Road Transport Investment Projects and Additional Economic Benefits

Dr. Torben Holvad
Transport Studies Unit
University of Oxford
Torben.holvad@tsu.ox.ac.uk

Dr John Preston
Transport Studies Unit
University of Oxford
John.preston@tsu.ox.ac.uk

Abstract

The paper examines the linkages between transport and the economy with particular focus on the basis for the additionality of wider economic benefits from road transport infrastructure improvements. A major weakness of current appraisal practice of road transport infrastructure projects is its basis on partial equilibrium analysis. The partial equilibrium approach implies that the linkage from changes in the transport market is ignored creating the scope for a less than comprehensive consideration of all benefits and costs. The importance of ignoring other markets in transport appraisal has been subject to much analysis in the available literature.

The paper will review available theoretical and empirical evidence of how road transport improvements are linked to the wider economy including the possibility for addditionality. It will re-assess the role of Computable General Equilibrium models in measuring these additional benefits.

Keywords: Wider economic benefits, additionality, Computable General Equilibrium Models, macro-production function estimation, ex-post analysis.

1. Introduction

The measures proposed [new roads] will provide the means to improve the country's economic geography, increasing opportunities for the less-favoured areas, assisting urban regeneration and helping the more prosperous areas to cope with growth (DoT, 1989).

There is no evidence whatsoever to support the myth that roads are good for the economy (Whitelegg, 1994).

It has long been recognised that transport investments may have benefits through stimulating economic growth, see for example Rostow (1971) or the quote from the UK Department of Transport above. However, it has been contended that in advanced economies road investments will merely redistribute economic activity rather than generate new activity (Whitelegg, 1994 – and see the quote above). Moreover, it has also long been recognised that in a perfectly competitive economy with perfect forecasting any assessment of the benefits of a road investment to transport users will also be an accurate assessment of the benefits to the wider economy (see, for example, Dodgson, 1973, Jara Diaz, 1985). To count these benefits as additional would involved double counting (Mohring, 1993).

There are at least two concerns with this viewpoint. Firstly, we do not have perfect forecasting. In particular, it is difficult to determine the extent to which roads generate both passenger <u>and</u> freight traffic. This issue was considered in the UK by SACTRA (1994) but there are number of unresolved issues. Secondly, and of most concern to this paper, we do not have a perfectly competitive economy. In particular SACTRA (1999) suggested that both the transport sector and the transport using sectors were imperfectly competitive.

Where investment, pricing and output decisions within the transport sector are at economically efficient levels (including the internalisation of externalities such as congestion, accident and environmental damage), it might be expected that the effects of transport investments on the wider economy by reducing market imperfections will be positive. However, a key issue is whether these potential additional benefits are large enough to be material. A further issue is the spatial distribution of these benefits. Although positive in aggregate, some local areas may be disadvantaged.

To some extent the UK Government's response to SACTRA's 1999 report was lukewarm (Cm 4711, 2000). In particular, the response was dismissive of Computable General Equilibrium (CGE) models that SACTRA (1999) saw as being a key tool in assessing the linkages between transport and the wider economy. Instead, Government emphasized Economic Impact Reports, with a particular focus on transport's impacts on labour and land markets, and the development of Land-Use and Transport Interaction Models (LUTI) to assess changing patterns of activity.

Recently, there have been a number of studies that reflect the continued interest in the linkages between transport and the wider economy. These include UK Department for Transport sponsored studies on the importance of transport on business location decisions (Transport Research Institute and Employment Research Institute, 2004) and of transport and city competitiveness (Llewelyn-Davies, 2004) and the ODPM/RICS (2002) study of land values and public transport. The European Conference of Ministers of Transport (ECMT) has also commissioned research in this field (Goodwin and Persson, 2001).

Another important development has been the refinement of production function and cost function approaches to estimating the wider economic impact of transport and other public investments. There have also been a number of practical advances in the use of CGE models to better understand these linkages (see, for example, Munk, 2003, and Holvad, 2004). This research has been particularly focused at the European Union level and includes the TRENEN (Proost and Van Dender, 1999) and IASON (Bröcker et al., 2001) models.

2. Theoretical Issues

The theoretical framework for this paper is provided by SACTRA (1999), which illustrated some of the circumstances in which additional benefits may occur by developing the three by three matrix illustrated in Table 1. This may be viewed as illustrating the impacts of a transport project that reduces transport times and costs, such as a new road investment. Assuming transport benefits are correctly measured (including externalities), then additionality occurs where B** >1. B** is thus the multiplier described above and is greater than one in three of the nine scenarios. This occurs due to the presence of imperfect competition in the transport using sectors that means prices in these sectors are above marginal cost. This seems to be a likely scenario for the UK. For example, Harris (1999) finds price:cost ratios of between 1.2 and 1.3 for most (two digit) manufacturing industries and most regions of the UK, using data covering the period 1968 to 1991.

Follow-up work by Davies (1999) for three digit manufacturing in the UK between 1980 and 1992 suggests a mark up in the range of 0.22 to 0.26, with a standard deviation between 0.07 and 0.09. However, these margins need be adjusted for normal rates of return, which Davies estimated to be of the order of 7%. With respect to the transport sector (and particularly road transport) the most likely scenario is that prices are below (long-run) marginal costs as prices do not take full account of externalities such as road damage, accidents, congestion and environmental costs (see, for example, Sansom et al, 2001). In such cases, the impact of standard cost benefit analysis is indeterminate. We need to know the magnitude of transport's negative externalities and the transport using sectors' positive externalities. This is an empirical issue. However, were cost benefit analysis to take into account transport's negative externalities, then the benefits of increasing the competitiveness of transport using sectors through either opening them up to more competition and/or permitting the exploitation of greater economies of scale would be additional in most circumstances. It is these circumstances that our work has explored.

Table 1: Partial Equilibrium analysis of Imperfect Competition and External Cost Effects on the Evaluation of Transport Projects

	Transport Using Sectors		
Transport Sector	P< MC	P = MC	P> MC
P<LRMSC	B<1; B**<1	B<1; B**=1	B=?; B**>1
P=LRMSC	B<1; B**<1	B=1; B**=1	B>1; B**>1
P>LRMSC	B=?; B**<1	B>1; B**=1	B>1; B**>1

P = Price
MC = Marginal Cost
LRMSC = Long Run Marginal Social Cost
B = Total Economic Benefits/ Total Transport Benefits where the latter is measured by conventional CBA
B** = Total Economic Benefits/ Total Transport Benefits where the latter is measured by CBA that includes all transport externalities.

Additionality can also be explained by way of Figure 1. Suppose we have an industry that exhibits monopoly characteristics so that private benefits (determined from the marginal revenue curve) are below social benefits (determined from the demand curve). Suppose also that, solely as a result of transport improvements, the unit costs of producing this good is reduced, leading to an expansion of output from x to x'. A conventional transport cost-benefit analysis would solely take into account the benefits of reduced costs to existing freight movements (rectangle A) and the benefits of reduced costs to generated freight movements (triangle B). However, it would not take into account the additional social benefits (quadrilateral C) arising from the benefits to consumers and producers of increased output. In this instance, the multiplier can be computed from the ratio of A + B + C to A + B. In essence, the multiplier here may be seen as being a gain from trade.

Figure 1: Additional Benefits when Social Costs Exceed Private Costs (Source Venables and Gasiorek, 1999)

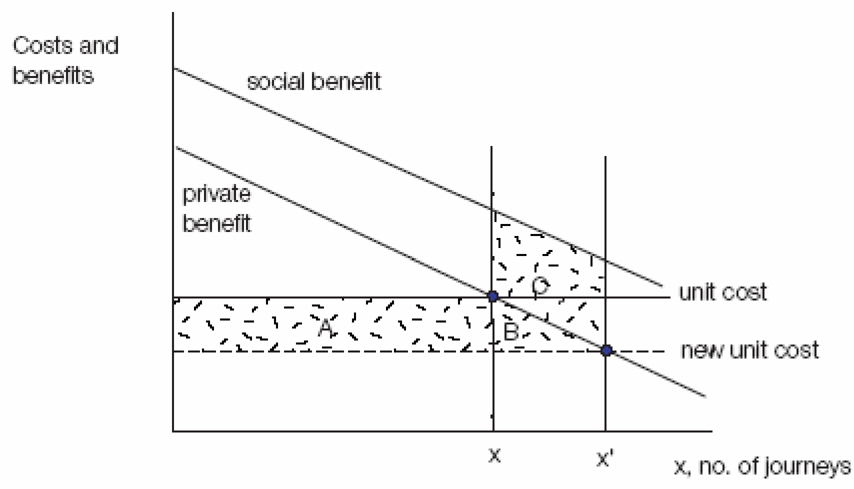
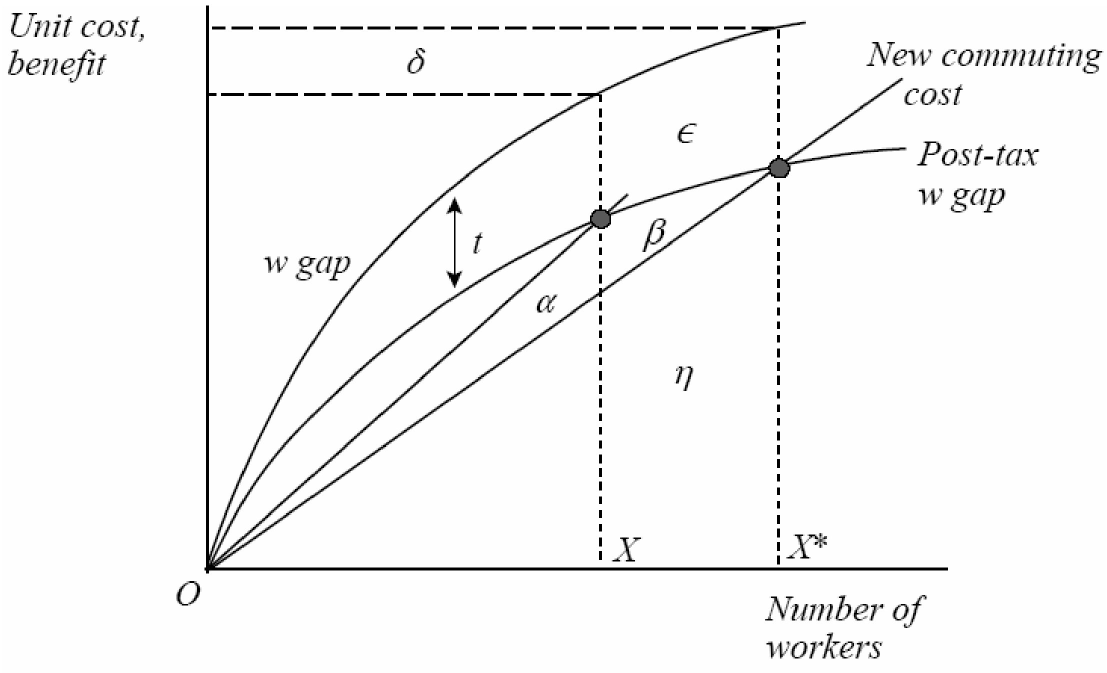


Figure 2 illustrates an alternative source of additional benefits. This is predicated on a positive elasticity of productivity with respect to city size due to a range of agglomeration economies. Rosenthal and Strange (2004) estimate such elasticities to be in the range 0.04 to 0.11. As a result there is a positive wage gap between urban and rural areas and this gap increases, albeit at a decreasing rate, with city size. Suppose we have a linear city with employment located in the CBD. Commuting costs will increase with distance (and hence the number of workers in this linear arrangement). The initial extent of the city will be determined by the intersection of the commuting cost curve and the post tax wage gap curve. Hence, the city will be composed of X workers. If commuting costs reduce, the city will expand to X* workers. Area α is the transport gains to existing commuters. Area β is the transport gain to newly generated commuters. These are the calculations usually included in a conventional cost-benefit analysis. However, we also need to include the area δ, which is the productivity gain, and the area ε, which is the additional tax revenue accruing to government. In this case, our multiplier is given by $(\alpha+\beta+\delta+\varepsilon)/(\alpha+\beta)$.

Figure 2: Additional benefits in the presence of agglomeration economies. (Source: Venables, 2004)



3. Practical Issues

This theoretical framework is linked to a consideration of practical issues. Road transport investments may be expected to lead to the reduction in the generalised costs of a variety of passenger and freight movements. Here we assume a comprehensive generalised cost that includes out-of-pocket costs, journey times and other factors such as reliability and comfort. Five inter-related transmission mechanisms are identified. First, transport improvements will promote regional trade. In extremis, this will include bringing new assets into production such as difficult to access development land or remote tourist sites. Secondly, transport improvements will promote competition in product and factor markets. For product markets, this will involve the extension of the market areas of existing firms and the emergence of new firms. For factor markets, this may involve the reduction in search costs and the extension of search areas in the labour and property markets. Transport improvements may assist in reducing the monopsony powers of employers (Manning, 2003). Thirdly, transport improvements may encourage agglomeration economies through promoting forward and backward linkages between economic agents as well as thick labour markets and knowledge spillovers. These may be thought of as external economies of scale. Fourthly, transport improvements may permit firms to re-organise to exploit internal returns to scale. This may be particularly important in the distribution sector where transport improvements have encouraged consolidation of warehousing and reduction of shipment sizes (Lakshmanan and Anderson, 2002). Here there may be a trade-off between reduced production costs and increased market power. Lastly, by reducing congestion and environmental pollution, transport improvements may reduce some of the key disbenefits of agglomeration.

This suggests that road transport may indeed have some additional economic benefits. However, there are also a number of important caveats and counterarguments. Transport costs only account for a small proportion of total costs, particularly for manufacturing industry, and unit transport costs have been falling. Recent estimates from OECD find that in developed countries transport costs are typically between 2 and 4% of total production costs (OECD, 2002). However, transport is only a small proportion of total logistics costs and with globalisation of trade there is some suggestion that, at least for international movements, transport costs are increasing as a proportion of total production costs. McCann (1998) estimates that transport costs only constitute 10% to 30% of total logistic costs. A further issue is that because there are important adjustment costs in relocating or reorganising production, transport improvements need to be non-marginal to induce an effect. However, this is difficult to achieve in advanced economies where the level of road accessibility is already high.

Another set of concerns relate to displacement. Much of the impact of road improvements may be redistributive rather than generative. This is highlighted by the two way road argument where a road investment linking a backward peripheral region with an advanced core region may lead to economic activity migrating from the peripheral region to the core, contrary to the intended impact of the intervention to promote the migration of activity from the core to the periphery.

Further issues relate to crowding out. Excessive public investment can result in higher tax rates and or interest rates, thus reducing private investment. Moreover excessive investment in road transport may reduce public investments in other sectors that may have additional economic benefits. This includes non-road transport and direct grants to industry. There is also the related issue of leakage into higher costs. Where investment projects are procured in non-competitive situations there is a risk that the investments may merely leak into higher construction and maintenance costs.

Overall, it is concluded that transport investment may be a necessary condition for economic development but it is not a sufficient condition. Other conditions relate to factor endowments (land, labour, capital, natural resources), governance structures, social capital and individual agency.

4. Empirical evidence regarding the magnitude of wider economic effects

Following a taxonomy suggested by Lakshmanan and Anderson (2002) we have identified three broad types of empirical evidence namely general equilibrium approaches; macroeconomic approaches based on production and cost functions; and microeconomic approaches based mainly on studies of employment effects and land values. These are discussed in turn.

4.1 CGE Models

In recent theoretical work, Rouwendal (2002) has reiterated that in conditions of perfect competition additionality is not an issue. However, in the case of a monopoly it is shown that there is an additional indirect effect equivalent to 50% of the direct effect if there is a linear demand function and constant returns to scale. With linear demand and cost functions, there is an additional indirect effect which is positive and at most 50% of the direct effect. By contrast, with a log linear demand function and linear cost function, and in which fixed costs are independent of price, the additional indirect effect is then always larger than the direct effect and especially so, if the elasticity of demand is just above 1.

However, for monopolistic competition models it is not possible to produce generalisable results. Dixit-Stiglitz models that assume constant elasticity of substitution will tend to result in positive additional indirect effects (Dixit and Stiglitz, 1977) but alternative demand formulations (e.g. the logit) can lead to negative additional indirect effect (Rouwendal, 2002). This is because logit models are affected by the independence of the irrelevant alternative axiom that can lead to an overvaluation of product diversity and excessive brand proliferation.

In addition to such theoretical work, the empirical evidence on the magnitude of wider economic effects comes from two main sources. The first set of sources come from stylized theoretical models, typified by the work of Tony Venables (e.g. Venables and Gasiorek, 1999 and Venables, 1999). More empirically based models such as the work of the IASON project provide the second set of evidence. As can be seen from Table 2, these models suggest a multiplier in excess of one although in extreme circumstances they can lead to multipliers of less than one. These multipliers exist because in general transport investments that lower transport costs will reduce the extent of imperfect competition in transport using sectors by reducing prices and increasing output. However, in extremis, transport investments could have multipliers of less than one because they encourage wasteful competition, switch resources from imperfectly competitive sectors to perfectly competitive sectors or promote monopoly rents, in essence making imperfect competition more imperfect.

Overall, the lowest multipliers are obtained from models where the market structure is either based on an oligopoly or a form oligopolistic competition. The low values in Newbery's work are determined in a model where firms are differentiated by distance from the market. In such a case, reducing transport costs increases the market share of the more distant (and hence more costly) firms thus negating much of the benefits of increased competition. It should be noted that in this model the number of firms is fixed, thus excluding one important source of possible additional benefits. Monopolistic competition models of the Dixit-Stiglitz type tend to give larger multipliers, although it is interesting to note that there is little difference between Venables and Gasiorek's partial and general equilibrium models. It is also worth noting that in monopolistic competition models of this type the number of firms can vary but there is no scope for examining the rationalisation of existing firms' operations – again a possible source of additional benefits is excluded. The highest values are given by Venables' work on urban commuter traffic (but this will comprise at most 20% of traffic in most cases) and Oosterhaven and Elhorst's work in the Netherlands of the impact of a magnetic levitation system of the economies of the core and periphery. The eight studies and 13 values in Table 2 suggest a multiplier in the region of 1.4, but with considerable variation around this (standard deviation 0.4).

Table 2: Evidence on Multipliers

Author	Model	Market Structure	Multiplier
Jara Diaz (1986)	Partial	Monopoly	1.5
Venables & Gasiorek (1999)	Partial – Regional Trade	Monopolistic Competition	1.28 – 1.42
Venables & Gasiorek (1999)	General – Regional Trade	Monopolistic Competition	1.35 – 1.44
Newbery (1998)	Partial	Oligopolistic Competition	1.03 – 1.08
Davies (1999)	Partial	Oligopoly	1.12
Bröcker et al. (2002)	General – CGEurope	Monopolistic Competition	1.20
Venables (2004)	General – Urban Commuting	Monopolistic Competition	1.60 – 2.52[1]
Oosterhaven and Elhorst (2003)	General – RAEM	Monopolistic Competition	1.20 (Urban) 1.80 (Inter Urban)

[1] If commuter traffic represents 20% of urban traffic and for the rest of urban traffic a multiplier of 1 applies then a multiplier of around 1.3 applies.

Davies (1999) notes that using a Cournot-Nash oligopoly framework the extent of the multiplier can be determined from any two of the following three variables: price mark-up, number of firms or the elasticity of final product demand to price. Davies argues that, due to measurement problems, there is only limited empirical evidence on elasticities and that the use of the other two variables is more appropriate.

4.2 Cost and Productivity Models

The second set of substantive evidence relates to ex post modelling, particularly the work on production and cost functions. Some of the key evidence here is presented in Tables 3, 4 and 5. Table 3 shows that initial production function work was based on time-series data and gave an elasticity of output with respect to public capital in the range 0.15 to 0.77 (mean 0.52, standard deviation 0.18).

Critics such as Gramlich (1994) believe the initial results of such studies were 'stratospheric' suggesting implausible rates of return (in particular that public capital investments would have a payback period of around one year). Attention was placed on statistical problems related to the non-stationarity of the data and misspecification of causality. In addition, problems with data quality and missing variables were identified. Attempts to deal with these problems generally led to lower elasticity estimates.

Table 3: Output elasticities derived from aggregated production functions (data sets based on time series)

Country	Output elasticity
United States	0.29-0.64
Netherlands	0.48
Japan	0.15-0.39
Germany	0.53-0.68
Canada	0.63-0.77
Belgium	0.54-0.57
Australia	0.34-0.70
France, UK, Finland, Norway, Sweden	Wide range between highest and lowest value

Source: Johansson et al. (1996) as cited in Goodwin and Persson (2001).

Table 4 shows the results from production function models based on pooled time-series and cross-section data. It can be seen that the range of elasticities is much reduced (0.03 to 0.20) as is the mean (0.12), although there remains considerable variation (standard deviation 0.08), not least because of different definitions of the key variables.

Table 4: Examples of output elasticities derived from aggregated production functions (pooled data sets)

Author	Coefficient	Level of analysis	Infrastructure variable	Productivity variable
Costa, Ellson, Martin (1987)	0.20	State	Public capital	Output
Munnell (1990)	0.15	State	Public capital	Gross State Product
Duffy-Deno and Eberts (1991)	0.08	Metro Area	Public capital	Personal income
Eberts (1989)	0.03	Metro Area	Core public capital	Manufacturing value added

Source: Department of Transportation and Federal Highway Administration (1992)

Table 5 show the results of production function work that specifically focuses on the transport sector. This table suggests an elasticity of output with respect to transport capital in the range 0.04 to 0.31, with a mean value of 0.17 and a standard deviation of 0.12. Variants of this work have examined the output of the transport sector with respect to transport capital. For example, Aschauer (1989) found that in the US the elasticity of trucking industry output to highway investment was 0.8.

Table 5: Selected results from studies of the impact of transportation infrastructure investment on economic growth

Study	Type of model and data	Effect of transportation investment	Output elasticity of public capital
Aschauer (1991)	Production function growth model (USA data)	1. Total transport capital effect on growth of K_p/L 2. Transit capital effect on growth of K_p/L 3. Highway capital effect on growth of K_p/L	0.166 0.384 0.231
Seitz (1993)	Leontief cost function (German highway data)	Change in average private cost	0.05
Garcia-Milà and McGuire (1992)	Production function (USA data from the 48 contiguous states)	Elasticity of Gross State Product with respect to highway capital	0.04
Munnell (1990b)	Production function (USA data from the 48 contiguous states)	Elasticity of Gross State Product with respect to highway capital	0.06
McGuire (1992)	Production function (USA data from the 48 contiguous states)	1. Elasticity of output with respect to highway capital 2. Elasticity of output with respect to highway capital – controlling for state effect	0.121-0.370 0.121-0.127
Deno (1988)	Profit function model (USA data)	Elasticity of output with respect to highway capital	0.31
Haughwout (1996)	2SLS spatial equilibrium model (USA data from the 48 contiguous states)	Elasticity of output with respect to highway capital	0.08

Source: Banister and Berechman (2000)

Production function work has been relatively limited in the UK. Demietriades and Mamuneas (2000), using a profit function approach, estimated an output elasticity with respect to public capital of 0.358. Pereira (2001), using a Vector Auto Regressive Error Correction Methodology, estimated an elasticity of 0.143. Lynde and Richmond (1992), using a translog value added cost function, estimated the output elasticity to be 0.2. Their work suggested that approximately 40% of the UK's observed productivity slowdown could be attributed to the decline in public capital to manufacturing labour ratio.

Quinet and Vickerman (2004, p28) summarise similar evidence and conclude that a plausible range of the elasticity of output with respect to public capital is 0.05 to 0.30. However, they argue that these aggregate ex-post macroeconomic studies do not usually examine the impact of transport infrastructure capital or accessibility on technical progress although they do examine the direct impacts of reduced transport costs. In other words, such studies do not normally examine the scope for endogenous growth (e.g. Crafts, 1996) and hence positive externalities. Quinet and Vickerman go on to argue that such external effects are captured by studies of individual investments and quote two such studies (Quinet, 1992, Prud'homme, 1996) that suggest output elasticities of between 0.10 and 0.60, an approximate doubling of the range suggested by the literature. They suggest that these studies indicate '*the existence of external impacts .. which are worth further investigation*'.

4.3 Ex-Post Monitoring

The third set of evidence is based on ex post monitoring of investment schemes. These usually focus on the impact of road investments on the location of employment and population and on land prices. There is a substantial literature both with respect to the impact of public transport and private transport oriented interventions. For example, ODPM/RICS (2003) identified 150 references on the topic of land value and public transport, with 18 key references examined. They concluded that '*the expected effect on both the residential and commercial property markets is positive but the range of impacts is very variable – from marginal to over 100% in the commercial sector in North America'*, although a follow-up study of the land value impacts of the Croydon Tramlink has failed to pick up statistically significant effects.

A recent review of the influence of highways on metropolitan development in the US (Boarnet and Haughwhat, 2000, pp 6 to 10) identified some 20 references that revealed empirical evidence. They conclude that '*In sum, the evidence suggests that highways influence land prices, population and employment changes near the project, and that the land use effects are likely at the expense of losses elsewhere*'. This work also highlights that highway investments may have negative spillovers by promoting decentralization and suburban sprawl and thus offsetting the economic benefits of agglomeration and the social benefits of integrated communities. They go on to state that '*changes in metropolitan location patterns are induced by highways and these changes are not, on net, costless. A rational highway investment plan should account for the effects on location that highways induce*'.

Some of the evidence that we have uncovered with respect to road transport investments is summarised by Table 6.Table 6 summarises 22 empirical studies examined in the course of this research, of which nine were from the UK, nine from North America and four from continental Europe.

Table 6: Summary of studies examining links between transport infrastructure and local economic development

Author	Geographical Scale	Infrastructure	Conclusions
Botham (1980)	28 Zones (UK)	Changes in national highway stock	Small centralising effect on employment
Briggs (1981)	Non-metropolitan counties (US)	Presence of inter-state highway	Presence of interstate highway is no guarantee of county development
Bruinsma et al. (1996)	Orbital corridor (Netherlands)	New urban motorway	No clear impact on office rents. Some increase in productivity and employment
Cleary & Thomas (1973)	Regional level (UK)	New estuarial crossing	Little relocation but changes in firm's operations
Dabinett et al (1999)	Metropolitan area (UK)	New local roads	Substantial increase in planning applications
Dodgson (1974)	Zones in North (UK)	New motorway	Some relationship between transport costs and employment growth
Eagle and Stephanedes (1987)	87 counties (US State)	County highway expenditure	No relationship with employment growth
Headicar (1996)	Regional corridor (UK)	New motorway	Substantial development
Judge (1983)	Regional level (UK)	New motorway	Very limited economic impact
Langley (1981)	Highway corridor (US)	Highway	Devalued property area

Table 6 (continued)

Author	Geographical Scale	Infrastructure	Conclusions
Linneker and Spence (1996)	South East (129 zones) Rest of GB (50 zones)	Orbital motorway (M25)	Employment growth in areas of accessibility growth (decentralising)
Mackie and Simon (1986)	Regional level (UK)	New estuarial crossing	Small overall effect - some reorganisation of operations
Mills (1981)	Metropolitan areas (US)	Presence of orbital highways	No significant effect on location patterns
Mills and Carlino (1989)	Counties (US)	Interstate highways	Significant effect on population and employment
Moon (1986)	Metropolitan areas (US)	Highway interchanges	Existence of inter-change villages identified
Orus (1997)	Urban and rural areas (France)	Access to national network	Employment growth concentrated in urban areas with good access
Rienstra et al. (1998)	National study (Netherlands)	Motorways	No clear impact on employment
Stephanedes (1990)	87 counties (US State)	Highway investment	Could affect economic development – depends on county's economy
Stephanedes and Eagle (1986)	87 counties (US State)	County highway expenditure	Some positive association with employment levels
Welsh Economy Research Unit (1996)	Regional corridor (UK)	Trunk road improvements	Small increase in employment
Wilson et al (1982)	Regional level (Canada)	Highway investment	Some regional economic develop-ment identified
Zembri- Mary (1996)	Regional corridor (France)	New Motorway	Large increase in land values

Sources: Nelson, Leitham and McQuaid, 1994, David Simmonds Consultancy, 2000, Banister and Berechman, 2000, Quinet and Vickerman, 2004.

In four of these studies no effect on the wider economy is detected, in one study the effect is in the wrong direction, in 13 studies there is a weak or mixed effect, whilst in four there is a strong effect. Two of the four cases of strong effects occur where a radial motorway extend the hinterland of the capital region (London and Paris). Similarly, Quinet and Vickerman (2004, p 45) illustrate the impact of the A6 autoroute Paris-Lyon (completed 1970) on employment growth within 20 km of the corridor. The other two cases involve local road investments that in one case (Sheffield, UK) were accompanied by investments in light rail, with the developmental impacts of the former being stronger than the latter.

Studies of the type shown by Table 6 have been described as being consistent in their inconsistency (Giuliano, 1995). However, Ryan (1999) in reviewing the property value and transportation facilities literature notes that results are more consistent if travel time is used as a measure of accessibility rather than travel distance, whilst the delineation of study area can also affect results.

5. Conclusions and perspectives

This study has shown that there are theoretical and practical reasons to expect that road transport investments might in general be expected to have a modest beneficial effects on the wider economy in advanced economies, although in certain extreme circumstances negative effects could be anticipated. Furthermore, given the prevalence of imperfect competition in transport using sectors, it seems likely that these benefits will be additional to those included in a conventional cost-benefit analysis, even if the level of generated traffic is accurately forecast. Both stylised and spatial CGE models suggest that a multiplier of around 1.4 might be feasible. However such a multiplier can be expected to vary with the price elasticity of the final product market, the extent of increasing returns to scale and forward and backward linkages, the extent of agglomeration economies and with market power (measured by price mark-ups or the number of firms in the market). Production and cost function models similarly indicate modest impacts, for example a short run elasticity of output with respect to public capital of around 0.1, falling to 0 in the long run. However, such macro-economic models are not usually able to determine the extent to which increases in output will lead to additional benefits to those measured in a standard cost-benefit analysis. Similarly, although ex-post studies of road investment tend to suggest that they have modest positive impacts on the wider economy, such studies do not indicate the extent to which these benefits may be considered additional.

Given the above, we believe an important challenge is to unearth real life evidence of additional economic benefits. The most realistic studies so far have been ex-ante appraisals of transport infrastructures that have yet to be built. We suggest that an alternative approach might be an ex-post evaluation of the economic impacts of a major transport infrastructure that has been in operation for a considerable period of time. Great Britain's motorway network might provide an appropriate case study.

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