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FINANCING SCHEMES OF TRANSPORT INFRASTRUCTURE

Public and Private Initiatives in Infrastructure Provision[1]

Introduction

What to do about infrastructure remains a vexed question in the transport sector. Traditionally the preserve of the public sector in most economies, there has been increasing questioning of the rationale for this as the cost of both maintaining the existing infrastructure and making marginal additions to the infrastructure stock have escalated. If it is the case that better transport infrastructure boosts the productivity of private capital, then are there ways of shifting at least some of the responsibility for infrastructure provision to those who may benefit most?

Private infrastructure provision is not a new idea. Bridges have been privately owned for centuries[2]; the early turnpikes were privately provided and tolled; early railway development in many countries was purely private-sector driven. However, government approval or licensing, regulation and eventually, in most European countries, state ownership became the norm. This state involvement was sometimes for ideological reasons, sometimes for military/security reasons, but more often for purely economic reasons as the private sector failed to meet rapidly growing or changing demands.

Growing concern over state budgetary deficits, and an (often ideologically driven) concern over the inability of the public sector to manage complex infrastructure efficiently in an increasingly competitive climate, led to the reversal of this trend from the 1980s. Led by the deregulation movement in the US, enthusiastically picked up by the privatisation movement in the UK, and

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[1] Roger Vickerman , Centre for European, Regional and Transport Economics, University of Kent at Canterbury Paper for STELLA Workshop, Brussels, 26-27 April 2002.

[2] Note that the original classic of infrastructure economics (Dupuit, 1844) referred to bridges.

fuelled by the availability of a highly liquid private capital market, the past two decades have seen a major change in the way infrastructure is viewed. But this has not been without its disappointments for the supporters of private initiatives or for governments wishing to see the off-loading of some of their financial responsibilities.

In this paper we first review key elements in the economics of infrastructure provision, concentrating on the risks involved, before examining options for both public and private funding. From this we identify two key questions for further examination, the problem of providing effective networks and the problem of the vertical integration of infrastructure and the services provided on that infrastructure. The framework is then used for a brief analysis of examples of private involvement in infrastructure provision. The paper concludes with a short summary of key issues for future research.

The infrastructure provision problem

The basic underlying conflict in infrastructure is that it has all the characteristics of a public good at levels of demand below capacity, but the lack of competition in infrastructure supply leads to the problem of a natural monopoly. The natural monopoly argument has been the underlying rationale for public involvement in infrastructure provision since the nineteenth century. The public good argument depends on the recognition that infrastructure is expensive to provide, and that the lead time in construction requires a large advance funding. Once provided, however, the short-run marginal cost of usage is zero (or close to zero) leading to the basic pricing difficulty.

This problem has been recognised in the debate on "fair and efficient pricing" for infrastructure conducted by the High Level Group for the European Commission.[3]

Central to the problem of infrastructure provision is the question of opportunity cost and risk. Fixed infrastructure typically has a zero opportunity cost. Infrastructure providers, unlike transport service providers, cannot cover the risks of their investment by the residual value of the infrastructure. This is central to the notion that infrastructure should be priced at its short-run marginal cost, since there is no transfer price of the capital asset to be taken into account. But at levels of usage below capacity the short run marginal cost is effectively zero and hence the infrastructure can make no contribution to its capital costs. Against this we have to reckon with the lumpiness and long gestation period of infrastructure which prevents perfect marginal adjustments of capacity to demand. It is this characteristic which is seen as a valid argument for public funding as well as public provision, since only the public sector will be able to take future needs into account adequately and ensure the correct level of provision at the right time and this may imply cross-subsidy to cover the shortfall in revenues against full costs in an infrastructure priced at short-run marginal costs. At capacity the situation reverses, however, and prices based on short-run marginal cost rise rapidly, making the infrastructure cash rich, implying the need for expansion. Such an expansion, however, even if it is able to be financed over its life, will pose problems in its early years when it will require subsidy.

Those financing infrastructure face three main types of risk which can affect provision:

[3] See: European Commission (1999)

construction risk; revenue and maintenance risk; and planning and political risk. Construction risks arise because of the individuality of large infrastructure projects and their long gestation periods, both of which make costs difficult to estimate accurately. Large infrastructure projects frequently require detailed design to be carried out whilst construction is in progress, for example to overcome specific construction problems encountered.[4] Sometimes inadequate specification of the project compounds the expected construction cost risk. This compounds the problem of inefficiency in the actual management of the construction contract which can make it easy for contractors to inflate costs and not appear to be responsible for these increases.[5] Despite these tendencies for costs to increase there is a risk to the commissioning organisation that contractors may systematically underestimate the costs involved. Lower costs increase rates of return and make it more likely that projects will be undertaken; although aware of this commissioning organisations may also wish to see the costs underestimated in order to get a project accepted. Once large infrastructure projects are started it becomes very difficult to abandon them completely.

Once completed, infrastructure providers also face operational risks. Where usage is below that expected there may be revenue risks.[6] These are the other side of the coin from construction cost risks, but may be associated with particular problems since the tendency to systematically underestimate costs is often seen to go together with the tendency to overestimate usage. The most difficult infrastructures, those with the highest costs, are likely to be those with the greatest risks from the combination of these two factors since they are the ones where previous experience is unlikely to be useful.[7] Where traffic forecasts are wrong in the other direction there can also be a problem since this may impose much higher maintenance costs on an infrastructure, both because of the need to repair structures designed for lower traffic levels and because of the loss of revenue during the repair periods, which will arise sooner and more frequently. This would be compounded by poor construction which could arise if contractors were not responsible for its consequences.[8]

Finally, and most difficult to assess are the policy and planning risks which any infrastructure provider has to take into account. Once again the long gestation periods and the longevity of pay-back periods for major infrastructures makes them vulnerable to changes of policy. Enthusiasm for private finance has been tempered where there is a risk that a change of government may lead to re-nationalisation. Even more worrying can be the lack of consistency displayed by a

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[4] For example much of the cost increase associated with the construction of the Channel Tunnel was due to detailed design only being carried out as construction proceeded and despite detailed geological surveys problems of excessive wetness in the strata were unexpected. Another well quoted example is that of the south tower of the Humber Bridge which was unexpectedly located at a point where an underground stream was washing away concrete almost as fast as it was poured in.

[5] The successive increases in the cost of the West Coast Main Line Route Modernisation in the UK appear to have been associated with a failure to specify the project and then control costs adequately.

[6] These arise principally for the use of directly tolled infrastructures, but some road schemes can be provided on the basis of shadow tolls in which the provider is paid by the government or roads authority for the estimated usage. In the case of UK private road contracts this estimate is based on average traffic growth rather than the specific traffic usage of each length of road.

[7] International infrastructures such as the Channel Tunnel and Øresund link have been particularly problematic.

[8] One of the major reasons behind the DBFO contracts used in the UK highway programme was to try and secure higher construction standards if contractors were directly liable for the consequences of any construction failures.

government with respect to its own decisions.[9] When this becomes an open conflict between two levels of government as in the case of the mechanism for bring private funding into London Underground it is difficult for the private sector to receive clear signals.[10]

Similar difficulties arise with the EU's Trans-European Networks programme. Direct EU funding for these schemes is only a small fraction of their total value, they depend for 90-95% of finance on member states and private sector finance. Hence the EU cannot force the pace of development, such that only 20% of the planned network had been completed in the by 2001. Where international connections are concerned, different levels of commitment by member states can lead to continuing problems with incomplete networks.

Even without changes of policy which impact directly on the way infrastructure is operated, changes of policy which affect the competitive position of the mode to which the infrastructure relates can cause problems. Again it is often uncertainty over future directions of government policy which cause difficulties. Confusion over the position of Railtrack in the UK causes problems for the rail operators and their commitment to co-financing infrastructure improvements

Continual ambiguity over the attitude of governments to some form of universal road pricing poses problems for potential investors in both road and competing modes.

We need, however, to retain some perspective over the relationship between infrastructure costs and total transport costs. Infrastructure is a problem because it is costly to provide, but the unit costs of that infrastructure per passenger or tonne km are relatively small, both with respect to total transport costs,[11] and even more so with respect to total logistics costs. One of the problems here is that the end users of infrastructure are taking a whole series of independent decisions about their logistics and transport needs for which demand for infrastructure is then a derived demand which it is expected will be available at the place and time needed.

The possible benefits of infrastructure go beyond the immediate user, however. A basic rationale for public involvement is that there are wider economic benefits from transport infrastructure which affect both the level and the spatial distribution of economic activity. The debate on the impact of infrastructure on economic growth and development, and how to capture this in project appraisal, is beyond the scope of this paper.[12] The question of the balance between the competitiveness and the cohesion impacts of infrastructure remains, however, crucial in the debate over funding since if the primary economic impact of public infrastructure is on the productivity of private capital, then it is reasonable to expect that part of that surplus should be made available to fund the infrastructure. Where that surplus would lead to infrastructure being built in the wrong place to secure the regional development/ cohesion benefits desired.

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[9] The initial placing of Railtrack into administration in the UK, with no compensation for shareholders, displayed what was thought to be a reneging on a government undertaking not to re-nationalise because of the costs involved. Subsequent moves to provide the successor proposed not-for-profit company with government funding sufficient to make compensation available to shareholders (though not explicitly given for this) have been thought to have been occasioned by fear of the drying up of private sector enthusiasm for funding infrastructure schemes in general.

[10] See below for further discussion of the PFI versus bonds debate for the improvement of London Underground infrastructure.

[11] For example it is estimated that infrastructure costs contribute between 18% and 23% of average road costs per vehicle km (including external costs, but excluding congestion) (ITS, 2001) and see also Link et al (2000).

[12] See Vickerman (2001a) for a summary of the issues and SACTRA (1999) and Mackie et al (2001) for a discussion of the relevance of this for evaluation procedures.

Perhaps the most difficult issue with respect to the balance between the market and planning approaches to infrastructure development is the question of network planning. One of the characteristics of private sector financed infrastructure is that it typically has to be broken into manageable "chunks". But transport infrastructure only works as a network, thus investors have to be assured that each relevant part of the network will be constructed and means have to be found of ensuring that appropriate external spillovers can be identified and compensated.[13] This problem is compounded by the recognition of the need to provide interoperability, now enshrined in successive EU transport policy documents. This limits the scope of individual infrastructure providers to minimise costs by providing for access only for users imposing the least costs; for example the need for road operators to meet minimum axle weight and safety standards, new rail infrastructure to meet common loading gauge and signalling requirements. We return to this question in section 5 below.

We have set out in this section a range of the basic issues which arise in considering the provision of infrastructure. In the following two sections we examine how far the public and private sectors are able to meet these requirements.

Public infrastructure and public funding

The principal rationale for public sector provision of infrastructure is through its public good characteristics. This would imply that infrastructure should be financed directly out of general tax revenues. However, infrastructure rarely meets all the criteria for a public good. In particular, mode specific transport infrastructure is excludable and at levels of use approaching capacity becomes rival. This shifts the argument towards the externality effects of infrastructure, and in particular the wider economic effects. Too frequently these wider effects have been used as an assumption rather than as the outcome of a rigorous assessment.[14]

Concern over the validity of the traditional arguments, coupled with the need to reduce public sector budgets, led to a retreat from routine acceptance of public funding. The debate initiated by the Ashauer and Biehl studies in the late 1980s[15] showed that there were identifiable wider economic impacts which could justify public funding, but that these were not universal and needed to be justified on a case by case basis.[16]

If there is a case for arguing that there are identifiable external/spillover benefits rather than just a general public good contribution this may raise questions as to why most public sector funding

[13] As an example see the question of the completion of the high-speed rail network associated with the Channel Tunnel; different attitudes to the network were taken in France and the UK. In France announcement of the construction of the TGV-Nord was made just ahead of the public flotation of Eurotunnel; in the UK concern over public opposition to construction of a high-speed line and recognition of the problems of separation of the marginal returns to high-speed line and tunnel (which had been instrumental in the abandonment of the previous scheme in the 1970s) led to a delay in even considering construction of CTRL which will only be completed some 13 years after the Channel Tunnel was opened (see Vickerman, 1995).
[14] See the discussion in SACTRA (1999)
[15] See Aschauer (1989), Biehl (1986, 1991)
[16] See Gramlich (1994), SACTRA (1999)

comes out of general funding. Since users of infrastructure create external costs of congestion and environmental damage there is a case for raising charges for the use of infrastructure to reflect this use of resources. The revenues from such charges should be regarded as the payment for a resource and not as general tax revenue and hence there is a case for these to be hypothecated to the transport sector, not on a mode by mode basis, but treating the transport sector as a whole. A case can hence be made for a self-financing, user-pays transport infrastructure network.[17]

The difficulty remains that many of the wider benefits of transport may accrue to individual firms and people, whose potential surplus could be expropriated to pay for the infrastructure, but disentangling private and social benefits is not easy.

We have referred above to the problems caused by the long gestation and construction periods of infrastructure. These frequently do not coincide with the planning horizons of public finance. Experience with railway investment in the UK has shown clearly the impact which public expenditure constraints and short-term horizons have led to levels of investment below that which would have been optimal for the system as a whole. Two related points are relevant here; infrastructure does not have an immediate impact on voting behaviour and thus is easier to defer than social welfare expenditure, likewise the perceived benefits are long-term and diffuse and thus difficult to capitalise into voting behaviour.

Private funding options

The identification of a range of private benefits which are potentially able to be cashed in leads to the case for the private financing of infrastructure. Although this argument for private finance has existed for some time, the renewed interest in the use of private finance in the 1980s occurred for two main reasons, increasing concern about the efficiency of the public sector in the management of large scale projects and the availability of substantial volumes of finance capital seeking projects. The first of these was part of the general argument about the inefficiency of the public sector and evidenced by the regularity of cost overruns and delays. The private sector would, it was argued, be more efficient in managing the construction projects and this would be secured by ensuring that the private sector took an appropriate risk stake in projects. The second factor may have been of more practical significance in securing the change of emphasis since this also ensured that projects which would have been delayed in the highly constrained public sector could receive a rapid go-ahead in the private sector. These two factors combined would be expected to reduce the total cost of projects.

The main counter-argument to this expected cost advantage is that the cost of finance to the private sector would typically be higher than to the public sector given the higher degree of risk to the former. This raises the question as to whether the public sector should provide guarantees to ensure that any benefits are not lost through inability of the private sector to complete a project.[18]

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[17] This has been argued in more detail in Peirson and Vickerman (1993); see also the evidence for the UK in Peirson et al (1995) and Peirson and Vickerman (1998).

[18] The argument for a guarantee rests on the existence of difficult to identify wider economic benefits which would otherwise be lost, but also in relation to the planning blight which a partially completed infrastructure project would have on other potential projects. Against this is the argument that any public guarantee undermines the "at own risk"

The problem for the private sector is that of identifying the beneficiaries from a project such that they can be appropriately charged. Since infrastructure operators will typically only have access to the direct users of the infrastructure this requires that the total benefits are sufficiently captured by user surplus. Such projects are likely to be those which are discrete, clearly bounded and largely self-contained with no close competitor. For this reason the most common privately financed schemes have been bridges and tunnels.[19] *Thus private sector funding of infrastructure is likely to be associated with a degree of monopoly power.*

If this is the case then the public sector may wish to consider exercising some control over pricing freedom through regulation. Most toll bridges for example do face price controls, but Eurotunnel, the operator of the Channel Tunnel was not subjected to such regulation given its competitive situation with the ferries, which are (largely) private sector operated, although it does face a degree of quantity regulation in having to provide certain minimum levels of service.[20] *The issue for the public sector is the balance to be struck between seeking the expected benefits of private sector finance and maintaining a degree of control for public benefit reasons, including the key issue of maintaining appropriate safety standards.*

A number of options are open as summarised in Table 1. The most important distinctions are between the full scale private provision of infrastructure and those which involve some form of contract between public and private sector. These involve schemes such as the Private Finance Initiative (PFI) and Public Private Partnerships (PPP) in the UK. PFI involves a long-term contractual partnership in which the private sector takes on the risks of a venture in return for payments dependent on agreed standards of performance. PPP is a rather more general arrangement between public and private sectors (often with legal force) for expected mutual benefit in the provision of services. The distinction between the two is rather blurred with PFI being a specific subset of PPP.

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element in private finance and thus interferes with the operation of capital market more generally.

[19] This could include parallel road schemes reserved for specific types of traffic, e.g. express lanes or truck lanes on motorways, or roads aiming to offer a higher quality of service through price restricted access.

[20] This is common with private sector urban transit schemes and it is interesting to note that even the early private sector railways were subject to some regulation over minimum levels of service at a maximum fare, the so-called Parliamentary train.

Table 1. Schematic outline of private finance options

Type of scheme	***Example scheme***	***Advantages to private sector***	***Disadvantages to private sector***	***Advantages to public sector***	***Disadvantages to public sector***
Full private provision	*Channel Tunnel*	*Full control of project; limited regulation*	*Full risk exposure; possible need to transfer project at end of agreed concession period*	*Transfer of all risk; retain some rights to asset at end of concession period*	*Residual risk of failure;* Lack of control over prices etc unless regulatory structure.
PFI-scheme	*DBFO Road schemes; Urban rapid transit (tram) systems*	*Greater control over project management; some risk retained by public sector*	*Value of project depends on correct forecasting of costs and revenue streams; need to return asset to public sector at agreed end of franchise*	*Transfer of (some) risk; lower overall cost of project;* typically receive asset at end of agreed payback period	*Retention of some risk;* Need to fix payment for services to be delivered over long life of project
PPP-scheme	*Channel Tunnel Rail Link;* London Underground Modernisation	*Agreed framework for payment received*	*Little or no ownership rights*	*Retention of ownership and control; all rights to asset revert at end of agreed payback period*	*Cost of payments; retention of risk elements*

Generally the conclusion from UK experience is that full privatisation raises considerable difficulties. The one pure private sector developed scheme, the Channel Tunnel, suggests that the expected cost savings in managing construction may not be as great as believed and that a PPP scheme such as the Channel Tunnel Rail Link and PFI road schemes may have offered better results.[21] The difficulties faced by Railtrack in managing and developing the rail network in the private sector without increasing public sector support also cast some doubt on pure private sector provision.

The argument against this view usually takes the form that such private sector schemes have not

[21] The Channel Tunnel scheme was delivered at about a 100% overrun on its budget and one year late (although much of this may be due to latent risk in changing government safety requirements and slow approval procedures); CTRL is currently on schedule and to budget (see Vickerman, 1995). The Highways Agency estimates cost savings of about 15% on PFI road schemes.

worked because of the residual regulation preventing full competition. There are two responses to this. First, it can be argued that the competition does take place in the form of the competitive bidding for the rights. This is argued to be the most potent factor in reducing costs in PFI schemes.[22] Secondly, it has to be questioned whether a framework allowing for full competition, rather than competitive bidding, could ever be introduced for major infrastructure.[23]

PFI/PPP schemes, as well as allowing for lower costs of delivery, have typically delivered on time at a lower overall costs and thus meet the basic public sector test of value for money. The questions which are raised against such schemes is whether they sufficiently transfer risk to the private sector, given the agreement for the public sector to make certain contractual payments against a defined performance regime and the extent to which projects achieve cost savings, not through greater efficiency but through schemes which are inherently less safe. In the UK all PFI projects have to be set against a relevant Public Sector Comparator (PSC), the reference cost of a project in the public sector which define the value for money of the private sector option. Defining the PSC then becomes the critical issue.

A battle has raged over the PPP scheme for London Underground which sees the transfer of the management and responsibility for upgrading of the infrastructure (but not the ownership) to private sector consortia, whilst control remains firmly in the public sector through Transport for London (TfL). TfL and the London Mayor have argued strongly in favour of a public sector managed scheme financed by bonds. There seems to be little to choose in the relative costs of alternative means of finance, PPP projects do give savings over the agreed PSC (although bond finance appears to be more uncertain)[24], but there is a major political battle over the real degree of residual control retained in a PPP scheme.

The key question remains that of the distribution of risk in privately financed schemes. Although the principle of PFI-type projects is that there is a shift from the procurement of the assets involved in infrastructure to the purchase of the services provided by those assets, with the responsibility for provision and management of the assets remaining in the private sector, there is still a residual risk left with the public sector. As has been seen both with the early development of CTRL and the later problems with Railtrack, the public sector remains as the ultimate guarantor of a scheme.

The issue then is the appropriate length of the franchise/concession period. The usual basis sees the contract fixing a maximum period at the end of which the asset reverts to the public sector free of any encumbrances, but reversion will usually occur at the time that the asset is fully amortised. In this way the public sector tries to shift the downside risk onto the private sector whilst retaining the upside "risk". The adjustment of the concession period can be a bargaining issue, as for example in the case of the Channel Tunnel where the original concession of 55 years (including construction) was extended to 99 years to enhance the project's overall value at a time of crisis in the financing. Later projects have seen the transfer of a revenue earning asset to a concessionaire

[22] This is a similar argument to that of the benefits of franchising transport services: compare for example the experience of a franchising system for bus services in London with the full privatisation in the rest of the UK (Mackie and Preston, 1996)

[23] On a historical note, there was considerable competitive construction of railways in the UK, often leading to some of the residual problems of the network experienced today, and during the 1870s there were two rival Channel Tunnel schemes being constructed in parallel.

[24] See Ernst and Young (2002).

to help provide a cash flow during the construction period as a means of easing the potential revenue risk in the early years. [25]

There appear to be two main sources of risk which we term the network question and the vertical integration question. The network question relates to the problem of defining the private sector project. The vertical integration question relates to the transaction costs in a project.

The network question

Measuring network economies is a complex issue and one where it is difficult to separate the pure infrastructure economies form those of operation. Network economies comprise economies of scale, scope and density. Network density economies are of two types. One relates to the density of the network, such that the infrastructure provides operators with the opportunity to supply services which link conveniently together thus lowering idle time of rolling stock and maximising the number of passengers who face less disrupted journeys. The other relates to the average length of haul within a network of given density since the longer the average journey length the greater the economy from spreading the fixed terminal costs.[26]

Clearly fragmenting the network between different infrastructure operators presents problems in terms of ensuring that seamless journey opportunities can be provided to service operators and users. Apart from questions of the compatibility of the physical characteristics of the infrastructure networks, slot allocation becomes more difficult.[27]

However, the problem then becomes one of whether it is ever possible to define an optimum networks, and how far the optimal network from the point of view of the operators and users of services coincides with the optimum network from the point of view of infrastructure supply. Thus the question of financeability, which typically requires smaller, more manageable and identifiable networks has to be set against network management from the point of view of the user.[28] Compromises may mean less than optimal solutions from both perspectives.

The vertical integration question

The vertical integration question is that of the extent to which infrastructure and service operation need to be combined, from the perspectives of both ownership and management. The traditional principle for railways was one of vertical integration whereas for most other modes of transport separation was practised. That was changed with the advent of EC Directive 91/440 which legislated for separation.

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[25] An interesting debate has begun to emerge from the Dartford Crossing scheme in the UK which delivered a parallel bridge, doubling the capacity of the existing tunnels on the congested London Orbital Motorway (M25) route. The bridge was delivered on an expected payback period of a maximum of 20 years financed by regulated tolls; it is likely that this will have been achieved inside 10 years when it reverts as a free asset to the Government, who have indicated that they will continue to charge tolls.

[26] For a fuller discussion see Vickerman (2001b)

[27] The lack of a Europe-wide air traffic control system is one of the causes of greater air traffic delays when compared with the US. Problems arise with Eurostar services through the Channel Tunnel where late running on one network causes problems of missed slots at the Tunnel and on the other main rail networks compounding the delays.

[28] The proposal for the PPP scheme for London Underground envisages the setting up of three infrastructure companies, each of which would be responsible for a group of lines, but with coordination and the operation of services remaining integrated and in the public sector.

The main reason for separation was to ensure greater transparency in the accounting of operators such that clear evidence of the application of fair and efficient prices for the use of infrastructure existed, enabling comparison of modes. Greater transparency would lead to greater efficiency and the potential for competition which would tend to lead to lower prices. Competition here can be thought of in three forms: competition for infrastructure; competition on infrastructure and competition between infrastructures (modes). We have already addressed the competition for infrastructure in terms of the relative merits of tendering and franchising competition. Competition on infrastructure is a means of ensuring greater efficiency in infrastructure provision through ensuring that there is no monopsony in the purchase of infrastructure services. Thus airports are typically limited in their ability to exercise monopoly power by the presence of many airlines competing for the slots available, but able to take business elsewhere of charges become too high. The moderation of on-track competition in the case of railways in the UK, coupled with the ability of the operators to seek revenue support where track-access charges make services otherwise unprofitable has enabled Railtrack to escape this form of competitive pressure. Finally the extent of competition between infrastructures is very limited, principally because infrastructure operators are shielded from end-user demand by service operators.

This highlights the importance of transaction costs in the analysis, in particular the conflict between transparency and contractual complexity. A major rationale for separation of infrastructure and service operation is to make the cost of infrastructure transparent. This transparency should lead to more competition for the provision of infrastructure and thus bring down the prices charged by infrastructure suppliers. This does not of course require private ownership,[29] but the latter does imply a greater degree of both vertical and horizontal separation to ensure financeability.

However, separation requires explicit and therefore contractual relationships to be established between the various parties. Just how complex this can become is shown for the UK rail industry in Figure 1. Each of the links implies at last one contract (in most cases many) which has to be complied with in order to operate the infrastructure effectively. Each carries a potential penalty if some aspect of the operation goes wrong. In the case of a regulated or franchised operator there is the penalty imposed by the regulator or franchiser, but this can be a slow process. The implication, and close examination of the Railtrack case tends to bear this out,[30] is that the complexity of these transaction leads to a higher cost than where transactions were less transparent but hidden in a vertically integrated structure.

This is then the basic choice which confronts the analyst, whether any gains from the greater transparency and potential competition in the private provision of infrastructure will be outweighed by the increasing transaction costs associated with the administration and enforcing of complex contractual arrangements between independent organisations rather than within the same organisation.

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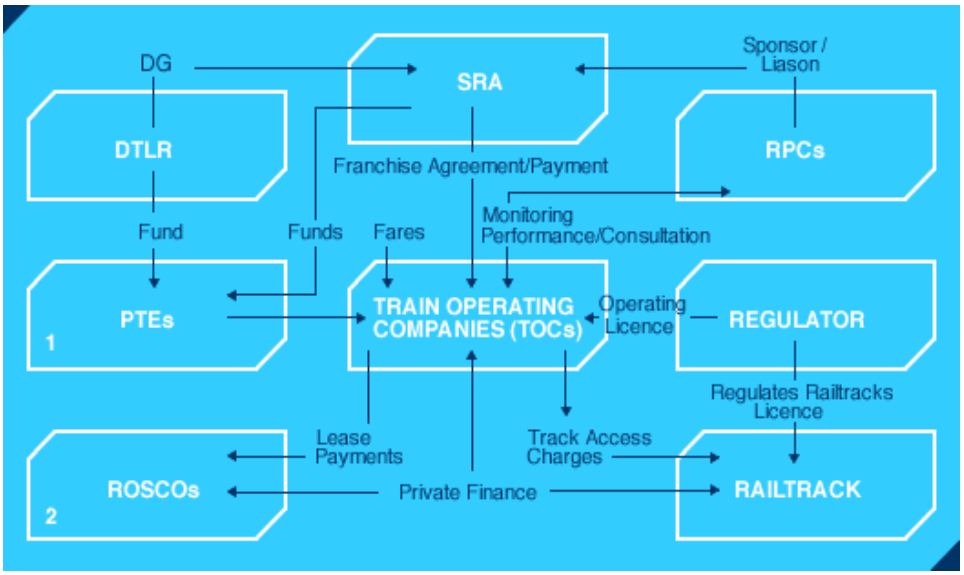
[29] Many European railway companies have formally separated infrastructure and operations within the same State-owned organisation, e.g. RFF and SNCF in France; Japanese railways were privatised on a vertically integrated regional basis; most US railroads are vertically integrated, with substantial mutual cross running, for freight services although the main passenger services provide by Amtrak are provided over other companies' rails.

[30] Similar considerations also apply to some urban rapid transit projects where there is also separation.

Figure 1 UK Rail Structure 2001



Source: Strategic Rail Authority

Some examples

Table 2 provides an overview of some examples of private finance use in major UK infrastructures in four main categories: international fixed infrastructures; national rail infrastructures; national road infrastructures; urban metro systems.

The UK provides examples of a wide range of types of private involvement. Other countries provide variations on the theme. France has had a system of toll roads provided under concessions since 1955, the present system dates from 1970. By 1998 this accounted for some 6490km out of a total length of motorways of 8490km. Although the network is largely under concession, there is a strong element of public involvement with a system of cross-subsidies between the more and less successful. In the US there has been use of privately provided and tolled express lanes in California as additions to existing highways. This foreshadows the planned tolled Birmingham Northern Relief Road as a parallel motorway to the heavily congested M6 motorway in the West Midlands in the UK and the proposed "A-model" for tolled additional lanes for heavy goods vehicles in Germany. Germany has also had the "F-model"[31] in operation since

1994. This relates principally to key links in the network, mainly bridges and tunnels, and currently involves 10 projects totalling 70.7km with a total construction cost of €2.9bn. These are designed as tolled links, aided where necessary with up to a 20% federal subsidy.[32]

[31] Fernstraßenbauprivatfinanzierungsgestetz
[32] For further details see Ewers and Tegner (2000)

Table 2 Examples of Private Finance Use in Major UK Infrastructures

Infrastructure	Size of investment	Type of private finance used	Public sector involvement
International project Channel Tunnel (UK/F)	£10bn	Private: equity and loan capital.	Minimal: quality regulation
National rail projects CTRL (UK)	£5.2bn	PPP	£3.1bn capital grant
National road projects A1(M) Alconbury-Peterborough (UK): (21km road upgrading) A50: Doveridge By-pass (7.7km upgrading and new road as part of 57km strategic Stoke-Derby link)	£128mn £29.6mn	DBFO PFI DBFO PFI	Shadow tolls Shadow tolls
Urban Metro projects ***Midland Metro (UK): 20.4km new tram network*** ***DLR Lewisham extension (UK): 4.2km light rail extension***	£145mn £202mn	PPP PPP	Govt and EU grants; Govt approved loan TfL subsidy

Key issues for future research

This paper has identified that, although we have a good understanding of the basic economics of infrastructure provision and the arguments for and against the use of private finance, there are still considerable areas of uncertainty surrounding the precise definition and measurement of key elements. Much of the research to date has tended to examine specific projects in a largely descriptive manner. One of the problems is that examining projects within a single legislative/administrative structure does not give sufficient variation to be able to identify the key drivers of differential performance. The next stage is to try and examine similar projects in a comparative framework. Three main issues for this further research have been identified:

- Definition and measurement of network economies.
- Definition and measurement of transaction costs in vertically integrated and vertically separated transport systems.

- Assessment of the policy and political risks involved in private provision of infrastructure.

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