



Market analysis and transportation procurement for food aid in Ethiopia



Marie-Ève Rancourt ^{a,*}, François Bellavance ^b, Jarrod Goentzel ^c

^a CIRRELT, ESG UQÀM, case postale 8888 succursale centre-ville, Montréal H3C 3P8, Canada

^b CIRRELT, HEC Montréal, 3000 chemin de la Côte-Sainte-Catherine, Montréal H3T 2A7, Canada

^c MIT Center for Transportation & Logistics, 77 Massachusetts Avenue, Cambridge 02139, United States

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ABSTRACT

Empirical research characterizing transportation markets in developing countries is scarce. By analyzing contracts between the World Food Programme and private carriers, we identify the determinants of transportation tariffs in Ethiopia and quantify their relative importance. The econometric models devised from our unique dataset provide insights for shippers to improve procurement processes, for carriers to develop competitive business models and for government authorities to define effective investments and policies. Results indicate that the number of carriers on a given lane significantly reduces transportation tariffs and that policies stimulating competition may be as important as road infrastructure investments in Ethiopia's development strategy.

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1. Introduction

In Africa, freight transportation can be a costly and time-consuming component of the supply chain due to issues such as poor infrastructure, security risks and complex regulations. For basic goods and commodities, transportation can represent a significant portion of the overall cost to the consumer. In the private sector, volatile transportation markets are seen as a challenge for multinational companies looking to Africa as a key region for growth. Africa's competitiveness suffers from high transportation costs [49]. This is particularly true for Sub-Saharan African countries, where the average freight costs are 20 percent higher than those of other countries [50]. Indeed Limão and Venables [24], have shown that a 10 percent increase in transportation costs reduces trade volumes by 20 percent. Increasing the competitiveness and transparency of transportation markets should enable many

African countries to better meet the needs of their citizens and be positioned for economic investment.

The markets for freight transportation in African countries are not well understood due to the lack of available objective data. Previous studies are based on surveys which may be unreliable, especially when carriers are asked about their cost structures. In this study, we analyze shipper data that include bids from numerous carriers and the subsequent contracted tariffs that were effective in the market. Our data set includes over 10,000 data points from over 75 carriers, corresponding to about 70 percent of the transporters registered at the Ethiopian Road Transport Authority at the time of data collection. These transporters provide service on numerous origin-destination lanes within Ethiopia as well as international corridors from nearby seaports. To our knowledge, this study is the first to analyze carrier bids and effective transportation tariffs in order to understand the transportation market in an African country.

Dry goods account for the majority of the cargo moved in Ethiopia, with the primary commodities being grains and pulses (with a significant portion in the form of food aid), fertilizers, cement, sugar, coffee and oilseeds. In humanitarian supply chains, high transportation costs reduce the number of beneficiaries that aid organizations can reach with the funding they receive. Data for our study were provided by the World Food Programme (WFP), the primary food aid transporter in Ethiopia, which moves nearly all of its cargo in the country with third-party transport carriers.

List of acronyms: CIRRELT, Interuniversity Research Center on Enterprise Networks, Logistics and Transportation; ESG UQAM, École des sciences de la gestion de l'Université du Québec à Montréal; MIT, Massachusetts Institute of Technology.

* Corresponding author. Tel.: +1 514 987 3000x5304; fax: +1 514 987 3343.
E-mail addresses: rancourt.marie-eve@uqam.ca, marieeve@mit.edu (M.-È. Rancourt), francois.bellavance@hec.ca (F. Bellavance), goentzel@mit.edu (J. Goentzel).

Between 1988 and 2011, the WFP delivered approximately 896,000 tonnes of food aid per year on average, which translates into 22,400 truckloads (TL) per year or 61 TL per day with 40-tonne trucks. Because of the large volumes and regularity of food assistance, the WFP transportation procurement and truckload operations are similar to those of commercial shippers.

We use multiple linear regression to determine which factors influence the linehaul truck transportation tariffs, our dependent variable. The tariffs are specified in cost per tonne for transportation service by lane, which is the route between the origin and destination points for the cargo. Our model considers a number of independent variables grouped into three broad sets: cost driven factors, market structure measures, and socio-economic variables. The cost driven factors include distance, road conditions and risk perception. Exploiting the richness of our data set, we have used information from the full set of carrier bids to generate proxies for the market structure. Socio-economic factors are based on regional statistics, such as population and economic activities.

Our results show that market structure variables, particularly competition intensity, are good predictors of the tariffs paid by the WFP in Ethiopia. Contrary to similar studies of transportation markets in developed countries, which generally find very little variation in prices per kilometer across lanes, our results show that road conditions and competition levels explain a significant amount of the variability observed in transportation tariffs for Ethiopia. At a macro-level, we are able to quantify the causes for the generally poor development of transportation in Ethiopia. Simple reduced form counterfactual analysis shows that better road conditions should reduce shipping costs by 18 percent and increased competition by 44 percent on the international corridors. Similarly for the domestic routes, better road conditions would reduce shipping costs by 12 percent and increased competition should reduce them by 39 percent.

The paper is organized as follows. Section 2 reviews the literature on transportation procurement and market analysis, focusing on truckload and less-than-truckload sectors in both Africa and more mature markets. Section 3 describes the WFP operations in Ethiopia and outlines its transportation procurement process. Section 4 describes the data collected for this study and the variables used in the regression models. Section 5 presents the model building approach and interprets the results. This is followed by conclusions in Section 6.

2. Literature review

This study concentrates on the contractual aspects, especially pricing, between shipping organizations and commercial carriers for transporting in-kind donations (food aid) from their points of entry in Africa to their final distribution points in Ethiopia. Transportation procurement processes in this context are similar to those established in the commercial sector due to the extent and continuity of such aid operations. The interested reader is referred to Refs. [2,28] for further information on food aid and food security. In the following literature review, we thus focus on studies related to transportation market analyses and transportation procurement systems.

Very few empirical studies have attempted to understand transportation costs or prices in Africa. One reason is likely due to the scarcity of digital data archives. Empirical studies based on surveys of the trucking industry carried out in the last 20 years show that transportation prices were higher in Africa than in developed countries and most developing countries. Rizet and Hine [38] have found freight tariffs to be four to six times higher in three African countries (Cameroon, Ivory Coast and Mali) than in Pakistan

during the late 1980s. These authors also present an analysis of the main factors behind these differences in tariffs, such as transportation costs, taxes, profitability and vehicle productivity. Teravaninthorn and Raballand [46] studied four main international corridors in four African sub-regions (West, Central, East and Southern Africa) using carrier surveys. In order to analyze the differences in transportation cost and price structures, the potential explaining factors were disaggregated into three categories: the vehicle operating costs, the overall commercial providers' costs and the transportation prices paid by end users. The authors observe that market organization and strict regulations lead to low transportation service quality and high profit margins in West and Central Africa, while the trucking market is more mature and competitive in East Africa. Southern African corridors are found to be the most efficient in terms of price competitiveness and service quality.

Lall et al. [22] aim to explain high transportation prices in Malawi, based on trucking surveys designed according to the methodology developed by Teravaninthorn and Raballand [46]. They perform two sets of empirical analyses: farmers' costs for transporting tobacco to markets, and carriers' prices for transporting commodities on routes both within the country and on specific international corridors. Their analyses reveal that both the infrastructure quality and the market structure of the trucking industry are important contributors to transport prices. The quality of the trunk road network is not a major constraint, but differences in the quality of the feeder roads that connect villages to the main roads have a significant bearing on transport prices. These findings are consistent with those of Pedersen [34] who shows that transportation costs depend on the availability of infrastructure and on the density of demand on specific links, which implies that Africa is especially disadvantaged with low and dispersed demand and many landlocked countries that are difficult to serve. On a macroeconomic level, some studies based on bilateral trade flow data have shown that the cost of transporting goods and getting them across borders is a major obstacle to African trade performance. Limão and Venables [24] found that the relatively low level of African trade flows is largely due to poor infrastructure, which also affect transportation costs. Portugal-Perez and Wilson [35] provide estimates suggesting that improvements in logistics are more important in terms of trade expansion than are reductions of barrier tariffs.

In contrast to most African markets, the United States (US) transportation market is mature and well-studied, especially since the deregulation of the trucking industry in 1980 that increased competition. Caplice [5] and Nandiraju and Regan [30] describe the American truckload (TL) transportation market in detail and explain how the procurement of transportation services is managed in the context of electronic marketplace formats. Combinatorial auction mechanisms, by which carriers can bid on bundles of items for more economically efficient allocations, are commonly used for TL transportation procurement in practice (see Refs. [6,16,43]). In transportation procurement, the savings that can be generated by the use of combinatorial auctions are based on the principle of economies of scope. Shippers commonly use sophisticated transportation management systems to manage their TL operations, but determining the auction's winners is an *NP*-hard problem for which optimization algorithms must be implemented (see Refs. [40,27]; for examples). Powell et al. [36], Lee et al. [23] and Ergun et al. [17] have studied TL operations and pricing strategies from the carrier's perspective. These optimization problems are rooted in operations research analysis mostly conducted on randomly generated instances rather than empirical data.

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