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Assessing the impact of investment in transport infrastructure on regional development

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Abstract

The OECD project reported in this paper examined a series of ex-poste case studies to explore the relationship between investment in transport infrastructure and regional development. The key variables considered by the Working Group included those included under traditional benefit-cost analysis, as well as broader socio-economic objectives such as employment, accessibility, social cohesion, etc.

Regrettably, there were few examples of ex-ante and ex-poste case studies available to assess whether or not the benefits expected from infrastructure projects were achieved in terms of the initial objectives set for the project. There is a need for research to understand how expected positive impacts can be realised and negative unintended impacts can be avoided (ie. attracting resources to a region and drawing resources away from it).

The research was undertaken by an OECD Working Group under the direction of the author while Principal Administrator of the OECD Programme of Research on Road Transport and Intermodal Linkages.

[1] This paper is based on research conducted at the OECD, Paris. It was undertaken during my role as Principal Administrator of the Programme of Research on Road Transport and Intermodal Linkages.

The views expressed in this paper are those of the author and do not necessarily represent those of the Bureau of Transport and Regional Economics. The usual caveats apply.

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Introduction

OVERVIEW

The Organisation for Economic Co-operation and Development (OECD) is an international organisation that represents the 30 most highly developed nations in the world. Following a review of transport activities in the OECD conducted in 1997, road transport and maritime activities were brought together in the newly created Division of Transport in the OECD Directorate of Science, Technology and Industry (DSTI) in January 1998. This reflected a broader intermodal approach to transport issues, and the recognition by Member Countries that advances in regulatory reform of modes and transport technology required an approach that went beyond traditional modal lines. Further, with mounting budgetary pressure being placed on governments over the deployment of public funds, there was greater emphasis being placed on the role of transport in the economy and sustainabilty.

A key issue identified by Member countries was the role that investment in transport infrastructure could play in facilitating regional growth and development. With advances in transport technology, the expansion of road networks that by-passed local communities, and the growth in business logistics, coupled with rural-urban migration, many governments raised concern about the emergence of local “back-waters”. At the same, major cities were reaching the limits of infrastructure (i.e., road, water and sewerage) and live-ability, with resultant pressures being placed on their long term sustainability.

The OECD project reported in this paper examined the relationship between investment in transport infrastructure and its impact on regional development. In particular, it examined the efficiency infrastructure investment decisions based on traditional engineering principles, relative to the incorporation of broader socio-economic variables into the decision-making framework.

The OECD Working Group for the research on regional impacts was assigned the following tasks:

- Establish what links exist between investment in transport infrastructure and regional development;
- Evaluate the impact on regional development, including employment, accessibility, social cohesion, mobility and efficiency; and
- Develop an evaluation framework that could be used to assist governments to improve the efficiency of investment in transport infrastructure.

The approach was based on analysis of (ex-ante and) ex-poste evaluations of infrastructure projects. In order to undertake such evaluations, the Working Group adopted a case study approach based on the responses from OECD

Member countries. However, there were very few examples of evaluations that compared realised with expected outcomes in terms of whether projects delivered against set objectives.

THE EVALUATION FRAMEWORK

The first part of the project was designed to develop a framework against which investment projects could be compared internationally. The second part of the project was focused on developing a methodology capable of examining the benefits of infrastructure investment projects.

Regional Impacts

One of the many difficulties in evaluating infrastructure projects is that of defining a "region" and identifying the impacts relevant to that region. The context can be applied to the full spectrum of transport investment activities, including cross modal effects. That is, what effects do improvements in road infrastructure have on demand for rail transport?

It is reasonable to argue that it is the performance of the entire network that matters and that evaluating transport infrastructure investments and their regional impacts should include all relevant elements. To do so would be immensely complex, and perhaps unmanageably so. While in principle a focus on anything less than the full regional network and links to the region runs the risk of encouraging partial optimisation, in practice this risk may be small. For the purpose of developing an evaluation framework, it is better to focus on a smaller but more manageable set of activities.

Externalities generated by the investment project also need to be taken into account; e.g., broader environmental impacts beyond those directly associated with the construction of the project itself.

In general, traditional benefit cost analysis has been used to evaluate infrastructure projects. For the analysis of regional/network impacts, there are two options. First, the traditional approach may be extended to encapsulate the broader impacts that extend beyond the direct user benefits (i.e., time cast savings, and reductions in safety costs and vehicle operating costs). Second, the traditional evaluation framework may be extended with complementary analysis of the set of key variables identified by decision-makers as being relevant to regional development (i.e., employment, accessibility, social cohesion, etc). This would enable decision-makers to weigh-up investment proposals against a wider set of variables. The latter approach was adopted for the for OECD analysis. However, a critical issue in adopting such an approach is that of drawing a clear distinction in the determination of benefits and beneficiaries in order to avoid double counting.

Benefit Cost Analysis

In undertaking transport projects, benefit cost analysis is the main approach used by transport administrations in OECD Member countries to evaluate infrastructure proposals. Application of the approach varies across countries in terms of benefits included, valuation of benefits, discount rates and time horizon. However, there was general consensus that a wider evaluation framework should be adopted than that traditionally incorporated under benefit cost analysis. The approach was based on the synthesis of ex-post studies of transport infrastructure projects that had attempted to assess the impacts of such investment against broader socio-economic criteria.

The alternative approach considered by the Working Group was that of extending the traditional benefit cost framework by evaluating the spill-over effects of infrastructure investment on other variables identified as *a priori* important to regional development, and then adding those impacts back into the benefit/cost calculation. A recent study on benefit cost analysis by the BTE (1999) concluded that the time cost savings are likely to capture all employment benefits associated with such infrastructure projects. Hence, the "independent" estimate of such effects may lead to double counting suggesting that improvements to transport often provide a smaller stimulus to regional economies than is claimed.

Concept of a "Region"

A key issue at the outset of the project was that of defining the boundaries of a region. The Working Group considered several definitions, including those of Perloff et al (1960), Richardson (1969), and Diamond (1974). Diamond (1974) lists the following goals of regional policy:

- Reduce unemployment in areas where it is persistently high;
- Reduce the pressure of population in areas where it is already high;
- Reduce the average rate of use on natural resources;
- Reduce interregional differences in demand pressures in order to reduce inflationary pressures;
- Preserve and strengthen regional cultures and regional identities;
- Achieve a better balance between the population and the environment.

On this basis, the Working Group based its approach to a "region" on policy objectives. That is, a region was defined as an area requiring specific policy initiatives to meet broader socio-economic objectives of government. Hence, the concept of a region was not confined by a geographic location but by policy imperatives. It is worth noting that within such a concept there is scope to reduce pressures on major conurbations through investment in regional centres.

Framework for Evaluating Impacts

The approach used by the Working Group is summarised in Table 1.

Table 1: Evaluation framework

Traditional CBA	**Complementary analysis**
User benefits - Travel Time - Vehicle operating costs - Safety	Transport Network Effects - Induced travel - Modal shift - Reliability - Quality of transport service Socio-economic spillovers - Accessibility - Employment - Efficiency and output - Social inclusion - Land use effect Environment

Source: OECD (2002).

As suggested by Table 1, traditional benefit cost analysis includes time cost savings, reductions in vehicle operating costs and safety benefits. As these were discussed at length in the OECD report, this paper focuses on the variables included under the "complementary analysis".

Induced Travel

Issues surrounding the level of induced demand have been discussed in BTE (1999) and SACTRA (1999). The issue here is whether or not, and to what extent, appraisals of infrastructure proposals take induced travel into account and the extent to which ex-ante estimates stack up against ex-poste evaluations (i.e., expected vs. realised travel).

Modal Shift

An element of induced travel may be associated with cross-modal shifts. From a transport planning/management perspective, it is important to know the impact that investment in one mode (e.g., road) may have on demand for other modes (e.g., rail). Improvements in the road network may result in a reduction in demand for rail passenger services and the subsequent withdrawal/closure

of those services.

Reliability

Reliability has two dimensions. First, a transport link may be inherently unreliable, but not "predicably unreliable" (i.e., the extent of unreliably cannot be factored into delivery times with minimal variance), relative to other parts of the network that service a region. Such unreliability could have significant impacts on business activities where there are critical connections to other modes (e.g., an airport for the export of just-in-time freight or perishable commodities). Second, a region may be serviced by a key transport link that periodically experiences failure due to major external events (e.g., a flood).

Quality of transport service

This variable may contain many elements, and may be disaggregated into:

- Passenger, including comfort, convenience, ride quality, security, crowding, provision of information, cleanliness, ambience;
- Freight, including convenience, loss, damage.

Socio-economic spill-overs

In attempting to estimate the wider impacts of infrastructure development, a key issue is that of double counting the benefits. Improved transport links may result in an expansion of existing activities as well as a built up of "new" activities.

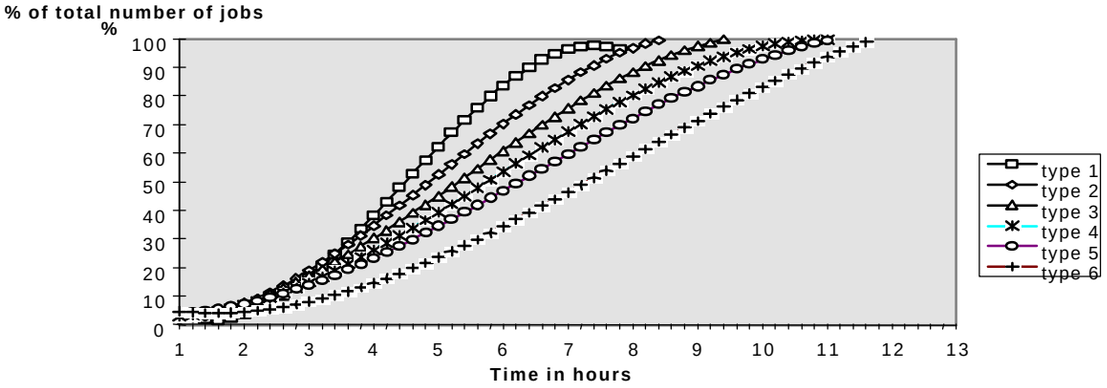
The impact of re-location of industry resulting from improved transport links will depend on whether or not the region is experiencing a localised unemployment problem arising from a change in industry structure (e.g., closure of rail workshops) and the state of employment in the broader economy. In an economy with full employment, it is questionable whether there would be a net gain to the national economy, unless for location-specific reasons, there was a net improvement in the sourcing, production and distribution of products as a result of the re-location (ie., net gain in economic efficiency).

Accessibility may manifest itself in several ways. First, for those in the region, improved links may provide access to a broader employment market, thereby drawing out some resources to neighbouring regions. This may occur not only directly through the labour market but also indirectly through access to training and education resulting in improvement in the skills base. Second, resources may be drawn to the region with industry benefiting from better access to markets with potential productivity gains. Third, improved access may allow the region to better exploit its tourism opportunities. The combined result may be a re-allocation of activities/resources through increased inter-regional competition and hence inter-regional transfers.

Access to a broader employment market may be realised through a reduction in travel time. In estimating the employment impact, jobs classification may be used. As distance from a node increases, the potential number of jobs for that

job type is assumed to increase at destination. Hence, transport infrastructure projects that reduce travel time have the capacity to increase the employment prospects for an individual in that job type. In Figure 1, before the introduction of a new transport link, for job type 6, access to 14 percent of available jobs may be reached within four hours. By reducing travel time by one hour, the available jobs market increases to 25 percent.

Figure 1: Distribution of jobs according to journey time from a reference town or city



Source: OECD (2002).

Effect of road construction on employment

Many studies have been undertaken on the employment generation effects of road projects (eg., BTCE 1994, BTE 1999, SACTRA 1999, ECMT 2001). These employment effects relate directly to the construction of the project and not to the broader spill-over effects to the local and/or national economies arising as a result of the new transport infrastructure. The OECD report (2002) outlines the approaches used in France and the United States. Under traditional benefit cost analysis, employment is included as part of the cost of construction. Whether or not an infrastructure project creates additional jobs over and above those costed as part of the project depends on several factors:

- The project has a net positive effect on long term structural unemployment;
- The road project represents the “best” use of available funds, and does not draw resources from more productive uses elsewhere in the economy (ie., competing projects which have a higher net rate of return).

Two different approaches to estimating employment effects associated with

the construction, operation and maintenance of a new road project were reported by the Working Group. These included:

- Input-output analysis, as used by the Federal Highway Administration (FHWA) of the US Department of Transport, based on:
    - First round effects: direct employment with construction phase;
    - Second round: indirect employment generation arising from purchase of materials and equipment;
    - Third round: expenditures of incomes earned by those engaged on construction/supply activities.

For expenditures of $US1.25 billion, the FHWA has estimated the following impacts for each of the above as:

- First round: direct employment income of $US 572.7 and total jobs of 19672.8 person-years of which 12453.5 person-years in the construction sector and 7219.3 person years in the materials/equipment supplies sector;
- Second round: indirect employment benefits in the production sector of $US 212.9 million and 6851.2 person-years;
- Third round: induced employment of 21052.4, with income generation of $US 527.5 million.

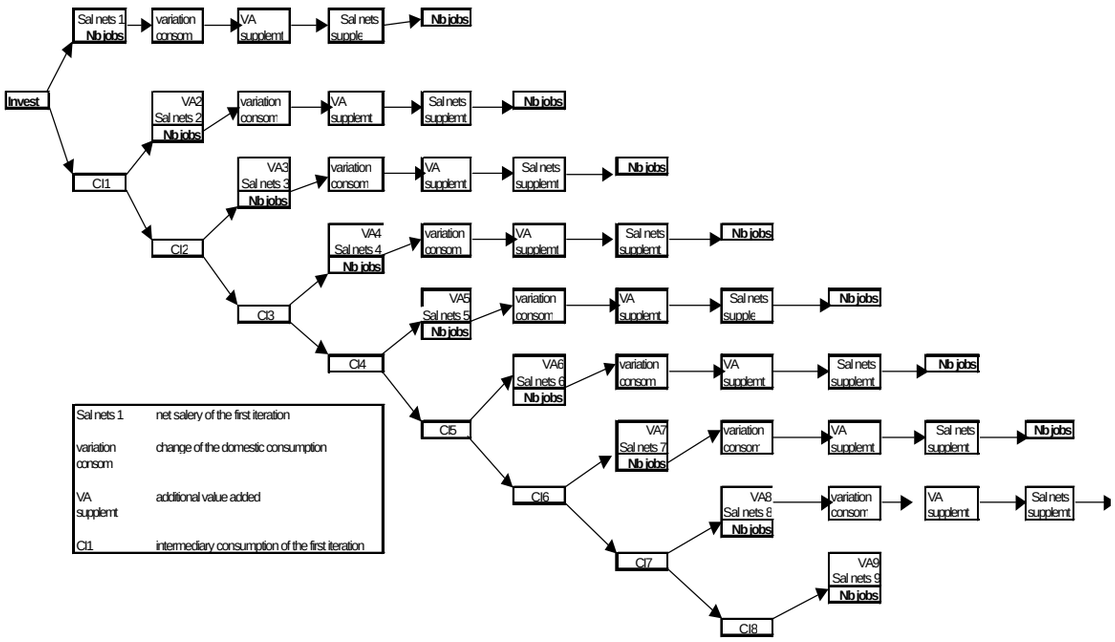
In total, the employment effects were estimated at $US 1.313 billion, with a total number of 47576.4 per-years. The estimated dollar value of expenditure on all goods and services across the economy arising from the $ 1.25 billion investment in highway construction amounted to $US 6.097 billion, implying a spending multiplier of 4.88.

In France, the “Effects Method” is used to estimate the economy wide impacts of infrastructure projects (Cherval 1987). The Effects Method is summarised in Figure 2. These encompass direct and indirect impacts along the production chain, and include:

- Employment in the construction industry;
- Employment in the supply sector; and
- Employment arising from distributed revenues.

The impacts on employment for expenditure of Euro 1.0 billion are summarised in Table2.

Figure 2: Employment modelling using the Effects Method.



Source: OECD 2002.

Table 2: Direct and indirect employment and income effects.

	Employment
Direct jobs – linked to construction activities	7940
Indirect jobs – linked to manufacturing of site supplies	8070
Induced jobs – revenue effect	5250
Total	**21260**

Source: OECD 2002.

The wide divergence between the US-FHWA and the French estimates illustrate clearly that the interpretation of impacts depends very much on different approaches and assumptions underlying the analysis.

Efficiency and Output

Under the assumption of perfect competition, traditional benefit cost analysis does not include estimates of efficiency gain arising from infrastructure projects. That is, the project results in a redistribution of activity and income

with no net gain to the economy. However, SACRTA has argued that where market failure exists, there may be a net economic benefit (SACTRA 1999). In practice, it is very difficult to measure such impacts and avoid the problem of double counting.

Social Inclusion

In a recent report to the (former) United Kingdom Department of Transport and the Regions (DETR 2000), the following conclusion was drawn:

> *Poor transport is neither a necessary nor a sufficient condition for an individual or neighbourhood to be "socially excluded." It is, however, one of a number of contributory factors and can be a very important one. Some areas of "social exclusion" such as peri-urban post-war estates and rural areas are profoundly affected by the inadequacy of transport. There is a great variation between individuals and areas.*

Environment

Environmental Impact Assessments are standard procedure in the evaluation of project proposals in OECD countries. The main indicators identified by the Working Group are based on those developed by the ECMT, which are summarised in Table 3.

Table 3: Summary of key impacts and indicators for strategic environmental assessment

Impacts	**Indicators**
Climate change	Emission of greenhouse gases
Acidification	Emission of S02, NOX
Use of natural resources	Energy consumption, land take
Loss of biodiversity	Loss and damage of habitats and species
Air quality	Emissions or concentrations of pollution
Water quality	Number of water sources affected, concentration of pollutants
Visual impacts	Scale and key physical characteristics
Severance	Barriers, population size in affected areas
Noise	Noise levels, affected surface, population affected

Historical, archaeological, conservation	nature Recognised sites and areas of importance

Source:ECMT (1998).

CASE STUDIES

The Working Group examined case studies drawn from OECD Member countries to provide insight to variables included in the appraisal of infrastructure projects and their estimated impacts. However, a major constraint faced by the Working Group was the general lack of available studies on which to base their conclusions. There were no examples brought to the attention of the Working Group that included a direct comparison of both an ex-ante and ex-post evaluation (or whether the same method was applied) of a given project. Further, the ex-pot studies varied markedly in their methods of analysis, variables, definition of the project's objectives.

The case studies used by the Working Group are summarised in Table 4.

Table 4. Ex post case studies

Country	**Ex post study**	**Title of the studies**	***Type of infrastructure projects***
Australia	After 5 years	Berrima and Mittagong Bypass case studies	Highway system
France	Between 3 and 5 years after.	Motorways and their impacts on the main towns at each end.	Motorway projects
Norway	3 years after opening	Kristiansund Project	Road tunnels and Bridges system project
United Kingdom	After 5, 10 or 20 years,	Severn Bridge, open in 1966 Humber Bridge, open in 1981 M62, open in 1966 and 1976 M40 Motorway, A55 North Wales Expressway	Road crossing bridges Road projects Motorway
United States	??	"Appalachian Development Highways Economic Impact Study"	Highway system made of different highway corridors from Mississippi to New York

Source: OECD 2002

The variables considered under each of the case studies are presented in Table 5.

Table 5 Variables surveyed in ex-post studies

	Travel time	Safety	Induced travel	Modal shift	Reliability	Quality	Access-ibility	Employ-ment	Efficien-cy	Social Inclusion	Land use	Environ-ment
Berrima & Mittagong		?						?				?
French motorway	?		?				?	?				
TGV												
Severn bridge	?		?	?	?		?	?				
Humber Bridge	?						?	?				
M62	?		?				?	?			?	
M40							?				?	
A55	?		?				?	?	?			
Kristiansund	?		?		?	?	?	?		?		?
Amsterdam orbitral												
Zuiderzee rail link												
Amsterdam Brussels Paris												

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Appalachian	?	?	?				?	?	?	?		

Source: OECD 2002.

LESSONS LEARNED AND RECOMMENDATIONS

Governments are responsible for national transportation, and regional, policy. Differences in the performance of different regions can give rise to social inequity. Policy makers want to know if the direction they are proceeding is right, how their transport policies impact the development of regions and how they compare to other countries. Included in these considerations is the support of economic growth at the national and regional levels, facilitation of the competitive position of regions and national carriers in a global market, improved efficiency leading to decreased cost and the reduction of environmental and social costs. The basic conclusion of the Working Group was that there is a lack of information available from case studies to provide a clear, quantitative basis for the claims about the impact of transport infrastructure investment on regional economies and regeneration.

Lessons Learned

- Studies on the regional impacts of transport infrastructure investment are limited in scope by the availability of data, in particular data that are standard across the region or modes on which the comparative analysis is being done. Policy makers, and other decision-makers, must ensure that the conclusions drawn from such analyses reflect the limitations of the information, and the approach, being used.
- Investment in transport infrastructure alone is unlikely to generate the social benefits expected of such projects.

Recommendations

- One of the difficulties in evaluating the impact of transport projects is the lack of definition of objectives set for many projects.
- The choice of variables is crucial for identifying and evaluating the benefits of infrastructure projects. Policy makers must ensure that indicators that are most appropriate for the objectives and scope of the exercise are used, although the availability and reliability of the data must also be taken into account.
- This is an important area for government policy and warrants further research. There is a need for further research based on before and after studies to evaluate:
    - The realised vs. expected effects of transport infrastructure projects (ie., how the project stacks up against its objectives);
    - The impact of such projects on key variables and their relative importance in the decision-making framework for infrastructure projects.
    - There is need for research to understand how expected positive impacts can be realised, and negative unintended impacts can be avoided (ie., attracting resources to a region and drawing resources away from it).

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