



# How modes of transport perform differently in the economy of Andalusia

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## ABSTRACT

This paper analyses the impact of the different modes of transport in the economy of Andalusia. This assessment makes use of multipliers analysis based on a Social Accounting Matrix (SAM). It has been performed a breakdown of output multipliers as a sum of direct, indirect and induced effects, and the salary and employment multipliers have also been calculated. The starting point is the creation of a SAM from the existing one of year 2010, but disaggregating the sector of transport into their different modes. Thanks to this, we establish the different impact in the economy of each mode of transport, highlighting their different performance. Regarding freight transport, train offers better effects in terms of output multipliers than transport by road. In transport of passengers, the impact of high speed train is more important than air transport, two modes that compete in some routes. The results in this paper are the kind that is of highest interest to policy makers, moreover when large investments are required.

## 1. Introduction

The motivation for this work is the need to know about long-term impact of each mode of transport in the economy. Our main interest lies in highlighting the differences between modes of transport. In short, the focus of this work is to calculate the output, salaries and employment multipliers for each mode of transport, identifying the main differences between them. Andalusia, the most populous region in Spain, is taken as the economic framework of reference.

This information helps to policy makers to improve their decision making. They should be aware about the effects of promoting one mode instead of others or evaluate the impact of investing in infrastructures of transport or other policies to increase its demand. This information is important due to the cost of investing in transport infrastructures. However, there is not literature including a comprehensive comparison of economic impact between modes of transport, only assessments about economic impact of a certain infrastructure or a single mode of transport.

This study confirms the different impact of modes of transport in the economy of Andalusia, based on their effects in term of multipliers. It is interesting the comparison between modes of transport that enters into competition in some routes. As an example, this is the kind of results that

give information about the effects of future investment in rail infrastructure in Andalusia (The Mediterranean Corridor) or policies subsidizing air transport or High Speed Train (HST).

Regarding freight transport, this work shows how transport by train has better performance than road transport, except in term of employment multipliers, because transport by road is more labor intensive. However, it has poorer performance in term of number of jobs induced by direct employment.

In transport of passengers, one interesting case is the competition between HST and air transport. In the case of Andalusia, HST has better impact in the economy in terms of total output (multiplier is 25% higher), in the creation of employment (multiplier is also 25% higher) and in the generation of indirect and induced jobs per direct employment (32% more than air transport).

Analysis of economic impact can be calculated using standard Input-Output (IO) model (Leontief, 1966). Similar calculations can be done with Social Accounting Matrix (SAM) models, which extend the inter-industry Leontief model to take into account the income generation and expending. Therefore, SAM models allow also to gather induced effects, which sometimes are an important part of the economic impact. The use of SAMs was first introduced by Stone (1962) who published a SAM for

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the United Kingdom, as a useful tool to organize national accounts. Later on, [Pyatt and Round \(1979\)](#) further developed this methodology and its applications, in particular the use of multiplier analysis.

The study is structured as follows. First of all, there is a short literature review about the application of IO methodology to modes of transport, followed by a description of the basis of the SAM model as an extension of the Leontief model. Later on, we explain shortly how SAM has been built up, because it will be used for obtaining the results in following sections. In next section the multiplier theory is applied to the SAM model, using the one of Andalusia of year 2010 with modes of transport disaggregated. Finally, we stated the conclusions and discuss constrains and possible extension of the model.

## 2. Brief literature review

Economic Impact Analysis (EIA) is used to either predict the impact in the economic indicators as a result of the implementation of future investment or policies, or to evaluate the impact of past or present policies.

EIA methodology is mainly based on the use of mathematical models. Analysis based on IO models is a key component in most impact analysis. It quantifies the multiple economic effects resulting from a change in the final demand of a specific product or service. Similar calculations can be done with SAMs, which are an extension of IO tables to take into account income generation and expending.

The methodology based on IO models was first put into practice in the 60's and it was applied first to seaports in the United States, and later on in Europe. Since then, the impact analysis of seaports has had predominance over other transport infrastructures. [Pérez and García \(2004\)](#) provide a detailed review of the literature about this methodology applied to seaports. However, this methodology has also been used to assess the impact of infrastructures linked to other sectors through the use of multipliers, as the one for the Highway Widening Projects in Texas ([Buffington and Wildenthal, 1998](#)). Today the economic impact analysis of seaports has shifted to airports, and its amount has increased recently. We can cite the ones of the airport of Dublin ([Vistas Consulting Ltd, 2015](#)) and the commercial airports in the U.S. ([Smith, 2014](#)).

In the early times of IO methodology already appeared some critics ([Christ, 1955](#)). They focused on the lack of dynamism or their inability to adequately reflect the replacement of local production by imports, as a consequence of changes in prices (R. C. [Waters, 1977](#)). Nevertheless, there were also defenders ([Chang, 1978](#)) by showing them as very useful tools, despite their limitations. However, the methodology is not exempt from inaccuracies in the results or difficulties of interpretation.

The debate about the limitations of the methodologies based on IO tables has not been completely closed. [Verbeke and Debisschop \(1996\)](#) listed the limits on the use of economic impact studies in transport infrastructures, concluding that they can perform a major role as complement to other decision criteria, such as the cost-benefit analysis. Today the limitations of IO models are well known ([Kockelman et al., 2013](#)), as the existence of fixed prices, fixed coefficient technology or constant returns of scale. More recently [Cardenete and Sancho \(2012\)](#) showed the limitations to the use of multipliers based on IO models when there are supply constraints.

Computable General Equilibrium (CGE) provides a modelling approach that overcomes these limitations, since it takes into account the price effects, elasticities of demand and substitution of products and factors. CGE can furthermore make use of different production functions for each sector and different utility function for utility-maximizing consumers. There is also literature addressing issues on transport topics with CGE models, which have been improved with multiregional and dynamic CGEs. [Chen et al. \(2016\)](#) made use of a dynamic CGE to assess the economic and environmental impact of high speed train in China on the 2002–2013 period, concluding that rail investment has had an important effect on economic growth and a substantial positive impact in terms of CO<sub>2</sub> emissions. [Bröcker et al. \(2010\)](#) made use of a multi-regional CGE model to analyze the economic impact of the Trans European Network

(TEN) and found that welfare impact was modest.

But CGE models also have some limitations and critics, such as the need of a big amount of statistical data, whose updating or quality is variable. Additionally, the accuracy of their results relay on how the equations reproduce the real behavior of the economy in a certain point of the time. For this reason, methodologies based on IO and SAM tables are the most widely used due to their simplicity, that they are easily implementable and that they are empirically operational.

Methodologies based in IO tables or SAM have evolved since they started to be used. One of the last improvements is the use of multiregional IO tables, which allow the analysis of impact beyond the area where the transport infrastructure is located. In this line, [Merk et al. \(2013\)](#) not only analyze the interregional impact of four seaports in North-West of Europe but also quantify spillover effects. Previously [Coto-Millán et al. \(2010\)](#) already assessed the impact of the port of Santander in the city of Santander, in the region of Cantabria and in its hinterland.

The literature about impact analysis of modes of transport in Spain is slightly more modern. The first references are from the early nineties, such as the one from [Villaverde and Coto-Millán \(1998\)](#) for the port of Santander. The production of academic literature about impact analysis of modes of transport has continued, with a predominance of those related to port infrastructures; [Acosta et al. \(2011\)](#) not only provide an economic impact of the port of Algeciras, but also a forecast of its future expansion. Nevertheless, there are also examples about others means of transport in Spain, as those for the airport of Santander ([Carrera-Gómez et al., 2004](#)) or the logistic platform of Zaragoza ([Sainz et al., 2013](#)).

As in other countries, in Spain these methodologies have been also widely employed in works prepared by consultancies or institutions, as part of their economic impact analysis. In some cases, they are issued with the objective of social justification. These have been carried out not only for ports, such as the one for the port of Tarifa ([Universidad de Cádiz, 2009](#)), but also for rail ([PWC, 2010](#)) or airports ([Analistas Económicos de Andalucía, 2007](#)).

However, this paper is more in line with the studies that establish the economic impact of a mode of transport in a region instead of the impact linked to a certain infrastructure, as the one carried out for the air transport in Canada ([Snc-Lavalin, 2013](#)) or for the port's sector in South Africa ([Chang et al., 2014](#)). In this line, we are analyzing the long-term effects of each mode of transport in the region of Andalusia.

After the literature review, there has not been detected any impact analysis comparing the relative importance of modes of transport in the Spanish economy or in any of its autonomous regions. Therefore, this paper fills the gap in the academic literature by providing such comparison among modes of transport, in particular in the autonomous region of Andalusia. In addition, this work is making use of a SAM model instead of IO tables, where the different modes of transport are disaggregated. This methodology has been already applied to analyze the impact of other sectors in the Andalusian economy ([Cardenete and López, 2015](#)).

## 3. Social Accounting Matrix and the model

### 3.1. Social Accounting Matrix

IO tables give a detailed account of inter-industry transactions in an equilibrium setup in which total supply matches the sum of intermediate and final demand. This methodology analyses the structural composition of the economy and the productive system. SAMs improve IO tables by introducing balanced accounts for factors, institutions, and other auxiliary accounts, to close the process of income distribution and income spending. As [Stone \(1962\)](#) pointed out, a SAM is an efficient and transparent device that presents the circular income flow of an economy over a period of time by means of a square flow matrix. Each row and corresponding column in the matrix contains information about the resources and uses of an account; they represent industries, factors income (labor

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