Does Transport Investment Really Boost Economic Growth?

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Abstract

The SACTRA (1999) report on Transport and the Economy found strong theoretical grounds for believing that transport investment could boost national economies but that the empirical evidence was "weak and disputed". This study asks whether a different conclusion should be drawn today.

The different approaches to evaluating the relationship between transport investment and economic output are reviewed: cross-sectional and time series, regional, cross-regional and national. The range of elasticities calculated is large: mostly positive but sometimes negative. There is fairly strong (but highly variable) evidence that transport investment (measured in a variety of ways) can influence local economic output and/or employment. At national levels there is strong evidence of cross-sectional and longitudinal associations between these factors but the issue of causality (what causes what?) remains unresolved.

Various methods used to address the issue of causality are reviewed. Studies using Granger causality produce mixed findings; in some cases economic growth precedes transport investment; in others transport investment precedes economic growth. Some local or regional studies have found negative 'spillover effects' of transport investment on surrounding areas. None of the studies reviewed has empirically demonstrated that transport investment boosts national GDP or employment growth. Claims to that effect are (still) based on theoretical analysis, which should be treated with caution for several reasons, particularly: the aggregation problem and deadweight loss. The aggregation problem means for example, that increased productivity in the area around a new road will not necessarily increase national production. Deadweight loss is the negative economic impact of taxation, or deferred taxation when infrastructure is financed by borrowing.

Given the uncertainty surrounding these findings, the study concludes that claims made about the national economic benefits of transport investment are not robustly supported by the underlying evidence. It is more appropriate to view transport investment as a facilitative factor rather than a causal factor.

1 Policy Context and Purpose of the Article

In 1999 the Standing Committee on Trunk Road Assessment of the UK Parliament conducted a comprehensive review of the evidence on the relationship between transport and the economy. They found "a strong theoretical expectation" that transport investment would lead to a "range of different wider economic impacts" but that quantitative empirical evidence was "weak and disputed" (SACTRA, 1999 p. 7-8). They concluded that in mature economies the impact of transport investment was "likely to be modest" but emphasised the uncertainties and dependency on "local circumstances and conditions".

In 2005, the UK Department for Transport published a consultation document with proposals to update the project appraisal system to capture wider economic benefits from transport investment (DfT, 2005). They noted SACTRA's reservations about the evidential uncertainties but stated that "positive wider economic benefits are more likely" because of imperfect competition, which left scope for infrastructure improvements to boost the economy. In more recent years, the UK government has significantly increased spending on transport infrastructure, particularly road building (and longer-term plans for high speed rail), emphasising the economic benefits expected to flow from this investment, including growth in: GDP, productivity and employment (H M Treasury, 2013, DfT, 2017a, DfT, 2017b). In its plans for nationally significant infrastructure projects, the Treasury sets out three criteria one of which states that projects must "have the potential to drive economic growth" (H M Treasury, 2016 p.17).

WebTAG, the project appraisal system used in England (and with some variations in other parts of the UK) today enables estimates of 'wider economic impacts' to be added to the monetised benefits of proposed projects, increasing their Benefit to Cost Ratios (BCRs) (DfT, 2014). The validity of this procedure has been a key issue of contention at a recent public inquiry into a proposed extension to the M4 motorway in Wales, in which the author gave evidence (Melia, 2017).

The aims of this paper are to consider whether the evidence available today might lead to different conclusions from those of SACTRA (1999) and to analyse the policy implications of what is known and not known about the relationship between transport investment and the economy. Section 2 outlines the theoretical reasons supporting and challenging the view that transport investment boosts national economies. It concludes that a positive relationship cannot be inferred on theoretical grounds (as DfT 2005 did); empirical evidence of the relationships and causal mechanisms is needed.

Section 3 briefly summarises some of the more recent empirical evidence and its interpretation. It takes as its starting point four recent meta-analyses (Melo *et al.,* 2013, Bom and Ligthart, 2014, Holmgren and Merkel, 2017, Elburz *et al.,* 2017) and two analytical summaries (Venables *et al.,* 2014, Laird and Venables, 2017) Venables *et al.,* (2014) was written for the DfT, who have cited it in support of their approach (DfT, 2017b) as did the Welsh Government at the M4 inquiry (Welsh Government, 2017b).

Section 4 discusses the implications of the evidence and uncertainties for transport appraisal and national transport policy, using the UK as an illustration although the principles would also apply elsewhere.

2 Theoretical Frameworks and their Limitations

Most of the literature in this area starts from a neoclassical framework, assuming rational, utility-maximising firms and individuals, for example. This analysis will begin by accepting that framework; where some of the assumptions underlying that framework have been contested, the implications will be discussed. The appropriateness, desirability and even (in the long-term) feasibility of GDP growth have all been contested (Meadows *et al.,* 1972, Jackson, 2009), but that will not be discussed here. As GDP growth is a stated objective of governments in the UK and elsewhere, the aim is to examine the effectiveness of pursuing that objective through investment in transport infrastructure.

Following Laird and Venables (2017) the main theoretical reasons for hypothesising a (positive) relationship between transport investment and GDP are as described below. That study was concerned with welfare benefits, including private user benefits, which do not directly contribute to GDP, but in other respects the framework is appropriate. As much of this literature (particularly in the UK) has been concerned with refining the process of CBA for transport appraisal, a distinction has often been drawn between business user benefits and the other headings below. Business user benefits will be directly measured by a CBA, whereas the other mechanisms would only influence CBAs if an additional adjustment is made to reflect 'wider economic impacts' (as suggested by DfT, 2014).

It is often stated (by Venables *et al.,* 2014 and, DfT, 2005, for example) that these additional impacts can only occur where market imperfections exist. This presupposes a counterfactual of perfectly competitive markets, where all of the benefits would be captured by the user benefits. It implies that the perfect (presumably private) market would supply all necessary transport infrastructure. A more realistic assumption is that some factors of economic life, such as land-use planning and transport infrastructure, are necessarily controlled or influenced by public authorities. Where one or more of these factors is constraining economic output, then public investment may facilitate increased output.

Section 4 will return to the question of CBA and 'wider economic impacts' after considering the main question – whether transport investment causes change in national economic output. The four mechanisms below overlap and may be difficult to isolate. To answer that main question we do not necessarily need to separate them – identifying their combined impact would be sufficient.

2.1 Positive Mechanisms of Transport Infrastructure Investment

2.1.1 Business User Benefits

The largest element of economic benefits from most large transport projects tends to flow from direct user benefits, including the value of business time saved and other savings from reduced transport costs. These savings are presumed to be a direct benefit to businesses, which will increase GDP through increased output (and productivity) and/or increased profits, the latter being more likely in imperfect markets where producers exercise market power.

2.1.2 Productivity Increases through Proximity and Agglomeration

A substantial literature has demonstrated a positive relationship between economic density – the clustering of economic activity in towns and cities – and output. Rosenthal (2004 based on a review of earlier studies) estimated that doubling the size of a city is associated with an increase in output of between 3% and 8%. Melo et al., (2009) also found a positive relationship, although there was evidence of positive publication bias amongst their sample of studies. Several reasons have been hypothesised to explain agglomeration effects; Puga (2010) concluded that the literature had been relatively unsuccessful in distinguishing between the different reasons for it but factors are believed to include: greater availability of skilled labour, clustering of specialised suppliers, and increased innovation (Gordon and McCann, 2005).

Expansion of a conurbation in order to access those gains will generally require some investment in transport infrastructure. It has also been inferred that transport improvements, which reduce generalised travel costs for businesses and employees (the proximity effect), can extend the geographical reach of these agglomeration benefits, particularly into the hinterland of city regions (Gordon and McCann, 2005).

2.1.3 Labour Market Improvements

Transport improvements may increase labour supply, by increasing the pool of employees available to employers at particular locations, and also because some people who were previously unemployed might decide that travel to a job opportunity becomes worthwhile.

2.1.4 Land-Use Changes

Where transport infrastructure is constraining the development or redevelopment of land, improvements to that infrastructure may facilitate increased economic activity on that land. Greenfield industrial development and urban intensification around transport hubs would be two examples. Agglomeration benefits would only be one part of the additional output generated.

2.2 Countervailing Mechanisms

Although the explanations above seem plausible there are several countervailing mechanisms, which complicate the picture. Seven of these mechanisms will be considered in turn.

2.2.1 Deadweight Loss

Deadweight loss is the additional burden placed on an economy by taxation. In the illustrations provided by SACTRA (1999 p.48) the cost of financing investment in a transport project was assumed to fall on (undefined) transport users. This causes travellers to reduce their number of trips, and by implication transport suppliers to reduce their output. Similar analyses would apply to most forms of taxation (land taxation is a more complicated exception). The overall implication is that raising £1bn from taxation will cause an economy to shrink by more than £1bn, counterbalancing whatever benefits are obtained from the additional public spending.

2.2.2 Opportunity Costs

A related issue is the opportunity cost of other public spending foregone. If budget constraints in other areas (public housing, for example) are constraining output then spending more on transport at their expense may reduce GDP growth. The use of CBA across all forms of public spending would not necessarily address that problem. Even assuming that all CBAs were correctly calculated and that only those projects with the highest BCRs were implemented (which is not the case for transport

projects in the UK: Eddington, 2006) a large part of CBA benefits derive from private user benefits, which do not directly affect GDP.

2.2.3 The Aggregation Problem

A defining feature of the neoclassical framework is that macroeconomics is grounded in microeconomics, so that an aggregate demand function for a national economy can be derived from demand in individual markets. This implies that a transport improvement that reduces costs in one or more local markets (and does not increase costs anywhere else) would cause a small increase in the size of the national economy. This aggregation mechanism is one of several assumptions, which have been contested by economists from outside the neoclassical paradigm, who argue that the relationship between micro markets and the macro economy may not be derived in that way; the relationship may be unpredictable and unstable (see for example: Keen, 2011). Assessing the validity of the aggregation assumption would fall outside the scope of this article; we may simply note that it is contested.

2.2.4 Induced Traffic

The largest part of the economic benefits from road schemes usually derives from time savings, which may be eroded if the road expansion induces more traffic and increases congestion. An earlier report from SACTRA (1994) confirmed the traffic-inducing properties of road expansion, a conclusion which has never been seriously challenged since then, although the magnitude and patterns of induced traffic remain uncertain and contested (Sloman *et al.,* 2017, Highways Agency, 2013). Induced traffic will erode the time-saving benefits of road capacity expansion on which the first three of the positive mechanisms above all depend. Mogridge (1997) has demonstrated how road expansion in urban areas may increase overall congestion. Road capacity expansion is likely to increase the total volume of travel and hence the total user benefits, even if congestion increases. However most trips in the UK are for non-business purposes (DfT, 2016a) so the main impacts of road capacity expansion may be an increase in private user benefits, a loss of business time and an increase in the transport costs of businesses. The net effect of those three changes could be a reduction in GDP.

2.2.5 Spatial Changes and Urban Sprawl

Transport infrastructure investment changes the spatial distribution of economic activity, although not always in expected ways. The “two way road” problem discussed in SACTRA (1999) can cause economic activity to shift away from areas where roads are improved. Road-building (in particular) enables conurbations to expand; this is an essential element of the agglomeration benefits explained above. It may also enable conurbations to ‘sprawl’ i.e. to reduce in density or concentration, imposing higher costs, particularly on public services, which must be paid for through taxation or charges (Burchell *et al.,* 2002, Balaguer-Coll *et al.,* 2013).

2.2.6 Constraints as a Spur to Innovation

Conventional CBA assumes that a constraint on economic activity (current or planned) will reduce that activity. So if firms are subject to higher costs because of road congestion, or measures aimed at reducing traffic to avoid road building, they will reduce their output and possibly raise their prices. Porter (1991) proposed what became known as ‘the Porter Hypothesis’: that environmental regulation may spur innovation, increasing output in ways that were unforeseen when the regulations were introduced. The hypothesis remains controversial but there is some evidence to suggest that it does occur in practice (Ambec *et al.,* 2013). If so, then similar mechanisms may apply to constraints on movement, whether these result from demand management measures or passive constraint due to congestion. Constraints on movement which encourage clustering within larger cities may be one explanation for the greater incidence of innovation observed within such cities (part of the agglomeration effect).

2.2.7 Climate Change and Longer-term Uncertainties

Where road-building or other transport investments cause increases (or prevent reductions) in carbon emissions, they may contribute to climate change with serious longer-term implications for economic output as well as human welfare (Stern, 2006). Whether mechanisms such as carbon pricing (incorporated into WebTAG) will prove effective in averting climate change may be open to doubt. These longer-term uncertainties do not feature in the empirical analysis outlined below.

2.2.8 Implications of the Countervailing Mechanisms

The magnitude and prevalence of the countervailing mechanisms are as contested and uncertain as the four positive mechanisms. For this analysis it is not necessary to prove or to quantify those countervailing mechanisms, only to note that they *might* occur in practice and that collectively they might outweigh the positive mechanisms. If so, a positive impact of transport investment on GDP cannot be cannot be assumed based on theoretical analysis, nor can it be inferred (or quantified) from evidence on the individual factors. So for example, evidence of increased productivity of businesses around a new road or railway station does not demonstrate that the road or railway has caused an increase in national GDP. Empirical evidence of the overall impacts and causal mechanisms is needed.

3 Empirical Evidence and its Interpretation

3.1 Evidence from Recent Meta-Analyses

A vast and growing number of studies have examined relationships between various measures of transport investment (or in some cases, transport volumes) and various measures of economic output. This section will briefly summarise some of the most recent evidence.

	Studies	Estimates
Melo *et al.* (2013)	35	563
Bom and Ligthart (2014)	68	578
Holmgren and Merkel (2017)	78	776
Elburz *et al*., (2017)	42	912

Table 1 Numbers of Studies and Elasticity Estimates Used in Recent Meta-analyses

The last two meta-analyses listed in Table 1 build on the earlier two; Holmgren and Merkel (2017) include all the studies used by Melo *et al.* (2013) plus some additional studies. Most of the underlying studies analyse changes in national economies, of one or several countries; some use regional data instead or as well as national data. Elburz *et al.* (2017) focus specifically on the regional studies. Most of the studies focus on road infrastructure; some also consider other modes. Most of the studies include some breakdown by industry sector and/or mode of transport investment. Cross-sectional, panel and time-series studies were included. Most use GDP as the measure of output; some use GVA (Gross Value Added) and a few use employment.

The underlying studies generate a wide range of elasticity estimates, with more positive than negative. Elburz *et al.* (2017) found 45% of estimates were positive, 11% were negative and 44% were insignificant. Holmgren and Merkel (2017) found 23% of estimates were negative.

There is no clear consensus on which types of investment are more likely to produce what types of impact or where. Melo *et al.* (2013) found significant differences in the impacts on different industry sectors and they found stronger positive impacts in the US than in European countries. By contrast Elburz *et al.* (2017) found stronger positive impacts in Europe and no significant differences between industry sectors. Bom and Ligthart (2014) found mainly positive "spillover effects" from regions benefiting from infrastructure improvement towards their surrounding regions, whereas Elburz *et al.* (2017) found mainly negative regional spillover effects.

3.1.1 Publication Bias

Publication bias, already mentioned in the context of agglomeration effects above, was also investigated by three of the four meta-analyses. By comparing the estimates of output elasticity and their standard errors Melo *et al.* (2013) found no evidence of publication bias, whereas Bom and Ligthart (2014) and Holmgren and Merkel (2017) both found evidence of publication bias, weighted towards more positive impacts. Holmgren and Merkel (2017: abstract) note that "the estimated effects exhibiting high precision are clustered around zero. This is to say that the higher the reliability of the estimate, the closer it is to zero."

3.1.2 What Causes What?

All of the meta-analyses recognise the problem of "reverse causality" that GDP growth might influence investment in transport infrastructure, instead of, or as well as, vice versa. The language used to describe this issue is revealing. Melo *et al.* (2013) talk about "correcting for reverse causality" (Melo *et al.,* 2009 p. 704); Holmgren and Merkel state that "the relationship between infrastructure and GDP might actually be reversed" (Holmgren and Merkel, 2017 p. 15). Reflecting the assumption of the underlying studies, these statements imply a nul hypothesis, that association between the variables is *primae facie* evidence of transport investment boosting economic output unless there is evidence of reverse causality.

Only a minority of the underlying studies attempt to correct for reverse causality. A few more recent studies which have specifically investigated this problem using Granger causality tests (essentially testing what came first – the investment or the GDP growth); these have produced mixed results. Beyzatlar *et al.* (2014) found mainly bi-directional causality for the EU-15 countries between 1970–2008. Meersman (2017) found uni-directional causality from transport investment to economic output for Belgium for the period 1980 to 2012. Maparu and Mazumder (2017) found uni-directional causality from economic output to transport investment for India between 1990 and 2011.

3.2 Interpretations of the Evidence

Faced with this inconclusive picture Bom and Ligthart (2014) prefer to interpret their findings as evidence of a positive causal relationship, notwithstanding the evident uncertainties (a position also taken by some earlier meta-analyses e.g. Bhatta and Drennan, 2003). Melo et al. (2013) avoid using the language of causality but conclude that public investment in transport infrastructure is associated with a "modest" increase in output. Elburz *et al.* (2017) come to no direct conclusion on the substantive question preferring to "give a clear picture of the model building process" that should be followed. Holmgren and Merkel (2017) urge caution, pointing to the strong political forces favouring a positive interpretation, which may explain some of the publication bias they found. They criticise the practice of adding 'wider economic impacts' to CBAs and conclude that macro-studies of this kind are "not a good instrument for deciding which projects to invest in the future" (Holmgren and Merkel, 2017 p. 21).

In their report for the DfT Venables *et al.* (2014) conclude that there is strong evidence that transport investment can influence the location, and possibly the overall quantity, of economic activity but nowhere do they state that empirical evidence has demonstrated this (an interpretation that was placed on that report by counsel for the Welsh Government in the M4 public inquiry). Laird and Venables (2017), a related article, concludes that "transport investments are likely to have impacts (positive and negative) over and above conventionally measured user-benefits" but emphasise the uncertainties and knowledge gaps that still exist.

4 Implications of Uncertain Evidence

Although the review in Section 3 is not exhaustive, it is sufficient to illustrate that the claim that public investment in transport infrastructure boosts national economies has not been proven. The proliferation of studies and meta-analyses has not resolved the fundamental uncertainties, which led SACTRA (1999) to write of "weak and contested" empirical evidence. Their reference to the importance of local conditions also remains valid but neither the theoretical nor the empirical evidence shows how the *causal* impacts of local infrastructure improvements on *national* economies can be robustly measured.

Research evidence in the social sciences is rarely conclusive; conclusions usually involve interpretations of uncertain evidence. The key question in this case is whether the elasticities – more positive than negative – coupled with evidence of the positive mechanisms outlined in Section 2.1 should be sufficient to *infer* that transport investment can, or does, boost national economies. Section 2.2 gave some reasons for treating the theoretical arguments with some caution. Possible publication bias is one reason for treating the empirical findings with caution. There are some others.

4.1 What Causes What? Still Unresolved

Most studies in this field start from an assumption that associations between transport investment and GDP growth are *primae facie* evidence that the former causes the latter. A few test for "reverse

causality". If we take a longer-term view, the opposite would be more logical. The resources to pay for transport infrastructure are all generated by the economies it services. In the longer-term it is difficult to conceive how transport infrastructure could continue to expand without economic growth, whereas the opposite scenario, where economic growth is 'decoupled' from transport infrastructure growth is conceivable, whether it has actually occurred or not.

Where tests of Granger causality are correctly performed (in a minority of studies) the initial hypothesis is less important. Those studies have been inconclusive but testing which factor changes first would not necessarily establish the direction of causality in any case, for at least two reasons:

- Where public authorities upgrade transport infrastructure in areas or regions where development is planned (if the plans are fulfilled) economic output will increase in those locations, whether the transport infrastructure helped to cause the increase or not. This would affect those studies that use regional or local data.
- The relationship between taxation and public investment is complicated by the abilities of governments to borrow and print money. Public spending that is not directly financed by taxation will boost economic output in the short-term, regardless of the form that spending takes. Where governments decide to expand public infrastructure during, or immediately following, recessions (as the UK government has done in recent years) the investment is likely to be followed by economic growth, whether the former causes the latter or not. This would affect studies that use national data.

For these reasons we should expect to find more positive than negative elasticities of economic output with respect to transport investment (or vice-versa). Such findings tell us nothing about the causal relationships.

4.2 Wider Economic Impacts and Transport Appraisal

Following the guidance in WebTAG it has become more common to estimate wider economic impacts from major transport projects and to add these to boost the project BCRs. In the Welsh Government's case for the M4 extension these increased the overall BCR from 1.62 to 2.34, tipping the project over the critical threshold of 2.0, which the UK Government describes as 'high value for money' (Welsh Government, 2017a).

Adding the wider economic benefits to a project BCR in that way would only be valid if it was known that those wider benefits would be entirely additional at the national level. In 2016 the DfT consulted on updated WebTAG guidance, which included a default assumption that any economic benefits created by a transport project would be entirely displaced from elsewhere unless promoters were able to "present credible evidence of additionality" (DfT, 2016b p. 3). This effectively invites scheme promoters or their consultants to demonstrate what decades of international research has failed to demonstrate: that local investment in transport infrastructure can cause increases in national GDP (or employment). The procedures recommended to demonstrate additionality refer to positive mechanisms such as labour market improvements and agglomeration effects (DfT, 2016c, DfT, 2016d). The countervailing mechanisms outlined in Section 2.2, which might negate any additionality, are not mentioned in that context. Based on the evidence reviewed in this article it is difficult to see how scheme promoters could demonstrate such claims – and quantify them with sufficient accuracy – in a robust way consistent with the wider body of research evidence.

Goodwin and Turley (2005), who interviewed transport planners following the publication of DfT (2005) found that boosting the BCRs, making schemes more likely to attract funding, was the main attraction of wider economic impact assessments for scheme promoters. There is a parallel here with the evidence of publication bias discussed above. The belief that transport infrastructure projects boost economic output is useful to many parties involved in transport planning, construction and even transport research. In such circumstances we should not be surprised to find scheme promoters reporting economic benefits that are additional at the national level.

4.3 Transport Policy In Pursuit of a Hope

The wider economic literature on the causes of economic growth is no more conclusive than the specific literature reviewed here. Different hypotheses are tested with interest focussed on different causal variables such as international trade (Singh, 2001), energy consumption (Soytas and Sari, 2003) education (Hanushek and Woessmann, 2012) and fiscal decentralisation (Thiessen, 2003), amongst others. In some of those relationships transport fulfils a facilitative intermediary role. If it

does exert a causal impact, then compared to the range of other causal factors, its influence will be small.

In recent years in the UK, as in many other countries, promoting economic growth has become the principal objective of transport policy. This is mainly to be achieved through increasing road capacity to facilitate more movement by motor vehicles (DfT, 2017b, H M Treasury, 2013), a policy which conflicts with many social and environmental objectives (RCEP, 2007, Chapman, 2007). So current policies are effectively trading the certainty of environmental damage for the hope of a small increase in economic growth. The analysis in this paper suggests that hope may be illusory.

Although the claim that transport investment can cause higher GDP is unproven, there is clearly a causal relationship between economic growth and demand for transport infrastructure. The nature of that demand will vary depending on the type of economic growth. So in the context of a rising population low-density development on the edge of a city will create more motorised movements and hence more demand for road infrastructure whereas urban intensification will create more demand for public transport and sustainable modes, and a need to constrain urban traffic growth (Melia *et al.,* 2011). To ask of individual projects in those two scenarios 'which ones will create the greatest economic benefit?' would be spurious; transport is not the primary factor causing economic growth in either scenario.

It is more valid, therefore, to view transport infrastructure as a facilitative factor, responding to the needs of the economy and society. There is always more than one way to respond to those needs. The current focus on economic benefits as the main objective of transport policy is obscuring the real challenge, of how to satisfy the mobility needs of a growing population on a land mass that is not growing.

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