EXPERIENCE WITH THE PRIVATE FINANCE OF TRANSPORT INFRASTRUCTURE: SOME EVIDENCE FROM THE UK

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Abstract

Private finance of transport infrastructure has developed rather further in the UK than in most European countries over the past two decades. This paper considers the lessons that can be drawn from this experience and, in particular, whether the use of private finance leads to any bias in the spatial allocation of investment. The paper develops a framework which identifies the importance of the contractual structure for private finance. This shows how in the presence of asymmetric information it is difficult to achieve the expected shifting of risks to the private sector and although transactions costs become more transparent, they may also increase. The UK experience is used to illustrate this and to assess the extent to which private sector provision impacts on regional development.

Keywords: Infrastructure; Private finance; Transactions costs; Regional development
Topic area: H2 Public/Private Partnerships and Major Infrastructure Projects

1. Introduction

Private finance of transport infrastructure, either through direct private provision or through public-private partnerships has developed rather further in the UK than in most European countries over the past two decades. It is appropriate to consider what lessons can be drawn from this experience. In particular, does the emphasis on private finance lead to a bias in the spatial allocation of investment and what are the consequences of this?

The paper uses a framework which identifies the importance of the contractual structure for private finance. This shows how in the presence of asymmetric information it is difficult to achieve the expected shifting of risks to the private sector. Given the complexity of such contractual structures, although transactions costs become more transparent, they may also be expected to be higher than in a vertically integrated public sector provider. The benefits may thus depend on the private sector being able to manage the process of investment and introduction into service more efficiently than traditional public sector transport providers.

This paper reviews the UK experience in terms of developments in various modes. The paper highlights the variety of methods of introducing private finance and assesses these against the criteria of risk bearing, transaction cost reduction, and efficiency in delivery. The key problems are identified as relating to the treatment of network effects and the vertical separation of infrastructure and service (unbundling).

The framework is used to assess the extent to which private sector provision impacts on regional development either positively, by advancing the provision of infrastructure which can provide wider benefits, or negatively by becoming a drag on future development by imposing higher costs of infrastructure usage and maintenance. It becomes clear that a distinction needs to

be drawn between infrastructure which is mainly used for intra-regional transport and that which has an inter-regional or international dimension.

2. The economics of infrastructure provision

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. Hence 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. However, the lumpiness and long gestation period of infrastructure prevent perfect marginal adjustments of capacity to demand. This characteristic provides the 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, although 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 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: 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. Sometimes inadequate specification of the project compounds the expected construction cost risk. Inefficiency in the management of the construction contract can make it easy for contractors to inflate costs and not appear to be responsible for these increases. 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. Commissioning bodies 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.

In a recent survey Flyvbjerg *et al* (2002) (and see Flyvbjerg *at* al, 2003) suggest that infrastructure costs are underestimated in 90 per cent of transport projects and that actual costs are on average 28 per cent higher than estimated. This figure rises to 34 per cent for fixed-link (major bridge and tunnel) projects and 45 per cent for rail projects, and is around 20 per cent for road projects. The data used in the study cannot determine whether private sector projects are more or less prone to such underestimation than public sector projects, but it does suggest that transport projects are not more susceptible to this problem than other large infrastructure projects.

Once completed, infrastructure providers also face operational risks. Where usage is below that expected there may be revenue risks. The tendency to underestimate costs is often seen to go together with the tendency to overestimate potential usage. Flyvbjerg *et al.* (2002, 2003) suggest that the degree of overestimation is greater in rail projects (average 40%) than for road projects (9%), but both suffer from a similar degree of risk of error. 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. Where traffic forecasts underestimate traffic, 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.

Most difficult to assess are the policy and planning risks which any infrastructure provider has to take into account. 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 governments with respect to their own decisions; the lack of clarity in the handling of Railtrack by the UK government is an example of this. 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.

Changes of policy which affect the competitive position of a mode also cause problems. The confusion over Railtrack caused problems for private UK rail operators and their commitment to co-financing infrastructure improvements. Continuing 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. Although infrastructure is costly to provide, the unit costs of infrastructure per passenger- or tonne-km are relatively small. One estimate is that infrastructure costs contribute between 18% and 23% of average road costs per vehicle km (including external costs, but excluding congestion) (see ITS, 2001 and Link *et al*, 2000).

A basic rationale for public involvement has been 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. Vickerman (2000, 2002) provides a summary of the issues and SACTRA (1999) and Mackie *et al* (2001) discuss the relevance of this for evaluation procedures. The question remains 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. However, there may be occasions where that surplus would lead to infrastructure being built in the wrong place to secure the desired regional development/cohesion benefits Then the public sector has to manage private sector pressure for specific investments which may not be seen to be in the wider public interest.

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 sized projects in order to be financed. 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. For example, consider the case of the Channel Tunnel where the linking high speed rail infrastructure in the UK will only be fully completed in 2007, 13 years after thw tunnel opened. This problem is compounded by 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 have set out in this section a range of the basic issues which arise in considering the provision of infrastructure. In the following two section we examine how far the public and private sectors are able to meet these requirements.

3. Funding options

3.1. Public infrastructure and public funding

The principal rationale for public sector provision of infrastructure is as a public good. This implies that infrastructure should be financed directly out of general tax revenues. However, infrastructure rarely meets all the criteria for a public good. 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 (SACTRA, 1999).

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 Aschauer (1989) and Biehl (1986, 1991) studies in the late 1980s showed that there were potential 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 (Gramlich, 1994; SACTRA, 1999).

If 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 comes out of general funds. Since users of infrastructure create external costs there is a case for raising charges for the direct use of infrastructure to reflect this use of resources. Many of the wider benefits of transport also 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.

The long gestation and construction periods of infrastructure frequently do not coincide with the planning horizons of public finance nor the political cycle of elections. 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.

3.2. Private funding options

The existence of private benefits is the basis of the case for the private financing of infrastructure, but the two principal arguments used in its favour are: concern about the ability and efficiency of the public sector in the management of large scale projects and the availability of finance capital seeking projects which could advance the scheduling of a project. These two factors are expected to reduce the total cost of a project.

The counter-argument is that the cost of finance to the private sector is typically higher than to the public sector, given the higher degree of risk to the former. This problem can be partially overcome if the public sector provides guarantees to ensure that any benefits are not lost through inability of the private sector to complete a project. However, guarantees reduce the incentive for the private sector to seek cost reductions in construction or to be accurate in traffic forecasts. This necessitates the development of more effective contracts which reduce the implicit problem of asymmetric information and provide the right incentives.

The operator has to identify the beneficiaries from a project in order that they can be appropriately charged. Since operators will only be able to charge direct users of the infrastructure, this requires that total benefits are sufficiently captured by user surplus. This is only likely in projects 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, but it could also apply to parallel roads or express or truck lanes on highways. Private sector funding of infrastructure is thus likely to be associated with a degree of monopoly power and the public sector may need to consider exercising some regulatory control.

Most toll bridges and motorways do face price controls, but Eurotunnel, the operator of the Channel Tunnel, was not subjected to price regulation given the competition from ferries, which are (largely) private sector operated. It does face some quantity regulation in having to provide certain minimum levels of service. Where franchises are granted on the basis of competitive tenders it can be argued that the tendering process ensures an element of regulatory control, the idea of competition for the market instead of competition in the market, but in practice operational regulation is usually necessary. 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 private finance options are open (see 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.

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. CTRL is currently on schedule and to budget and the Highways Agency estimates cost savings of about 15% on PFI road schemes. 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 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. Secondly, it has to be questioned whether a framework allowing for full competition, rather than competitive bidding, could ever be introduced for major infrastructure.

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

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.

The PPP scheme for London Underground has been particularly controversial. This transfers the management and responsibility for upgrading of the infrastructure (but not the ownership) to private sector consortia, whilst control and responsibility for service delivery remains firmly in the public sector through Transport for London (TfL). TfL and the London Mayor 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 (Ernst and Young, 2002). The real question is the effective degree of residual control retained in a PPP scheme.

The key questions remain those of the distribution of risk and the level of transaction costs 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 the ultimate guarantor of a scheme. 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. CTRL is currently on schedule and to budget and the Highways Agency estimates cost savings of about 15% on PFI road schemes. 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.

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This raises the question of the appropriate length of any 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 concession period can become a bargaining issue, as for example in the case of the Channel Tunnel where the original concession of 55 years 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 to help provide a cash flow during the construction period as a means of easing the potential revenue risk in the early years (such as with the Dartford and Severn bridges).

The vertical separation of infrastructure and service provision (unbundling) inherent in the private finance of infrastructure implies that transaction costs become more transparent and therefore open to competitive pressure leading to greater efficiency. However, protecting each organisation against risk of default implies contractual obligations which may raise effective transaction costs. This is compounded by the asymmetry of information in such contracts which leads to their being incomplete and therefore more costly.

In the following section we consider a number of examples of private provision in the UK and assess these against the framework developed above.

4. Some UK examples of private finance

4.1. The channel tunnel

The Channel Tunnel is a unique case and in many respects not typical of private project finance. Entirely privately financed through a fixed-term concession, with neither government subsidy nor guarantees, the project has a complex contractual structure involving two governments, construction companies, banks, and the national rail operators. The total cost increased progressively during construction from €7.5 billion to over €16 billion (in 1987 prices), due to problems in construction, changing government safety requirements and a delay of about a year in the start of operation. The governments agreed to successive increases in the length of the concession, from the initial 55 years to an eventual 99 years. As well the increase in costs, revenues have not met original expectations. The first three years of operation were characterised by intensive price competition from the ferry operators such that revenue yields were much worse than had been forecast. Through rail services have never reached the traffic levels forecast.

A number of lessons can be drawn from the experience of Eurotunnel. First, there was a high degree of risk and uncertainty over construction costs and traffic/revenue forecasts. Secondly, the concessionaire, Eurotunnel, had no record of project promotion or management and experienced problems in negotiating contracts and then managing them. Finally, the exceptional character of the financing necessary for a project of this size and complexity posed immense difficulties. Construction took seven years, during which time there was no revenue but a mounting debt, rendering the project unsuitable for the typical 15-20 years financing package for projects.

4.2. Railtrack

The UK attempted to effect a wholesale transfer of its rail system to the private sector. The track network was privatised as a public limited company, Railtrack; passenger rail services were franchised as 25 separate operations; and freight services were sold to private sector companies. The privatisation of Railtrack was similar to that previously used for other public utilities with shares offered to the public at a price which discounted the true value of the assets. Railtrack's revenue was derived from track access charges, regulated by the Rail Regulator, paid by the operators, but derived in part from subsidies provided to the franchised operators by the government. Thus an enormously complex contractual structure for the rail industry was created (Figure 1).

Railtrack had to face the consequences of long-term under-investment in Britain's railway infrastructure. The need was to establish an investment programme to modernise the network. This was to be financed out of Railtrack revenues, borrowing, and joint ventures with the public sector where it could be shown that there were wider social benefits. Previous under investment in rolling stock also led to investment needs since new trains using new technology placed major demands on infrastructure.

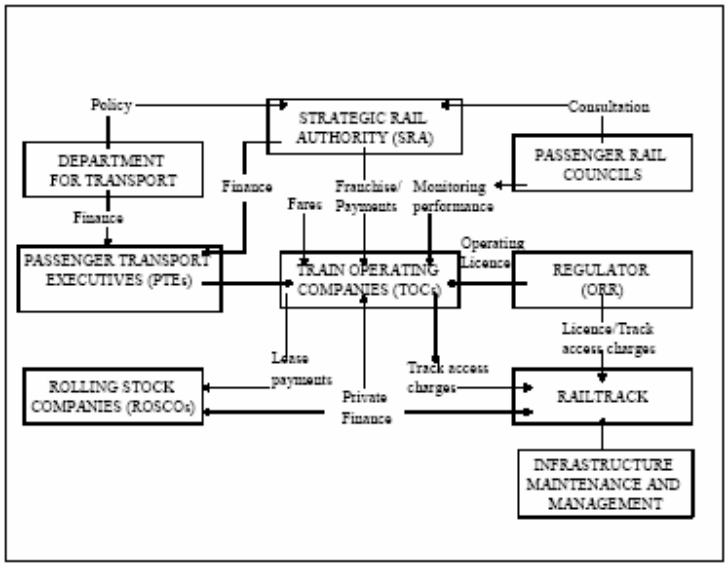

Figure 1 Organisational structure of British Railways, 2001

Although the income stream from track charges guaranteed by government subsidy appeared fairly certain, there was a risk problem in that failure to deliver a slot on the network led to a penalty claim by the operator. Thus if the signalling failed the operators of all affected trains were entitled to compensation, if the train of one operator derailed due to problems with the track or failed due to rolling stock problems, then a complex set of contractual claims ensued. Given the state of the network this began to arise regularly causing Railtrack income problems. There were also delays in finalising the investment programme and the flagship WCRM project began to escalate in costs, but the major problem arose due a series of serious accidents each of which identified problems with the sate of the infrastructure, or the management of maintenance. This increased Railtrack's costs and reduced its revenues leading to increased demands for government assistance. Finally Railtrack effectively failed and was placed in administration by the government,[1] eventually being replaced by a new not-for-profit company, Network Rail, which took over Railtrack's rail assets in 2002.

The largest rail investment programme, West Coast Route Modernisation (WCRM), is an interesting case study of private sector infrastructure problems. Originally Railtrack planned a €2.1bn core investment programme to restore the infrastructure to "modern standards", to which were added upgrades, essentially to allow 200km/h operation (€230mn) and a further enhancement to 225km/h (€930mn). The latter involved an agreement with the main train operator, Virgin. The allocation of financing between a (then) privately owned Railtrack which, however, depended on government funding, through regulated track access charges and direct grants for investment, and the privately owned rail operator (responsible for making the investment in rolling stock) is complex. The original concept emerged as flawed, as well as the initial management of the project, and the project subsequently had to be reformulated into two Phases. This makes it difficult to identify where the costs went out of control, but the total cost of the project has risen to at least €9.75bn of which around €6.7bn is the cost of the core investment programme over the two phases. There remains some doubts over the achievement of some of the potential benefits of the 225km/h operation for which Virgin has spent around €1.55bn on new tilting trains and the current plan is only for a delayed introduction of 200km/h operation.

More successful has been a scheme which has been largely outside the influence of Railtrack, the Channel Tunnel Rail Link. CTRL is a PPP scheme to construct a 120km high speed rail line in two stages between London and the Channel Tunnel. The government is providing €2.8bn of direct support (to secure the regional benefits), but is also supporting a further €5.8bn through guarantees to reduce the cost of the €9bn project to the private sector, a deal which the National Audit Office has deemed to be poor value for money. Actual private finance is thus very limited. Interestingly this project appears to have been managed both on time and on budget as the first stage came into operation in September 2003.

It is difficult to identify a clear set of implications from the Railtrack experience, but it seems to reflect a number of separate factors. The initial state of the network was clearly a problem, coupled with some inadequacies in management. The temptation for an apparently cash-rich company to appease shareholders with increasing dividends as share prices rose rapidly in a stock market boom meant that the investment programme was insufficiently developed. Above all the company came under increasing pressure as reliability fell and the fatal accidents led to claims of profitability being placed ahead of safety. It seems unlikely that the principle itself was flawed, the separation of infrastructure and services in rail has been required under European Commission directive 91/440 of 1991, and although many have argued that the resulting vertical separation is inefficient, Banverket in Sweden has not had the same problems. However, the practice in the UK clearly had serious weaknesses, at least in the early stages before the creation of a Strategic Rail Authority to provide some overall direction to the rail system as a whole. This has highlighted both the transactions costs problem of complex structures and the risks involved in taking on responsibilities within such a structure.

4.3. Urban public transit

The construction of new infrastructure for urban light rail transit has also seen the use of private finance in various forms. The UK has used various forms of public-private partnership (PPP) for this type of investment. In most cases this involves a joint venture of construction firms, finance providers and transport operators to provide the private investment whilst the public sector contributes some combination of initial grants, guarantees and ongoing subsidies. Not surprisingly the first of these to be completed (see Table 2) have occurred in the major urban areas (London, Birmingham and Manchester). There is a long list of projects under construction or at the advanced planning stage, with extensions to each of the existing schemes and new projects in other cities such as Nottingham, Bristol, Leeds, Portsmouth.

Table 2 Examples of urban metro projects

Project	Length	Total investment	Private sector investment	Public sector involvement
Midland Metro (Birmingham)	20.4km	£145mn	£11.4mn	Govt and EU grants
Manchester Metrolink Salford Quays/Eccles extension		£160mn		Govt grants
DLR Lewisham extension	4.2km	£202mn	£202mn	Govt approved loan TfL subsidy
Croydon Tramlink	28km	£205mn	£75mn	Govt grants

PFI projects have also been used for developments on the London Underground, initially for the provision of new rolling stock (e.g. a €635mn project for new trains for the Northern Line), but now controversially for maintenance and investment in the infrastructure.

4.4. Privately financed road projects

Whereas the French system of Autoroute concessions uses direct tolls, the UK has used a system of shadow tolls. This involves contracting out the provision and maintenance of sections of road to private contractors in return for a payment based on traffic flow and a notional toll. In some cases this has involved transferring the responsibility for a complete route in return for new construction (or upgrading) of one section. The incentive to the operator is to balance the higher cost of quality in construction against lower potential maintenance costs (and loss of traffic volume and hence revenue) in the future. Eight projects totalling nearly 600 km of route and involving new investment of more than €900 million have been completed (see Table 3) and a further two projects are in the contract stage.

A concession system has been used for some of the principal estuary crossings. Two of the more recent ones, the construction of new bridges at Dartford on the M25 London Orbital Motorway and across the Severn on the M4 London – South Wales Motorway, involved transferring existing tolled crossings to the new concessionaire, thus providing a source of revenue during construction. The concessions have a fixed maximum length (typically 20 years), but expire when the capital cost of the new infrastructure is amortised if that is sooner. Thus the concessionaire accepts the downside risk, but benefits from a better than forecast traffic flow by being released from the concession early.

The UK is experimenting with a purely private road, the Birmingham Northern Relief Road, to provide an alternative to a particularly congested section of the M6 Motorway. The idea is that this should be a section for which users would be prepared to pay for a better, less congested, route than the parallel free road. There were long delays in approving this road and signing the necessary contracts, but it was opened for operation in January 2004. Interestingly, as with the Second Severn Crossing, the route is being configured so as to direct though traffic towards the tolled link.

Table 3 UK DBFO road schemes

Project	Length	Total investment	Region
A69: Carlisle-Newcastle	84km	£9.4mn	N
A417/419: Swindon-Gloucester	52km	£49mn	SW
A1(M) Alconbury-Peterborough:	21km	£128mn	E
M1-A1 Lofthouse-Bramham	30km	£214mn	YH
A50: Stoke-Derby link	57km	£20.6mn	EM/WM
A30/35: Exeter-Bere Regis	102km	£75.7mn	SW
M40 Denham-Warwick	122km	£65mn	SE/WM
A19/A168: Dishforth-Tyne Tunnel	118km	£29.4mn	N
A249 Sheerness Link Road*	17km	£75mn	SE
A1(M) Darrington-Dishforth*	22km	£240mn	YH

There are similarities between this scheme and the concept of tolled express lanes on some highways in the US. This idea is being carried forward in Germany with truck lanes paralleling existing Autobahn routes for which extra charges would be levied in the proposed 'A-modell'. Germany has also had the 'F-modell' in operation since 1994 which 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. (Ewers and Tegner, 2000).

5. The regional impacts of infrastructure provision

It is not proposed to review the question of the relationship between infrastructure provision and regional development in detail here. Our main interest is the way in which alternative methods of finance may have differential impacts, positive or negative, on regions.

Such differentials can arise from both the *type* of finance and the *source* of finance. Starting with the type of finance, the relative balance of public and private finance will have implications for the fiscal pressure exerted on the region. Where a public contribution to the finance is required this will require a contribution from the region which has to be met via increased taxation (or reduced expenditure on other areas of public services) or by borrowing. Expenditure is required not just for the initial capital outlay, but also for the long-term maintenance of the infrastructure. Even where 100% private funding is used there may be some diversion from other uses of such funding (e.g. alternative PFI projects in health or education).

The source of finance relates to the geographical and distributional origin of the finance. Thus infrastructure projects in economically lagging regions may be funded to a large measure by transfers (public or private) from economically more advanced regions. In both cases the overtly redistributional nature of this finance may hide implied greater returns to the source region. Where private finance is used this may involve a redistribution from areas of greater savings to areas of lower savings, but the greater risk often attached to projects in more peripheral regions may cause investors to be more reluctant to back projects in less dynamic regions. This pushes back investment into the public sector with the attendant fiscal pressure problems.

As previous sections have identified, however, the key issue to be resolved is the distribution of risk. There is not just the distribution between public and private sectors, but also the spatial distribution within each sector.

The evidence from PFI road projects and urban metro projects in the UK suggests a rather mixed outcome. By and large the main projects have been in the more economically dynamic regions of the Midlands and South, despite a policy which overtly targets transport infrastructure towards the regeneration needs of regions. However, some of the larger projects (e.g. the M1-A1 link and A1(M) upgrade in Yorkshire) are in more northerly regions. Historically there had been greater emphasis on the provision of road developments in less prosperous regions as part of regional development initiatives, and this may be a reflection of the rebalancing necessary to address increasing congestion in the Midlands and South. Certainly for the private DBFO developer receiving shadow tolls, the greater certainty associated with higher traffic volumes may be an incentive. It may also be argued that it is part of government redistribution policy to use public funds for roads in lagging regions and use the private sector where user benefits can be predicted with greater certainty.

Not surprisingly the first urban light rail developments to be completed have occurred in the major urban areas. These projects have all required direct government finance in the construction phase and/or continuing subsidies in operation. PFI projects have also been used for

developments on the London Underground, where there has been a long period of failure to manage investment effectively in the public sector.

In the national rail network the two major projects, the Channel Tunnel Rail Link and the upgrading of the West Coast Main Line, are clearly major inter-city schemes. CTRL, linking London with Paris and Brussels, could be viewed as having a very metropolitan focus, but also has important regional implications in the provision of accelerated regional rail services for the least developed part of the south-east region. West Coast Route Modernisation (WCRM) is much more difficult to disentangle in its regional effects. It links the major urban areas of London, Birmingham, and Manchester; it parallels one of the most congested stretches of inter-urban motorway; and it provides links to less developed areas of Merseyside and the North-west. However, it also helps to reinforce the accessibility and dominance of London.

The problems with delivering the upgraded railways has led the Strategic Rail Authority to return to the concept of a new dedicated high speed rail infrastructure for London-North of England/Scotland rail services. This would, of course, have a major impact on regional economies and the battle is clearly on in terms of determining the optimal route for such a link.

6. Some quantitative evidence

The location of such investments does not therefore demonstrate a clear regional bias, but we still have to face the question of what happens when expectations are not met by reality. Cost overruns or traffic shortfalls may make the initial planned level of service difficult to sustain. This may happen with domestic services on CTRL where the consultation document issued by the SRA (SRA, 2003) shows extremely marginal returns from even the most basic service pattern. If such a situation develops local authorities may be put under pressure to sustain levels of service through subsidy thus placing a long-term fiscal burden on residents. The problems with the WCRM project are placing particular difficulties on some regions because of disruption to service through long-term blockades of particular parts of the route – this could have consequences for local business and for regional development. Judging the long-term regional impact of major transport infrastructures thus becomes a more complex issue than just a simple cost-benefit calculation; it is one in which the risks and uncertainties of the development play an major role. These risks and uncertainties are compounded by the way a project is financed.

At this stage it would be useful to assemble some empirical evidence of the distribution of different types of investment expenditure across the UK regions and assess whether this has had any significant impact on regional performance. This is not an easy exercise. Parry (2002) assembled evidence on both the physical lengths of surface roads and expenditure on road development for the English regions for the period 1979-1994. This is the period immediately before the first use of privately financed DBFO schemes and could suggest whether the distribution in Table 3 was a compensation for, or a continuation of previous regional distribution.

This was divided into motorways and trunk roads which were classed as inter-regional infrastructure, and other non-trunk roads which were classed as intra-regional infrastructure. Although overall expenditure is an important measure, there have been substantial differences in both inter- and intra-regional expenditure over the period, it is affected by regional size and urban densities as well as location on the overall network. Thus the spending intensity (defined as expenditure per km) was derived as a measure of quality for each set of roads. For both inter- and intra-regional infrastructure, there was both a steady rise in spending and more interestingly significant reduction in the gap, by about a half, between the regions with the highest spending intensity and those with the least over the 1979-1994 period.

Table 4 summarises the changes in spending intensity and also the road density (km of road/km^2 area) along with changes in regional GDP. This displays an interesting mix of changes in both inter- and intra-regional infrastructure, but no clear picture. As a final text the infrastructure variables were used to condition a standard convergence model following the suggestion of Martin (1998) who identified an increased rate of convergence in European regions when infrastructure variables were added.

Table 4. Summary of changes in regional road infrastructure, 1979-1994

	% increase GDP	% increase intra-regional intensity	% increase inter-regional intensity	% increase intra-regional density	% increase inter-regional density
North	225.4	212.8	141.8	3.0	0.8
Yorkshire and Humberside	219.5	801.0	45.7	3.7	8.9
North West	220.7	328.2	227.4	9.1	7.3
West Midlands	227.4	668.7	430.4	5.2	9.2
East Midlands	232.5	180.6	814.7	2.9	- 8.6
East Anglia	269.6	317.2	146.1	0.7	- 0.7
South West	256.2	474.4	356.2	6.2	12.8
South East	251.0	271.9	186.6	10.5	2.2

Source: Department for Transport data

Using the following estimating equation for a set of different infrastructure indexes:

$$\frac{1}{16}\ln\frac{Y_{94}}{Y_{79}} = \alpha + \beta \ln Y_{79} + \gamma I_t^e$$

produced the results summarised in Table 5. None of the coefficients are significant, but the results do show that against a background of underlying divergence in the English regions, road infrastructure, and especially road infrastructure spending does seem to have slowed down the rate of divergence.:

Table 5. Estimation results

	α	β	γ
I1: basic index	0.064	+0.00172	-0.000418
I2: density	0.0277	+0.00611	-0.0000552
I3: inter-regional intensity	-0.024	+0.0128	-0.000207
I4: intra-regional intensity	-0.131	+0.026981	-0.000901

One further test was simply to relate GDPO changes to expenditure intensities, these suggest an elasticity of GDP with respect to intra regional expenditure intensity of 0.05 and with respect to inter-regional intensity of 0.03. Significantly these estimates were based on the flow of expenditure and not on the more traditional infrastructure stock variable which showed much lower impacts, especially the intra-regional intensity which had a negative coefficient. This

suggests that expenditure during this period was at least addressing the issue of historical deficiencies, and most especially in intra-regional infrastructures. If privately financed DBFO schemes are regionally distributed similarly to previous public expenditure and if they are not at the expense of correcting deficiencies in the intra-regional infrastructure they can make a positive contribution.

7. Conclusions

In this paper we have highlighted how the basic characteristics of infrastructure lead to a number of major difficulties in the introduction of private finance. This has been illustrated with examples from British experience in a number of contrasting projects. The difficulties arise principally from the various dimensions of risk which are present in such projects: construction, operational and planning risks. However, the sheer complexity of major transport infrastructures and how they relate to the operation of services leads to problems. The idea that increased efficiency can be gained from the greater transparency of transactions costs when infrastructures separated from operation and provided privately has been shown to be misplaced.

The UK examples range from the purely privately financed Channel Tunnel project to a variety of public-private partnerships in the provision of new urban public transit projects. Risk, and the ability of the private sector to shift risk back onto the public sector, has clearly caused problems in each of the cases examined. The complexity of organisation has caused difficulties, not least in the saga of Railtrack.

At the regional level each of these issues involves both a horizontal and a vertical dimension. Distribution occurs between different spatial units at the same level and between spatial units at different levels. This leads to the possibility of both conflict and collusion in the planning and financing of transport infrastructure; both of these are likely to led to distortion in the efficient allocation of resources.

The conclusion to be drawn from this analysis is that, although private finance may have a role to play in the provision of infrastructure, especially where clear private sector benefits can be identified, this is only likely to be successful in a public-private partnership where a clear allocation of responsibilities between the two sector can be identified and maintained. Thus estuarial bridge schemes or urban public transit projects have been successful, major fixed link or network infrastructures much less so. This confirms the view that private sector involvement requires projects to be discrete and clearly defined.

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