lower end of the scale.

38. An earlier indication of the financial and ridership challenges of AVE appeared when, in 1992, after the Olympics, fare reductions of 30 percent on the Madrid–Seville line and 50 percent on the Madrid–Ciudad line were initiated to attract traffic. Those price reductions increased ridership, but the elasticities of demand did little for the financial situation; see Ginés de Rus and Christopher Nash, "In What Circumstances Is Investing in HSR Worthwhile?" (Working Paper 8044, Institute of Transport Studies, Leeds, UK), 580.
39. Many of the subsidized airports are small but provide a competitive mode to HSR. The economic problem is that having the HSR system not cover its costs and the airports largely in the same position results in significant overcapacity in the overall Spanish passenger interurban transportation system. The problem seems to be exacerbated by inefficiencies in the system operations.
40. Roger Vickerman, "High-Speed Rail—the European Experience," in *Territorial Implications of High Speed Rail: A Spanish Perspective*, ed. José M. de Ureña (Farmham, Surrey, UK: Ashgate Publishing, 2012).

The Japanese HSR system was initially funded with World Bank assistance (7.5 percent of the construction cost of the Tokaido Shinkansen being a loan). Subsequently, finance came in the form of public-private partnerships after the corporatization of the Japanese rail system in 1987. For example, the Yamagata and Akita Shinkansen infrastructure was 20 percent financed by the central government, 40 percent by local governments, and the remainder by JR East Rail Company.

The substantial traffic volumes enjoyed by the Shinkansen suggests that, although only the Tokyo–Osaka line more than covers its full costs (including interest payments on capital, amounting to about 25 percent of costs) and although the Hakata–Osaka line breaks even, many of the other services could likely do so with pricing targeted to that objective. The ability to build large developments alongside the high-speed railways has also been of financial advantage to the Japanese HSR lines, as is the ability to charge high ticket prices in markets where, until recently, low-cost airline competition had been limited.[41] Even so, 71 percent of the revenue from passenger tickets at JR East comes from the conventional, slower railway, the less glamorous side of the company's business.

Overall, while there may be arguments that there are economic development effects that exceed user benefits, there are equally important arguments that the costs of HSR exceed those directly attributed to HSR. Furthermore, these latter costs are inevitably higher than those forecast when initially planning any HSR line. No consensus exists, however, on the ratio of the total economic to narrower transportation user benefits of HSR investments, and they are, in any case, inevitably case specific. Appraisals of transportation investments that have, in general, produced ratios as low as 1.25 and as high as 1.6 are of little use in the HSR debates because of the specificity of each HSR service and the peculiarities of the mode in general.

One of the problems with HSR systems is the lack of incentive for them to minimize their costs. Lack of competition both within the HSR industry and between it and other modes of transportation contributes to that lack of incentive. Part of the cause is institutional. In Europe, the EU has had difficulty transforming the established national rail monopolies into a pan-European market, with operators competing across borders. The reforms to date have often seen national railways preferring to collaborate than to compete—for example,

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41.Changmin Jiang and Xiaoyu Li, "Low Cost Carrier and High-Speed Rail: A Macroeconomic Comparison between Japan and Western Europe," *Research in Transportation Business & Management* 21 (2016): 3–10. For a discussion of competition between low-cost airlines and HSR in Europe, see Daniel Albalate, Germà Bel, and Xavier Fageda, "Competition and Cooperation between High-Speed Rail and Air Transportation Services in Europe," *Journal of Transport Geography* 42 (2015).

France's SNCF and Germany's Deutsche Bahn joint venture, Alleo. On a few of the busiest routes, competition may, however, be emerging; for example, Deutsche Bahn has gradually pulled out of Thalys, a venture with SNCF and its Belgian and Dutch counterparts, intending to compete with it.

Competition is also gradually appearing in domestic markets. For example, Europe's first private HSR operator, Italy's Nuovo Trasporto Viaggiatori (NTV), started services in 2012 and, although struggling to compete with the indirectly state-owned HSR incumbent, Trenitalia, has more than 20 percent of the market. In 2015, NTV carried 9.1 million passengers, with a load factor of 71.5 percent on 56 daily trains. Competition from other forms of transport is also growing. Low-cost airlines are continuing to expand, and in parts of Europe, the long-distance coach market is being liberalized. Germany opened up its coach market in 2013; consequently, Deutsche Bahn estimated that it lost $55 million in revenues in the first half of 2014.[42]

SOME CONCLUDING THOUGHTS

Inevitably, attempts are made to transfer previous experiences from other locations to situations nearer home, and that has been an element of the US deliberations over HSR investment. In many cases, this transfer has brought forward useful insights. That high-speed railways can, when the economic and geographical conditions are correct, serve an important economic and social function is undoubtedly true. Ample evidence from experiences outside the United States, however, also reveals many instances of "irrational exuberance," to borrow former Federal Reserve Board chairman Alan Greenspan's phrase, to direct resources to railways according to the misguided perspective that economic development automatically follows. The provision of HSR investment is, in fact, neither a necessary nor a sufficient input for economic development in many cases and, indeed, is largely a consumer good rather than an intermediate good.

The experiences of China, Japan, and Spain indicate that HSR infrastructure can prove far more expensive to construct than suggested in ex ante, quasi-political analysis and that ridership, combined with that national economic development, can prove to be disappointing at fares even remotely close to cost recovery. If the objective is less that of national economic development and more that of spreading economic activities from congested regions, the results have

42. For a general discussion of HSR-bus competition in Germany, see Katrin Augustin, "Contestability of the German Long-Distance Coach Market" (paper presented at the European Transport Conference, Frankfurt, Germany, September 2013).

also generally been disappointing. HSR provides two-way services, and the tendency has been for its introduction to lead to more longer-distance commuting to and from established economic centers rather than to the geographical spread of employment and production.

Although exceptions exist, most locations along an HSR line enjoy little economic stimulus from their situation and, indeed, may have some economic vitality drained from them by cities at or near the main stations. Even the those cities, however, often require significant, generally publicly funded, supplementary investment to facilitate access to HSR and to take advantage of any potential local agglomeration economies. Such supplementary outlays add to the overall costs of any HSR line but are not typically included in the costs of the HSR system. They are, however, part of the overall HSR infrastructure, being highly complementary to it, and de facto a joint cost involved in any economic development that takes place.

Limitations also emerge when looking at the experiences of the three largest HSR systems and in trying to transfer those experiences elsewhere, and this paper has mentioned many of those limitations. Added to the list is the retrospective nature of looking at what has been done to date when, often, public and political policy—rather than strict economic development considerations—dominated. Given rising populations, the ongoing global urbanization process, the growth of megacities, and increased internationalization, a future need for more high-capacity and faster long-distance transportation seems inevitable if economic growth is to continue. Within the right context, HSR has a clear contribution to make.

With advanced air traffic control systems, new airline technologies, and innovative management, aviation may also partially fill that role, and, indeed, that sector has proved ingenious at contributing in the past when not overburdened with economic regulation. In densely trafficked corridors, however, aviation has its limitations. HSR, as its technology is further refined, can serve that role, but the challenge for it to do so is neither economic nor technical but political. The market can provide the guidance, but the main reason HSR has, to date, failed to meet its promise has been because markets have not been allowed to determine the initial allocation of resources. Also, once constructed, HSR has too often been managed and priced as a vehicle of political integration rather than one of economic development.

ABOUT THE AUTHOR

Kenneth Button is a fellow of the Academy of Social Sciences, a fellow of the Institute of Logistics and Transport, and a fellow of the Institution of Highways and Transportation, and he was the initial distinguished fellow of the Air Transport Research Society. He is a recipient of the Transportation Research Forum's Distinguished Transportation Researcher Award and Herbert O. Whitten Service Award as well as the Distinguished Scholarship Award from the Transportation and Public Utilities Group at the American Economic Association. He has twice been elected president of the Transportation Research Forum. He is currently a professor in the Schar School of Policy and Government at George Mason University. Button's experience in policymaking includes being conseiller in the Advisory Unit to the Secretary-General of the Organisation for Economic Cooperation and Development and special advisor to the UK House of Commons Transport Committee. Previously he was a professor of applied economics and transport at Loughborough University, VSB professor of transport and the environment at the Tinbergen Institute in Amsterdam, and MBP visiting professor in economics at the National University of Singapore. He has also held visiting posts at the Universities of Porto, Ihna, Bologna, Bergamo, Maribor, British Columbia, and California, Berkeley. Button has published, or has in press, about 100 books and more than 400 papers in leading academic journals. He was editor-in-chief of the academic journals *Transportation Research Part D: Transport and the Environment* and *Journal of Air Transport Management*.

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