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Economic Assessment Methodology to Support Decisions for Transport Infrastructure Development

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Abstract**—**The decades after the end of the second War provide evidence that infrastructures investments contibute to economic development, on terms of productivity and income growth. In order to force productivity and increase competitiveness the financing of large transport infrastructure projects are on the top of the agenda in strategic planning process. Such a decision may take form some days to some decades and stakeholders as well as decision makers need tools in order to estimate the economic impact on natioanl economy of such an investment. The key question in such decisions is if the effects caused by the new infrastructure could be able to boost economic development on one hand, and create new jobs and activities on the other. This paper deals with the review of estimation of the mega transport infrastructure projects economic effects in economy.

Keywords—Economic impact, transport infrastructure, strategic planning.

I. Introduction

GOVERNMENT and decision makers promote investments in large transport infrastructure projects in order enhance productivity and achieve socioeconomic goals in terms of economic development. One of the most critical issues for decision makers is to select which investment projects will be funded and financed and there are many debates about the scheme. Decision makets and stakeholders need accurate estimations about the economic contribution of new transport infrastructure projects on national economy.This assessment framework is an essential challenge, because the outputs focus on decision key factors that highlight demand and supply variables. risks, uncertainties and limitations [1].

II. Methods

There are many empirical analyses and ex-post assessments in literature that analyse the socioeconomic impact of large transportation infrastructure projects with different methodologies

A. Economic Benefits Appraisal

Economic value referred to as "economic benefit," "net economic value," or "net economic benefit") measures how much an economic activity is worth to community of a specified geographic area. Total benefits can include benefits that are dericed from market transactions, and benefits that are not derived from transcations but they are non-market.

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Cost-benefit analysis (CBA) for transport infrastructure investments may be is a tool for cases where a large number of investments have to be ranked against each other and define a strategic investment plan in order to influence decision making process [2].

Cost Benefit Analysis (CBA) is an analytical method that is frequently used in ex-ante analysis and is applied to investment into large transportation infrastructures in order to provide evidence so decision makers can justify their decisions.

Mackiea et al. [3] presented the role and position of CBA in the transport planning process, partly based on a survey of a number of countries where CBA plays a formalised role in decision-making and is concerned with the appraisal situation in the overall decision-making process and if CBA appraisal results actually influence decisions. Eliasson et al. [4] confirmed that since decision makers are knowledgeable in regard of CBA appraisals, they take this into account when selecting public investment early in the decision-making process.

There are many researches that claim that CBA doesn't support decision making process. Odek 2010 [5] claimed that most of the variables determining decisions are included in benefit-cost analyses (BCAs) evaluation, except that the decision-maker takes account of them in non-monetary units rather than in a composite benefit-cost ratio or net present value. So, other previous studies supported to the extent that a BCA does not matter in decision-making, but its components matter in a non-monetized form.

Kelly et al. 2015 [6] examined 10 large transport projects in eight countries that had benefited from EU Cohesion and ISPA funding and identified the not extended contribution of all the relevant economic impact analysis tools, especially such as the cost benefit analysis framework and multi-criteria analysis framework.

Mouter et al. (2013) [7] claimed that the debate between economists that claim the fact that CBA is an over estimated methodology framework not so extended and not so useful in the decision-making process, is problematic as it results in big debates about the positives and negative effects of CBA instead of the positive and negative effects of the spatial-infrastructure projects.

B. Review: Research Progress over Time and across Different Transport Infrastructures

Economic impact analyses of transport infrastructures have become an increasingly important area of study to support decisions in transport infrastructure development.

TABLE I
SUMMARY OF STUDIES ON ESTIMATING ECONOMIC IMPACT OF DIFFERENT TRANSPORT INFRASTRUCTURES AND METHODOLOGIES

Authors	Method	Type of Infrastructure	Catchment area	Outputs	Results
Zhenhua Chen Junbo Xue Adam Z. Rose, Kingsley E. Haynes (2016) [8]	Dynamic recursive CGE framework	High Speed rail investment	National level National Economy	Land use, output effect and demand effect The effect on generation of CO_2	The economic impacts of rail investment are achieved primarily through Induced demand and output expansion
J.S. Li, G.Q. Chen, B. Chen, Q. Yang, W.D. Wei, P. Wang, K.Q. Dong, H.P. Chen [9]	Input Output analysis	Embodiment fluxes of fuel-related mercury emissions	Three-scale level which distinguishes local, domestic and international activities	Effect of trade	Mercury emissions resulting from final fuel consumption were induced were attributed to domestic and international imports
Ana Alises, José Manuel Vassallo [10]	Input–Output SDA technique	Road freight transport in Europe	Different decoupling levels in European Union countries.	Domestic production, imports and exports and tonne-kms for 11 types of commodity classes.	Aggregate road transport demand has grown—driven mainly by economic activity—but this growth has been strongly curbed in some countries by changes in road freight transport intensity and moderately by the dematerialization of the economy.
Ridwan Anas, Ofyar Z. Tamin, Sony S. Wibowo [11]	Input Output analysis	Tollroad Investment in Cipularung	Regional economy	Indirect benefits received by the production sector (key sectors) in relation to the associated decrease of freight transportation costs	The regional GDP increases 1% after the operation of Cipularang Tollroad
Stefan Tscharaktschiew,Georg Hirte [12]	Spatial CGE approach	Urban passenger transport in German metropolitan area	Metropolitan regional area	Welfare, environmental and spatial effects of different kinds of transport subsidies	Welfare enhancing, subsidies to urban road traffic reduce aggregate urban welfare. distributional effects are substantial
Johannes Bröcker, Artem Korzhenevych, Carsten Schürmann [13]	Spatial computable general equilibrium (SCGE)	Trans-European transport (TEN-T) networks in different European countries	Regional level	Welfare effects generated effects related to trade in goods	The contribution of each project to the spatial cohesion objective check whether significant benefit spillovers to countries not involved in financing might prevent realization of projects in spite of their respective profitability from European wide point of view
Xueqin Zhu, Jos Van Ommeren [14]	Spatial two-region general equilibrium model, CGE	Transport Infrastructure Improvement	Spatial two-region level	Social welfare or total welfare) consists of the direct effect in transport market and the indirect effect in other markets.	The indirect welfare effects are larger, the poorer the initial transport infrastructure and the larger the labour market imperfections.
Euijune Kim, Geoffrey J.D. Hewings, Hidayat Amir [15]	Financial Computable General Equilibrium (FCGE)	Transport infrastructure investment projects in Indonesian economy	National level	Economic effects of fiscal policies such as the transportation investment expenditures and alternative procurement approaches on economic growth and distribution among socio-economic classes,	Government financing with tax revenues could generate higher effects on GDP than other financing methods.
Young-Tae Chang, Sung-Ho Shin, Paul Tae-Woo Lee [16]	Input–output analysis	Port sectors in South African	National level	Production effect together with the forward and backward linkage effects, price change effects and employment effects	The port sector does not appear to use other sectors much in producing its activities whereas the port sector is used relatively more by other industries owing to its relatively high forward linkage effect.
Karyn Morrissey, Cathal O'Donoghue [17]	Input–output (IO) methodology	Irish marine sector	National and Regional level	Inter-industry linkage effects, production-inducing effects and employment multipliers in the marine sector.	As a whole the marine industry has a low forward linkage effect, a relatively high backward linkage effect, a high production-inducing effect and a high employment-inducing effect.
Takayuki Ueda, Atsushi Koike, Katsuhiro Yamaguchi, Kazuyuki Tsuchiya [18]	SCGE model	Airport Haneda project in Jamaica	Regional level	Spatial incidence of the project's benefits. Indirect benefits and distribution of benefits by region and economic sector.	Expansion of Haneda can bring a large amount of benefit to all regions in Japan, particularly peripheral regions and (ii) consumption at trip destination increases in special regions
Isabelle Laplace, Chantal Latgé-Roucolle [19]	Two stage econometric model	Air transport activities in four ASEAN countries.	National and regional economies.	Impact of expected development of airport activity	GDP is the most sensible to air traffic growth in region where only international airports are located, The magnitude of the impact depends on the tourism development expectation as well as on the tourism contribution to GDP.

C. Economic Impact Analysis

Economic impact analysis traces the effects of expenditures through the economy. An initial expenditure circulates through the economy and creates and chain reaction of additional expenditures.

The quantification of benefits as part of the previous analysis is calculated through economic impact analysis. Economic impact analyses usually are based on two different methods for analyzing economic impact. The one is the input-output analysis (I/O analysis) , based on inter-industry transactions and business sectors in order to quantify the response of the change in one business sector on an another Based on this data, multipliers are calculated in order to be used to estimate economic the economic impact [20]. Alternative methodologies for conducting economic impact analyses are the simulation models such as General Equilibrium Models (CGE). The fundamental difference is that in addition to what IO analysis does, CGE attempts to forecast the impacts due to future economic, prices, economic and population changes.

1.Input Output Analysis

Correa et al. [21] indicated that input–output models allow for a comprehensive and systematic study of the managerial and administrative processes within an organization and for the analysis of its dependence on the environment. The basic structure of input output model and the collection of data to describe and quantify that structure, provide decision makers with a more thorough understanding of the internal processes of the institution being studied. Chiu et al. [22] investigated the role and influence of the transportation sector on the national economy of Taiwan by using input-output analysis [22]. Setol et al. [23] used an input output inoperability model as a mechanism for analyzing the induced effects caused by critical infrastructure dependencies and interdependencies.

Developed by Wassily Leontief in the 1930s, Input-Output analysis analyzes the interdependence of industries within a given economy. Input-Output analysis is based on a system of linear equations that describe the distribution of an industry’s product throughout an economy [23].

IO analysis based on the concept of multipliers is an appropriate approach to evaluate how an economy may react to specific policies or external shocks or changes such an investment in a new transportation infrastructure project. More specific, input–output tables provide a complete picture of the flows of products and services in an economic system for a given year, illustrating the relationship between producers and consumers and the exchange of goods and services among economic sectors. In other words, they illustrate all monetary market transactions between various businesses and also between businesses and final demand sectors (i.e. consumers, government, investment, exports, etc.). Thus, they can be used to construct disaggregated multipliers in order to estimate apart from the direct impacts of a particular investment also its indirect and induced impacts.

The impacts due to the project investment are divided into four distinct categories: direct, indirect, induced, and catalytic. More specific direct effects are associated with the businesses directly involved in the given project or industry. In transportation infrastructure projects, direct effects are related to the employment and GDP generated by firms which will construct and operate the transportation infrastructure. Indirect effects occur in the wider supply-chain as firms directly involved in constructing and operating the transportation infrastructure purchase goods and services from nation-based suppliers, in turn generating output, profits and employment among suppliers. Induced effects arise because the direct and indirect effects mean additional wages are paid to workers, some of which are used to purchase goods and services for their own consumption. This spending supports additional businesses (and so additional output and jobs) in the industries that supply these purchases. Induced effects result from the employees of the transportation infrastructure purchasing goods and services at a household level.

Concerning catalytic impacts, in many cases, the objective of large transport infrastructure investments is to improve the accessibility by reducing travel time. Improvement in accessibility will increase the size for trade, manufacturing, tourism and/or labour, leading to increased competition and/or centralisation. In such a context, the evaluation of these infrastructures should involve the estimations of the changes in the interregional trade and the regions’ economic development.

Mainly limitations of input output analysis are; lack of price effect, difficulties at the data collection stages or differences in defining and calculating each effect, as analytically described by Huderek-Glapska et al. [24]. In a large part of U.S. studies indirect effect is calculated on the basis of non-residents expenditure made in the region, in contrast to Europe and Canada

2.Computable General Equilibrium Model

CGE models can be described as a set of equations solved simultaneously to find prices at which quantity supplied equals quantity demanded (equilibrium) across all (general) markets. CGE models can broadly be distinguished according to their level of spatial detail (i.e. national, multi-country, regional or multi-regional) or to time dimension (static versus dynamic)

CGE models are good for analyzing policies that affect different sectors in different ways. They can help capture the impacts of a policy on factor (capital, labor and land); on commodity markets; on households' types and on different regions. CGE models are also good for understanding the welfare and distributional impact of alternative policies.

Table II highlights the main differences between IO and CGE. CGE models have a solid microeconomic foundation and are capable of capturing the indirect and feedback effects of a wide range of possible policy change without excessive simplification and aggregation.

In evaluating economic impacts, there is a need to model the economy, as far as is possible, as it really is, recognising other sectors and markets, and capturing feedback effects. CGE models do this, and thus they represent a much more rigorous approach to estimating impacts. They are used extensively in other sectors of the economy, and these days, economic agencies, when being presented with assessments of the impacts of shocks or policy shifts, expect them to be used [25].

A CGE model has an Input–Output model embedded in it, but it also has other markets, and the links between markets, explicitly modelled. These recognize that consumers must choose how to spend their budgets—they do not have unlimited budgets. Resources are limited too, and they are normally allocated by markets [26].

CGE analysis is being employed to explore the economic impacts of policy initiatives and frameworks and broader changes as diverse as hazardous waste management, trade liberalization, tariff protection, environment-economy interactions, structural adjustment, agricultural stabilization programs, technological change, labour market deregulation, financial market deregulation, taxation changes, macroeconomic reform, economic transition, international capital linkages, public infrastructure, and industry sector studies.

TABLE II
DIFFERENCES BETWEEN INPUT OUTPUT AND CGE

Input Output	CGE
Static	Static (some dynamics, e.g. capital stocks)
Linear functions	Non-linear functions
No supply constraints	Demand and supply (demand driven)
No price effects	Full response price effects
Partial equilibrium (quantities only)	General equilibrium (prices and quantities)
Partial optimization	Optimization model
Full employment (in region) but infinite elastic labour supply	Full employment (in region) or Unemployment
Wage income only	Total (wage and non-wage)
Household expenditure determined by average expenditure patterns	Household expenditure determined by utility maximization
Intermediate and primary factor demands determined by Leontief function	Intermediate factor demands determined by Leontief function
	Primary factor demand – based on production function e.g. Cobb-Douglas function (cost minimization)

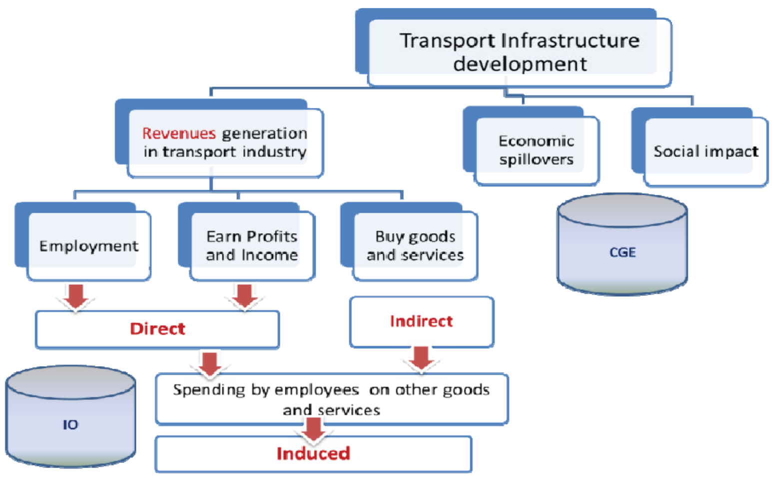

Fig. 1 Transport infrastructure impact analysis

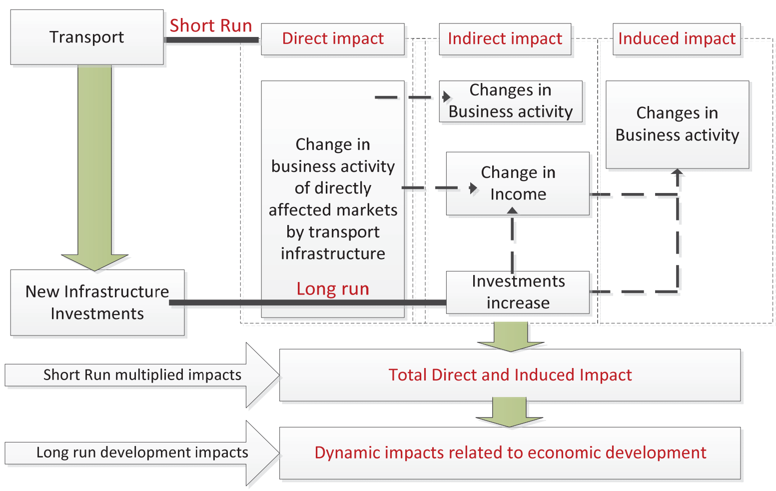

Fig. 2 Impact analysis assessment flowchart

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