



# Transport-mode competition in intra-national trade: An empirical investigation for the Spanish case

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## ABSTRACT

Trade within and between countries can take place by alternative *transport modes*. Economic and logistical complexity is fostering multimodality as well as transport-mode competition. The international trade literature has given little attention to this issue. The aim of this paper is to analyze transport-mode competition in inter-provincial deliveries within Spain. To this end, we use a detailed dataset with fifty inter-provincial, industry-specific flows by four transport modes (*road, train, ship and aircraft*). We then feed this dataset into various specifications of a gravity model that incorporates cross-sectional dependence attributable to unobservable factors directly associated with the presence of transport-mode competition schemes. In considering alternative distance segments, we also test for competition effects between *road* and the other three modes.

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## 1. Introduction

Trade within and between countries can take place by alternative *transport modes*. Economic and logistical complexity is fostering multimodality as well as transport-mode competition (Rodrigue, 2003; Hesse and Rodrigue, 2004; Rodrigue and Notteboom, 2010).

According to the World Trade Organization (WTO), from 1990 to 2013 the world's international exports of goods increased about 8% annually. Most international trade had taken place by sea (89.8% in 2008), and to a lesser extent by land (road and, more rarely, train, with a total of about 9.96%). Ships are simply the most efficient mode for long distances, while road is the most convenient for door-to-ship/ship-to-door hauls and for distribution between and within countries. But when we look at trade *within* countries the pattern changes drastically. In Spanish interregional trade, for example, *road* is the transport mode with the greatest share, representing on average approximately 83% of trade value in 2005–2009, with ships representing around 19% and trains 3% for the same period.

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Several factors can explain this polarized modal split in Spain. On the one hand, short-distance distribution of goods by truck represents a significant share of total trade within the country. On the other, Spain's geographical characteristics—natural impediments in some areas, small national territory—limit the maximum road distance to about 1230 km, at times making train transport or train-road combinations very costly. The [Spanish Ministry of Public Works \(2004\)](#) has estimated that for a road-train combination to be profitable the trip must exceed 600 km, a distance threshold that we test in forthcoming sections.

As the next section will show, the variety and interconnection of transport modes are key to promoting economic and social welfare within countries ([Bensassi et al., 2015](#); [Duranton et al., 2013](#); [Moïse and Le Bris, 2013](#); [Nguyen and Tongzon, 2010](#); [Korinek and Sourdin, 2011](#); [Vasiliauskas and Barysienė, 2008](#); [Martinez-Zarzoso et al., 2008](#); [Lee and Rodrigue, 2006](#); [Yap et al., 2006](#)). Indeed, competition between these modes can bolster overall economic competitiveness and progress nationally, as the availability of transport modes other than road can be critical to making freight activity, and the whole modern economy, more sustainable. The European Commission is working in this direction for the EU ([Feo-Valero et al., 2011](#); [European Commission, 2001, 2004, 2006](#)).

Within this context, this paper analyzes the presence of transport-mode competition within a country, taking into consideration the international openness and key logistical infrastructures of each province. In contrast to other papers ([Cantos-Sánchez et al., 2009](#); [Álvarez-SanJaime et al., 2013a, 2013b](#)), where modal shifts are modeled on demand functions, our methodology seeks to identify competing transport-mode structures (mainly between *road* and the other three modes) within actual flow data. For this purpose, we use a novel dataset, with aggregate and sector-specific flows between Spain's fifty-two provinces by four different transport modes (*road, train, ship and aircraft*). Our database includes 110,000 origin-destination observations ( $50 * 50 * 4 * 11$ )<sup>1</sup> for the single year of 2007, along with a comprehensive set of regressors and rich distance measures drawn from Spain's actual transportation network.

To deal with transport-mode competition, we plug our data into various specifications of the Spatial Autoregressive Gravity Model (SARGM), following [LeSage and Pace \(2009\)](#). These specifications incorporate spatial dependence for the endogenous variable attributable to omitted variables. In all of these specifications, we use three novel variables to capture competing effects between the main transport mode (*road*) and the three alternatives (*train, ship and aircraft*). Moreover, we define a set of specifications that accounts for four sources of cross-sectional effects. These effects can be associated with competition effects taking place not just between the trading provinces (*origin-destination* dyads), but also between each trading province and its neighboring regions, by each of the four alternative transport modes. This strategy allows us to identify *transport-mode competition schemes* hidden within aggregate trade flows. Furthermore, we define an extended specification of the SARGM in which transport distance is segmented. The aim of this extension is to test if the “road” transportation mode is able to co-exist (compete) with the other three alternative modes within each one of these segments of distance.

This empirical approach permits us to delve deeply into a recent literature ([Bensassi et al., 2015, 2011](#); [De la Mata and Llano, 2013](#); [LeSage and Fischer, 2008](#); [LeSage and Llano, 2013](#); [Márquez-Ramos et al., 2011](#); [Gallego et al., 2015](#); [Alamá-Sabater et al., 2013](#); [LeSage and Polasek, 2008](#)) that links trade to transport through augmented gravity equations and includes either spatial or network autocorrelation terms in its trade-flow modeling. Whereas this literature covers both aggregate and sector-specific interregional flows, our empirical analysis provides a new *within-country spatial dimension* that, to the best of our knowledge, has not previously been considered.

The rest of the paper is structured as follows: Section 2 describes some important links between trade, transportation and logistics and briefly reviews the state of the art in the analysis of these complexities in Spain and elsewhere. Section 3 lays out our empirical strategy for dealing with transport-mode competition schemes. Section 4 describes the dataset. Section 5 comprises our descriptive and econometric analysis of the patterns obtained for each product type, and uses a hierarchical cluster analysis to elucidate differences and similarities. We finally estimate kernel regressions in search for the segments of distance at which the intensities of the flows using different modes tend to agglomerate.

## 2. Trade, logistics and transport-mode competition

The literature on trade and transportation emphasizes the quality of logistics as a trade facilitator ([Lee and Rodrigue, 2006](#); [Vasiliauskas and Barysienė, 2008](#); [Nguyen and Tongzon, 2010](#); [The World Bank, 2014](#)). High-quality logistics improve the competitiveness of a country by reducing the cost of transporting goods. In our view, it is straightforward to consider that countries (or regions within countries) with strong competition between transport modes are more likely to enjoy efficiency gains, not just when exporting to other countries (or regions) but also when distributing within their own territory.

Several studies have analyzed the link between international trade and logistics, but few have simultaneously considered the link between logistics, on the one hand, and internal and external trade flows, on the other. In [Korinek and Sourdin \(2011\)](#), for example, ‘only logistics services that are directly related to international trade and the transport of goods from one economy to another are covered...’. Others just focus on logistics and the distribution of products within a country. Thus [Alamá-Sabater et al. \(2013\)](#), who analyze whether transport connectivity affects trade flows within a country. To find out, they develop a logistics-network index and plug it into a spatial autoregressive model for fifteen inner regions (Nuts 2) of Spain and sector-specific flows by road. The results confirm the role of logistics-platform location in satisfying existing

<sup>1</sup> The dimensions considered here correspond to: 50 provinces; 4 transport modes; 1 vector of aggregate flows + 10 vectors of sector specific flows.

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