

## Accepted Manuscript

---

This is an Accepted Manuscript of an article published by Taylor & Francis Group in Transport Reviews on 09.08.2016, available online:

<http://www.tandfonline.com/10.1080/01441647.2016.1217283>.

Wangsnæs P B, Rødseth K L, Hansen W. 2017. A review of guidelines for including wider economic impacts in transport appraisal. Transport Reviews. 37 (1): 94-115.

It is recommended to use the published version for citation.

---

The final publication is available in: Transport Reviews. 2017, 37 (1), 94-115.  
<https://doi.org/10.1080/01441647.2016.1217283>

# A review of guidelines for including wider economic impacts in transport appraisal

Paal Brevik Wangsness<sup>1</sup>, Kenneth Løvold Rødseth, Wiljar Hansen

Institute of Transport Economics – Norwegian Centre for Transport Research,  
Gaustadaleen 21, 0349 Oslo, Norway

---

**Acknowledgements:** This work was supported by the Norwegian Public Roads Administration.

---

<sup>1</sup> Corresponding author at: Institute of Transport Economics – Norwegian Centre for Transport Research, Gaustadaleen 21, 0349 Oslo, Norway. Tel.: +47 91699070. E-mail address: pbw@toi.no

**Abstract:** In this paper we examine how 23 industrialized countries treat wider economic impacts in transport appraisals. We identify 12 different types of impacts based on these countries' appraisal guidelines. *Agglomeration impacts* and *Production changes in imperfect markets* are the most widely accepted, being recognized by 14 and 10 countries, respectively. However, about half of the impacts are mentioned by only one country, and few recommend including the impacts directly in cost–benefit analyses. Several countries provide provisos or criteria that must be met before WEI can be assessed in the first place. We found method recommendations for quantifying wider economic impacts in 10 countries. However, with the exception of the UK Department for Transport's methodological framework, there is very little international consensus on the choice of appropriate methods. Our findings thus supplement and reinforce the conclusions from the Norwegian Official Report of the Hagen Committee (NOU 2012:16, 2012) that there is currently no established consensus on the magnitude and relevance of WEIs, or on how and which of these impacts should be taken into account in transport appraisals. Recommendations for further research and appraisal practices are provided.

**Keywords:** *Transport appraisal; Cost–benefit analysis; Wider economic impacts; Agglomeration, Productivity*

**JEL-codes:** *R42; D61; R11*

---

## 1 Introduction

The supply of transport infrastructure requires prioritization of the proposed infrastructure projects. The critical questions involved in the selection process concern: the projects' feasibility, the costs of implementing them, who will be paying, and whether funding the projects will be worthwhile (Mackie et al., 2014). Cost–benefit analysis (CBA) is a popular tool for synthesizing the anticipated costs and benefits of planned infrastructure projects. It provides politicians and other decision-makers with useful information on how the societal returns to transport investments can be maximized, and facilitates efficient allocation of society's scarce resources.

The economic impacts of transport investment can be classified as direct or indirect (Oosterhaven & Knaap, 2003). Direct effects are changes in user costs and in the external costs of transportation, while indirect effects concern the economic effects for markets not directly associated with transportation, e.g. labour and commodity markets. CBA is founded on traditional microeconomic partial equilibrium theory, assuming perfect competition. Hence, the well-known results of Dodgson (1973) and Jara-Diaz (1986) apply; namely, that indirect impacts correspond to direct impacts. Adding spillover effects to direct effects would then merely lead to double counting (Mohring, 1993). If, in reality, markets are distorted, the direct and indirect impacts may differ. Thus, by emphasizing only direct impacts, the CBA may not appropriately capture the societal costs and benefits of the transport investment (Harberger, 1964; Jara-Diaz, 1986). In this case, decisions made based on CBA may lead to suboptimal investment strategies. We refer to cases where indirect effects do

not correspond to direct effects due to market failure as Wider Economic Impacts (WEIs). Note that WEIs encompass both gross economic benefits and gross economic costs (Elhorst & Oosterhaven, 2008; Vickerman, 2007). The latter is frequently ignored (Kanemoto, 2013a).

The debate on the existence and magnitude of WEIs is heated. It involves analysts trying to find methods by which to measure WEIs, and policy-makers and interest groups seeking to justify or refute the need for a given investment (Vickerman, 2007). It is firmly believed that transport investments are paramount to productivity and economic growth (Mackie, Worsley, & Eliasson, 2014). Thus, in ignoring WEIs, CBA can readily be blamed for important growth effects being overlooked.

The theoretical foundations for WEIs are well defined, but their empirical verifications are debatable. For instance, they are often associated with productivity growth. Deng (2013) reviews the empirical literature on the relationship between transport investments on the one hand, and productivity and economic growth on the other. He argues that while most studies reveal positive but modest contributions from transport infrastructure to growth, there is a great deal of controversy concerning the direction and magnitude of the growth-enhancing effects. Vickerman (2007) identifies the need for further work on micro studies to unravel how the decision-making of firms and households is influenced by transport infrastructure.

In summary, recognition of WEIs comes with a trade-off. On the one hand, ignoring them may imply that CBA fails to achieve its overall objective of informing decision-makers about the societal costs and benefits of transport investment. On the other, current methods may not appropriately identify WEIs, thereby reducing the accuracy of the CBA. Our paper investigates how 23 developed countries – the Nordic countries, the remaining EU15, USA, Canada, Switzerland, Australia, New Zealand, and Japan – handle the WEI trade-off. It reviews these countries' guidelines for transport appraisals in order to identify: i) which WEIs are considered important, ii) how countries propose treating WEIs in transport appraisals (e.g. whether or not they are integrated in CBAs), and iii) which methodological approaches are preferred for quantifying WEIs.

The literature review was originally an assignment from the Norwegian Public Roads Agency as part of a process of updating its own transport appraisal guidelines<sup>2</sup>. A relatively large sample of developed countries consisting of 22 countries in addition to Norway was deemed sufficient in order to get a big-picture overview on how WEIs are treated in official guidelines. The selected countries were also assumed to have transport appraisal guidelines of a certain level of sophistication, with possible important learning points.

Our paper differs from previous surveys on WEIs, e.g. those of Vickerman (2007) and Lakshmanan (2007), in emphasizing how practitioners rather than the scientific community approach WEIs. We consider this information of value to a wide range of stakeholders. In establishing the types or categories of WEIs that receive international attention, our paper is helpful to the research community in pinpointing areas in need of more research. It may also be useful to transport agencies and

---

<sup>2</sup> A report in Norwegian can be found in Wangsness, Rødseth, and Hansen (2014)

decision-makers worldwide who face the dilemma about how to cope with the ongoing debate on WEIs. Our paper can be seen as input towards harmonization of appraisal guidelines, which is crucial to transport planning in for example the EU. A previous research project entitled HEATCO<sup>3</sup> has been essential in developing harmonized guidelines for project assessment at the EU level. Our paper corresponds to this project's Work Package 3 by providing supplementary information on the member countries' current practices for handling WEIs. Following HEATCO's approach, this information is a key input to developing guidelines for harmonizing the treatment of WEIs in project appraisal.

Based on the different countries' appraisal guidelines, we identify 12 WEIs considered important. In total, 15 of the 23 countries consider some WEIs to be important, but half of the 12 WEI types are only mentioned by 1 of the 23 countries. *Agglomeration impacts* and *Output Change in Imperfectly Competitive Markets* are the most widely accepted impacts, recognized by 14 and 10 countries, respectively. Even so, few of the countries recommend including the impacts in CBAs. Of the country guidelines reviewed by us, 10 of them have method recommendations for quantifying wider economic impacts. However, with the exception of the UK Department for Transport's methodological framework, there is very little international consensus on the choice of methods.

This paper proceeds as follows. The theoretical and empirical foundations for WEIs from the scientific literature are reviewed in Section 2, while the review methodology is outlined in Section 3. Section 4 summarizes the main findings from the practitioners' literature, i.e., the guidelines for transport appraisal, with comparisons to the scientific literature reviewed in Section 2. Section 5 concludes.

## **2 A Review of the Scientific Literature: Theoretical and empirical foundation for Wider Economic Impacts**

In the event of prices in secondary markets not equalling marginal costs, the most important welfare effects not captured in a traditional and well-specified CBA are, according to SACTRA (1999), i) agglomeration externalities, ii) labour market effects, and iii) impacts in markets with imperfect competition.

### **2.1 Agglomeration externalities**

Agglomeration externalities are the main focus of attention in the literature on the wider economic impacts of transport infrastructure investments (e.g., D. Graham & Dender, 2011; D. J. Graham, 2007; Laird, Nellthorp, & Mackie, 2005; van Exel, Rienstra, Gommers, Pearman, & Tsamboulas, 2002; Venables, 2007). Improving the quality of the transport network increases the effective density of an area by bringing people, businesses and jobs closer together, in this way increasing productivity and enhancing economic output. Economies of agglomeration are positive externalities

---

<sup>3</sup> See <http://heatco.iwr.uni-stuttgart.de/>

induced through the spatial concentration of economic activity, and are additional to transport user benefits from the CBA (Venables, 2007). It is a long established fact that firms and workers are, on average, more productive in areas with dense economic activity, the urban wage premium being well documented (Melo, Graham, & Noland, 2009; Rosenthal & Strange, 2004; Weber, 1899). Increasing returns to density may originate from several different sources, including *knowledge spillovers* (Glaeser, Kallal, Scheinkman, & Shleifer, 1991; Marshall, 1890), *localized human capital externalities* (Moretti, 2004) or synonymously labelled as *learning* (Duranton & Puga, 2004), *demand linkages* (Fujita, 1988; Krugman, 1991), *matching processes* (Duranton & Puga, 2004; Helsley & Strange, 1990), and *sharing* effects (Duranton & Puga, 2004) such as *specialized input sharing* (Holmes, 1999), *facilitating innovation* (Helsley & Strange, 2002), *risk-sharing in pooled labour markets* (Diamond & Simon, 1990; Ellison, Glaeser, & Kerr, 2007) and *sharing of facilities and indivisible goods*. In the literature, a distinction is often drawn between productivity gains that arise from firms in the same sector or along the same value chain geographically co-locating (intra-industry), and productivity gains from having a large and densely populated city (inter-industry) (Fujita & Thisse, 1996). The former is often referred to as *localization economies*, and the latter as *urban agglomeration economies* (Duranton & Puga, 2004).

The standard approach to estimating the impact of agglomeration externalities on economic output is use of a production function framework (Melo et al., 2009), usually under the assumption of Hicks neutrality. Agglomeration is normally approximated by variables such as total urban population, employment densities, or distance-unrestricted market potentials.

Most studies estimate agglomeration impacts under the assumption that agglomeration promotes productivity. However, some authors claim that the observed relationship between productivity and agglomeration may well come from statistical sorting and selection effects, potentially leading to biased estimates of agglomeration elasticity values. An overview of this research can be found in e.g., Behrens, Duranton, and Robert-Nicoud (2014). Graham and van Dender (2011) find that agglomeration elasticity values are highly sensitive to the econometric model specification, and that agglomeration effects cannot readily be distinguished from other potential drivers of productivity. While Combes, Duranton, Gobillon, Puga, and Roux (2012) find positive agglomeration effects on firm productivity that do not relate to firm selection, Melo et al. (2009) point out that controls such as time-variant labour quality may be significant regarding the magnitudes of estimated agglomeration elasticity values.

## 2.2 Labour market effects

The scientific literature distinguishes at least five different labour market effects that may lead to wider economic impacts of transport infrastructure investments (e.g., DfT, 2008; Elhorst & Oosterhaven, 2008; Laird & Mackie, 2009; Manning, 2003; Venables, 2007):

1. Changes in the number of workers choosing to work as a result of lower commuting costs.
2. Changes in the number of hours worked as a result of changes in commuting costs.

3. Re-localization of labour to more productive sectors.
4. The effect of excess supply in the labour market.
5. The effect of a “thin” labour market.

There is a close link between the transport market and the labour market, the latter typically being subjected to several market imperfections such as distortionary taxation, imperfect information and imperfect competition. Distortionary taxation creates an efficiency loss in the labour market, i.e. while workers make their choices based on net wages, the productivity gains for society equal his/her gross wages. Hence, the benefits of increased wages are only partly captured by the consumer surplus used in the CBA (Venables, 2007). The tax impacts of moving to more productive jobs are often calculated by multiplying the tax rate with the relative productivity adjusted wages. It is the net effects that are important, and it is often assumed in transport appraisals that there is no net additional employment.

In cases of involuntary unemployment, the wage that clears the labour market lies below the actual wage, and the actual employment below the market clearing level. If employment increases as a result of investments in infrastructure, the welfare gains will be greater than the user benefit associated with the change in commuting costs. Elhorst and Oosterhaven (2008) study four different variants of the Dutch Maglev-line projects, and find WEI additionality due to impacts on involuntary unemployment in the range  $-1\%$  to  $+38\%$  of the CBA calculated user benefits. This challenges the traditional view that involuntary structural unemployment is not relevant to a CBA in mature transport networks (Laird & Mackie, 2014).

Labour markets in rural areas are often characterized as *thin*, giving firms power over workers (Manning, 2003). In such cases the rate of exploitation (Hicks, 1932; Pigou, 1924) drives a wedge between the marginal productivity and marginal costs of workers. The employer will increase his profit by hiring an additional worker, but the fact that the wages for the entire stock of workers will have to be increased gives no incentive to hire. Transport infrastructure improvements may result in lower job search costs for unemployed workers, and hence reduce the market distortion of imperfect information creating additionality in the CBA calculated commuter benefits (Pilegaard & Fosgerau, 2008). In addition, larger labour markets increase the incentive for workers to acquire skills, and thereby increase their productivity, without the danger of being held-up by the monopsonist employer, since they can always threaten to take their specialist skills elsewhere (Matouschek & Robert-Nicoud, 2005). Laird and Mackie (2014) identify the importance of WEIs in rural areas and discuss how these might be captured in ex ante project appraisal.

### **2.3 Impacts in markets with imperfect competition**

In many cases the absence of a functioning and well-developed infrastructure will act as an entry barrier to goods and service markets in rural areas. An investment in infrastructure that provides increased accessibility and lower transport costs may result in new entries in markets characterized by few actors prior to the investment (Laird & Mackie, 2014). New entries will increase competition and efficiency in the economy and have welfare effects beyond user benefits in the CBA. Jara-Diaz (1986) studies two regions with one monopolist in each region producing homogenous goods. Reduced transport costs enable the monopolists to attract customers from the

adjacent region by lowering the price of the product. Increased competition reduces prices, raises total production and reduces the deadweight loss of monopoly. Lower production costs and enhanced efficiency may, in turn, lead to the development of regional specialization and greater intra-industry and inter-regional trade and freight movements over an expanded production space (Lakshmanan & Anderson, 2002).

Product differentiation (monopolistic competition) allows firms to exercise some market power over consumers. In a market structure like this, a reduction in transport costs may permit firms to explore their economies of scale by spatially expanding their markets. This leads to an additional welfare effect for consumers, as they experience a larger variety of supplied products (Rouwendal, 2002).

#### **2.4 Negative wider economic impacts**

Finally, there also exists some literature on the possibility of negative wider economic impacts, i.e. wider economic costs. As shown in Kanemoto (2013b) and Kanemoto (2013a), an increase in productivity in an area may be counterbalanced by a decline in productivity in other areas, and positive tax effects and increased productivity might be offset by more expensive public services. Ignoring such possibilities may lead to an upward bias in the calculation of wider economic impacts.

This section has reviewed the state-of-the-art in the scientific literature on WEIs. We now turn our attention to how this literature has been received by practitioners. All of the above described types of WEI are represented in at least one of the reviewed countries' guidelines. However, some countries also have guidelines that include other types of WEI, based on impacts in other markets with other types of market failures. This is further described and discussed in section 4.

### **3 Review Methodology**

The review methodology is based on extracting information from the official guidelines for transport appraisal of each of the 23 countries in the sample. If not available, we consult their general guidelines for project appraisal and/or CBA. Similar to the HEATCO project (Odgaard, Kelly, & Laird, 2005) and Mackie and Worsley (2013) we review the countries' pro forma practices relating to transport appraisal. Examining how transport appraisals are conducted in practice in all of these countries would entail a much larger scope of work.

The first step of the review is in locating the official guidelines. Some were readily available or easy to find in the literature used in Mackie and Worsley (2013). The rest were found through systematic searching. With 24 pre-defined search word combinations, we systematically used the search engines and literature databases Google, Google Scholar, TRID, Science Direct, Springer-Link and Taylor Francis.

For countries where it was not possible to locate relevant information through this literature search, we tried to find updated guidelines on the web-pages of relevant government agencies. If the guidelines were not available, we used contact information from the HEATCO project to obtain the necessary information from



transport agencies or the scientific community. These contacts either helped us to find the relevant guidelines or confirmed that appraisal guidelines did not exist.

The next step is extracting information about WEIs from the guidelines. We focused on the following variables: 1) the types of WEIs acknowledged in the guidelines; 2) how the acknowledged WEIs *may* be assessed in transport appraisals, given that circumstances allow for this; 3) the kind of methodology the guidelines prescribe for assessing the acknowledged WEIs.

Table A in the Appendix provides an overview of the countries' guidelines and the secondary literature used to assess the pro forma practice regarding WEIs in transport appraisal. In the following sections, we do not insert citations directly into the text when referring to a country's official guidelines, but instead encourage interested readers to consult the Appendix to find the literature that corresponds to the country mentioned.

## 4 Main findings

During our review of the 23 countries' transport appraisal guidelines, we uncovered a number of different types of WEIs. They can be classified into five main categories, and again into 12 sub-categories, which have all been acknowledged in an official guideline at least once (see Table 1 for an overview of the types of WEI divided into main categories, sub-categories, and in some cases sub-sub categories).

Table 1: Typology of Wider Economic Impacts

Main category	Sub-category	Sub-sub-category
WEI1: Agglomeration impacts <sup>4</sup>		
WEI2: Impacts in markets with imperfect competition	WEI2a: Output change in imperfectly competitive markets	
	WEI2b: Increased competition as a result of better transport	
WEI3: Labour market impacts	WEI3a: Increased labour supply as a result of a change in commuting costs	WEI3aa: Changes in the number of people choosing to work
		WEI3ab: Changes in the number of hours worked
	WEI3b: Move to more or less productive jobs	

<sup>4</sup> There exists literature where agglomeration impacts could be divided into sub-categories, e.g. *proximity effects* and *cluster effects* (see e.g. Venables, Laird, and Overman (2014)), but we were unable to find any consistent patterns in the various countries' guidelines that could be used to divide the observations of agglomeration impacts into meaningful sub-categories.

Main category	Sub-category	Sub-sub-category
	WEI3c: Excess labour supply effects	WEI3ca: Employment impacts from building transport infrastructure
		WEI3cb: Employment impacts from operating transport infrastructure
		WEI3cc: Labor demand impacts from increased international trade through improved links to and from seaports and airports
	WEI3d: Thin labour market effects	
WEI4: Impacts from improved international connection	WEI4a: Increased Foreign Direct Investments	
	WEI4b: Contributions to promoting international relationships	
WEI5: Other Wider Economic Impacts	WEI5a: Interaction impacts with inefficient land-use regulation	
	WEI5b: Re-organization impacts	
	WEI5c: Innovation impacts in the construction and transport sector	

It can be seen from Table 1 that some practitioner guidelines include types of WEI in addition to those in the review of the state-of-the-art in the scientific literature on WEIs. Section 2 covered the first three main categories, but not *Impacts from improved international connection* and *Other types of WEIs*. Some of these deserve additional explanation. *Contributions to promoting international relationships* refer to the productivity impacts that may arise through increased international trade, such as increased competition, specialization and better use of national comparative advantages (Federal Ministry of Transport, 2003b). *Interaction impacts with inefficient land use regulation* refers to impacts the project may have on land use or property prices, when land use is not regulated optimally (i.e., either too strong or too weak from an economic point of view) or it is taxed or subsidized in ways that do not correct for externalities (Ministerie van Verkeer en Waterstaat & Ministerie van Economische Zaken, 2004). *Re-organization impacts* refers to the productivity impacts that may arise when improved transport allows businesses to re-organize (e.g. centralize) and exploit economies of scale (National Roads Authority, 2011b). We will see later in this section, that each of the types of WEI that belong to main categories 4 and 5 are only recognized by one country and thus cannot be described as “mainstream”.

Note that even though all of the WEIs are acknowledged in at least one official guideline, several caveats apply to how the guidelines deal with WEI:

- Several of the different types of WEI are not well founded theoretically or empirically – neither in the guideline(s) nor in general. This goes for both the underlying market distortion and the possible impact of infrastructure project. An example is *Increased Foreign Direct Investments* (FDIs). There exists some theory that claims that FDIs may have positive externalities in the form of knowledge transfer, and thus may lead to enhanced competition in domestic markets. However, there is little or no reliable evidence on how transport effects FDIs or how FDIs affect productivity (National Roads Authority, 2011b).
- One and the same type of WEI can be justified and treated differently in different country guidelines.
- If the applied method is not specified correctly, different types of WEI may overlap with each other and/or user benefits in conventional CBA.
- Most guidelines have a restrictive attitude towards calculating WEIs and require certain conditions to apply if WEIs are to be calculated (e.g. a checklist or a requirement to consult the transport agency before proceeding with the calculations). We therefore stress that while a guideline *may* allow for assessment of WEI, it does not necessarily intend such assessments to be the general practice.

The output from our review is summarized in Table 2. If an official guideline acknowledges one of the 12 types of WEIs, it is counted as one observation. First, the observations are classified according to how the guidelines *may* allow WEIs to be assessed, given that circumstances allow for this. We define three categories:

A: WEIs may be monetized and included in the CBA as part of the net present value (NPV) and/or in the benefit–cost ratio (BCR).

B: WEIs may be monetized/quantified but presented separately from any CBA-part in the project appraisal, e.g. as an account of its own in a multi-criteria analysis, impact assessment or other form of appraisal.

C: WEIs may be presented, but only as a qualitative assessment, or not recommended to be assessed at all.

Second, the observations are classified according to whether the guidelines have specific recommendations with respect to the type of methods to be used.

M: The corresponding type of WEI is included in the country guideline, with method recommendations.

NM: The corresponding type of WEI is included in the country guideline, but with no method recommendations.

A schematic presentation of the observations from 23 countries is given in Table 2. It shows 54 observations of the various types of WEI, how they may be assessed in a given country and whether the country guideline recommends any particular methods. It also names the countries that do not acknowledge WEI in their guidelines, and which do not have official guidelines.

Table 2: Overview of country guidelines for including wider economic impacts in transport appraisal.

	WEI1: Agglomeration impacts			WEI2a: Output change in imperfectly competitive markets			WEI2b: Increased competition as a result of better transport			WEI3a: Increased labour supply as a result of a change in commuting costs			WEI3b: Move to more or less productive jobs			WEI3c: Excess labour supply effects			WEI3d: Thin labour market effects			WEI4a: Increased Foreign Direct Investments			WEI4ab: Contributions to promoting international relationships			WEI5a: Interaction impacts with inefficient land use regulation			WEI5b: Re-organisation impacts			WEI5c: Innovation impacts in the construction and transport sector			SUM		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C						
Australia		M			NM					NM		NM			NM																						5		
Belgium	M			M						NM						M																					4		
Canada			NM																																		1		
Denmark			NM							NM																											3		
Finland			NM							NM					NM																						3		
France	M			M																																	2		
Greece																																					0		
Ireland			NM							M					NM																						9		
Iceland																																					0		
Italy																																					0		
Japan																																					0		
Luxembourg																																					0		
The Netherlands	M			M											M																						6		
New Zealand	M			M											M																						3		
Norway																																					0		
Portugal																																					0		
Spain			NM							NM																											3		
UK			M							M																											5		
Switzerland			M																																		NM	2	
Sweden			NM							NM																											5		
Germany																																					M	2	
USA	M																																				1		
Austria																																					0		
<b>SUM</b>	<b>5</b>	<b>9</b>	<b>0</b>	<b>4</b>	<b>6</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>4</b>	<b>3</b>	<b>4</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>54</b>

A = «May be monetized in CBA», B = «May be quantified/ monetized in project appraisal (though not in any CBA part)», C = «Acknowledged, but only assessed qualitatively or assessment not recommended», M = The corresponding type of WEI is included in the country guideline, with method recommendations, NM = The corresponding type of WEI is included in the country guideline, but with no method recommendations. Grey = WEI are not included in country guidelines, Black = There are no country guidelines.

Table 2 can be visualized in ways that highlight the main findings of the review. The remainder of this section therefore presents a descriptive analysis of the observations plotted in Table 2. Figure 1 plots the distribution of the 54 observations according to the types of WEIs recognized by the countries' guidelines. The different types of WEIs are sorted from most widely recognized to least recognized. *Agglomeration Impacts* is the WEI that is most widely recognized, i.e. by 14 of 23 countries. The next is *Output Change in Imperfectly Competitive Markets*, which is acknowledged in 9 out of 23 countries. Six of the 12 types of WEI are only included once in our entire literature review, and thus cannot be called "mainstream."

The figure also shows another aspect of the status of the various types of WEI, namely *how* they may be included in transport appraisals, cf. the description of how observations are categorized above. Looking at all 12 types at once, we can see that the types of WEI that are most "mainstream" are those that to the greatest extent are allowed monetization. The most common category of recognition is WEIs included in the guideline may be monetized/quantified but presented separately from the CBA (25 out of 54). Some guidelines give explicit arguments for their recommendations. We provide some examples. The UK guidelines state that WEI should not be included in the initial BCR, as the evidence for estimation of these impacts is less robust than for the other impacts that *are* included in the initial BCR. Similar arguments are found in the Swedish guidelines. They argue that the high degree of uncertainty and lack of standardization in methods for estimating WEI, should imply caution in the use of it for decision-making, citing Banister and Berechman (2000), OECD (2008) and Nash and Laird (2009). They also point out that there might be negative WEI (making the use of the term Wider Economic Benefits quite unfortunate), although this is rarely reflected in neither the methods nor the debate on WEI. The Irish guidelines also points out lack of evidence as reasons for not including monetized WEI in the BCR, and rather to present the results separately, either monetized or assessed qualitatively.

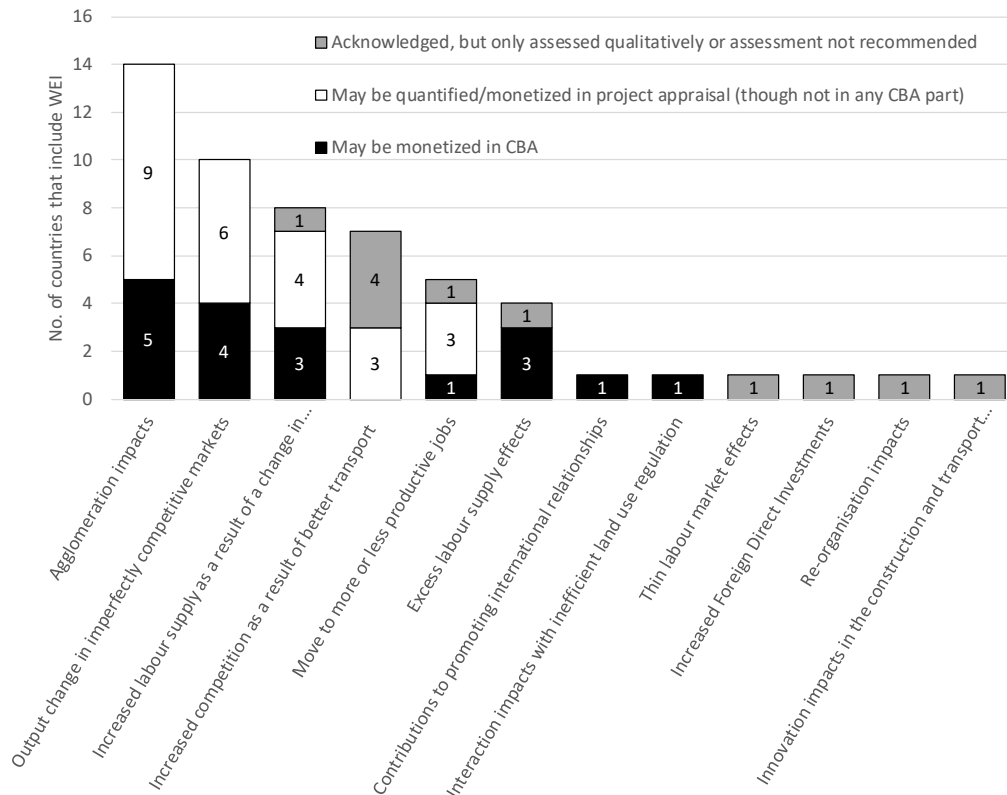


Figure 1: The types of WEI that are acknowledged in reviewed countries.

Countries in the sample that acknowledge WEIs are shown in Figure 2. Ireland has the widest selection of WEIs described in its guidelines. However, note that only two of the nine types may be quantified and presented separately from the CBA. The country with the second highest number of WEI types that also allows monetization and inclusion in its guidelines is The Netherlands. Not only does this country include a relatively high number of WEIs, it may do so directly in the CBA. The Netherlands also stands out from the other countries in the sample in its choice of methods. The primary recommendation is to model WEIs through SCGE<sup>5</sup> and/or LUTI<sup>6</sup> - modelling (for a review of the Dutch modelling system, see Koopmans and Oosterhaven (2011)). In contrast, most of the other countries calculate WEIs by first calculating user benefits, as in traditional CBA, and then by inserting these results in a set of equations with pre-estimated parameters for calculating WEIs. These methods vary in complexity, from pure “rules of thumb” (e.g. a 10% uplift to business user benefits to calculate *Output change in imperfectly competitive markets*) to more complex calculations (e.g. applying sector and location specific parameters for calculating *Agglomeration impacts*), with a pre-set of estimated WEI parameters. In the guidelines from the UK we find such recommendations for estimating WEI with methods of varying complexity. It is worth noting here that even though WEI are not supposed to be included in the initial CBA (as shown in Figure 2), they are

<sup>5</sup> Spatial Computable General Equilibrium models

<sup>6</sup> Land-Use Transport Interaction models

recommended to be included in a Value for Money assessment, usually carried out for larger projects, as a part of an Adjusted BCR.

Of the 23 countries in the sample, eight make no mention of WEIs in their transport appraisal guidelines (see Figure 2). However, it is worth mentioning that four of these countries (Iceland, Luxembourg, Greece and Portugal) do not have official guidelines for transport appraisal and/or CBA. The latter three, which are EU countries, have implemented projects funded by the EU Structural Fund or the European Investment Bank, both of which have their own guidelines. The former recognizes WEI, but does not specify which types. The latter recognizes WEI and mentions *Increased Labour Supply as a result of change in commuting costs*, *Excess labour supply Impacts*, *Agglomeration Impacts* and *Interaction impacts with inefficient land use regulation* (without recommending any specific method for assessing these impacts).

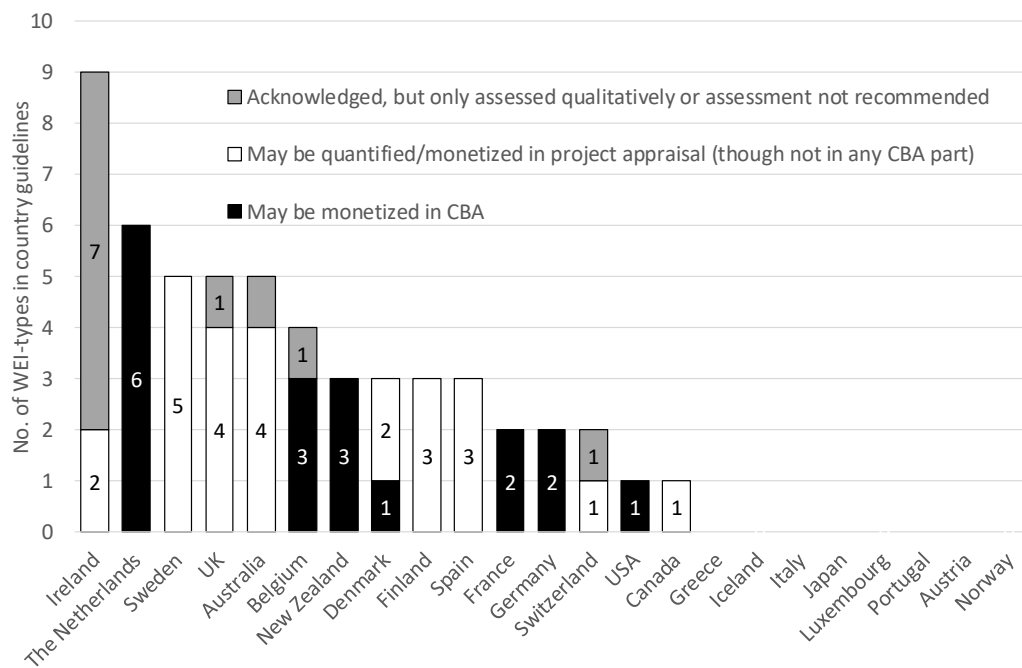


Figure 2: Countries that acknowledge WEI

Another interesting aspect is whether the countries that acknowledge WEIs recommend methods for quantifying and monetizing them. Figure 3 shows that 10 of the 23 countries recognize WEIs *and* provide method recommendations for calculating them (i.e., for at least one of the types of WEIs they acknowledge). Five countries that recognize WEIs do not refer to any specific method in their guidelines. Japan, Italy, Norway and Austria do not recognize WEIs. Finally, four countries do not have national guidelines for impact assessment and/or CBA.

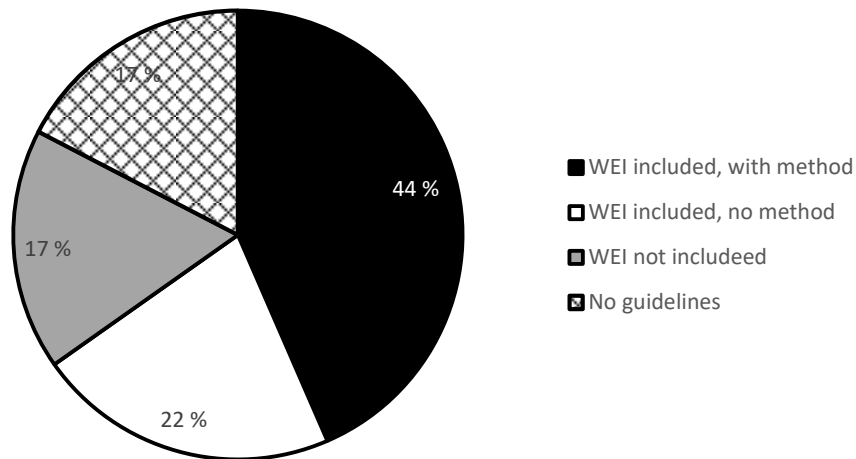


Figure 3: Overview of countries with and without methods for calculating WEI

Countries which recommend methods for calculating magnitude and value in WEIs are shown in Figure 4. Of 54 observations of the various types of WEI in guidelines, we found recommendations for methods for 26. For the six "mainstream" types of WEI that are described in four or more official guidelines, we found that there is some correlation between the number of countries recognizing WEI and the number that recommend methods for calculating them. For example, *Agglomeration Impacts* and *Output Change in Imperfectly Competitive Markets* are the types of WEIs that most countries recognize and for which most countries recommend methods. The exception is the category *Increased Competition as a Result of Better Transport*, for which no country guidelines provide method recommendations, despite it being referred to in seven of the country guidelines.



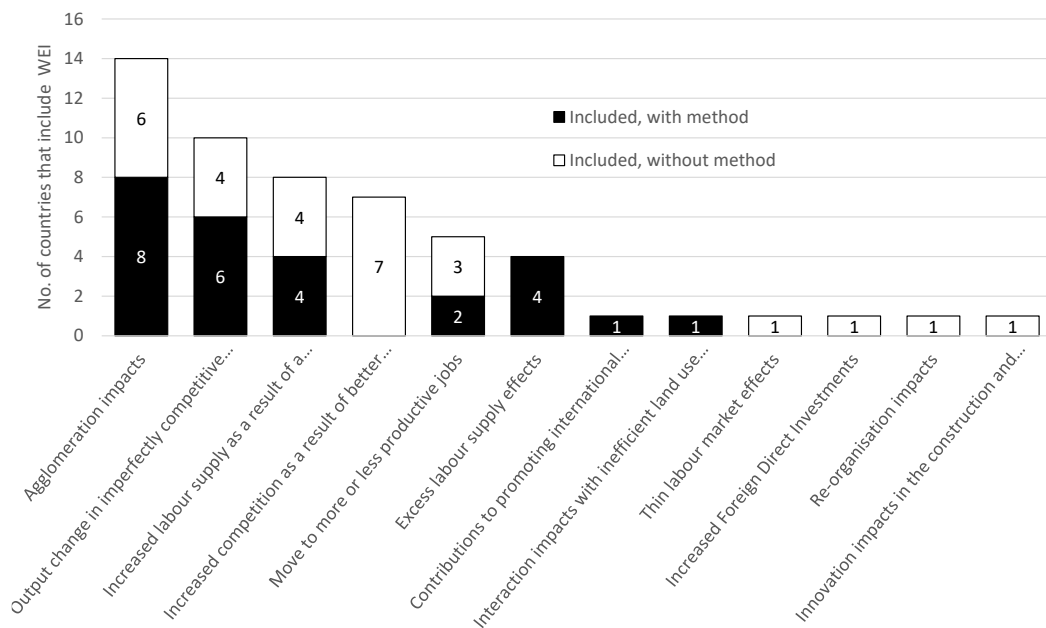


Figure 4: Distribution of WEI types with methods of calculation

Looking more closely at the methods applied, we found, with one exception, that no country recommends similar methods for calculating the same WEIs. The exception is the methodology developed for the UK Department for Transport (DfT). Their guidelines for treatment of WEIs, last updated in 2014 (Department for Transport, 2014b), seems to have had significant influence outside the UK: New Zealand has adopted the DfT methods for *Agglomeration Impacts*, *Increased labour supply as a result of a change in commuting costs* and *Output change in imperfectly competitive markets*. Ireland, France and Belgium have also adopted the method for *Output change in imperfectly competitive markets*. It is worth noting that the guidelines of six additional countries in the sample refer to DfT when presenting aspects related to WEIs. Guidelines often refer to DfT, because they can “provide additional information on WEIs and their calculation to assist those preparing economic appraisals” (Infrastructure Australia, 2012).

## 5 Discussion and concluding remarks

The aim of this article has been to provide transport agencies, transport appraisal practitioners and academics with relevant information about the state-of-the-art in treating WEIs in transport appraisal. Transport agencies in the process of revising their guidelines for transport appraisal might find it particularly relevant.

First, the article is a status report on how WEIs are treated in official guidelines in a relatively large sample of industrialized countries. It allows transport agencies to identify what is “mainstream” and what is not as of 2016. Second, the article

provides relevant sources of information on how WEIs are considered in the sample countries, potentially saving valuable information gathering time.

Our findings show that there is great variation in whether and what type of Wider Economic Impacts (WEI) the 23 countries in the sample acknowledge, and in whether their guidelines recommend methods. Several countries provide provisos or criteria that must be met before WEI can be assessed.

Most of the countries under consideration recognize the importance of WEIs in project appraisal, which underlines the need for establishing international consensus about how WEIs are to be addressed. However, our findings supplement and reinforce the conclusions from the Norwegian Official Report of the Hagen Committee (NOU 2012:16, 2012) that there is currently no established consensus on the magnitude and relevance of WEIs, or on how and which of these impacts should be taken into account in transport appraisals. As discussed in Section 2, SACTRA (1999) considers agglomeration externalities, labour market effects and impacts in markets with imperfect competition to be the most important WEIs. Our results show that these WEI-types also receive most attention in the national guidelines. While these findings suggest that the scientific literature has been helpful in steering the development of appraisal guidelines, we also find several types of WEIs mentioned that has little or no support from the scientific literature. This concerns e.g. WEIs of improved international connection or foreign direct investments. For the purpose of harmonising guidelines for WEIs across countries, we believe that such effects should receive less attention and that the emphasis should be on SACTRA's (1999) categories or on a subset of these. These WEIs have received thorough treatment in the literature and are recognized by several national guidelines. Future research should focus on WEIs that are likely to be the most influential with respect to project outcomes<sup>7</sup>.

The recommended methods found in guidelines range from sophisticated SCGE/LUTI modelling to mere rule-of-thumb uplift of user benefits. Most countries calculate WEIs by first calculating user benefits, and then by inserting these results in a set of equations with pre-defined parameters for calculating WEIs. With the UK method as an exception, no countries recommend the same or similar methods. The UK Department for Transport's work on WEI seems to serve as general inspiration in a number of official guidelines. Consequently, they offer a valid starting point towards harmonising WEI-appraisal practices among countries.

This review cannot provide concrete recommendations for *which methods* to pursue with regards to harmonisation of guidelines. However, we can provide arguments for important *principles* for the way forward for including WEIs in transport appraisal. With regards to principles for choice of method for assessing WEIs, we support the recommendations from Venables et al. (2014). According to them, methods for assessing WEI require: (a) *An appropriate analytical framework that captures effects and can ascribe social values to economic change.* (b) *Good estimates of how transport changes quantities, i.e. journeys, patterns of investment and employment.* (c) *A robust evidence base combined with local and project specific knowledge that can inform judgement about whether such changes are additional (to a*

---

<sup>7</sup> We are grateful to an anonymous referee for pointing this out to us.

*particular area and the country as a whole); whether they displace other activity; and how they interact with market imperfections thereby creating social value.*

However, it is not only the methods for calculating WEI that are desirable to harmonise, but also the underlying general criteria for which type of projects that should initiate WEI investigation. The analyst should explicitly ask himself some important questions before deciding to calculate WEIs, in particular whether it is reasonable to expect a given project to have a sizable net effect on economic activity in secondary markets and whether these secondary markets are associated with significant market imperfections. The Belgian appraisal guidelines provide an instructive decision-tree for how to address such questions explicitly. We recommend that any harmonizing of guidelines regarding WEIs should include something similar.

Even though the concept of WEIs has matured over the last decade, there is still relatively little consensus about their magnitude and relevance. This implies that estimates of WEIs in transport appraisal will contain relatively high levels of uncertainty. This indicates that any calculation of WEIs used for decision-making should be supplemented with an assessment of the uncertainty (e.g. sensitivity analysis, scenario analysis etc.) that also gives some consideration to the possibility of negative WEI/wider economic costs. An informative way of doing this is to present WEI estimation results as a range and not just a point estimate to the decision-makers in order to communicate this uncertainty. The more simplified the method is, the more important it is to communicate the associated uncertainty. This is also a question of transparency in calculating WEIs, which is also highlighted in Venables et al. (2014). To increase transparency, these authors recommend reporting a summary checklist of the applied approach to calculating WEIs. We agree with this recommendation.

It is clear that transport appraisal that includes WEIs in an appropriate way will be costlier to conduct, both for analysis and reporting. The additional cost of analysis will largely depend on choice of methods. While methods that are more sophisticated are likely to produce results that are more reliable, their costs of implementation are also likely to be higher. There is consequently a need for examining the trade-off among the qualities and costs of available methods, as the resources of transport agencies are scarce.

Only 7 of the 23 countries under consideration accept including monetized WEIs as a component in an overall CBA. This may reflect a general scepticism towards the state-of-the-art in quantifying and monetizing WEIs (several guidelines express and this scepticism explicitly and provide arguments for it, as noted in section 4). It could also reflect the level of sophistication of methods available in a given country. For example, the Netherlands allows monetizing all of the WEI-types included in its guidelines, but it also stands out from the other countries in its sophistication of methods used for quantifying WEIs. For harmonizing guidelines, we currently advise to quantify/monetize relevant WEIs and to present the results separately from the CBA as a supplement. This advice is based on our finding that a majority of countries under consideration supports this approach, and because our review indicates that current methods have not reached the appropriate level of maturity for providing reliable results on WEIs.

We would like to highlight several promising areas for future research. The first relates to better understanding the nature of WEIs. The most recent important advance for empirical research on agglomeration economies has been the development and utilization of micro data, such as firm- and establishment-level datasets of economic activity (Duranton & Kerr, 2015), and individual level data on employment, education and consumption. The tremendous amount of available data creates numerous possibilities for researchers in the near future, especially in the advent of tools for analysing big data. Secondly and independent of applied scientific method, there is a need for country specific estimation of important analytical parameters. Examples being decay rates in the calculation of effective density and sector and country specific agglomeration elasticity values. Lastly, a better understanding on how the costs and benefits of WEI are distributed across the economy, is of importance. This may involve micro-economic founded models with an explicit and detailed spatial nature, such as SCGE-models and to an extent LUTI-models. An important prerequisite for such models is that they depart from the assumption of perfect competition in all secondary markets. New micro-level data and opportunities for analysing them, will provide better parameter estimates that can be used in these types of spatially detailed models.

Several issues should be considered by transport agencies in their future work on WEIs. First, there is still great potential for improving conventional cost–benefit analysis. Some claim that there is more to gain from improving conventional CBA than introducing monetized WEI (Hof, Heyma, & van der Hoorn, 2012). Second, "correct" consideration of WEIs will involve assessing complex impacts that are responsive to changes in the economy besides transport investment. A WEI is a symptom of existing inefficiencies in the economy. Hence, the size of the WEI will be affected by *direct* government interventions to correct market failures (e.g. adjustments of the tax and benefits system in order to induce more labour supply). It is also important to consider how competing transport projects affect WEI. Under different circumstances, WEIs from competing projects might either enhance or neutralize each other. This is further discussed in Wangsness et al. (2014).

It would also be interesting to analyse the extent to which including WEI in transport appraisal actually matters for decision-makers. A report from the Norwegian CONCEPT program (Welde, Eliasson, Odeck, & Börjesson, 2013) shows that there is no significant relationship between the cost–benefit ratio (or any of the components of it) of a project in a project portfolio, and the probability of selecting the project for implementation. In fact, very few aspects of transport appraisals seemed to affect the decision-making in any systematic way. Will including monetized WEI make any difference?

## 6 Acknowledgement

We appreciate receiving the financial support from the Norwegian Public Roads Administration that made this research possible, and are indebted to Harald Minken for his comments. We are also indebted to the constructive comments from three anonymous reviewers.

## 7 References

- American Association of State Highway and Transport officials (AASHTO). (2003). *User Benefit Analysis for Highways*.
- Australian Transport Council. (2006). *National Guidelines for Transport System Management in Australia*. Canberra.
- Austrroads. (2011). *A Guide to Project Evaluation*.
- Banister, D., & Berechman, Y. (2000). *Transport investment and Economic Development*. Retrieved from
- Behrens, K., Duranton, G., & Robert-Nicoud, F. (2014). Productive cities: Sorting, selection, and agglomeration. *Journal of Political Economy*, 122(3), 507-553.
- Beria, P., Giove, M., & Miele, M. (2012). A Comparative Analysis of Assessment Approaches. Six Cases from Europe. *International Journal of Transport Economics*, 34(2), 32.
- Bundesamt für Strassen, & Ecoplan. (2010). *Handbuch eNISTRA*. Bern.
- Bundesamt für Strassen (ASTRA). (2003). *NISTRA: Nachhaltigkeitsindikatoren für Strasseninfrastrukturprojekte - Methodenbericht*. Bern.
- Bundesministerium für Verkehr, I. u. T., & Österreichische Forschungsgesellschaft Strasse – Scheiene – Verker. (2010a). Bewertung des Neuverkehr im Rahmen einer Nutzen-Kosten-Analyse RVS 02.01.23.
- Bundesministerium für Verkehr, I. u. T., & Österreichische Forschungsgesellschaft Strasse – Scheiene – Verker. (2010b). *Nutzen-kosten-Untersuchungen im Verkehrswesen RVS 02.01.22*. Wien.
- California DOT. (2007). *Life Cycle Benefit Cost Analysis Model*.
- Centraal Planbureau, & Nederlands Economisch Instituut. (2000). *Evaluatie Van Infrastructuurprojecten-Leidraad Voor Kosten-Batenanalyse*.
- Centro de Estudios y Experimentación de Obras Públicas (CEDEX)/ Ministerio de Fomento. (2010). *Economic Evaluation of Transport Projects - Guidelines*. Madrid.
- Combes, P. P., Duranton, G., Gobillon, L., Puga, D., & Roux, S. (2012). The productivity advantages of large cities: Distinguishing agglomeration from firm selection. *Econometrica*, 80(6).

- Commissariat général à la stratégie et à la prospective. (2013a). *Cost benefit assessment of public investments: Final Report - Summary and recommendations*. Paris.
- Commissariat général à la stratégie et à la prospective. (2013b). *L'évaluation socioéconomique des investissements publics*. Paris.
- Commonwealth of Australia. (2006). *Handbook of Cost-Benefit Analysis*. Canberra.
- Copenhagen Economics. (2014). *Bredere økonomiske effekter af transportinvesteringer - Debatoplæg udarbejdet for Transportministeriet*. Retrieved from Copenhagen:
- Deng, T. (2013). Impacts of transport infrastructure on productivity and economic growth: Recent advances and research challenges. *Transport Reviews*, 33(6), 686-699.
- Department for Transport. (2013). *Value for Money Assessment: Advice Note for Local Transport Decision Makers*. London.
- Department for Transport. (2014a). *TAG unit A1.1, Cost Benefit Analysis*. London.
- Department for Transport. (2014b). *TAG unit A2.1, Wider Impacts*. London.
- Department of Infrastructure and Regional Development. (2014). *Overview of project appraisal*.
- Department of Transport. (2010). *Guidelines for Cost Benefit Analysis*. Melbourne.
- Department of Transport. (2012). *Job density, productivity and the role of transport*. Melbourne.
- DfT. (2008). *The Additionality of Wider Economic Benefits in Transport Appraisal*. London.
- Diamond, C. A., & Simon, C. J. (1990). Industrial specialization and the returns to labor. *Journal of Labor Economics*, 175-201.
- Douglas, N., & Brooker, T. (2013). International Comparison of Transport Appraisal Practice - Annex 6 NSW Australia Country report.
- Duranton, G., & Kerr, W. (2015). The logic of Agglomeration. *Harvard Business School Working paper*(No. 16-037, September 2015).
- Duranton, G., & Puga, D. (2004). Micro-foundations of urban agglomeration economies. *Handbook of regional and urban economics*, 4, 2063-2117.
- Elhorst, J. P., & Oosterhaven, J. (2008). Integral Cost-Benefit Analysis of Maglev Rail Projects Under Market Imperfections. *Journal of Transport and Land Use*, 1(1), 65 - 87.

- Ellison, G., Glaeser, E. L., & Kerr, W. (2007). What causes industry agglomeration? Evidence from coagglomeration patterns. *NBER Working Paper*(13068).
- EU Structural Fund – ERDF, Cohesion Fund, & ISPA. (2003a). *Guide to Cost-Benefit Analysis of investment projects - English version*.
- EU Structural Fund – ERDF, Cohesion Fund, & ISPA. (2003b). *Guide to Cost-Benefit Analysis of investment projects - Greek version*.
- European Commission. (2008). *Guide to Cost-Benefit Analysis of investment projects - Structural Funds, Cohesion Fund and Instrument for Pre-Accession*.
- European Investment Bank. (2013). *The Economic Appraisal of Investment Projects at the EIB*.
- Federal Highway Administration. (2003). *Economic Analysis Primer*.
- Federal Ministry of Transport, B. a. H. B. (2003a). *Federal Transport Infrastructure Plan 2003*. Berlin.
- Federal Ministry of Transport, B. a. H. B. (2003b). *Macroeconomic evaluation methodology - Federal Transport Infrastructure Plan 2003*. Berlin.
- Fujita, M. (1988). A monopolistic competition model of spatial agglomeration\* 1:: Differentiated product approach. *Regional science and urban Economics*, 18(1), 87-124.
- Fujita, M., & Thisse, J. (1996). Economics of agglomeration. *Journal of the Japanese and international economics*, 10(4), 339-378.
- Glaeser, E. L., Kallal, H. D., Scheinkman, J. A., & Shleifer, A. (1991). Growth in cities. *National Bureau of Economic Research*.
- Graham, D., & Dender, K. v. (2011). Estimating the agglomeration benefits of transport investments: some tests for stability. *Transportation*, 38(3), 409-426. doi:10.1007/s11116-010-9310-0
- Graham, D. J. (2007). Agglomeration, productivity and transport investment. *Journal of Transport Economics and Policy (JTEP)*, 41(3), 317-343.
- Harberger, A. C. (1964). The measurement of waste. *The American Economic Review*, 58-76.
- Helsley, R. W., & Strange, W. C. (1990). Matching and agglomeration economies in a system of cities. *Regional science and urban Economics*, 20(2), 189-212.
- Helsley, R. W., & Strange, W. C. (2002). Innovation and input sharing. *Journal of Urban Economics*, 51(1), 25-45.

- Hensher, D. A., Truong, T. P., Mulley, C., & Ellison, R. (2012). Assessing the wider economy impacts of transport infrastructure investment with an illustrative application to the North-West Rail Link project in Sydney, Australia. *Journal of Transport Geography*, 24, 292-305.
- Hicks, J. R. (1932). *The theory of wages*: Macmillan.
- Hof, B., Heyma, A., & van der Hoorn, T. (2012). Comparing the performance of models for wider economic benefits of transport infrastructure: results of a Dutch case study. *Transportation*, 39(6), 1241-1258.
- Holmes, T. J. (1999). Localization of industry and vertical disintegration. *Review of Economics and Statistics*, 81(2), 314-325.
- Infrastructure Australia. (2012). *Reform and Investment Framework*.
- Jara-Diaz, S. (1986). On the relation between users' benefits and the economic effects of transportation activities. *Journal of Regional Science*, 26, 379-391.
- Kanemoto, Y. (2013a). Pitfalls in estimating “wider economic benefits” of transportation projects. *GRIPS Discussion Papers*, 13.
- Kanemoto, Y. (2013b). Second-best cost–benefit analysis in monopolistic competition models of urban agglomeration. *Journal of Urban Economics*, 76, 83-92.
- Kansas DOT. (2010). Expanded Highway Project Selection Process *Kansas DOT*.
- Kernohan, D., & Rognlien, L. (2011). *Wider economic impacts of transport investments in New Zealand*. Retrieved from Wellington:
- Koopmans, C., & Oosterhaven, J. (2011). SCGE modelling in cost-benefit analysis: The Dutch experience. *Research in Transportation Economics*, 31(1), 29-36.
- Krugman, P. (1991). *Geography and trade*: the MIT Press.
- Laird, J., & Mackie, P. (2009). *Review of economic assessment in rural transport appraisal*: Scottish Government Social Research.
- Laird, J., & Mackie, P. (2014). Wider economic benefits of transport schemes in remote rural areas. *Research in Transportation Economics*, 47, 92-102.
- Laird, J., Nellthorp, J., & Mackie, P. (2005). Network effects and total economic impact in transport appraisal. *Transport Policy*, 12(6), 537-544.
- Lakshmanan, T. (2007). *The Wider Economic Benefits of Transportation*. Paper presented at the Discussion paper no. 8, 2007, International Transport Forum.



- Lakshmanan, T., & Anderson, W. P. (2002). *Transportation infrastructure, freight services sector and economic growth*. Paper presented at the Centre for Transportation Studies, Boston University. <http://www.ncgia.ucsb.edu/stella/meetings/20020115/Lakshmanan.pdf>.
- Liikennevirasto. (2011). *Liikenneväylien hankearvioinnin yleisohje*. Helsinki.
- Liikennevirasto. (2013). *Tiehankeiden arviointiohje*. Helsinki.
- Mackie, P., & Worsley, T. (2013). International comparisons of transport appraisal practice: Overview report. *Institute for Transport Studies, University of Leeds*.
- Mackie, P., Worsley, T., & Eliasson, J. (2014). Transport appraisal revisited. *Research in Transportation Economics*, 47, 3-18.
- Manning, A. (2003). The real thin theory: monopsony in modern labour markets. *Labour Economics*, 10(2), 105-131.
- Marshall, A. (1890). *The Principles of Economics*. 8th. edn.(1920). London: Macmillan.
- Matouschek, N., & Robert-Nicoud, F. (2005). The role of human capital investments in the location decision of firms. *Regional science and urban Economics*, 35(5), 570-583.
- Melo, P. C., Graham, D. J., & Noland, R. B. (2009). A meta-analysis of estimates of urban agglomeration economies. *Regional science and urban Economics*, 39(3), 332-342.
- Ministerie van Verkeer en Waterstaat, & Ministerie van Economische Zaken. (2004). *Indirecte Effecten Infrastructuur-projecten-Aanvulling op de leidraad OEI*.
- Ministry of Land Infrastructure, T. a. T. (2009). *Technical Guidance of Cost-benefit Analysis for Public Project Evaluation*. Tokyo.
- Ministry of Land Infrastructure, T. a. T. (2010). *Cost-benefit Analysis Manual (for road projects)*. Tokyo.
- Ministry of Transportation and Infrastructure. (2014). *Benefit Cost Analysis Guidebook - Guidelines for the Benefit Cost Analysis Of Highway Improvement Projects In British Columbia*.
- Minnesota DOT. (2009). *Implementation of Minnesota Statewide Transportation Plan Cost-Effectiveness Policy - Technical Memorandum No. 09-13-IM-01*.
- Minnesota DOT. (2012). *Benefit Cost Analysis for Transportation Projects*.
- Mohring, H. (1993). Maximizing, measuring, and not double counting transportation-improvement benefits: A primer on closed-and open-economy cost-benefit analysis. *Transportation Research Part B: Methodological*, 27(6), 413-424.

- Moretti, E. (Ed.) (2004). *Human capital externalities in cities* (Vol. 4): Elsevier-North Holland.
- Nash, C., & Laird, J. (2009). Chapter 5: Cost–Benefit Analysis in Transport: Recent Developments in Rail Project Appraisal in Britain. In R. J. Brent (Ed.), *Handbook of Research on Cost–Benefit Analysis*.
- National Cooperative Highway Research Program. (2014). *Assessing Productivity Impacts Of Transportation Investments: Final Report And Guidebook*. Retrieved from
- National Roads Authority. (2011a). *Project Appraisal Guidelines: Unit 6.1 Guidance on Conducting CBA*. Dublin.
- National Roads Authority. (2011b). *Project Appraisal Guidelines: Unit 6.8 Wider Impacts*. Dublin.
- National Roads Authority. (2011c). *Project Appraisal Guidelines: Unit 7.0 Project Appraisal Balance Sheet*. Dublin.
- North Carolina DOT. (2014). *Strategic Transport Investments/ Highway Quantitative Scoring Criteria*
- NOU 2012:16. (2012). *Samfunnsøkonomiske analyser*. Oslo: Departementenes servicesenter.
- Nuclei regionali di valutazione e verifica degli investimenti pubblici. (2001). *Studi Di Fattibilità Delle Opere Pubbliche*.
- NZ Transport Agency. (2013). *Economic Evaluation Manual*. Wellington.
- Odgaard, T., Kelly, C., & Laird, J. (2005). *HEATCO Work Package 3: Current practice in project appraisal in Europe*. Retrieved from Stuttgart, Germany:
- OECD. (2008). *The Wider Economic Benefits of Transport: Macro-, Meso- and Micro-Economic Transport Planning and Investment Tools*. Retrieved from
- Oosterhaven, J., & Knaap, T. (2003). Spatial economic impacts of transport infrastructure investments. A. Pearman, P. Mackie, J. Nellthorp & L. Giorgi (eds.), *Transport Projects, Programmes and Policies: Evaluation Needs and Capabilities*.
- Pigou, A. C. (1924). *The Economics of Welfare*. London: Macmillan.
- Pilegaard, N., & Fosgerau, M. (2008). Cost Benefit Analysis of a Transport Improvement in the Case of Search Unemployment. *Journal of Transport Economics and Policy (JTEP)*, 42(1), 23-42.
- Rosenthal, S. S., & Strange, W. C. (2004). Evidence on the nature and sources of agglomeration economies. *Handbook of regional and urban economics*, 4, 2119-2171.

- Rouwendal, J. (2002). *Indirect welfare effects of price changes and cost-benefit analysis*. Retrieved from
- Rus, G. d. (2009). *Indirect effects and additional economic benefits*.
- SACTRA. (1999). *Transport and the Economy*. Retrieved from London:
- Strategic Highway Research Program. (2014). *Development of Tools for Assessing Wider Economic Benefits of Transportation. SHRP2 Report S2-C11-RW-1*. Retrieved from
- Trafikverket. (2014). *Sambällsekonomiska principer och kalkylvärden för transportsektorn: ASEK 5.1 - Kapitel 17: Indirekta effekter utanför transportsektorn*.
- Transport Canada. (1994). *Guide To Benefit-Cost Analysis In Transport Canada*.
- Transport for New South Wales. (2013). *Guidelines and Principles for Economic Appraisal of Transport Investment and Initiatives*
- Transport Scotland. (2008). *Scottish Transport Appraisal Guidance*. Edinburgh.
- Transport Scotland. (2014). *STAG Technical Database Section 9 - Economy*. Edinburgh.
- Transportministeriet. (2003). *Manual for samfundsøkonomisk analyse - anvendt metode og praksis på transportområdet*. Copenhagen.
- Transportministeriet. (2015). *Manual for samfundsøkonomisk analyse på transportområdet – Anvendt metode og praksis i Transportministeriet*. Copenhagen.
- Treasury Board of Canada Secretariat. (2007). *Canadian Cost-Benefit Analysis Guide: Regulatory Proposals*.
- US Department of Transport. (2012a). *TIGER Grant Program: Benefit-Cost Analysis Resource Guide*.
- US Department of Transport. (2012b). *TIGER Grants: Federal Register Notice of Funding Availability*.
- van Exel, J., Rienstra, S., Gommers, M., Pearman, A., & Tsamboulas, D. (2002). EU involvement in TEN development: network effects and European value added. *Transport Policy*, 9(4), 299-311.
- Vegdirektoratet, S. v. (2014). *Håndbok V172 Konsekvensanalyser*. Oslo.
- Venables, A. J. (2007). Evaluating urban transport improvements: cost-benefit analysis in the presence of agglomeration and income taxation. *Journal of Transport Economics and Policy*, 173-188.
- Venables, A. J., Laird, J., & Overman, H. (2014). Transport investment and economic performance: Implications for project appraisal.

Vickerman, R. (2007). *Recent evolution of research into the wider economic benefits of transport infrastructure investments*. Paper presented at the Discussion paper no. 9, 2007, International Transport Forum.

Vlaamse Overheid-Departement Mobiliteit en Openbare Werken, & RebelGroup Advisory Belgium nv. (2013a). *Standaardmethodiek voor MKBA van transportinfrastructuur-projecten - Algemene leidraad*.

Vlaamse Overheid-Departement Mobiliteit en Openbare Werken, & RebelGroup Advisory Belgium nv. (2013b). *Standaardmethodiek voor MKBA van transportinfrastructuur-projecten - Kengetallenboek*.

Wangsness, P. B., Rødseth, K. L., & Hansen, W. (2014). *22 lands retningslinjer for behandling av netto ringvirkninger i konsekvensutredninger: En litteraturstudie / Treatment on Wider Economic Benefits in Project Appraisals in 22 countries: A Literature Review*. Retrieved from Oslo:

Weber, A. F. (1899). *The growth of cities in the nineteenth century: a study in statistics*: New York: Pub. for Columbia university by the Macmillan Company.

Weisbrod, G. (2013). *International Comparison of Transport Appraisal Practice - Annex 5 US Country Report*. Retrieved from

Welde, M., Eliasson, J., Odeck, J., & Börjesson, M. (2013). *Planprosesser, beregningsverktøy og bruk av nytte-kostnadsanalyser i vegsektor - En sammenligning av praksis i Norge og Sverige / Planning, analytic tools and the use of cost-benefit analysis in the transport sector in Norway and Sweden*. Retrieved from Trondheim:

## 8 Appendix

Table A: List of sources of information, by country

Country	Sources
Australia (nationally)	(Commonwealth of Australia, 2006), (Austroads, 2011), (Australian Transport Council, 2006), (Department of Infrastructure and Regional Development, 2014), (Infrastructure Australia, 2012)
Australia (New South Wales)	(Transport for New South Wales, 2013), (Hensher, Truong, Mulley, & Ellison, 2012), (Douglas & Brooker, 2013)
Australia (Victoria)	(Department of Transport, 2010), (Department of Transport, 2012)

Austria	(Bundesministerium für Verkehr & Österreichische Forschungsgesellschaft Strasse – Scheiene – Verker, 2010a, 2010b)
Belgium	(Vlaamse Overheid-Departement Mobiliteit en Openbare Werken & RebelGroup Advisory Belgium nv, 2013a, 2013b)
Canada (nationally)	(Transport Canada, 1994), (Treasury Board of Canada Secretariat, 2007)
Canada (British Columbia)	(Ministry of Transportation and Infrastructure, 2014), (National Cooperative Highway Research Program, 2014) Correspondence with The Highway Planning & Programming Branch's Manager for Economic Analysis
Denmark	(Transportministeriet, 2003, 2015), (Copenhagen Economics, 2014) Correspondence with Transportministeriet
Finland	(Liikennevirasto, 2011, 2013) Correspondence with Liikennevirasto (Finnish Transport Agency)
France	(Commissariat général à la stratégie et à la prospective, 2013a, 2013b) Correspondence with Emile Quinet
Germany	(Federal Ministry of Transport, 2003a, 2003b)
Greece	(EU Structural Fund – ERDF, Cohesion Fund, & ISPA, 2003a, 2003b) Correspondence with Hellenic Institute of Transport
Iceland	Correspondence with Icelandic Road and Coastal Administration and School of Science and Engineering, Reykjavik University
Ireland	(National Roads Authority, 2011a, 2011b, 2011c)
Italy	(Nuclei regionali di valutazione e verifica degli investimenti pubblici, 2001), (Beria, Giove, & Miele, 2012)
Japan	(Ministry of Land Infrastructure, 2009, 2010) Correspondence with Yoshitsugo Kanemoto
Luxembourg	Correspondence with Ministère du Développement durable et des Infrastructures - Département des transports og Universty of Luxembourg
The Netherlands	(Centraal Planbureau & Nederlands Economisch Instituut, 2000), (Ministerie van Verkeer en Waterstaat & Ministerie van Economische Zaken, 2004)
New Zealand	(NZ Transport Agency, 2013), (Kernohan & Rognlien, 2011)

Norway	(Vegdirektoratet, 2014)
Portugal	Correspondence with TIS.pt – Consultores em Transportes Inovação e Sistemas, S.A.
Spain	(Centro de Estudios y Experimentación de Obras Públicas (CEDEX)/ Ministerio de Fomento, 2010), (Rus, 2009)
Sweden	(Trafikverket, 2014)
Switzerland	(Bundesamt für Strassen (ASTRA), 2003), (Bundesamt für Strassen & Ecoplan, 2010)
United Kingdom (England)	Department for Transport (2013, 2014a, 2014b)
United Kingdom (Scotland)	(Transport Scotland, 2008, 2014)
USA (nationally)	(Federal Highway Administration, 2003), (US Department of Transport, 2012a, 2012b), (National Cooperative Highway Research Program, 2014), (Strategic Highway Research Program, 2014), (Weisbrod, 2013)
USA (California)	(California DOT, 2007), (American Association of State Highway and Transport officials (AASHTO), 2003)
USA (Kansas)	(Kansas DOT, 2010)
USA (Minnesota)	(Minnesota DOT, 2009, 2012), (American Association of State Highway and Transport officials (AASHTO), 2003)
USA (North Carolina)	(North Carolina DOT, 2014)
European Commission	(European Commission, 2008)
European Investment Bank	(European Investment Bank, 2013)