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Estimating the wider economic benefits of transport investments: The case of the Sydney North West Rail Link project

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ABSTRACT

This paper develops a practical framework for estimating the wider economic benefits generated from transport investments. The methodologies for measuring the broader set of influences, including agglomeration economies, increased output in imperfectly-competitive markets and welfare benefits arising from improved labour supply are identified. The gross domestic product (GDP) impacts from transport investments (often used as a *proxy measure* for a number of economic impacts that are the result of increased productivity that are not included in the set of welfare benefits in the cost benefit analysis) are also explored. The wider economic benefits are illustrated by a real project – the North West Rail Link, a 23 km rail link in north west of Sydney with an estimated investment of $8.3 billion. The Sydney Strategic Travel Model (STM) was used to model the changes of trips made from private cars, trains and buses, and changes in travel time, waiting time and the generalised travel costs. These are combined with macroeconomic data on employment and productivity to estimate the welfare benefits and GPD impacts of the project. The study indicates that the wider economic benefits represent an 8% mark up over the conventional economic user benefits in the benefit-cost calculation, the latter comprising value of travel time savings, accident reduction, road decongestion and externality benefits.

1. Introduction

Investment in transport projects will not only bring benefits to transport users in terms of travel time savings, vehicle operating cost savings, traffic accident reduction, and mitigated environmental impacts, but also provide stimulus to the economy during the construction phase, and improve ongoing productivity through a more efficient transport network. Evidence from the United Kingdom indicates that large transport projects can have significant impacts on the economy (DfT, 2007). These economic impacts, in addition to the benefits captured in conventional economic appraisal are increasingly referred to as the wider economic benefits (WEBs), as a way to assist projects in producing positive net benefits.

Table 1 summarises the categories of economic assessment of transport investments. Often, Cost Benefit Analysis (CBA) has been used for justifying transport investments while occasionally an Economic Impact Analysis (EIA) has been used as a complementary tool for large scale projects with capital investment over a billion dollars. The CBA focuses on welfare benefits to users (e.g., travel time savings and operating cost savings) and to the broader community (e.g., safety improvement and environmental impact mitigation). Traditionally, the computable general equilibrium (CGE) model has been used for the EIA to estimate impacts on business output, GDP, job creation and imports/exports.

There are other benefits that can influence project appraisal. In this paper we refer to such benefits as wider economic benefits (WEBs) as (i) a set of welfare benefits (WBs) included in a conventional cost benefit analysis, and (ii) the GDP impacts (GIs) which are outside the calculation of the benefit cost ratio. Greater effort has been devoted to estimate welfare benefits as, in practice, CBA has been often used as a tool for investment decision making. Since these benefits are mutually exclusive to those benefits estimated in conventional CBA, they can be directly added to conventional welfare benefits without double counting.

The following section presents the methodology for estimating the welfare benefits of WEBs from transport improvements. As the welfare benefits are a subset of GDP impacts (GIs), methodologies of estimating GIs will also be presented in Section 3. A case study is presented in Section 5 followed by concluding remarks in the final section.

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Table 1
Economic assessment of transport projects.

	Economic Impact Analysis (EIA)	Cost Benefit Analysis (CBA)
Conventional assessment method	**Computable General Equilibrium (CGE)** • Business Output • Value Added (GDP) • Job creation • Imports/exports	**Welfare benefits (WB)** • Value of Travel Time Savings (VTTS) from business, commuting and leisure • Vehicle Operating Cost Savings (VOC) • Benefits of accident reduction • Benefits of reduced environmental impacts
Wider economic benefits (WEBs)	**GDP impacts (GI)** • **GI1**: Agglomeration economies • **GI2**: Productivity of business time savings and reliability • **GI3**: Additional productivity from more people choosing to work • **GI4**: Additional productivity of people choosing to work longer hours • **GI5**: Additional productivity of people moving to a higher paid job	**Welfare benefits (WB)** • **WB1**: Agglomeration economies (GI1) • **WB2**: Increased output in imperfectly competitive markets (a proportion of GI2) • **WB3**: welfare benefits arising from improved labour markets (additional tax revenue from GI3, GI4 and GI5)

2. Welfare benefits

The wider economic benefits, as measured in welfare benefits (WBs), include the following:

- WB1: agglomeration economies.
- WB2: increased output in imperfectly competitive markets.
- WB3: welfare benefits arising from improved labour supply.

2.1. Agglomeration economies

Agglomeration economies describe the productivity benefits that firms located close to each other derive. The benefits arise from three specific market-oriented externalities: backward linkages, forward linkages, and knowledge spill-over (Trubka, 2009). Backward linkage benefits are derived when firms are located close to their markets and forward linkage benefits arise when firms are located close to their suppliers. The knowledge spillovers are the exchange of ideas that occur without an exchange of money. As a city grows and becomes denser, firms become more productive. The productivity benefits arise from proximity and clustering as explained by economies of scale, access to more customers, access to more suppliers, knowledge spill-over, and access to a greater workforce enabling better job matching. Despite the higher costs of operating in the Central Business District (CBD), many firms choose to locate in the CBD because of these productivity benefits.

2.1.1. How a transport project affects agglomeration

Agglomeration economies of a transport project are measured based on the following logic: A transport project reduces the generalised travel costs for its affected areas; reduced generalised costs lead to increased effective employment density; and as effective employment density increases, the productivity and welfare benefits increase. The degree of agglomeration or clustering is often measured by employment density, defined as the number of jobs per square kilometre. A better measure of agglomeration, however, is effective employment density defined as total employment in the locality plus employment in surrounding areas weighted by their proximity, where proximity is a function of the generalised travel cost. As the generalised travel cost between two zones decreases, the weight increases. The effective employment density increases if a transport project reduces the generalised travel cost even if the total employment in different zones remains unchanged.[1]

[1] Department for Transport (DfT) UK (2005).

2.1.2. Measurement of agglomeration economies

A transport project can have a wide area of influence. For example, a railway project in North West Sydney (23 km from the CBD) can impact the Sydney CBD as the travel time between two areas is reduced. The project can also affect other transport modes; for example a rail link project is expected to reduce traffic congestion in the road network. Agglomeration economies are typically analysed at a zonal level; thus the total impacted area is divided into travel zones for transport modelling and aggregated for estimating total outcomes. The equation for calculating agglomeration economies (after Graham, 2005) is:

$$\mathrm{WB1} = \sum_{i,j}\left[\left(ep_{i,j} \times \frac{\Delta \mathrm{ED}_j}{\mathrm{ED}_j}\right) \times \mathrm{GDP}_{i,j} \times E_{i,j}\right] \quad (1)$$

where, WB1 represents the welfare benefit of agglomeration economies. i represents industries. It is expected that GDP per worker varies between industries, and the response to a transport project is different between industries. j represents locations, generally the same as travel zones in transport demand modelling. $ep_{i,j}$, Elasticity of productivity with respect to effective employment density on industry i and location j. $\Delta \mathrm{ED}_j/\mathrm{ED}_j$ represents the percentage change in effective employment density as a result of a transport project. $\Delta \mathrm{ED}_j$ is the change in effective density of employment in location j due to a transport project, and ED_j is the original effective density of employment in location j. GDP_{ij} is the GDP per worker in industry i and location j. E_{ij} is the total number of jobs in industry i and location j associated with the post transport improvement.

Eq. (1) indicates that agglomeration economies are the product of the percentage change of effective employment density, the total number of jobs, GDP per worker, and elasticity of productivity in respect to effective employment density. The total impact of a travel zone is the sum of impacts of all industry sectors. The total impact of the project is the sum of impacts of all affected travel zones. The higher density could be caused by more workers attracted from other areas, new employment and 'effective density' changes due to reduced travel cost. The agglomeration economic benefits being estimated in Eq. (1) refer to the productivity benefits of existing workers and diverted workers as well as new employment in a particular area. It should be noted however, that with a transport improvement, some localities may gain and others may lose, which is generally referred to as a 'negative' agglomeration impact (as shown in Hensher et al., 2014).

It is important to distinguish, however, the agglomeration benefit emanating from GDP changes, further discussed in Section 3. The agglomeration benefit estimated by Eq. (1) captures the productivity benefits for being closer to customers, suppliers and for having an expanded market catchment. The GDP impacts, on