Economic Development Benefits of Transport Investment

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An important note for the reader

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This report is the final stage of a project commissioned by Land Transport New Zealand before 31 July 2008 and is published by the NZ Transport Agency.

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The material contained in this report is the output of research and should not be construed in any way as policy adopted by the NZ Transport Agency but may be used in the formulation of future policy.

ADDITIONAL NOTE

The NZ Transport Agency (NZTA) was formally established on 1 August 2008, combining the functions and expertise of Land Transport NZ and Transit New Zealand.

The new organisation will provide an integrated approach to transport planning, funding and delivery.

This research report was prepared prior to the establishment of the NZTA and may refer to Land Transport NZ and Transit.

Abbreviations and acronyms

BCR	Benefit-Cost Ratio
CBA	Cost Benefit Analysis
CBD	Central Business District
CGE	Computable General Equilibrium model, empirical economic model used to simulate economy-wide reactions to changes in policy, technology or other external factors.
EAM	NSW Road and Traffic Authority's Economic Analysis Manual
ESSAM	Energy Substitution, Social Accounting Matrix
GDP	Gross Domestic Product, one of the measures of national income and output for a given country's economy
GNE	Gross National Expenditure, measures total expenditure on goods and services by a given country's residents
GRIT	Generation of Regional Input Output Tables
GRP	Gross Regional Product
GSP	Gross State Product
I-O	Input-output analysis, a method which shows how the parts of a system are affected by a change in one part of that system.
LUTI	Land Use Transport Interface
MCA	Multi Criteria Analysis
MMRF	The Monash Multi-Regional Forecasting model
NPV	Net Present Value, the difference between the present value of cash inflows and the present value of cash outflows.
NSB	Net Social Benefits
O-D	Origin-Destination
SACTRA	Standing Advisory Committee for Trunk Roads Assessment, UK
SCBA	Social Cost Benefit Analysis
TEN	Trans-European Networks
TFP	Total Factor Productivity
VAR	Vector Autoregressive Modelling
VTTS	Value of Travel Time Savings
WTP	Willingness To Pay
2SLS	Two Stage Least Squares, an instrumental variables estimation technique
$>$	Greater than
$<$	Less than
$\geq$	Greater than or equal to
$\leq$	Less than or equal to

Contents

Executive summary

The purpose of this report was threefold:

- To review the major approaches to assessing the national economic benefits of transport investment and, in particular, the role of Social Cost Benefit Analysis (SCBA);

- To review the role of transport investment in national and regional economic development and, in particular, whether it has a special role to play in such development;

- To review approaches for assessing regional economic and other distributional effects.

Key questions posed by, and findings derived from, this work are detailed below:

National economic benefits

This section revolved around three key questions.

- Question 2.1: In what circumstances, and to what extent, does a (fully-specified) SCBA not capture all the national economic costs and benefits arising from a transport investment?

- Question 2.2: What alternative approaches exist to assessing the national economic impacts of transport investments, and what are their merits in place of, or to supplement, SCBA (particularly to capture any costs and benefits not adequately addressed by SCBA)?

- Question 2.3: How should the impacts of transport investment on national economic growth (GDP and similar measures) be assessed; and how do such assessment methods and their outputs relate to the methods/outputs involved in the SCBA approach?

The following conclusions were reached:

Question 2.1

- SCBA can be defined as a policy assessment method that quantifies, in monetary terms, the value of all policy consequences to all members of society. Social benefits are subtracted from social costs to derive net social benefits (NSB), measuring the value of the policy.

- A critical distinguishing feature of SCBA is its focus on the need to maximise economic efficiency by maximising societal welfare. SCBA also provides clear decision rules (i.e. the Net Present Value (NPV) of project benefits and benefit-cost ratio (BCR)). These indicate the extent to which society is better off (in economic efficiency terms) from undertaking a project. In addition, SCBA measures the marginal effects of a given project to society; it is not intended as a broad strategic tool.

- These factors distinguish SCBA from economic impact methodologies such as Input-Output (I-O) analysis, Computable General Equilibrium (CGE) analysis and Land Use

Transport Interface (LUTI) modelling. These focus on broad measures of economic impact such as employment, income and GDP and lack such specific decision rules.

- The inclusion of induced and diverted demand effects within a SCBA effectively captures most of the indirect (or flow-on) effects to the broader economy associated with a transport improvement. So long as a transport SCBA allows for induced and diverted demand effects, the extent to which it 'misses' economic benefits will be small to modest.

- Even if induced/diverted demand effects are omitted, (i.e. a 'fixed trip' travel matrix is used) the degree of benefits underestimation will generally be modest, since induced traffic effects are generally small and transport improvements are unlikely to have a dramatic economic effect on competitive, modern economies such as New Zealand's.

- Technically speaking, the difference between results obtained using fixed and variable trip matrix may be large in extremely congested situations, where allowance for induced traffic may actually reduce benefits to existing users (and thereby total benefits). However, to the extent this occurs, benefits may be overestimated rather than underestimated by use of a fixed trip matrix.

- Where strong contextual (and material) evidence exists, consideration of the relevance of additional factors such as additional logistical and agglomeration benefits, property and labour market effects, imperfect competition and specific regional development issues could be considered on a less formal, case by case basis. This could involve consultation with key affected industries and stakeholders.

- If these additional effects are not amenable to monetization and incorporation within an SCBA they could be considered in a 'below the line' qualitative analysis.

- However these factors are only likely to be worth addressing for major projects. Further, it is considered that allowance for such effects will not be an issue in the great majority of such cases.

- Allowance for environmental externalities may be made either within an SCBA or 'below the line', depending on issues of context and data availability.

Question 2.2

- Arguably, 'alternatives' to SCBA include macroeconomic approaches such as I-O analysis, CGE modelling or LUTI modelling. These could be used to estimate the economic impacts of transport investment.

- However, these approaches produce different 'raw' outputs to SCBA (i.e. they report macroeconomic impacts), do not provide clear social decision rules (unlike SCBA), do not measure the economic efficiency of an investment and do not include some of the non-market commodities allowed for by SCBA (such as some non-work travel time savings). Further, unless a nationwide investment scheme is envisaged, these alternatives may constitute something of a 'blunt instrument'.

- As such, undertaking SCBA is fundamental to the appropriate assessment of the benefits and costs of transport investment.

- Some attempts have been made to estimate changes in economic welfare associated with a given project (i.e. equivalent to that derived via SCBA) through the use of

modified CGE modelling. However, adding up the results of SCBA and CGE modelling, as in ACG's recent modelling of New Zealand road projects, is wrong. In addition, the use of CGE modelling to derive welfare outcomes, such as advocated by Dwyer et al (2004), still faces investment modelling and non-market transactions issues. Thus, any use of other macroeconomic modelling approaches in combination with SCBA should carefully note issues of double counting and compatibility. In addition, the issue of parsimony, namely the extensive work required to develop and maintain CGE (or, theoretically, LUTI) models in return for modest improvements in SCBA accuracy, should be noted. This is especially true given limited resources in small economies, such as New Zealand's.

- There would therefore not seem to be a strong case for abandoning SCBA for more complex techniques to account for 'missing benefits'; the proposed alternatives do not provide a reliable substitute and do not appear to be justified on grounds of parsimony.

Question 2.3

- It is not possible to derive a direct linkage between the outputs of SCBA and changes in macroeconomic indicators, such as GDP. SCBA provides no direct information on such indicators. Thus, projects which record a negative NPV (BCR below 1.0) may still produce increases in GDP. While it is likely that projects which produce a positive NPV (BCR above 1.0) will be associated with GDP growth, even this is not certain (particularly given that SCBA may include valuations of non-market products such as environmental externalities and some non-work travel time).

- In theory, I-O, LUTI and CGE models could be used to complement the results of SCBA. All of these models may provide some form of national macroeconomic information of use to policy makers. Depending on the model, these may include data on employment, income, GDP, land use, investment, trade, consumption, wages and tax. However CGE modelling is the most accurate and reliable methodology and should be preferred if national impacts are to be modelled. I-O analysis may be acceptable (and preferable) within a regional context – see below.

- As SCBA does not produce these broader measures as outputs, using SCBA in combination with of these approaches could provide a policymaker with a broader view of the overall impacts of the project.

- CGE could also help pinpoint some omitted benefits, such as the impacts of imperfect competition, however there may still be some issues of compatibility with SCBA.

- However, it is recommended that SCBA be viewed as the primary decision-making tool in such cases.

- Further, given the issues of time and expense and the scepticism expressed regarding the need to develop/maintain such models by governments in larger jurisdictions (such as the UK), it is likely that only the largest New Zealand projects would require development and maintenance of such models This is particularly the case since the average impacts of imperfect competition in New Zealand may be even smaller then those derived by UK studies such as SACTRA (1999).

- Moreover, in many cases, any changes in GDP from individual projects may be extremely small, given the size of national economies relative to the projects in question.

Role of transport investment in promoting economic development

This chapter sought to address the following key question:

- Question 3.1: Are there particular features of transport investment (in general) that make it especially effective (such effects maybe not fully reflected in SCBA or alternative methods of assessment) in promoting/increasing national (and regional) economic growth?

The conclusions and observations of this chapter can be summarised as follows:

- Evidence for a 'special role' in respect of transport infrastructure investment's economic growth effects (as opposed to effects generated by other public spending, such as on education or health) is limited. The high rates of return to transport investment claimed by some past studies are likely the result of statistical correlation or other model specification issues.

- Likewise, there is nothing 'special' about investment in transport infrastructure from a regional perspective. While there is some evidence regarding the responsiveness of growth to investment in transport infrastructure, this is no less true then other forms of public spending. It is unlikely that investment in transport infrastructure will have dramatic effects on regional economies.

- In general, development of transport infrastructure is a necessary but not sufficient condition for national and regional economic development and growth.

- The incremental economic gains of further investment in transport infrastructure in developed economies are likely to be small. Arguably, there is a spectrum within which some developed economies may experience greater gains more than others, but solid evidence to this effect is lacking.

- There is no strong evidence that SCBA omits significant flow-on effects to the broader economy. The argument that previous work, citing high returns to transport investment, has somehow revealed SCBA's 'omitted benefits' is therefore unsustainable.

Approaches for assessing regional economic and other distributional effects

This chapter posed the following questions:

- Question 4.1: Is the upgrading of transport links within or to/from a particular ('disadvantaged') region likely to be an effective means of enhancing the economic development of that region, and in what circumstances?

- Question 4.2: How are the distributional impacts of transport investment on particular regions/areas best assessed; and how do the results of such assessments relate to SCBA assessments of national economic costs and benefits?

- Question 4.3: How are the other (non-geographic) distributional impacts of transport investment on different social/demographic and market segments best assessed?

- Question 4.4: Would the assessments of distributional (geographic, socio/demographic etc) impacts of transport investments provide useful additional information (additional to the overall impact assessment) for decision-makers?

The answers to these questions, along with other key points of interest and relevance, can be summarised as follows:

Question 4.1

- Upgrading of transport links within or to/from a given 'disadvantaged' region, in and of itself is insufficient for enhancing regional economic development. As is the case for national development, transport is, in general, a necessary but not sufficient condition for regional development. There is a clear need for other supporting programs and infrastructure to be in place.

- Further, economic theory offers no conclusive guidance regarding the distributional impact of transport investment on specific regional economies. Issues such as the 'two way road problem', the need for supporting measures, well developed transport networks and economic displacement effects cloud the ultimate impacts of transport investment on economic development within a specified 'target region'.

- Analysts such as O'Fallon (2004) have stressed that regional growth may simply result in the displacement of economic activity from one region to another. Though she may overstate her case, displacement effects are a real issue.

Question 4.2

- While SCBA offers, perhaps, the best method of assessing the geographic distributional effects of transport investment, the difficulties of ring fencing regional growth effects using 'either' SCBA can be significant. A possible (or partial) solution may be the use of origin-destination (O-D) data, other survey work and/or census data to identify regional beneficiaries, through this may be complicated by the nature of regional benefits and migratory movements over project timeframes.

- If SCBA is not feasible within a given context, the best approach may be the use of descriptive and/or qualitative indicators (e.g. likely changes in regional income, land values) in conjunction with a global SCBA.

- I-O modelling could be used as a complement to SCBA at the regional level if there is a need to assess economic impacts as opposed to benefits. CGE analysis is generally not practical at a regional level.

- Whether SCBA is used alone or in combination with I-O analysis, regional economic appraisals should also take into account impacts on other regions and the national economy as a whole. Doing so would allow for an examination of inter-regional displacement effects – or at least in comparison to the broader national viewpoint. Not to do so risks presenting a distorted picture of net benefits (SCBA) or impacts (I-O analysis).

Question 4.3

- Several methods may be used to measure the impacts of transport development on specific socio-economic groups. These include financial appraisal, survey work, census data, origin-destination data, multi-criteria analysis (MCA) and 'environmental justice' approaches.

- However, some of these (e.g. MCA) are of questionable reliability.

- Cross-sectional information such as origin-destination (O-D) data, and, to some extent, census data may help identify specific groups benefiting from changes in transport infrastructure (e.g. unemployed, disabled, low income). Data which specifically and directly relate the groups in question to transport improvements (such as O-D data indicating travel time savings to low income earners) would be the most useful approach in this respect. Merely inferring causal relationships between broad indicator variables (such as arguing that a transport improvement has resulted in a nationwide improvement in the incomes of low income groups) is of questionable utility in the absence of firm theoretical/contextual backing.

- The use of O-D data may have several drawbacks, however, including difficulties in attributing non-transport benefits, limitations on attributing net project benefits to specific sub-groups and the usage of differential unit values in benefit calculations. For example the transport behaviour of a 'lower income' sub-group (and therefore the distribution of benefits) may change over time. This may complicate estimation efforts.

- A partial solution to this issue may be the presentation of limited gross benefits based on O-D data 'below the line' in an SCBA.

Question 4.4

- While the above methodologies may provide some useful data to policymakers, in general, assessment of socio-economic impacts on specific groups should be seen as a complement to the broader use of SCBA, in the first instance.

- As indicated, if policymakers are interested in determining the benefits (or otherwise) accruing to specific groups then O-D data disaggregated into defined social groups could be collected.

- It is noted however, that this process will involve additional costs. Further, the difficulties and uncertainties associated with O-D data, noted above should not be ignored.

Abstract

This report reviews the major approaches for assessing national and regional economic benefits, as well as the potential distributional implications of transport induced benefits. The paper assesses whether transport influences national and regional economic development, and if so, how this is role is best asserted.

The primary economic assessment methods considered include: Social Cost Benefit Analysis (SCBA), Input-Output Analysis (I-O), and Computable General Equilibrim (CGE). SCBA is most effective for determining the value of project objectives and outcomes from a social welfare perspective. I-O and CGE take macroeconomic perspectives of system wide effects of transport investment including employment, GDP and taxes.

The link between transport improvement and economic development depends on complementary regional infrastructure and specific contextual considerations. I-O poses a risk of over-stating results. CGE may be effective at a national level, but faces scaling issues for regional or local effects. Neither is particularly useful for assessing distributional affects of investment.

The findings supports SCBA as a policy assessment methods that quantifies, in monetary terms, the value of policy consequences to society with recommendations for accommodating non-market and qualitative consideration into value propositions.

1.   Introduction

The overall objective of this report is to appraise the evidence available internationally on the national and regional/local economic development benefits of land transport investment, and to develop recommendations and guidelines to assist New Zealand authorities in the assessment of economic development benefits of potential transport investment projects.

The project relates directly to the statement in the New Zealand Transport Strategy (NZTS) of December 2002: 'To help make decisions that are economically, socially and environmentally sustainable we will need to improve our understanding of the relationship in the New Zealand context, between economic development and transport'.

In broad terms, the purpose of this report is threefold:

- To review the major approaches to assessing the national economic benefits of transport investment and, in particular, the role of social cost benefit analysis (SCBA);

- To review the role of transport investment in national and regional economic development and, in particular, whether it has a special role to play in such development;

- To review approaches for assessing regional economic and other distributional effects.

These key issues have been broken down into a number of sub-questions, consistent with chapters 2, 3 and 4 of this report. These sub-questions are detailed below.

1.1   National economic benefits

Three key questions were specified for this section:

- Question 2.1: In what circumstances, and to what extent, does a (fully-specified) SCBA not capture all the national economic costs and benefits arising from a transport investment?

- Question 2.2: What alternative approaches exist to assessing the national economic impacts of transport investments and what are their merits in place of or to supplement SCBA (particularly to capture any costs and benefits not adequately addressed by SCBA)?

- Question 2.3: How should the impacts of transport investment on national economic growth (GDP and similar measures) be assessed; and how do such assessment methods and their outputs relate to the methods/outputs involved in the SCBA approach?

1.2　Role of transport investment in promoting economic development

One key question was specified for this chapter:

- Question 3.1: Are there particular features of transport investment (in general) that make it especially effective (such effects maybe not fully reflected in SCBA or alternative methods of assessment) in promoting/increasing national (and regional) economic growth?

1.3　Approaches for assessing regional economic and other distributional effects

Four key sub-questions were specified for this chapter:

- Question 4.1: Is the upgrading of transport links within or to/from a particular ('disadvantaged') region likely to be an effective means of enhancing the economic development of that region, and in what circumstances?

- Question 4.2: How are the distributional impacts of transport investment on particular regions/areas best assessed; and how do the results of such assessments relate to SCBA assessments of national economic costs and benefits?

- Question 4.3: How are the other (non-geographic) distributional impacts of transport investment on different social/demographic and market segments best assessed?

- Question 4.4: Would the assessments of distributional (geographic, socio/demographic etc) impacts of transport investments provide useful additional information (additional to the overall impact assessment) for decision-makers?

2.   Approaches to assessing national economic benefits

2.1   Scope

This chapter seeks to address the issue of the most appropriate approach to assessment of national economic benefits of transport projects. A significant theme is the adequacy (or lack thereof) of traditional social cost benefit analysis (SCBA) in assessing the totality of benefits flowing from a given transport project. Key questions this chapter seeks to address include:

- Question 2.1: In what circumstances, and to what extent, does a (fully-specified) SCBA not capture all the national economic costs and benefits arising from a transport investment?

- Question 2.2: What alternative approaches exist to assessing the national economic impacts of transport investments, and what are their merits in place of or to supplement SCBA (particularly to capture any costs and benefits not adequately addressed by SCBA)?

- Question 2.3: How should the impacts of transport investment on national economic growth (GDP and similar measures) be assessed; and how do such assessment methods and their outputs relate to the methods/outputs involved in the SCBA approach?

These questions are addressed by considering three other evaluation approaches in addition to SCBA – Input-Output, Computable General Equilibrium, and Land Use Transport Interface approaches.

2.2   Introduction to evaluation approaches

2.2.1   Social Cost Benefit Analysis

A broad definition of SCBA is offered by Campbell and Brown (2003):

> *Social cost-benefit analysis is a process of identifying, measuring and comparing the social benefits and costs of an investment project or program. A program is a series of projects undertaken over a period of time with a particular objective in view. The project or projects in question may be public projects – undertaken by the public sector – or private projects.*

Boardman, Greenberg, Vining and Weimar (2001) offer the following definition:

> *Cost-benefit analysis is a policy assessment method that quantifies in monetary terms the value of all policy consequences to all members of society. The net social benefits measure the value of the policy. Social benefits (B) minus social costs (C) equals net social benefits (NSB).*

However, apart from these broad textbook definitions, as Duncan (2001) notes, a critical distinguishing feature of SCBA is its focus on the need to maximise economic efficiency by maximising some objective function (generally societal welfare).

SCBA compares project benefits with project costs over a period of time (the evaluation period) and uses discounting to reflect the current value of a series of future values. Importantly, SCBA provides clear decision rules (i.e. the Net Present Value, NPV, of project benefits, and benefit-cost ratio, BCR). These indicate the extent to which society is better off (in efficiency terms) from undertaking the project relative to some other course of action (i.e. the Base Case). The NPV indicates the excess of project benefits over project costs (if any) over the evaluation period. The BCR is the ratio of project benefits to project costs. Thus, a BCR above 1.0 represents a project worth undertaking from the point of view of social investment. Conversely, a BCR of less than 1.0 indicates that society would be better off using its resources elsewhere. As suggested above, SCBA thus provides a clear decision rule as to the economic efficiency and social welfare effects of undertaking a given transport project.

Key to the understanding of SCBA is the concept of consumer and producer surplus. The consumer surplus represents the benefits derived from the purchase of a commodity, less the costs of the purchase. This is generally represented as the area under a demand curve (and above a given 'price line'). The demand curve, in turn, reflects the 'willingness to pay' (WTP) for a given commodity by various members of society. Likewise the producer surplus, represents the area above the supply schedule (but below the given price line). Within an SCBA framework, total benefits of a given project are measured by the sum of the consumer and producer surpluses.

For example, to the extent that a given change (e.g. a transport improvement which lowers the cost of a given trip) results in a change (i.e. increase) in the consumer surplus (and assuming no impacts on the producer surplus), society is said to be better off (in gross terms). Naturally, such benefits would need to be weighed against the social costs of undertaking the project.

Implicit to the evaluation of a proposal is the need to compare the situation with the proposal (the project case, e.g. construction/augmentation of a highway, railway or port) with some alternative, i.e. the base case (which is generally specified as a 'do minimum' scenario).

The 'opportunity costs' to society of constructing and operating the project (e.g. construction and operations costs) are therefore set against the social benefits arising from undertaking the project. Note that the opportunity costs essentially reflect the diversion of resources – land, labour and capital – away from other productive sectors towards undertaking the project. The benefits reflect how much 'better off' members of society are, as measured by the sum of the increase of consumer and producer surpluses. This provides a net benefits result – the extent to which society is better off from undertaking the project.

Figure 2.1 indicates the basic process involved in constructing a 'generic' SCBA.
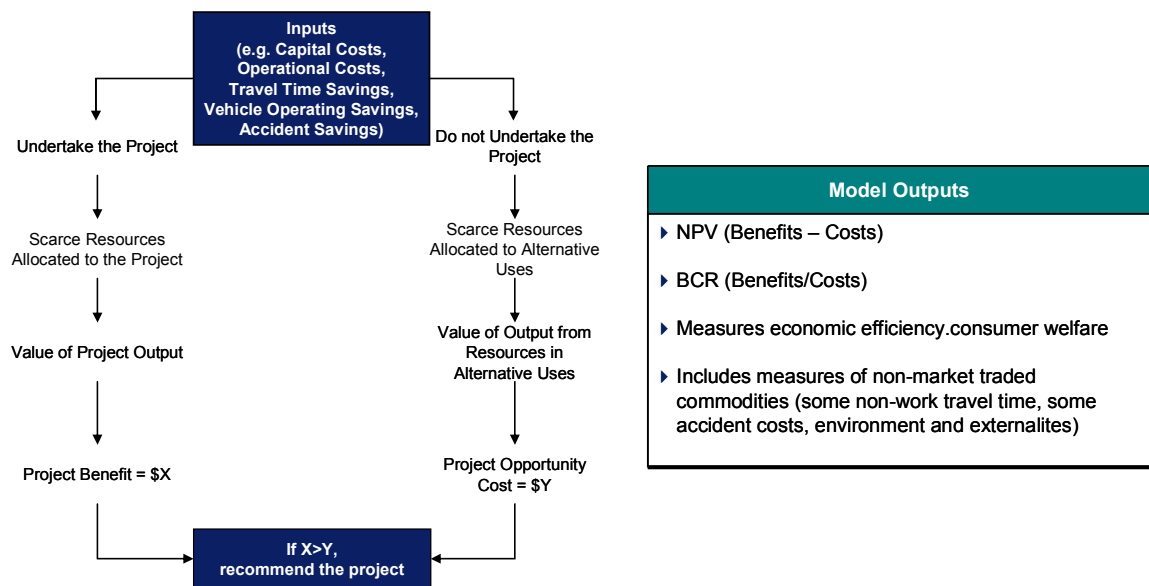
Figure 2.1   SCBA process

Transport SCBA, in the form generally recommended in manuals and text books typically allows for the following factors arising from the project:

- Project capital costs

- Project operating costs

- Travel time savings (or additional costs) including non-work travel time savings

- Vehicle operating cost savings (or additional costs)

- Accident cost savings (or additional costs)

- Changes in environmental impacts

The recommended form also includes accounting for the effect of induced demand (also called generated trips, i.e. new trips prompted by the transport improvement) and diverted demand (i.e. trips diverted from other modes to the project mode).

However, organisations such as the UK's Standing Advisory Committee for Trunk Roads Assessment (SACTRA) have called for the development of a more fully specified SCBA, which would also include allowance for additional factors[1] such as:

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[1] In addition to this list, some commentators have called for the inclusion of the social cost of public funds, i.e. an allowance for the distortionary effects of financing transport investments through taxation. Recent Australian estimates suggest that every extra dollar of (Australian Commonwealth) government spending imposes a social cost of taxes equivalent to some $0.24 – i.e. implying that costs for any given government financed project should be increased by an additional 24% (BTE 1999, p. 79).

An obvious point is that allowance for such a factor would *reduce* the net benefits from transport investment – implying that conventional estimates overestimate such benefits (rather than the reverse, as critics of SCBA often argue).

However, there are many objections to allowance for the social cost of public funds. Most notably, governments may finance transport investment from a variety of other (less distortionary) devices such as budget surpluses, reduced spending in other areas, increased borrowing or direct charges. A further point is that an increasing number of transport projects are partly or wholly funded by the private sector.

- Land use changes (including product market (logistical adaptation, industry agglomeration) property market (commercial and housing markets) and labour market effects)

- Imperfect competition

- Taxation benefits

Arguments for and against these additional benefits are discussed in the course of a review of SCBA in Section 2.3.

2.2.2   Input-Output analysis

An issue typically of interest to policymakers is how government (or private) consumption expenditure spending on transport infrastructure and/or post construction benefits, such as travel time savings and vehicle operating cost savings, (i.e. initial inputs) will ultimately impact on growth, jobs and household income. One approach to answering this question is to use input-output (I-O) analysis.

As Duncan (2001, p. 9) notes, impact analyses (such as I-O) typically start by identifying the direct injection of funds or expenditures generated by a resource or activity (e.g. government expenditure on transport in constructing infrastructure). Further expenditures generated indirectly or induced elsewhere in the local economy are then estimated, as the recipients of these funds use them in successive rounds of further spending.

I-O analysis (sometimes also referred to as 'multiplier analysis') makes use of statistical tables (I-O transactions tables) to measure the relationship between industries in the economy. I-O transactions tables indicate the sales from one industry to another and also indicate the value of purchases of intermediate inputs, capital and labour each industry must make in order to produce a product (CIE 1994, p. 3). Transport may be set out as a sector (subdivided into several industries in some cases) (CIE 1994, pp. 5-6).

Technical coefficients (or 'multipliers') showing the relationships between different sectors, suppliers and consumers in the economy are calculated using the I-O transactions table[2]: Multipliers describe the indirect and induced effects (or flow-on effects – see below) on outputs, income and employment and indicate the overall change in the level of activity that results from an initial change in activity. Multipliers effectively 'add up' all of the successive rounds of re-spending, assuming that major factors such as input prices are unchanged and that there are no resource limitations. Using a simplistic example, assuming an initial expansion of direct activity (e.g. expenditure) by $1 million and a multiplier of 1.1, the total economic impact could be calculated as $1.1 million (Hone 2005, p. 5).

Multipliers typically used include the employment multiplier (measuring the change in employment levels), the household income multiplier (measuring the change in household

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Finally there is considerable uncertainty about the 'correct' social cost associated with the various taxes used to fund government spending.

For these reasons many jurisdictions omit an allowance for the social cost of public funds from estimations of project costs.

[2] The process for doing so is somewhat technical and involves use of coefficients derived from an analysis of the transactions table ('the table of direct requirements coefficients') and the inverse of an identity matrix ('the table of interdependence coefficients').

income) and the value added multiplier – i.e. GDP/GSP (measuring the change in levels of activity).

Thus, I-O analysis allows analysts to trace the impact of a change in final demand for one sector on the demand and output of each other, or the impact of a change in costs of supplying one input on all other sectors. Properly specified, I-O analysis proceeds as follows:

- The direct effects of the activity being studied (involving the direct injection of funds or expenditures and the initial round of output, employment and income generated by the project) are estimated.

- The flow-on effects represent the other activities in the specified region that are generated by the initial expenditure. These are calculated using multipliers and include:

    - Indirect production effects (re-spending by firms that receive income from the sale of commodities to firms undertaking the direct activities).

    - Induced consumption effects resulting from re-spending by households receiving income from employment in direct and indirect activities.

The basic process is illustrated in Figure 2..
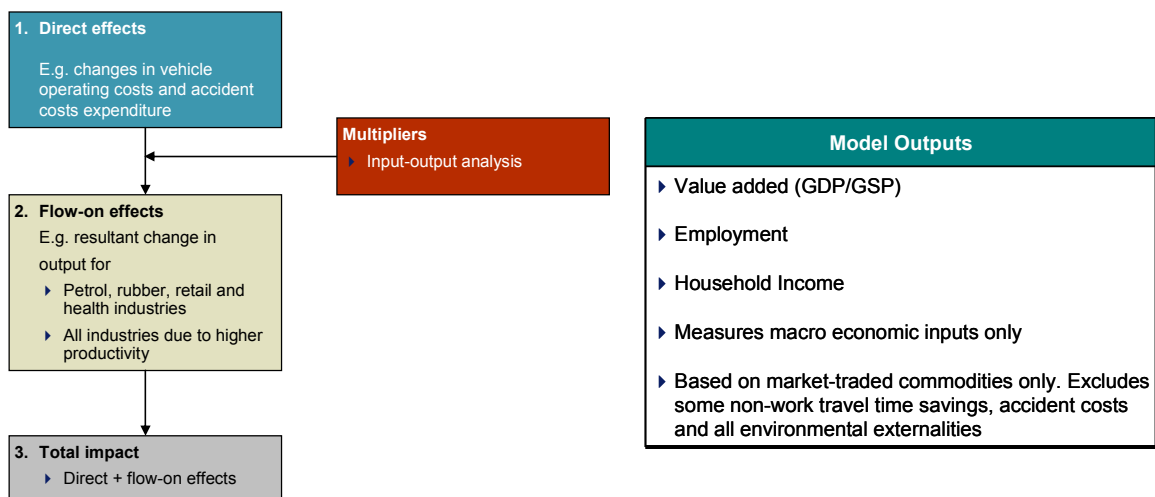
Figure 2.2   Basic steps involved in Input-Output analysis (derived from BTE[3] 1999, ACG 2004)

In the context of transport infrastructure development, I-O analysis typically stresses the flow-on effects of a boost in employment, spending and productivity, generated by the construction and/or operation of a given infrastructure project.

For example, as noted by the BTE, a typical scenario (focussing on just the induced employment effects in the construction phase) is as follows: A transport infrastructure project employs workers (who would otherwise be unemployed). By increasing national employment, total labour income is also increased. Workers then use part of their additional income for increased consumption. This results in an increase in consumer goods, providing for still more jobs for workers, who, in turn, increase their own consumption and so on. In some

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[3] The Australian Bureau of Transport Economics (BTE) is now known as the Bureau of Transport and Regional Economics (BTRE).

cases, I-O modelling indicates that the induced consumption effects actually generate much more indirect employment then the original transport infrastructure project's requirement for workers – though problems with this outcome are noted below (BTE 1999, pp. 50-51).

To give another example, Allen Consulting Group (ACG) used the reduction in vehicle operating costs, accident costs and increased labour efficiency (the latter as a proxy for reduced travel times) as 'negative shocks' to estimate the flow-on effects of the operational phase of a proposed New Zealand road investment program. The flow-on effects of these negative shocks were estimated (using multipliers) as a proxy for the value of liberated resources which could be used elsewhere in the economy. To do this, ACG imposed output shocks on the petroleum, rubber, retail trade and health industries (to capture the impacts of changes in vehicle operating costs and accident costs) and on all industries (to capture the changes in productivity arising from reduced travel times). This produced (raw) changes in regional GDP for Auckland, the Bay of Plenty and Wellington (ACG 2004, pp. 69-70).

The major outputs of I-O analysis are typically changes in GDP (or GSP or regional output equivalent), employment and household income. The framework of linkages used in I-O models can in turn, be used to develop CGE and Land Use Transport Interface (LUTI) models.

It is important to draw a distinction between outputs from I-O modelling and those from SCBA. I-O modelling measures economic impacts rather than economic efficiency or net benefits (as measured by SCBA). That is, unlike SCBA it takes no account of the opportunity costs in terms of land, labour and capital involved in undertaking a given project. Therefore project outputs measured by I-O analysis will generally be 'positive' (i.e. increased employment, GDP, household income), regardless of the type of project undertaken. In contrast, SCBA allows for opportunity costs and results may be 'positive' or 'negative' (i.e. a positive or negative project NPV) depending on the comparison of opportunity costs and project benefits. Thus it is entirely possible for I-O analysis to demonstrate positive employment and GDP, while an equivalent SCBA would find a negative project NPV (and a BCR below 1.0).

Results for I-O models are typically reported for given years in the project construction period and the project operational period. While in theory, project impacts such as higher GDP could be summed across the project lifespan, and a NPV estimated (as is typically performed for SCBA) this runs the risk of ignoring changes in the multipliers over time and may distort final results.

2.3   General Equilibrium (CGE) modelling

One method of dealing with the problem of constraints, faced in I-O analysis, is to use General Equilibrium modelling. (also known as Computable General Equilibrium (CGE) or 'national economic modelling')[4].

Like I-O analysis, CGE models essentially represent a macro-economic approach to analysing transport infrastructure. CGE models often draw on I-O models for their basic framework. In fact, CGE models are built on top of an I-O framework, and to this extent, share similar inputs.

However, CGE models typically employ econometrics to allow for the constraints on consumption and government spending that are absent in I-O analysis. They are therefore

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[4] Much of this discussion is drawn from Dwyer, Forsyth, Spurr & Ho 2004, p. 9.

generally better able to deal with economic interactions and represent a more sophisticated modelling approach then is the case with I-O analysis.

CGE models utilise extensive quantitative information relating to detailed commodity flows, labour market data, and national accounts data. The economy is presented by CGE models as a system of flows of goods and services between sectors. Goods and services include produced commodities and primary factor services (labour, land, capital). The sectors include the household sector, several industry sectors, government and the foreign sector. An I-O table is used to represent flows between sectors.

Commodity flows might include flows from industries to households, governments, export markets and investment; flows of commodities from industries to other industries for use in current production (intermediate usage); imports of commodities from abroad to meet domestic demand, and flows of primary factor services from households to industries. The theoretical structure and overall accounting framework are therefore calibrated to actual conditions in a particular year. Responses within the model to changes in economic conditions are determined by parameters. The values of the parameters are estimated from actual economic data (Dwyer, Forsyth, Spurr & Ho, 2004, p. 9).

As indicated, a key disguising feature of CGE models is their ability to incorporate constraints (i.e. behavioural assumptions) into modelling. These behavioural assumptions indicate how linked sectors respond to 'shocks' and how these shocks are transmitted to other sectors. Unlike I-O models, CGE models make specific assumptions about the behaviour of consumers, producers and investors, and, in particular, the extent to which the supply of factors of production can be increased (i.e. resource constraints).

Explicit assumptions can also be made about government policy settings using CGE modelling. They could allow for the fact that if governments spend (to raise money for infrastructure works, for example) they may need to raise taxes, meaning that consumers and firms would spend less – with consequent economic effects. Allowance can also be made for linkages to the rest of the world in relation to the foreign exchange market – e.g. when demand for exports increases, the exchange rate rises, discouraging exports and encouraging imports (Dwyer, Forsyth, Spurr & Ho 2004, pp. 9-10).

Dwyer, Forsyth, Spurr and Ho (2004, p. 8) illustrate the differences between I-O analysis and CGE modelling, and the importance of incorporating resource constraints, by reference to the case of Australia's resources boom of the early 1970's. I-O analysis would have suggested that Australia's manufacturing industry would be boosted by orders from the growing mining industry. However, this would not allow for the fact that the resources boom led to a major appreciation of the Australian dollar. This, in turn, resulted in a contraction of manufacturing due to its loss of competitiveness as an import-competing industry. In contrast, CGE modelling could have allowed for these impacts.

Thus, unlike I-O analysis, the results of CGE analysis are not a predictable increase in output stimulated by an initial increase in activity – more realism is added into the process.

CGE model outputs may include a range of macroeconomic variables such as GDP/GSP employment, imports and exports, taxes, government spending and budget surplus, as well as output results for individual industries.

The distinction between outputs from CGE modelling and those from SCBA largely mirror those discussed above for I-O modelling. Like I-O modelling, CGE modelling measures economic impacts rather than economic efficiency or net benefits (as measured by SCBA).

While CGE modelling allows for constraints, and GDP, employment and household income measures arising from a project will not always be positive, the opportunity costs of land, labour and capital are still ignored.

As discussed in Section 2.6.2, Dwyer, Forsyth, Spurr and Ho (2004) have recently suggested a more structured approach to deriving a measure of net social benefits, comparable to SCBA, from the output of CGE modelling. Their suggested approach explicitly recognises that (unlike SCBA) CGE modelling does not allow for opportunity costs in terms of land, labour and capital when assessing economic impacts such as changes in GDP.

As is the case for I-O models, results for CGE models are typically reported for given years in the project construction and operational period. While results can be presented on an NPV basis over the project lifespan, this runs the risk of ignoring the fact that multipliers and constraints are likely to change over time.

2.4 LUTI models

While not as ubiquitous as I-O or CGE modelling it is worthwhile briefly referring to Land Use Transport Interface (LUTI) models, particularly given the interest shown towards these by SACTRA. SACTRA has called for the development of LUTI models to further investigate the linkages between the product, property and labour markets (SACTRA 1999, paras. 10.146, 11.42).

In brief, these models attempt to predict the effects on land use of changes in the price, quality and availability of transport brought about by transport schemes or policies, and also the effect of land-use changes on transport networks.

Typically such models examine the behaviour of the key agents-investors, residents, producers, property developers and transport suppliers. Each agent group has key decisions to make, some requiring transport. For example, residents choose where to live, whether and where to work, how much to spend/save, how much training to acquire, how to allocate time between leisure activities, and so on. The price, quality and availability of transport influences some or all of these decisions (SACTRA 1999, para. 10.101).

SACTRA's interest in such models stems from its perception that they may be of use in uncovering the links between:

- the product market – potentially incorporating issues such as agglomeration effects and scale economies;

- the property market – examining issues such as effects of enhanced accessibility in vacant areas, migration responses and changes in land values, particularly in cases of imperfect competition where property market outcomes will not simply reflect pure transfers from the transport market;

- the labour market – in particular, the relationship between wages and employment (the wage equation) in local labour markets and how this is affected by the costs of transport (both into and out of a region and within it) and with commuting responses to changes in transport provision. A key question here is whether traveller benefits/dis-benefits are passed on to employers in the form of lower real wages or higher quality for a given real wage (SACTRA 1999, para. 10.112).

SACTRA is particularly interested in the interaction of these effects between different regions – an issue further explored in Chapter 3 below.

2.5   Critical appraisal of SCBA

- Poor application of accepted practice, in particular:

    – Non-allowance for induced and diverted demand (i.e. use of fixed rather than variable trip matrices);

    – Failure to allow for environmental externalities.

- Failure to capture all project benefits, which related to:

    – Broader economic benefits arising from logistical adaptation, agglomeration economies and taxation impacts);

    – An inbuilt assumption of perfect competition, which ignores the competitive gains arising from improved transport links;

    – Failure to allow for the additional benefits resulting from regional development.

These criticisms are reviewed below, along with responses. In assessing such criticisms two issues, in particular, should be kept in mind:

- the materiality of the omitted benefits; and

- the most cost-effective or parsimonious approach in dealing with any omissions.

2.5.1   Induced/diverted demand

Criticisms

SACTRA draws attention to the need to allow for 'transport market responses' in estimating SCBA (SACTRA 1999, paras. 8.30-8.33). In essence this would involve the use of variable rather than fixed trip matrices in SCBA (i.e. the inclusion of induced and diverted demand). This is considered to be an essential requirement for what SACTRA term 'CBA*' – a best practice transport SCBA which excludes the impacts of land use changes, imperfect competition and environmental externalities (SACTRA 1999, paras. 8.29, 8.33-8.34).

Conversely use of a fixed trip matrix may provide an inaccurate representation of benefits, as this omits the behavioural responses of individual travellers and firms to improvements in transport links. To SACTRA 'inasmuch as the focus is on the benefits of business reorganization and generation effects of improved infrastructure, the fixed trip simplification omits the very responses that are of central interest' (SACTRA 1999, para. 3.40).

Likewise, BTE indicates that these responses may then be passed on to other sectors of the economy through expanded production and/or lower consumer prices (BTE 1999, pp. 15-17). Indeed, as already noted, BTE's basic claim is that allowance for induced (and, presumably, diverted) demand negates many of the criticisms of SCBA, as it incorporates indirect producer and consumer responses (BTE 1999, pp. 11-17). However, to the extent SCBAs do omit such impacts in practice they therefore omit such responses.

SACTRA indicates that fixed trip matrices were the norm in the UK prior to the acceptance by the Department of the Environment, Transport and the Regions of the 1994 SACTRA report

(SACTRA 1999, para. 8.32). Likewise, many transport appraisals in New Zealand and Australia continue to use fixed trip matrices[5].

It should be noted however that inclusion of induced and diverted demand will not necessarily increase the net benefits arising from a project. For example, SACTRA notes that, in congested conditions, use of a fixed trip matrix could overestimate benefits significantly, by failing to allow for the additional congestion caused by induced traffic (SACTRA 1999, para. 3.39).

Responses

Use of a fixed trip matrix implies that transport projects have no effect on the behaviour of people. Changes in behaviour can include diversion of demand (to other modes and to other times) and induced demand (as people take advantage of improved accessibility to undertake more travel, either by current travellers making longer trips or people undertaking travel not previously made). In cases where projects are small, this may not be a serious misrepresentation of the impact of the projects. However, in the case of larger projects, SCBAs which only use fixed trip matrices can rightly be criticised for their failure to allow for induced/diverted demand.

Advocates for the sound application of SCBA, such as the BTE, see allowance for induced/diverted demand impacts as being important for ensuring the proper estimation of total benefits resulting from projects. Nonetheless, they argue that induced traffic responses are often modest in developed nations, citing a cost elasticity of demand for car travel on rural Australian roads of -1.08 (BTE 1999, pp. 16-17). Given the consistency of such small induced demand estimates across various studies in New Zealand and Australia (using a variety of modelling assumptions about induced responses), taken together with other evidence discussed above, it could also be argued that any omitted benefits from use of fixed trip matrices are relatively modest.

This will be less true in the case where a project may have a substantial effect on travel demand and in extremely congested situations. In these cases, allowance for diverted/induced traffic can significantly reduce benefits to existing users (and thereby total benefits), as has been noted by SACTRA. For example, depending on the shape of the relevant speed/flow curve, it is possible to imagine a situation where induced traffic resulting from a road improvement constitutes only, say, 10% of volumes but reduces benefits to existing road users by 50% due to the marginal effects of the additional congestion. However, it is equally true that, to the extent this occurs, benefits will be overestimated rather than underestimated by use of a fixed trip matrix.

2.5.2   Environmental externalities

Criticisms

SACTRA also point to the omission of environmental impacts from SCBA as an issue, although it is somewhat equivocal as to whether or not these should be monetised or accounted for 'below the line' (SACTRA 1999, para. 8.37). The treatment of externalities is also an emerging issue in New Zealand.

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[5] Bray (2005) discusses the use of fixed and variable trip matrices in transport planning and evaluation, and presents additional references on the subject.

Responses

There is little debate about the need to include environmental (and other) externalities in SCBA, though SACTRA has been somewhat ambivalent as to whether these are included 'above the line' or below it. Recently released Australian Transport Council guidelines (ATC 2004) recommend inclusion of externalities, while noting the difficulty of valuing the externalities in monetary terms. Austroads (2003a) provides unit values for environmental externalities for use in road projects calibrated to New Zealand and Australian conditions.

The effect of including environmental impacts in SCBA can vary. In the case of a fixed trip matrix, it is likely that project benefits will increase due to environmental benefits associated with the improved transport conditions, albeit modest benefits commensurate with the lack of any effect on travel behaviour. The outcome would be different where travel demand changes as a result of a project, but is seems likely to reduce project benefits if travel demand rises.

The inclusion of environmental externalities does not present an insurmountable issue for SCBAs and, in principle; they should be included within such an assessment. However, notwithstanding the Austroads work, monetary values are not available for every appraisal context. Where this is the case, such externalities may be included 'below the line' as a qualitative (dis) benefit.

Broader economic benefits

It can be claimed that SCBA does not take account of some broader economic benefits, primarily because it is a partial equilibrium approach. This is addressed in the general sense in the next subsection. Consideration is then given to the nature of these benefits, which include: logistics benefits; agglomeration benefits; other positive externalities; taxation impacts; and regional impacts.

2.5.2.1   SCBA as a partial equilibrium approach

Issues

A typical transport SCBA captures impacts from investment in transport by examining only the effects of a proposal on transport outcomes, which are typically reduced travel time, vehicle operating costs and accident costs. Critics of SCBA often characterise this 'partial equilibrium' approach, which assumes that the broader economy is 'fixed' (e.g. typically treating factors such as the prices of transport inputs as exogenous and valuing savings in inputs at observed market prices), as thus failing to take account of all of the effects of a proposal[6].

Such critics argue that the development of transport infrastructure can yield more extensive, follow-on or transmitted economic benefits throughout the economy that are not picked up in SCBA due to its assumptions about exogeneity. These additional benefits (or 'positive externalities') are argued to be above and beyond those accruing due to the passing through of benefits such as initial travel time savings and vehicle operating cost savings to producers and consumers. Two commonly cited positive externalities claimed to be 'omitted' by SCBA

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[6] In fact there is some blurring between the 'partial equilibrium' approach offered by SCBA and the general equilibrium approach offered by economic models. This is an issue which is further explored below.

are logistics benefits and agglomeration benefits – these are addressed in more detail in following sections.

Responses

Two responses are made regarding the claimed inadequacies of the partial equilibrium approach inherent to SCBA. Firstly, BTE notes that all economic models, including so-called 'general equilibrium' models, hold some elements of the economy fixed (i.e. exogenous). BTE suggests that rather than labelling SCBA as partial or general equilibrium it is more useful to attempt to identify the sources of exogeneity (BTE 1999, p. 107).

In doing so, BTE notes that soundly applied SCBA takes account of indirect effects of projects to the extent that estimates of induced/diverted demand are accurately estimated because flow-on responses to new transport improvements such as changes in inventory and warehousing arrangements, regional development benefits and improved access to labour supply that eventually are eventually reflected in changes in traffic movement (BTE 1999, pp. 13-17, 110, 154, 158, 164, 181).

For example when farmers expand production in response to a new road link the induced freight traffic (i.e. higher trip numbers) reflects the increase in farm profits (producer surplus) plus benefits and costs to other parties such as consumers. Or, put another way, the expansion in production depends on the increased use of transport. This, in turn, reflects how much people are willing to pay for the extra transport – which, in turn, is revealed by a transport demand curve including allowance for induced demand (BTE 1999, pp. 11-26)[7].

Thus, the measurement of 'transport benefits' by SCBA (though the use of transport demand curves alone) may effectively allow for broader economic benefits, particularly if induced demand is allowed for. Conversely 'adding on' benefits such as improved productivity and higher land prices to travel time and vehicle savings would constitute double counting. To its supporters, SCBA therefore represents a powerful and cost-effective tool for measuring economic benefits.

Even so, to the extent that induced traffic responses to projects are modest in developed nations such flow-on benefits must also be modest. For example BTE (1999, pp. 16-17) reports a cost elasticity of demand for car travel on rural Australian roads of -1.08.

2.5.2.2   Logistics benefits

Issues

A common argument made in the case of road infrastructure is that, apart from improving travel times and vehicle operating costs, a relevant transport investment may also ultimately result in an entirely new set of logistical arrangements through warehouse consolidation, the use of 'just in time' production methods, improved fleet and driver utilisation better inventory arrangements and the connection of two disjoint networks by a new link, thereby opening up for trade previously non-trading markets (Kinhill Economics 1994, p. 13; BTE

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[7] Of course, it is noted that induced demand is *not* allowed for within the 'limited SCBA' defined above. This is an issue which is explored further below. The most salient point however, is whether allowing for induced demand *alone* is sufficient to capture other 'flow –on' economic effects. Many critics argue that it is not (or ignore the issue) Others, such as BTE maintain that allowance for induced and diverted demand alone is sufficient to capture most of the material indirect (or transmitted) benefits.

1999, pp. 163-164; Banister and Berechman, 2000b, p. 5)[8]. This, it is sometimes argued, could also lead to an entirely new round of economic benefits.

To the extent that such decisions are exogenous, i.e. are not allowed for in traffic modelling assumptions, they will not be incorporated into the benefits measured by SCBA[9]. In many cases incomplete knowledge, or lack of evidence, will inhibit the estimation of traffic impacts and such benefits within SCBA. For example, many past SCBAs in New Zealand and Australia have failed to allow for influences such as heavier trucks, the value of time for freight contents, improvements in predictability and convenience.

Critics such as Aschauer and Quarmby (BTE 1999, p. 163) have argued that in not allowing for such impacts SCBA may be seriously understating final project benefits. For example, Quarmby's experimental work on British warehouse logistics in the 1980's suggested that 23% of the total benefits due to higher road speeds could be explained by logistics adaptations such as warehouse consolidation (the other benefits being savings in transport costs, exclusive of logistics adaptations). Quarmby also claimed that depending on relevant assumptions, logistics adaptations could account for 30%-50% of total benefits (BTE 1999, p. 165).

Likewise, US studies of the impacts of highway construction on supermarket logistics (i.e. warehouse consolidation and more frequent deliveries) of Phoenix's 'Paradise Parkway' during the 1990's have claimed additional indirect benefits of 105% of direct benefits (BTE 1999, p. 167). In Australia ACG's SCBA of Melbourne's CityLink project estimated that the greater use of articulated trucks, facilitated by CityLink ('fleet mix' benefits) would add 25% to more traditional transport cost savings while 'off road' savings in inventory costs due to warehouse consolidation would add 20% (BTE 1999, pp. 168-172).

In addition, SACTRA cites the submission of the Freight Transport Association, which points to increased vehicle utilization, better journey time predictability and wider sourcing of inputs arising from improvements to the A55 in Wales (SACTRA 1999, para. 5.25).

Aschauer has also cited phenomenal rates of return (90% or more over a project life of 50 years) accruing to the private sector (alone) arising from public investment in infrastructure (Kinhill Economics 1994, p. 7; BTE 1999, p. 183). Aschauer argued that deficiencies in SCBA, including a failure to allow for logistics reorganization, resulted in an understatement of the returns to public sector capital formation (BTE 1999, p. 183). Likewise, Otto and Voss' past studies of Australian road investment suggests very large returns to government spending. Otto and Voss identify logistics adaptations are a source of external benefits (BTE 1999, p.

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[8] Banister and Berechman (2000b, p. 5) use the example of the Oresund Link bridge and tunnel connection between Sweden and Denmark, opened in 2000, to justify the latter point. However, this example appears odd as it can hardly be argued that the two countries were not linked by trade before the bridge was opened. As indicated below, and as Banister and Berechman themselves note (p. 4), additions to the transport infrastructure in developed countries are likely to have incremental rather than dramatic economic impacts.

[9] BTE (1999, pp. 108-109) provides a similar example, in which a new rail link between grain farmers in northern NSW and the port of Brisbane might be assumed to result in a diversion of grain traffic away from the Port of Newcastle. While the impacts on rail traffic would be expected to be modelled by SCBA, follow-on effects which lead to a lowering of port charges by the Port of Newcastle would generally not be. Note however, that in this case, the increase in rail traffic – and resultant benefits – would be lower than modelled.

182) and argue that microeconomic analysis could identify indirect benefits which SCBA would fail to adequately measure (BTE 1999, p. 183).

In both of these cases, however, it should be noted that logistics reorganization was only part of the alleged reasons for the omission of benefits from SCBA. Others include expansions of labour market catchment areas and/or greater labour force flexibility (BTE 1999, p. 183, p. 186) and agglomeration benefits, noted below. In addition, as discussed below, there has been substantial criticism of the methodological approach and results of such work.

Responses

Responses to these criticisms include:

- Quarmby's work, cited above, suffers from a variety of suspect methodological assumptions. These include overestimation of inventory savings and of statutory limitations. Similar work by Mackie and Tweedle, published in 1992, suggests indirect benefits accounted for less than 20% of total benefits – though it is unclear how much less (BTE 1999, pp. 166-167).

- The US studies of the Paradise Parkway, referred to above, would appear to rely, to some extent, on undocumented hypothetical assumptions and it is unclear if logistics arrangements were initially optimal, raising the issue of how much of the alleged impacts were due to improved management (BTE 1999, p. 167).

- ACG's 1995 assessment of fleet mix cost reductions for CityLink was based on comparisons with the US experience. However, this may be flawed due to differing route lengths in each case and lack of allowance for higher inventory costs and inconvenience costs (both associated with larger trucks providing fewer deliveries). The assumption that 'off-road' benefits would add 20% to other project benefits was based, in part, on Quarmby's work which is of questionable relevance to the context of CityLink (BTE 1999, pp. 166-171).

- A 1995 analysis of the logistics effects of the Melbourne Ring Road by FDF Management estimated the 'off road' impact of savings in inventory and warehousing costs as equal to 3% of total benefits. Since the study did not allow for induced demand impacts, this in itself may be an overestimate, as the negative effects of more frequent deliveries were not allowed for (BTE 1999, pp. 167-168).

- SACTRA cites McKinnon's (1995) point that enhanced reliability of journey times is likely to be much more important to firms than logistical reorganization (though the latter has reduced inventory levels) (para. 5.33). In general, SACTRA finds that the area has been subject to claims based on survey evidence rather than 'consistent and rigorous economic analysis' (SACTRA 1999, para. 5.37).

- Partial allowance is already made for logistical impacts in some current transport appraisal guidelines and unit costs. For example, Austroads unit values of time (also adopted by the NSW Road and Traffic Authority's (RTA's) Economic Analysis Manual (EAM)) allow for the value of time of freight contents (from the point of view of freight consignees) (Austroads 2004; RTA 2004, p. 8).

- To the extent that this represents a value for logistical efficiencies resulting from speedier freight deliveries to business, this allows for such impacts to be incorporated into a relevant transport SCBA. Such figures also allow for a comparison with the value

of occupant time and a rough estimate of the relative importance of freight travel time savings within total project benefits.

- The original Austroads research (Austroads 2003b) from which the above value of time for freight deliveries, was based on the Australian automotive components industry. However, this took into account the very wide range of enterprise types, transport modes, tasks and goods involved in servicing this industry. The results indicate that, in general, the relative importance of freight travel time savings is small. Austroads suggest that this is due to the fact that the industry already has highly developed 'just-in-time' practices and agreed delivery windows. Therefore, the value of additional time savings is modest. To the extent that this is true of other contemporary industries, 'flow-on' gains from improved freight times will be modest.

- Conversely, the Austroads work also found that shippers placed a relatively large value on receiving reliable and undamaged shipments (Austroads 2003b, p. iii). Reliable shipments, in particular, can help reduce inventory holding costs. However, these impacts do not appear to be incorporated in publications such as the RTA's EAM.

- Any failure to allow for logistical adaptation by SCBA will generally apply only to commercial freight (and perhaps passenger bus/rail/sea travel) rather than travel by private in means such as cars. This will tend to limit its impact.

- Arguably, allowance for induced traffic may go some way to addressing logistics adaptations (BTE 1999, p. 164). That is, to the extent that induced demand is allowed for and that assumptions about changes in logistical practices are factored into traffic modelling, many of the 'omitted' logistics benefits will, in fact be captured by SCBA.

- Needless to say, in many cases, specific assumptions about changes in logistical practices will not be allowed for in traffic modelling. For example many New Zealand and Australian estimates of induced road demand simply use rough 'rules of thumb' based on demand elasticities (BTE 1999, p. 164) Alternatively, SCBA could then incorporate such impacts through assessing them as a separate category based on case by case evidence. A somewhat similar approach is envisaged by SACTRA in calling for an analysis of land use changes as part of a fully specified SCBA (para 8.30/Table 8.1) and of the likely consequences of transport investment in specific contexts (SACTRA 1999, Summary Report para. 43).

- Several commentators have noted that, (as is the case with transport infrastructure) logistics networks in New Zealand, Australia and other modern economies are generally well developed (SACTRA, paras. 1.32, 2.59, 2.74, 4.19, 4.73; BTE p. 16, 145, 147; Kinhill; Banister and Berechman). For example BTE argues that Australian supermarket warehousing is already highly consolidated and it is questionable whether individual projects such as CityLink would induce further consolidation (BTE 1999, p. 171). Therefore incremental changes in logistical arrangements (and ensuing benefits) attributable to transport links, are likely to be modest.

In short, while it is probable that traffic demand modelling, and hence SCBA, do not fully allow for logistical changes resulting from improvements to transport networks, it is far from clear is that these impacts are material. What is more likely is that SCBA underestimates some benefits arising from improved journey times, reliability and changes in fleet mix. The broader evidence about the magnitude of such omissions is, at best, inconclusive. However, the Austroads work cited above represents a beginning in terms of quantifying such impacts.

Thus, rather then rejecting SCBA, to the extent that such omitted benefits can be incorporated into the framework through good traffic demand estimation and case-by-case analysis, there seems little reason not to do so. For example, the Austroads results relating to the value of increased freight reliability could be applied to appropriate contexts.

2.5.2.3   Agglomeration benefits

Issues

Another source of additional economic benefits, often cited as not being captured within SCBA, relates to agglomeration impacts. Analysts such as Venables and Gasiorek argue that transport improvements may allow firms within a given region to agglomerate within a given region. This will result in a decline in average costs and external scale economies as a result of companies co-locating within a single region. 'Knowledge spillovers' may emerge as firms and individuals are better able to observe new methods and techniques and industry 'best practice' the closer they are to the event (BTE 1999, pp.95, 178-179; SACTRA 1999, para. 4.12). These impacts will ultimately foster greater productivity and increased inter-firm competition, resulting in cheaper products. Such additional pro-competitive impacts are said to be ignored by conventional SCBA (BTE 1999, p. 179).

Similarly Rye, Ohr and Lyche (2001) maintain that knowledge spillovers, resulting from agglomeration, generate external economies of scale, thereby increasing firm profits. This may also produce a higher willingness to pay for the marginal labour, especially within industrial clusters, than is the case for the average industrial wage. Therefore measures of the value of travel time savings, based on average wages will understate project benefits[10].

Some theoretical work suggests that decreases in commuting time may produce industry agglomeration. Analysts such as Beimborn and Horowitz have also noted that transit investments may affect land use by resulting in increased networking, interpersonal contacts and productivity (BTE 1999, p. 179).

SACTRA has also given some qualified support to the concept of agglomeration benefits, noting that 'there do, however, seem to be quite strong grounds for expecting substantial effects from the development of networks, so called super-additivity effects' (SACTRA 1999, para. 5.97).

At the same time, SACTRA note that impacts in any given region/scenario can be ambiguous, depending on relative scale economies, the size of the local market, the nature and scale of backward and forward linkages in local sectors and the nature and scale of transport improvements (SACTRA 1999, para. 5.85). Evidence cited by SACTRA from the US and EU regarding increases in industry agglomeration over time (which one would expect given improved transport links) would also appear to be insufficient and inconclusive (SACTRA 1999, para. 5.86).

More recently, the UK Department for Transport (DfT) has also argued the case for agglomeration economies. It is argued that firms are more productive when clustered

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[10] These authors do note, however that improved access to the pool of highly skilled labour *is included* in standard SCBA through estimates of induced traffic (Rye, Ohr and Lyche 2001, p. 16). BTE makes a similar point (BTE 1999, p. 181). The issue here is whether the use of induced traffic benefits, (typically largely composed of travel time benefits) is an adequate proxy given that such travel time benefits are based on national average wages.

together more densely, despite the fact that cities typically have higher labour and transport costs. Agglomeration results in access to larger product, input and labour markets and allows for the benefits of face to face contact. DfT argues that as cities grow and become denser they also become more productive. Positive externalities arise with agglomeration, as firms will allow for their own productivity gains when deciding to locate in a city but will ignore the gains to society. Thus, social gains will exceed private (i.e. firm specific) gains (DfT 2005).

Further, DfT argue that transport schemes may produce the benefits associated with agglomeration in two ways:

- Firms and workers in their existing location will be closer to each other and the location more accessible, as generalised costs fall. This is related to the idea of 'effective density' – i.e. even if transport improvements do not cause physical re-location they may produce some of the benefits of increased direct physical density through reduced generalised costs.

- Firms and workers may relocate in response to the change in transport costs and thereby have further effects on density (DfT 2005, paras. 70-76).

Responses

Similar issues to those identified for logistics benefits emerge when the claimed omitted 'agglomeration benefits' are more closely examined. Issues include:

- The benefits of agglomeration (i.e. increased competition) will tend to fall as transport costs fall. That is, as the costs of transport fall, dispersed industries will become more competitive even without changing firm location. Thus the scope for further increasing competition through agglomeration is reduced (BTE 1999, p. 96).

- After over 20 years of reform, levels of competition in many sectors of the New Zealand and Australian economies are already fairly intense. Thus the scope for further increasing competition though agglomeration that results from transport projects may be limited.

- Knowledge spillovers in the 'real world' may also not be as beneficial as they would be in theory. For example, in investing in R&D individual companies will be guided by self interest rather then accounting for the social benefits of knowledge spillovers. Thus companies could reject R&D in a project which is worthwhile for society but not for it alone. Thus the level of knowledge spillover could be at inefficiently low levels as the companies from which they would emanate do not full see them as a benefit (BTE 1999, pp. 178-179).

- Some transport projects will foster dispersion rather than agglomeration. For example, transport projects cantered on rural areas will tend to draw companies away from urban agglomerations.

- While suggesting that regional agglomeration benefits should occur, Rye, Ohr and Lyche (2001, p. 16) are not able to find any empirical evidence of such effects in their own work or in the studies of others.

- Use of induced demand impacts may be only a partial proxy for the differential wage impacts cited by Rye, Ohr and Lyche (2001). However, the reality and materiality of such effects would likely be highly case specific (i.e. would a higher willingness to pay for labour be reflected in actual wage rates and would resultant benefits be material?).

An additional issue from a New Zealand perspective is that Transfund's equity based approach to treatment of travel time savings implies that regions should not be separated out (or projects favoured) based on (potential) higher regional wages. For example, Brown Copeland & Co (2004, p. 13) decided against making an adjustment for additional benefits accruing to Wellington residents (based on their above average annual incomes) due to Transfund's equity based approach.

- Likewise, as noted above, SACTRA does not find conclusive empirical evidence regarding the benefits and/or tendencies towards agglomeration. In addition, negative economic impacts of agglomeration mentioned in planning and transport literature include congestion, environmental degradation and crime (SACTRA 1999, para. 5.77; BTE 1999, pp. 180-181).

- Thus SACTRA conclude that 'this process can have ambiguous effects on the relative development of different regions. Where scale economies dominate, any reduction in transport costs may lead to greater concentration of economic activity in larger core regions up to the point where diseconomies of aggregation set in. Where lower input costs such as wages or rents dominate there may be a de-concentration of economic activity. However large changes in transport costs may produce indeterminate effects' (SACTRA 1999, para 5.86).

- The DfT (2005) arguments seem to ignore the impacts of increasing city size on agglomeration impacts. By extension, it would appear that all cities should expand indefinitely, as agglomeration benefits would thereby become progressively larger, and that transport improvements should be aimed at facilitating this. However, as suggested above, there are evidently diseconomies associated with increasing city size.

- Given that there are diseconomies associated with increasing city size, a key issue in a New Zealand context may be at what point such diseconomies will be reached. The work of the Australian Commonwealth Grants Commission (CGC), which determines grant funding levels to Australian states, may be instructive in this respect.

- In its recent deliberations, the CGC (CGC 2003; 2004) noted arguments by NSW and Victoria that government service provision in the cities of Sydney and Melbourne was handicapped by dis-economies of city scale. In order to determine if such arguments were valid, the CGC reviewed the international evidence on 'optimal' city size. This evidence suggested that, while there is no generic relationship between size and unit costs, increasingly complex cities may eventually face higher per capita government service provision costs.

- The CGC identified factors such as greater congestion, constraints on infrastructure provision (due to past development, geography, the environment or local economics) and the need to provide services to increasingly specialised sub-groups as driving up unit costs in larger cities such as Sydney and Melbourne, relative to other Australian cities. However, it noted that rather than cutting in at some specified population size, the point at which urban diseconomies are reached may be affected by geographic, economic, social and political circumstances.

- While urban centres such as Wellington and Auckland have much smaller populations then Sydney or Melbourne, this suggests that some caution must be advanced when considering agglomeration benefits in such centres. For example, the difficulties associated with Wellington's local geography may mean that increased agglomeration

would drive up government (and presumably business) service provision costs at an earlier point than would be the case for an equivalent-size city, located on a plain.

• In addition, the quantum of the DfT estimate for Crossrail (see Table 2.1) appears to be very large, relative to benefits measured by the traditional 'limited' SCBA. Further, the cited agglomeration benefits add some 25% to the results obtained via use of a 'traditional SCBA'. This seems a very large additional benefit for a city such as London, which is already one of the developed world's larger cities. It is also somewhat at odds with DfT's own reference to SACTRA's earlier work that existing transport appraisal methodologies already capture most economic benefits and costs (DfT 2005, para. 8).

2.5.2.4   Other positive externalities

Issues

Apart from logistical and agglomeration economies, other positive externalities are also sometimes suggested by analysts. In New Zealand, Brown, Copeland & Company Limited (2004) reviewed a variety of possible additional economic benefits arising from the Transmission Gully road project, including possible regional benefits. The authors support an allowance for the reduced incidence of abnormal delays (Brown, Copeland & Company Limited 2004, pp. 10-12, 23). Arguably though, this is really a measurement issue – as discussed below.

SACTRA (1999) lists a number of ways in which transport improvements could improve national economic performance which touch on many of those discussed in this chapter These include:

• reorganization or rationalization of production, distribution and land use;

• effects on labour market catchment areas and hence on labour costs;

• increases in output resulting from lower costs of production;

• stimulation of inward investment;

• unlocking inaccessible sites for development; and

• triggering growth which, in turn, stimulates further growth.

(SACTRA 1999, Summary Report, para. 8)

In particular, SACTRA notes that transport could be expected to affect wages, firm costs and hence economic growth within a region, but also that there is little empirical evidence for how the relationship between local labour markets and transport actually works (SACTRA 1999, para. 5.131).

SACTRA also argues that changes in land rents/values will only reflect changes in transport investment (as argued by BTE, above) under conditions of perfect competition. Where imperfect competition exists this may not be the case; benefits (or dis-benefits) may be additional to those represented by induced demand effects. This may be compounded by linkages between the property market and labour market through home ownership and migration (SACTRA 1999, paras. 5.132-5.133, 10.122-10.124).

To investigate these linkages SACTRA calls for the development of Land Use Transport Interface (LUTI) models (SACTRA 1999, paras. 11.42, 10.146), as further discussed below.

2.5.2.5 Imperfect competition

Issues

SCBA implicitly assumes the existence of perfect competition throughout the economy. A key issue then becomes the level of competition extant within a given scenario and to what extent departures from this assumption matter.

Critics of SCBA argue that the assumption of perfect competition tends to understate benefits. For example, if competition is imperfect, a new transport improvement could strengthen competition within a given industry. This in turn, may result in lower prices to consumers. This may be especially true if a given industry is dominated by a monopoly or oligopoly. However, such benefits will not be recorded by SCBA as it assumes that the economy already reflects perfectly competitive outcomes (BTE 1999, pp. 23-26; SACTRA).

Austroads, Venables and Gasiorek, and Mohring and Harwitz have argued (in various ways) that the assumption of perfect competition has resulted in SCBA understating benefits of transport investment (BTE 1999, pp. 23, 89-92). While Venables and Gasiorek focus on the issue of agglomeration fostering competition, noted above, Mohring and Harwitz, focus on the extent to which 'elements of monopoly' present within the broader economy may lead to an understatement of transport investment benefits (BTE 1999, pp. 1-92).

Likewise, SACTRA views the assumption of perfect competition as an important issue (SACTRA 1999, paras. 3.45-3.53, 4.43-4.78). It concludes that 'imperfect competition in transport-using sectors can mean that conventional measures of SCBA fail fully to capture the economic benefits of transport schemes...explicit consideration of endogenous growth and competitiveness makes this failure potentially more serious' (SACTRA 1999, para. 4.74). At the same time, SACTRA's work indicates that in some circumstances SCBA's assumption of perfect competition may overstate benefits (SACTRA 1999, para. 4.51) and that there is still no compelling evidence of large errors due to the assumption of perfect competition within SCBA (SACTRA 1999, para. 4.74).

Recent analysis by Preston and Holvad (2005), explicitly designed to follow up on SACTRA's findings, has also emphasised the need to allow for imperfect competition in estimating the effects of transport investments. The authors refer to CGE modelling by Venables and Gasiorek (1999), Davies (1999) and Newbery (1998) (all three of which were also noted by SACTRA) as well as more recent CGE studies using the CGEurope model (Brocker et al 2004) and the Dutch RAEM model (Oosterhaven and Ellhorst 2003).

The focus of Preston and Holvad's work is the development of a 'multiplier' which could be applied to standard SCBA results (for road projects). This would correct for the assumption of perfect competition and allow for the assessment of full economic benefits. By comparing eight studies (including the work reviewed by SACTRA and the later studies employing RAEM, CGEurope), the authors derive a general multiplier of 1.4, with a standard deviation of 0.4. However, they caution that this multiplier will vary with particular regional circumstances. In particular, variations may be created by the price elasticity of the final product market, the extent of increasing returns to scale and backward and forward linkages, the extent of agglomeration economies and market power (as measured by price mark-ups and the number of firms in the market).

Responses

Arguments against the claim for additional benefits due to the assumption of perfect competition can be summarised as follows:

- Assumptions of imperfect competition would also impact on factors such as discount rate assumptions. SCBA often employs private discount rates as the basis for project discount rates. Under conditions of prefect competition these will equate to social discount rates. However imperfect competition will drive a wedge between private and social discount rates. It is quite conceivable that imperfect competition will result in social discount rates being higher than private ones, precisely because imperfect competition exists.

  For example, a telecommunications investment (displaced by a transport investment) may well extend the market reach of companies and enhance competition. Private returns to the telecoms investment may then be lower then social ones. Thus the discount rate will be underestimated by SCBA. It is also conceivable (though perhaps less likely) that imperfect competition will result in private discount rates exceeding social ones (BTE 1999, pp. 95-98).

- In short, assuming imperfect competition opens up a new area of considerable indeterminacy. BTE conclude that 'the overall direction of the errors whether favouring or opposing the investment is generally ambiguous' (BTE 1999, p. 100).

- SACTRA echo a similar theme in considering the impacts of external costs, perfect competition and imperfect competition on SCBA. For example, in some circumstances the assumption of perfect competition might result in a SCBA which overestimates benefits (SACTRA 1999, Table 4.2).

- As indicated above, after over 20 years of reform levels of competition in many sectors of the New Zealand and Australian economies is already fairly intense. Thus the divergence from perfect competition, and the scope for further increasing competition through improvements to transport infrastructure, may be limited. (BTE 1999, pp. 23, 92, 96, 126).

- SACTRA used a range of past theoretical reasoning and empirical work to conclude that, under a given set of assumptions, allowing for imperfect competition might add 6% to total economic benefits estimated by SCBA (SACTRA 1999, para. 4.70). In SACTRA's words 'typically, although the assumptions of perfect competition in [the] non-transport using sector introduces errors, they may be quite small relative to those involved in estimating conventional transport benefits' (SACTRA 1999, para. 4.75).

- BTE reach a similar conclusion, noting that 'the loss of realism in assuming perfect competition may be worth the enormous saving in analytical effort' (BTE 1999, p. 101).

- The work of Preston and Holvad (2005) draws heavily on material already utilized by to SACTRA in 1999, particularly the studies of Newbery, Davies and Venables and Gasiorek. While some more recent studies are also considered, it is therefore somewhat unclear as to why the conclusions are reached by these authors vary so greatly from those of SACTRA.

- No formal reasoning is given for the selection of an average 'omitted benefits' multiplier of 1.4. However, mathematical reconstruction indicates that this is the

simple average of the eight studies considered by these authors. Were such an approach adopted to the pre-2000 studies cited by Preston and Holvad (i.e. those available to SACTRA in 1999) it would suggest a multiplier of 1.33, rather than the 1.06 ultimately adopted.

- A further issue is the assumptions made by the base studies cited by Preston and Holvad and their relevance in a contemporary New Zealand context. For example, Venables and Gasiorek's modelling assumes price mark-ups of 30% above marginal cost, consistent with the work of Harris (1999), which was also presented to SACTRA. However, such mark-ups omit an allowance for normal rates of return and Harris' work was based on UK data spanning the years 1968-1991. The fact that the early years of the series would reflect a UK economy prior to the major structural changes of the 1980's and 1990's would seem to reduce its utility to the present.

- Drawing on the alternative work of Davies (1999), Preston and Holvad indicate that allowance should be made for a rate of return of 7% and that a mark-up of 14%-16% is more applicable. It is notable that Davies' work (which allowed for oligopolistic rather than monopolistic competition) was adopted by SACTRA in arriving at its estimate of a multiplier of 1.06.

- However, even Davies' data set is somewhat dated, covering UK industry between 1980 and 1992. As indicated, after a lengthy process of structural reform, most industry sectors in the present-day New Zealand economy are highly competitive. This would tend to reduce any divergence from perfect competition and limits any comparisons based on the past structure of the UK economy and/or studies based on monopolistic competition. If anything, any average imperfect competition multiplier for present-day New Zealand would be expected to be smaller then those determined by SACTRA.

2.5.2.6 Taxation benefits ('exchequer consequence')

Issues

DfT (2005) indicates that a transport improvement could have positive effects on tax revenues ('exchequer consequences') through stimulating higher levels of GDP. For example, a transport improvement means that workers will be attracted to higher paying jobs. However, their decision-making in terms of electing to switch to such jobs (and the volume and nature of their consequent transport behaviour) will be based on after-tax wages, rather than pre-tax ones.

As already noted, supporters of SCBA typically argue that the impacts of increased labour force participation and/or higher wages are captured through measures such as induced demand effects (BTE 1999, p. 181). However, to the extent that labour productivity is related to pre-tax rather than post-tax incomes, there is a 'missing benefit', not captured though measures such as induced demand. Put another way, there is an additional tax benefit to society, which is not allowed for in conventional SCBA analysis.

It is argued that commuting travel time savings will have three effects on GDP:

- GP1: more people choosing to work, or fewer people choosing to stop work (because one of the costs of working, commuting costs, has fallen).

- GP2: some people choosing to work longer hours (because they spend less time commuting).

- GP3: relocation of jobs to higher-productive locations (because better transport makes the area more attractive to employers and workers).

To the extent that these impacts raise GDP they will also raise the government tax take. This tax take can then be used for other projects (i.e. to the benefit of society).

An illustration of such impacts in the case of Crossrail is offered in Table 2.1.

Responses

There may be a case for such indirect benefits due to taxation effects. However, care must be taken to ensure that the behavioural assumptions underlying such estimates are accurate. DfT rellies on past measures of the elasticity of the UK labour supply with respect to wages in order to determine GP1. However, it is likely that such elasticities will vary greatly across jurisdictions and time. Further, small changes in elasticities can produce large effects, making the accuracy of the measure of considerable importance. It is noted that the range of labour supply elasticities (with respect to wages) examined by DfT (0.05-0.15) could imply that the calculated estimate could vary by +/- £400 million, over 10% of the total calculated exchequer benefits (DfT 2005, paras. 239-244).

Likewise, the calculation of GP3 relies on wage differentials between workers in inner London and those in outer London. The calculated wage premium differential of 30% (while adjusted for differing skills and job types) may be high when compared to New Zealand centres. This wage differential would appear to be driving the great majority of taxation benefits (DfT 2005, paras. 248-253).

Not surprisingly, as is the case with DfT's measurement of agglomeration benefits, the calculated taxation benefits appear very large, when related back to traditional SCBA benefits (adding some 28% to the traditional total).

However, a broader issue in considering taxation effects relates to the 'ignored' social cost of public funds, discussed in Footnote 1, above. To the extent that allowance is made for 'taxation benefits', similar allowance should also be made for the additional cost of public funds, involved in financing the project in the first instance. Arguably, too, the projects which are funded by the increased taxation collected due to Crossrail (or any other project) should also (ultimately) allow for the social cost of taxation, though this is a separate consideration and depends on the final usage of such funds.

However, as noted above, there are considerable uncertainties over issues such as how to measure the social cost of public funds within particular contexts. The potential errors involved in such measurement are large. These considerations effectively mirror those discussed for 'taxation benefits' above.

Given the large uncertainties involved (and the potential for significant error) a more parsimonious approach would therefore appear to be to ignore both potential social costs of taxation and 'taxation benefits' when conducting SCBAs.

2.5.2.7   Regional benefits

Issues

SCBA has occasionally been criticized for ignoring or understating the 'additional' regional benefits which flow from improvements (BTE 1999, p. 143). Local business expansion, and tourism development are the more frequently cited omitted benefits. Some analysts such as Seskin have claimed that regional economic benefits may be 50-150% greater than the traditionally measured 'road user' benefits (BTE 1999, p. 157).

This issue is also related to that of agglomeration economies, noted above. For example, the work of Rye, Ohr and Lyche (2001) suggests that impacts of a higher willingness to pay for labour will be reflected in higher regional wages and therefore should be allowed for in assessing the value of travel time savings.

SACTRA has also touched on this issue when considering the broader issue of linkages in a spatial economy and assessing the effects of agglomeration (SACTRA 1999, Chapter 5). However, much of the discussion focuses on measuring the regional distribution of economic benefits from SCBA rather than finding convincing evidence of the omission of economic benefits from regional SCBA studies.

The most appropriate approach to regional distribution issues and regional benefits is further examined below.

Responses

Two matters seem to underlie the concern with regional economic benefits. The first relates to benefits that may not be fully taken into account in SCBA, whilst the second interest is the distribution of benefits between geographic locations.

The issue of regional benefits is closely related to questions of project scope and definition. Leaving aside issues discussed in previous sections, other claimed 'omitted benefits' of regional development appear to stem from confusion over these issues.

However, as discussed below, such critiques may run a serious risk of double-counting so called 'road user benefits' (as these are passed on through the regional, and global, economies) and of confusing the scope of the relevant SCBA (BTE 1999, pp. 151-160).

The population over which benefits and costs are measured is sometimes referred to as 'the population of standing' (BTE 1999, p. 149). In New Zealand and Australia transport-related projects generally purport to measure benefits to the 'global' populations. That is, no specific bounds (or 'ringfences') are set as to the population of standing (though in reality the majority of effects are typically localised). Thus, (without ringfencing) 'regional development benefits' are typically subsumed within the global measures adopted by SCBA.

In many cases this distinction is blurred by studies which claim 'additional' regional benefits. BTE provide the example of a Wisconsin highway study which appeared to refer to the original State population as the population of standing but added in benefits enjoyed by in-migrants and highway users from outside the State to those enjoyed by the original state population. In another case, a Texas highway study added improved local land values to savings in transport costs – a clear example of double counting (BTE 1999, pp. 152-154).

In contrast, Brown, Copeland & Company Limited (2004) are cautious in their examination of additional regional benefits for Wellington as a result of the Transmission Gully project. There is a recognition that allowance for additional economic activity in Wellington resulting

from the project would likely be at the expense of other regions (rather than constitute a clear cut 'additional' benefit and that adding on increased output to traditional transport cost savings could constitute double counting (Brown, Copeland & Company Limited 2004, pp. 17-18).

BTE (again) argues that, allowance for induced traffic impacts will capture many regional development benefits, providing the example of the road improvement which stimulates local wheat production and creates more grain traffic (BTE 1999, p. 154). Thus 'adding on' the increased local farm output is double counting – not an additional regional benefit.

A further issue is structural. New Zealand and Australia already have relatively well developed transport links. Thus, the extent to which a given transport improvement could be said to 'open up' an area, stimulate rural/regional production and produce significant local benefits, as is often claimed, is limited. In addition, as transport costs are often not large in relation to total production costs or revenues, the extent to which an improvement in links to rural/regional areas will stimulate further production is typically small (BTE 1999, pp. 144-149).

In reality, transport SCBAs will miss some impacts. BTE provides the example of services relocating to a nearby highway service centre as a result of a town bypass. Even if this occurs within a 'ringfenced' study area, SCBA may miss some costs such as the opportunity cost of (now vacant) town service facilities and residential re-location costs. However, these would appear to be modest and the 'errors' in SCBA could go either way, (BTE 1999, pp. 154-156). SACTRA also make the point that it can be difficult to predict outcomes at a regional level (SACTRA 1999, Summary Report, para. 40).

More generally, SACTRA find that 'there is no guarantee that transport improvements will benefit the local or regional economy at only one end of the route - roads operate in two directions…assessment of whether economic benefits will actually benefit the intended target area will need to consider impacts outside the immediate neighbourhood' (SACTRA 1999, Summary Report para 40). Likewise 'there is no simple rule which can be applied to predict the regional outcomes of transport projects, the outcome will depend on a particular set of regional and sectoral circumstances' (SACTRA 1999, para. 5.97).

2.5.3   Conclusion

It is concluded that caution must generally be used when reviewing the context of claimed 'positive externalities'. In some cases these may be a measurement issue rather than evidence of a new class of benefits.

For example, as noted above, Brown, Copeland & Company Limited (2004) argue that reductions in 'abnormal delays' in the Wellington region constitute an additional benefit of the Transmission Gully project. It is not completely clear why such delays would not be incorporated within existing traffic data. However, it may be due to the way in which local traffic sampling and modelling is undertaken. If so, the claim for additional benefits, while legitimate, is more a measurement issue than an argument for a new class of benefits. Further, to the extent that such delays are, indeed, abnormal, the materiality of such impacts is open to question.

2.5.4   Comparison of SCBA and other models

SCBA and other models that seek to assess the effect of a proposal differ fundamentally in the matters they address, how they value the matters, and how they report the results of their analyses.

SCBA focuses on primary welfare benefits (or the value to consumer of using a facility or resource) while I-O analysis and CGE modelling focus on the secondary effects accruing to the producers of inputs to the production process, in the shape of labour, goods or services (Duncan 2001). It is generally not possible to derive a direct linkage between the outputs of SCBA and changes in macroeconomic indicators, such as GDP. SCBA in itself provides no direct information on such macroeconomic impacts.

As indicated in Figure 2.3 (presented in DfT 2005), welfare benefits (as estimated for SCBA) and GDP (as estimated for I-O and CGE approaches) seek to value some common things, but differ substantially with respect to other matters. Of particular note is the absence of impacts such as unpaid travel time, environmental and uncompensated safety and social impacts from macroeconomic measures because they do not have market prices attached to them.
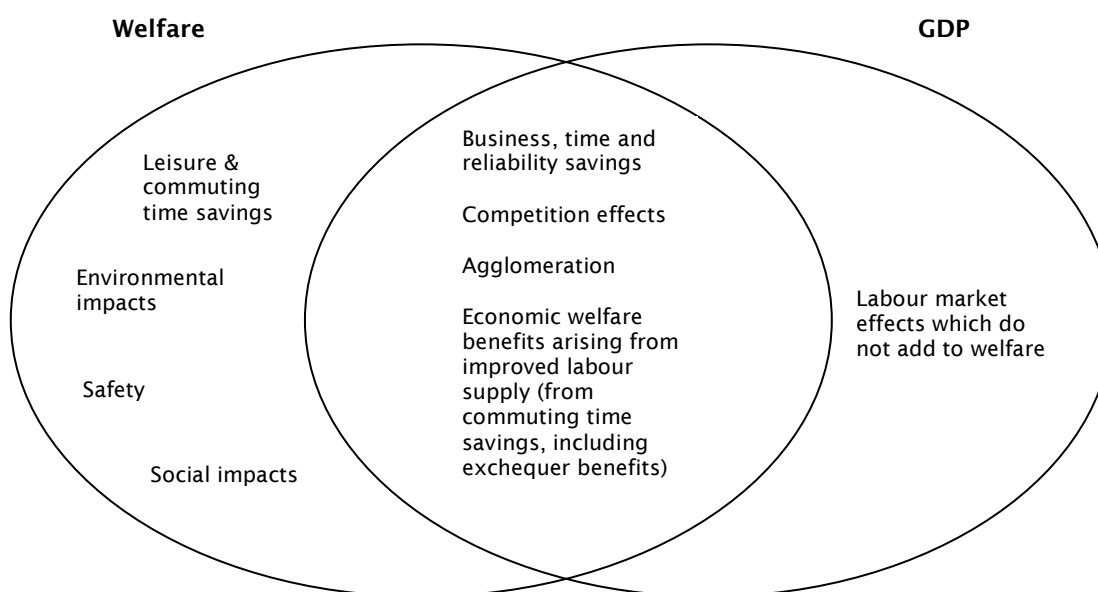
Figure 2.3   Connection between welfare and GDP impacts

Table 2.1 shows an attempt by DfT to show correspondence between the welfare and GDP approaches to appraisal for the Crossrail project that sought to improve rail linkages across London. Notably, the DfT approach to GDP effects relates only to benefits (or changes in gross welfare), and does not indicate the net outcomes of the project. That is, it is entirely possible that the costs of the project will exceed its benefits (i.e. BCR < 1) but that GDP growth will nonetheless occur.

Table 2.1   Estimated Welfare and GDP impacts of Crossrail (DfT 2005)

Benefits	Welfare (£m)	GDP (£m)
Business time savings	4,847	4,847
Commuting time savings	4,152	
Leisure time savings	3,833	
Total transport user benefits – conventional appraisal	**12,832**	
Increase in labour force participation		872
People working longer		0
Move to more productive jobs		10,772
Agglomeration benefits	3,094	3,094
Increased competition	0	0
Imperfect competition	485	485
Exchequer consequences of increased GDP	3,580	
Additional to conventional appraisal	**7,159**	
Total (excluding financing, social and environmental costs and benefits)	**19,991**	**20,069**

To continue this theme, it is also unclear if the DfT's approach could substitute for full CGE modelling of economic impacts. As discussed below, one of the suggested advantages of CGE modelling is its ability to allow for negative impacts of investment on GDP, such as displacement effects and resource constraints. For example, investment in Crossrail might draw labour away from other projects (or increase the cost of labour) and have implications for taxes and foreign exchange markets, which in turn, would also impact on final GDP outcomes. However, the DfT approach, illustrated above, focuses only on the direct GDP outcomes and does not seem to allow for any displacement effects or resource constraints.

Therefore, while it may be possible to trace out a relationship between gross benefits and GDP, using the methodology suggested by DfT, such a simplistic approach will not be reflective of any linkage between the final outputs of SCBA (i.e. NPV and BCR) and final GDP outcomes. Thus, projects which record a negative NPV (BCR below 1.0) may still produce increases in GDP. While it is likely that projects which produce a positive NPV (BCR above 1.0) will be associated with GDP growth, even this is not certain (particularly given that SCBA may include valuations of non-market products such as environmental externalities and some non-work travel time).

Further, SCBA has specific decision rules such as NPV and BCR. The general role of I-O and CGE models in measuring economic output does not allow for such clear-cut decision rules. This is discussed further in following sections, which examine these other models.

2.6   Critical appraisal of other models

2.6.1   Input-Output analysis

As indicated in the previous section, I-O analysis does not include items which are not included in macroeconomic measures, as currently reported by National Accounts data. These items include:

- Non-work travel time (to the extent that this is used for pure 'non-productive' leisure purposes and not diverted into other productive activities);

- Some accident costs (to the extent that these involve loss of life and major disability); and

- Environmental externalities (fully specified SCBA only).

This is because, as noted, SCBA measures changes in consumer (and producer) welfare and is based on the concept of consumer 'willingness to pay' (WTP). Consumers (or producers) may be willing to pay for commodities which are not traded directly within the market (e.g. environmental externalities). To the extent that they are 'better off' by doing so, and that this WTP can be monetised, SCBA may attempt to capture this. This drives a wedge between SCBA and other methodologies such as I-O analysis and CGE modelling (which make extensive use of National Accounts data) as discussed below.

Due to its broader scope, it is sometimes argued that I-O analysis 'captures' economic benefits which are missed by SCBA. I-O models are also particularly favoured for the analysis of regional impacts, as they can allow for the regional disaggregation of economy-wide impacts. For example, as noted above, ACG used regional economic activity multipliers, derived from regional inter-industry tables, to estimate the regional economic benefits of three proposed New Zealand road projects (ACG 2004).

While offering some useful insights, I-O analysis has been subject to a number of criticisms. These include:

- As Duncan (2001) notes, I-O analysis offers a measure of economic impacts (e.g. GDP growth, employment growth). It does not provide a measure of economic efficiency – involving the use of clear decision rules (e.g. NPV, BCR) such as that provided by SCBA. That is, while I-O analysis may indicate that GDP may grow as a result of a transport improvement, it is entirely possible that such growth is not economically efficient as measured by SCBA (i.e. BCR <1). This is a critical point.

- As already suggested, I-O analysis can tend to exaggerate economic benefits depending on the multipliers used. This is because no account is taken of capital formation effects (it is assumed output can be increased without limits), government budget constraints, labour constraints and changes in real wages, taxation changes, trade sector effects (such as currency fluctuations) or of substitution in consumption and production in response to price changes (ACG 2004, pp. 68-70; BTE 1999, p. 50; Dwyer, Forsyth, Spurr & Ho 2004, p. 7). In addition, it is assumed that productivity is constant, as interactions between industries, presented in I-O tables, are fixed.

  In effect, it is assumed that all resources (land, labour, capital) would have been unemployed and available in the absence of the increased expenditure.

  Ignoring these facts can create a misleading impression that investment in transport (or some other commodity) is somehow 'special'. As Duncan points out, NZIER work with I-O models suggests that expanding any sector of the economy will increase GDP (Duncan 2001, pp. 12-13). Likewise Dwyer, Forsyth and Spurr (2005, p. 313) see the results of I-O analysis as 'rather predictable; the final change in activity is some multiple of the initial change in production'.

An indication of the size of the exaggerated benefits in an economy only slightly larger than New Zealand's is provided by Dwyer, Forsyth, Spurr and Ho's (2004) modelling of a major sports event in NSW (equivalent to the Melbourne Formula One Grand Prix). For a $51.3 million injection of expenditure, I-O modelling suggests a $38.9 million increase in GSP while CGE modelling suggests a $19.4 million rise, a difference of around 100% (Dwyer, Forsyth and Spurr, 2005, pp. 354-355).

- A related point is that the lack of constraints within I-O models means that they ignore some 'displacement effects' on labour and capital. These arise due to constraints in government budgets and resources and are most apparent at the national level. In reality, when more resources are dedicated to the project, they are drawn away, at least in part, from other productive uses. This is often ignored by I-O analysis.

  In contrast, the diversion of productive resources away from other sectors is allowed for within SCBA as a matter of course though measuring project opportunity costs (e.g. construction costs).

- Producing a set of input-output tables requires data from a large number of sources (from national accounts to specific industry sources) and ensuring their consistency is a lengthy process. Input-output tables therefore reflect a considerable time lag, up to five years. Further, data for regional (and sub-regional) I-O tables is often extremely sparse, which can lead to speculative multiplier values, as discussed below.

The BTE has been particularly critical of multiplier models for their lack of model constraints. For example, I-O analysis of a project's employment effects during the construction phase can indicate the impact of project employment effects but give a misleading impression as to the impact on national (or 'aggregate') employment, as it ignores displacement effects on employment elsewhere in the economy, caused by the crowding out of other investment.

In addition, the positive impacts on consumption spending, suggested in the 'project construction phase scenario', given above, may not materialise at the national level. For example, if a project is tax financed then disposable income will be redistributed rather than increased. Thus, the indirect employment effects resulting from induced consumption, suggested in the example above, are unlikely to materialize[11] (BTE 1999, pp. 50-51).

Since I-O analysis is often 'sold' as providing information to policymakers on issues such as employment outcomes, (and it is frequently argued that such analysis indicates that transport investment has created jobs, both in the construction and post-construction phases) this is an important point.

Thus, I-O analysis and SCBA essentially measure different things and cannot be directly compared.

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[11] BTE does point out that I-O analysis may be more appropriate on a regional level as the ignored constraints, such as those on labour availability and mobility, may matter less and it is also conceivable that induced consumption may create further employment (BTE 1999, p. 50). Of course, the ring-fencing of the regional economy may also be kept in mind. For example, assume the national government uses tax financing for transport in a 'depressed' region which makes little contribution to the national tax base. In such a scenario, *regional* employment could conceivably be stimulated by induced consumption effects, as the negative impacts of higher taxation are more then offset by the positive ones of higher incomes associated with employment. Conversely, the national employment impacts would be quite different, as noted above. Similar issues are further examined below.

SCBA provides for a measure of the net economic benefits associated with a given project, i.e. benefits (the sum of producer and consumer surpluses) are netted off against social opportunity costs (e.g. construction costs, operational costs) to produce a project NPV (and, by derivation, a BCR). Ultimately, this activity could be expected to affect GDP, though such effects are not an output of SCBA.

However I-O analysis (and for that matter CGE analysis) does not present a similar measure of net economic 'benefits'. Rather, it produces the macroeconomic variables noted above (i.e. GDP/GSP, employment and income). These are not comparable to the welfare (i.e. economic efficiency) benefits recorded by SCBA, This is because, unlike SCBA, I-O analysis generally provides no allowance for the full opportunity costs to society of using labour and capital for the project rather than for some other purpose.

In other words, the broad gross macroeconomic 'benefits' of the given project are allowed for by I-O analysis (e.g. higher GDP). However, unlike SCBA, the full costs (i.e. the diversion of labour and capital away from their alternative uses) are not.

Put another way, (and as noted above) SCBA stresses the need to maximise economic efficiency (through provision of project NPV and BCR). I-O analysis focuses on measuring broader economic impacts (e.g. outputs, income, employment). SCBA focuses on the primary benefits (or the value to consumer of using a facility or resource) while impact analyses such as I-O analysis focus on secondary effects accruing to the producers of inputs to the production process, in the shape of labour, goods or services.

SCBA emphasises consumer willingness to pay for goods and services and on the related concept of consumer and producer surplus. A key question is whether the community would be better-off in adopting a given policy measure then it would be otherwise, using monetary values as a measure of utility.

In contrast, I-O analysis traces the flow of funds from market transactions and emphasises the distribution of expenditures derived from a resource, rather than its value to the community. Thus, as Duncan (2001) notes, in assessing the development of a new tourist attraction, funded by ratepayers, SCBA would ask the following:

- What are the benefits to taxpayers of the amenity, relative to the costs incurred?

- How much would they be willing to pay or forgo for access to the amenity?

- How does the amount they are willing to pay compare with the costs incurred?

I-O analysis would focus on how much additional spending, employment and output occurs in the economy and in what sectors, and how would these flow through to other sectors.

Duncan (2001) also points out that ranking alternative projects with impact analysis is problematic, as results tend to be in dollar (i.e. output or turnover) terms which have a broad rather than a specific relationship to opportunity costs of inputs.

A further issue, worthy of note, relates to scope. I-O analysis (and CGE analysis) exclude the impact of some 'non-market' factors not measured in National Accounts data which are allowed for in a typical SCBA for a transport project. These include non-work travel time savings (to the extent that these are incorporated into increased leisure time), some accident cost savings (such as lives lost and permanent disability avoided) and environmental externalities (to the extent these are allowed for in monetary terms within the SCBA).

Figure 2.4 gives an indication of the divergence between SCBA and CGE. In addition, Table 2.2 above provides for a comparison between the inputs and outputs of SCBA and I-O analysis.
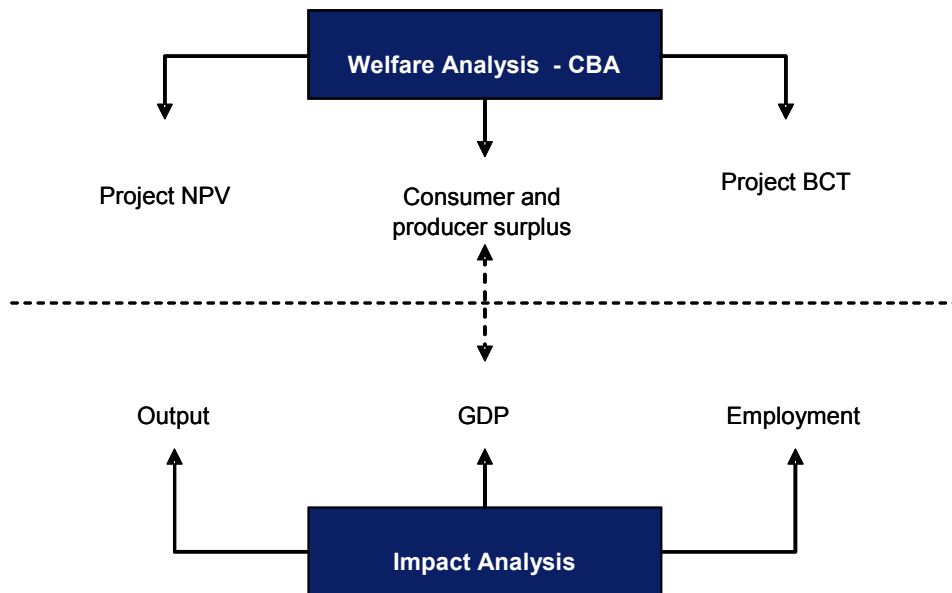
Figure 2.4   Comparison of CBA and Impact Analysis (I-O Analysis) (Adapted from Duncan 2001)

A consequence of these features is that a given project which only breaks even (or worse) in SCBA terms (i.e. BCR ≤ 1) can result in increased GDP if assessed using I-O analysis. In simple terms, this is due to the fact that GDP can increase either as a result of the expansion of existing activities, i.e. more of the same, or through higher productivity, i.e. more consumption or exports for the same inputs. (Though as Duncan notes, governments typically focus on higher productivity as a path to GDP growth rather than on simply increasing output through greater use of inputs.)

Thus, simply providing an indication of output measures such as GDP (which analysts such as ACG (2004) focus on) says nothing about the economic efficiency of transport investment.

As such, use of I-O analysis, in isolation, runs the risk of providing a highly misleading guide to national investment policymaking. An obvious problem in simply using I-O analysis to guide decision-making is that it may not separate out projects which only increase GDP through the consumption of more inputs. In contrast, other economies, which use principles of economic efficiency (as indicated by SCBA) to guide transport and other investment decisions would be able to sustain more efficient GDP growth. In the long term, a 'more of the same' growth approach would obviously have deleterious effects on a given national economy.

Duncan (2001) suggests that impact analysis is often employed simply to provide an 'upper bound measures' to the gain from increased use of underutilised resources and because the distribution of expenditure across a range of sectors may be of use in decision-making.

As suggested above, this second point has also been noted by Docwra and West (1999) who also note the potential for conflict between the SCBA and I-O, providing the example of an 'inefficient' road construction project which also generates employment. They suggest that

use of I-O analysis in combination with SCBA may allow policymakers to choose between conflicting goals (without indicating whether one methodology should be preferred as a decision-making tool). Preference for I-O results over SCBA would seem questionable in the long term, since it is not clear why the focus should not simply be on the development of efficient projects and thereby on efficient growth.

A more useful approach would therefore be to base decision-making on the results of SCBA and then employ I-O if impacts analysis is required, taking account of the fact that I-O analysis is likely to provide upper bound macroeconomic results.

Note that these outputs are quite different to those estimated by SCBA (i.e. project NPV and BCR). The comparison between I-O analysis and SCBA issue is further discussed below.

2.6.2 General Equilibrium Analysis

CGE modelling has often been suggested as an alternative to more traditional, project focussed, SCBA for two major reasons:

- CGE models typically present the impacts of a given investment in transport (or other defined change in inputs) in terms of its effects on GDP, employment, investment, trade, consumption, wages and tax. As such, they are of particular interest to policymakers, who cannot obtain such economic impact data from SCBA. They are therefore said to allow for a 'wider test' of the public benefit then is obtainable through SCBA alone (Docwra & West 1999, pp. 933-934).

- The use of a general rather than a partial equilibrium approach gives CGE modelling potential to capture the 'missing benefits', related to suggested 'flow-on' effects[12] (Kinhill Economics 1999, pp. 10-11). This is particularly true for large projects which have major impacts on other sectors of the economy. Docwra & West argue that, in principle, a CGE model would be needed to measure the efficiency effects on such sectors (Docwra & West 1999, pp. 933-934).

ACG has been particularly supportive of the use of CGE modelling in assessing the impacts of New Zealand and Australian transport investments (ACG 1993, 1996, 2003, 2004).

As is the case with SCBA and I-O analysis, CGE has its drawbacks, including the following:

- CGE models tend to be something of a 'black box' with key linkages and assumptions left undocumented. ACG (2004) provides some indications of the assumptions underlying the ESSAM model, though by their very nature, the operation of such models is arcane. Potential therefore exists for the incorporation of naïve or seriously misleading assumptions into model structures.

- An often-cited advantage of CGE models, that they provide an insight into employment effects arising from transport investment, may be illusory. The BTE provides an extensive critique of past (Australian and international) attempts to analyse national employment outcomes from infrastructure projects using CGE modelling. Invariably the models are handicapped by a lack of knowledge regarding the labour supply and demand markets and the nature of wage adjustments. The BTE concludes that it is

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[12] As noted above the distinction between the terms 'partial' and 'general' equilibrium can be somewhat blurred.

unlikely that CGE modelling can provide credible estimates of national employment effects. (BTE 1999, pp. 51-53).

- While some studies focus on increases in consumption expenditure as a measure of project benefit, others focus on outputs such as GDP and employment. A focus on measures such as GDP or employment can be seriously misleading, since as suggested above, estimating employment effects are unlikely to be credible and there is a distinction between economic impacts, such as increased GDP, and the economic efficiency measures assessed by SCBA.

- The time, cost and complexity involved in constructing CGE models can be considerable. The increase in accuracy promised by such models must be traded off against the degree of increased model accuracy. It is notable that the UK Government response to SACTRA (DfT 1999) rejected SACTRA's proposal for the development of a CGE model, essentially on these grounds (SACTRA 1999).

- The extent to which CGE models can truly be distinguished from 'partial equilibrium' approach of SCBA is less then sometimes claimed. CGE models incorporate their own (varying) assumptions regarding exogenous inputs and typically operate at a broad (rather than geographically specific) level. For example, the ESSAM model used by ACG to model New Zealand road projects (ACG 2004) assumes stocks and government consumption are set exogenously (ACG 2004, p. 64). Australian models such as MMRF and ORANI assume perfect competition in product markets (as does SCBA).

  Apart from these assumptions, such models typically cannot allow for the 'feedback effects' of specific issues, such as the strategic pricing behaviour by transport competitors within particular geographical regions, any more than can SCBA (BTE 1999, pp.109-110). Given the need to use exogenous variables in any case, and the necessarily broad nature of the approach, the reasoning in adding on the additional complexity entailed in CGE modelling is debatable.

- A corresponding point is that many CGE models are comparative static, rather than dynamic. That is, they omit inter-temporal relationships between endogenous variables. For example, a dynamic model might link changes in capital stock in one period with past levels of investment and savings (using specified elasticity measures) where all of these are defined as endogenous variables.

  Models commonly used in Australian transport appraisals, such as MMRF and ORANI are comparative static. The ESSAM model used by ACG to model New Zealand road projects would also appear to lack some dynamics. For example, government consumption is either a fixed percentage of GDP or determined exogenously.

  A practical implication of the lack of dynamic structure in CGE models is that the results may be distorted when compared to the outputs of SCBA, as discussed below.

  In addition, Docwra and West note that CGE models may be particularly poorly suited to analysing the impacts of transport investments such as road developments due to their lack of inter-temporal relationships. This is because road investments (and, by extension, most other transport investments) typically have a 'long tail' with respect to construction expenditures and flow-on impacts within the local area. Thus, a new arterial road to a port will affect local and global economies for many years, as local development gradually takes advantage of the new facilities. As CGE models often lack

inter-temporal dynamics, they are not optimal for assessing such impacts (Docwra & West 1999, p. 942).

- The benefits of such models are assumed to spread across the economy. This may be inappropriate for many transport investments which are local in character and where benefits tend to be 'lumpy'. For example highway improvements in Perth may have only small impacts per se in Brisbane (Kinhill Economics 1994, pp. 15-16). Likewise, ACG's analysis indicates most of the benefits from the Wellington Regional Land Transport package will accrue to Wellington (ACG 2004, pp. 43-46). Of course in cases where an investment program is truly national in character a national approach may be entirely justified – e.g. New Zealand Passing Lanes Project (ACG 2004).

- Correspondingly, if the focus of the SCBA is on predicting transport outcomes CGE modelling will be of little use, due to its coarse, broad brush approach (BTE 1999, p. 104).

Some further key issues covering the 'relationship' between CGE and SCBA in particular are discussed below.

2.6.2.1   CGE and SCBA

As is the case with I-O analysis (and unlike SCBA) CGE modelling output consists of macroeconomic variables (GDP, employment, taxes consumption, investment, exports and imports, industry output impacts). As already noted, these are measures of economic impact rather than of economic efficiency or welfare.

In addition, like I-O analysis, CGE analysis excludes the impact of some 'non-market' factors not measured in National Accounts data such as non-work travel time savings (to the extent that these are incorporated into increased leisure time), some accident cost savings (lives lost and permanent disability avoided) and environmental externalities.

Some attempts have been made in the past to reconcile CGE model outputs with those of SCBA. In some cases these have focused on using changes in consumption expenditure produced by CGE models as a proxy for changes in net social welfare. This is argued to be comparable to the net social welfare measures (i.e. project NPV) produced by SCBA. An associated argument is that such approaches pick up the benefits allegedly omitted by SCBA.

However, even when this is done, past Australian experience does not indicate that CGE models will necessarily produce greater indicators of benefit than traditional SCBA.

For example, ACG analysed the benefits and costs of CityLink, using both the MMRF model and more 'traditional' SCBA measures (ACG 1996)[13].

The SCBA results indicated welfare gains some 11% greater than those estimated by the MMRF, after an adjustment for lack of model dynamics, discussed below (ACG; BTE 1999, p. 113). Conversely, this does not imply that SCBA overestimated the benefits of CityLink; as BTE note, modelling uncertainties (such as the lack of dynamics) makes it difficult to infer much about the direction of the difference (BTE 1999, p. 113).

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[13] The measure of welfare gain from the MMRF results was the change in real private and public consumption expenditure over the project life.

Likewise, Austroads compared a number of past Australian SCBAs of rural and urban roads with equivalent BCRs derived from an Australian economic model (AE-CGE). In some cases the CGE-modelled BCRs exceeded those estimated by SCBA; in others the reverse was true. Austroads concluded that 'it appears that any economic benefits that flow on to the economy from road projects that are not captured in cost benefit analysis are relatively minor' (BTE 1999, pp. 115-116).

To the extent such differing approaches can be compared, these results do not indicate that CGE captures significantly greater economic benefits than SCBA.

Moreover, the lack of dynamic structure within a given CGE model may bias its results in relation to those obtained by SCBA, unless it is allowed for. For example, ACG's (1996) modelling of the impacts of CityLink using the MMRF indicated that it would reduce production costs and thereby induce investment, boosting the productive capacity of the economy. This, in turn, would cause gains in national output and thereby in national consumption.

However, the lack of a dynamic modelling structure in the MMRF meant that the cost of the induced investment was not allowed for. In order to allow for such costs, ACG adjusted consumption gains during the project's operational phase downwards. The consumption losses during the construction phase were adjusted upwards, with simulations indicating that CityLink would 'crowd out' other investment prior to becoming operational (BTE 1999, p. 115; ACG 1996, p. 40).

There is no evidence that ACG has similarly adjusted the ESSAM model to account for any lack of dynamics in its study of New Zealand road investments.

If a lack of model dynamics is an issue, why not simply create fully dynamic models, with specified relationships (i.e. elasticities) between key endogenously specified variables? A simple answer is that costs of doing so would be considerable and the credibility of such work, particularly in view of data restrictions, would be questionable. For example, as noted above, models which do specify employment impacts endogenously have come under considerable criticism for their lack of realism. Investment decision-making process also constitute a particularly difficult issue (see below). In many cases, data to permit the development of such models simply do not exist.

A related point, suggested in the discussion of partial and general equilibrium above, is that if both CGE and SCBA must, by necessity, treat some variables as exogenous, the reasoning in employing the more complex CGE methodology is questionable on grounds of parsimony. A partial defence is that CGE offers at least some additional degrees of realism by relaxing some of the exogenaity assumptions of SCBA, such as prices. However, BTE contends that in many cases SCBA's assumptions regarding exogenaity and the ignored 'feedback loops' are of little consequence (BTE 1999, p. 110). The above comparisons with the Austroads and ACG studies being a case in point.

Further, even assuming 'correct' specification of CGE models, the ambiguous results obtained with the Austroads and ACG CityLInk studies noted above could also be taken to indicate that SCBAs can either overestimate or underestimate benefits, depending on assumptions and circumstances. There does not appear to be a consistent underestimation of benefit streams by SCBA. Indeed there is no reason why a partial equilibrium approach such as SCBA should consistently underestimate benefits (BTE 1999, p. 109). As BTE note, when attempted, sensitivity testing of CGE models produces a range of outcomes, - within which SCBA

assessments often fall: 'The result is a bland conclusion: the CBA estimate could be either too high or too low depending on factors that are beyond the modeller's knowledge' (BTE 1999, p. 127).

2.6.2.2   Adding CGE modelling outputs and SCBA results

An incorrect approach to comparing CGE model outputs and SCBA results, employed by ACG in estimating the benefits from four proposed New Zealand road projects is to add the direct benefits of SCBA to those derived by CGE modelling. ACG justifies this approach by indicating that it is adding the direct 'non-economic' benefits not allowed for in the CGE modelling such as savings in non-work travel time and value of lives saved (ACG 2004, p. 51).

However, O'Fallon (2004) questions whether combining savings in non-work travel time with the private consumption expenditure constitutes a form of double counting, as non-work travel time and money saved will be used in other ways (O'Fallon 2004, p. 5). In reality, it is likely that some non-work travel time will be used for other productive activity (e.g. additional consumption) while some will be used for pure non-productive 'leisure' purposes. Depending on the ratio of these two effects there is likely to be double counting under the ACG approach. It is also noted that DfT (2005) appears to make a similar error, apparently assuming that leisure time savings do not translate into GDP benefits (see Table 2.1).

In addition, while various macro-economic outputs (such as consumption, investment, trade GDP, real wages and household income tax rate) are provided by ACG's ESSAM (i.e. CGE) model, the precise derivation of ACG's total benefits (or 'economy wide benefits') is not clearly explained. Nor is it clear precisely what these 'benefits' represent.

Economy-wide benefits appear to subsume 'direct benefits'. Direct benefits, in turn, relate to SCBA outcomes and include allowance for direct economic benefits and direct non-economic benefits such as (all) non-work travel time, lives lost, and permanent disability.

However it is not clear how the indirect benefits (as opposed to macroeconomic impacts) are derived from ACG's CGE modelling, raising the question as to whether these might capture economic benefits already allowed for in the estimation of direct economic benefits[14].

Thus, the lack of clarification regarding this process raises further questions regarding double counting. It is further noted that whereas only one of the four projects passes Transfund's 'hurdle rate' for road projects under 'traditional' SCBA (i.e. BCR = 4.0 at a 10% discount rate), three do after combining SCBA and CGE results (ACG 2004, p. 52).

This case indicates the ambiguities and dangers involved in 'mixing and matching' SCBA and CGE modelling. The approach adopted by ACG appears to be a response to arguments that

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[14] For example, the Wellington Regional Land Transport Package is recorded as having economy wide (or total) benefits of $148.7m, of which $82.1m are direct benefits. It is unclear precisely how the differential (i.e. $66.6m in indirect benefits) is calculated under ACG's approach (ACG 2004, pp. 43-45, 50-51, 59-60). It is also unclear what the calculated 'total benefits' actually represent.

It is also unclear whether induced/diverted demand effects have been incorporated into the 'direct effects' in some form, though there is a reference to. 'changes in travel behaviour' (ACG 2004, p. 60) resulting in reduced vehicle operating costs. If such effects have been allowed for, this would also raise issues of double counting.

the exclusion of externalities from macro-economic analysis makes it difficult to compare with SCBA (while their inclusion would necessitate yet more assumptions).

2.6.2.3   Using GDP as a proxy for SCBA outputs

Apart from such estimation issues, similar issues to those mentioned by Duncan (2001) above also apply to CGE analysis in many contexts. In particular, it has been argued that even if CGE modelling incorporated unpriced effects, such as externalities, the use of GDP constitutes an inappropriate measure of investment return, just as business turnover is not a measure of profit (Kinhill Economics 1994, pp. 10, 14-15).

The BTE also criticise the use of GDP as a 'benefit'. Using GDP for this purpose may not accurately reflect investment decision-making processes or the costs of investment in a given transport (or other) project measure using CGE. More specifically:

- Investment modelling can be extremely complex. Project resource requirements can displace other projects, while project outcomes (such as better roads) can induce complementary investments.

- These changes in complementary investment will affect GDP. With investment decisions therefore being very difficult to accurately model, the ultimate effects on GDP can be hard to predict (BTE 1999, p. 133).

- Focussing on GDP will not provide an accurate picture of the costs of investment. Consider a road project decreasing costs to the farm sector. Lower freight costs may induce farmers to spend more on machinery, inducing investment elsewhere in the economy and adding to direct farm output, both of which would increase GDP.

  However, the costs of the induced investment would not show up in the modelled changes in GDP, as farmers may have reduced consumption expenditure to fund increased machinery purchases. Thus merely modelling an increase in GDP would reflect the gains from induced investment but not the costs (BTE 1999, p.134).

It is again noted that consumption expenditure rather than GDP is often used as a measure of welfare by CGE modellers. However, to the extent that that consumption expenditure is also related to modelled investment decisions within a CG framework, it could be expected that it would likewise be dependent on the accuracy of such modelling.

Dwyer, Forsyth, Spurr and Ho (2004) have recently suggested a more structured approach to deriving a measure of net social benefits, comparable to SCBA, from the output of CGE modelling. This explicitly recognises that (unlike SCBA) CGE modelling does not allow for opportunity costs in terms of land labour and capital when assessing economic impacts such as changes in GDP.

The authors therefore suggest a methodology for assessing net benefits from a CGE model within the context of a rise in tourism to NSW:

> *To do so, one subtracts the cost of additional inputs used to produce the increase in activity. Thus the cost of additional labour used (wage by quantity), the cost of additional capital services and cost of additional natural resources must be subtracted from the*

change in the value of the increased economic activity, as measured by the change in GNP or National Income[15].

(Dwyer, Forsyth, Spurr & Ho 2004, p. 28)

The authors apply this methodology to the assessment of a 10% increase in tourism to NSW. CGE modelling is used to assess the economic impacts, including a $364 million increase in GSP. However net benefits are determined to be only $96 million due to the costs of additional labour ($296 million) (Dwyer, Forsyth, Spurr & Ho 2004, pp .28-29).

Elsewhere, Dwyer, Forsyth and Spurr (2004) also argue that factors such as additional road expenditures, congestion costs, environmental costs and economies of density could likewise be netted out from CGE modelling of the effects of additional tourism.

This approach would appear to address many of Duncan's criticisms and the second of the BTE's criticisms, noted above. Dwyer et al's approach does not yet appear to have been widely applied[16], however there is no reason why it would not be equally valid within a transport investment context.

However, it is not clear if such an approach would address the first point made by the BTE above. That is the accuracy of the approach will only be as good as the CGE modelling, including the modelling of investment decisions and therefore of GNP, allows it to be.

Further, even allowing for the treatment of externalities, a more complex issue would appear to be the treatment of non-work travel time, as discussed above. In most cases, it would appear that SCBA would offer a more reliable, and certainly a more parsimonious approach to the modelling of social benefits.

While criticisms of DfT's recent work have been noted above, Figure 2.2 and Table 2.1 are useful in this respect, in indicating the differences between the welfare effects measured by SCBA and GDP impacts. As Table 2.1 indicates, even if the additional welfare and GDP benefits associated with agglomeration, imperfect competition and the exchequer benefits are ignored, there is still a wedge between the welfare measures and GDP impacts due to the treatment of commuter and leisure travel time savings, though as noted above at least some of these should be included in GDP impacts.

That said, there may be a case for complementing the economic efficiency outputs produced by SCBA with the macroeconomic outputs of CGE modelling, particularly in preference to the less reliable outputs of I-O analysis, though as already noted, SCBA should be retained as the primary. decision-making tool. However, as the development of CGE models involves considerable time and expense, policymakers will need to be certain that information on macroeconomic outputs are of sufficient importance to justify the creation and maintenance of such models. Given this, along with the scepticism expressed over the need for such models by the UK Government, and the fact that transport projects are typically small in relation to the size of developed economies, it is likely that only the largest New Zealand projects would require development and maintenance of such models.

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[15] Note that GNE is used in place of GDP to exclude overseas transactions.

[16] However one recent application was the hypothetical modelling of the benefits of a government-subsidised steel mill (Layman 2004).

2.6.3 LUTI models

As SACTRA also notes, however, it is currently uncertain as to whether it is actually feasible to use LUTI to develop estimates of total economic impacts as well as benefits and dis-benefits. This is because past work with these models has focused on economic impacts and that the models themselves initially concentrated on measuring flows of goods, and people. It is also (as yet) unclear if they can be reliably used to measure characteristics such as agglomeration effects and scale economies. This, in part, is the impetus for their call for the further development of such models (SACTRA 1999, paras. 4.72, 5.124, 10.99-10.147, 11.42).

In addition, such models can be extremely large and complex and it is uncertain if sufficient data can be produced to enable calibration of large scale versions of such models (SACTRA 1999, paras. 5.125–5.126).

A further issue, perhaps not fully addressed by SACTRA given the uncertainty of LUTI model outputs, is that of potential double counting. For example, the intention to use LUTI to examine the labour market 'flow-on' effects of traveller benefits/dis-benefits appears to be prompted by questions over whether employers or employees are the ultimate beneficiaries of changes in transport provision (i.e. the distribution of (dis)benefits). However as induced demand effects captured within SCBA should already capture such aggregate employment benefits, including changes in relative labour costs and access to skills (BTE 1999, p. 181), care would need to be taken not to double count LUTI results within the context of an SCBA.

Further, as already hinted at, there is the additional issue of parsimony. In particular, caution would seem also seem to be called for when assessing the impacts of the property market outcomes using LUTI in the case of imperfect competition. Not only should care be taken not to double count SCBA outcomes, but, if the effects of imperfect competition in the first instance are only small in most cases, as suggested by BTE, then likewise the divergence between transport and property market outcomes should only be minor.

2.7 Other assessment approaches: summary

Table 2.2, provides a summary of the key inputs, outputs, advantages and disadvantages associated with each of the three main methodologies (SCBA, I-O, CGE) described above.

Table 2.2   Comparison of SCBA, I-O analysis and CGE modelling

	SCBA	I-O Analysis	CGE Modelling
Major Inputs	Project costs and benefits, assessed at market prices or market equivalents (e.g. WTP measures for externalities).	Various, -e.g. initial project expenditure, productivity benefits/'output shock' from project operation.	Various, – e.g. initial project expenditure, productivity benefits/'output shock' from project operation.
Major Outputs	Project NPV, BCR – i.e. net benefits (costs) to society of project.	Range of macroeconomic variables, generally employment, outputs and GDP (or regional equivalent) impacts.	Range of macroeconomic variables, including employment, consumption, investment, taxes, exports and imports, industry output impacts and GDP (or regional equivalent) impacts.
Major Advantages	Transparent measure of project benefits (and costs) and provides clear basis for decision-making.	Provides measure of macro-economic impacts of interest to policymakers; complements SCBA.	Provides measure of macro-economic impacts of interest to policymakers; complements SCBA.
	Relatively easy/inexpensive to construct.	May be more practical for modelling small regions than CGE analysis.	Allowance for constraints potentially provides for more realistic modelling of outputs than I-O.
	Provides measure of economic efficiency.		
	Can allow for an indication of 'non-market' costs and benefits (e.g. non-work travel time savings devoted to leisure, accident cost impacts on lives lost, environmental externalities).		
Major Limits	Does not provide macro-economic outputs detailing impacts on employment, consumption, GDP etc.	Does not provide clear and direct measure of net project benefits (costs).	Does not provide clear and direct measure of net project benefits (costs); benefit measures may be derived however still questionable if these allow for all 'costs' and contingent upon 'correct' modelling in the first instance.
	Simplistic assumptions mean that some economic effects may not be captured in the analysis (e.g. imperfect competition), though materiality of this is debatable.	Does not provide clear 'decision rule' as to whether to proceed with the project or not akin to NPV or BCR.	Does not provide clear 'decision rule' as to whether to proceed with the project or not akin to NPV or BCR.

Table 2.2 (continued)   Comparison of SCBA, I-O analysis and CGE modelling

	SCBA	I-O Analysis	CGE Modelling
Major Limits (continued)		Outputs do not constitute measure of economic efficiency; resulting growth may be 'inefficient'.	Outputs do not constitute measure of economic efficiency; resulting growth may be 'inefficient'.
		May not allow for full impact of all project 'costs' – i.e. full opportunity costs may not be netted out.	May not allow for full impact of all project 'costs' – i.e. full opportunity costs may not be netted out.
		Broad scale of analysis of questionable relevance to generally 'local' nature of transport projects (exception: national projects).	Broad scale of analysis of questionable relevance to generally 'local' nature of transport projects (exception: national projects).
		Does not allow for constraints on various factors, resulting in overestimate of impacts – potentially producing 'expenditure without end'.	Modelling approach is not transparent and open ; questionable assumptions/relationships may be hidden in 'black box'.
		No allowance for environmental and some accident externalities, partial allowance for non-work travel time.	No allowance for environmental and some accident externalities, partial allowance for non-work travel time.
			Highly complex, expensive and data hungry process; may not be suitable for small regions.

2.8   Conclusions on alternative approaches

In assessing the 'omitted benefits' of even the 'limited SCBA', defined above, it should be recalled that project appraisal takes place 'at the margin' and typically relates to additions to existing transport infrastructure. Correspondingly, and to repeat a point made by numerous commentators, in developed economies (such as New Zealand), any improvement in existing infrastructure is likely to have only modest impacts on the broader economy[17]. Therefore claims that SCBA is dramatically underestimating the quantum of benefits flowing from transport investment should be viewed with considerable scepticism.

A related point is that, in developed nations, most transport projects tend to be relatively small when compared to the size of national economies (SACTRA 1999, para. 4.19). Thus claims of dramatic economic benefits arising from transport investment must be viewed with some scepticism.

These issues should also be noted when considering the DfT (2005) work, cited above. DfT cites the main conclusions arising from SACTRA (1999), including that 'it would be surprising if the wider economic benefits addressed in this paper (either individually or in combination) were even nearly as large as the impact on time savings and reliability' (DfT 2005, para. 8). However, the additional benefits (i.e. agglomeration, imperfect competition and exchequer benefits) noted in Table 2.1 represent a 56% increase over the benefits measured using a traditional SCBA. The credibility of additional benefits of this magnitude for an urban centre with an economy and transport links as well developed as those in London must be seriously questioned.

A broader issue when considering the DfT work is the consideration that transport is a necessary rather than sufficient condition for bringing such additional benefits about. That is, benefits such as agglomeration impacts may be the result of a variety of factors present in urban and surrounding environments. To attribute the full benefits purely to the introduction of improved transport links may be misleading, as it masks the contribution of a range of other factors, such as the availability of an appropriately skilled workforce and education levels, without which such benefits would not materialise.

It is also worth reviewing the conclusions of the main sources referred to above – i.e. SACTRA (1999) and BTE (1999). Both agree on the retention of SCBA as the key measure of project benefits, though SACTRA sees I-O, LUTI and CGE analysis as important supplements to SCBA. BTE suggests that many so called 'omitted benefits' are in fact captured by SCBA, particularly in studies which allow for the induced/diverted demand (and the implied behavioural impacts therein).

Under certain conditions, SACTRA concurs, noting that under conditions of perfect competition:

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[17] Of course it could be argued that developed economies differ within themselves and that New Zealand's transport infrastructure is less developed than that in the US, Europe or Australia. This is a point that ACG (2004) suggest. However, it is also notable that ACG have previously suggested that Australia may be deficient in its provision of transport infrastructure. (ACG 1993, 2003). Further, the argument is one of broad orders of magnitude – that the 'missing benefits' due to deficiencies in SCBA are unlikely to be significant.

..the value of the estimated costs and benefits to transport users (namely time savings, operating costs and accident reduction) and to non-users (notably environmental impacts) – provided that they have all been identified and a money value attributed to them) would give a full and unbiased estimate of the estimate of the additional economic impact. This is equivalent to the statement that no 'additional' economic value exists. However, the incidence may change, as the initial transport benefits may accrue to different people from those who receive the final economic benefits.
(SACTRA 1999, Summary Report para. 24)

Correspondingly, however, SACTRA suggests that a variety of SCBA approaches (i.e. CBA*, CBA** and CBA***) be developed to allow for the additional 'real world' impacts, discussed above (i.e. induced demand, logistical, agglomeration and other local land use issues, imperfect competition and environmental impacts).

CBA*** would represent the most comprehensive, or 'fully specified' SCBA, as previously defined above and indicated in the table below.

Table 2.3   SACTRA definition of fully specified SCBA and partial specifications

Inclusion of allowance for				
	Transport behaviour (induced and diverted demand)	**Land use responses in product market (logistical adaptation agglomeration), property market, labour market , other)**	**Imperfect competition**	**Environmental Impacts***
CBA*	Yes	No	No	No and yes
CBA**	Yes	Yes	No	No and yes
CBA***	Yes	Yes	Yes	No and yes

> *   'No and yes' refers to whether the decision to include environmental impacts within the CBA is taken. One view holds that environmental impacts should be included within the CBA, whether or not they can be monetised. Another is that only monetised environmental values should be allowed for within a CBA.

However, SACTRA also indicate that I-O analysis, LUTI and General Equilibrium modelling be used as an aid to the development of a fully specified SCBA. The first two of these may (potentially) be of most use in pinning down any regional issues and impacts stemming from inaccuracies in SCBA, such as agglomeration effects.

In addition, SACTRA sees LUTI as potentially allowing for the calculation of benefits/dis-benefits from the property market (rather than from the transport market) under conditions of imperfect competition, as changes in land values may not perfectly reflect changes in transport under such conditions (SACTRA 1999, paras. 10.122-10.147). This is in contrast to BTE's argument that the transport market serves as an appropriate proxy for others and that transmitted benefits are captured through allowance for induced demand.

SACTRA also argue for CGE modelling to be used to estimate the extent of imperfect competition, labour market imperfections and to measure effects such as agglomeration benefits and scale economies, particularly as LUTI may be found wanting in this respect. This

is reflected in SACTRA's call for the further development of CGE modelling (SACTRA 1999, paras. 4.54, 4.58, 4.72, 4.76, 11.05), in contrast to BTE's arguments that CGE modelling is generally not justified in modelling net benefits of transport investment.

The differences between the SACTRA and BTE approaches to the use of SCBA and accompanying approaches are indicated in Table 2.4 below.

Table 2.4   Comparison of SACTRA and BTE conclusions on role and scope of SCBA

	SACTRA	BTE
1. Recognise role of SCBA as the key measure of project benefits?	Yes	Yes
2. What is included within a fully specified SCBA?	Need to separately allow for factors indicated in Table 2.2 above. Simply allowing for induced/diverted demand will be insufficient as it does not allow for land use effects (e.g. agglomeration, land markets under imperfect competition) or imperfect competition in general.	Only need allowance for induced/diverted demand. Including this effectively allows for most land use factors (e.g. changes in land values, agglomeration). Imperfect competition is a minor issue, which could 'go either way'. No apparent opinion on inclusion of environmental externalities.
3. To what extent does a fully specified SCBA omit benefits?	Fully specified SCBA would not omit benefits. However may need to develop I-O, CGE and LUTI models to inform a fully specified SCBA.	Some benefits may be omitted but they are minor.
4. Is there a role for other approaches such as CGE, I-O or LUTI?	Yes. Useful as complement to SCBA to pin down omitted benefits. I-O analysis could help uncover regional economic outcomes. LUTI modelling could shed further light on impacts on product, property and labour markets. CGE analysis could be employed to estimate effects of imperfect competition.	No. Add very little degree of accuracy for large cost (CGE) or run the risk of seriously overestimating benefits (I-O).

However, SACTRA itself questions the degree to which LUTI models are able to provide economic welfare measures as usable outputs, rather than just economic impacts. SACTRA also questions whether LUTI models are able to measure impacts in areas such as the product market (e.g. agglomeration benefits), given their current state of development (SACTRA 1999, paras. 5.124-5.127,10.99-10.147)[18].

In addition, CGE would appear to fail a test of parsimony, given that SACTRA itself sees the typical impacts of imperfect competition as small and the task of maintaining and using a CGE model would be significant. This same conclusion is reflected in the UK government response to SACTRA's proposal for the use of CGE modelling and would apply with even

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[18] Thus, its recommendation is to examine whether LUTI can actually be used to derive robust estimates of economic impacts *and* transport benefits/disbenefits (SACTRA 1999, para. 11.42).

greater force to nations with even more limited resources such as New Zealand. This is particularly the case since, as noted above, the average impacts of imperfect competition in New Zealand may be even smaller then those derived by SACTRA.

Arguably too, at a global level, it is worth asking whether the utility of the I-O and LUTI approaches would be worth the cost if they were to require considerable additional data inputs and modifications in each and every instance. More modest alternate measures may be reference to past research on such impacts and/or local industry consultation/surveys.

A distinction must also be drawn between economic efficiency (or welfare) measured by SCBA and economic impacts measured by macroeconomic approaches such as I-O analysis and CGE These approaches measure different things in their 'raw' forms, with SCBA focussing on the efficiency measures of project NPV and BCR, while I-O and CGE focus on GDP, employment and household income.

Further, non-traded factors incorporated within SCBA such as environmental externalities and complementary investments (Kinhill Economics 1999, pp. 14-15) along with non-work travel time and some components of measured accident costs (lives lost, serious/permanent disability) drive a wedge between SCBA and the macroeconomic approaches (which rely on National Accounts data).

Whether or not it is believed that these issues can be overcome (as both ACG and Dwyer et al have attempted to do), in many cases, macroeconomic approaches can be something of a 'blunt instrument', estimating nation-wide economic impacts based on projects which are location specific (Kinhill Economics 1994).

Given the above, the following conclusions can be reached with regard to the three key questions that this section sought to address:

Question 2.1: In what circumstances and to what extent does a (fully-specified) SCBA not capture all the national economic costs and benefits arising from a transport investment?

- SCBA is limited by the underlying assumption of an economy with perfect competition and availability of information. This allows it to take a partial equilibrium approach, with all consequent economic impacts of a proposal being reflected in the quantity, mode, location and timing of trips.

- The balance of evidence suggests that the degree of underestimation of benefits due to these assumptions in competitive, modern economies such as New Zealand's is small to modest.

- The inclusion of induced and diverted demand effects within a SCBA effectively captures most of the indirect (or flow-on) effects to the broader economy associated with a transport improvement. SCBA will be limited to the extent that this demand is not accurately identified.

- Exclusion of induced and diverted travel demand can have a significant impact on the benefits of a proposal, for example where congestion is serious or the project is large. It is likely to result in an overestimation of benefits in the former case and underestimation in the latter instance, when taken in isolation. Exclusion of induced or diverted travel demand will be less of an issue in other circumstances.

- SACTRA has made a case for a more 'fully specified' SCBA to capture flow-on benefits such as land use effects and imperfect competition. BTE argues that this is unnecessary if account is taken of induced demand.

- Where strong evidence exists, consideration of the effect of factors such as logistical and agglomeration benefits, property and labour market effects, imperfect competition and specific regional development issues could be considered. If these additional effects are not amenable to monetization and incorporation within an SCBA they could be considered in a 'below the line' qualitative analysis. However it appears these factors are only likely to be worth addressing for major projects and even then, it is considered that the effects will generally not be a major issue.

Question 2.2: What alternative approaches exist to assessing the national economic impacts of transport investments and what are their merits in place of or to supplement SCBA (particularly to capture any costs and benefits not adequately addressed by SCBA)?

- The principal alternatives to SCBA are macroeconomic approaches such I-O analysis, CGE modelling or LUTI modelling. These models typically estimate economic impacts of proposals, i.e. changes in the level and structure of gross domestic product and associated changes in employment and, in the case of LUTI, land use.

- In comparison with SCBA, these approaches produce different outputs, do not provide clear decision rules, do not measure the economic efficiency of an investment and do not include non-market impacts included in SCBA (such as non-work travel time savings, social costs of crashes and environmental impacts). Moreover, they are limited by the quality of their data, and are generally inappropriate for projects with small local impacts.

- Some attempts have been made to estimate changes in economic welfare associated with a given project (i.e. equivalent to that derived via SCBA) through the use of modified CGE modelling. However, aggregating the results of SCBA and CGE modelling is wrong, and results in double-counting. In addition, the use of CGE modelling to derive welfare outcomes still faces investment modelling and non-market transactions issues. In addition, considerable work is required to develop and maintain these models in return for modest improvements in SCBA accuracy.

- There would therefore not seem to be a strong case for abandoning SCBA for more complex techniques to account for relatively modest missing benefits. The proposed alternatives do not provide a reliable substitute and do not appear to be justified on grounds of parsimony.

Question 2.3: How should the impacts of transport investment on national economic growth (GDP and similar measures) be assessed; and how do such assessment methods and their outputs relate to the methods/outputs involved in the SCBA approach?

- I-O, LUTI and CGE models provide some form of national macroeconomic information of use to policy makers. Depending on the model, these may include data on employment, income, GDP, land use, investment, trade, consumption, wages and tax.

- CGE modelling is the most accurate and reliable of these methodologies and should be preferred if national impacts are to be modelled. I/O analysis may be acceptable (and preferable) within a regional context. CGE can also help pinpoint the effect of impacts of imperfect competition.

- Considerable time and expense is needed to develop and maintain such models, and they are limited by the detail and quality of the available data. Hence, they are likely to be useful only for very large projects. For smaller projects, typical average data on the number of jobs and other macroeconomic indicators for a given level of project expenditure could be used, recognising the general limitation that this provides no guidance on the opportunity cost of the expenditure.

- There is no direct linkage between the outputs of SCBA and changes in macroeconomic indicators, such as GDP. Projects which record a negative NPV (BCR below 1.0) may still produce increases in GDP. It is somewhat likely that projects which produce a positive NPV (BCR above 1.0) will be associated with GDP growth, though this will depend on the extent of non-market impacts of projects.

- SCBA can be used in combination with these alternative approaches to provide decision makers with a broader view of the overall impacts of projects but care is needed to avoid double-counting of project impacts. It is recommended that SCBA be viewed as the primary decision-making tool in such cases.

2.9   Recommendations on practice

2.9.1   Role of SCBA

In general, there seems little doubt that an appropriately specified SCBA represents the best approach to measuring the economic efficiency effects of transport investment.

As suggested above, the two major grounds for supporting the use of SCBA include:

- *Economic efficiency measure* – Unlike I-O and CGE modelling, SCBA provides a measure of the economic efficiency of a given transport improvement.

- *Parsimony* – SCBA is a powerful tool for capturing most of the economic effects of a transport improvement. Other methodologies such as I-O and CGE typically require far more information then SCBA.

Based on the above discussions, in theory, a 'best practice' New Zealand SCBA is suggested in Table 2.5, below.

Table 2.5   New Zealand best practice approach to SCBA

Inclusion of allowance for				
'Traditional benefits' based on fixed trip matrix (travel time savings, vehicle operating cost savings, accident cost savings)	Transport behaviour (induced (and diverted) demand)	Land use responses in product market (logistical adaptation agglomeration), property market, labour market, other)	Imperfect competition	Environmental externalities
Yes	Yes	No, apart from previously monetised values incorporated in VTTS or elsewhere (unless strong contextual evidence of material effects exists, justifying additional complexity).	No (unless strong contextual evidence of material effects exists, justifying additional complexity).	Yes (using previously monetised values only) If no monetised values exist, assess 'below the line' as qualitative indicator.

The New Zealand 'best practice' approach therefore resembles CBA*, specified by SACTRA above, rather than their 'fully specified' CBA***. As indicated above, allowance for induced and diverted demand accounts for most of the flow-on benefits arising from a transport development, and, in most cases, other effects (land use, imperfect competition, environmental benefits) will make only small differences to the assessed SCBA. Further, in many cases, these effects may 'go either way'; they do not necessarily represent 'additional benefits'.

Nonetheless, the proposed approach also suggests that, in the presence of strong contextual evidence, consideration be given to whether land use effects and imperfect competition may be issues in the assessment.

Therefore, a decision rule should be developed along the lines that:

- the starting point should be a default 'no additional (dis)benefits' position;

- strong contextual evidence (including material evidence) should be provided for the existence of such additional (dis)benefits (perhaps gathered through survey work and/or industry/stakeholder consultation);

- consideration be given to whether there are other, more efficient means for addressing structural issues such as imperfect competition than the transport proposal;

- consideration should be given as to whether modelling the additional benefits is justified by the additional cost and complexity involved (i.e. effectively an internal cost-benefit analysis); and

- if it is considered that there is strong contextual evidence for the above effects, but the effects are too complex to model, these effects could be represented 'below the line' of the SCBA through qualitative analysis.

The following issues should also be noted in respect of induced/diverted demand, land use factors, imperfect competition and environmental impacts in developing a 'best practice' SCBA:

- *Induced/diverted demand* – This is the important issue of those discussed above, from both a technical and presentational viewpoint. While generally small, allowing for induced demand addresses many of the typical criticisms about 'omitted benefits' from SCBA, while also directly dealing with often-cited community concerns regarding the impacts of generated traffic.

  Many studies already employ measures of induced demand. However, in may cases these are based on 'off the shelf' elasticities or else appear as model outputs from a transport demand model, where behavioural assumptions are unknown (or questionable). Though induced demand effects may be small, there is obviously always a case for better estimation of impacts based on context specific information. Depending on the study in question (and the resources available) use of direct measures of induced demand, such as those derived from stated preference work and other survey work, should be preferred.

- *Logistics effects* – As indicated above, unit values incorporating some of these are already in existence. An example is Austroads' inclusion of freight travel time allowances in its value of time measures though more work needs to be done in this area and it is arguable that reliability impacts should also be included. Such unit values should be employed if available.

  As indicated, to the extent that there is a strong argument for additional logistical impacts arising from improved logistics, beyond those incorporated in unit values, these should be considered based on strong contextual evidence, with a default 'no benefits' position.

- *Agglomeration and other land use effects* – The empirical case for inclusion of agglomeration benefits does not appear to be strong. Further, an approach which values these via divergent values of travel time savings is inconsistent with Transfund's equity based approach.

  Land use issues connected with the property and labour markets have been noted above. Regardless of whether a LUTI style model is ever developed in New Zealand, if additional property and labour market (dis)benefits are claimed, questions of double counting and parsimony must be carefully examined.

- *Imperfect competition* – The effects of this within a New Zealand context may be even smaller then SACTRA's past estimates for the UK. Allowance for imperfect competition should be considered only in specific cases where there is strong contextual evidence that such effects exist (e.g. breakdown of regional monopolies due to transport improvements).

- *Environmental impacts* – Environmental impacts generally tend to be modest at best within the framework of SCBA. If monetised values exist these can be incorporated within the SCBA. If no monetised values exist, non-monetised values can be incorporated as 'below the line.' qualitative indicators.

A range of monetised environmental values including Austroads' recently developed road user externalities for New Zealand are now available for analysts to use.

2.9.2   Role of I-O, CGE or other models

Given that SCBA is favoured as the default approach to national economic effects, is there a case for the adoption of I-O and/or CGE modelling in estimating economic effects within a New Zealand context? The answer to this question depends very much on the intention behind the initial analysis.

As indicated above, if the aim is to assess efficient economic growth, then there is generally little justification to supplement SCBA with other forms of modelling. If, however, the aim is to understand 'economic impacts' such as effects on GDP, trade and employment or the distribution of impacts across different New Zealand industry sectors then I-O and/or CGE modelling could be employed.

If this is done however, it is advisable to do so as a complement to SCBA rather than as a supplement. This is because such modelling, and the use of GDP as an indicator, will not necessarily indicate whether such growth is efficient or not. As indicated above, use of I-O and CGE modelling can indicate the benefits of investment but will not fully reflect the costs. Further, other model outputs, such as employment growth, are based on highly questionable assumptions when measured at a national level.

The use of such modelling, in isolation, will therefore provide an illusory guide to New Zealand (or any other) policymakers. The economy may well grow, but through the use of increased inputs to provide higher output, rather than through the more efficient use of resources.

The case of the former command economies serves as one warning of the use of such an approach. A transport infrastructure investment program which focuses solely on I-O and CGE measures, without reference to SCBA modelling, could produce damaging long run economic consequences (for New Zealand or any other jurisdiction). This is because other nations, with more targeted investment approaches based on methodologies such as SCBA, could allow for more efficient growth, i.e. produce the same output while consuming fewer inputs.

If one of these approaches is to be utilised then CGE would generally be favoured on a national level, as it suffers from fewer constraints than I-O, in particular labour market constraints. Regional specialists such as Madden have also favoured the use of CGE on a national scale, suggesting that I-O analysis is better suited to analysis on a regional level (Madden 2000, cited in Klienhardt 2002).

The outputs of CGE and I-O modelling should not be added to SCBA, as done by ACG's (2004) review investment in New Zealand's road infrastructure. This produces a substantial risk of double counting. It is of particular concern that this process produced a result in which several projects which failed to meet Transfund hurdle rate (i.e. BCR = 4.0) using only a conventional SCBA, could now exceed it.

An overriding issue, however, is that of resources. As noted above, the UK Government response to SACTRA's recommendation for the further development of CGE modelling, the resource required to maintain a CGE model are considerable. It remains a policy decision as to whether the need to obtain such outputs, with the above caveats attached, is worth the costs involved. This is a particular issue within small jurisdictions such as New Zealand.

In addition while LUTI modelling of the type discussed by SACTRA would complement the analysis of land use impacts, issues of parsimony again emerge, particularly within a New Zealand context. To the extent that resources are limited the impacts are relatively modest and land use impacts are already captured by unit values, LUTI would appear to have marginal value. Once again, much would depend on the alleged salience of changing land use within a given study.

3. Role of transport investment in national/regional economic development

3.1 Scope of chapter

Issues regarding the role of transport in stimulating national and regional economies have been touched on above. This chapter seeks to address the following key question:

- Question 3.1: Are there particular features of transport investment (in general) that make it especially effective (such effects maybe not fully reflected in SCBA or alternative methods of assessment) in promoting/increasing national (and regional) economic growth?

3.2 Effectiveness of transport investment in promoting economic development

In considering the impact that transport has on national development, it is first necessary to clarify the 'transmission mechanism' through which transport contributes to national economic growth.

In traditional macroeconomic models of growth, output is a function of capital and labour inputs and the efficiency with which these inputs are used (SACTRA 1999, para 4.07). Growth is dependent on increases in the factor inputs and on total factor productivity (TFP). Transport may therefore have a role in growth through increases in the capital stock and through more efficient transport, which, in turn, increases the efficiency of other sectors (SACTRA 1999, para. 4.07).

Neo-classical theorists such as Solow argue the case for diminishing returns to capital accumulation. Long term growth in incomes per capita would therefore rely on TFP growth. However, some theorists have argued that taking a broader view of capital (including human capital as well as infrastructure and directly productive physical capital) would effectively imply that boosts to growth would take longer to work their way through the economy. Public investment could therefore be seen as an antidote to diminishing returns experienced by the private sector (SACTRA 1999, paras. 4.08-4.10).

However, SACTRA quotes Oulton and Young's (1996) extensive investigation, which indicates that the 'broad capital' model is still subject to decreasing returns (para. 4.11). This has led to a focus on TFP growth. From this viewpoint additions to the capital stock are seen as encouraging innovative effort to reduce costs. In SACTRA's words:

> *For transport, the key question is whether improvements in transport provision are likely to generate more TFP growth by improving incentives to innovative activity. This is more likely to be important at the level of the mega project or when a series of schemes has a large cumulative effect on the transport network than for the individual road scheme. For example, this might work through increasing the size of markets, thereby allowing higher expected sales to cover fixed costs in the event of successful innovation or through encouraging the formation of clusters of firms*

with favourable knowledge spillovers, or by stimulating technology transfer through foreign investment.

(SACTRA 1999, para. 4.12)

That said, this still leaves open the question of why investment in transport should have a 'special quality' any more than government investment in health or education.

Yet, SACTRA make the point that while developed economies must have developed transport systems (i.e. transport is a necessary condition for economic development), marginal changes in transport investment in such economies will not necessarily have major impacts on either the level or growth rate of per capita income. One reason for this is the relatively small size of transport projects relative to GDP. A second is the evidence of the historical record and consideration of the components of TFP growth which indicate the difficulties of raising GDP growth rates in mature economies (SACTRA 1999, para. 4.19).

This point has been made by a variety of analysts. A corresponding point, also made by several analysts, as noted in Chapter 2, is that developed economies already have well developed transport networks. Further, as noted below, 'beyond the farm gate' freight costs are likely to account for only small proportions of total costs in developed economies, such as New Zealand. Thus, incremental changes will be of only small significance in terms of the broader transport task and economy.

Aschauer's thesis on the impacts of infrastructure investment upon economic growth has been touched on in Chapter 2, above. Briefly, Aschauer sought to relate investment in transport with national GDP growth. Aschauer's approach conceives of infrastructure as an additional factor input, within an aggregate production function which related GDP to the use of labour and capital. This approach was similar to that of the 'broad capital' methods and no argument was made regarding the impact of infrastructure investment on productivity. Thus, Aschauer did not formally identify how infrastructure investment impacted on GDP, the process was essentially a 'black box'.

As indicated above, Aschauer found rates of return (to the private sector alone) of public sector infrastructure investment of some 90%, assuming a 50 year project period. SACTRA quote a social rate of return in excess of 100% and an elasticity of output with respect to public infrastructure capital of 0.4 (SACTRA 1999, para. 4.21; NIEIR 2002, p. 38).

While not necessarily supporting the magnitude of Aschauer's results the concept that transport may have a 'special role' to play in economic development and offers a particularly cost effective approach to national development has been expressed by a variety of other authors and in a range of contexts.

As noted above, Otto and Voss have argued the case for large returns to investment in Australian roads (BTE 1999, p. 183). Similarly, the National Institute of Economic and Industry Research (NIEIR) has argued that the annual long run rate of return for transport infrastructure marginal physical product in Australia is 70% (NIEIR 2002, p. 43).

Likewise, in examining the benefits of investing in New Zealand's road infrastructure, ACG (2004) have made the case for further investments in transport infrastructure. ACG argues that 'in most developed nations there has historically been a strong relationship between economic growth and transport activity. The provision of physical infrastructure is generally recognised as being of vital importance to economic development' (ACG 2004, p. 4).

ACG quotes previous work by SACTRA (1998) suggesting that transport projects could, in principle, promote economic growth by reducing transport costs, thereby lowering prices and promoting inter-firm competition. These, in turn, would promote economic growth.

Further, ACG draws on its own past empirical work in Australia (ACG 1993) as providing empirical evidence that investment in improved road infrastructure promotes growth. Such investment results in vehicle operating cost benefits, travel time benefits, accident benefits, environmental benefits and other productivity and indirect benefits. These, in turn, 'flow on' to the broader economy in two main ways. First, resulting productivity improvements in freight and passenger transport increase income and lower costs to using industries. Second, this, in turn, expands national output, the size of the increase depending on the initial productivity improvement and market characteristics faced by industries benefiting from these (ACG 2004, p. 4).

SACTRA itself does note that the development of the UK motorway network over the past 40 years has enabled systemic transition in the logistics and distribution sectors (para. 2.56). (However, perhaps this should now be seen in historical terms and is more in the fashion of cumulative effect, as referred to in para 4.12, rather than incremental project impacts.). In some cases significant travel time savings are still being accomplished by UK transport projects, e.g. Humber and Severn bridges, A14 (paras. 2.60-2.61).

In some cases the argument that there are major benefits associated with the provision of transport infrastructure is linked in with a preference for the use of I-O and/or CGE modelling rather than SCBA (the differences in the outputs of these modelling approaches notwithstanding). That is, it is argued that as SCBA's omitted 'flow-on benefits' have 'shown up' in the studies by Aschauer and others noted above. Further, it is argued that use of I-O and/or CGE is necessary to reveal these 'hidden' flow-on benefits.

This issue was explored in Chapter 2, in the context of Aschauer's comments on the 'omitted benefits' of logistics reorganisation (among other things). This theme also seems evident in ACG's (2004) comments above, its claim that SCBA 'does not take into account the flow-on effects from one industry to another' (ACG 2004, p. 16) and its corresponding use of the ESSAM (CGE) model to capture such flow-on effects. Likewise, NIEIR has pointed to the studies of Aschauer (and others) as evidence of the vital importance of transport in promoting economic growth, while criticising SCBA's failure to allow for flow-on effects (NIEIR 2002, pp. 34-46).

However, SCBA's allowance for flow-on effects to the broader economy has already been discussed in the previous chapter. In general, SCBA's 'omitted benefits' are, at best, of modest significance. As already noted, the logistical benefits cited by Aschauer may already be partly incorporated in some SCBAs and would appear to be of modest significance in developed economies in any case. While, as already discussed, the outputs of SCBA and I-O and CGE are not directly comparable, inferring that the work of Aschauer and others has (by implication) revealed major deficiencies in SCBA would not appear to be logically sustainable[19].

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[19] If the evidence presented in Chapter 2 pointed to major 'omitted benefits' on the part of a 'limited SCBA' we might find circumstantial evidence for the Aschauer thesis. To the extent that they consist of market transactions these benefits could be expected to flow through to broader economy (though measures such as higher productivity) and be picked up by macroeconomic models. However, the evidence presented in Chapter 2 suggests that benefits omitted by even a 'limited SCBA' are not likely to be major and therefore cannot be cited as an explanation of the Aschauer results.

Further, there is little proof that transport investment intrinsically has a 'special role' to play in economic growth any more than is the case for other forms of public investment (particularly in developed economies such as New Zealand). To summarise, a variety of studies, ranging from formal econometric surveys to more informal regional reviews, have pointed to the following:

- The ACG (1993) Australian empirical work cited above has been the subject of extensive criticisms (Kinhill Economics 1994). In particular, it has been argued that ACG ignores the differences between public and private rates of return. The latter cannot 'capture' flow-on benefits which the former can. Thus the high rates of return quoted by ACG (17% for rural roads to 55% for national urban roads) cannot be directly compared to private sector discount rates as ACG does. This criticism also applies to interpretations of Aschauer's work (Kinhill Economics 1994, pp. 16-19).

- Aschauer's work relates to the correlation between infrastructure investment and GDP growth. However, the causal linkage remains unproven. It is entirely possible that GDP growth is stimulating demand for additional infrastructure rather than vice versa (Kinhill Economics 1994, p. 9; SACTRA 1999, para. 4.23; Banister and Berechman 2000a, p. 144).

- Other statistical issues, i.e. sample size sensitivity, have been uncovered by Niienhaus (1991). Nienhaus added two years (1986 and 1987) to the original data set of Aschauer's 1989 paper (which covered 1949-1985). This reduced the elasticity estimate based on Aschauer's model from 0.39 to 0.24 (BTE 1999, p. 184).

- Further, GDP may grow as a result of many factors and it is statistically very difficult to isolate the effects of any one of these. In addition, exclusion of other variables may result in overestimation of the alleged source of the benefits (Kinhill Economics 1994, p. 9).

- Many subsequent US studies have failed to reproduce Aschauer's spectacular results. Based on subsequent work SACTRA suggest an output elasticity (in respect of general infrastructure expenditure) of 0.1 for the US based on this work (SACTRA, paras. 4.22-4.23). The 1997 work of Kelejian and Robinson on US national data, reported by BTE, was unable to confirm that infrastructure has positive impacts on private output (BTE 1999, p. 184).

- Banister and Berechman report results of a broad range of sub-national (see below) and non-US studies of the impact of infrastructure investment on output. They also note that results vary widely and that model specification may be an issue. In particular, non-US output elasticities are generally below US ones – a particularly puzzling result for developing countries (Banister and Berechman 2000a, pp. 145-158).

- Likewise, national results for US highway investment, following up Aschauer's work have generally produced lower output elasticities (in the range 0.04-0.37) (Banister and Berechman 2000a, p. 150).

- Problems arise when valuing the true cost of capital to the public sector. This may mean that Aschauer's 'production function' approach could overestimate the value of output

elasticity as the shadow price of public investment is underestimated (SACTRA 1999, para. 4.24).

- Studies which have attempted to overcome the above problem using cost functions suggest that public capital investment does make a positive contribution to growth. These suggest that efficient public infrastructure can lower costs to the private sector and thus enhance rates of return – but at far lower rates than suggested by Aschauer. US research also indicates that investment in infrastructure may have had more impact on US manufacturing productivity, per dollar spent, than publicly financed R&D (SACTRA 1999, para. 4.24).

- However, investment in transport infrastructure by itself would not appear to yield 'special benefits' or be particularly cost effective in terms of increasing national economic growth. Kinhill Economics makes the point that statistical models will likewise produce high rates of growth from expenditure on education/human capital and health. Assumptions which reduce the contribution of some of these factors automatically increase that of others (Kinhill Economics 1994, p. 9). O'Fallon cites similar research conducted by the ECMT (2002) which claims that, once opportunity costs are fully allowed for, investment in human capital will produce greater rates of return than investment in transport (O'Fallon 2004, p. 14).

- Likewise Banister and Berechman note that 'other public inputs, such as education, have a substantially higher impact on growth than transportation capital' (Banister and Berechman 2000a, p. 149). Likewise a 1997 review of infrastructure investment by the US Transportation Research Board (TRB) concluded that 'when the opportunity costs of infrastructure investment are taken into account, it is likely that other forms of capital accumulation by the private sector or putting more resources into education and training are likely to lead to better returns' (SACTRA 1999, para. 4.25).

- Banister and Berechman also cite the results of a number of US state 'production function' studies which compared the impact of highway investment and other investments such as water and sewerage infrastructure and 'other' public capital on gross state product (GSP) (pp. 148-149). These have mixed results and are reproduced below, along with Deno's 1988 study using a profit function approach and Aschauer's original results[20]. (Note that the use of State-level data within production function models may introduce some biases into the estimation of output elasticities for transport. (Banister and Berechman 2000, pp. 148-149)).

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[20] Note that the use of State-level data within production function models may introduce some biases into the estimation of output elasticites for transport. This is because the major effect of transport investment is to change the relative accessibility and attractiveness of specific regions. This, in turn, causes the relocation of firms, labour and households across jurisdictions. Failing to account for this will produce biased elasticity estimates. McGuire's (1992) results attempt to control for such state effects. In addition, Deno's approach uses a profit function model (rather than a production function model). Profits of the private sector are specified as a function of the prices and quantities of private capital, of labour and of the stock of public capital (Banister and Berechman 2000, pp. 148-149).

- Kamps (1984) suggests that the 'supernormal' returns to public capital cited by Aschauer may be a result of his use of the production function approach. Vector autoregressive (VAR) modelling may offer a superior approach to production function approaches as it allows for feedback effects between output (GDP) and inputs (higher public capital spending). Past VAR modelling cited by Kamps and his own work indicates a much weaker long run response to increases in public capital spending then that cited by Aschauer.

- VAR work by Kamps (2004) for New Zealand and Australia (as part of a broader survey of OECD countries) is reproduced in Table 3.2 below. While Kamps found a positive long run elasticity of New Zealand real GDP with respect to public capital (0.11), based on a dataset covering 1960-2001, this result was not statistically significant at the 95% level, or even at the 68% level. Nor, in common with other OECD results, was there any evidence for positive New Zealand employment results.

- Also reproduced in Table 3.2 below are findings of a variety of Australian studies of output elasticity of infrastructure investment. With the exception of Song's work, these report much smaller elasticities then Aschauer's findings.

Table 3.1   Comparison of New Zealand and Australian evidence on responsiveness to public infrastructure investment

Study	Study Type and scope	Elasticity of variable with respect to public infrastructure investment		
		GDP/output*	Private capital	Employment
New Zealand Results				
Kamps (2004)	VAR model, 22 OECD countries including New Zealand	0.11	0.15	0.06
Australian Results				
Kamps (2004)	VAR model, 22 OECD countries including New Zealand	0.29**	0.33**	-0.24
Otto and Voss (1996) (cited by Econtech 2004)	Australia	0.17	-	-
Pereira (2001) (cited by Econtech 2004)	Australia	0.17	-	-
Kam (2001)	Australia	0.10	-	-
Song (2002)	Australia	0.27-0.39	-	-
NIEIR (2002)	Production function, Australia	0.18	-	-
Econtech (2004)	CGE model, Australia	0.13	-	-

*   Specified as real GDP by Kamps

**   68% confidence interval does not cross zero (relevant to Kamps results only)

Table 3.2   Comparison of US National and State-based studies on elasticity of GSP with respect to investment

Study	Study Type and scope	Elasticity of GDP/GSP with respect to investment					
		Highway Capital	Human Capital	Water and Sewer	Other Public Capital	Labour	Private Capital
Aschauer (1989)	Production function, national level	-	-	-	0.4 (a)	-	-
Deno (1988)*	Profit function; national level	0.31	-	0.30 (s) 0.07 (w)	-	-	-
Munnell (1990)	Production function; 48 contiguous states	0.06	-	0.12	0.01	0.55	0.31
Garcia-Mila & McGuire (1992)	Production function; 48 contiguous states	0.04	0.15	-	-	-	0.10 (ps) 0.37 (pce)
McGuire (1992)**	Production function; 48 contiguous states	0.121-0.127	-	0.043-0.064	-	-	-
Haughwout (1996)	2SLS spatial equilibrium model; 48 contiguous states	0.08	-	-	-	-	-

Source: Banister and Berechman 2000, pp. 148-149

Key: ps = Private structures
        pce = Private capital equipment
        a = Transport, energy and water
        s = Sewer capital
        w = Water capital
        * Result appears to refer to state level private profits rather than GSP
        ** Controlling for state-level effects

Some context is also set by historical research. Banister and Berechman, cite Fogel's famous (1964) study of US railway development in the 19th century. While railways had an important effect on US economic growth in the 19th century, such growth cannot be attributed to any single innovation. Rather, economic growth resulted from a variety of innovations, with rail

helping to shape growth rather than being responsible for it (Banister and Berechman 2000b, p. 7).

Likewise SACTRA refers to estimates indicating that direct resource savings from rail freight transport (compared to alternative modes) were equivalent to some 4% of Britain's 1865 GDP (SACTRA 1999, para. 2.57). This is a notable gain, but still relatively modest considering the spectacular economic impacts often attributed to 19th century rail transport. Further, context and measurement issues aside, it is at least worth considering such figures when set against modern claims regarding economic impacts of transport investments, e.g. ACG's estimate that its four specified road projects would produce economic benefits (in 2012) equivalent to almost 1% of New Zealand's GDP (ACG 2004, p. 51).

Additional evidence can also be found in the comparisons between SCBA and CGE approaches in Chapter 2, above. To the extent that such approaches can be compared, there seems to be little evidence that SCBA is 'missing' substantiative quantums of benefits, which one might expect if the Aschauer thesis proved true.

Banister and Berechman conclude that 'transport infrastructure seems to have a small but significant impact on economic growth in terms of output elasticity' (Banister and Berechman 2000a, p. 149). Similarly SACTRA notes the conclusion of the US TRB that 'the evidence suggests that infrastructure investments have a modest positive effect on the nation's private economic activity (para. 4.25).

Nonetheless there is no specific evidence which points to transport investment by itself as having a unique role in national development or being of greater cost effectiveness than any more than other type of public spending.

The same is true at the regional or sub-national level, particularly as the studies presented in Table 3.1 above used State-based databases in many instances. This indicates that transport investment is unlikely to have any 'special' impacts on states or regions any more than is the case at the national level.

Further, Banister and Berechman note that while transport infrastructure development can propel economic growth and productivity, it is unclear what other conditions are also needed. For example, high rates of population growth and increasing population densities might be a pre-requisite for transport infrastructure to have a significant impact on growth. Moreover economic growth tends to lag behind transport investment as capitalisation of investment's effects is time dependent. Transport investment will also depend on the degree to which labour and private capital inputs are affected relative to their price, actual use and productivity (Banister and Berechman 2000a, pp. 150-151).

3.3 Conclusions

This chapter sought to address the following key question:

- Are there particular features of transport investment (in general) that make it especially effective in promoting/increasing national (and regional) economic growth, and are such effects fully reflected in SCBA or alternative methods of assessment)?

The conclusions of this chapter can be summarised as follows:

- Evidence for a 'special role' in respect of the effect of transport infrastructure investment on economic growth is limited. The high rates of return to transport investment claimed by some past studies are likely the result of statistical correlation or other model specification issues.

- Likewise, there is nothing 'special' about investment in transport infrastructure from a regional perspective. While there is some evidence regarding the responsiveness of growth to investment in transport infrastructure, this is no less true then other forms of public infrastructure. Investment in transport infrastructure is likely to have a dramatic effect on regional economies only where current transport accessibility is exceptionally poor and other factors conducive to growth are present in the region. That is, good quality transport is a necessary but insufficient condition for regional growth.

- The impact of improved transport links on regional areas is not unambiguous because the 'two-way' nature of transport can both challenge and assist people living in them.

- The incremental economic gains of investment in transport infrastructure in developed economies above that needed to respond to demand are likely to be small. Arguably, there is a spectrum within which some developed economies may experience greater gains more than others, but solid evidence to this effect is lacking.

- As discussed previously, there is no strong evidence that SCBA omits significant flow-on effects to the broader economy. The argument that the work of Aschauer and others has somehow revealed SCBA's 'omitted benefits' has not been convincingly demonstrated.

4.   Approaches to assessing regional economic and other distributional effects

4.1   Scope of chapter

Much of the recent debate on the economic impact of transport investment is connected with the distribution of the economic benefits of such investment to particular regions and/or socio-economic groups. This chapter seeks to address the following, interconnected, key questions:

- Question 4.1: Is the upgrading of transport links within or to/from a particular ('disadvantaged') region likely to be an effective means of enhancing the economic development of that region, and in what circumstances?

- Question 4.2: How are the distributional impacts of transport investment on particular regions/areas best assessed; and how do the results of such assessments relate to SCBA assessments of national economic costs and benefits?

- Question 4.3: How are the other (non-geographic) distributional impacts of transport investment on different social/demographic and market segments best assessed?

- Question 4.4: Would the assessments of distributional (geographic, socio/demographic etc) impacts of transport investments provide useful additional information (additional to the overall impact assessment) for decision-makers?

4.2   Effectiveness of transport investment in promoting regional development

4.2.1   Regional development themes

If transport has no 'special role' in regional development, to what extent does it have a role of any sort in fostering such development and what are its distributional effects?

A common theme in literature on the provision of transport infrastructure to regional areas is the need to alleviate some perceived form of regional 'disadvantage' in relation to other regions and the national economy as a whole. In particular, the concept of improving regional 'accessibility' (variously defined) and of promoting 'regional employment' in areas identified as suffering from high unemployment (or 'depressed') dominate the literature. The provision of new transport links is often assumed to lay the basis for new investment (and, particularly, jobs) to flow into the identified region. (Presumably this increased economic activity will also be reflected in higher regional output measures such as Gross State Product (GSP) or Gross Regional Product (GRP).)

Thus, Ockwell's (2002) review of the OECD Working Group's study of the impacts of transport investment on regional development noted that 'region' was defined by the Working Group not by geography but 'as an area requiring specific policy initiatives to meet broader socio-economic objectives of government' (Ockwell 2002, p. 3). In reaching this definition the Working Group referred to the work of several authors including that of Diamond (1974) who

suggested that a key goal of regional policy was to reduce unemployment in areas where it was persistently high (Ockwell 2002, p. 3).

Likewise, SACTRA note that transport improvements are often seen as the key to providing for economic regeneration and unlocking underutilized land and labour within a given region, providing jobs for the unemployed and/or access to derelict sites. Doing so would contribute to 'the typical high level aims of removing deprivation and enhancing economic development and social cohesion' (SACTRA 1999, para. 2.35).

Within a New Zealand context, the New Zealand Transport Strategy (NZTS 2002) lists one of its five economic objectives as 'assisting economic development', both nationally and within regions. In particular, the NZTS notes that new transport infrastructure would 'support regional development especially in regions of acute need such as Tairawhiti (East Cape) and Northland' (NZTS 2002, pp. 10-11 as cited in O'Fallon 2004, p. 15).

4.2.2 Economic growth or economic efficiency?

An issue underlying the above discussions, but rarely discussed in a regional context, is whether the aim of regional policy are measured by economic impacts (or growth) or economic efficiency.

Much of the discussion of regional effects focuses on measures of economic growth, e.g. Gross State Product (GSP) or Gross Regional Product (GRP) and employment. Yet, as indicated in the comparison between I-O, CGE and SCBA, above, issues of economic efficiency may be distinguished from economic impacts.

In keeping with the themes noted above, in general, most regional literature stresses the economic impacts of regional investment (as per I-O and/or CGE modelling) rather than the economic efficiency benefits (of the type focused on by SCBA) or appears to confuse the distinction between the two. Thus while regional or national employment and/or GDP gains are often referred to as 'benefits', these outcomes do not necessarily imply that a given regional transport development is economically efficient.

4.2.3 Evidence for regional economic benefits

On a formal level, economic theory suggests that changes in the supply of transport can promote economic development in the long run in two ways, through the goods market and the employment market. These have been noted in the European Conference of Transport Minister's Round Table 119: 'Transport and Economic Development (2001) ('ECTM')'.

First, by widening the area of goods markets, transport improvements may promote competition, thereby enhancing economic efficiency. The effect may be analogous to the removal of customs barriers. The removal of such barriers results in higher productivity and raises the purchasing power of populations, which benefit from the specialisation of trade.

Second, improved transport links which increase transport speeds may have the same effect as increasing the size of the employment market, as a greater number of job-seekers will be able to travel to more distant jobs. This will allow for greater productivity as employers are better able to find employees qualified for the jobs they are seeking to fill (ECTM Summary 2001, p. 3)[21].

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[21] As indicated above, the value of this increased productivity to the employer is *not* an additional benefit above and beyond the traditional SCBA assessment. See BTE 1999, p. 181.

Though not explicitly pointed out by ECTM, it should be noted that these impacts might occur within a defined region or more broadly across several regions, and that much depends on how a 'region' is defined. For example, to the extent that jobseekers in one region access 'more distant jobs' located in another region, new transport links may result in somewhat ambiguous outcomes, a point taken up below.

A related problem, both with the available literature and regional development scheme objectives themselves, is that little clear distinction is often made between investment aimed at improving links investment within a given (typically disadvantaged) region and that aimed at improving links between such regions and others. The two can be blurred in reality (e.g. a new freeway link which serves regional towns and connects to main centres outside the area). However, a clearer initial distinction may help to hone in on specific issues such as the 'two way road problem' (discussed below) connected with the latter of these effects.

Whether theory is involved or not, regional development themes have found particular resonance within the EU with a focus on investment in the infrastructure of disadvantaged regions and promotion of the Trans-European Transport Network (TEN) as an instrument of EU policy. The TEN projects are intended to improve competitiveness, income, output and employment within the EU as a whole by providing peripheral regions of the EU with better access to economic centres. This may also foster the (non-economic) goal of improved social cohesion. On the local (and national) levels the improved accessibility offered by transport projects is seen as an aid to reducing regional disparities in terms of employment, income and wealth and fostering social cohesion (van Excel, Rienstra, Gommers, Pearman & Tsamboulas 2002).

Examples of similar thinking on a smaller scale are common. Brown, Copeland & Co. Ltd (2004) suggest that the attraction or retention of freight and passengers through Centre Port and Wellington International Airport could be economic benefits arising from the Transmission Gully project. Mees (2001) cites common perceptions that Melbourne's Western Ring Road will promote economic growth in Melbourne's Western Suburbs.

SACTRA also pointed to many such claims, noting arguments that improved transport links can overcome investor perceptions of distance, peripherality and disadvantage (SACTRA 1999, para. 2.33).

Thus, the Welsh Economy Research Unit (1997) argued that improved local road access was an important issue in influencing the location decisions of recent investors and provided for new income and employment opportunities in the region. The Black Country Development Corporation (1997) indicated that direct access to 3 million square feet of industrial/commercial floor space provided by the Black Country Spine Road was critical to its program of regenerating derelict land (SACTRA 1999, paras. 2.34, 2.36). Other submissions pointed to the potential positive local effects of providing for direct Channel Tunnel services to the north of England and to Scotland and for providing a motorway link further into England's south-west in order to overcome perceptions of distance from key markets (SACTRA 1999, para. 2.33).

In practice, the provision of improved transport links may have more ambiguous outcomes. on both regional and national economies. A variety of case studies, drawn from the literature and cited by Banister and Berechman (2000a) and SACTRA (1999) is documented below:

4.2.3.1 Banister and Berechman citations

- Linneker and Spence (1996) used multiple regression analysis to asses the economic impacts of the M25 ring road around London, completed in 1986. They found that areas with high accessibility, relative to others, lost employment. Proximity to centres of high population densities produced the poorest employment performance while the London region performed better than other locations. Banister and Berechman (2000a, pp.244-245). In reviewing these results Banister and Berechman noted that improved physical accessibility, as measured by Linneker and Spence was only one measure of activity. Improved access could allow local firms to expand market area and employment and/or allow expansion of firms outside the region into newly accessible locations.

- Gould's (1987) study of planning applications for retail development in the area of the M25 included retailer survey work. This indicated that over 75% of retailers did not view proximity to the M25 as important. However many of these were for establishments such as smaller supermarkets, whose convenience-oriented customers would generally not travel more then 10 minutes by car in any case. In contrast, larger regional shopping centres and warehouses (accounting for 45% of the floor space in the survey) indicated that M25 access was very important (Banister and Berechman 2000a, pp. 246-247). Thus the M25 had an important role in enlarging the catchment area for larger establishments, but not for smaller ones[22].

- Bannister and Berechman also note the example of the Amsterdam orbital motorway, competed in 1990. This runs some 5 km from the city centre. They suggest that the Ottoway reinforced the position of locations already in a strong competitive position. They also note mixed evidence provided by Bruinsma et al's (1996) study of the orbital. Qualitative work indicated that office rents in areas affected by the motorway increased by much less then in areas not affected by it. However, regression analysis found that rents at motorway junctions were 10% higher than those 1 km away and that the motorway was an important location factor for firms – though not the only one (Banister and Berechman 2000a, pp. 251-253).

- Other Dutch studies, during the 1990's (Rienstra et al 1998; Reitveld and Brunisma 1996) analysed road investment over the whole of the Netherlands These provided no clear or consistent evidence of the impact on employment in regions resulting from new patterns of accessibility. However, this finding may, in part be due to the need to adopt a lower level of spatial disaggregation (Banister and Berechman 2000a, p. 253).

- The Buffalo Light Rapid Rail Transit System (LRRT), completed in 1982 was targeted at revitalising the city's urban core and stimulating public and private investment in the CBD. Nonetheless, after completion of the line, the city suffered a major loss of employment, particularly in heavy manufacturing. Banister and Berechman note that the project's success was mitigated by factors such a lack of retail incentives to lure

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[22] Banister and Berechman also note that political, market and institutional factors played a key role in shaping the pattern of development and in determining the M25's regional economic growth effects. These factors include a strong initial growth in planning applications backed by political support which was then tempered by such factors as the decline in the UK property market in the late 1980's/early 1990's and a desire to maintain a 'green belt' around London. One consequence of the latter is that much development has taken place further away from the M25, beyond the green belt. They use this and the other case studies cited above (Banister and Berechman 2000a, pp. 247-249).

developers to the CBD and the construction of suburban shopping malls. They cite this case as evidence of the need to adopt coordinated policies aimed at enhancing the attractiveness of an area in step with transport investment. These include emphasising the variety and quality of activities, safety, ease of access to retail outlets and paying attention to competition from other accessible and attractive areas in the region (Banister and Berechman 2000a, pp. 246-247).

- Sands (1993) analysed the impact of the Japanese high speed rail (Shinkansen) network using multivariate analysis. He noted that population growth could be predicted with 90% accuracy in areas served by Shinkansen. However, aside from access to the Shinkensen, prerequisites included the presence of universities and 'information exchange' industries (i.e. business services, banking, real estate). Brotchie found growth rates of 16-34% in retail, industrial, construction and wholesale sectors in cities serviced by Shinkensen. However this may conceal relocation processes within the affected cities to station-accessible cites (Banister and Berechman 2000a, pp. 278-280).

- Economic development in response to France's TGV high speed network has been uneven. Some cities such as Lyon have experienced sizable growth (i.e. 43% between 1983-1990) in office space around the station due to the improved access to Paris and a lack of office space in central Lyon. Other centres such as Les Mans, Nantes and Vendome, with buoyant local economies also experienced substantial growth with a 20% rental premium being typical. However, there has been little development in other centres such as Le Creusot and Mâcon. Banister and Berechman suggest the uneven pattern of development is due to the strength of the local economy and the existence of service firms requiring access to Paris (Banister and Berechman 2000a, pp. 278-280).

4.2.3.2   SACTRA citations

SACTRA also refer to a number of UK-based studies (SACTRA 1999, paras. 5.111-5.115). These are indicated below.

- Dodgson's (1974) modelling of the M62 indicates a weak relationship between falling transport costs and local employment growth rates, in likelihood due to the fact that employment growth is influenced by many non-transport factors.

- Botham's (1983) work on the potential spatial redistribution of economic activity arising from the UK national roads program up to the early 1970's finds only small impacts on redistributed employment relative to the overall changes in the UK over the same period.

- Halden and Sharman's (1984) qualitative study of changing accessibility around Inverness found no causal relationship between accessibility and economic development.

- The Welsh Economy Research Unit's (1997) analysis of road improvements in Merthyr found only marginal direct benefits but argued that indirect benefits from improved locational and commercial compositeness were much more important. However, this study employed regional and sub-regional I-O tables to model the effects of improved competitiveness (and hence the I-O analysis caveats noted elsewhere apply) and there

was no indication that the positive effects did not merely reflect displacement of other economic activity outside the region.

Several major reasons may be advanced for the lack of clear results from the provision of new transport infrastructure, namely:

- The possibility that people, jobs and investment may flow out of the targeted region (the 'two way road' problem).

- The lack of complementary supporting measures in place to alleviate the initially identified problems of disadvantage (e.g. unemployment).

- The economic displacement impacts on other regions and the national economy as a whole.

These are discussed in turn below.

4.2.4   The two way road problem

A key issue identified by SACTRA is the 'two way road problem'. Improving transport links to a region identified as depressed or disadvantaged may result in investment and/or employment opportunities flowing into a region. However, equally, people, jobs (and perhaps investment) may flow out of the 'target' region due to the improved access to other centres – roads (and other transport links).

More formally, SACTRA notes that the interregional impacts of transport investment can be classified into a commuting response and a migration response. Improved transport links increase the size of labour markets, as falling transport costs mean workers are prepared to make longer journeys for the same generalized cost. This may increase competition for jobs within a given region but also open up opportunities in other regions for local workers. This could bid up local wages, as local employers seek to retain staff. However, the impact on unemployment and nominal wages is ambiguous, and will depend on the specific regional worker and job characteristics (SACTRA 1999, para. 5.44).

In terms of the migration effect, SACTRA argue that lower commuting costs may cause migration into the target region as those employed in other regions seek lower house prices and better living conditions (though it is also possible to theorise that the opposite may occur – see below). This may result in downward pressures on local wages and/or unemployment and upward pressure on local house prices. SACTRA note that much will depend on the degree of 'slack' in the labour and housing markets and the possible feedback impacts of the commuting effect (SACTRA 1999, paras. 5.48, 5.51).

ECTM also makes the additional point that inefficient local industries (i.e. those in the originally targeted disadvantaged regions) may be put out of business by industries located in more distant areas as a result of increased competition, promoted by the new infrastructure (ECTM Summary 2001, p. 3). SACTRA and the BTE make a similar point regarding the impacts of improved infrastructure on local monopolies (SACTRA Report Summary, para. 40; BTE 1999, pp. 24-25). However, all of this depends on the particular industry structure of the region in question.

SACTRA also notes studies indicating that transport factors have not played a major role in causing people to move jobs or residences. Instead, the housing market would appear to have a stronger impact on decisions to migrate between regions then transport. House price levels, reflecting the constraints of the housing market, would appear to be the key factor in

whether to commute or migrate between nearby regions. The impact of transport improvements may therefore largely depend on the relative states of the housing and labour markets in the affected regions. (SACTRA 1999, paras. 5.64-5.66).

In essence, theory provides no definitive answer to the issue of whether a specified region will 'benefit' (through higher wages and employment) from the impact of transport investment. It is for these reasons that SACTRA has expressed an interest in LUTI modelling of the links between the product, property and labour markets, though the problems associated with this have already been noted above.

Within a New Zealand context analysts such as O'Fallon (2004) see the two way road problem as creating a 'significant risk' that the benefits of improving transport infrastructure in a smaller, less developed region will not accrue to that region (unless it has a unique asset) but, instead, flow to larger, more diverse ones. This may be particularly true of areas close to major cities, such as Auckland (O'Fallon 2004, p. 16).

However, a further complication is the differing urban/regional context of the UK/Europe as compared to New Zealand. While labour market commuting/migration decisions may be an issue in the densely populated UK/Europe, (and in some New Zealand conurbations) this may be less of a factor in determining regional impacts of transport improvements in more isolated New Zealand locations with smaller populations. Thus geographical factors may obviously limit the labour market impacts of transport improvements in some rural New Zealand contexts.

Many studies would appear to miss issues connected with the two way road problem As SACTRA notes direct transport effects are often assessed only for a defined area in the neighbourhood of the improvement (SACTRA 1999, Summary Report, para. 40.) However, as hinted above, the two way road problem does not necessarily result in 'negative' outcomes for targeted regional populations, though migration issues do create questions about whom the 'regional' population is ultimately composed of (i.e. the issue of the 'population of standing').

For example, assume that a new transport link is constructed between two contiguous regions: Region A, an underprivileged region of high unemployment and Region B a better-off area of low unemployment. A study which only reviewed changes in job vacancies or some other measure of employment opportunities (as opposed to unemployed residents, regardless of where they were now employed) within Region A would not pick up the fact that many previously unemployed residents may now be able to commute to new work opportunities in Region B. It is noted for example that some of the individual measures used in Mees' (2001) study of the impacts of the Western Ring Road, such as changes in local (Western Melbourne) jobs and the ratio of local jobs to local residents might miss some of these employment flow impacts – though Mees' other data may be sufficient to make up for this.

Similarly, it is quite possible that no new investment opportunities may be created within Region A – rather those in Region B may be further enhanced by ready access to cheaper labour from Region A. Thus a study examining the development of new industries in Region A may find little evidence of any such growth (at least in the short term). However, in both cases residents of Region A could be said to have benefited from the new link. (Whether this would result in increase in GRP is, however, a more complex issue.)

Alternatively, it may be the case that some residents of Region A migrate to Region B due to a combination of job opportunities, lower costs of relocation and the increased ease of return visits to visit friends and family. Migration to region B could reduce unemployment problems (and increase wages in Region A), though wages in region B may fall, however it might also reduce Region A's resident population. Whether a falling population is seen as a positive (or intended) outcome of regional development policy is open to debate; though this is an issue which is generally outside the sphere of 'economic impacts'.

The issues raised by SACTRA and ECTM, along with the cases raised immediately above, may help to explain the ambiguous results of the studies quoted above.

While noting the practical and theoretical issues described above, is it possible to describe any broad typology of conditions under which improved transport links will benefit the target regions and when will jobs and investment flow outwards?

SACTRA suggest six key issues in assessing the regional impacts of transport development:

- Scale economics (e.g. where these dominate, lower transport costs thorough improved accessibility may encourage an increased concentration of firms in core regions until the point that diseconomies set in).

- Size of the local market.

- Local land and labour conditions.

- The nature of backward and forward linkages in the local economy.

- The nature and scale of transport improvements.

However, SACTRA also notes that the interplay of these factors is 'indeterminate' – i.e. it is impossible to predict outcomes using theory alone (SACTRA 1999, paras. 5.85-5.86).

SACTRA (paras. 5.92-5.96) also refers to Venables and Gasiorek's (1998) model of typical regional impacts following a transport improvement. This model was developed in Venables and Gasiorek's report to SACTRA *The Welfare Implications of Transport Improvements in the Presence of Market Failure* (1998). The model assumes an economy comprised of 2-3 regions, each of which has two transport-using sectors, one of which displays imperfect competition, the other perfect competition. Labour markets are assumed to be perfectly competitive in all regions. Their typology is described below:

- *The centre periphery case* – Considers the impacts of a transport improvement between a large central region, which enjoys high levels of activity and scale economies, and a smaller peripheral one. Transport improvements tend to reduce output and wage differentials between the regions (except in cases of very high initial transport costs, which would be unlikely in a developed New Zealand context). Welfare gains tend to be proportionately larger for the smaller region.

- *The production diversion case* – Examines the case of three initially identical regions in which there is a transport improvement between any two but not the third. Assuming the same initial levels of wages and output, activity becomes concentrated in the two benefitting regions at the expense of the third, with significant wage differentials opening up in relation to the third region. The welfare gains in the two linked regions outweigh the smaller welfare losses in the third, resulting in net welfare benefits.

- *The three region periphery case* – Considers the case where three regions lie along one corridor. An improvement takes place between the central region and one of the peripheral regions but not the centre and third one. The central region is assumed to have a greater share of regional production and higher wages due to its locational advantages. The transport improvement shifts production to the peripheral region enjoying the improved link (and increase regional wages) at the expense of the other peripheral region. There is little effect on the central region. However all regions make a welfare gain. This is largest in the peripheral region enjoying the improved link, however, the other peripheral region also benefits from network effects.

- *The three region network case* – Is similar to the three region periphery case but assumes links between the centre and both regions are improved. Here both peripheral regions gain at the expense of the centre region. The overall improvement in welfare is greater than the sum of the improvements associated with each link independently as the total market has been enlarged.

While this typology may offer some broad guidance, SACTRA do not provide any clear empirical evidence in support of Venables and Gasiorek's suggested outcomes. In addition, the BTE has been critical of some aspects of Venables and Gasiorek's agglomeration theory, developed in the same paper (BTE 1999, pp. 95-96, 210).

It therefore seems clear that given the two way road problem, the impact of improved transport links on regional economies is context specific and must be assessed on a case by case basis. SACTRA itself concludes that:

> ..*there is no guarantee that transport improvements will benefit the local or regional economy at only one end of the route – roads operate in two directions and in some circumstances the benefits will accrue to other competing regions...assessment of whether economic impacts will actually benefit the intended target area will need to consider impacts outside the immediate neighbourhood...greater attention should be paid to the question of where the impacts will occur and on whom they will fall.*

> (SACTRA 1999, Summary Report, para. 40)

As suggested above, particular attention must be paid to such conclusions within a New Zealand context. While the theoretical issues raised above should be considered, differences in geography, population density, urban form and the urban/rural relationship in relation to the UK/Europe (and North America) mean that care must be taken in applying theoretical results within a New Zealand context. For example, as suggested above, lower population densities and geographical factors may mean that the commuting/migration issues described for the UK may be different for New Zealand outside major conurbations. This reinforces the need to examine development impacts on a case by case basis.

4.2.5   Supporting measures and limits on impacts

A key issue, identified by SACTRA and other commentators is that transport improvements alone are unlikely to stimulate a region's economy. As is the case with national development, transport is likely to be a necessary but not sufficient basis for regional development.

SACTRA (1999) quotes the AA/CBI (1998) survey of economic development officers which indicates that the availability of suitable sites and a skilled workforce are important decisions

in determining where investors choose to locate. It also notes McKinnon's (1996) work indicating that the Scottish economy has successfully adapted to its geographical isolation by focusing on high value added products and exploiting traffic flow imbalances to obtain favourable export rates. However McKinnon also warns compressed logistical cycle times and rising fuel costs may create difficulties for peripheral regions in the future.

Similarly, SACTRA cite Parkinson's (1981) review of empirical evidence, which indicates that area with low levels of development rarely lack more then just good accessibility, also being deficient in skilled labour and suitable sites (SACTRA 1999, paras. 2.39-2.44).

Likewise, an obvious – and important – point made by ECTM is that simply providing a transport link to an area of high unemployment is insufficient Rather, the benefit of improved transport links on unemployment would remain limited unless supporting measures were put in place to raise workforce skills levels and strengthen regional economic potential. Moreover, it is noted that the impact of transport improvements are found to be 'contingent on the spatial organization of the economy' and that individuals and firms often respond slowly to improvements in transport infrastructure (ECTM 2001, p. 3). ECTM also noted that, the ability of the transport sector to reach its full potential is dependent on the existence of complementary networks, such as ICT which can help generate productivity gains (O'Fallon 2004, p. 10).

Similarly, Banister and Berechman (2000a) find that the relative 'success' of transport investment in regional areas of developed nations is contingent on pre-existing factors. This is consistent with the findings on the link between national economic growth above In particular, improved transport accessibility alone many be a necessary, but not sufficient condition, for promoting economic growth (either regionally or nationally). Rather, growth will ultimately depend on the appropriate and economic, investment and political/institutional conditions being in place.

Banister and Berechman' s necessary economic conditions include the existence of positive agglomeration and labour market externalities, availability of skilled labour and the presence of a buoyant local economy[23]. Necessary investment conditions relate to the funding, scale, location and timing of the investment and how well it fits into the rest of the transport network (e.g. a stand-alone investment may do little to enhance network economies). Political/institutional conditions include legal, organizational and managerial frameworks conducive to investment, complementary policy actions (e.g. tax breaks, training programs) and efficient management of infrastructure facilities (Banister and Berechman 2000a, pp. 318-319, 324-325).

In addition, on the regional level, key factors (other than accessibility) include firm location decisions, availability of good quality locations external demand for output, individual preference structures the provision of other necessary supporting infrastructure and the shape of the transport network, will determine ultimate growth impacts (Banister and Berechman 2000a, pp. 231, 324-325).

These considerations lead on to a related theme: namely that the initial transport (or 'accessibility') barriers must be high in order for improvements to have noticeable impacts on

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[23] The requirement for 'buoyant' local conditions appears to be drawn from the analysis of TGV network, discussed above. Given that many projects are aimed at helping disadvantaged areas the requirement for a 'buoyant' local economy may be somewhat problematic, as it implies that the chances for successful economic developed are reduced. The authors do not appear to address this issue.

growth. Banister and Berechman note that the ambiguous results of the case studies explored above may be partially explained by the fact that the impacts of transport investment tends to lessen rapidly as more capacity is added. Thus even major infrastructure projects may have only negligible impacts on national growth as they represent relatively small improvements in terms of the national economy. Further, they suggest that even if transport improvements are implemented in 'open dynamic' economies, with the right political, economic and investment pre-conditions, they may have little impact (Banister and Berechman, 2000a, pp. 231, 325).

This last point bears further consideration on a regional basis. One would expect a more sizable impact from infrastructure projects on regional growth than on national growth, given the smaller scope in question. However, as Banister and Berechman suggest, even if the economic, financial and political conditions allow it, projects may have little impact on regional growth in developed countries such as New Zealand and Australia for much the same reasons as is the case on a national scale. These have been noted by both BTE (1999, pp. 145-149) and O'Fallon (2004, pp. 13-16). In particular, BTE notes that:

- The Australian regional transport network is already well developed meaning that, for many projects, the reduction in transport cost will be small. Likewise O'Fallon (2004, p. 16) concludes that New Zealand's transport infrastructure is also already well developed and that improvements will only impact at the margin.

- Transport costs are generally not a large component of total production costs or revenues, hence reduced transport costs are of minor consequence. For example, 'beyond the farm gate' freight costs account for only 8% of the price paid for domestic agricultural products and 12%-13% for manufacturing and mining products. Given shorter haulage distances, in many cases, it might be expected that these proportions would be the same, or even lower, in New Zealand.

- Producers often view differing modes of transport as poor substitutes. For example, road haulage may be favoured in many cases for the transport of some goods such as horticultural produce. Thus even if a rail alternative is constructed it may not be fully utilized.

- Increased rural production in Australia may be limited due to natural resource constraints, e.g. water. While New Zealand faces different resource constraints, this is no less true, along with the issue of the constraints posed by concerns over environmental impacts.

While the BTE focuses on case studies relating to the improved transport of bulk commodities from rural areas, the basic theme that increases in accessibility engendered by transport developments are unlikely to be dramatic in many cases is true for both urban and rural regions. This is likely to be equally true in the case of New Zealand.

4.2.6   Economic displacement

The problems associated with the two way road problem and the need for supporting measures have been noted above. However, even assuming that a targeted region does 'benefit' from improved transport links (whether the measure is economic efficiency (i.e. using SCBA), or macro-economic variables such as employment/GRP/GSP) this says nothing about the impacts on other regions. Leaving aside the complex issues associated with the 'two way road problem' (i.e. assuming no movement of resources away from the target

region) it may well be the case that implantation of the project will draw scarce resources (labour, capital) away from other underdeveloped regions and competing projects.

The theme of economic displacement has been taken up by a number of New Zealand based studies and authors. Thus, Brown, Copeland & Company Limited (2004) note that funding for the Transmission Gully project may cause other Transfund sponsored projects to be cancelled or postponed (p. 16). While these authors note that the end result may be more economically efficient if Transmission Gully is judged to have a higher BCR then other regional projects – the fact remains that the economic impacts might involve a displacement of resources away from other regions.

O'Fallon (2004, p. 10) notes contributions to ECTM indicating that transport investment may only result in the 'reshuffling' of activities within a region by encouraging concentration of some activities in some area and the 'de-concentration' in others. This will result in little net economic growth at the national level (though it should be noted that this does not preclude growth for particular regions).

Likewise, she also argues that travel time savings arising from the implementation of new projects may well be diverted into increased leisure time rather then work, limiting productivity gains. In addition, by encouraging the growth of urban sprawl, travel times may not be reduced at all, as workers may now live further away or work elsewhere, while non-transport intensive industries are unlikely to experience any benefit (O'Fallon 2004, pp. 13-14). Thus, there will be little net impact on economic growth.

Reviewing ACG's (2004) work O'Fallon (2004) states that in all cases (except the 'passing lanes' project) the regional benefits were expected to outweigh national economic benefits, providing evidence of a displacement effect (p. 5). In particular, with reference to the Auckland Western Ring Road Package, she argues that ACG's work supports the concept that labour and industry will be displaced from other regions to Auckland and that national growth will be quite marginal (p. 16).

While O'Fallon's arguments have implications on both the national and regional levels she appears to overstate her case and contradict her other criticisms of ACG's modelling. The diversion of travel time savings into non-work activities is well-known as an issue within transport economics and may arguably lead to the overestimation of the efficiency gains from travel time savings in some contexts (BTE 1999, p. 34). However, this is something of a technical issue and does not invalidate the concept that there are efficiency benefits arising from travel time savings on a regional or national level. Further, the 'urban sprawl' arguments ignores the likely positive amenity of improved housing conditions and related construction impacts, i.e. the transmission of the 'missing' travel time benefits into other sectors of the regional and national economies.

Moreover, from a pure 'economic impacts' perspective, O'Fallon herself criticises ACG's modelling for double counting the impacts of non-work travel time savings with private consumption gains, as time and money saved on travel is used in other ways (p. 5). However, presumably, the same could be said of travel time savings which people have actually converted into leisure time.

Finally, O'Fallon's interpretation of the ACG work as indicating economic displacement effects is clouded both by uncertainty over O'Fallon's own use of the term 'benefits' and by difficulties in interpreting ACG's own work, given likely double counting.

Displacement effects can also occur within a given region. For example, the BTE's review of the impacts of highway bypasses on Mittagong and Berrima in NSW indicated that the social and financial impacts had clearly been positive in the case of Berrima. However, for various reasons they were far more ambiguous in the neighbouring town of Mittagong and it is unclear if other regional towns in Southern Highlands of NSW (such as Bowral) gained or lost visitors (BTE 1994).

The issue of economic displacement is also connected with considerations of the 'population of standing', discussed above and the discussion of assessment methods and the issues of modelling constraints. In particular, there is a need to clearly define who the intended beneficiaries of a given project are. As the BTE notes, in reality benefits accrue to populations rather than regions (BTE 1999, p. 151). From a regional perspective, some possibilities might include:

1. The existing population within a region at the date of the projects commencement; or

2. As per 1. above plus allowing for any regional in-migration and out-migration connected with the implementation of the project (over a defined period); or

3. As per 2. but also including impacts on other regions and the nation as a whole.

The BTE suggests that caution should be exercised in including 'in-migrants' in the study scope, and (if they are included) caution should be exercised attributing benefits to such migrants (BTE 1999, p. 153). However the BTE's response does not appear to adequately cover the issue of long term population shifts over the lifetime of a project (typically 30 years or so). This issue is further addressed below.

Once the beneficiaries are defined, the issue of whether (or how) to deal with any displacement effects then arises. There are two broad responses to the possibility of economic displacement:

1. *Ignore it* – Since the focus of a given regional study is on regional development, to the extent that displacement impacts on other regions are incorporated in a given model (an issue in itself) they should be set aside.

2. *Allow for other regional and perhaps national impacts* – Impacts on other regions should be allowed for to gauge the broader effects of the proposed development.

In practice, it is improper to ignore the impact of transport development projects on other regions, particular given the issues raised above. SACTRA also comes to this conclusion, noting that the initial impacts of a given transport development may be quite different from its final impacts (given its impacts on the national economy) – i.e. initial 'winners' may end up 'losers'. This reinforces the need to consider impacts on other competing areas as a part of an appraisal (SACTRA 1999, Summary Report, para. 40). Some attention may also be paid to the issue of distribution within a given region.

4.3   Assessment of regional economic effects – appraisal of approaches

If anything, assessing the regional economic impacts of transport projects poses more problems for the analyst than those faced in assessing national benefits.

To some extent, the issues are similar to those explored in the arguments regarding the 'omission' of regional benefits from a 'global SCBA', the potential problems of double counting and the issue of the population of standing.

The possibilities, and pitfalls, of using various methods are discussed below.

4.3.1　Role of SCBA

The discussion of national economic impacts in Section 2 concluded that use of SCBA was the preferred assessment tool in understanding national economic effects of transport investment.

In principle, many of the points regarding the advantages of SCBA in estimating effects also apply at the regional level. However, the situation at a regional level is complicated by the issue of 'ringfencing' the SCBA to a particular region/population.

Thus arguments, made by the BTE, and noted above, that regional impacts are typically included in 'global' SCBA's are essentially valid. However, when the intent is to tease out only the regional benefits, this is somewhat beside the point, as it still leaves the analyst with the issue of how to 'ringfence' the SCBA.

As noted previously, a key question at the outset is to define the 'population of standing', i.e. the population over which benefits and costs are measured (BTE 1999, p. 149). Is it the regional population prior to the commencement of the project? Or the final population, including 'immigrants' to the region, once the project is complete? Is there a concern for the impacts on other regions, or are these to be 'abstracted away'?

As indicated above, the BTE suggests caution in treatment of in-migrants in any regional analysis. If in-migrants are to be included, caution should be exercised in attributing benefits to such migrants through measures such as higher incomes. In particular, if incomes are used as a benefits measure it would be necessary to measure only the incremental change in migrants' incomes relative to incomes they would have received if they stayed in their original region (BTE 1999, pp. 151-153).

However the BTE's considerations do not appear to adequately cover the issue of long term population shifts over the lifetime of a transport infrastructure project (typically 30 years or so).

The BTE appears to recognise issues such as this and other complications arising from project ringfencing, noting that highway bypasses may create relocation costs not captured in a transport SCBA and that:

> *A transport improvement that revives a declining region could reduce the flow of out-migration and the associated costs. Proper allowance for this benefit would seem to require more information than CBAs normally collect — information beyond transport outcomes.*

> (BTE 1999, p. 155)

The BTE does, however, suggest that such errors are generally small (BTE 1999, p. 155). While there is no simple answer to the issue of migratory ringfencing, in general, one would also expect long term migration patterns for a given region to be captured by transport demand modelling. That is, such modelling should allow for the presumed migration impacts of the transport development itself as well as long term population growth.

Even when the issue of migration is set aside, other issues associated with the need to ringfence local populations are relevant if a regional SCBA is to be undertaken. For example, consider the case of the benefits to a rural sub-population of a highway improvement running between two major cities. In such a case only a small portion of travel time savings may accrue to locals and some work may need to be undertaken to discern this proportion. In addition only considering local travel time savings would seem to understate benefits.

An alternative, and more comprehensive, approach may be to measure any change in incomes and/or land values accruing to local populations due to increased traffic both from within and outside the region[24]. These measures would reflect the 'local capture' of the global travel time savings associated with the improved link. While not conducting a formal SCBA, the BTE's ex post study of the impact of highway bypasses on Berrima and Mittagong essentially adopted such an approach (BTE 1994).

However, such an approach could also run into difficulties due to the issues connected with network effects. For example, assume that the highway improvement was part of a larger works program and that three-quarters of the travel time savings (and infrastructure costs) of the highway improvement lay outside the region in question. Land values and incomes within the affected region would partly reflect the travel time savings along the route outside the local area. Further, if only the regional cost of infrastructure improvements was allowed for in the BCR this would be inconsistent with the captured benefits.

Census data (which, among other things, records incomes,) may therefore reveal some trends. For example, Mees' work on the relationship between changes (or the lack thereof) in employment, population and income in Melbourne's western suburbs and the opening of the city's Western Ring Road employed data from the 1991 and 1996 Australian censuses as a database.

However, it should be noted that changes in employment and population are impacts rather than benefits, as discussed above. Further, such evidence is somewhat circumstantial. Precise causal relationships cannot be determined from such a broad study – that is we cannot be sure that presence (or absence) the transport improvement has actually resulted in changes in income levels (for example) given the myriad of other effects. In the case of Mees' analysis, economic restructuring in the area under scrutiny and recession complicated the analysis.

Another possible (or partial) solution may be the use of origin-destination (O-D) data, other survey work and/or census data to identify regional beneficiaries. O-D data, in particular, may be of use, as it clearly ties people, disaggregated by geography, income status (e.g. high medium low), social group (e.g. pensioners, disabled) to transport outcomes. 'Base case' O-D results can be compared to 'project case' results in order to identify the benefits flowing to specific groups. Thus O-D survey work may 'pin down' recipients of benefits such as travel time savings (and perhaps vehicle operating cost savings), including regional beneficiaries.

However while O-D data may be of use in some circumstances it will not apply to all. Thus, in the case of the Mittagong and Berrima highway bypasses above, much of the regional benefit

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[24] Note that the BTE suggests rises in local income should be a preferred welfare measure to increased local retail and service sales. This is because an increase in sales would also be associated with increased costs and some revenues may flow to non-local owners. (BTE 1994, p. 11; BTE 1999, pp. 152-153). While higher regional incomes may be offset by reduced incomes outside the region, as the study is 'ringfenced' such effects may be set aside initially. Ultimately, the income effects on other regions and/or 'global' outcomes should also be considered in addition to that of the target region.

appears to have accrued through increased visitation to local towns from people outside the region and increases in regional land values. Direct travel time benefits/ operating cost benefits to regional residents appear to have been only a small component of total regional benefits.

Another issue arises from changes in travel behaviour. For example, the opening of a new regional road link may result in new job opportunities, perhaps out of the local region. People who walked to work may now decide to drive. In such cases O-D data focussing on travel time benefits may indicate an increase in travel times. Presumably the increase in travel times is justified by the superior employment pay/conditions at more distant locations. However O-D data will not pick up these effects.[25]

A further issue is that O-D work is, by necessity, cross-sectional. Thus, results may be complicated by migratory movements over project timeframes, including movements induced by the transport improvement in or out of the region in question. This issue has been noted above in considering the definition of the 'population of standing'. While this may be overcome by good planning and modelling work, it is necessary to consider who the 'regional population' is defined to be over time, and whether (in the case of large inter-regional population shifts) there may be changes in travel behaviour over time.

Finally, it is noted that the collection and analysis of detailed O-D data generally involves additional costs. Analysts and policymakers will need to consider whether the advantages of having access to such data given the above-noted situational constraints justify such additional expenditure.

Naturally, not all regional transport projects involve such complications. In particular, SCBA may be much more easily applied to projects in which infrastructure construction mainly occurs within the local area and where local residents are the main beneficiaries, e.g. upgrading of local roads used almost entirely by local residents[26]. However, such issues often arise, at least to some extent, when ringfencing is attempted.

A further issue, connected with discussions above, is that SCBA will be unable to discern some of the key issues of interest to policymakers when framing regional policy, e.g. employment outcomes or changes in GRP/GSP.

These issues do not imply that SCBA should not be employed to estimate regional benefits. As is the case on a national level, SCBA generally represents the best approach for estimating efficient economic growth. However, they do indicate the need for caution and definitional accuracy when estimating 'regional' economic benefits.

In situations where network impacts complicate the assessment of regional economic effects, a global SCBA could be developed. This could be complemented by a more descriptive analysis of local effects focusing on changes in income and land values, without seeking to

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[25] Similar issues can cause a complication for SCBA in general (and there are various technical responses to this). However, this may be even more true at the regional level, given the major changes such improvements can have on relatively small sub-groups.

[26] The BTE also provides a useful regional case study of in its *Economic Benefits of Upgrading the Canberra-Tumut (Brindabella) Road* (1997). This measured regional benefits accruing from a road *wholly within a defined regional area* by assessing the proportion of generalised travel cost savings accruing to the regional population. Allowance was also made for a (very small) induced interregional tourism benefit as reflected by new/longer visitor stays and an estimate of the profit margin per tourist per night based on National Accounts data.

reconcile these to changes in the global SCBA (and noting that simply adding these on would constitute double counting). The BTE adopted a similar approach when reviewing economic effects of the Berrima and Mittagong bypasses (BTE 1994), albeit on an ex-post basis.

4.3.2   I-O analysis

Unlike SCBA, I-O analysis enjoys the advantage of being able to provide policymakers with information on the economic impacts of transport such as employment outcomes, changes in regional product and impacts on defined local industrial sectors (e.g. accommodation, finance, transport, construction, personal services).

SACTRA also sees I-O as useful in a regional context, arguing that it can help identify 'key linkages' in regional economies which could assist in understanding impacts of changes in transport provision (SACTRA 1999, para. 5.106).

Thus, ACG used I-O analysis to model the impacts of three New Zealand road funding packages on 'regional GDP' (ACG 2004, pp. 68-70).

I-O analysis gives an idea of economic impacts rather than economic efficiency and suffers from issues such as its relating to its lack of model constraints (especially its lack of capital formation and labour market constraints) and assumptions about constant levels of productivity and technology. However, the issue of constraints poses less of a problem at the regional level. BTE notes that I-O's ignored constraints matter more at the national level and that labour supply constraints, in particular, are weaker across regions than is the case for the nation, given that labour is somewhat regionally mobile (BTE 1999, p. 50).

Other constraints and issues mentioned by BTE such as restrictions on capital availability, crowding out of competing national investments, national government budget constraints and the reduction of consumption expenditure may also generally be less of an issue in regional assessments (assuming that impacts are 'ringfenced' in the first instance) though they may be relevant at a national level depending on the scale of the project[27].

Likewise, despite their strong general preference for CGE over I-O modelling, Dwyer, Forsyth and Spurr also see I-O modelling as acceptable at the local level, noting that the 'Input-Output assumption of freely available resources is closer to the truth at the local level because labour and capital can flow to the area from other areas' (Dwyer, Forsyth & Spurr 2004, pp. 313-314).

Further, I-O can be a quite parsimonious method of modelling economic impacts. I-O effectively represents a simplified form of CGE modelling and econometric work has demonstrated that CGE model solutions converge on the I-O solutions under 'small region' assumptions (Docwra & West 1999, p. 937). Dwyer, Forsyth and Spurr also see CGE modelling at the 'local level' as costly and unwarranted (Dwyer, Forsyth & Spurr 2004, p. 313).

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[27] In particular, BTE sees it as 'conceivable' that regional projects will result in higher consumption expenditure, thereby inducing more regional employment than the project does itself, as is often indicated by I-O models. Conversely, at the national level, flow-on impacts higher taxes and the crowding out of competing projects will result in reduced consumption expenditure and may actually lower employment due to the crowding out of other investment, lowering consumption expenditure (BTE 1999, pp. 50-51).

However, 'government budget constraints' and crowding out may also be issues at regional level,. Key issues include the level of government funding a project (National ? Local ?) and whether there are other competing projects in the region.

For this reason I-O has traditionally been favoured as a measure of regional impacts. Thus, ACG (2004) indicated that development of a regional CGE model for New Zealand was beyond its project resources, it was able to use I-O as a means of estimating changes in 'regional GDP'.

However, ACG also noted the issues arising from the lack of constraints in I-O modelling, particularly capital formation and labour constraints. Accordingly ACG's preferred CGE model (ESSAM) was used in conjunction with national I-O analysis as a method to scale down the 'raw' regional I-O results. Use of this methodology suggested that I-O analysis overestimated 'regional GDP' by between 6.2% - 7.7% (ACG 2004, pp. 68-70).

ACG's recognition of the problem of I-O overestimation is notable. Theoretically, its assessed degree of I-O overestimation may be 'at the high end', given that the modelled results were derived from national level, where I-O's lack of modelled constraints may be most serious. However, this methodology implies access to a national CGE model. In many cases, analysts are unlikely to have such an asset[28].

A more fundamental problem concerns the derivation of multiplier values for regions. Official sub-national I-O tables do not exist in Australia and New Zealand. Thus, the relevant tables are often 'synthetically created', base d on reasoned conjecture. One example of this is the I-O tables used in ACG's study of the CityLink project (BTE 1999, p. 136).

Likewise, ACG's survey of New Zealand road investment refers to the use of 'regional inter industry tables' to derive changes in 'regional GDP' however, the source of these is unclear (ACG 2004, p. 68). Previous New Zealand studies have estimated inter-industry tables by use of methods such as GRIT (Generation of Regional Input Output Tables). However one such study, focussing on Christchurch Tourism, indicated that GRIT tables had a margin of error of +/- 20%. The authors advise using survey work to establish more reliable results (Butcher, Fairweather & Simmons 2003, pp. 27-28).

Further, information problems connected with the use of multipliers increase as the scale of the regional analysis becomes smaller and multipliers are applied to 'regions within regions'[29]. Not surprisingly, Docwra and West (1999) note that in general the smaller the region, the less reliable and available the data (Docwra & West 1999, p. 941).

In spite of these difficulties, I-O analysis would appear to have a role to play in measuring regional economic impacts, given typical policy requirements for information on output and employment. The UK Government appears to have recognised this in its acceptance of

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[28] Further, Dwyer, Forsyth and Spurr argue that I-O and CGE models will generally only give similar answers if implausible inputs are fed into the CGE model. Thus, these authors argue that adjusting I-O results downwards 'misses the point' (Dwyer, Forsyth and Spurr 2004, p. 312). Whether this comment would apply in the case of ACG's modelling is uncertain and would seem to require a detailed review of both the I-O and CGE modelling undertaken. Again, this would seem to constitute part of the 'black box' problem encountered with such econometric modelling.

[29] Recent studies of the Australian tourist industry also indicate the problems faced by applying multipliers within small areas. For example, a recent study of Queensland tourism noted that the size of multipliers is dependent on the size and complexity of the region in question. Nonetheless it applied multipliers developed for tropical North Queensland to Fraser Island in the South-East (Kleinhardt 2002, pp.30-31, 50). A recent review of the Victorian Alpine Region estimated regional economic impacts by applying *national* direct value added and employment multipliers and *halving* the value of *state level* indirect multipliers. It was indicated that this approach was consistent with the procedure for 'special events'(KPMG 2000, p. 54).

SACTRA's recommendation that I-O be used to help analyse impacts on regional economies (DfT 1999, para. 75).

However, as is the case on a national level I-O impacts should be seen as complementary rather then supplementary to SCBA. That is, SCBA should form the basis of the regional analysis (with regard to the ringfencing issues noted above). The outputs of the I-O model (i.e. GDP/GSP, income and employment) could then provide an additional set of data of interest to policymakers. Further, the issues relating to multiplier estimation and model constraints should be made transparent in the analysis.

4.3.3   CGE analysis

In theory, CGE analysis offers a more comprehensive approach to the estimation of regional economic effects than I-O, given its allowance for the operational of at least some economic constraints.

In practice, the construction of regional CGE models is extremely problematic. The main problem is that of obtaining appropriate data on a regional scale.

In many cases, regional CGE models have been developed within national models. This can be done through a 'bottom up' or 'top down' approach.

The bottom up approach is based on the integration of sub-national I-O tables in combination with parameter estimates for location choice equations. However, as noted above, the derivation of I-O tables is a process which is open to considerable question, while the estimation of location choice parameters is often conjectural (BTE 1999, pp. 137-138).

The top down approach is rarely used and involves defining national industries which drive demand for local industries. However, as it assumes that the location of 'national industries' is given, its utility for assessing transport investments is limited (BTE, pp. 136-137).

As noted above, past work has indicated that CGE models will often converge on I-O solutions at the regional level. Thus considerations of parsimony weigh against use of CGE within a regional context. This is also the conclusion of Docwra and West, who note that the difficulties of parameterising a large number of coefficients and parameters in the absence of local data will more then offset the increased model sophistication, and that applying CGE to regional economics may not be 'a very efficient use of resources' (Docwra and West 1999, p. 941). Likewise, despite their general support for CGE (as opposed to I-O) modelling, Dwyer, Forsyth and Spurr agree that CGE modelling, while feasible, is 'costly and unwarranted' at the 'local level'[30].

It is therefore considered that CGE analysis does not offer a practical approach to the modelling of regional economic impacts of transport investment in most cases.

4.3.4   Other approaches

Some analysts have suggested broad guidelines for the assessment of regional economic effects, without necessarily relating these to a specific modelling approach. For example,

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[30] Note however, that these authors see CGE modelling as having a role to play at the 'State-wide' level (Dwyer, Forsyth & Spurr 2004, pp.313-314). This raises the question of application within a New Zealand context. Since the authors comments seem to relate to Australia, it is likely that CGE analysis is better applied to areas with larger economies and populations than those of most New Zealand regions (i.e. Australian states).

Steer Davies Gleave's (SDG) Guidance on Preparing an Economic Impact Report (2003) provided advice to the UK Department for Transport on the development of such an assessment.

SDG suggests measuring impacts of transport developments through use of a single indicator (changes in employment) within defined 'regeneration areas' (i.e. areas of deprivation, identified urban renewal areas and identified rural areas requiring improved productivity/accessibility). It is suggested that the assessment of impacts be limited to the region in question and surrounding regions (it is not necessary to demonstrate whether any new jobs generated by a transport scheme would have gone elsewhere in the country). However, the SDG report does not specifically indicate how changes in employment are to be assessed.

The SDG work again reveals a focus on the impact of disadvantaged regions. However, while these are often of interest, policymakers are often interested in how transport investment impacts on a variety of areas.

Further, the SDG approach's focus on unemployment is problematic. Regional employment results may be difficult to reliably estimate for the reasons discussed above. A focus on employment may also ignore other indicators such as changing incomes. For example, if a transport investment generates a large number of low paying jobs, should it be judged superior to one which generates fewer jobs but increases regional incomes by a greater amount?

Another issue relates to SDG's argument that only impacts on the defined region and surrounding regions. It seems perverse to restrict the analysis to such a limited scope, particularly as there may be negative impacts on more distant areas, and without considering the national impacts of transport investment.

For these reasons, the SDG approach is not seen as a particularly useful advance on other approaches.

4.4 Assessment of other distributional effects – appraisal of approaches

The above discussion indicates there is no clear answer to the question of whether or not improving transport links within a given region will result in higher regional output, jobs or wealth. Much depends on complementary regional infrastructure and how the 'two way road' problem applies within a specific context.

Likewise, it is difficult to fully ascribe impacts on particular socio-economic groups (e.g. pensioners, disabled, unemployed) either within a given region or nationally, though there may be clear correlations between regions and certain sub-groups, e.g. the unemployed. Indeed, it is precisely the presence of such correlations which lies behind much of the intent to use transport investment to promote regional development.

For example, as noted above, much stress is often laid on the need for transport projects to 'create jobs' at both the national and regional levels in order to alleviate unemployment. In many cases, this finds a particularly regional focus, with the emphasis on providing transport links to economically depressed regions with high unemployment. However, as suggested above, there is no guarantee that regional transport investment will necessarily assist regional employment in the short or long term.

A key issue here is that SCBA, I-O and CGE modelling are not particularly focussed on assessing impacts on particular socio-economic groups. As Forkenbrock, Benshoff and Wesibrod note, research on 'environmental justice' (i.e. distributive impacts) related to transport is 'fairly limited' (Forkenbrock, Benshoff & Wesibrod 2001, p. 54).

As noted above, SCBA is best suited to measuring impacts on society as a whole and great care must be taken when applying SCBA to particular regions. In the case of particular sub-groups (e.g. unemployed, elderly, disabled) the information necessary to perform and ringfence, a meaningful economic evaluation may simply not exist (e.g. sub-group discount rates, values of time, environmental valuations).

I-O analysis may be useful in measuring regional impacts. However, this may indicate little about the precise impacts on particular sub-groups. A partial exception may be if a particular sub-group is overwhelmingly concentrated within a given region, e.g. the elderly. However this would require inferences, which may be quite unjustified, concerning the likelihood of such sub-groups receiving benefits.

CGE modelling can provide some indications of impacts at a national (or in some cases the state/regional) level, by producing estimates of employment gains. However, these estimates have been the subject of considerable criticism and must be treated with extreme caution. At this stage, it appears unlikely that I-O, CGE or any other form of modelling can accurately predict national employment impacts of a given transport investment (BTE 1999, pp. 39-55).

I-O and CGE may give some indication of the effects on broad industry groups (e.g. construction, mining etc). However, this is of little use if the policy focus is on specific socio-economic groups.

In practice a variety of methods may be used to assess socio-economic impacts. Common methods are noted below. It should be noted however that some of these may be suited to ex-ante analysis, others to ex post (e.g. regression), others, in theory, to both (e.g. financial appraisal). In addition, rather than being mutually exclusive these may often overlap (e.g. financial appraisal and survey work).

- *Financial appraisal* – An approach commonly used in connection with SCBA is to measure impacts on pre-defined stakeholders (e.g. government, retailers, 'consumers'). While financial analysis can be conducted on socio-economic groups such as pensioners and the unemployed, this would generally require more data than is usually gathered in the course of a normal SCBA. This could be acquired through additional survey work.

- *Regression and related econometric modelling* – Econometric modelling is generally used as an ex post approach and has found a very wide variety of applications within the literature.

  To give only one example, Banister and Berechman refer to Berechman and Passwell's modelling of the impact of transport improvements on labour force participation in an economically depressed area of the South Bronx (New York, USA). The model estimated the impact of travel time reductions on the propensity to enter the labour market allowing for factors such as income, education, age of children and residential location. The modelling found that reduced travel time (i.e. improved accessibility) did encourage higher labour market participation (Banister & Berechman 2000a, p. 230).

While this study has merit, the general caveat applying to regression work applies equally to transport appraisals, i.e. correlation does not infer causality. Thus, sound theoretical and/or contextual evidence should be advanced in order to support the results of regression analysis.

- *Survey work* – Survey work prior to a project's commencement may help establish expectations regarding a project's impact and provide key demographic descriptors. For example, it could establish the number and proportion of pensioners within an area, their average incomes, their weekly spending on transport and their usage patterns.

  More sophisticated surveys (such as stated preference work) could also be employed to estimate key values for certain socio-economic groups (e.g. elasticities value of time).

  In addition, complementary survey work may be undertaken on an ex post basis. A good example of an ex post survey (employing quantitative indicators) is the BTE's analysis of the Berrima and Mittagong bypasses in NSW, AustraliA. While not singling out sub-groups per se, this examined the differing changes in retail sales, property values and tax receipts in the two towns. These gave an indication of the economic impacts   of the bypasses in each area.

- *Census data* – Census data can assist in identifying particular social groups such as low income earners. However, the problem of causality, referred to in relation to Mees' work on Melbourne, remains. That is, it is difficult to infer specific causal relationships simply by comparing census outcomes to transport outcomes. As noted above, this problem may also occur with regression, depending on the context and basis for the research.

- *Origin-Destination (O-D) data* – O-D data can be considered a specialised form of survey data. O-D data can, in theory, help pin down the beneficiaries of a transport development such as unemployed, pensioners, disabled, low income earners etc. This should allow for the identification of specific benefits to specific groups. In theory this data could be used in combination with SCBA to determine the share of benefits attributable to each social group.

  For example, it might be found that low income earners enjoy a 10 minute travel time saving from the opening of a new road link, as opposed to an average 5 minute time saving for all other users. Data permitting, this could be extended to the assessment of vehicle operating cost savings attributed to low income earners.

  However, the caveats noted above also apply. That is, transport benefits for sub-groups may not always be measurable through direct transport outcomes but may arise indirectly, through factors such as higher wages or superior housing. These can be difficult to predict in advance. Further, the issue of behavioural change over time may also be even greater for social groups than is the case for regional sub-groups, as low income earners may well change their transport preferences over a 30 year period. These issues may also occur when undertaking a 'global' SCBA but could be magnified by a focus on specific sub-groups.

  Even if O-D data are available, these might be of use in attributing only some of a project's gross benefits to specific social groups. For example, take the project above, providing a 10 minute travel time saving to low income earners. Even if data on vehicle

operating cost savings to such users are available, it is unlikely accident cost savings (or specific environmental unit values/benefits) will exist for sub-groups.

More significantly, project costs cannot easily be attributed to specific sub-groups (e.g. to what extent have low income earners contributed to funding project capital costs?). This being the case, net benefits (i.e. project NPV) cannot easily be ascribed to specific social groups. An alternative may be a 'below the line' matrix indicating the gross benefits flowing to social groups, where O-D data permit such identification.

Other issues arise in relation to the unit values used to measure benefits to specific groups, as opposed to the average values used across all members of society. To take the example used above, it might be inappropriate to value a 10 minute saving in travel time by low income earners using the unit rate for the 'average' value of travel time savings. Low income earners would tend to value travel time savings at less then most other sub-groups.

Thus, the rate applied should be a specific value of travel time savings for low income earners (which would result in lower benefits to such individuals than if the 'standard' rate was used). However using differential values of travel time for different groups would seem to contradict Transfund's equity approach to the valuation of travel time savings.

Finally, the costs and time involved in the collection of such data may be significant and raise questions about the utility of doing so.

- *Multi Criteria Analysis (MCA)* – One approach to measuring the impacts on various community groups is to use Multi Criteria Analysis (MCA). In many cases MCA uses a mix of qualitative and quantitative measures – including criteria relating to socio-economic goals and/or groups. The criteria are organized into a matrix, weighted and added to produce a final result. This allows for the comparison of different transport development options and their impacts on varying socio-economic groups/objectives.

  However, MCA is weakened by the lack of generally accepted weights for different socio-economic groups/goals and the absence of a common methodology. Judgements regarding the relative importance of differing socio-economic groups typically reflect the values of planers and analysts rather then the 'willingness to pay' of consumers themselves.

  As suggested by the BTE, if MCA is adopted as a guide to socio-economic impacts, it is generally preferable to assess it a 'below the line' item, and avoid mixing it with a formal SCBA which uses values based on consumer preferences.

- *Other approaches* – Forkenbrock, Benshoff and Weisbrod (2001, pp. 54-55) refer to a variety of other methods in assessing the 'environmental justice' impacts of transport projects. Their focus is on analysing the effects of transport projects on disadvantaged socio-economic groups.

  Work referred to by Forkenbrock, Benshoff and Weisbrod includes:

  –   Werner's (1998) work investigating the demographic effects of changing a bus route and whether it would disproportionately impact on elderly, poor and minority groups. Werner used census data, demographic information and route data in combination with statistical tests to analyse how minorities were affected by the changes.

- Lane et al (1998) focused on the 'environmental justice' aspects of proposed highway bypass alternatives in North Carolina, USA. Their 'environmental justice' approach emphasised reflecting the values of the local community. Thus, they sought community input on the bypasses through project development meetings in order to hear concerns and to describe how these could be mitigated[31]. Potentially disproportionate impacts on socio-economic groups residing near the proposed bypasses were considered by use of a reference population. Survey work was undertaken to determine the race, numbers and income levels of those likely to be displaced by the bypass alternatives. However neither of the alternatives was judged to have a disproportionate impact on minorities based on a range of environmental and community service factors.

- Forkenbrock and Schweitzer (1999) analysed the spatial occurrences of air pollution and noise associated with changes to an existing arterial road. The focus was on the impact of these factors on low-income and minority groups. It was found that low income households were not disproportionately affected by noise, however minority households were.

4.5　Conclusions and recommendations

This chapter posed the following questions:

Question 4.1: Is the upgrading of transport links within or to/from a particular ('disadvantaged') region likely to be an effective means of enhancing the economic development of that region, and in what circumstances?

- As is the case for national development, transport is, in general, a necessary but not sufficient condition for regional development. There is a need for other supporting programs and infrastructure to be in place, in addition to other natural and human resources. Various commentators have emphasized this point, including ECTM, which concluded that:

  regional development...clearly does not depend solely on investment in transport. The causal link between the two is, in fact, weak. Curves showing the link between investment in transport infrastructure and economic growth quickly level off once a certain threshold has been reached...the overriding opinion of the experts at the Round Table was nonetheless to the effect that improvements in transport systems did not induce specific effects capable of systematically increasing the production of a region.

  (ECTM 2001, p. 4)

- Further, experience offers no conclusive guidance regarding the distributional impact of transport investment on specific regional economies. Issues such as the 'two way road problem', the need for supporting measures, well developed transport networks

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[31] Note however that BTE warns against the use of local community consultation in the (similar) context of setting MCA weights. For example local interests may favour local traffic over through traffic, with results which are likely to be sub-optimal from a national decision-making perspective (BTE 1999, p. 198). Of course, consideration of such effects may be more defensible if they are considered in addition to formal SCBA results -i.e. 'below the line'.

and economic displacement effects cloud the ultimate impacts of transport investment on economic development within a specified 'target region'.

- Analysts such as O'Fallon (2004) have stressed that regional growth may simply result in the displacement of economic activity from one region to another. Though she may overstate her case, displacement effects are a real issue.

Question 4.2: How are the distributional impacts of transport investment on particular regions/areas best assessed; and how do the results of such assessments relate to SCBA assessments of national economic costs and benefits?

- While SCBA offers, perhaps, the best method of assessing the geographic distributional effects of transport investment, the difficulties of ringfencing regional growth effects using either SCBA can be significant. A possible (or partial) solution may be the use of origin-destination (O-D) data, other survey work and/or census data to identify regional beneficiaries, through this may be complicated by the nature of regional benefits and migratory movements over project timeframes.

- If SCBA is not feasible within a given context, the best approach may be the use of descriptive and/or qualitative indicators (e.g. likely changes in regional income, land values) in conjunction with a global SCBA.

- I-O modelling could be used as a complement to SCBA at the regional level if there is a need to assess economic impacts as opposed to benefits. However, I-O analysis suffers from other problems (previously identified), while CGE analysis is generally not practical at a regional level.

- Whether SCBA is used alone or in combination with I-O analysis, regional economic appraisals should also take into account impacts on other regions and the national economy as a whole. Doing so would allow for an examination of inter-regional displacement effects, or at least in comparison to the broader national viewpoint. Not to do so risks presenting a distorted picture of net benefits (SCBA) or impacts (I-O analysis).

Question 4.4: Would the assessments of distributional (geographic, socio/demographic etc) impacts of transport investments provide useful additional information (additional to the overall impact assessment) for decision-makers?

- Conventional SCBA treats a unit of benefit and disbenefit as being of equal value (e.g. a reduction in travel time for one person has the same value as an equivalent rise in travel time for an equivalent person). Past work has generally concluded that analysts are not well placed to weight these changes and thus derive a net effect. However, decision-makers will appreciate the likely greater negative reaction from those who lose from a proposal than positive reaction from those who gain.

- Decision-makers will therefore be well-served by advice of the differential effects of proposals on various social groups so that the need for remedial measures can be identified and implemented.

- Such analysis does not substitute for SCBA, but will provide feedback to project design and a more nuanced understanding of projects to decision-makers.

5.   Conclusions

As indicated in the Introduction, the purpose of this report was threefold:

- To review the major approaches to assessing the national economic benefits of transport investment and, in particular, the role of Social Cost Benefit Analysis (SCBA);

- To review the role of transport investment in national and regional economic development and, in particular, whether it has a special role to play in such development;

- To review approaches for assessing regional economic and other distributional effects.

Key questions posed by, and findings derived from, this work are detailed below:

5.1   National economic benefits

5.1.1   Questions

This section revolved around three key questions

- Question 2.1: In what circumstances, and to what extent, does a (fully-specified) SCBA not capture all the national economic costs and benefits arising from a transport investment?

- Question 2.2: What alternative approaches exist to assessing the national economic impacts of transport investments, and what are their merits in place of, or to supplement, SCBA (particularly to capture any costs and benefits not adequately addressed by SCBA)?

- Question 2.3: How should the impacts of transport investment on national economic growth (GDP and similar measures) be assessed; and how do such assessment methods and their outputs relate to the methods/outputs involved in the SCBA approach?

The following conclusions were reached:

5.1.2   Question 2.1

- SCBA can be defined as a policy assessment method that quantifies, in monetary terms, the value of all policy consequences to all members of society. Social benefits are subtracted from social costs to derive net social benefits (NSB), measuring the value of the policy.

- A critical distinguishing feature of SCBA is its focus on the need to maximise economic efficiency by maximising societal welfare. SCBA also provides clear decision rules (i.e. the Net Present Value (NPV) of project benefits and benefit-cost ratio (BCR)). These indicate the extent to which society is better off (in economic efficiency terms) from undertaking a project. In addition, SCBA measures the marginal effects of a given project to society; it is not intended as a broad strategic tool.

- These factors distinguish SCBA from economic impact methodologies such as Input-Output (I-O) analysis, Computable General Equilibrium (CGE) analysis and Land Use

Transport Interface (LUTI) modelling. These focus on broad measures of economic impact such as employment, income and GDP and lack such specific decision rules.

- The inclusion of induced and diverted demand effects within a SCBA effectively captures most of the indirect (or flow-on) effects to the broader economy associated with a transport improvement. So long as a transport SCBA allows for induced and diverted demand effects, the extent to which it 'misses' economic benefits will be small to modest.

- Even if induced/diverted demand effects are omitted, (i.e. a 'fixed trip' travel matrix is used) the degree of benefits underestimation will generally be modest, since induced traffic effects are generally small and transport improvements are unlikely to have a dramatic economic effect on competitive, modern economies such as New Zealand's.

- Technically speaking, the difference between results obtained using fixed and variable trip matrix may be large in extremely congested situations, where allowance for induced traffic may actually reduce benefits to existing users (and thereby total benefits). However, to the extent this occurs, benefits may be overestimated rather than underestimated by use of a fixed trip matrix.

- Where strong contextual (and material) evidence exists, consideration of the relevance of additional factors such as additional logistical and agglomeration benefits, property and labour market effects, imperfect competition and specific regional development issues could be considered on a less formal, case by case basis. This could involve consultation with key affected industries and stakeholders.

- If these additional effects are not amenable to monetization and incorporation within an SCBA they could be considered in a 'below the line' qualitative analysis.

- However these factors are only likely to be worth addressing for major projects. Further, it is considered that allowance for such effects will not be an issue in the great majority of such cases.

- Allowance for environmental externalities may be made either within an SCBA or 'below the line', depending on issues of context and data availability.

5.1.3   Question 2.2

- Arguably, 'alternatives' to SCBA include macroeconomic approaches such as I-O analysis, CGE modelling or LUTI modelling. These could be used to estimate the economic impacts of transport investment.

- However, these approaches produce different 'raw' outputs to SCBA (i.e. they report macroeconomic impacts), do not provide clear social decision rules (unlike SCBA), do not measure the economic efficiency of an investment and do not include some of the non-market commodities allowed for by SCBA (such as some non-work travel time savings). Further, unless a nationwide investment scheme is envisaged, these alternatives may constitute something of a 'blunt instrument'.

- As such, undertaking SCBA is fundamental to the appropriate assessment of benefits and costs of transport investment.

- Some attempts have been made to estimate changes in economic welfare associated with a given project (i.e. equivalent to that derived via SCBA) through the use of modified CGE modelling. However, adding up the results of SCBA and CGE modelling,

as in ACG's recent modelling of New Zealand road projects, is wrong. In addition, the use of CGE modelling to derive welfare outcomes, such as advocated by Dwyer et al (2004), still faces investment modelling and non-market transactions issues. Thus, any use of other macroeconomic modelling approaches in combination with SCBA should carefully note issues of double counting and compatibility. In addition, the issue of parsimony should be noted, in particular the extensive work required to develop and maintain CGE (or, theoretically, LUTI) models in return for modest improvements in SCBA accuracy. This is especially true given limited resources in small economies, such as New Zealand's.

- There would therefore not seem to be a strong case for abandoning SCBA for more complex techniques to account for 'missing benefits'; the proposed alternatives do not provide a reliable substitute and do not appear to be justified on grounds of parsimony.

5.1.4   Question 2.3

- It is not possible to derive a direct linkage between the outputs of SCBA and changes in macroeconomic indicators, such as GDP. SCBA provides no direct information on such indicators. Thus, projects which record a negative NPV (BCR below 1.0) may still produce increases in GDP. While it is likely that projects which produce a positive NPV (BCR above 1.0) will be associated with GDP growth, even this is not certain (particularly given that SCBA may include valuations of non-market products such as environmental externalities and some non-work travel time).

- In theory, I-O, LUTI and CGE models could be used to complement the results of SCBA. All of these models may provide some form of national macroeconomic information of use to policy makers. Depending on the model, these may include data on employment, income, GDP, land use, investment, trade, consumption, wages and tax. However CGE modelling is the most accurate and reliable methodology and should be preferred if national impacts are to be modelled. I/O analysis may be acceptable (and preferable) within a regional context – see below.

- As SCBA does not produce these broader measures as outputs, using SCBA in combination with of these approaches could provide a policymaker with a broader view of the overall impacts of the project.

- CGE could also help pinpoint some omitted benefits, such as the impacts of imperfect competition, however there may still be some issues of compatibility with SCBA.

- However, it is recommended that SCBA be viewed as the primary decision-making tool in such cases.

- Further, given the issues of time and expense and the scepticism expressed regarding the need to develop/maintain such models by governments in larger jurisdictions (such as the UK), it is likely that only the largest New Zealand projects would require development and maintenance of such models This is particularly the case since the average impacts of imperfect competition in New Zealand may be even smaller then those derived by UK studies such as SACTRA (1999).

- Moreover, in many cases, any changes in GDP from individual projects may be extremely small, given the size of national economies relative to the projects in question.

5.2 Role of transport investment in promoting economic development

5.2.1 Question

This chapter sought to address the following key question:

- Question 3.1: Are there particular features of transport investment (in general) that make it especially effective (such effects maybe not fully reflected in SCBA or alternative methods of assessment) in promoting/increasing national (and regional) economic growth?

5.2.2 Question 3.1

The conclusions and observations of this chapter can be summarised as follows:

- Evidence for a 'special role' in respect of transport infrastructure investment's economic growth effects (as opposed to effects generated by other public spending, such as on education or health) is limited. The high rates of return to transport investment claimed by some past studies are likely the result of statistical correlation or other model specification issues.

- Likewise, there is nothing 'special' about investment in transport infrastructure from a regional perspective. While there is some evidence regarding the responsiveness of growth to investment in transport infrastructure, this is no less true than other forms of public spending. It is unlikely that investment in transport infrastructure will have dramatic effects on regional economies.

- In general, development of transport infrastructure is a necessary but not sufficient condition for national and regional economic development and growth.

- The incremental economic gains of further investment in transport infrastructure in developed economies are likely to be small. Arguably, there is a spectrum within which some developed economies may experience greater gains more than others, but solid evidence to this effect is lacking.

- There is no strong evidence that SCBA omits significant flow-on effects to the broader economy. The argument that previous work, citing high returns to transport investment, has somehow revealed SCBA's 'omitted benefits' is therefore unsustainable.

5.3 Approaches for assessing regional economic and other distributional effects

5.3.1 Questions

This chapter posed the following questions:

- Question 4.1: Is the upgrading of transport links within or to/from a particular ('disadvantaged') region likely to be an effective means of enhancing the economic development of that region, and in what circumstances?

- Question 4.2: How are the distributional impacts of transport investment on particular regions/areas best assessed; and how do the results of such assessments relate to SCBA assessments of national economic costs and benefits?

- Question 4.3: How are the other (non-geographic) distributional impacts of transport investment on different social/demographic and market segments best assessed?

- Question 4.4: Would the assessments of distributional (geographic, socio/demographic etc) impacts of transport investments provide useful additional information (additional to the overall impact assessment) for decision-makers?

The answers to these questions, along with other key points of interest and relevance, can be summarised as follows:

5.3.2   Question 4.1

- Upgrading of transport links within or to/from a given 'disadvantaged' region, in and of itself is insufficient for enhancing regional economic development. As is the case for national development, transport is, in general, a necessary but not sufficient condition for regional development. There is a clear need for other supporting programs and infrastructure to be in place.

- Further, economic theory offers no conclusive guidance regarding the distributional impact of transport investment on specific regional economies. Issues such as the 'two way road problem', the need for supporting measures, well developed transport networks and economic displacement effects cloud the ultimate impacts of transport investment on economic development within a specified 'target region'.

- Analysts such as O'Fallon (2004) have stressed that regional growth may simply result in the displacement of economic activity from one region to another. Though she may overstate her case, displacement effects are a real issue.

5.3.3   Question 4.2

- While SCBA offers, perhaps, the best method of assessing the geographic distributional effects of transport investment, the difficulties of ringfencing regional growth effects using either SCBA can be significant. A possible (or partial) solution may be the use of origin-destination (O-D) data, other survey work and/or census data to identify regional beneficiaries, though this may be complicated by the nature of regional benefits and migratory movements over project timeframes.

- If SCBA is not feasible within a given context, the best approach may be the use of descriptive and/or qualitative indicators (e.g. likely changes in regional income, land values) in conjunction with a global SCBA.

- I-O modelling could be used as a complement to SCBA at the regional level if there is a need to assess economic impacts as opposed to benefits. CGE analysis is generally not practical at a regional level.

- Whether SCBA is used alone or in combination with I-O analysis, regional economic appraisals should also take into account impacts on other regions and the national economy as a whole. Doing so would allow for an examination of inter-regional displacement effects – or at least in comparison to the broader national viewpoint. Not to do so risks presenting a distorted picture of net benefits (SCBA) or impacts (I-O analysis).

5.3.4 Question 4.3

- Several methods may be used to measure the impacts of transport development on specific socio-economic groups. These include financial appraisal, regression, survey work, census data, origin-destination data, multi-criteria analysis (MCA) and 'environmental justice' approaches.

- However, some of these (e.g. MCA) are of questionable reliability.

- Cross-sectional information such as origin-destination (O-D) data, and, to some extent, census data may help identify specific groups benefiting from changes in transport infrastructure (e.g. unemployed, disabled, low income). Data which specifically and directly relate the groups in question to transport improvements (such as O-D data indicating travel time savings to low income earners) would be the most useful approach in this respect. Merely inferring causal relationships between broad indicator variables (such as arguing that a transport improvement has resulted in a nationwide improvement in the incomes of low income groups) is of questionable utility in the absence of firm theoretical/contextual backing.

- The use of O-D data may have several drawbacks, however, including difficulties in attributing non-transport benefits, limitations on attributing net project benefits to specific sub-groups and the usage of differential unit values in benefit calculations. Further, cross-sectional approaches however, may be the lengthy timeframe involved in project assessment. For example the transport behaviour of a 'lower income' sub-group (and therefore the distribution of benefits) may change over time. This may complicate estimation efforts.

- A partial solution to this issue may be the presentation of limited gross benefits based on O-D data 'below the line' in an SCBA.

5.3.5 Question 4.4

- While the above methodologies may provide some useful data to policymakers, in general, assessment of socio-economic impacts on specific groups should be seen as a complement to the broader use of SCBA, in the first instance.

- As indicated, if policymakers are interested in determining the benefits (or otherwise) accruing to specific groups then O-D data disaggregated into defined social groups could be collected.

- It is noted however, that this process will involve additional costs. Further, the difficulties and uncertainties associated with O-D data, noted above should not be ignored.

6.   References

Allen Consulting Group Pty Ltd. 1993. *Land Transport Infrastructure: Maximising the Contribution to Economic Growth*, Report to the Australian Automobile Association, Canberra, Australia.

Allen Consulting Group Pty Ltd, Cox, J.B. & Centre of Policy Studies 1996. *The Economic Impact of Melbourne City Link: Transurban Project,* Consultancy Report to Melbourne City Link Authority, Melbourne, Australia.

Allen Consulting Group Pty Ltd. 2003. *Benefits of Public Investment in the Nation's Road Infrastructure: An Update of an Earlier AAA Report on the benefits of Infrastructure Investment and a Tour of the Issues in Response to the Commonwealth Government's Green Paper on AusLink* Prepared for the Australian Automobile Association, Canberra, Australia.

Allen Consulting Group Pty Ltd. 2004. *Benefits of Investing in New Zealand's Road Infrastructure,* Report to the New Zealand Automobile Association.

Australian Transport Council, Guidelines Assessment Methodology Working Group 2004. *National Guidelines for Transport System Management in Australia,* Commonwealth of Australia, Canberra, Australia.

Austroads 2003a. *Valuing Environmental and other Externalities*, Austroads Publication AP-R229/03, Canberra, Australia.

Austroads 2003b. *Economic Evaluation of Road Investment Proposals: Valuing Travel Time Savings for Freight*, Austroads Publication AP-R230/03, Canberra, Australia.

Austroads 2004. *Economic Evaluation of Road Investment Proposals: Unit Values for Road User Costs at June 2002*. Austroads Publication AP-R241/04, Canberra, Australia.

Banister, D., & Berechman, Y. 2000a. T*ransport Investment and Economic Development,* London, U.K.

Banister, D., & Berechman, Y. 2000b. 'The Economic Development Effects of Transport Investments', Paper presented at the TRANS-TALK Workshop, Brussels, Belgium, November 2000.

Boardman, A., Greenberg, D., Vining, A., & Weimer, D. 2001. C*ost-Benefit Analysis: Concepts and Practice,* 2nd Edition, Upper Saddle River, N.J., USA: Prentice Hall.

Bray, D. J. 2005. 'Improving economic evaluation of urban transport projects in Australia', *28th Australasian Transport Research Forum,* Sydney, Australia, 28-30 September.

Brown, Copeland & Company Limited, for Greater Wellington City Council 2004. *Additional Economic Benefits from the Transmission Gully Project.* Wellington, New Zealand.

Bureau of Transport and Communications Economics 1994. *The Effects on Small Towns of Being Bypassed by a Highway: A Case Study of Berrima and Mittagon*g, Working Paper 11, Commonwealth of Australia, Canberra, Australia.

Bureau of Transport Economics (BTE) 1999. *Facts and Furphies in Benefit-Cost Analysis: Transport,* Report No. 100, Commonwealth of Australia, Canberra, Australia.

Campbell, H., & Brown, R. 2003. Benefit-Cost Analysis, *Financial and Economic Appraisal using Spreadsheets,* Cambridge, U.K.

Butcher, G., Fairweather, J. & Simmons, D. 2003. *The Economic Impact of Tourism on Christchurch City and Akaroa*, Township Tourism Recreation Research and Education Centre (TRREC) Report No. 37, Lincoln University, Christchurch, New Zealand.

Centre for International Economics (CIE) 1994. 'The Role of Transport in the Economy' in *Building for the Job: Commissioned Work, Volume 2: Economic Studies,* National Transport Planning Taskforce, January 1995, Sydney, Australia.

Commonwealth Grants Commission 2003. *Draft Assessment Paper* CGC 2003/64: Assessing Urban Influences, Canberra, Australia.

Commonwealth Grants Commission 2004. *Report on State Revenue Sharing Relativities,* Working Papers, Volume 7, Canberra, Australia.

de Brucker, L., de Winne, N., Verbeke, A., & Winklemenas, W. 1995. 'The limits of social cost-benefit analysis for the appraisal of public investment in transport infrastructure', *7th World Conference on Transportation Research,* Sydney, Australia.

Department for Transport and the Regions 1999. T*ransport and the economy: Government response to SACTRA report*, London, U.K.

Department for Transport 2005. *Transport, Wider Economic Benefits and Impacts on GDP*, London, U.K.

Docwra, G., & West, G. 1999. 'Predicting the Impacts of Road Investment on Gross State Product and Employment', Contributed paper presented at 23rd Australasian Transport Research Forum, Perth, Australia, Sept-Oct 1999.

Duncan, I. 2001. 'Economic Development Initiatives: Reflections on evaluation methods', Contributed paper presented at The Economic Society of Australia, 30th Annual Conference of Economists, Perth, Australia, September 2001.

Dwyer, L., Forsyth, P., & Spurr, R. 2004. 'Evaluating Tourism's Economic Effects: New and Old Approaches', *Tourism Management* 25, 307-317, Australia.

Dwyer, L., Forsyth, P., Spurr, R., & Ho, T. 2004. *The Economic Impacts and Benefits of Tourism in Australia: A General Equilibrium Approach,* CRC for Sustainable Tourism Pty Ltd, Australia.

Dwyer, L., Forsyth, P., & Spurr, R. 2005. '*Estimating the Impacts of Special Events on an Economy'*, Journal of Travel Research, 43, 351-359, Australia.

EconTech 2004. *Modelling the economic effects of overcoming under-investment in Australian Infrastructure,* Report prepared for the Australian Council of Infrastructure Development, Australia.

European Conference of Transport Ministers, Economic Research Centre (ECMT) 2001. *Round Table 119: Transport and Economic Development,* France.

Forkenbrock, D., Benshoff, S., & Weisbrod, G.E. 2001. *Assessing the Social and Economic Effects of Transportation Projects,* NCHRP Web Document 31 (Project B25-19): Contractor's Final Report. USA.

Hone, P. *Assessing the Contribution of Sport to the Economy,* Working paper 2005-11, School of Accounting, Economics and Finance, Deakin University, Melbourne, Victoria, Australia.

Kam, T. 2001. *Public Infrastructure Spillovers and Growth: Theory and Time Series Evidence for Australia,* Department of Economics, University of Melbourne, Australia.

Kamps, C. 2004. *The Dynamic Effects of Public Capital: VAR Evidence for 22 OECD Countries,* Kiel Working Paper No. 1224, Kiel Institute for World Economics, Germany.

Kinhill Economics 1994. *'Economics of Investment in Transport Infrastructure' in Building for the Job: Commissioned Work*, Volume 2: Economic Studies, National Transport Planning Taskforce, January 1995, Australia.

Kleinhardt-FGI Corporate Advisors 2002. *Tourism & Recreation Values of the Daintree and Fraser Island,* Cairns, Australia.

KPMG 2000. V*ictorian Alpine Resorts Economic Significance Study 2000*, report prepared for Victorian Alpine Resorts Coordinating Council, Australia.

Laird, J. J., Nellthorp, J., & Mackie, P. J. 2005. *'Network effects and total economic impact in transport appraisal',* Transport Policy, 12(6), 537-544, University of Leeds, U.K.

Layman, B. 2004. '*CGE Modelling as a Tool for Evaluating Proposals for Project Assistance: A View from the Trenches',* Paper presented at Forth Biennial Regional Modelling Workshop in Melbourne: Policy applications of regional CGE modelling. Melbourne, Australia.

Mees, P. A. 2001. The Short-Term Effects of Melbourne's Western Ring Road. In P Nicholls (ed), *Australasian Transport Research Forum 2001. Zero Road Toll: A Dream or a Realistic Vision?* 1-9. Hobart, Australia: Tasmanian Dept of Infrastructure, Energy and Resources.

National Institute of Economic and Industry Research (NIEIR) 2002. *Transport Infrastructure: a perspective and prospective analysis of its role in Australia's economic growth,* A report for the Australian Council for Infrastructure Development Limited (AusCID) and the Association of Australian Ports and Marine Authorities (AAMPA), Australia.

Ockwell, A. 2002. *'Assessing the impact of investment in transport infrastructure on regional development',* Paper to the 25th Australasian Transport Regional Forum, Canberra, Australia, October 2002.

O'Fallon, C. 2004. *Linkages between transport infrastructure and economic growth,* Paper presented to the Towards Sustainable Land Transport Conference, Wellington, New Zealand, 2004.

Preston, J., & Holvad, T. 2005. Road Transport and Additional Economic Benefits: Deliverable D1 - *A Review of the Empirical Evidence on the Additional Benefits of Road Investment*, University of Oxford, Transport Studies Unit, Oxford, U.K.

RTA 2004. *Economic Analysis Manual: Appendix B and Appendix C,* Sydney, Australia.

Rye, M., Ohr F., & Lyche, L. 2001. 'Cost-benefit analysis, regional impacts and external economies of scale', 7th International Conference on Competition and Ownership in Land Passenger Transport, Molde, Norway, June 2001.

Sugden, R. 1999. 'Developing a Consistent Cost-Benefit Framework for Multi-Modal Transport Appraisal', University of East Anglia, Norwich, prepared for the Department of the Environment, Transport and the Regions, UK.

Song, L. 2002. *Public Capital, Congestion and Private Production in Australia,* The Melbourne Institute Working Paper No 23/02, Melbourne Institute of Applied Economic and Social Research, University of Melbourne, Melbourne, Australia.

Standing Advisory Committee on Trunk Road Appraisal (SACTRA) 1999. *Transport and the Economy: Full Report*, Department for Transport and the Regions, London, U.K.

Standing Advisory Committee on Trunk Road Appraisal (SACTRA) 1999. *Transport and The Economy: Summary Report,* Department for Transport and the Regions, London, U.K.

Steer Davies Gleave (SDG) 2003. *Guidance on Preparing an Economic Impact Report* Prepared for Department for Transport, London, U.K.

U.S. Government Accountability Office 2004. '*Highlights of an Expert Panel: The Benefits and Costs of Highway and Transit Investments',* GAO-05-423SP, Washington DC., USA.

van Excel, J., Rienstra, S., Gommers, M., Pearman, A., & Tsamboulas, D. 2002. *'EU involvement in TEN development: network effects and European value added',* Transport Policy 9, 299-311, European Union.

Weisbrod, G. 1997. 'Evaluation of Public Infrastructure Effects on Macro-Level Public Welfare*', Workshop on Economic Impacts of Infrastructure Investments,* The Hague, Netherlands, July.

Appendices – Literature Summary/Review

A   Additional Economic Benefits from the Transmission Gully Project

B   Assessing the impact of investment in transport infrastructure on regional development

C   The short term effects of Melbourne's Western Ring Road

D   Cost-benefit analysis, regional impacts and external economies of scale

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H   Economic Development Initiatives: Reflections on evaluation methods

I   Predicting the Impacts of Road Investment on Gross State Product and Employment

J   A Review of the Empirical Evidence on the Additional Benefits of Road Investment (and related material)

Appendix A: Additional Economic Benefits from the Transmission Gully Project

(Brown, Copeland & Company Limited, for Greater Wellington City Council, Wellington, New Zealand, March, 2004)

AA.1   Synopsis

This paper reviews the appraisal mechanism for the Transmission Gully road project in Wellington. The key focus is on whether any there are additional economic benefits (in addition to the 'traditional benefits of travel time savings, vehicle operating costs and accident costs) arising from the completion of the project.

A number of sources of additional national or regional economic benefit are identified. Major identified benefits include:

- *Generated traffic* – This will produce additional economic benefits from a national and regional perspective. These are seen as significant in this case and should be included as a part of the assessed benefits if they have not already been so.

- *Local network traffic benefits* – Access between Wellington CBD and the suburbs will be improved by the project. These impacts should be addressed by the appraisal (if they are not already).

- *Hutt Valley traffic benefits* – Effects for traffic to and from the Hutt Valley should be included in the analysis as part of a full network analysis of benefits.

- *Impacts of Abnormal Delays* – The existence of an alternative route out of Wellington will reduce the incidence of abnormal delays due to accidents or floods. These will not be built into average travel times used by models, as these work on the basis of observed times during typical AM inter-peak and PM periods. Allowance should be made for this in any appraisal.

- *Responses to unreliability of travel time* – Abnormal delays, if frequent enough, can cause motorists to change their behaviour patterns (e.g. travelling earlier/later than necessary, working longer hours, travelling off-peak and over-investing in vehicles). This economic cost will probably be ignored by a conventional SCBA and should be allowed for in an assessment.

- *Intangibles* – These include environmental and social impacts.

Less significant national and regional benefits include:

- *Ability to handle oversized or very heavy vehicles* – This was seen as a longer term benefit which might be quantified following additional studies.

- *Wider catchment for job seekers and employers* – An increase in workforce quality could ensue from the route; however, this should only be treated qualitatively.

- *Potential travel benefits* – These include the utility residents and businesses get from knowing a journey is possible, without necessarily making the journey. It is suggested these could be estimated on a broad 'willingness to pay' basis.

It was also suggested that temporary economic benefits could arise from construction induced regional economic activity, but the magnitude of this was seen as related to project funding issues. The paper also considered, and rejected, arguments for increases in longer term regional economic activity being included as a benefit. This was largely due to concerns over double counting and the fact that increased activity in Wellington might displace it elsewhere.

AA.2 Comments

The paper explores a number of interesting potential additional benefits within the Wellington region; however the case for many of these is unconvincing.

For example, it is unclear why abnormal delays would not be captured by traffic data and the materiality of such delays is also questionable (precisely because they are abnormal). The 'inefficiency' of the alleged responses to such delays is also questionable from an economic point of view.

While not quantified, the suggestion that employment impacts also be considered separately would not appear correct. These should be captured by generated demand.

Generated traffic demand aside, the case for additional benefits above and beyond the traditional ones is questionable.

Appendix B: Assessing the impact of investment in transport on regional development.

(A. Ockwell, Paper to the 25th Australasian Transport Regional Forum, Canberra, Australia, October 2002)

AB.1   Synopsis

This paper summarises and reviews the results of a 2002 OECD study: *Impact of Transport Infrastructure Investment on Regional Development*. The OECD study was aimed at examining the relationship between investment in transport infrastructure and impacts on regional development.

Given issues of geographical ambiguity, 'regions' were defined as 'an area requiring specific policy initiatives to meet broader socio-economic objectives of government'.

The paper considered the user benefits allowed for in the 'traditional' transport SCBA evaluation framework (travel time, vehicle operating costs and safety). In addition it suggested three other categories of benefit to be included as 'complementary analysis':

- Transport network effects (induced travel, mode shift, reliability, quality of transport service)

- Socio-economic spillovers (accessibility, employment, efficiency and output, social inclusion, land use effect)

- Environment

In addition, a number of ex-post studies of the regional impacts of transport projects were reviewed. These were drawn from countries such as Australia, France, Norway, the UK and the US.

The paper concludes that there is a lack of information available from the case studies to form a clear quantitative basis for claims regarding the regional economies and regeneration.

It also finds that investment in transport infrastructure alone is unlikely to generate the social benefits expected of such projects.

AB.2   Comments

Although inconclusive, the findings are similar to those of other researchers.

The 'complementary analysis' categories form a useful framework for consideration of possible benefits omitted from traditional SCBA. However, some caution should be exercised regarding the possibility for overlap and double counting. E.g. increased accessibility is cited as having the advantage of access to a broader labour market, but this may already be captured in induced demand impacts.

Appendix C: The short term effects of Melbourne's Western Ring Road

(P. Mees, Paper to the Australasian Transport Regional Forum, Hobart, Tasmania, Australia, 2001)

AC.1   Synopsis

This paper reviews the immediate impacts of the opening of Melbourne's Western Ring Road. This runs through Melbourne's outer western and northern suburbs between the Hume Highway and Princes Freeway.

The emphasis is on the 'economic benefits', somewhat broadly defined but focussing on employment, population and income implications.

The study's background is a consideration of the arguments of urban planners and economists regarding the wisdom and effects of such projects, namely:

- Whether transport and environmental effects are adverse (e.g. increasing trip lengths, reduced walking and cycling and public transport) or positive (the dispersal of activity to edge cities brings employment and services closer to suburbs and reduces trip lengths).

- Whether transport investment generates new economic activity or merely causes a intra-urban redistribution of such activity.

The Western Ring Road was opened in stages between 1989 and 1997. The study uses employment, unemployment, population and income data from the 1986, 1991 and 1996 Australian censuses.

While trends are clouded by the recovery of the Victorian economy from recession, overall employment in Melbourne's west grew faster than in other areas between 1991 and 1996 – the period corresponding to the opening of the Western Ring Road. However, it is unclear if this was due to the ring road or to the recovery of the west's manufacturing base. Further, unemployment remained significantly higher than in other areas of Melbourne in 1996. Further, average incomes in the region fell between 1991 and 1996. Thus, western regions had fallen behind the rest of the city in relative terms.

It is possible that a review of 2001 census results would indicate a more positive set of indicators; given the impact of time lags on local jobs and that the final section of the link was only completed in 1997. However, for the period of review, this result contrasts with earlier predictions that the ring-road would improve the economic fortunes of local residents.

Appendix D:Cost-benefit analysis, regional impacts and external economies of scale

(Rye, M., Ohr F., & Lyche, L., 7th International Conference on Competition and Ownership in Land Passenger Transport, Molde, Norway, June 2004.)

AD.1 Synopsis

This is a largely theoretical paper which reviews the issue of 'agglomeration benefits' and 'knowledge spillovers' as additional benefits, ignored by SCBA. The central argument is that improved transport links which remove 'vital bottlenecks' may increase a firm's willingness to pay for an additional worker, above the average industrial wage.

This is related to the fact that new transport links may create external economies of scale, including knowledge spillovers if firms co-locate within the region now serviced by such links. The formation of such industrial clusters will enhance firm profitability and therefore increase potential wages.

While SCBA will take into account access to a larger labour pool through induced demand effects, the standard value of travel time savings (VTTS) measure will be based on average industrial wages. Therefore, the higher regional willingness to pay for additional workers in industrial clusters as a result of improved transport links will not be reflected in the VTTS and the project will underestimate regional benefits.

The authors note however, that empirical evidence for such regional agglomeration benefits is lacking in their own ex-ante studies (Lych 2001) and in other ex-post work (Brathen 2001). They suggest this may be because the infrastructure improvements must represent a significant improvement over past links – or alternatively that such benefits may not exist!

They conclude that SCBA offers a satisfactory measure of efficiency in most cases, but call for the use of judgement for individual projects to determine whether there may be a case for factors such as agglomeration benefits.

AD.2 Comments

While theoretically interesting, the empirical case for agglomeration benefits remains unproven in this paper. One issue is whether a – theoretically – higher firm willingness to pay would necessarily be reflected in actual wage rates (and thus in VTTS).

Another issue is whether improved transport links actually result in wages in the region under question benefiting from the suggested higher productivity, or whether, in part, these benefits would flow to another region (the 'two way road problem'). Even assuming that the benefits remain within a given region it may be difficult to 'pick out' the trips made by those who are beneficiaries and to apply a differential VTTS.

From a New Zealand perspective a further concern is that of equity. Differentially separating out projects in areas which may potentially offer higher wage rates runs counter to Transfund's equity-based approach to valuing the benefits of travel time savings.

Appendix E: Facts and Furphies in Benefit-Cost Analysis: Transport

(Bureau of Transport Economics, Commonwealth of Australia, Canberra, Australia, 1999)

AE.1   Synopsis

This wide ranging study reviews the current practice of the economic appraisal of transport projects. Many of the claims regarding whether or not the standard SCBA process is biased due to 'omitted benefits' are examined in some detail.

While the focus is on recent Australian experience, many of the issues are of general relevance.

Key conclusions include:

- Improvements to transport can induce adaptations beyond transport, such as expansions of output by regional industries. CBAs tend to measure the benefits from these adaptations obliquely, inferring their magnitudes from transport outcomes, particularly induced demand. To add further, more direct, measures of these benefits will usually result in double counting.

- Improvements to transport often provide a smaller stimulus to regional economies than is claimed. Many projects reduce regional transport costs by only a small proportion, and transport costs are only one component of regional production costs (and generally not a large one).

- Many proponents of public investment in transport infrastructure emphasise job creation. However, the use of workers on an infrastructure project may reduce the availability of workers elsewhere in the economy. Estimates of the overall employment effect of a transport project will generally be speculative because of difficulties in modelling labour markets.

- Competition within the Australian economy is already very keen. Therefore arguments that SCBAs underestimate benefits from transport development due to an assumption of perfect competition are less valid. In addition, the assumption of perfect competition could result in an over-estimation of benefits using 'traditional' SCBA in some instances.

- SCBAs have tended to omit or measure crudely some of the benefits from logistics adaptations to transport improvements. The adaptations can include warehouse consolidation and reductions in inventories. However the available evidence on the magnitude of these benefits is inconclusive. Further research is required into the value of travel time.

- Arguments about 'knowledge spillovers' and resulting agglomeration benefits may be overstating the case, particularly as knowledge spillovers in reality may not be as large as they appear in theory due to divergences between social and private benefits.

- It is not clear that national economic models hold any advantage over the standard tools of CBA. They are also more costly. Popular macroeconomic indicators, such as

real GDP and the current account deficit, are of questionable relevance. A transport project could benefit society greatly and yet increase the current account deficit.

- Transport projects can generate positive environmental externalities, but they are often difficult to measure. Claims that CBAs omit benefits from other 'positive externalities' should be treated with caution.

AE.2   Comments

The paper includes a wealth of source material and takes a sceptical view of claims regarding additional benefits above and beyond those measured by traditional transport SCBAs'.

Some key issues have since been the study of further research by bodies such as Austroads (e.g. Value of Freight Travel Time).

Another issue is the extent to which the observations apply to the New Zealand context. While there are many similarities there are also clear differences between the two countries economies and appraisal practices.

Appendix F: Linkages Between Transport Infrastructure and Economic Growth

(O'Fallon, C., Paper presented to the Towards Sustainable Land Transport Conference, Wellington, New Zealand, 2004)

AF.1   Synopsis

This paper summarises and reviews past evidence for a linkage between transport investment and economic growth with reference to a New Zealand context. Studies reviewed include those prepared by Allen Consulting Group (2004), SACTRA (1999) and the European Conference of Ministers of Transport (March 2001).

Of particular note is the reference to the work of ACG's (2004) work: Benefits of Investing in New Zealand's Road Infrastructure: A Report for the New Zealand Automobile Association. This points out that the methodology used by ACG (i.e. adding the results of a traditional SCBA to the output of a national model) could involve a substantial amount of double counting.

Reference is also made to the above studies findings on regional impacts. It is noted that, in general, such findings are inconclusive and that transport investment may or may not result in regional development (e.g. SACTRA, European Conference of Ministers). Thus a distribution between areas rather than national economic growth may result from transport investment.

The basic conclusion echoes Banister and Berechman's findings that in developed economies transport investment, on its own, will not result in economic growth, but is rather dependent on more important underlying conditions.

Further, it is argued that savings in travel time may not contribute to greater labour productivity (and hence economic growth) as workers may choose to spend the time saved for increased leisure or social activities.

In terms of a New Zealand context, it is argued that transport, on its own, cannot be relied on to facilitate regional development and that there is a significant risk that benefits in improved transport in a less developed region could flow to more developed regions. A further point, made in the context of recent (Dec. 2003) plans to ease congestion within an already developed region (Auckland), is that much of the consequent growth will be at the expense of other regions. The displacement of resources from these regions to Auckland will ensure that any national economic growth will be marginal and will take place over a long period, as the national transport network is configured.

AF.2   Comments

The paper is highly sceptical of the alleged benefits of investment in transport infrastructure. Many of the technical points appear to be valid, such as the critique of the ACG approach. However the case may be somewhat overstated.

For example, it is unlikely that transport projects will only result in an inter-regional transfer of economic activity and the extent to which workers substitute leisure time for work time

after a transport improvement remains unproven. Further, in critiquing the ACG approach, O'Fallon herself notes that non-work time can contribute to economic activity.

Appendix G: The Economic Development Effects of Transport Investments

(David Banister and Yossi Berechman, Paper presented at the TRANS-TALK Workshop, Brussels, Belgium, November 2000)

AG.1 Synopsis

This paper is effectively a précis of the author's book on the subject, published in the same year. It essentially argues that where a well-connected transport system exists, further investment in transport infrastructure may be a necessary (but not sufficient) condition for further economic growth and development. Rather, transport infrastructure will act as a complement to other, more important, underlying conditions which must be met if economic development is to proceed. In some cases (see below) the provision of additional transport infrastructure may not even be a necessary condition for growth.

The authors note that network accessibility may lead to growth, in cases where there are 'allocative positive externalities in specific markets which are amenable to improved accessibility'. The scale, spatial and temporal distribution of these externalities affects the magnitude and scope of the economic development. Examples include where two disjointed networks are linked by a new facility and where a new freight terminal allows for intermodality and improves 'just in time' production.

However, the authors also note that in many cases transport acts as a growth supporter rather than a growth generator. Growth within regions with reasonable levels of transport accessibility will generally be achieved through a variety of policies and forces not all of which are transport related.

Historical evidence (e.g. Fogel's work on the effect of 19th century railways on US growth) is also cited as indicating that while transport development helped shape growth in the past no single innovation was vital for economic growth at the time (i.e. transport development may be associated with economic development but there is no strong evidence for it acting as the key growth generator).

A further point is made that 'multiplier' analysis which focuses on the indirect effects of transport investment may not be a good indicator of long term economic growth. This is because, some multiplier effects (e.g. employment and income) are short term (and economic growth is a long run phenomenon). In addition, long run multiplier effects on income and employment are often unclear in their scale and nature. Moreover, multipliers are often taken from previous studies and do not relate to the specific project under investigation (e.g. the specific nature of transport improvements and their unique effects on households and firms).

On the regional level, it is argues that transport infrastructure investment may often create a redistribution between regions (often to the further advantage of already accessible core areas). However whether this will result in economic development is unclear.

In attempting to determine whether a transport infrastructure improvement will result in growth, the authors draw up a matrix based on accessibility and 'dynamism' (i.e. the

presence of the correct political, economic and investment conditions)[32]. Only in 'open dynamic systems' will transport investment have a real impact. Further, if accessibility is already high (as in most Western countries) transport investment will only support growth and will not be necessary for it to occur.

Thus, in the authors' opinion, the ability of transport investment to generate economic growth is critically dependent on political and economic pre-conditions.

AG.2   Comments

The paper is consistent with other literature in the field indicating that transport investment is generally a necessary but not sufficient condition for economic growth. In many respects, this paper also concurs with other literature, that the precise nature of the relationship between transport development and economic growth is indeterminate.

However, the authors' emphasis on underlying political, investment and economic factors as being key to growth, and the use of a dynamism/accessibility matrix sets it slightly apart from the other literature. Indeed the authors suggest that in the case of an 'open dynamic' system with high levels of accessibility transport investment may help growth but, in this particular case, is not actually necessary to achieve it.

A negative of the paper (and the accompanying book) is that the authors are rather vague as to precisely what these underlying political/investment/economic conditions are. While a number of examples are provided, these are of a rather broad 'motherhood' variety and may give little hint as to what measures should be adopted in particular cases. While this model is discussed in the context of regional development it is also unclear as to whether it would apply to national development (though this would seem logical). This may be a product of a focus on the EU and the treatment of 'national' and 'regional' economies as interchangeable.

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[32] Though somewhat vague as to what these pre-conditions are in this paper, the author's book, released in the same year, notes that economic conditions include the existence of positive agglomeration and labour market externalities, availability of skilled labour and the presence of a buoyant local economy. Necessary investment conditions relate to the funding, scale, location and timing of the investment and how well it fits into the rest of the transport network. Political /institutional conditions include legal, organizational and managerial frameworks conducive to investment, complementary policy actions and efficient management of infrastructure facilities.

Another point is that although the authors refer to this model in referring to 'regional' development, it is unclear if 'regions' are to be considered as nations (e.g. within the EU) or as sub-units within a given country.

Appendix H: Economic Development Initiatives: Reflections on Evaluation Methods

(Ian Duncan, Senior Research Economist, NZIER, Contributed paper presented at The Economic Society of Australia, 30th Annual Conference of Economists, Perth, Australia, September 2001)

AH.1   Synopsis

While prepared by NZIER, the theme of this paper is general in nature, focussing on the comparison between models measuring the economic efficiency of transport investments (i.e. SCBA) and those assessing their economic impacts (i.e. input-output (I-O) or 'multiplier' analysis).

Duncan notes that SCBA focuses on primary benefits (i.e. the value to consumers of using an opportunity or resource), on consumer willingness to pay for goods and services and on the related concept of consumer surplus. A key question is whether the community would be better-off in adopting a given policy measure then it would be otherwise, using monetary values as a measure of utility.

In contrast, impact analysis (of which I-O is the best example) comes from a different tradition. I-O analysis focuses on secondary effects accruing to the producers of inputs to the production process, in the shape of labour, goods or services. It traces the flow of funds from market transactions and emphasises the distribution of expenditures derived from a resource, rather than its value to the community. Typically, impact analysis focuses on how much additional spending employment and output occurs in the economy, in what sectors, and how would these flow through to other sectors.

Using a practical example drawn from a non-transport sector (mussel farm production) Duncan demonstrates a consequence of these facts. Namely, that a given project which only breaks even (or worse) in SCBA terms (i.e. BCR ≤ 1) can result in increased GDP if assessed using impact (i.e. I-O) analysis.

In simple terms, this is due to the fact that GDP can increase either as a result of the expansion of existing activities (i.e. more of the same) or through higher productivity (i.e. more consumption or exports for the same inputs). However, Duncan notes that governments typically focus on higher productivity as a path to GDP growth rather than on simply increasing output through greater use of inputs.

Duncan also suggests that impact analysis is often employed simply to provide an 'upper bound measures' to the gain from increases use of underutilised resources and because the distribution of expenditure across a range of sectors may be of use in decision-making.

AH.2   Comments

This paper is most useful for the way in which it draws out the key differences between SCBA and I-O. Of particular note is Duncan's point that I-O analysis can point to GDP growth from a given (transport or other) investment, but that such growth is not necessarily efficient. This

implies that simply relaying on I-O modelling to provide guidance for long term policymaking decisions could have deleterious effects on a given national economy (i.e. inefficient growth which simply suck in more and more inputs). Conversely, the utility of SCBA as providing a foundation for efficient outcomes is reinforced.

Appendix I: Predicting the Impacts of Road Investment on Gross State Product and Employment

(George Docwra and Guy West, Contributed paper presented at 23rd Australasian Transport Research Forum, Perth, Australia, Sept-Oct 1999)

AI.1   Synopsis

As its name suggests, the focus of this paper is on examining the utility of various approaches to measuring the impacts of road projects on regional output and employment.

The authors view SCBA as useful, but also see it as providing limited guidance due to the fact that policymakers often wish to have a wider test of 'public benefit' than the economic efficiency impacts captured by SCBA (i.e. one including measures of regional employment, output and income). As such, they see Input-Output (I-O) and/or General Equilibrium (CGE) modelling as complementing the results of SCBA. They indicate that applying a model which provides knowledge of employment and Gross State Product (GSP) outcomes may be useful for a variety of reasons, including:

- It may assist in obtaining funding allocations.

- There may be conflict between the results of SCBA and employment implications of a given project. For example, projects with low benefit-cost ratios could generate high levels of employment. Using SCBA in conjunction with other models can help decision-makers identify when choices need to be made between conflicting policy goals.

- Various projects may have different impacts on regional development. These may not match differences in benefit-cost ratios.

The authors compare what they term the Applied General Equilibrium (ACGE) and input-output econometric (IOEC) models. The second of these appears to combine standard I-O modelling with some additional econometric data. In general, the IOEC model is preferred to the ACGE approach for regional analysis. This relates to the authors' specification of the properties which an 'ideal regional model' for road investment should possess. These include:

- Use of a bottom-up modelling approach.

- Comprehensive supply-side specification supplemented by data on capacity limits and endogenised prices.

- Integration with the national economy, allowing for feed back interactions to measure both region-specific and national policy impacts at the regional level. This would include an inter-regional model to allow for flow-on effects to surrounding regions.

- A fully comprehensive labour market sub-model, allowing for differential skills, labour mobility and turnover.

The authors also note that only IOEC modelling can adequately cater for the short run dynamics of road investment programs. In addition, the lack of dynamics in ACGE models

also hampers them in the long run, as new road links will generate benefits for many years to come. A further issue is that ACGE model solutions will converge on those offered by (simpler) IO models at a regional level (i.e. calling into question the need for a more complex ACGE approach).

A final point is that an IOEC model should be seen as a complement to SCBA rather than as a supplement.

AI.2   Comments

This paper is useful for its focus on the regional perspective and the comparison of the uses and drawbacks of the SCBA, ACGE and IOEC models. However, while it sees IOEC as a complement to SCBA, the paper is equivocal as to which should form the basis of decision-making in the case of a conflict between the results of the two. As suggested in Appendix H, above, it is generally preferable that SCBA should form the basis of decision-making; otherwise there is a risk that any long run growth outcomes may be inefficient.

An additional point is that, as the authors admit, no model currently meets their 'ideal model' specifications. Furthermore, it is far from clear whether a model meeting such specifications could be developed and/or would yield credible results. The criteria laid down by the authors would appear to require a level of data that is simply not available at the regional level in many cases. In particular, as other analysts (e.g. BTE) have noted modelling of labour market responses may prove to be extremely difficult (though such difficulties may be reduced at the local level).

Appendix J: A Review of the Empirical Evidence on the Additional Benefits of Road Investment (and related material)

(Dr John Preston and Dr Torben Holvad for the University of Oxford's Transport Studies Unit, Oxford, U.K., June 2005)

AJ.1   Synopsis

Preston and Holvad's work is an ongoing project, aimed at updating some of SACTRA's 1999 work on the benefits accruing from transport investment. The focus of Preston and Holvad's study is limited to roads.

The study (to date) is comprised of three parts:

Deliverable D1 - A Review of the Empirical Evidence on the Additional Benefits of Road Investment

Annexes to D1 - A Review of the Empirical Evidence on the Additional Benefits of Road Investment

Deliverable D2 – A modelling framework for the Measurement of the Additional Benefits of Road Investment

The focus of this review is on Deliverable D1. (The annexes expand on the work in D1, while D2 concerns proposed approaches to estimating the long-run economic effects of post-war British motorways, using a growth accounting approach. This bears similarities to Fogel's (1964) seminal work on US railways.)

The focus of Preston and Holvad's work in D1 is the development of a 'multiplier' which could be applied to standard SCBA results. This would correct the assumption of perfect competition, and thus allow for the assessment of the full economic benefits of road projects. The authors refer to CGE modelling by Venables and Gasiorek (1999), Davies (1999) and Newbury (1998) (all three of which were also noted by SACTRA) as well as more recent CGE studies using the CGEurope model (2004) and the Dutch RAEM model (2003).

By comparing eight studies (including the work reviewed by SACTRA and later studies employing CGE models such as RAEM, and CGEurope), the authors derive a general multiplier of 1.4, with a standard deviation of 0.4. However, they caution that this multiplier will vary with particular regional circumstances. In particular, variations may be created by the price elasticity of the final product market, the extent of increasing returns to scale and backward and forward linkages, the extent of agglomeration economies and market power (as measured by price mark-ups and the number of firms in the market).

Analysis is also conducted of other evidence for omitted benefits, including a review of the evidence for agglomeration benefits, the production function work of Aschauer and later analysts, and the results of studies investigating the link between road projects. While some evidence is found for agglomeration effects, it is noted (in the Annex) that Aschauer's work is methodologically flawed, with the more modest results of later studies being more robust.

Evidence for studies analysing the local impacts of transport investment is found to be mixed and inconclusive.

AJ.2   Comments

This paper is of interest for its attempt to build on the work of SACTRA, and its reference to several more recent studies, which add to the debate about the impact of transport investment on the broader economy. Ultimately, however, the study breaks little new ground.

In particular, the following points should be noted:

- This work draws heavily on material already utilized by SACTRA in 1999, particularly the studies of Newbery, Davies and Venables and Gasiorek. While some more recent studies are also considered, it is therefore somewhat unclear as to why the conclusions are reached by these authors vary so greatly from those of SACTRA.

- No formal reasoning is given for the selection of an average 'omitted benefits' multiplier of 1.4. However, mathematical reconstruction indicates that this is the simple average of the eight studies considered by these authors. Were such an approach adopted to the pre-2000 studies cited by Preston and Holvad (i.e. those available to SACTRA in 1999) it would suggest a multiplier of 1.33, rather than the 1.06 ultimately adopted.

- A further issue is the assumptions made by the base studies cited by Preston and Holvad and their relevance in a contemporary New Zealand context. For example, Venables and Gasiorek's modelling assumes monopolistic competition and price mark ups of 30% above marginal cost, consistent with the work of Harris (1999), which was also presented to SACTRA. However, such mark ups omit an allowance for normal rates of return and Harris' work was based on U.K. data spanning the years 1968-1991. The fact that the early years of the series would reflect a UK economy prior to the major structural changes of the 1980's and 1990's would seem to reduce its utility to the present.

- Drawing on the alternative work of Davies (1999), Preston and Holvad indicate that allowance should be made for a rate of return of 7% and that a mark-up of 14%-16% is more applicable. It is notable that Davies' work was adopted by SACTRA in arriving at its estimate of a multiplier of 1.06. However, even Davies' data set is somewhat dated, covering UK industry between 1980 and 1992.

- Other, more recent, European studies cited by the authors, employing CGEurope and RAEM modelling, assume the presence of monopolistic competition (and derive relatively high multipliers). As noted by the authors, the degree of assumed competition, in particular, will affect multiplier results. Davies (1999) and Newbery (1998) both assumed oligopolistic competition and, accordingly, derived much smaller multipliers then Venables and Gasiorek.

- The application of this study within a New Zealand context is questionable. After a lengthy process of structural reform, most industry sectors in the present-day New Zealand economy are highly competitive. This would tend to reduce any divergence from perfect competition and limits any comparisons based on the past structure of the UK economy and/or assumptions based on monopolistic competition. If anything,

any average imperfect competition multiplier for present-day New Zealand would be expected to be smaller then that determined by SACTRA.

- The reference to new evidence for agglomeration economies is of interest, but is also subject to the issues raised in the chapters of the main body of this report. The consideration of Aschauer's (and subsequent) production function work relates to studies already considered above (and is likewise subject to the same issues). Finally, the evidence for local growth impacts is mixed, which is again consistent with the findings of the main body of this report.