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Economic Impact of Infrastructure

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Introduction

This paper looks at the need for and criteria used to invest in infrastructure. This term can cover a wide variety of assets. One element of the infrastructure of the UK is its language and its institutions, which are arguably among the most important elements in our continued success and some commentators would like to see us invest more effort into them. However, for the purposes of this paper, I shall concentrate on assets which have a physical dimension.

To qualify as infrastructure, assets must have more than a physical dimension, however. Many physical assets, even long lived ones, are not infrastructure because they can be used for different purposes and moved about. An infrastructure asset is fixed to its geography. It also needs an element of distribution capacity – it is networked or connected to networks. This requirement is why institutions are part of a wider definition of infrastructure, since they govern how we connect to each other in contract, law and language.

Regarding institutions as an element of infrastructure also makes it clear that these assets have elements of a public good – something where my use does not prevent yours. Up to the point of over-crowding, my use of the transport network, or the power network does not prevent you also using it. Clean water and good drains benefit all residents by preventing disease. Network benefits also have this element – my benefit from a telephone or email system is increased if you also have access to it.

On the definition of a physical asset which has both a network and a public good dimension, telecommunications, transport, power, water supplies and sewerage clearly all qualify as infrastructure. They enable connections and work only when connections are present. Each also needs further fixed assets to work, such as power stations, sewage farms, signaling systems for roads and rail and so on. There are grey areas. Housing and other built assets are long term assets, the presence or absence of which determines the need for underlying distribution systems. Trains, road vehicles and telecommunication equipment define how connecting systems must be designed and will be used. However, most of us would not think of a car in the same way as a road. It has a shorter life, is not geographically fixed and it cannot be simultaneously used by different people for different purposes. For this paper, therefore, I shall concentrate on the provision of the network asset rather more than the uses to which that network may be put.

This means that transport systems, power networks, water and sewerage systems, as well as telecommunications, become the main assets of focus. Developing a definition of such assets is important not just for deciding what we should be concerned with, but it also has implications for decision making and for finance.

In the next sections, I will examine the kind of infrastructure that cities in particular require, and how we should make decisions about its provision and in turn the implications for who should finance and charge for it.

Cities and the need for infrastructure

Without infrastructure there can be no cities. Residents would quickly die without a food supply system and reasonable public health. In medieval times cities such as London were so unhealthy that continued streams of immigrants were needed to keep them populated. Only the extra incomes which the city generated made it possible to attract sufficient people. So infrastructure is tightly bound up with the existence and success of the city. In turn, cities are bound up with the success of the economy.

Not only are 60 per cent of jobs in cities, which cover less than 10 per cent of our land mass, but also cities are where innovation and new ideas generally come to fruition. More than 70 per cent of high skilled jobs in Britain are in cities (Centre for Cities, 2015). Over recent decades, a modern knowledge economy has flourished in our cities, at the heart of dynamic city regions. They have shown how larger centres can generate greater density and higher wages, if supported by good transport systems both for the labour market and business to business access.

For cities, jobs and productivity are related to density, as Figure 1 shows. The figure compares wage levels and density across the largest local authority districts and illustrates this curve. The densest and most highly paid districts are all in London, where there is also a high concentration of private sector knowledge intensive jobs – 51% in 2011. The other major cities are all in a middle range of densities, and have not all yet achieved relative wages significantly above the average.

Cardiff is just on the cusp of achieving a scale and density which would allow higher wages and productivity. Swansea is below the curve.

The concept lying behind the relationship between density and wages is that of agglomeration. This is the idea, first formulated in the 1890s by Alfred Marshall, that cities enable more efficiency and better ideas generation. Only in the last decade or so have these insights been more widely understood and empirically estimated, (see, for example, Rosenthal and Strange, 2004). Larger labour markets enable better matching of people to jobs, but more importantly better connections enable better transfer of ideas and the ability to establish new firms with enough scale to get going. A study of innovation in Manchester for the Manchester Independent Economic Review showed that supply chain relationships with close contact were the most effective route to generate innovation and economic growth (Volterra, 2009).

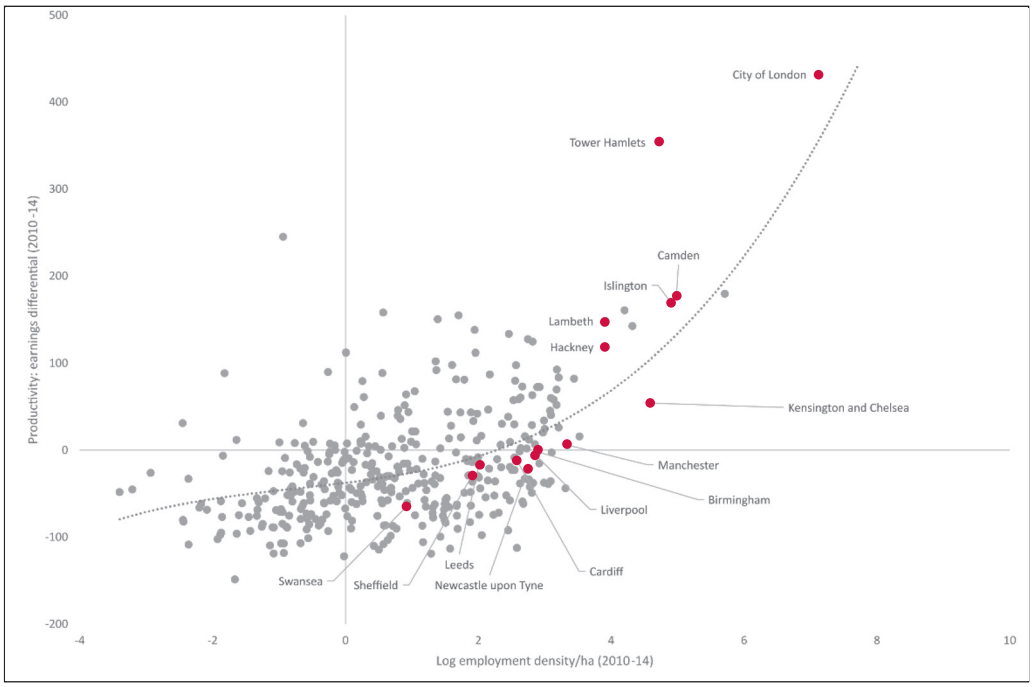
The success of cities is not just about their internal development and agglomeration. It also relies on their ability to trade with neighbours and further flung entities. Access to wider markets enables further development of scale, of new products as well as potential specialisation. Hausman (2013) has shown that capacities are central to economic development and that the exploitation of comparative advantage does not restrict the range of activities and products that an economy produces. Scale requires the ability to support larger markets, and the transport and other infrastructure necessary to make this possible. There can be quite specific requirements, such as power for data servers, broadband for data distribution, as well as physical transport networks.

Evaluating Infrastructure Investment

The foregoing section has laid out why we might be interested in supporting the economy, especially its capacity for growth and innovation, with investment in infrastructure. Unfortunately, infrastructure investments are seldom evaluated in practice taking proper account of their likely effects on innovation and growth.

A private sector investor would try to evaluate the revenues infrastructure would generate and then consider whether they were likely to be sufficient to cover the costs of provision, running costs and finance costs with a margin for risk. Early railway investors did that and today's investments in telecom services, and oil and gas provision are made in this way. Prices are largely determined in markets that have relatively little intervention. However, this approach is not taken to power networks or to transport or water. Telecommunications are also partly treated differently.

Figure 1: Employment density against earnings differential, 2010-2014 average

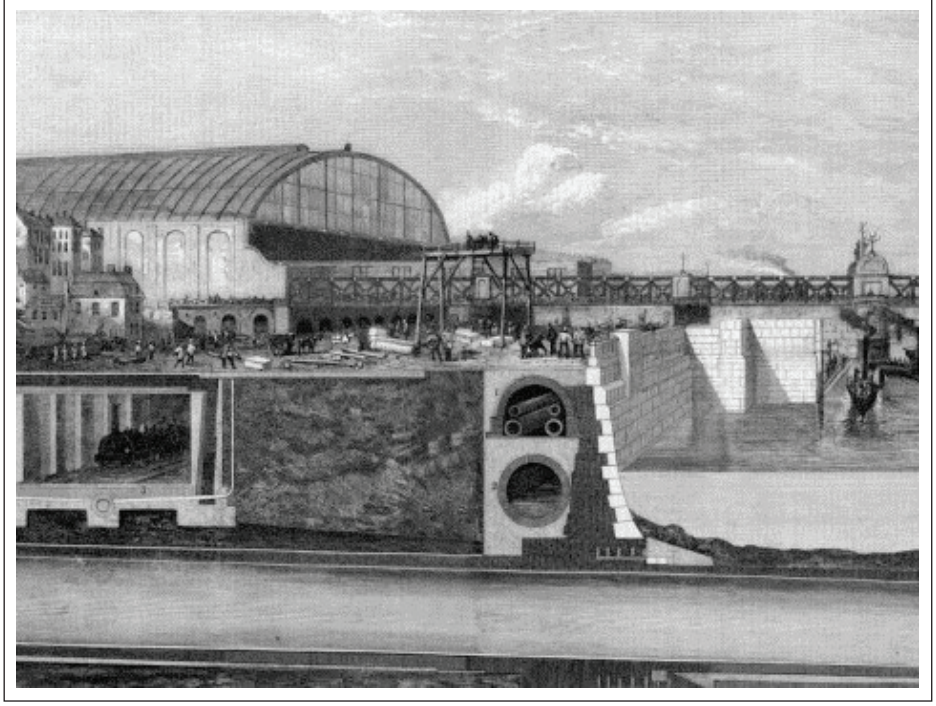


Source: Nomis and Volterra

In the case of power, water and telecommunications networks, we have economic regulators who have the task of deciding what a competitive market would look like if it existed and setting price and investment returns accordingly. The modelling strategy which underpins such an approach essentially takes growth and innovation as being generated outside the model and assumes that it will happen without further intervention. The market equilibrium that is sought is a static one in which no further change is required. While superficially attractive, it fails to pick up on either any sense of network and network dynamics, or on the public good element of infrastructure.

Public goods are hard to supply, as they are hard to charge for, or to charge for at a rate that supports a sufficient output. Moreover, the relationship between such network effects and the need for resilient capacity and the opportunity for growth is not part of the decision making process. In 1858 there was in London the Great Stink. Hot weather, combined with untreated effluent, made the capital both unhealthy and unpleasant. Parliament decamped and the incident gave weight to existing plans for sewers. These had been designed by Joseph Bazalgette. He estimated how large they should be based on some simple metrics. He measured the effluent from the densest part of London, Westminster. He then assumed that the rest of London had the same density. And then he doubled the requirement. The result was a sewer system that is only now having to be upgraded and added to, as much as the result of new regulations as of the need for more capacity. The long term payback on this investment has been immense.

Figure 2: Cross-section of part of the London sewer system designed by Bazalgette



Simultaneously, he provided for additional transport capacity. Figure 2 shows the sewers in cross section but to their left is a railway line – now the District and Circle. He designed an embankment that would be large enough to carry both a major sewer and a major transport link.

In modern times, we believe ourselves to be cleverer. We model future demand and provide just sufficient capacity to deliver it. Often this means under-provision. Heathrow is the busiest international airport in the world, operating at 98 per cent capacity, while Gatwick is the busiest single runway airport. So little spare capacity means an inability to cope with disruption and certainly an inability to cope with growth. There is no way today that we would agree to Bazalgette's sewers and the Thames Tideway Tunnel, which is the upgrade system, has required a new approach to evaluation. It does not fit the standard model.

Power has followed a similar trajectory.

Privatisation was accompanied by regulation that provided for creating an efficient industry. But the context for this was a world that was predictable. As the world has become less easy to forecast and in which policy has required new forms of investment, we are left with more government intervention and the highest strike price for nuclear power in the world.

Power, water and telecommunications have followed a model in which regulation has prescribed rates of return for private investors. It worked in creating an environment in which money flowed in to take advantage of that security. While the world was predictable costs fell and so did prices. This model also applied and worked in much the same way for air transport. It never worked in road or rail and in all of the other sectors it has not supported capacity resilience or economic growth more generally.

A major reason why road and rail have generated a different approach is that they have never been privately funded. There are very few toll roads or bridges and the railways were always in receipt of subsidy even when privatised. There is also an expectation that transport is a service that will be provided. So the decision making process has been much more murky. Rail infrastructure provision does have an economic regulator but until the creation of Highways England it only had one firm – Network Rail – to regulate. Even now, the role of the regulator is unclear when road and rail funds come direct from central government. Cases for investment in these are based on a system of cost benefit analysis which essentially assumes that the economy is independent of such activity and/or that the measures of time savings for assumed trips is somehow equivalent to the benefits to economic output. The assumptions necessary to make this true are mind-blowing. They include an assumption of perfect competition across the economy, of full employment, of independent innovation and that the value of time savings to users is correctly measured.

There are currently two examples of transport schemes which have been successfully evaluated on a wider basis to consider the impact on economic output. One is Crossrail, where a measure of additional output generated by the agglomeration effect was included after a lengthy battle. The other is the Northern Line Extension to Battersea, where the creation of high productivity jobs and a proportion of foreign direct investment was included in the business case. (The proposed siting of the U.S. embassy may have been particularly influential.) Nothing outside London has yet successfully used such measures in quantification although they have been prayed in aid for such schemes as the Manchester Metro and the A14.

Where Next?

It might be thought that schemes such as High Speed 2 would have focused on the role of transport in the economy. However, much of its evaluation so far has rested on traditional measures, which prioritise speed over capacity or connectivity. Speed means time savings which is the focus of valuation, rather than connectivity which would generate trips, market access or labour market improvements.

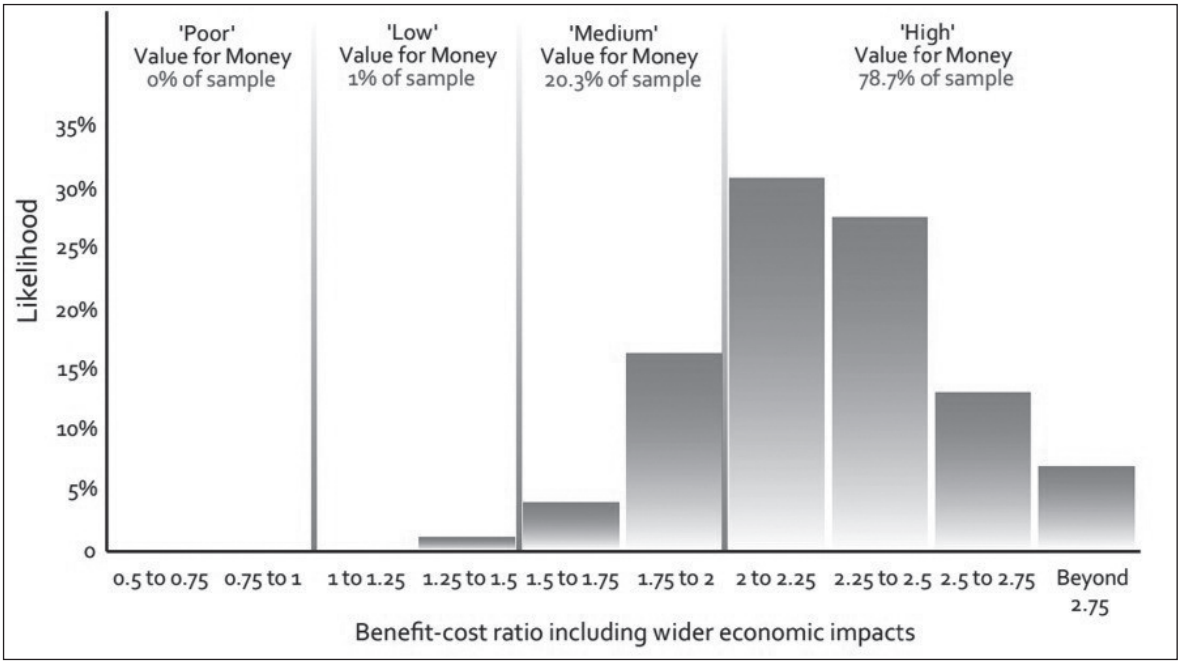
Indeed when the National Audit Office (2013) undertook an initial evaluation of the scheme it concluded that value for money could not be judged as the objectives of the investment were not well enough articulated for it to be possible. Subsequent business cases on the scheme, particularly for the phases to Leeds and Manchester have taken a more holistic view and have helpfully provided a range of possible cost benefit ratios, as shown in Figure 3. A major contribution is that the various ranges reflect different futures and different assumptions. Nonetheless the core analysis still rests on time savings for a given population making known numbers of trips rather than on the economic value of providing an infrastructure to enable trips to happen.

Finance

Evaluation of cost benefit ratios says nothing about how costs are to be recouped if the benefits are valued in different terms to the costs. Payback in time savings will not bring down debt. Moreover, generating benefits in 'funny money' obscures risk analysis and how to capture benefits to enable both payback of existing debt and the capacity to recycle borrowing into further investment.

There are a variety of mechanisms which can be explored. In some infrastructure areas, as we have seen, regulation has provided a secure return mechanism which attracts private sector investment with low risk premium and which is repaid

Figure 3: Cost Benefit Ratios from HS2 Business Case



Source: HS2

from consumption of the product – be that water, power or telecommunications. In other areas, we continue to either charge below cost, or not at all, as in roads. Where charges do not cover the costs, it is possible to consider recouping investment from other mechanisms. It is also important to distinguish between running costs, which ought to be covered by charges where they are made and the repayment of construction costs. Too often costs are lumped into one pot, which is not necessarily appropriate.

In the case of the Northern Line Extension, it was shown that business rates on the new office space, which could not be built without the additional access, could cover a considerable proportion of the cost. Other contributions from housing developers and Community Infrastructure Levy were also estimated. This financial case needed to be presented to lenders who themselves needed to be convinced that a mechanism existed to allow for the debt to be paid back by the Greater London Authority, thus also creating financial discipline on the cost side.

Of course, not all projects can be pinned to particular developments. In the case of, for example, the South Wales Valley lines it may be hard to distinguish where individual development may happen as a result of the investment. In that case a wider definition of where additional prosperity would be generated needs to be taken. In principle, consequential reductions in other forms of government support are also relevant, though harder to capture directly.

Finally, network availability, public goods and network resilience are benefits which accrue generally to everyone. As a result, a proportion of the costs should be supported through general government. Nothing wrong with that.

Conclusion

Infrastructure is essential to any economy. Without means of power or transport, we are forced into self-sufficiency. However, infrastructure may be necessary but it is not sufficient. It interacts with other forms of investment by firms and individuals to create products and services that people want to buy and the potential for innovation and growth.

Evaluating infrastructure provision needs to take this into account and consider the ways in which benefits can accrue, their potential value and how they should be captured to fund the investment. In doing so, it is also possible to decide which benefits cannot be captured and need to be provided to us all and therefore paid for by us all.

References

Centre for Cities (2015). Cities Outlook 2015 http://www.centreforcities.org/publication/cities-outlook-2015/

Hausmann, R. (2013). The Specialization Myth. Social Europe Journal

National Audit Office, (2013). High Speed 2, A review of Early Programme Preparation

Rosenthal S. and W. Strange, (2004). Evidence on the nature and sources of agglomeration economies, Handbook of Regional and Urban Economics Cities and Geography, Edited by V. Henderson, and J.F. Thisse, Elsevier

Volterra, (2009). Innovation, Trade and Connectivity, Manchester Independent Economic Review http://volterra.co.uk/wp-content/uploads/2013/02/Innovation-Trade-and-Connectivity-MIER.pdf