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# Domestic road infrastructure and international trade: Evidence from Turkey☆

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ABSTRACT

Drawing on the large-scale public investment in roads undertaken in Turkey during the 2000s, this paper contributes to our understanding of how internal transportation infrastructure affects regional access to international markets. Using data on international trade of Turkish provinces and the change in the capacity of the roads connecting them to the international gateways of the country, we estimate the distance elasticity of trade associated with roads of varying capacity. Three key results emerge. First, the cost of an average shipment over a high-capacity expressway is about 70% lower than it is over single-lane roads. Second, the present value of a 10-year stream of trade flows generated by a one-dollar investment in road infrastructure ranges between $0.7 and $2. Third, the reduction in transportation costs is greater the more transportation-sensitive an industry is. To the extent that efficient logistics enable countries to take part in global supply chains and exploit their comparative advantages, our findings have important developmental implications.



## 1. Introduction

Poor domestic transportation infrastructure in developing countries is often cited as an important impediment for accessing international markets. Yet, evidence on how a major improvement in the transport network of a country affects the volume and composition of its international trade is scarce. We fill this gap by estimating the impact of a recent large-scale public investment in Turkey aimed at improving the quality of the road network. Our main finding is that, by reducing the cost of shipping, high-capacity expressways improved the foreign market access of regions remote from the ports.

A typical international shipment involves both domestic and international transportation with a possible transhipment across different modes at a harbor, an airport, or a border crossing. Quantitative models of international trade rarely distinguish these separate segments. Bilateral distances used in the estimation of gravity equation are typically the distances between the main cities of countries. While measures taking into account internal distances are available (Redding and Venables, 2004), they do not explicitly control for the quality of transportation infrastructure which is clearly important in determining domestic freight costs besides distance.

Intuition and evidence suggest that the domestic component may account for a nonnegligible part of the overall cost of shipping goods across borders. Decomposing the ad valorem tax equivalent of trade costs between industrialized countries, Anderson and van Wincoop (2004) estimate that domestic distribution costs are more than twice as high as international transportation costs (55 versus 21%, respectively). Rousslang and To (1993) document that domestic freight costs on US imports are in the same order of magnitude as international freight costs. Using data on the cost of shipping a standard container from Baltimore to 64 destination cities around the world, Limao and Venables (2001)find that the per unit distance cost in the overland segment of the journey is significantly higher than in the sea leg. Moreover, these costs critically depend on the quality of the transportation infrastructure. Atkin and Donaldson (2014) estimate that intranational trade costs in Ethiopia and Nigeria are 4 to 5 times larger than the estimates obtained for the United States. Consistent with this evidence, recent policy initiatives emphasize that an inadequate transportation infrastructure and inefficient logistics sector can severely impede developing countries' competitiveness (ADBI, 2009; WB, 2009; WTO, 2004). For instance, the World Bank cites trade facilitation, which incorporates domestic transportation, as its "largest and most rapidly increasing trade-related work" as of 2013. Thus, quantifying the effect of internal transportation costs on international trade and understanding its channels are important for assessing trade-related benefits of transportation infrastructure investments.

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As a case in point, Turkey increased the share of four-lane expressways in its interprovincial road stock from 11 to 35% between 2003 and 2012. The expansion of existing two-lane roads into divided four-lane expressways significantly improved the quality and capacity of roads while the total length remained essentially unchanged. Important for our study, these investments affected regions differently depending on where they were made, improving the connectivity of some regions to the international trade gateways of the country more than others. To exploit this variation, we use a rich dataset that provides information on province-level trade disaggregated by the international gateways of the country and estimate that the investment under study significantly reduced transport costs, and thus increased regional exports and imports. Using our baseline estimate, we calculate the cost of shipping over the mean distance in our data. Accordingly, the cost of an average-distance shipment drops by about 70% if the complete route is upgraded from a single carriageway to expressway. This result is robust to alternative specifications and instrumenting the change in route-specific road capacity with the initial capacity. Our estimates imply that the present value of a 10-year stream of trade flows generated by a one-dollar investment in road infrastructure ranges between $0.7 and $2. Finally, we show that transportation-intensive industries displayed higher trade growth in regions with above-average improvements in connectivity. This constitutes a plausible channel for the aggregate response of regional trade and strengthens our identification.

Recent work highlights the prevalence and importance of the issues that we explore. As noted above, Atkin and Donaldson (2014) estimate large internal trade costs in Ethiopia and Nigeria. Coşar and Fajgelbaum (forthcoming) develop a model in which these costs lead to regional specialization in export-oriented industries close to ports, and verify this prediction in China. Allen and Arkolakis (2014) incorporate realistic topographical features of geography into a spatial model of trade and estimate the rate of return to the US Interstate Highway System. Focusing on historical episodes, Donaldson (2012) and Donaldson and Hornbeck (2013) analyze the welfare gains from railroads in India and the United States, respectively. We complement these studies by providing evidence on how a large-scale, capacity-enhancing public investment in transportation infrastructure in a developing country affects the volume and composition of its regions' international trade.

Our paper also contributes to a strand of literature that focuses on estimating the effect of transport infrastructure on trade and sectoral productivity. Using cross-country data, Limao and Venables (2001) and Yeaple and Golub (2007) find that infrastructure is an important determinant of trade costs, bilateral trade volumes, and comparative advantage.[1] Volpe Martincus and Blyde (2013) use the 2010 Chilean earthquake as a natural experiment to estimate the response of firm-level exports to the resulting geographical variation in access to ports. Volpe Martincus et al. (2013) use historical routes in Peru to instrument for the location of new roads and find a sizeable impact on firm-level exports. A recent report by IADB (2013) explores the importance of domestic transportation infrastructure for regional exports in a number of Latin American countries. Albarran et al. (2013) find a positive impact of improved transportation infrastructure on small and medium-sized firms' probability of exporting in Spain. We complement these studies by proposing an alternative measure of road quality and an identification strategy for estimating its effect on trade. We also explore the importance of alternative channels through which transportation infrastructure could exert its effects. To the extent that reducing internal transport costs helps developing countries participate in global supply chains in transportation-intensive industries, our results have important implications for industrial and commercial policies.

The next section introduces the background and the data. The results are presented in Section 3.

## 2. Data and preliminary analysis

### 2.1. Background

Turkey is an upper-middle-income country (according to the World Bank classification) with a large population (78 million as of 2014) and a diversified economy. The country is the world's 17*th*-largest economy, 22*th*-largest exporter and 13*th*-largest importer of merchandise goods by value (World Trade Report 2014, excluding intra-EU28 trade). It has been in a customs union for manufactured goods with the European Union since 1996, which accounts for more than half of the country's trade. Turkey is the fifth-largest exporter to the European Union and its seventh-largest importer.

Administratively, the country is divided into 81 contiguous provinces (*il* in Turkish) of varying geographic and economic size.[2] Each province is further composed of districts (*ilçe*). Some of these districts jointly form the provincial center (*il merkezi*), which is typically the largest concentration of urban population in a province. The top map in Fig. 1 outlines provincial boundaries and centers (see the notes to the figure).

Road transport is the primary mode of freight transport in Turkey. It accounts for about 90% of domestic freight (by tonne–km) and passenger traffic.[3] While the interprovincial road network has been extensive and paved, its capacity was considered quite inadequate until recently. In order to relieve the congestion and reduce the high rate of road accidents, the authorities launched a large-scale public investment in 2002 in order to expand existing single carriageways (i.e., two-lane undivided roads) into dual carriageways (i.e., divided four-lane expressways). The investment was centrally planned and financed from the central government's budget with no direct involvement of local administrations.

As a result, the length of dual carriageways increased by more than threefold during the 2003–2012 period, while total road stock remained essentially unchanged (middle and bottom maps in Figs. 1 and 2). This capacity-expansion feature of the investment distinguishes the episode under study from the construction of new roads or the pavement of existing dirt roads, settings on which the related literature typically focuses (IADB, 2013).

External evidence suggests that the upgrades improved road transport quality in Turkey. Since 2007, the World Bank has been conducting a worldwide survey among logistics professionals every two years. The results are aggregated into the Logistics Performance Index (LPI), which ranges between 0 and 5; a higher LPI value indicates a more developed transportation sector as perceived by industry experts. In 2007, Turkey's score was 2.94, lower than the OECD average of 3.61. In 2012, Turkey's LPI value of 3.62 almost caught up with the OECD average of 3.68. Broken down into its components, the LPI covers the following six areas: customs, infrastructure, logistics competence, tracking and tracing, international shipments, and timeliness. In 2007, Turkey ranked 39*th* among 150 countries for the quality of trade- and transport-related infrastructure and 52*nd* for the timeliness of domestic shipments in reaching the destination. In 2012, Turkey scored higher on both indices; the country moved up 14 places in the infrastructure ranking, and 25 places in the timeliness ranking. On other indices, Turkey's rankings

[1] Besides the length of roads, paved roads, and railways per sq km of country area, the infrastructure index used by Limao and Venables (2001) contains telephone main lines per person as well, making it impossible to tease out the isolated effect of the transportation infrastructure. In contrast, Yeaple and Golub (2007) investigate roads, telecom, and power infrastructure separately and find roads to have the biggest effect.

[2] Provinces correspond to the NUTS 3 (Nomenclature of Territorial Units for Statistics) level in the Eurostat classification of regions.

[3] See page 7 in GDH (2012). Data on modal shares by value are not available.