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# Can high-speed rail have a transformative effect on the economy?<sup>1</sup>

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## Abstract

High-speed rail is frequently claimed to have a transformative effect on the economy. By bringing cities and regions closer together it is argued that economies can benefit from lower generalised costs of transport leading to enhanced growth and productivity. A counter argument is that such effects are largely redistributive with some regions benefiting and others suffering depending on their ability to take advantage of new opportunities. However, some argue further than this and claim that such step changes in transport provision can lead to major changes in economic structure that can transform regions' absolute as well as relative position and thus redress the existence of regional disparities. In this paper, we address the question as to whether there is a clear and robust economic theory of the transformational impact of high-speed rail and if there is any consistent evidence to support it? The paper uses evidence from the North-west European High-Speed Rail network and a more detailed study of the UK's first high-speed line, HS1. This is followed by a discussion of the various claims and counter-claims for the impact of the proposed HS2 that will link London with Birmingham, Leeds and Manchester. On the basis of this some of the implications for the appraisal of such projects are considered. The main conclusion from the paper is that transport infrastructure by itself is not likely to be transformative, but coupled with other policy interventions it can contribute to such an effect.

*Keywords:* High-speed rail; economic appraisal; wider economic impacts; economic transformation; regional development

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## 1. Introduction

Transport has for a long time been seen as a major determinant of land use and economic development. The economic evaluation of this link – the wider economic impacts (WEI) – has, however, been the subject of continuing controversy. As a result, formal appraisal techniques have tended either to exclude the possibility of wider economic impacts, largely because of the fear of double counting, or have simply included an arbitrary add on. The double counting issue arises because of the concern that the economic impacts are adequately taken care of in the user benefits; consumers' willingness to pay for time savings translate directly into increased rents or land values at locations with improved accessibility. This argument depended on the assumption that there would be perfect competition in the transport using sectors such that any change in transport generalised costs would be translated directly and fully into prices in the using sectors (SACTRA, 1999). An arbitrary add

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<sup>1</sup> This is a revised version of a paper first presented in the E Session, Transport Economics and Finance at the 14<sup>th</sup> World Conference on Transport Research, Shanghai, July 2016

on of around 10 per cent of benefits has often been used reflecting the typical mark ups in imperfectly competitive sectors.

Recent work, both theoretical and empirical, has improved our understanding of the way in which accessibility affects the performance of firms and particularly the operation of labour markets. Starting with the 'new economic geography' (Krugman, 1991) it could be shown that changes in transport costs and accessibility could, in some cases, in an imperfectly competitive world, have profound effects on the location of activities and agglomeration. Increased agglomeration would, in turn, impact on productivity and create potential benefits in addition to the direct user benefits. This idea was captured in the context of the appraisal of transport investments by Venables (2007). Empirical support was provided by Graham (2007).

However, the empirical evidence remains problematic for a number of reasons: endogeneity and causality questions; conflicts between macro-and micro-based estimates; and the interrelationship and spillovers between different areas. Recognition of the potential of wider impacts is important in appraisal and the UK, amongst other countries, does have a formal estimation procedure for including WEI in investment appraisal (Department for Transport, 2014). This provides a means of assessing the impacts on local economies of an investment with a direct effect on that locality. It separates out the labour supply effects, the impact of increased density, the relocation of employment and an allowance for changing the degree of competition as a result of improved accessibility. However, as further work by Graham et al (2010) has shown, the distance decay of these impacts is likely to be quite strong such that changing accessibility only has a very localised effect.

The Eddington Report (HM Treasury, 2006) into the likely impacts of major new transport investment in the UK raised the question as to whether such investment could have a transformative impact on the economy as a whole, rather than just on directly affected local areas. In particular, this posed the question as to whether such investment could change the regional balance of the economy. This view has come to dominate discussion of the creation of a new high-speed rail line in the UK, HS2, which would link London with Birmingham, Manchester and Leeds (HS2 Ltd, 2014). Similar issues have been raised in the context of improving communications between the cities of Northern England (SERC, 2009). Laird et al (2014) have shown the limitations of conventional cost-benefit analysis in dealing with investments of this type. But attempts to go beyond conventional cost-benefit analysis approaches to try and capture this effect in terms of a direct impact on output (KPMG, 2013) have led to serious criticism, in terms of both the assumptions and the net result (Overman, 2013).

Meanwhile there are those who continue to argue that the concept of wider impacts is misguided and that should not be used to justify investment (e.g. Crozet, 2015).

In this paper, we look at the specific case of high-speed rail (HSR) that has the potential to create step-changes in accessibility. We first examine the theoretical arguments in favour of the existence of wider economic impacts. We then assemble some evidence from existing HSR projects to determine whether there is a case for their existence. Finally, we suggest

some ways forward in moving to a more robust and transparent way of assessing such impacts.

## **2. The theoretical basis of wider economic impacts**

Transport and the economy are inextricably linked. Transport is usually described as being a derived demand from the demand for activities; transport is only useful as a way of bridging the spatial gap between locations, it has no value in its own right. This suggests that transport only responds to the needs of the wider economy. However, transport is also a substitutable input so that cheaper transport can be substituted for other more expensive inputs such as land leading to relocation and the potential for an increase in productivity. In this way, transport can be argued to be an engine of growth.

Here we see the potential problem of causality arising. In the aggregate, better transport and better economic performance are clearly associated, but which is the driving force is ambiguous. It is clear that without good transport economic performance may be constrained, but simply improving transport, without ensuring that other conditions for growth are met, is likely to be counter-productive. This is the problem with attempts to assess the role of transport in the type of aggregate growth models that follow the tradition of Aschauer (1989). But it can also lead to attempts to underestimate the role that transport may have as an enabler of growth; Ansar al (2016) have argued that HSR investment has slowed rather than enhanced Chinese growth by essentially resurrecting the crowding-out argument in a purely aggregate study that ignores the economic geography context (see Chen and Vickerman, 2017).

The key to understanding the economic impact of transport is in understanding the role of accessibility. Changes in accessibility affect the generalised cost of transport. If transport costs are reduced industries become more competitive and hence improved transport contributes to productivity growth. But it may also lead to changes in the optimal location of activities thus leading to faster growth in employment in some areas and slower growth in others. This is the potential for an agglomeration effect. But conventional measures of continuous accessibility may be inadequate in identifying the way that HSR changes the potential for firms and individuals to connect with each other. HSR has an essentially discontinuous effect where some lose accessibility through the penalty of connecting to the new network and any associated reduction in service on classic rail lines.

The 'new economic geography' (Krugman, 1991) provides the necessary linkages to sustain this argument. Transport costs are the determinant of the real price of an urban location and hence of the real wage. Note that it is the real rent or wage that is critical here; as transport costs fall the implicit real wage will rise. This takes us beyond the simple valuation of time savings as the indicator of a transport benefit.

Agglomeration lies at the heart of the argument since it is agglomeration that is associated with higher levels of productivity. This is an old argument about the extent to which larger cities are more productive than smaller ones (Glaeser and Gottlieb, 2009). Although the evidence is mixed there is general acceptance that the association is normally

positive. The theoretical basis of agglomeration lies in the extent to which in an imperfectly competitive world larger markets can accommodate increasing returns. Lower transport costs enable markets to expand in size thus resources are drawn into the larger market, which can continue to grow as the increasing returns cancel out the self-balancing mechanism that would apply in a perfectly competitive world. Backward and forward linkages in the local economy reinforce this process of cumulative causation. The circular process continues with increased market size promoting further increasing returns, which in turn reduce costs and encourage the further inward movement of resources as real wages and profits increase. Firms in the core region can better overcome the transport costs and supply markets in the periphery more cheaply.

This core-periphery effect suggests that lowering transport costs will always increase movement towards the core and hence centralisation and increasing inequality between regions – an argument that is frequently used to counter any arguments in favour of HSR rebalancing regional development. However, the new economic geography model (see Fujita et al, 1999) shows that this is not inevitable. Whilst the general result seems to hold for small changes in inter-regional transport costs, it does not necessarily hold for large changes or in cases where the existing structures of industries in the core and periphery are less appropriate for changing patterns of demand. Large changes in transport costs, making them less relevant in the choice of location can restore the advantage to firms in the periphery whilst negative externalities in the core such as congestion, pollution or crime constitute a constraint on ever increasing size at the core.

This is where the argument ceases being a purely theoretical one and becomes an empirical one.

### **3. From a theoretical model to appraisal**

The problem with the theoretical model is that it does not have an easy analytical solution. Numerical simulations can show the range of possible outcomes, but this is less satisfactory as a decision-making model to build into an appraisal framework. Venables (2007) provided a valuable link between the theoretical model and its potential use in an extended cost-benefit analysis framework. The essence of this model is that as transport costs fall labour markets thicken in the sense that at each location labour has a wider choice of potential jobs and employers have a wider choice of potential employees. Thus, better sorting and skill matching becomes possible. From an evaluation perspective, the important issue is not just that labour markets get larger, but that the agglomeration effects increase the productivity of all workers and this is the additional benefit the traditional model does not capture.

This enables an empirical model to be developed in terms of the effective density of the labour market at each location (now often referred to as economic mass, see Venables et al, 2014). Graham (2007) estimates the effective density as a function of the generalised costs for each mode and the rate of distance decay, for each sector, given total employment in each area.

Given the change in density as a result of the improvement compared to the base case, and given GDP per worker and employment for each area and each sector for the forecast year, and given the elasticity of productivity with respect to density in each sector, we can derive an estimate of the implicit wider agglomeration impacts. This is the approach now adopted by the UK Department for Transport (2014) in its appraisal methodology WebTAG.

This model works well for large urban areas and was instrumental in the decision to proceed with the Crossrail project in London (Department for Transport, 2005) identifying potential wider impacts equal to more than 30% of the direct user benefits. These depend on the relatively high elasticities associated with key employment sectors in the London metropolitan region, such as financial and business services, when compared to the agglomeration elasticities traditionally found in models of urban size that are heavily dominated by industrial sectors.

The model presents greater problems in dealing with larger scale inter-urban and inter-regional projects. Graham et al (2010) have shown that the distance decay applicable to the effective density calculations is quite steep suggesting that benefits are combined to quite small areas around access points such as rail stations. Graham and Melo (2011) found relatively minor additional impacts when applying essentially the same model structure to the proposed HS2 HSR link between London, Birmingham and the North.

Venables (2013) has suggested that the clustering that lies at the heart of the agglomeration story may not in fact apply at the sectoral level, but rather at the level of skills and occupations. Thus, in an inter-urban context it is activities that move and cluster, within sectors and even within firms, as the traditional Marshallian externalities operate more effectively at this level.

However, this attempt to extend the cost-benefit analysis framework to encompass wider impacts may not be the most appropriate way forward to understanding the overall impact on regional development from a major HSR project. Laird et al (2014) have attempted to map out the requirements of an extended CBA approach and contrast this with an alternative view that tries to go straight to the impact on output or gross value added (GVA). Models that try to do this have been around for many years in the form of land-use transport interaction (LUTI) models (Wegener, 2011). These have been supplemented in recent years by spatial computable equilibrium (SCGE) models (Bröcker and Mercenier, 2011).

The problem with these models is their dependence on imported data for calibration and the assumption of market clearing equilibrium. What is needed is an approach that allows for disaggregated behavioural responses to changing accessibility. One controversial approach is that developed by KPMG (2013) that attempts to estimate both labour market and business responses to changing accessibility to produce regional estimates of employment and output change. The controversy has arisen over the assumptions made about modal elasticities from changing accessibility and the fact that very high, much higher than obtained from alternative methods, figures have been obtained for overall economic impact (House of Commons, 2013; House of Lords, 2015). An alternative, using an SCGE model, was used in estimating the potential impact of extra runway capacity in the UK (PwC,

2013a, b). As with the KPMG model, this produced estimates of impact on GDP significantly higher than by the now more accepted methodology, such that the Department for Transport (2016) roughly halved the estimates in its decision to recommend proceeding with a new runway at London Heathrow airport.

#### **4. Some ex post evidence**

The methodology for identifying the impacts of HSR development ex post is difficult. As with all ex post analysis it is often difficult to isolate the impact of the transport investment from other changes in the economy. This has been particularly true over the recent past given the impact of a worldwide recession following the financial crisis and the rather patchy recovery. Thus, Wellings (2014) suggests that the HS1 line in the UK that provides both a direct HSR link between London and the Channel Tunnel and regional high-speed services between London and towns in Kent has not been successful in promoting economic development. Even allowing for the fact that this was being used as evidence to counter claims for HS2, a very different inter-urban, rather than essentially a regional commuting, link, the evidence used ignored all the other factors affecting employment in the Kent towns.

Cheng et al (2015) looked at the impact of the development of the largest HSR network in Europe, that linking Paris, Brussels, Amsterdam, Köln, Frankfurt and London. Using employment data for the major metropolitan regions and their hinterlands, Cheng et al suggested that the HSR network had led to a broad convergence in economic structure between the major cities, but also between these cities and their hinterlands. In this sense HSR development had been associated with convergence. In a comparative study, they show that the development of HSR in China, albeit over a shorter time period, had tended to lead to divergence as cities began to specialise to take advantage of the emerging agglomeration economies.

Vickerman (2015) looked in more detail at the relationship between service level development at intermediate stations and concluded that unless there was good integration between the HSR network and regional/local networks there was little evidence of HSR promoting development. This confirms the ex-ante analysis in Vickerman et al (1999) that HSR development would reinforce the major metropolitan centres and create shadow areas between them – in effect HSR, despite reducing headline access times could lead to a fragmentation of geography. This is evidence of the non-continuous nature of HSR on accessibility.

There is relatively little direct evidence of the wider impact of HSR from projects around the world. Most of the ex-post evidence has focused on passenger numbers and the direct impact in terms of the achieved internal rates of return from the project as an investment (e.g. Crozet, 2013; Kurosaki, 2013). There have been estimates of the achieved social rates of return in France (RFF, 2005), showing that only the original LGV Sud-Est line achieved its forecast rate of return whilst LGV Nord barely achieved 25 per cent of the original forecast rate of return. These are, however, based on a very narrow definition of social rate of return, essentially measuring employment change, rather than the wider economic impact



discussed above. Other evidence tends to be essentially anecdotal, for example Plassard and Cointet-Pinell (1986), Klein and Claisse (1997), Dornbusch (1997), Burmeister and Colletis-Wahl (1996) on various French TGV lines or Nakamura and Ueda (1989) on the initial impact of the Shinkansen in Japan.

In this same tradition, we have examined the overall impact on Kent of the creation of HS1, which provides fast services into London for a range of Kent towns, using the same infrastructure as the international Eurostar London to Paris and Brussels services. There was an immediate growth in passenger numbers to 7million journeys in the first year and then continued growth to 10 million over the next 3 years. Although there was some displacement of passengers from the classic rail network, there is clear evidence of newly generated traffic. This has been particularly pronounced at key stations such as Ashford, Dover and Canterbury where journey times to London were reduced by around 35 minutes, a saving of 40 to 50 percent on previous times by conventional rail.

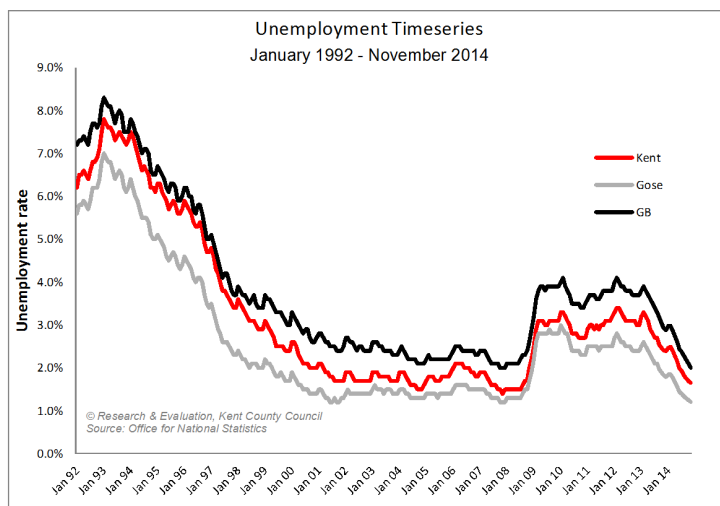


Figure 1 Comparative unemployment rates (Source: Kent County Council)

However, if we turn to the performance of the Kent economy over this period, Figure 1 suggests that in terms of unemployment there was little to distinguish the now better connected Kent region from the wider South-east region (GOSE area) or from Great Britain as a whole. Unemployment in Kent as a whole remained higher than both the wider region and the national average. But the new HSR services impact differentially on individual towns rather than on the country as a whole and the distribution of unemployment across the districts of Kent shows considerable unevenness (Figure 2). The principal beneficiaries of HS1 (Ashford, Canterbury, Thanet, Shepway and Dover) in fact all had pockets of unemployment in the highest quintile in 2014 whilst areas well away from the benefit of HS1 remained as those with the lowest unemployment.

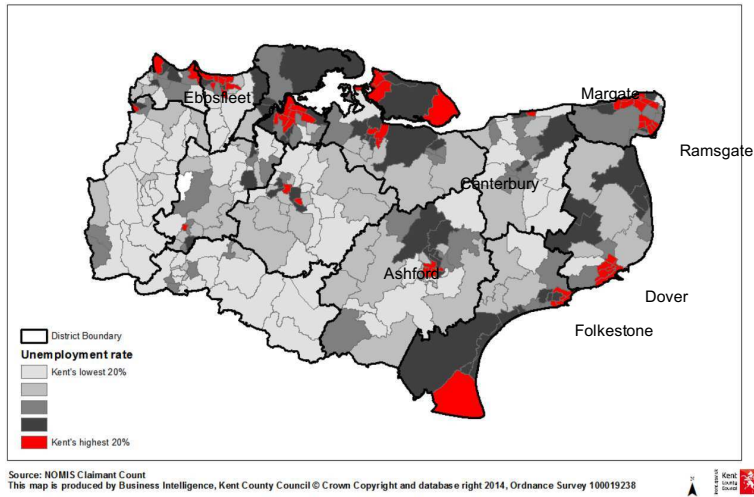


Figure 2 Unemployment rates by Ward (Source: Kent County Council)

To get a feel for the wider economic impact we look at trends in GVA (Figure 3) which show that there was considerable variation by District. Dover, one of the main beneficiaries of improved services on HS1 shows the greatest fall in GVA from 2008, but this is largely explained by the closure of one major employer in the District, a multinational pharmaceutical company's research centre. On the other hand, Shepway, the District around Folkestone, performed relatively well over this period. Over the entire period, the greatest growth in GVA was in Dartford and Ashford, the two locations with the greatest accessibility to London via HS1 (Dartford is the District containing Ebbesfleet International station).

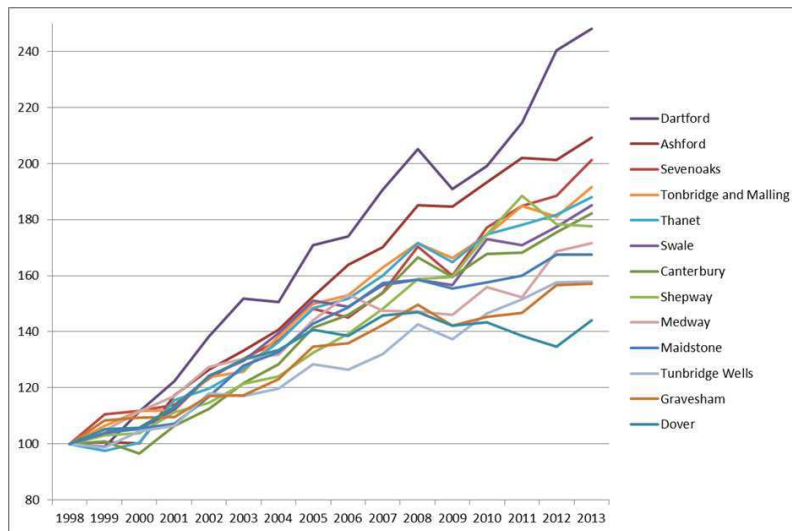


Figure 3 GVA growth by District (Source: Kent County Council)

A further dimension, reflecting the potential impact on different skills is provided by an analysis of changes in knowledge-based employment (Chen and Vickerman, 2017). Knowledge-based employment is likely to be one sector that is most likely to take advantage of the increased accessibility provided by HSR. Whilst knowledge-based employment in total remained highest in some areas away from HS1 for historical location reasons, considerable changes could be identified in some areas benefitting from the greater accessibility. Ashford for example showed an increase in knowledge-based employment between 2008 and 2014

of nearly 40 per cent whilst Canterbury with its university base showed an increase over the same period of almost 50 per cent taking the share of this sector in the local economy to 25 per cent.

The conclusion to be drawn from this rather simple overview is essentially that factors other than the improvement in accessibility have dominated local economic change. As suggested in Vickerman (2015), whilst HSR may be a catalyst for growth it is not a primary driver, especially for regions away from the major metropolitan centres.

## 5. Implications for future projects

The proposed HS2 project in the UK is a much more substantial one than HS1, linking London with Birmingham, Manchester and Leeds (Figure 4). The expectations from this are likely to be on a much larger scale given that it links some of the largest labour markets in the UK. Ex-ante analysis using the standard methodology for appraisal in the UK suggests relatively modest wider impacts that raise the benefit-cost ratio for the full network from 1.8 to 2.3 (HS2, 2013).

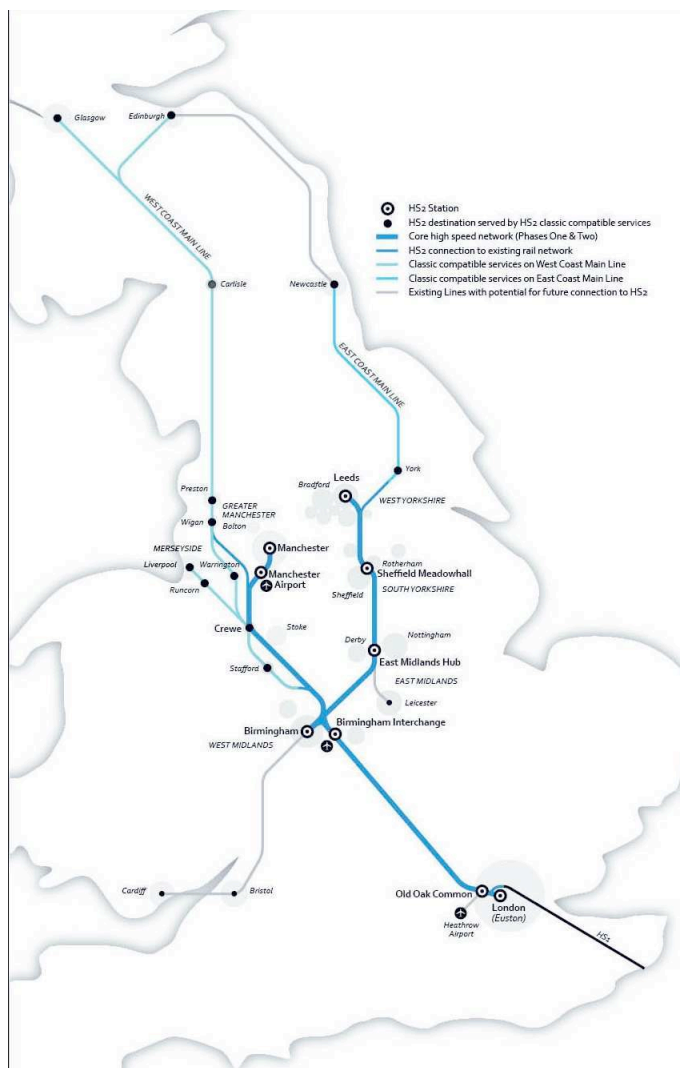


Figure 4 HS2 (Source: HS2 Ltd)

Using the method discussed above KPMG (2013) estimated the overall net impact on the UK economy from the calculated changes in business connectivity at around £15 billion/year. In comparison with the lifetime net present value from the standard CBA of £71 billion this figure seems large and, as been noted above, has been the subject of considerable critical comment. Most of this (£13 billion) is due to improvements in business connectivity that are argued to be underestimated in the approach based on effective labour market density. If we focus on the relative regional effects as the basis of any transformational impact, the estimates indicate that locations along the route of the line benefit considerably whilst those well away from the corridor suffer a relatively smaller decline. The estimates also suggest that there is little evidence of bias towards London and some of the gains are made by locations within the corridor but without direct access to the new line. This reflects the benefits from released capacity on the existing rail lines serving these places. Thus, on the basis of the full network and assuming a relatively high level of business relocation due to the new network the gains to London are smaller than those to West Midlands. Whilst the precise level of the impact may be open to criticism, this first attempt at a consistent model to estimate the regional distribution of benefit does suggest that some of the other centres on the line (e.g. East Midlands and South Yorkshire) will benefit from relocation to take advantage of connectivity that will improve more than for example in London. Thus, whilst we may accept that there is some doubt on the accuracy of the aggregate impact figure, the model does support the view that HS2 could lead to some redistribution of economic activity between the main urban centres. Moreover, although there are places that lose, essentially those well to the east or west of the main corridor served, the gains appear to outweigh the losses by a significant margin.

## **6. Some conclusions**

Forecasting the potential impacts of new infrastructure and making an ex post assessment of the impacts of existing infrastructure are fraught with problems that make a simple analysis of wider impacts difficult. Forecasting long-distance trip making over long periods is dependent on assumptions about economic growth, the value of in-vehicle business time and assumptions on fare structures and price elasticities. In this paper, we have raised the further questions as to whether we have got the wider benefits correct? This depends, inter alia, on whether agglomeration is different in an inter-urban context, the effects of connecting cities rather than just enlarging a single city, and whether focussing on skill specialisation rather than sector specialisation will give a better picture.

In discussing this, however, in the context of the projects mentioned, it raises the questions as to whether there is a tendency to over-analyse? Considerable effort has been expended on adjustments to allow for perceived optimism bias in appraisal (H.M Treasury, 2013). It is believed that project promoters have a tendency to overestimate demand and underestimate costs thus biasing appraisals in favour of projects. To some extent the wider benefits argument can be seen as a means of countering these adjustments. But it also poses the question as to how much risk should be left in a project appraisal? Whilst it can be argued that where there is a commitment of public money risk should be minimised and

where there is a greater risk private investment should be sought to bear that risk, does this mean that where there is a potential economic gain in terms of transformation or regional development the public sector should never take an investment risk? Attempts to minimise this risk usually take the form of additional and more complex analysis to make the investment seem less risky, but this can produce delay rather than greater clarity and risks the potential benefits themselves – a situation that has been termed “paralysis by analysis”.

So, can transport rebalance the economy? The evidence from Cheng et al (2015) suggests that in the case of a large network there is some evidence of rebalancing in that we can observe convergence in Europe and increasing concentration in China, an economy at an earlier stage of maturity. In the regional case of HS1 and Kent there is no evidence of any strong rebalancing despite significant increases in ridership. This relates more to the role that HSR may have in restructuring employment around major metropolitan centres (Garmendia et al, 2012). Such evidence is not picked up in the aggregate data used here, but may be clearer if we follow the argument suggested by Venables (2013). The evidence from both China and the UK in Chen and Vickerman (2017) does suggest that for knowledge-based industries, that are more likely to be impacted by HSR, we can observe some impacts leading such industries to cluster near to HSR stations. The work that has tried to capture connectivity for HS2 is controversial, but suggests that even if we are not confident about the absolute size of the impact there may be some potential for identifiable rebalancing. What none of this evidence has identified is the extent to which other factors may act as a constraint such that the potential created by the investment in transport cannot be realised.

The question can be posed another way: can the economy be rebalanced without major investment in transport? If (the lack of) transport is a constraint, then the answer is clearly no. But this also makes it clear that complementary policies may be required. Such policies may relate to connecting transport modes, to complementary planning and land use policies and policies towards labour markets, skill development etc.

Then the question is whether rebalancing can only occur with major investment in large-scale infrastructure such as an HSR network. This is the question that asks if there is £50billion to spend on transport projects is the greatest impact from investment in one single major project or a series of smaller projects each of which unlocks growth potential in a particular area. The arguments against very large projects are usually couched in terms of a rehabilitation of the crowding-out hypothesis that Aschauer (1989) sought to dispel. A recent example of this is given in Ansar et al (2016); this approach ignores the impacts on productivity through agglomeration and restructuring that the discussion above implies. Essentially this could be regarded as an empirical question that would be answered by implementing the sort of analysis discussed above. But it ignores one element that is difficult to answer on the same terms. Does the profile of a major new investment change perceptions more such that it for example increases both local and inward investment? The creation of an ‘address on the network’ has been regarded as an important factor in location choice, but one that is very difficult to quantify.

The convincing argument for a transformational impact thus remains somewhat elusive, although we have tried to clarify the necessary elements of that argument. What is clear that there can be no universal a priori assumption that major transport infrastructure

investment such as HSR can have a transformational impact, but clearly in some circumstances it can. The effort now needs to be directed towards identifying if there is a common set of criteria that characterise those cases that will have such an effect.

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