Evaluating Methods for Analyzing Economic Impacts in Environmental Assessment

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Background

Sound methodological guidelines are essential for generating accurate and consistent data for environmental assessment (EA) to determine whether a project is in the public interest and what conditions need to be attached to project approval to maximize benefits and mitigate adverse effects. Currently, Canadian EA processes at the federal and provincial levels lack comprehensive methodological guidelines for analyzing socio-economic impacts. Consequently, project proponents have wide discretion in the methods and presentation of socio-economic impacts in EA applications. This discretion can result in a lack of consistency in estimating and interpreting socio-economic impacts that makes it difficult for decision-makers, stakeholders, and rights-holders to properly assess projects. This research paper examines this issue by evaluating strengths and weaknesses of methods for assessing economic impacts, developing best practice guidelines for economic assessment, and identifying priorities for future research.

Objectives

This research focuses on the objective outlined in the SSHRC Knowledge Synthesis Grants request on *Informing Best Practices in Environmental and Impact Assessments* related to the research priorities under the socio-economic theme addressing "what quantitative and qualitative research methods are most appropriate for generating reliable estimates of direct and indirect social and economic effects and what are the reasons for any differences between the predictions and the reality?". The research deals primarily with the category of economic effects. The specific research objectives are to describe and evaluate the strengths and weaknesses of common methods for economic assessment in EA, develop best practices for applying these methods, and identify gaps and priorities for future research.

The research is based on a review of relevant literature covering a wide range of sources organized around key themes. The research fills a critical gap in the theory and practice of EA by evaluating strengths and weaknesses of alternative methods and identifying guidelines for using these methods to undertake economic impact assessments. It is important to note that the methods reviewed to assess economic impacts are also relevant for assessing the significance of economic, social and environmental effects to help determine if a project is in the public interest as defined under the new *Impact Assessment Act SC 2019 C28 s1*.

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Methodology

The methodology used for this research is to synthesize findings from a literature review. To narrow the research scope, the literature review focused on methods and recommended best practices for assessing economic impacts. Consequently, although some of the overview literature on impact assessment (e.g Hanna, 2016; Noble, 2015) and social impact assessment (e.g., Parkins & Mitchell, 2016; Vanclay et al., 2015) was reviewed, these reviews were designed to help inform and contextualize the review of methods for assessing economic impacts and are not summarized in this paper.

Based on the preliminary literature review, five methods were identified for in-depth review: economic impact analysis (EconIA), sustainability impact assessment (SIA), benefit-cost analysis (BCA), multiple account benefit-cost analysis (MABCA) and multiple-criteria decision analysis (MCDA). A further literature review was completed using search engines and expert input to review these five methods in more detail. Searches were conducted using the keywords "socioeconomic assessment", "environmental assessment", "impact assessment", cost-benefit analysis", "input-output", "multiple accounts analysis", "ecosystem services valuation", "economic forecasting", "economic impact guidelines", "sustainability assessment", "multi-attribute analysis", "multi-criteria analysis", and various combinations. To ensure that relevant grey literature was reviewed, the internet was also searched using the same keywords.

Websites of environmental impact assessment agencies and global development agencies were also reviewed for guidelines and research relevant to economic impact assessment. Due to resource constraints, the search of relevant government agency publications was limited to those published in English. Agency websites within the following jurisdictions were reviewed: Canada and its provinces, the United States, the United Kingdom, Australia, the European Union, and the United Nations. These agencies included the Impact Assessment Agency of Canada (formerly the Canadian Environmental Assessment Agency), provincial impact assessment agencies, the European Commission, and the US Environmental Protection Agency, among others. These sources were identified by looking at EA agencies in each jurisdiction and through examining sources of grey literature appearing in web searches. Additional literature was also identified by reviewing reference lists of studies that had already been reviewed. In total, 172 publications from academic, industry, governmental, and non-governmental organizations were reviewed. The studies reviewed used a variety of methods, including case studies, best practice reviews, modelling, and expert input. The literature review summarized below consists of a description of the method, summary of strengths and weaknesses, best practice guidelines and areas for future research. A case study example is included to help illustrate the strengths and weaknesses of the methods.

Methods for Economic Assessment

Economic Impact Analysis (EconIA)

Description

EconIA is a method that was developed to estimate how a project or policy will impact economic growth on a local, regional, and/or national scale. The method is based on Keynesian income determination theory and Leontief input-output (I-O) multipliers (Davis, 1990). Computable general equilibrium (CGE) models can also be used for an EconIA (Alavalapati et al., 1998; Troiano et al., 2017), but their use is less common. Each of these approaches is discussed below.

I-O models are based on the inter-connections of sectors within an economy. The I-O model uses these interconnections between economic sectors to forecast economic output, employment, labour income, and tax revenues generated by a project. These outputs can further be classified based on the type of effect: direct effects (the value of project production and employment), indirect effects (purchases of equipment and supplies necessary for the project), and induced effects (purchases made by project employees on consumer products) (Grady & Muller, 1986; Gretton, 2013; Manitoba Hydro, 2013; Poole, 1995; Troiano et al., 2017). Canada and most provinces have I-O models that are regularly used to forecast economic impacts (e.g., Hallin, 2010; Statistics Canada, 2019).

I-O models are defined as static, partial equilibrium models because all inputs (e.g., prices and materials) and multipliers are assumed to be fixed and therefore do not accurately account for producer or consumer behaviour or product substitutability (Alavalapati et al., 1998; Denniss, 2012; Grady & Muller, 1986; Gretton, 2013; Hallin, 2010; Lee et al., 2011; Miller & Blair, 2009). Sometimes this limitation is addressed by altering the economic sector linkage coefficients to create a "dynamic" I-O model, but incorporating the appropriate adjustments to these coefficients is difficult (Davis, 1990; Miller & Blair, 2009). I-O models used in EconIA also assume that there are no employment or capital constraints or limits to the economy and no opportunity costs associated with developing the project or policy (Davis, 1990; Grady & Muller, 1986; Gretton, 2013; Gunton, 2003a; Hallin, 2010; Kinnaman, 2011; Troiano et al., 2017; Williams, 2019).

An alternative to I-O models in EconIA is to use regional multipliers derived through either economic base or regional income-expenditure multiplier models. Economic base models assume that exports are the sole driver of economic growth, and so exports are used to forecast regional changes in economic activity (Davis, 1990; Williams, 2019). Accordingly, the regional economy is divided into two core sectors - the base (or export) sector, and the service (or local) sector- and a multiplier is estimated based on ratios of exports to total regional economic activity (Davis, 1990; Williams, 2019). Like an I-O model, the economic base model is a static model that uses a constant ratio of exports to total economic activity (Davis, 1990).

There are several key challenges with economic base modeling (Davis, 1990). First, it is difficult to divide the regional economy into export and non-export sectors because most sectors have both an export and non-export component. Second, it is difficult to obtain up to date data to populate the model. For these reasons, economic base modeling is only appropriate for analyzing short-run impacts on small, single-sector economies, and at best provides only a rough approximation of economic impacts.

Regional income-expenditure models disaggregate the regional economy into sectors normally comprised of consumption, government spending, exports, and imports (Davis, 1990; Williams, 2019). The regional income-expenditure multiplier model is somewhat more sophisticated than an economic base model because it uses more sectors and uses income which is a more accurate and unambiguous indicator of economic impacts than employment (Davis, 1990). The regional income-expenditure multiplier model allows for simple accounting of intergovernmental transfers and local or community-level consumption patterns (Davis, 1990).

Like the economic base model, the regional income-expenditure multiplier model is a static model that assumes constant coefficients, homogenous sectors, and no capacity constraints (Davis, 1990). Further, there is often a lack of data necessary to estimate marginal consumption patterns of local individuals, and therefore average consumption patterns are used that may be inaccurate (Davis, 1990). The model is also incapable of accurately incorporating multiple linkages between sectors, interregional feedback, changes in unemployment, and, like the economic base model, is only appropriate for analyzing short-run impacts on small, single sector economies (Davis, 1990).

Another approach that can be used for EconIA is a CGE model which is a top-down, macroeconomic model that incorporates interconnections between all sectors within the economy (Lee et al., 2011; Troiano et al., 2017; U.S. EPA, 2010). CGE models are grounded in neoclassical economic theory that views the economy as a circular flowing market in which supply and demand will balance over time to reach equilibrium (Dixon & Jorgenson, 2012). Key assumptions include: individuals participating in the economy are rational price-takers; markets are complete, and complete information about the market is available to everyone; there are no externalities; and market characteristics (e.g., preferences and technology) do not change rapidly over time (Van Daal & Jolink, 1993). An advantage of CGE models that increases their accuracy relative to other models is that they incorporate input constraints and do not assume unlimited production capacity or labour (U.S. EPA, 2010). Additionally, CGE models allow for input prices to vary with changes in output prices (Alavalapati et al., 1998). CGE models, however, are rarely used to estimate impacts of development projects in EA because CGE models focus on impacts across larger economic systems instead of at the small-scale regional level, and CGE modelling is complicated and time consuming (Alavalapati et al., 1998; Coordinator-General, 2017; U.S. EPA, 2010).

The outputs of an EconIA using any of these modelling techniques (I-O, economic base, regional income-expenditure, and CGE) are simulations that are used for forecasting economic impacts of a project and assessing the need for infrastructure and services. The academic literature includes case studies of EconIA applications in various types of projects including urban development (Mullin et al., 1981), energy projects (Broadbent, 2014; Joseph, 2013; Stacey & Duchi, 1980), coal mining (Robertson et al., 2017), agriculture (Piper, 2003), and habitat conservation (Prato &

Hamed, 1999). EconIA is often used in EA in Canada (e.g., Conference Board of Canada, 2014, 2015) and other jurisdictions, but has been subject to critical evaluation in recent EA hearings by intervenors on pipeline development (Broadbent, 2014; Gunton et al., 2015; Gunton & Joseph, 2019), energy development (Joseph, 2019) mining (Shaffer, 2009, 2013), and ski resort development (Shaffer, 2011).

Table 1 presents the outputs of a typical EconIA conducted by the Conference Board of Canada (2015) for a recent EA of a major Canadian project (the Trans Mountain Expansion Project).

Table 1. Summary of the economic and fiscal impacts of Trans Mountain Expansion Project

	Alberta	British Columbia	Other Provinces	Canada
Employment effects (person-years)	**27,978**	**75,110**	**20,114**	**123,221**
Project development	14,632	35,864	7,535	58,037
Project operations	13,346	39,246	12,592	65,184
GDP effects (2012 $ millions)	**6,534**	**13,862**	**1,730**	**22,126**
Project development	1,402	2,789	660	4,852
Project operations	5,132	11,037	1,069	17,274
Government Fiscal impact (2012 $ millions)	**14,462**	**2,956**	**10,812**	**28,229**
Project development	239	394	581	1,214
Project operations	568	1,191	1,546	3,305
Higher netbacks	13,655	1,371	8,685	23,710

Source: Conference Board of Canada, 2015, p. 8.

Strengths of EconIA

The literature identifies several strengths of EconIA that make it useful for project and policy evaluation. First, EconIA has a strong theoretical foundation that has been tested empirically and refined over many decades of application. Second, EconIA outputs provide important information to decision-makers by showing economic impacts at a local or regional scale and identifying employment and demographic impacts that are important inputs for regional planning of infrastructure and services to accommodate project development (Davis, 1990; Gunton, 2003a; Kinnaman, 2011).

Weaknesses of EconIA

The literature also identifies a number of limitations of EconIA. First, EconIA is a technocratic process based on computer modeling that rarely includes participation from stake- or rights-holders in the analytical process. Second, the models typically used in EconIA – I-O, economic base, or regional income-expenditure – are all static models in which labour and capital inputs and multipliers are assumed to be fixed, and therefore the models do not accurately account for producer or consumer behaviour or product substitutability that will change the linkages between sectors (Alavalapati et al., 1998; Davis, 1990; Denniss, 2012; Grady & Muller, 1986; Gretton, 2013; Hallin, 2010; Lee et al., 2011). These models also normally rely on outdated data (e.g., historical multipliers) and therefore are inappropriate for projecting long-term impacts. Sometimes this limitation is addressed by altering or updating the economic sector linkage coefficients, but accurately forecasting the appropriate adjustments to these coefficients is difficult (Davis, 1990; Miller & Blair, 2009; U.S. EPA, 2010).

Third, these EconIA models assume that there are no capital or labour input constraints or limits to economic activity, when in reality there are limits based on the supply of available inputs (Alavalapati et al., 1998; Denniss, 2012; Grady & Muller, 1986; Gretton, 2013; Hallin, 2010). This makes EconIA prone to overestimating project impacts by forecasting **gross** impacts of a project and not estimating **net** impacts that account for the opportunity cost of the next best alternative use of labour and capital (e.g., Davis, 1990; Grady & Muller, 1986; Gunton, 2003; Kinnaman, 2011; Lockie et al., 2008; Manitoba Hydro, 2013; Williams, 2019). The models used in EconIA incorrectly assume that any job created by a project would be a net gain to the economy, even though in a well-functioning economy most workers would be employed elsewhere and earn similar wages without the project (Crompton, 2006; Shaffer, 2010). The **net** change in national employment could therefore be closer to zero, and certainly much lower than the gross change estimated by an EconIA. EconIA also overestimates government revenues by omitting incremental costs to government generated by the project and by incorrectly assuming that all the labour and capital used in the project would be unemployed and generate no government revenue if the project did not proceed (Crompton, 2006; Shaffer, 2010). As the case study described later in this paper shows, these weaknesses in EconIA lead to overestimation of project impacts that can result in unjustified or misinformed project approvals (Anex & Focht, 2002; Crompton, 2006; Denniss, 2012; Flyvbjerg et al., 2003; Gretton, 2013; Hanley, 2001; Hollick, 1981; Lockie et al., 2008; Manitoba Hydro, 2013; Matthews, 1975; McAllister, 1982; McDonald, 1990). For example, the CBC EconIA summary shows employment growth of 123,221 person years in the EconIA for the Trans Mountain Expansion Project (Table 1), when the actual increase in direct permanent operating employment is 443 (Conference Board of Canada, 2015, p. 33).

Another weakness is that EconIA normally does not disaggregate impacts to determine who obtains employment (Crompton, 2006; Williams, 2019, 2016). Understanding the distribution of employment effects is a critical component of modern impact assessment (U.S. EPA, 2010; Vanclay et al., 2015).

Finally, outputs of an EconIA, such as employment growth, are often misinterpreted as measures of project benefits used to justify project approval when they are actually just impacts that omit important social, environmental, and economic factors that should be taken into account (Broadbent, 2014; Denniss, 2012; Gunton et al., 2015; Lockie et al., 2008; McDonald, 1990; Williams, 2019).

Recommended Practices for EconIA

A number of practices are recommended in the literature to improve the application of EconIA to help inform decision-makers when determining if a project is in the public interest.

First, the purpose of an EconIA of forecasting regional economic impacts should be clearly stated so that users do not misinterpret EconIA results as a means of estimating project benefits. Second, the limitations of EconIA- such as its inability to identify net impacts, its reliance on static economic relationship, and its assumption that there are no constraints on labour and capital- should be clearly stated (Broadbent, 2014; Gunton et al., 2015).

Third, the impact estimates should be disaggregated by geographic region and by demographic groups to show the distribution of jobs by key stakeholder groups (Crompton, 2006; U.S. EPA, 2010; Williams, 2019). Fourth**,** the **net** impacts should be estimated alongside the **gross** impacts to provide a more accurate estimate of the incremental impacts of the project and to reduce the likelihood of overestimating project impacts (Broadbent, 2014; Crompton, 2006; Gunton et al., 2015; Williams, 2019).

Fifth, the presentation of EconIA results should be done in a transparent and consistent manner by using appropriate metrics for outputs. Total person-years of employment, for example, are often used to present employment impacts, but this can lead to misinterpretation because one person-year may mistakenly be assumed to be equivalent to one permanent job when it is only one person working for one year. Using annual person-years avoids this misinterpretation by treating one person employed for 20 years as just one annual person-year of employment (Broadbent, 2014; Gunton et al., 2015).

Sixth, EconIA modellers should cross-reference multipliers used in an EconIA with average multipliers in the region or country and explain any significant discrepancies in the size of the multiplier (Williams, 2019). This would identify potential anomalies in the forecast that require further analysis. As well, sensitivity analyses should be conducted to address the uncertainty in multipliers and input parameters (such as project expenditures and commodity prices) and show the range of potential impacts (Coordinator-General, 2017).

Lastly, and most importantly, decision-makers should not rely solely on EconIA when determining whether a project is in the public interest since EconIA does not estimate net project costs and benefits or incorporate social or environmental impacts (Broadbent, 2014; Gunton et al., 2015; Williams, 2019). Additional evaluation methods such as BCA should be used in conjunction with EconIA for a more comprehensive evaluation of the project that estimates overall project costs and benefits (Coordinator-General, 2017; Manitoba Hydro, 2013; Pearce et al., 2006; U.S. EPA, 2010; Vickerman, 2007; Williams, 2019).

Research Priorities for EconIA

One research priority for improving EconIA is to develop better methods to take into account the opportunity costs of labour and other project inputs to ensure that constraints on labour and capital are incorporated into the analysis and forecasts estimate **net** instead of just **gross** impacts.

Related to this, more research is also required on how to develop more dynamic I-O models that take into account how changes in demand will impact linkage coefficients between sectors.

Second, research is required on how to provide more accurate estimates of net government revenue that take into account both the incremental costs to government and the opportunity costs of foregone government revenue resulting from reductions in economic activity in other sectors in which the labour and capital would have been employed if the project being assessed was not built.

Third, research is required on how to incorporate uncertainty in the modeling to produce a range of probable outcomes to replace the typical practice of providing only one forecast.

Fourth, standardized definitions of employment, gross domestic product (GDP), and government revenue impacts should be developed to reduce the likelihood of misinterpretation of results. Fifth, research is required on how to better disaggregate EconIA impacts to ensure appropriate attention on target groups and regions. Finally, comprehensive guidelines for undertaking an EconIA in EA should be developed to ensure that best practices are followed, and results are presented in a clear and consistent manner.

Sustainability Impact Assessment (SIA)

Description

SIA is a comprehensive evaluation and decision-making framework that analyzes the potential economic, environmental, social, heritage, and cultural impacts associated with a proposed policy, project, program, or plan from a sustainability perspective (Bond et al., 2012; Gibson et al., 2013; OECD, 2010; Sala et al., 2015). SIA is intended to improve upon standard EA by using a goals-oriented approach in which the results of the assessment are compared to sustainability targets (Bond et al., 2012; Gibson et al., 2013; OECD, 2010; Sala et al., 2015). SIA has been used in several Canadian EAs (Gibson, 2011; Kemess North Mine Joint Review Panel, 2007).

Although there are several approaches for conducting SIA, most SIAs consist of the following steps:

1. Determine the scope of the SIA;
2. Select tools and methodologies that correspond with the scope of the SIA;
3. Assess the impacts, incorporating quantitative and qualitative methods (including stake- and rights-holder participation), and using a multidisciplinary approach that considers economic, environmental, social, heritage, and cultural impacts;
4. Identify sustainability targets covering economic, social, and environmental objectives and measure the impacts of the project or policy relative to the sustainability targets;
5. Identify mitigation measures and recommendations regarding project approval; and

6. Communicate results to decision-makers.[3]

It is important to note that SIA is not a single, cohesive method but instead it is an analytical approach that utilizes a range of different methodologies to assess project impacts relative to sustainability targets. Some analysts conclude that there is no consensus on what SIA is or how it should be applied (Bond et al., 2012). For this reason, it cannot really be considered a stand-alone method similar to other methods reviewed in this paper.

Strengths of SIA

The principal strength of SIA is that it is a comprehensive approach that uses short- and long-run sustainability targets to assess projects, compared to other methods that just identify impacts without reference to sustainability targets. Other noteworthy strengths of SIA include its incorporation of qualitative and non-monetized data and its explicit focus on uncertainty of potential impacts (Bond et al., 2012; OECD, 2010; Sala et al., 2015).

Weaknesses of SIA

A potential challenge in using SIA is that it requires sustainability targets, which are difficult to determine (Sala et al., 2015), and it requires assessing full cumulative impacts of all proposed projects and policies to forecast the impacts of a proposed project on sustainability targets. Given the difficulties in assessing cumulative impacts, analyzing multi-geographical and long term temporal scale impacts with SIA is particularly challenging (Bond et al., 2012; Sala et al., 2015). A second weakness is that SIA requires using a number of analytical methods that are not clearly defined or specified in the SIA framework and, in many instances, methods to assess impacts of a project on sustainability targets may be deficient (Sala et al., 2015). A third weakness is that SIA is a comparative approach that assesses proposed policies or projects submitted for review rather than a solution-oriented approach that seeks the ideal or optimal project or policy for reaching sustainability targets (Sala et al., 2015). This latter critique applies to most EA processes that react to project proposals instead of proactively seeking to identify the best solutions to societal problems. Finally, as noted above, there is no consensus on what SIA is or how to apply it (Bond et al., 2012).

Recommended Practices for SIA

The literature recommends practices for conducting a SIA, including ensuring that stake- and rights-holder participation is representative, proper SIA tools and methods are used, comprehensive sustainability goals are set, cumulative impacts are assessed, and that SIA is undertaken as an interactive learning process that facilitates discussion as a decision-informing tool rather than a decision-making tool (e.g., Gibson et al., 2013; Sala et al., 2015).

Research Priorities for SIA

The principal research priorities for SIA are to identify appropriate means of defining sustainability targets, identify techniques for assessing cumulative impacts relative to the targets,

[3] List of steps adapted from Bond et al., 2012; Gibson et al., 2013; OECD, 2010; Sala et al., 2015

and determine how these targets used in SIA should be integrated into the EA decision-making process.

Benefit-Cost Analysis (BCA)

Description

BCA is considered by many to be the most comprehensive method for assessing the net impact of a project or policy on society as a whole and whether the project is in the public interest (Arvanitis et al., 2015; Boardman et al., 2017; Browne & Ryan, 2011; de Jong & Geerlings, 2003; Finnveden & Åkerman, 2014; Gasparatos et al., 2008; Rodrigo, 2005). BCA was first conceptualized in the mid-1800s and came into practical use in the 1930s in the United States water management sector. BCA's theoretical foundation and methodology were extensively developed in the 1950s, and various debates and refinements over theory, methodology, and recommended practices have continued into the present day (Hanley, 2001; Hanley & Spash, 1996; Major & Frederick, 1997; Pearce, 1998; Pearce et al., 2006).

BCA is used to compare project alternatives and determine whether the value provided by the best alternative project or policy outweighs the compensation that must be provided to those who are impacted (Boardman et al., 2017; Shaffer, 2010). BCA does this by assessing whether the total benefits of a project or policy are greater than the total costs. In BCA methodology, a benefit is defined as anything that a person would theoretically be willing to pay for and a cost is defined as anything that a person would need to be compensated for to accept a consequence (Boardman et al., 2017). BCA is comprehensive in its coverage of a project's potential impacts including the economic, social, and environmental impacts of a project or policy over a certain period of time (often the lifetime of the project or policy). Consequently, BCA is useful for assessing social and environmental impacts, as well as economic impacts. The result of a BCA is a bottom-line sum of all the benefits and costs, which helps indicate whether the project or policy generates a net benefit to society and therefore whether it is in the public interest. Typical steps in BCA include:

1. Determine the scope of the potential impacts of the project or policy and determine who has the potential to be impacted;
2. Predict all potential benefits and costs of the project or policy;
3. Convert any impacts that are not normally expressed in monetary values using appropriate non-market valuation techniques;
4. Discount all future monetized benefits and costs to the present using an appropriate discount rate;
5. Calculate the net present value (NPV), internal rate of return (IRR), and the benefit/cost ratio of the project or policy;

6. Perform a sensitivity analysis to provide a range of potential results under alternative assumptions; and
7. Interpret and communicate the results.[4]

Strengths of BCA

An important strength of BCA is that it is based on well-developed theory and practice that has been tested and refined over more than a century (Boardman et al., 2017; Hanley, 2001; Hanley & Spash, 1996; Major & Frederick, 1997; McAllister, 1982; Pearce, 1998; Pearce et al., 2006). BCA has been widely used in many project evaluations worldwide and numerous texts and guidelines have been developed to inform its use.[5] Additionally, BCA is an evaluation tool that is well recognized by many countries (Boardman et al., 2017; Browne & Ryan, 2011; Coordinator-General, 2017; Hanley, 2001; Rodrigo, 2005; U.S. EPA, 2010).

Second, unlike EconIA, BCA estimates **net** impacts rather than **gross** impacts and accounts for the opportunity cost of the next best alternative use of resources used by the project. Third, BCA is a comprehensive method that attempts to incorporate all relevant positive and negative social, environmental, and economic effects. Consequently, BCA provides a better accounting of a project's impacts than EconIA and therefore helps decision-makers to assess whether the project is in the public interest (Gillespie & Bennett, 2015; Hundloe et al. 1990). Also, with its broader scope covering environmental and social impacts as well as economic impacts, BCA can address the sustainability considerations in project assessment (Atkinson & Mourato, 2015; Barbier et al., 1990; Hundloe et al., 1990; Knowler, 2005; Roan & Martin, 1996).

Another strength of BCA is that it is flexible and can be adapted to evaluate a variety of projects and policies (Arvanitis et al., 2015; Broekx et al., 2013; Gunton et al., 2015; Jun, 2018; Kolosz & Grant-Muller, 2015; Manni & Runhaar, 2014; Mohammed, 2009; Shaton & Hervik, 2018). Also, the underlying concept of BCA is intuitively easy to understand since it primarily involves adding up all the costs and benefits and discounting them to the present value (Boardman et al., 2017; Shaffer, 2010).

Weaknesses of BCA

One weakness of BCA is that it often ignores the spatial and demographic distribution of costs and benefits, although it is theoretically capable of estimating these distributions (Pearce et al., 2006; Shaffer, 2010). This is important because a positive bottom-line sum of the costs and benefits does not necessarily mean that everyone is better off, and there may be some groups who are actually worse off.

Second, the requirement of BCA to convert non-market environmental and social impacts into monetary units is both challenging and contentious because all of the methods used to estimate the monetary value of non-market goods and services have limitations (Atkinson & Mourato,

[4] Adapted from Shaffer (2010).
[5] See for example See for example Boardman et al., 2017; European Union, 2008; Jenkins et al., 2007; OECD, 2018; Office of the Best Practice Regulation, 2016; Pearce et al., 2006; Robinson et al., 2019; Sartori et al., 2014; Treasury Board of Canada Secretariat, 2007; U.S. EPA, 2010.

2015; Bromley & Vatn, 1994; Hanley & Spash, 1996; Niewik, 1992; Pearce et al., 2006; Sagoff, 2007; U.S. EPA, 2010). Common methods of estimating non-market values such as public surveys (contingent valuation) can generate widely varying monetary results depending on the context and structure of the questions (Knetsch, 2005; Parks & Gowdy, 2013; Shaffer, 2010; Zerbe & Bellas, 2006). For example, valuation of environmental benefits is on average 10.4 times higher when surveys ask what people would be willing to accept (WTA) for an adverse environmental impact compared to what they would be willing to pay (WTP) to prevent the same impact (Horowitz & McConnell, 2000).

Third, BCA requires subjective judgements by the analysts that may not be transparent but can significantly impact the results. These subjective judgements include determining which benefits and costs will be included (e.g., who the impacted population will consist of), choosing a discount rate, forecasting future values, and estimating non-market impacts (Atkinson & Mourato, 2015; Bromley & Vatn, 1994; Broome, 2008; Hanley & Spash, 1996; Niewik, 1992; Sagoff, 2007; Stirling, 1997).

Fourth, although BCA is capable of incorporating public input in monetary estimations, conducting a BCA is often a complex, technocratic process that excludes effective public participation in the analytical process. It is often viewed as a "black box" (Hanley, 2001).

Fifth, although BCA is capable of considering the sustainability of a project through incorporating environmental and social impacts, it typically follows a weak sustainability approach that assumes environmental costs can be offset with financial benefits, so as to not limit the ability of future generations to meet their needs (Gutés, 1996). BCA does not properly consider the precautionary or sustainability principles as it is assumed the project should go ahead if there is a positive bottom-line sum.

Finally, BCA does not provide all the information that is important to the decision-making process, such as employment estimates and revenue impacts (Adamowicz, 2004; Atkinson & Mourato, 2015; Boardman et al., 2017; Crookes & de Wit, 2002; Navrud & Pruckner, 1997; Nelson, 2006; Pearce et al., 2006).

Recommended Practices for BCA

Recommended practices for undertaking BCA are outlined in a large number of manuals and texts.[6] In brief, key recommended practices are: (1) ensure that the scope of the BCA is broad enough to include all the relevant impacts to all of the impacted parties; (2) collaborate with stakeholders when appropriate to get input into decisions, such as determining what impacts to include in the study and how market and non-market impacts will be assessed (Plate et al., 2009; Udofia et al., 2015); (3) ensure that stakeholders have enough information to understand the assumptions, limitations and context regarding the valuation of the impacts (Lamarque et al., 2011); (3) use a range of discount rates as recommended in published guidelines (Boardman et al., 2017; Coordinator-General, 2017; Shaffer, 2010; U.S. EPA, 2010); (4) perform a sensitivity

[6] See for example: Boardman et al., 2017; European Union, 2008; Jenkins et al., 2007; OECD, 2018; Pearce et al., 2006; Robinson et al., 2019; Sartori et al., 2014; Shaffer, 2010; Treasury Board of Canada Secretariat, 2007; U.S. EPA, 2010

analysis to assess the effects on the results of the range of probable assumptions regarding project costs, revenues, and other parameters including discount rates and social costs (e.g., Almansa & Martínez-Paz, 2011; Gowdy, 2004; Boardman et al., 2017); (5) use BCA in conjunction with other impact assessment methods to provide alternative perspectives on project impacts (U.S. EPA, 2010); (6) be transparent with the results by making them publicly available and communicating them in an accessible way that clearly shows the benefits and costs of the project and how the project or policy is (or is not) in the public interest (Shaffer, 2010); (7) assess the distribution of benefits and costs and present results to support decision-makers' understanding of how impacting vulnerable populations may be affected (Shaffer, 2010; Treasury Board of Canada Secretariat, 2007; U.S. EPA, 2010); and (8) clearly state the limitations of the analysis and use the results as an input into decision making instead of accepting the results as a sacrosanct indicator of the optimal decision (Campen, 1986).

Research Priorities for BCA

An important area for further research in BCA is discount rates. The choice of a discount rate has a significant impact on the results, but there is no agreement on the appropriate rate or discounting approach to use. Various studies recommend uniform discount rates ranging from about 1.5% to 11.5 % (Table 2), and some researchers recommend using dual discount rates, with lower rates for environmental and public health costs and benefits and higher rates for market goods and services, or time-declining rates (Freeman & Groom, 2016; Kolosz & Grant-Muller, 2015; Kula & Evans, 2011; Postma et al., 2013; Weitzman, 1998). Others recommend against any discounting of high risk impacts such as climate change (Pearce et al., 2006). One of the issues underlying these debates is the choice between discount rates based on social time preference, which are relatively low, versus rates based on the social opportunity cost of capital, which are significantly higher (Table 2). Given the significant impact that discount rates can have on results, more research is required to define appropriate rates and the range of rates that should be used in sensitivity analyses.

Table 2. Alternative discount rates

Study	Time Preference Rates	Opportunity Cost of Capital Rates
Moore et al. (2004)	1.5%	4.5%
Jenkins and Kuo (2007)	4.0%	11.5%
U.S. Office of Management and Budget (2003)	3.1%	7.0%
U.S. EPA (2010)	3.0%	7.0%
Treasury Board of Canada Secretariat (2007)	3.0%	8.0%

A second issue is the valuation of non-market impacts, such as climate change and the value of ecological services. Common techniques for valuing non-market items include contingent valuation that asks people what they would be willing to pay, and hedonic pricing studies that estimate the variation in prices that people pay based on the impact of non-market factors such as the impact of air pollution on housing prices (Horowitz & McConnell, 2000). An issue is that these methods can generate a wide variation in monetary estimates (Horowitz & McConnell, 2000). Another problem is that these studies may be too costly or take too long to complete. In these cases, benefit transfer methods can be used in which analysts adopt and use valuation estimates from other studies, but the applicability of benefit transfer is limited to goods and services with similar characteristics (Pearce et al., 2006).[7] Therefore, meta-research summarizing the valuation of non-market goods and services adjusted for consistency in methodology and assumptions would be useful to provide an inventory of accepted values. Another area of research is to provide guidance and resolution of the debate over the use of WTP versus WTA values in BCA due to the significant impact that the choice between these valuation approaches can have on the estimated values and the results of a BCA (Horowitz & McConnell, 2000; Pearce et al., 2006)

A third area for research is how to assess the distribution of costs and benefits and how to incorporate equity into the BCA. Standard BCA practice relies upon a "one dollar one vote" calculus based on the current distribution of wealth, but this undervalues impacts on poorer people. Methodologies based on weighting costs and benefits have been developed to address this, but more research is required on how to apply them (Pearce et al., 2006).

A fourth area of research is how to address broader economy-wide impacts of a project (U.S. EPA, 2010). BCA is normally applied on the assumption that the project will not impact overall economic activity or prices, but this assumption is not always valid. For example, a BCA of a liquefied natural gas project should include an estimate of the cost of GHG emissions, but it is challenging to estimate what the economy-wide impact of the project will be on GHG emissions. One assumption could be that all the GHG emissions from the project are incremental and should form the basis for the cost estimate. An alternative assumption is that the emissions may offset emissions from other energy sources such as coal that the natural gas displaces and the project would therefore reduce world emissions and/or the project would not increase emissions because if it was not developed an alternative natural gas project may be developed elsewhere in the world to meet this demand. Each of these assumptions would generate significantly different estimates of GHG damage costs.

Multiple Account Benefit-Cost Analysis (MABCA)

Method Description

MABCA is an evaluative tool that was designed to address the deficiencies of traditional BCA by using a combination of BCA, EconIA, and other methods of impact assessment to assess

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[7] Environment Canada co-hosts an online database of studies that can be used for benefit transfer, the Environmental Valuation Resource Inventory (www.evri.ca).

projects and present results in a multiple account framework based on a number of indicators instead of a single bottom-line sum (Shaffer, 2010). MABCA was originally developed by the U.S. Water Resources Council (1983), which developed a framework consisting of four accounts: national economic development, environmental quality, regional economic development, and social effects. These guidelines were updated by the U.S. Council on Environmental Quality in 2014. Canada's Department of Fisheries and Oceans developed a similar framework consisting of five accounts to evaluate and compare salmonid enhancement projects (Shaffer, 2010), Applications Management Consulting Ltd. (2015) developed an MABCA to evaluate transportation options in Alberta, and the BC Ministry of Agriculture and Lands (2007) developed a version consisting of six accounts to evaluate land use options summarized below (Table 3). One of the most recent versions of MABCA, similar to the Ministry of Agriculture and Lands (2007) version, was developed by Shaffer (2010).

Unlike traditional BCA, MABCA is meant to inform discussion by disaggregating impacts into different categories rather than providing a single bottom-line sum of the net benefits of a project. The scope of MABCA is all consequences (positive and negative) associated with a project or policy for everyone with standing. Like BCA, MABCA includes a net benefit estimate based on a monetary summation of costs and benefits. But unlike BCA, MABCA disaggregates impacts by category and uses non-monetary measurement of impacts and their significance where monetary measures would not be reliable or acceptable (Shaffer, 2010).

The steps in conducting a MABCA based on BC government guidelines (Ministry of Agriculture and Lands, 2007) are as follows:

1. Identify the accounts to be used;
2. Estimate impacts of a project for each account;
    a. Assess the economic development impacts using EconIA for the economic development account;
    b. Assess the government revenue impacts for the government finances account.
    c. Assess the social impacts, such as demographic changes and impacts on income, housing, and unemployment rates by key stakeholder groups for the social implications account;
    d. Assess the impacts on Indigenous populations for the Indigenous implications account;
    e. Conduct a BCA to estimate the costs and benefits for the net economic value account;
    f. Assess the impact of valued components for the environmental assessment account.
3. Present the results in a summary of all the accounts in a single table format for decision-makers.

Strengths of MABCA

MABCA has many of the same strengths as traditional BCA including: estimating the net impacts of a project or policy (versus gross impacts); comprehensive coverage of social, environmental, and economic impacts; and providing information on project impacts useful for decision making. But MABCA also has some additional benefits that BCA lacks (Gunton 1992; Shaffer 2010).

First, while traditional BCA results in a bottom-line sum of the overall benefits and costs that may conceal key information and impacts relevant to decision-makers, MABCA provides results in a disaggregated matrix format that clearly displays key impacts. Disaggregating impacts by type allows decision makers and stakeholders to understand the range of impacts and to apply their priorities to weight different types of impact assessments in reaching their decisions.

Second, MABCA does not attempt to monetize all impacts, but instead assesses non-market and intangible impacts using more appropriate units of measurement and/or critical values and provides information on other key indicators important to decision-makers such as fiscal and employment impacts (Shaffer, 2010).

Third, MABCA is flexible and can be applied to a wide range of project and policy types and can be adapted based on the scope of impacts by further disaggregating or removing accounts. The summary matrix output is also relatively easy to understand for a broad audience.

Weaknesses of MABCA

MABCA faces the same challenges as BCA and EconIA in accurately estimating impacts because it uses both BCA and EconIA in the analysis (Shaffer 2010). As with traditional BCA, estimating impacts on non-market values is particularly challenging, although MABCA mitigates this problem by using non-monetary measures where necessary. Another weakness is that MABCA is not designed to provide a bottom-line estimate of project net benefits, and therefore does not attempt to provide a conclusion as to whether a project or policy is in the public interest (Gunton, 1992; Shaffer, 2010). Given the challenges in comparing all costs and benefits, this lack of a bottom-line aggregation in MABCA can also be viewed as a strength in that in avoids presenting a potentially misleading conclusion regarding project net benefits to society (Gunton 1992; Shaffer 2010).

Recommended Practices for MABCA

Recommended practices for MABCA are outlined in various guides and texts.[8] As is the case with BCA and EconIA, it is important in MABCA to state limitations and perform sensitivity analysis using alternative parameters (e.g., different input prices, discount rates, etc.), ensure the scope of the analysis is broad enough to include all impacts, and collaborate with stake- and rights-holders to ensure the results reflect public priorities (Plate et al., 2009; Shaffer, 2010; Udofia et al., 2015). Impacts that cannot be appropriately estimated quantitatively should be represented qualitatively (including description, extent, and significance) or using a critical value indicating what an impact would have to be worth for a particular alternative to be favoured (Shaffer, 2010).

[8] See for example Applications Management Consulting Ltd., 2015; BC Ministry of Transportation, 2014; City of Saskatoon, 2018; Ministry of Agriculture and Lands, 2007; Shaffer, 2010

Research Priorities for MABCA

MABCA is a combination of EconIA, BCA, as well as other environmental impact assessment methods. Consequently, research priorities for MABCA are similar to the priorities for EconIA and BCA outlined earlier in this paper. Additional research priorities for MABCA are to define the accounts and their contents and indicators. A second research priority is to determine how to compare and weight the different accounts to determine the overall assessment of the project.

Table 3. British Columbian Multiple Accounts Framework

Category	Analysis Techniques	Key Indicators
Socio-Economic Assessment		
Economic Development (local and provincial) by sector (e.g., forestry, mining, oil and gas, tourism, recreation, agriculture, trapping, botanical forest products).	Economic Impact Analysis	Expected economic activity including indicators such as number of existing jobs, potential number of jobs, indirect and induced jobs and income.
Provincial Government Finances	Fiscal Impact Analysis	Net provincial government revenues.
Social Implications (mainly local area). Includes local communities and aboriginal communities.	Social Impact Analysis	Population, jobs and incomes, distribution of job opportunities, resource-based recreation activities, and other aspects of wellbeing.
Specific Aboriginal Implications	Social and Heritage Impact Analysis	Specific Aboriginal implications that cannot be discussed in the Economic Development and Social Implications sections.

Net Economic Value (mainly provincial) by sector (e.g. forestry, mining, oil and gas, energy, tourism, recreation, and environment). Net Economic Value should consider existing and potential commercial and non-commercial sectors that depend on the resource.	Benefit – Cost Analysis	For commercial sectors: product prices before tax less production costs (economic rent); in addition, estimated rent taken by labour / industry. Net of any externalities. For non-commercial sectors: some measure of consumer surplus, i.e. what people would be willing to pay for the activity or amenity above what they are paying. Discussion of implications for natural capital and ecosystem goods and services.
Environmental Assessment		
Environment (provincial and regional)	Environmental Risk Assessment	Risk levels associated with different scenarios and quantitative and qualitative measures of outcomes on key fine filter and coarse filter indicators.
Socio-Economic and Environmental Assessment		
Social, Economic and Environmental Assessment	SEEA	Merges the Socio-Economic Assessment and the Environmental Assessment results and demonstrates synergies and trade- offs.

Source: Ministry of Agriculture and Lands, 2007, p. 4.

Multiple-Criteria Decision Analysis

Method Description

MCDA is a structured decision-making method developed in the late 1960s that is used to evaluate project or policy alternatives based on a set of attributes or criteria. MCDA has been widely applied in planning and policy analysis. There are three main MCDA techniques (Cheng et al., 2002; Thokala & Duenas, 2012). The first is the multiple attribute utility technique, also known as the value measurement technique, which consists of measuring individuals' preferences regarding project alternatives. A second technique is outranking which entails directly comparing alternatives on a one-on-one basis for each criterion to determine which single alternative is preferred, and then adding up the results to determine the best alternative. The third technique uses an interactive process to find the alternative that most closely satisfies all the criteria.

The typical steps in MCDA include:

1. Identify and clearly define the problem (in the case of EA, the problem would be to define and assess the impacts of a proposed project or policy);
2. Identify a range of alternatives that have the potential to address the problem or issue;
3. Develop a list of criteria that accurately reflect the objectives of society in relation to the problem being addressed. For example, some criteria for deciding where to locate a landfill may include impacts on agriculture, hydrogeology, heritage, cost, site extensibility, reliability, and political support;
4. Collect data to assess which criteria are perceived to be the most important (and apply numeric weights) as well as determine which alternatives are perceived to best satisfy the criteria. Common data collection techniques include surveys, interviews, literature reviews, and document analyses;
5. Rank all the alternatives based on how well they satisfy the criteria and present in a matrix summary; and
6. Select and implement the best alternative.

Strengths of MCDA

There are five main strengths of MCDA (Cheng et al., 2002). First, MCDA is a widely accepted and well-tested method for making planning decisions. Second, MCDA allows for stakeholder input and directly considers stakeholder preferences in the decision-making process. Third, MCDA can work with both qualitative and quantitative data. Fourth, MCDA allows for identifying similarities and differences in preferences between stakeholder groups because it records individual preference ratings. In cases where preferences are similar, this makes it easier for decision-makers to justify the chosen alternative and reduce opposition. Fifth, the MCDA process is relatively transparent in that it clearly shows how alternatives were ranked by respondents and which alternative is the best option, making a resulting decision more defensible.

Weaknesses of MCDA

A weakness of MCDA is that while it involves seeking the best alternative, it does not address whether there is a need for the project or policy in the first place. A second weakness is that it is challenging to rank the options in a manner that accurately incorporates the preferences of all stakeholders (Cheng et al., 2002). Reflecting the preferences of stakeholders is also difficult because the preferences of stakeholders may change over time (Cheng et al., 2002). Additionally, stakeholders must be properly informed to be able to participate effectively in the MCDA process.

A third problem is that it is difficult to apply MCDA to EA processes in Canada because many of the project details have already been determined by the proponent so there is not a full list of alternatives available to evaluate and rank by MCDA. Once the project proposal has entered the EA process, the proponent is unlikely to be considering multiple alternatives to the project and any changes made to the proposal are often marginal and for the purpose of mitigating adverse impacts. This may change somewhat under the new *Impact Assessment Act SC 2019 C28 s1* that allows for greater engagement and revisions in the earlier stages before the project proposal description is prepared, but the impact of this change on consideration of alternative project designs is unclear. For these reasons MCDA in its current form has lower utility for EA relative to the other methods reviewed in this paper.

Case Study

A case study example based on the literature review is helpful for illustrating the strengths and weaknesses of different methods for economic assessment in EA. The results of three methods are used in the case study: EconIA, BCA and MABCA. SIA is not used in the case study because it is a general approach as opposed to a specific method and its application requires sustainability targets that are not available. MCDA is also not used in the case study because it is not well suited to EA. The recent EA of the Trans Mountain pipeline expansion (TMX) is used for the case study and the results of the three methods applied to TMX are summarized in Table 4.

An EconIA of TMX was completed by the Conference Board of Canada (2015) for the project proponent. The CBC's EconIA estimated employment impacts to be between 443 and 123,221 "jobs" (Table 4). The low end of the range (443) is the number of direct operating jobs generated by TMX, while the upper end of the range (123,221) is the number of person-years of direct, indirect, and induced employment over the construction phase and a 20-year operating period based on the formula that one person working for 20 years is 20 person-years of employment. Interestingly, the lower direct operating job estimate (443) and the total direct, indirect, and induced job estimate (3,260) defined in annual person-years of employment are not provided in the summary table of the EconIA produced by the CBC for TMX (Table 1). Instead, the employment numbers presented in the summary table in the CBC report are the total person-years including indirect and induced multiplier effects for operating employment (65,184) and project construction employment (58,037), with the total combined person-years of 123,221 shown in bold in the CBC EconIA report (Conference Board of Canada, 2015, p. 8). The CBC report therefore highlighted the highest employment numbers, which can lead to misinterpretation by decision-makers that the project will create 123,221 jobs when the number of permanent jobs is 3,260.

Even this employment estimate of 3,260 overstates employment impacts because it measures gross impacts without taking into account that most of the workers employed on the TMX would be employed elsewhere in the economy if TMX did not proceed. Therefore, the net gain in employment is closer to zero and certainly much lower than 3,260 (Gunton et al., 2015). The CBC analysis illustrates how EconIA can overestimate economic impacts of projects and bias decision-makers towards project approval.

BCA does not generate estimates of the number of employees, so no employment numbers are shown in the BCA column (Table 4). However, a BCA for TMX conducted by Gunton et al. (2015) provides a monetary employment benefit estimate of $77 million based on the assumption that some of the employees on the TMX could earn higher salaries than they could earn in alternative employment (Table 4).

MABCA results for TMX provided in Table 4 estimate gross annual person-years of operating employment of 443 direct and 3,260 based on employment estimates from the project proponent's application and the CBC EconIA report (Conference Board of Canada, 2015). The MABCA also provides a **net** employment estimate of no change in employment based on the assumption that, given the high demand for workers in the economy, workers employed on the project would be employed elsewhere if the project did not proceed (Table 4). This net employment estimate could be adjusted upward if the economy was forecast to experience higher unemployment. Like the CBA, the MABCA also provides a monetary employment benefit estimate of $77 million based on the assumption that some of the employees on the TMX could earn higher salaries than they would earn in alternative employment. These employment estimates generated by the MABCA are lower than the employment estimates provided by CBC's EconIA and less prone to misinterpretation because they are annual person-years, which is a more accurate representation of jobs created than total persons years used in the CBC EconIA. The MABCA inclusion of a net employment estimate is also a more accurate estimate of overall employment impacts than the CBC's gross employment estimate because, unlike the CBC estimate, the MABCA estimate does not assume that all the employees on the project would be unemployed if the TMX was not built.

The CBC (2015) EconIA estimates government revenue from the TMX of $4.5 billion in the scenario without an increase oil price and $28.2 billion with the oil price increase (Table 4). The issue of whether the TMX would result in higher oil prices is an area of dispute that is not related to the EconIA method per se, so the evaluation will just focus on the $4.5 billion scenario without the oil price increase. The CBC's revenue estimate of $4.5 billion revenue is an estimate of **gross** revenue without any deductions for incremental costs to government generated by the TMX such as government's $1.5 billion Ocean Protection Plan which is designed in part to mitigate marine risks of the TMX (Canada Office of the Prime Minister, n.d.). The $4.5 billion estimate also does not account for the fact that most if not all of the labour and capital employed in the TMX would be employed elsewhere in the economy if the TMX was not built and would generate government revenue in the absence of the TMX. Therefore, the **net** change in government revenue would be much less than the $4.5 billion. By failing to provide a net estimate that takes into account additional costs generated by the TMX and alternative revenue that would be generated if the TMX did not proceed, the CBC EconIA gross revenue estimate significantly overestimates the impact of TMX on government revenue.

BCA does not generate estimates of government revenue, so no government revenue estimates are provided in the BCA column in Table 4. Unlike the BCA, the MABCA includes a government revenue account. The estimates of government revenue of $243 million provided in Table 4 are based on the TMX evaluation by Gunton et al. (2015). The $243 million estimate is a more accurate estimate of government revenue impacts than the CBC EconIA estimate of $4.5 billion because it is based on the **net** change in government revenue, which takes into account the revenue loss that would have been generated by alternative uses of the labour and capital if the TMX did not proceed. In effect, the $243 million estimate is based on the gross government revenue generated by TMX less the revenue that would have been generated by alternative use of the labour and capital if TMX was not built. This net estimate of $243 million in the MABCA also likely overestimates net revenue because it does not deduct incremental expenditures incurred by government such as marine protection measures in the Ocean Protection Plan associated with TMX.

The CBC EconIA does not provide any estimate of net project benefits because it omits most of the project's benefits and costs. The BCA conducted by Gunton et al. (2015) estimates all costs and benefits of the TMX and concludes that the costs exceed the benefits and the TMX would result in a net loss (net cost) to Canada of between $4.6 and $23 billion, with a base case net cost of $7.4 billion (Table 4). The range is based on a sensitivity analysis using different assumptions regarding future revenue and costs and different discount rates. The MABCA net economic value account provides the same net cost estimate as the BCA (Table 4).

It is interesting to compare the CBC's EconIA GDP impact "benefit" estimate of $22.1 billion (Conference Board of Canada, 2015) to the BCA and MABCA net cost estimate of between $4.6 and $23 billion. The GDP number provided in the EconIA ($22.1 billion) is the monetary estimate of the total output of the project, without taking into account the costs of production. In contrast, the net benefit estimate in the BCA and MABCA is the benefit of the project output less all the costs of producing the output. The BCA and MABCA result is a more meaningful measure of the contribution of TMX to the public interest than the GDP indicator because the BCA and MABCA estimate takes into account all the project costs and benefits while the GDP estimate just sums the monetary value of the output without deducting the costs. Using the GDP approach in the EconIA, for example, would show that digging holes and filling them back in would be beneficial simply because digging holes incurred a cost, even though there would be no benefit to society.

Table 4. Comparison of economic impacts studies for the TMX project

Indicator	EconIA	BCA	MABCA
Net Benefit **Base Case (millions of $)**	n.p.*	$(7,394)	$(7,394)
Net Benefit **Range (millions of $)**	n.p.	$(4,610) to (23,035)	$(4,610) to (23,035)
Construction employment (direct total person-years)	28,202	n.p.	28,202
Construction employment (total person years)	58,037	n.p.	58,037
Operating employment (direct total person years over project operating life)	8,870	n.p.	n.p.

Operating Employment (total person years over project operating life)	65,184	n.p.	n.p.
Total Employment (total construction plus total operating person years over project operating life)	123,221	n.p.	n.p.
Direct Operating Employment (annual person-years)	443	n.p.	443
Total Operating Employment (annual person-years)	3,260	n.p.	3,260
Net Direct Operating Employment (annual person years)	n.p.	n.p.	nil
Net Total Operating Employment (annual person-years)	n.p.	n.p.	nil
Net Employment Benefit over project life (millions of $)	n.p.	$77	$77
Total Gross Government Revenue over project life (millions of $)	$4,520	n.p.	n.p.
Total Net Government Revenue over project life (millions of $)	n.p.	n.p.	$243
Gross Annual Government Revenue (millions of $)	$165	n.p.	$26
Gross Government Revenue including higher oil prices over project life (millions of $)	$28,230	n.p.	n.p.
Net Government Revenue including higher oil prices over project life (millions of $)	n.p.	n.p.	$1,143
GDP over project life (millions of $)	$22,126	n.p.	n.p.
GDP Annual (millions of $)	$608	n.p.	n.p.

Source: EconIA results based on CBC (2015); BCA and MABCA results based on Gunton et al. (2015). Project life estimates are based on a 7-year construction period and 20-year operating period.

*n.p. means not provided by the analytical method.

Implications

This literature review shows that there are several well-developed methods based on a strong theoretical and practical foundation for assessing economic effects of projects. The strengths and weaknesses of the various methods are well documented and best practices for applying the methods are gathered from the literature. Nonetheless, as the case study of TMX illustrates, the application of these methods in EA can generate very different and potentially misleading impact results that can impede sound project evaluation and lead to misinterpretations of project impacts by decision-makers.

The review shows that while MCDA has merits for many applications related to planning and public policy, it is not well suited to EA. SIA also has strengths, but it is more of an analytical approach instead of a clearly defined method and considerably more work would need to be done to develop SIA so it can be easily applied to EA. However, some of the features of SIA such as using sustainability targets to assess cumulative impacts have considerable merit and could be integrated into other methods.

The review confirms that EconIA is a valuable, well defined method that generates important information on project economic impacts that is useful for planning infrastructure and services needed to accommodate economic and demographic changes resulting from new projects. However, there is also a consensus in the literature that EconIA has serious weaknesses because it relies on techniques that assume no constraints on labour and capital and consequently overestimates project economic impacts. This problem of overestimation is more pronounced at the provincial and national levels than the regional level where it is easier to import labour and capital to meet project needs and supply constraints are therefore less onerous than at the provincial and national levels. Therefore, the gross employment forecasts provided by EconIA are a reasonable indicator of incremental project impacts at the regional level where there is in-migration of labour, but a poor indicator of impacts at provincial and national levels.

The literature also shows that fiscal impacts generated by EconIA are often over-estimated because they are gross estimates that do not deduct incremental costs to government and do not account for the opportunity costs of labour and capital that would have generated government revenue if the project did not proceed. Another serious problem with EconIA is that the GDP, employment, and fiscal impacts are often misinterpreted as measures of project benefits when they are in fact only economic impacts that do not include costs.

The literature identifies strategies for addressing these weaknesses in EconIA including: (1) clearly stating the limitations of the EconIA; (2) providing a sensitivity analysis to capture the range of likely impacts instead of generating one forecast; (3) providing estimates of net economic changes as well as gross changes; (4) using standardized definitions of impacts such as annual person-years of employment instead of total person-years of employment to avoid misinterpretation of results; and (5) disaggregating impacts by key stakeholder groups such as current residents versus in-migrants. Some of these best practices were used in the case study illustration of the MABCA for TMX and provided more accurate results than the EconIA. But the problem is that currently there are no guidelines for undertaking an EconIA and presenting the findings to reduce the likelihood of misinterpretation. The priority for research on EconIA therefore is to develop comprehensive guidelines for undertaking an EconIA so it is done in a consistent and methodologically sound manner and to develop methods for estimating the net impacts as well as gross impacts.

The literature also confirms the merits of BCA for assessing both project economic impacts, as well as providing a framework for assessing other environmental and social impacts and estimating the overall net benefits of a project. There is a consensus in the literature on the issues and challenges with BCA that need to be addressed including defining appropriate discount rates, measuring non-market values, disaggregating impacts by geographic and stakeholder groups, dealing with uncertainty and risk, and providing information important to decision-makers such as employment and fiscal impacts. But unlike EconIA, there are a number of comprehensive manuals and guidelines that define the steps and best methods to follow when doing a BCA to address these challenges. However, the Canadian guidelines have not been updated nationally since 2007 (Treasury Board of Canada Secretariat, 2007) and there are no guidelines provided by EA agencies in Canada for undertaking a BCA[9]. Additionally, undertaking a comprehensive BCA is not currently required as part of an EA process. Consequently, despite its strengths as a method of project evaluation, BCA is rarely conducted as part of an EA review.

MABCA has a long history, commencing with publication of the US Water Resources Council's guidelines in 1983 and subsequent publications and guidelines in Canada reviewed in this paper (e.g., Shaffer, 2010). The strength of MABCA is that it combines EconIA, BCA, along with other methods of environmental impact assessment into a single evaluation framework that provides decision-makers with a transparent and systematic assessment of project economic, social, and environmental impacts. MABCA's applicability therefore goes beyond just assessing economic impacts, to providing a framework for assessing all project impacts. For these reasons, MABCA offers considerable promise. Consequently, the primary policy finding from this literature review is the need to develop a MABCA guidebook for EA in Canada. The guidebook should address a number of issues with MABCA including defining the accounts and identifying analytical techniques for generating accurate results for each account. Also, given that MABCA uses both EconIA and BCA in the analysis, all of the issues identified for EconIA and BCA would also have to be addressed in the guidelines.

Conclusions

The review of selected techniques for assessing the economic effects of projects in EA shows that there are several well-accepted methods with strengths and weaknesses. The practice in EA has been to largely rely on EconIA for economic impact assessment. EconIA can provide useful information to decision-makers on project economic impacts at the regional level to help plan provision of infrastructure and services to accommodate growth but EconIA has serious limitations and its practical application can result in providing exaggerated estimates of project

[9] Treasury Board of Canada Secretariat did produce a new directive based on their 2007 guidelines in 2018 (Treasury Board of Canada Secretariat, 2018) but have not published an updated version of the 2007 guidelines.

impacts and benefits. EconIA also does not provide an estimate of overall project benefits and costs necessary for assessing whether the project is justified and in the public interest.

SIA is more of an analytical framework than a specific method for assessing impacts. An important finding from SIA that should be incorporated into EA is the need to assess cumulative impact of projects relative to sustainability goals and targets.

BCA is the most well-accepted method for assessing both economic as well as social and environmental impacts of projects in a comprehensive framework that can be used to determine whether a project is justified and in the public interest. BCA therefore goes well beyond just assessing economic impacts. However, BCA does not provide all the information important to decision-makers, such as employment impacts and tax revenue. MABCA addresses these limitations in BCA by combining EconIA, BCA, and other environmental impact assessment methods into a single framework that allows for identification and assessment of all project impacts to provide decision-makers with the information they require to determine if the project is justified and in the public interest.

The literature clearly identifies the strengths and weaknesses of these methods and best practices for applying them to address their challenges and weaknesses. Based on this literature review it appears that the most fruitful approach is to develop a comprehensive set of guidelines for applying MABCA in EA in a consistent and methodologically sound manner and incorporate sustainability targets into MABCA guidelines.

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