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# Roads and trade in Colombia

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ABSTRACT

I estimate the effect of major roads within and between cities on the level and composition of trade for Colombian cities. I confirm that road distance between cities is a major impediment to trade. In addition, major roads within cities have a large effect on a city's exports and imports with an elasticity of approximately 0.20 estimated with OLS and up to 0.50 with IV. If anything, the effects are stronger for the value than for the weight of exports. I interpret these results as city roads shifting economic activity in cities towards the production of tradable and somewhat lighter goods.



## 1. Introduction

Road investments are often extremely large. Over 2006–2011, transport represented 16% of World Bank lending, that is about 30 billion dollars. For the US, (Allen and Arkolakis, 2014) compute the annualised cost of the Interstate Highway System at 100 billion dollars or 0.7% of US GDP. Despite the importance of the amounts at stake, very little is known about the economic effects of road networks.

While roads may affect a broad variety of outcomes, imports and exports to other places are of particular importance. That new or improved roads between cities should foster trade is the main direct consequence that we anticipate from this type of investment. In turn, more trade is often assumed to lead to more employment, higher wages, and other desirable outcomes. To make sure that new roads positively affect economic activity, it is important to verify that they have the intended effect on the main direct outcome, trade, before looking at more indirect outcomes such as wages or employment.

To make progress on this research agenda, this paper investigates the effects of major roads between and within cities on the weight and value of bilateral trade between Colombian cities following the same approach as (Duranton et al., 2014). I first confirm that road distance between cities is a major impediment to trade with an elasticity of trade with respect to distance of around −0.60. Roads within cities also affect trade. A 10% increase in major roads within a city is associated with about a 2% increase in exports to other cities using ordinary least square. Estimates using instrumental variables suggest even stronger effects with a 10% increase in major roads in a city causing up to a 4% increase in exports. There is evidence that the effect of city roads is modestly stronger for the value of trade than for its weight. I interpret these results as roads shifting economic activity in cities at the extensive margin towards goods that are tradable and goods that are lighter (e.g., light manufacturing goods exported to other cities instead of processed food sold locally). These headlines results contrast with those of Duranton et al., 2014 where highways in the United States are found to affect trade at the intensive margin and foster the weight of exports but not their value. However, these differences between Colombia and the US are significantly reduced when similar range of distances are considered for trade.

Although there is some emerging evidence about the effects of transport infrastructure on trade, this evidence concentrates either on rich economies with abundant infrastructure such as the early 21st century United States (Duranton et al., 2014) or, at the opposite end, extremely poor economies with no infrastructure such as 19th century India (Donaldson, 2014). Very little is known about middle-income, developing countries such as Colombia where the paucity of infrastructure is often deemed to be a brake on development.[1] More generally, trade is a particularly important outcome since it is often alleged to be a key driver of growth and development (e.g., Redding and Venables, 2004; Alcalá and Ciccone, 2004).

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[1] To the best of my knowledge, the only other piece of research that looks on the effects of roads on trade is (Volpe-Martincus et al., 2012) who examine the effects of roads in Peru on firms' exports to other countries.

Second, the tendency in the recent literature on the effects of transport infrastructure has been to look at different outcome variables and develop new methodologies.[2] To assess the effects of the US interstate system, Fernald (1999) used aggregate data and essentially performed a difference-in-difference exercise looking at the changes in the productivity of sectors of economic activity depending on their transport intensity. Chandra and Thompson (2000) focus on a variety of outcomes in rural US counties for which the incidental presence of a section of an Interstate Highway may be taken as exogenous. Baum-Snow (2007) and Michaels (2008) pioneered the use of instrumental variables to look at the effects of transport. They focus on suburbanisation and the demand for skills, respectively. This type of approach, which shares some commonalities with the work done here, has been pursued by Duranton and Turner (2012) and Duranton et al. (2014) to examine the effects of the US Interstate Highway System on urban growth and trade. More recently, Gibbons et al. (2012) have developed a spatial differencing approach using geocoded data and fine changes in accessibility to measure the effects of new roads on firm employment.

While it is important to develop new and better approaches and examine different outcomes, there is also a lot of value in taking the same outcome and replicating existing methodologies for different countries. This enables us to gauge the robustness of extant methodologies beyond the specific data for which they were originally developed. This also allows for an assessment of the external validity of the original findings. In this spirit, this paper essentially replicates the US work of Duranton et al. (2014) using Colombian data.

Finally, the results of this paper also matter for Colombian public policy. For many years, the Colombian government has somewhat neglected its road infrastructure. This neglect might seem surprising in light of a legacy of poor connectivity within the country due to its harsh geography (Bushnell, 1993; Samad et al., 2012). This relative lack of interest in the transport infrastructure is the consequence of both persistent civil unrest in many parts of the country and other policy priorities such as education and health taking precedence (Barco, 2013). With these policy objectives close to being fulfilled and a major decrease in civil unrest, the country has started to invest in its roads again (Roda et al., 2012). Trying to understand whether these on-going investments are appropriate and how they might effect Colombian cities is an important objective for this paper.

Like Duranton et al. (2014), my analysis of how roads in Colombia affect trade flows between cities consists of three components: a theoretical framework, which clarifies the effects of roads on trade, motivates the econometric specification, and highlights some identification issues; high quality data describing roads, trade flows and relevant covariates; and a strategy for resolving the possible endogeneity of roads to trade flows. The theoretical model is an extension of Anderson and van Wincoop' (2003) framework to an economy with multiple sectors of production. It follows the model developed by Duranton et al. (2014) to which it adds a sector producing a local non-traded good.

This model leads to a gravity equation describing the effects of distance on equilibrium trade flows. It also implies that cities with a relative abundance of roads also export and import more. Finally, this model provides a logically consistent framework to examine the effect of within- and between-city roads on the weight and value of inter-city trade and to assess the effect of roads on the composition of production and trade for a given city.

This model implies a two-step estimation strategy resembling (Redding and Venables, 2004). The first step estimates a gravity model for the value and weight of trade flows, each as a function of distance and exporter- and importer-specific fixed effects. These fixed effects measure a city's propensity to export (or import) value (or weight) conditional on distance and trading partner characteristics. In the second step, these fixed effects are regressed on within-city roads and other city characteristics.

My first main sources of data is the 2011 Commodity Flow Survey for Colombia which tracks truck shipments on major Colombian roads. These data allow me to calculate bilateral domestic trade flows for a cross-section of Colombian cities. To measure distances between these cities and roads within them, I use a combination of recent maps of Colombian roads and bilateral travel time and travel distance information extracted from Google Maps. I also use a rich set of city level control variables.

It is possible that the desire to trade causes cities to build roads, or that some unobserved city characteristics cause both trade and the availability of roads. Such endogeneity and missing variable problems may confound estimates of the relationship between roads and trade. Resolving these inference problems is the third part of our analysis. Like (Duranton et al., 2014), I rely on instrumental variables estimation using instruments based on maps of colonial routes ('caminos reales') and the 1938 road network.

The rest of this paper is organised as follows. Section 2 describes the data. Section 3 exposes the model and derives an econometric specification. The estimation issues raised by my empirical strategy are also discussed in this section. Section 4 presents the main results regarding the effects of roads between cities on trade. Section 5 reports OLS and IV results regarding the effects of within-city roads on the propensity of Colombian cities to export and import. This section also reports results for a number of robustness checks. Finally, Section 6 concludes.

## 2. Data

The main source of data is the 2011 Commodity Flow Survey (CFS) for Colombia ('Encuesta Origen – Destino a Vehìculos de Carga') from the Colombian Ministry of Transport. This is a survey of trucks on major Colombian roads. Trucks are pulled aside at weigh stations for inspection and taxation. During the period of the survey, the origin, destination, and the weight and nature of the cargo of trucks passing through a weight station is recorded. Trucks drivers are also asked about the frequency with which they do this particular journey. The objective of the survey is to inform the Colombian Ministry of Transport about freight traffic on major roads in the country.

In the data, an observation is an origin municipality, a destination municipality, a cargo weight, and a product (among 39). The original data contains 159,439 observations. Note that a shipment containing two different products is represented with two different observations. In most of the empirical work below, these observations are aggregated by pairs of municipalities to generate a measure of bilateral trade flows in weight. The Ministry of Transport also proposes average values for these products so that a measure of trade flows in value can be generated. Table 1 offers some descriptive statistics at the municipal level while Table 2 reports descriptive statistics for an aggregation into 16 product groups. Note that, although the main regressions below are estimated for fewer (larger) municipalities, these descriptive statics concern an extensive set of Columbian municipalities.

Although its name is similar, this survey should be distinguished from its US equivalent used, among others, by Duranton et al. (2014). The US CFS surveys firms about their shipments whereas the Colombian CFS surveys trucks along the main roads of Colombia. Obviously, the Colombian survey is restricted to road shipments. This is not an issue for Colombia since an overwhelming share of internal trade in Colombia goes by road. Trade along the main river, the Magdalena river, is limited; railroad trade is concentrated on mainly one link for

[2] See Anas et al. (1998) for a broad discussion of the effect of transport on cities. The recent literature is reviewed by Redding and Turner (2004).