WPS6844

Policy Research Working Paper 6844

What Drives the High Price of Road Freight Transport in Central America?

Theresa Osborne
Maria Claudia Pachón
Gonzalo Enrique Araya

The World Bank
Latin America and the Caribbean Region
Sustainable Development Department
April 2014

Abstract

In Central America, like many other developing regions, high transport costs are cited as an impediment to trade and economic growth. Prices for road freight transport —a key mode of transport comprising a significant share of total transport costs for intra- and extra-regional trade, are particularly high. Averaging 17 cents per ton-kilometer on main trading routes, these rates stand out even relative to other inefficient developing country markets (e.g., central and west Africa). However, the policy and other factors associated with increased prices have not been well understood. This paper uses data from a survey of trucking companies operating on the region's main trade corridors to analyze the determinants of firms' costs of providing service, as well as the effect of market structure and competition on prices. The analysis finds that whereas improved cost efficiencies could reduce prices by 3 cents per ton-kilometer, increased competition on national routes—those entirely within a nation's borders—would reduce prices by significantly more. Although there are many trucking companies, including small and somewhat informal operators, the degree of competition varies by route because of domestic restraints on competition and the prohibition on international competition on national routes. The paper shows empirically that imperfect competition accounts for at least 35 percent of mean prices on national routes. In addition, a lack of competition is likely to explain the persistence of an inefficient market structure, as well as a lack of innovation to reduce costs and enhance the quality of service.

This paper is a product of the Sustainable Development Department, Latin America and the Caribbean Region. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at tosborne1@worldbank.org.

What Drives the High Price of Road Freight Transport in Central America?

Theresa Osborne, Maria Claudia Pachón, and Gonzalo Enrique Araya
World Bank

KEYWORDS: Imperfect Competition, Road Freight, Cabotage, Central America, Oligopoly Pricing, Transportation Services, International Trade

JEL Codes: D4, L1, L11, L13, L41, N76, O18, R40

Acknowledgements

Funding for the survey and for subsequent analysis was provided by The Trade Facilitation for Regional Integration in Central America Trust Fund and the Latin America Region of the World Bank. In addition, the surveys for Panama where financed by the Spanish Fund for Latin America and the Caribbean (SFLAC). Tomás Serebrisky, Daniel Saslavsky, Maria Claudia Pachon, and Jordan Schwartz led the design and implementation of the survey. Jasmin Chakeri and Magaly Clavijo provided valuable support to the implementation of the survey. The survey data collection was led by Fares Khoury from EEC-Canada. Cecilia Briceno-Garmendia, Stefano Pagiola, Adam Stern, Maria Florencia Millan Placci, Ayat Soliman, Oscar Avalle, and Carlos Felipe Jaramillo, and peer reviewers Gael Raballand, Oscar Calvo-Gonzalez, and Anca Dumitrescu provided valuable comments on earlier drafts of this paper.

1. INTRODUCTION AND KEY FINDINGS

As formal trade barriers have declined within Central America over the past five decades, high logistics and transport costs have emerged as a key impediment to trade. The nations of the region have signed a series of agreements aimed at regional economic integration and both multi-lateral and bilateral treaties with countries outside the region. Most Central American countries rate relatively highly on international indicators of openness to trade, with Nicaragua, Guatemala, and Costa Rica ranking in the top 50 countries out of 180. Only Panama has a lower ranking on trade freedom than on economic freedom overall (see Table 1). Trade has expanded commensurately, with merchandise exports alone having attained 25 percent of GDP for the region over the past decade (See Figure 1) and total merchandise trade as a percent of GDP having substantially exceeded levels for other lower middle income countries (Table 2). Yet country rankings on the International Logistics Performance Index are relatively poor. Rankings out of 155 countries in 2012 were 61st for Panama, for Guatemala 74th, Costa Rica 82nd, El Salvador 93rd, Honduras 105th, and Nicaragua 107th (2010.)[1] Although in most countries of the region insecurity – crime, theft, and disorder – are viewed by businesses as a more severe constraint to doing business than transport costs, a substantial percentage of firms in Costa Rica (54 percent), El Salvador (32 percent), Guatemala (25), and Nicaragua (24) also rated the high cost of transportation as a major constraint[2] (see Table 3).

TABLE 1: SCORES ON ECONOMIC AND TRADE FREEDOM, 2013

Country Name	World Rank Economic Freedom Overall (out of 180)	World Rank Trade Freedom (out of 180)	Region Rank Economic Freedom Overall	2013 Score Economic Freedom	2013 Score Trade Freedom	Tariff Rate (%)
Costa Rica	49	43	8	67.0	85.1	2.4
El Salvador	53	74	10	66.7	79.0	5.5
Guatemala	85	41	16	60.0	85.2	2.4
Honduras	96	87	18	58.4	77.1	6.5
Nicaragua	110	39	21	56.6	85.4	2.3
Panama	71	99	13	62.5	74.8	7.6

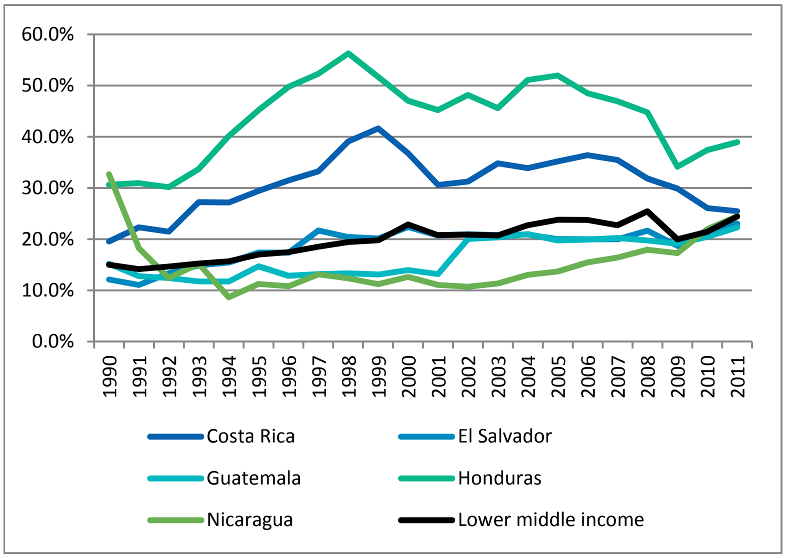
Source: Heritage Foundation (2013)[3]

Inefficiencies in the Central American road freight sector render international and domestic trade significantly more costly to exporters, importers, and consumers. High transport costs can take a variety of forms: long lead or delivery times, breakage, and spillage, all of which cause cargo to depreciate; uncertain timing of delivery, which impedes market access; and/or high transport and logistics prices, which reduce or "tax" the gains from trade directly.

[1]2012 rankings were not available for Nicaragua.
[2]Source: World Bank Enterprise Surveys 2010.
[3]Trade freedom is a composite measure of the absence of tariff and non-tariff barriers that affect imports and exports of goods and services. The trade freedom score is based on two inputs: (a) The trade-weighted average tariff rate and (b) non-tariff barriers.

While all these factors are present to some degree in the region, road transport prices are particularly high. Averaging 17 US cents per ton-kilometer on main routes for international trade, they stand out even relative to other inefficient developing country markets.[4] In a comparable 2008-2009 study on Sub-Saharan African main trade routes, for example, freight transport prices were estimated to be between 6 and 11 cents per ton-kilometer.[5] When adjusted for inflation and changes in petroleum prices, these would be equivalent to 7-12 cents in 2011-2012, when Central America price data were obtained.[6] In more advanced economies, trucking prices are observed to be as low as 2-5 cents per ton-kilometer (See Table 4 for relevant comparisons).

FIGURE 1: MERCHANDISE EXPORTS AS PERCENT OF GDP



Source: World Development Indicators
Note: Panama is excluded given inconsistent classification in series of re-exports.

TABLE 2: MERCHANDISE TRADE AS SHARE OF GDP, AVERAGE 2007-2011

Country	Percentage
Low Middle Income Countries	50.5
Costa Rica	73.1
El Salvador	62.6
Guatemala	55.7
Honduras	103.1
Nicaragua	66.9
Panama	112.3

Source: World Development Indicators

Although it is only one part of the transport and logistics equation, road freight represents a significant share of these costs in Central America. Road freight is used to link producers and consumers to airports and seaports and is the dominant transport mode for Central American intra-regional merchandise trade. Where estimates of total transport costs are available, road freight comprises between 20 and 50 percent.

[4] 2011-2012 data from Central America Trucking Survey.
[5] Teravaninthorn and Raballand 2009.
[6] Oil prices in the latter half of 2007 averaged approximately USD 80 per barrel, as compared to USD 107 in late 2011-early 2012, or a 33 percent increase, and USD cumulative inflation between these years was approximately 8.5 percent, so if transport prices in Africa were one half composed of fuel costs, or if they rose with general USD inflation, they would be approximately 7-12 cents per ton-kilometer in 2011-2012.

TABLE 3: COMPARISON OF TRANSPORT AND INSECURITY AS A CONSTRAINT TO DOING BUSINESS

	CR	ES	GUA	HON	NIC	PAN
Percent of firms identifying transportation as a major constraint	54.3	32.0	24.6	15.1	23.6	0.6
Percent of firms identifying crime, theft and disorder as a major constraint	21.3	51.4	43.8	31.3	48.4	8.2
Proportion of products lost to breakage or spoilage during shipping to domestic markets (%)	0.6	1.3	1.3	1.1	2.1	0.1
Products shipped to supply domestic markets that were lost due to theft (% of product value)	0.1	1.0	1.1	1.0	0.6	0.5
Security costs (% of annual sales)	1.4	3.4	1.9	3.8	2.3	1.1

Source: *World Bank Enterprise Surveys 2010*

This paper utilizes detailed data from a survey of Central American trucking firms to document and investigate road freight costs and pricing on main routes for international trade. The analysis broadly confirms earlier studies (e.g., World Bank 2012) which highlight the role of border frictions, wait times, traffic congestion, high empty backhaul, informal payments, and crime and insecurity in raising costs.[7] At the same time, by providing a more structured econometric analysis this paper quantifies these impacts more precisely, tests the significance of each factor in explaining firms' costs, and analyzes the impacts of market structure and competition on prices. The data and analysis are restricted to firms serving main trading routes, and therefore cannot speak to these or other issues – including market behavior or road quality – on rural or other domestic routes.

Some of the findings may be surprising. The analysis shows that variations in the quality – i.e., the surface type and condition – of existing roads serving the region's trade corridors make only a small difference in explaining prices, and only indirectly through travel speeds. In addition, there is no evidence that trucking firms forego profitable opportunities to invest in more advanced truck fleets, either due to credit constraints or other reasons.

Whereas newer, more modern equipment decreases fuel usage costs and vehicle emissions, it also carries additional financing and depreciation costs. Thus, firms with low truck utilization as are prevalent in the region would not find it beneficial to incur these higher fixed costs. Fuel-efficient technologies are available and known in the region; however, under the current market structure financial incentives are weak for many firms to adopt them.

In their totality, cost inefficiencies on main trade routes are substantial. If substantial improvements were possible in each of the significant cost variables (i.e., of 1/3 of their standard deviations), this would lead to a cumulative drop in the average costs of service cost of approximately 2.8 US cents per ton-kilometer. This represents about 16 percent of the mean price.

---

[7] Although firms' weighted average travel speeds were not a statistically significant correlate with average firm costs, firms price routes with higher travel speeds lower, presumably due to the greater flexibility this affords for increasing truck utilization.

BOX 1: International Experiences with Trucking Sector Liberalization

European Union. The European Union began a series of gradual steps to partially liberalize cabotage – foreign entry on national routes – within the Union in the 1990's. This has enhanced competition and efficiency of road freight transport, put downward pressure on costs and trucking firm profit margins to lower prices. The Benelux countries were the first countries in the union to liberalize cabotage, and did so fully in 1991. Positive trends followed in efficiency, reduced empty runs, and reduced Co2 emissions. The EU itself later began allowing limited cabotage. Although limitations remain – no more than 3 cabotage operations can be undertaken within a 7 day period following an international consignment, since the rules have been harmonized in 2009, the more cost-competitive providers have increased their shares on national EU routes. Total cabotage has increased from approximately 14 million ton-km in 2006 to 19 million ton-km in 2011 despite a drop in total freight hauled between these two years, given its efficiency advantages. Moreover, cabotage is generally higher as a percent of transport volumes in the smaller economies, where bilateral trucking operations are higher as a percent of total operations.

United States. The United States liberalized the trucking sector in 1980 with passage of the Motor Carrier Act as part of a broader set of transport sector reforms. The Act broadly deregulated entry into the sector, liberalized pricing, eliminated most restrictions on commodities that could be carried, and deregulated the routes and geographic regions that motor carriers could serve. Following the law's passage the number of new trucking firms increased dramatically, along with employment in the sector. Whereas the number of heavy duty tractors in use dropped, inter-city truck ton-miles increased 55 per cent, equipment utilization improved, and the length of average haul increased dramatically. Studies show that while in the year following deregulation costs rose by 7 per cent four years later they had declined by 23 per cent (Ying 1990). The reform is estimated to have generated $3-$4 billion per year in benefits to shippers (Winston et al., 1990), including $1 billion in service improvements and form of more reliable service as a result competition. Manufacturers, newly able to move their products more quickly and respond to customers, reduced their inventories, and consumers indirectly benefited from the more efficient, lower-cost transport of goods.

Mexico. Prior to liberalization in 1989, Mexico heavily regulated its trucking sector. Stringent limits were placed on prices and the quantity of cargo that could be transported, as well as what type of routes could be served by whom. Competition among the relatively few trucking companies was minimal, and as a result service quality was poor and prices were high. Once barriers to entry were removed and prices were liberalized, the industry grew. By 1996, registered transport units had grown 92 percent. Employment in the sector increased 5.25% between 1989 and 1995 and the volume of traffic has increased 8.6% annually. Prices also fell, between 1987 and 1994, by over 23% countywide and continued to drop – from 1995 and 1998, another 23 percent real terms. At the same time, the quality of service and innovation improved (Scheinvar 1999).

Zambia. Zambia and other member states of the Community of East and Southern Africa (COMESA) and Southern African Development Community (SADC) have adopted measures and rules aimed at liberalizing transport, harmonizing transport rules and developing infrastructure in the sub-region. Eight states in Southern Africa are members of both Communities and have ratified the transport protocols of both organizations. Moreover, Zambia has signed bilateral arrangements with 6 of the 8 countries to harmonize standards and allow interoperability. While Zambia does not permit cabotage, the vast majority of its international merchandise trade is conducted on international routes, where there is international competition. Moreover, South African companies have established Zambian companies to compete on national routes. Zambia's case underlines the potential benefits to landlocked countries of exposing national service providers to wider regional competition. Competition in trucking services contributes to lower transport tariffs, considered low by international standards at between 3.7 and 5.6 US cents per ton-kilometer in 2006 (Raballand *et al.* 2008).

TABLE 4: INTERNATIONAL COMPARISON OF ROAD FREIGHT TRANSPORT PRICES

	US cents tkm	Year	Source
Latin America			
Central America	17	2012	1/
Brazil	3.5	2007	2/
Africa			
Kenya	4	2010	3/
Uganda	8.5	2010	3/
Rwanda	9	2010	3/
Niger	13	2010	3/
Congo	12	2010	3/
Burundi	11	2010	3/
Burkina Faso	9	2010	3/
Durban- Lusaka Corridor	6	2007	2/
Lome- Ouagadougou Corridor	7	2007	2/
Mombasa-Kampala Corridor	8	2007	2/
Duoala- Ndjarrena Corridor	11	2007	2/
Zambia	3.7-5.6		5/
Asia		2006	
China	5	2007	2/
Pakistan	2	2007	2/
Advanced Countries			
USA	2-10.8		2/,3/,4
France	5	2009	2/

Source: *1/ World Bank LCSSD Economics Unit Trucking Survey (2012); 2/ Teravaninthorn, Supee and Raballand, Gael (2009) Transport Prices and Costs in Africa: A Review of the Main Corridor. The World Bank; 3/ Kabanguka, Jean Kizito (2010) Corridor Logistics Initiatives. Presented at the SSATP Annual Meetings 2010 (The World Bank); 4/ McKinsey & Company (2011) Building India: Transforming the nation's logistics infrastructure. Infrastructure Practice. 5/Raballand, G., C. Kunaka, B. Giersing (2008). The Impact of Regional Liberalization and Harmonization in Road Transport Services: A Focus on Zambia and Lessons for Landlocked Countries (The World Bank) WPS4482.*

Of even greater significance in explaining high road freight prices is the role of imperfect competition, particularly on national routes – routes with no international overland border crossing. Through econometric analysis of the determinants of prices, this paper provides evidence of anti-competitive pricing: Routes served by fewer firms show higher prices, when accounting for differences in costs and demand. Moreover, the number of firms on a route is dramatically lower relative to demand on national routes, where average markups over cost are significantly higher than on international routes. Service on such routes, which connect points within a country to and from air and sea ports, is essential for extra-regional trade, which represents 84 percent of Central American trade volumes. Averaging 8 US cents per ton-kilometer on national routes (and 32 cents in Panama), excess markups due to imperfect competition account for at least 35 percent of mean prices on national routes throughout the region.

The precise mechanisms limiting domestic competition are not clear and likely differ between countries. In some of the countries of the region formal requirements for entry, although seemingly reasonable and surmountable, effectively become barriers to entry in implementation. In some cases, the market is informally partitioned, with permission to operate depending on implicit agreement not to infringe a dominant firm's territory. Although it is not possible to identify the precise mechanisms which limit competition, prohibitions on foreign competition are likely to play a role. The structure of any market is dynamic and likely involves fluctuating levels of competition. However, it is easier to sustain anti-competitive behavior within a country, where various actors know each other and understand the rules restraining competition, whether tacit or explicit. In Central America, although foreign-registered companies can engage in cross-border freight delivery, cabotage – the provision of service on national routes by a foreign-registered truck – is prohibited. This restriction is reinforced by a prohibition on forming a trucking company with majority foreign ownership.

In addition to being associated with reduced competition, such barriers to entry make it more difficult to achieve cost efficiencies. They make it more difficult to obtain return loads on international routes. They segment the market and decrease fleet utilization, thereby decreasing economies of scale and scope. Market segmentation may also dis-incentivize the introduction of more flexible and efficient load dispatch systems which would improve vehicle utilization and intensify competition. Reduced fleet utilization in turn makes it less profitable to invest in fuel saving practices and technologies, including newer, more-fuel efficient trucks which entail higher financing and depreciation costs. Moreover, the lack of effective competition may inhibit innovation designed to improve quality or reduce costs.[8] Because high markups dampen downward pressure on costs, inefficient firms survive, and the market fails to restructure around the most efficient providers.

The analysis of firm costs reveals additional issues which increase costs as well – in particular, traffic congestion, high wait times, and high informal payments. Finally, although we could find no evidence that road quality explains costs or prices directly, it is associated with greater average travel speeds, which are inversely related to prices, probably due to the costs of operating in congested traffic.

The impact of high trucking prices on international trade appears to be economically important. Given available estimates of the elasticity of trade with respect to transport costs, halving trucking prices on domestic routes to ports, for example, would reduce total transport costs to extra-regional destinations by between 13 and 22 percent, which would increase trade volumes by a similar percentage if the transport cost elasticity of trade were equal to 1.[9] Reducing trucking prices on intra-regional overland routes by one third through cost efficiencies could similarly increase regional trade.

Although it is beyond the scope of this paper to estimate the investments required to achieve potential cost savings in each of the areas identified, some – in particular reduced congestion costs – could require a sizeable investment in infrastructure. Others, such as reducing bottlenecks at borders and ports, would require improved sector governance and transport strategies, in addition to physical investments. Among all possible measures, those targeted at improved competition are likely to be among the most cost-effective. As discussed in Box 1, liberalization of entry has generally been associated in other regions of the world with improved efficiency, quality, and pricing of trucking service.

In the next section of this paper, we describe the data and highlight key stylized facts. In Section 3, we econometrically estimate the main factors associated with firms' cost structures; in Section 4, we estimate the relationship between costs, trucking route characteristics, and the degree of competition in order to test for general forms of imperfect competition. The final section concludes.

2. DATA AND STYLIZED FACTS[10]

In 2011-2012, the World Bank commissioned a survey of trucking operators serving important international trade routes for the Central American countries of Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama. The first such survey in Central America, it was designed to enable

---

[8] See, e.g., Aghion et al. (2003) and (2009) and EU (2013).

[9] Estimates by Limao and Venables (2000) and others range from 2-3. However, as Novy (2012) shows, these elasticities tend to decline with distance between trading partners.

[10] Unless otherwise specified, all data presented henceforth in tables, figures, and text of this report are from the Central America Trucking Survey.

empirical analysis of costs and prices on these routes and to allow for direct comparisons with a recent Africa trucking survey (discussed and analyzed in Teravaninthorn and Raballand 2009). In addition, the survey included questions designed to elucidate market structure and firm behavior, as well as obstacles trucking firms face. To construct the survey population, the survey team first compiled a list of trucking companies for each of the six countries from listings provided by the main trucking associations in the region, as well as supplementary lists drawn from publically available documents (e.g., phone books), and a list of single-truck operators produced by traveling to truck parks and other locations such firms were likely to be found. The master lists were then filtered to include only firms which transported internationally-traded goods on routes to neighboring countries, routes to and from major international ports or airports, or routes to and from major border posts. The information obtained from the filtered master lists was used to compute the eligible population of firms from which the survey team drew a random sample. The eligible population identified through the listing process comprised 502 trucking companies and 192 mono-truck operators, is summarized in Table 5. (For more details, see Annex A.)

Of these, approximately 254 firms were sampled which collectively operate over 3,400 vehicles on over 430 distinct origin-destination pairs.[11] The sampling strategy was designed to ensure adequate representation of both single (mono-) truck operators and trucking companies with more than one truck, and the target sample sizes were designed to produce 120 route observations per country on firms' main routes. Although the survey targeted an even split of route-firm-level observations between companies and mono-truck operators, in practice there were insufficient mono-truck operators available to be surveyed, and the team increased the sample of companies with two or more trucks. The result is a slight under-representation of mono-truck operators relative to the others.[12] In addition, refusal rates were significant, and reluctance to answer questions about prices in particular was an issue.[13] Despite these issues, the sample represents a large share of the eligible population at approximately 37 percent, a factor which would mitigate any sample selection bias due to non-response.[14]

The survey made no attempt to capture firms operating on smaller national routes connecting rural areas or secondary markets, and this study does not attempt to assess costs or pricing on such routes. Thus findings must be carefully interpreted to apply only to main routes for international trade.[15] In addition, this study cannot capture all issues that affect costs beyond trucking prices – including the role of insecurity, product depreciation or losses due to delays, port inefficiencies, or other important issues. Rather it is focused only on the issue of trucking sector prices and the inefficiencies which drive them.

---

[11]The final sample excludes trucking firms which are vertically integrated subsidiaries of other companies and serving on an own account basis, and extreme outliers were excluded from the analysis as well.

[12]Where relevant, we weight the data using the appropriate sample weights by country and mono-truck versus larger firms.

[13]Refusal rates in the final survey were not provided, but in the pilot phase were as high as 75 percent.

[14]As a fraction of total registered trucks in the region, the sample is much smaller; however, national fleet statistics are not differentiated by dedicated service providers and it is unclear to what extent registration statistics are updated.

[15]There are approximately 60 price observations for domestic city-pair routes (excluding Panama) in the sample, and average price unconditional on costs or other route characteristics is statistically significantly lower on these routes than other national routes. However, this is not consistently the case when accounting for all other covariates. Ultimately, there are not sufficient observations on these routes to obtain conclusive results.

TABLE 5: ELIGIBLE POPULATION OF TRUCKING FIRMS (APPROXIMATE)

Country	Trucking Companies	Mono Truck Operators	Total	Sample
Costa Rica	75	26	101	44
El Salvador	60	22	82	35
Guatemala	75	18	93	37
Honduras	79	30	109	48
Nicaragua	108	48	156	48
Panama	105	50	155	42
TOTAL	502	192	696	254

The survey captured data on firm characteristics such as ownership, vehicle fleet characteristics, and percentage of firms' volume to and from international destinations, to and from international ports, airports, border posts, and other route types. It asked firms about their main method of obtaining cargo, client concentration, use of fuel efficiency measures, perceived level of competition, and perceived constraints. In addition, each firm was asked to name up to 4 of their main routes served in the last completed fiscal year and to provide detailed data on the type of service provided on each route, as well as route-level characteristics, main cargo types, average speeds, wait times, and other constraints, as well as the average prices they charged.

Market Characteristics and Structure

The Central American trucking market is somewhat segmented by country, route, and client. According to regional accords, trucking firms are permitted to serve routes crossing international borders within Central America. However, all six countries prohibit cabotage– the transporting of cargo by a foreign trucking company entirely within a given country's borders. In addition, all six countries require majority domestic ownership of trucking firms – a fact which makes it difficult for foreign firms to circumvent the cabotage restriction or to compete on some international routes. In fact, trucking company ownership is overwhelmingly national, with the national share averaging 93 percent (See Figure 2). In addition, almost all international routes that firms list as among their most important originate or end in the firms' countries of domicile. Thus, nationality restrictions appear to segment the market in an important way.

FIGURE 2: PERCENT NATIONAL OWNERSHIP BY COUNTRY (FIRM MEANS)

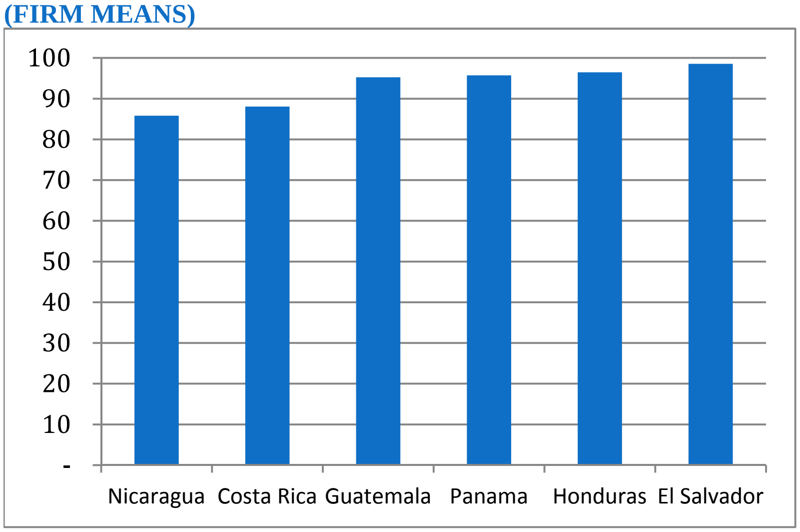
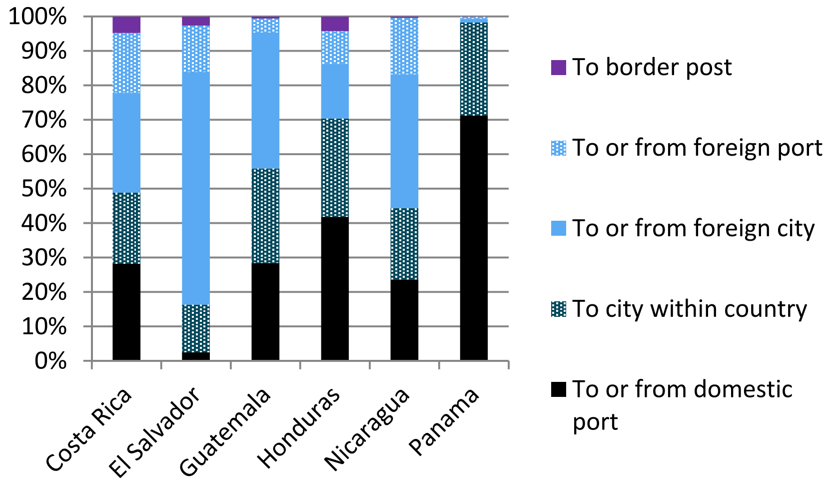


FIGURE 3: PERCENTAGE OF FREIGHT TONNAGE TRANSPORTED BY ROUTE TYPE

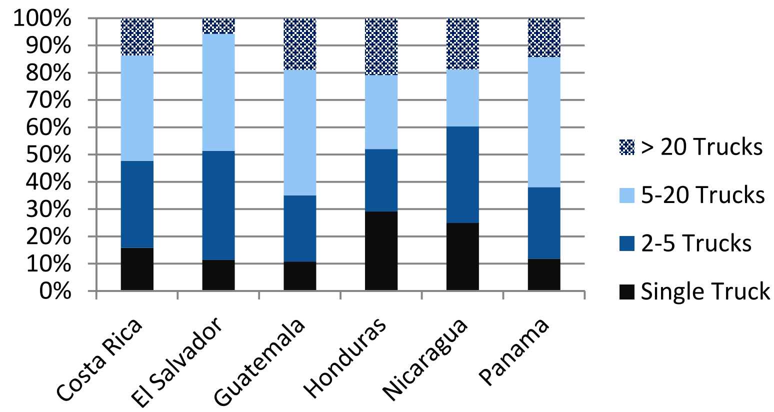


Extra-regional trade represents the lion's share of both tonnage and value, as shown in Table 6.[16] Because in most cases externally traded goods are transported on national corridors connecting to air and sea ports, efficient service on these routes is of considerable importance for the region's international trade.

Both international and national route service are important business segments in all countries but Panama. As shown in Table 6, national route service comprises an important share of tonnage transported by surveyed firms. These shares nonetheless vary considerably by country from 16 percent of the total tonnage for El Salvador, which lacks an Atlantic port, to 98 percent for Panama, where national routes are used to transfer cargo between international ports. At the same time, freight volumes to and from domestic ports are larger than those to and from foreign ports, with the exception of El Salvador, where these percentages are essentially equal.

Freight to a foreign capital city represents the major share of tonnage delivered by Salvadoran trucking firms and is an important share for Costa Rican, Guatemalan, and Nicaraguan firms as well (See Figure 3). Freight delivered to border posts is a small fraction of the total, and is almost uniquely to the border with Mexico. In addition, most firms – 60 percent in the sample – serve both international and national routes, with 22 percent serving only national and 18 percent serving only international routes. Moreover, firm size is not correlated with international orientation; international routes comprise on average 50 percent of volumes for all firm size categories, including mono-truck firms.

FIGURE 4: DISTRIBUTION OF FIRM FLEET SIZES IN SAMPLE



[16]The percentage of freight flows captured by the survey which are to or from a sea port roughly mirrors this, but represents a lower percentage in Costa Rica, El Salvador, and Guatemala. This is due in part to the value of air freight exports from those countries.

The market is composed of a number of relatively small, inefficient firms. Despite economies of scale in the industry, as illustrated in Figure 4, large firms coexist with medium sized and smaller firms, which tend to have higher costs (discussed in Section 3).

TABLE 6: EXTERNAL TRADE SHARE OF FREIGHT AND TOTAL TRADE VALUES

	Percentage of Total Freight to and from Ports (Trucking Survey)	External Trade Percent of Total Trade Tonnage	External Trade as Percent of Total Value of Trade	USD/Ton all Merchandise Trade by Country
Costa Rica	58	85	88	$ 1,727.38
El Salvador	19	63	72	$ 1,871.55
Guatemala	45	82	80	$ 1,328.46
Honduras	72	75	76	$ 1,087.62
Nicaragua	51	67	78	$ 1,556.54
Panama	98	89	92	$ 4,889.09

Source: CA Trucking Survey and World Integrated Trade Solution, The World Bank

Although the presence of over 100 operators per country (Table 5) would seem to provide effective competition, companies serve different routes and clients. Of all routes trucking companies list as among their main routes (including return trips), 57 percent are listed by only one sampled firm – as shown in Figure 5.

Adjusting for the appropriate sampling weights, this would indicate that on over half of all major routes, on average only 2.7 firms count the route as among their main ones served. Moreover, 87 percent of routes had five or fewer firms in the survey claiming it as a main route.

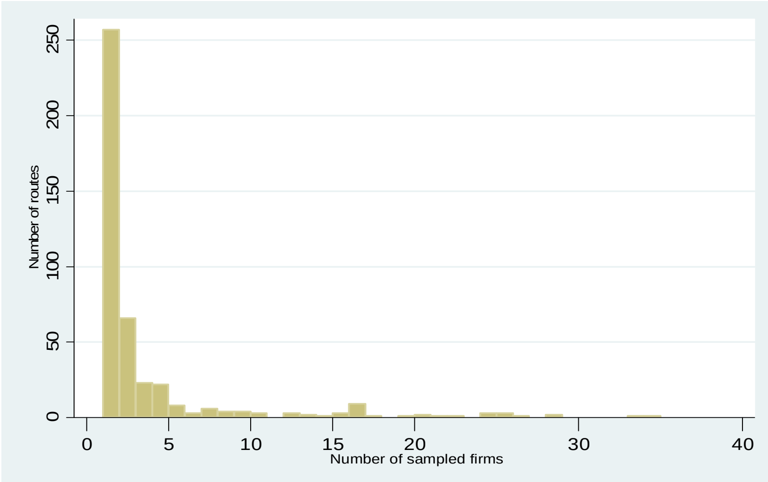
Viewed by market segment, market concentrations are fairly high. Revenue shares of the top five trucking firms by country range from 17 percent to an estimated 33 percent of total revenues in the sector for the Nicaraguan and Honduran markets, respectively (Table 7.) Since international routes are not as concentrated, this suggests higher revenue concentration on national routes. As shown Table 8, the top three trucking firms perform 77 of trips on a given route (comprising and origin and destination) and 26 percent of all trips from a given origin. This percentage is significantly higher for national routes by origin at 34 percent, as compared with 16 percent for international routes.

TABLE 7: ESTIMATES OF MARKET CONCENTRATION: REVENUE SHARES TOP 5 AND 10 FIRMS BY COUNTRY OF DOMICILE

Country	Top 5	Top 10
Costa Rica	20.8%	29.8%
El Salvador	22.7%	32.1%
Guatemala	19.6%	29.4%
Honduras	33.5%	37.7%
Nicaragua	17.0%	24.7%
Panama	19.3%	25.4%

Note: Estimates use survey sampling weights.

FIGURE 5: NUMBER OF SURVEYED FIRMS SERVING MAIN ROUTES



Many firms serve just a few main clients. As shown in Figure 6, for most countries and firm sizes, trucking companies rely on their main client for over 50 percent of their business. This degree of client specialization could be the result of a competitive process with emphasizes relationships, quality, and reliability, with firms competing periodically to serve different routes and clients. Yet if this were the case, one would expect high quality of service or competitive prices, controlling for quality, prices would be competitive. Instead, what we find is high costs and pricing on national routes.

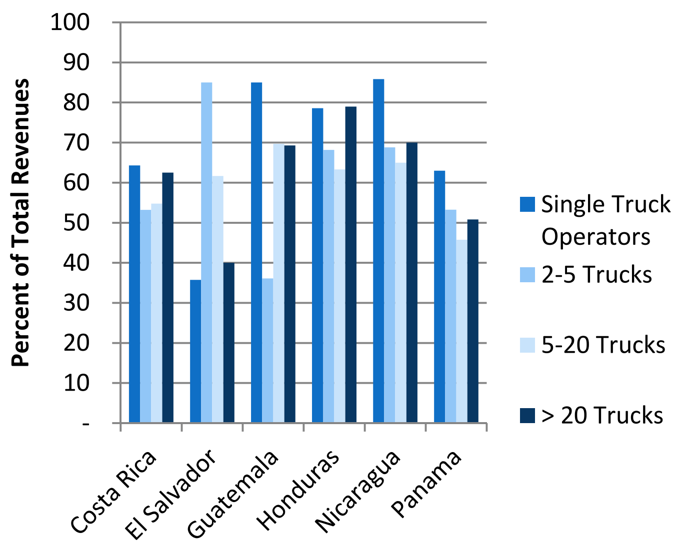
TABLE 8: ESTIMATED MARKET CONCENTRATION BY ROUTE (ORIGIN-DESTINATION) AND ORIGIN ONLY

	Fraction of Total Trips by Top 3 Firms
By Route (Origin-Destination)	77%
By Origin	26%
National Routes from origin	34%***
International Routes from origin	16%

***Difference with international routes significant at 1 percent level
Note: Calculated as fraction of trips by top single firm in the survey, with average sampling weight in population of 2.74 (approximately 3) total firms.

The number of competitors serving national routes is dramatically lower than on international routes relative to market size. Figure 7 shows the relationship between the number of firms in the sample listing a route as a main one and the total number of trips performed on the route per month by all firms in the survey. As shown, this relationship is generally positive for both international and national routes. However, the positive slope is much steeper for international routes than for national routes. For example, 10 sampled firms serve 22 total trips per

FIGURE 6: PERCENT OF TOTAL REVENUES FROM MAIN CLIENT



month on international routes, but on national routes the number of firms does not reach 10 at less than 500 trips per month.

Market segmentation also appears to be associated with low truck utilization, which raises average costs. Average annual truck utilization in kilometers travelled ranges between 10,500 and 200,000, and averaged only 59,000 among surveyed firms (Table 9).[17] Although meaningful comparators are difficult to obtain, this is much lower than for South Africa, Pakistan, and the United States, which have rates of approximately double this level.[18] At the same time, high empty backhaul rates translate into even fewer kilometers served with a payload. As shown, this averaged a low of 14,000 in Guatemala and range up to 39,000 in Costa Rica and 44,000 in El Salvador for the survey year.

FIGURE 7: NUMBER OF FIRMS RELATIVE TO DEMAND (TOTAL TRIPS)

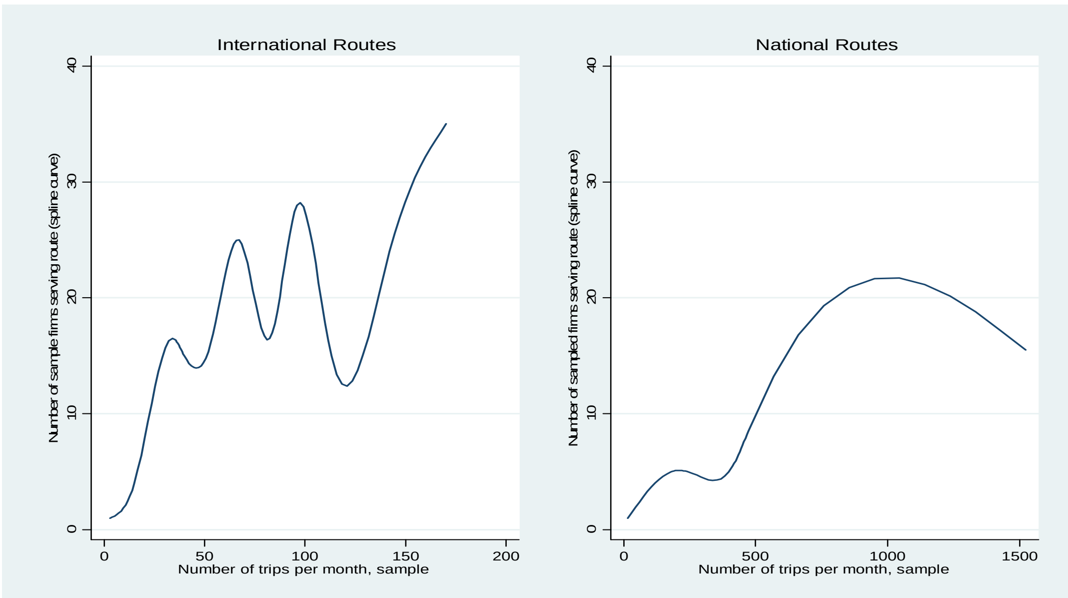


TABLE 9: AVERAGE ANNUAL KILOMETERS SERVED WITH LOAD (PER TRUCK)

Country	"Mileage" Per Truck in Kilometers	Kilometers served per Truck (Estimated)
Costa Rica	68,652	38,915
El Salvador	64,419	44,242
Guatemala	59,328	14,205
Honduras	56,398	36,611
Nicaragua	56,398	37,107
Panama	44,309	18,579

Note: Average kilometers served per truck is estimated using total mileage and empty backhaul rates reported on firms' main routes, weighted by the percentage of total business on the same route type.

A variety of factors may contribute to low truck utilization rates and kilometers served, potentially including high wait times, low travel speeds, high seasonality in demand. Long lags between trips due to

[17] Only four of the sampled firms had utilization over 105,000 kilometers per year.
[18] See Londoño-Kent (2008) and Teravaninthorn and Raballand (2009).

inefficient load allocation combined with short route distances could also play a role. Central American countries are geographically small and many routes are less than 150 kilometers long (See Table 10). However, with the exception of Panama, a majority of firms' main service routes are long haul routes. Moreover, short distances do not explain the lack of efficient truck dispatch systems. Other time-related factors – in particular, low travel speeds and high wait times – can also reduce vehicle utilization. Travel speeds in the region average 71 kilometers per hour, with substantially lower speeds on national routes to or from national cities or to ports, where traffic congestion is a major issue (See Figure 8).[19]

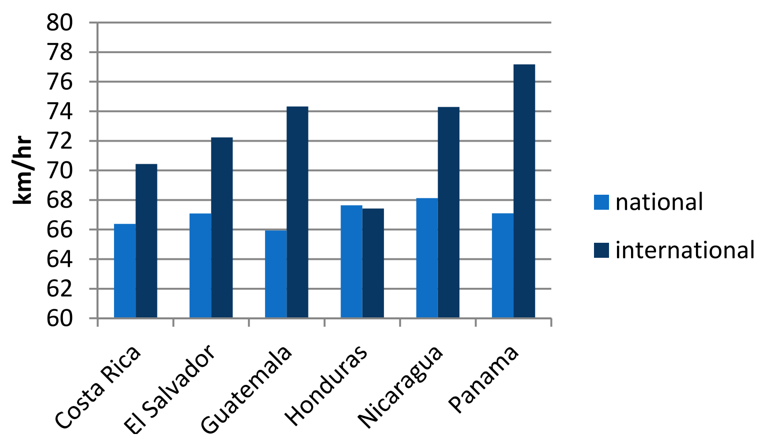
TABLE 10: PERCENTAGE OF ALL MAIN ROUTES SERVED BY LENGTH OF ROUTE

	Short-haul (less than 150 kilometer National Routes)	Long-haul (National)	Long-Haul (International)
Costa Rica	**6.7**	**17.5**	**75.8**
El Salvador	**14.0**	**1.7**	**84.3**
Guatemala	**11.2**	**16.3**	**72.5**
Honduras	**21.5**	**35.5**	**43.0**
Nicaragua	**12.0**	**33.3**	**54.7**
Panama	**70.8**	**14.4**	**14.8**
Total	**22.7**	**20.3**	**57.0**

Note: Data are based on listing of main routes from survey and are not weighted by intensity of service.

Wait times are also substantial (see Figure 9), and are highest for Honduras and Panama. Although wait times are generally considered a problem at overland border crossings, by kilometer traveled they are higher for national routes – 3 minutes per kilometer relative to 1.8 minutes on international routes. Wait times on domestic routes are typically due to turn around and wait time at sea ports. In addition, for security reasons trucks may be forced to wait overnight to avoid night travel.

FIGURE 8: SPEED ON NATIONAL AND INTERNATIONAL ROUTES



Nonetheless, low utilization and cannot be fully explained by low speeds and wait times. In the year of the survey, each truck was occupied – either with or without load, waiting, in traffic, or moving – on average 1,652 hours, or 18 percent of the year. Moreover, as shown in Figure 10, time utilization varies, and its distribution suggests that only a minority of trucks were fully occupied in the year of the survey. Thus for many, there remains significant scope to increase served kilometers, even with current speeds and wait times. Similarly, whereas some empty backhaul is normal given geographic imbalances in merchandise flows, it

[19]Of course, slower speeds overall might be socially optimal, since trucks travelling at faster speeds carry risks for other motorists. However, this is unlikely in cases where slow speeds are due to traffic congestion or queuing.

is somewhat improbable that these fully explain the high rate of empty backhauls – and low served kilometers – in the region (See Table 11).

A fuller explanation for low capacity utilization likely includes an inflexible market response to demand and excess capacity, both of which could be supported by an inefficient market structure and imperfect competition. Although a more flexible and efficient allocation of freight across providers (combined with alternative methods of guaranteeing reliability and service standards) could increase vehicle utilization, such solutions may not be desired by incumbent trucking companies since they would also facilitate greater competition.

FIGURE 9: AVERAGE HOURS OF WAIT TIME PER KILOMETER BY COUNTRY

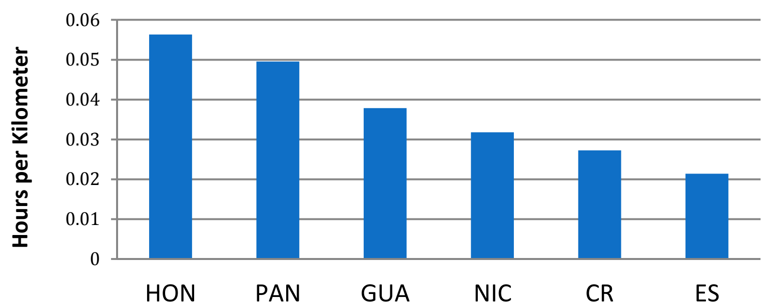


FIGURE 10: FIRM DISTRIBUTION OF AVERAGE TRUCK TIME USAGE (HOURS PER YEAR)

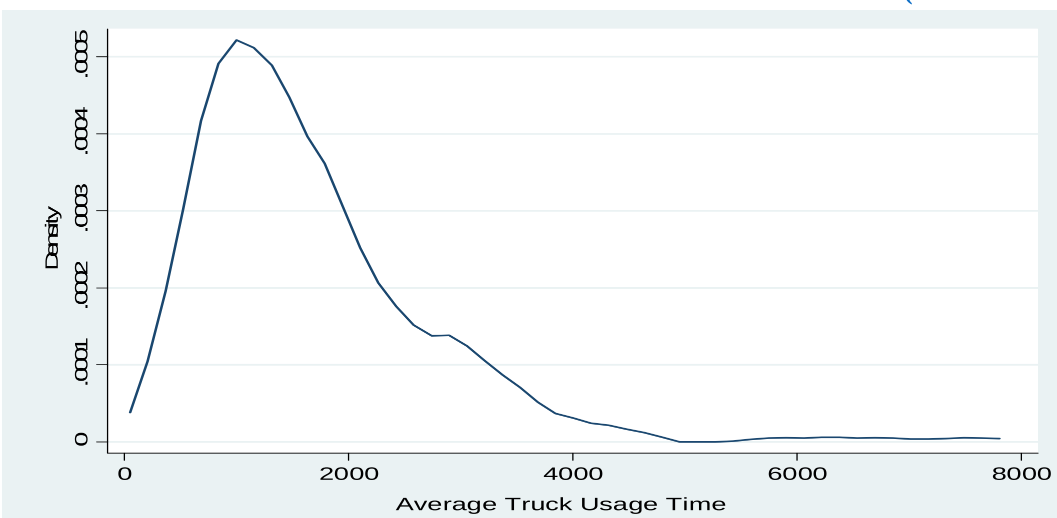


TABLE 11: PERCENTAGE OF TRIPS WITH EMPTY BACKHAUL

	Short Haul	Long Haul
Costa Rica	70.6	44.3
El Salvador	52.3	30.0
Guatemala	87.8	76.6
Honduras	40.3	41.2
Nicaragua	82.1	42.6
Panama	50.6	42.8
Total	**55.3**	**46.9**

Note: Short haul is defined as less than 150 km.

Costs and Prices

In addition to firm and route characteristics and volumes, the survey collected detailed revenue and cost data for the firms' previously completed financial year. In particular, firms provided data on their total operating costs, the portion of this spent on fuel and lubricant, tires, security, insurance, maintenance, labor costs (wages, salaries, bonuses, and social payments), and other costs, to include licenses, overhead, communication, losses, financial costs, depreciation, and informal payments. We combine these and make adjustments similar to Teravinthorn and Raballand (2009) to depreciation, fuel, and financing costs.[20] [21] We then estimate each firm's ton-kilometers served to produce an estimate of average direct ("accounting") cost per ton-kilometer (or ADC) for each firm.[22] As an accounting cost concept, ADC does not measure opportunity costs or the cost of capital, including normal profits.[23] Therefore, a normal markup between ADC and price is to be expected.

The means, medians, and ranges of firms' ADC are shown by country in Table 12. As shown, although the country means range from 5 to 7 cents per ton-kilometer, cost differentials between low cost firms (minimum average direct costs of 1.8) and high cost firms (with a high of 37 cents per ton-kilometer) are much greater than the mean differences across countries. As a result, only two countries – El Salvador and Honduras – have statistically significant mean costs higher than the lowest cost country (Costa Rica). When the data are weighted using the population weights by country for mono-truck operators versus larger companies, the result is similar. Figure 11 shows the distribution of ADC. While skewed somewhat, the overwhelming majority of firms have costs of less than 8 US cents per ton kilometer.

Table 13 shows the contribution of various factors to costs. As shown, fuel costs are estimated to account for 47 percent of ADC, followed by wages at 17 percent, tires at 8 percent, and other costs, including financing and truck depreciation costs, at 12 percent, maintenance at 7 percent and security at 2.7 percent.

Table 14 shows key firm indicators by size of firm. As shown, costs are highest for mono-truck firms. Markups are highest for companies with between 2 and 20 trucks, whereas the largest companies have the newest fleets, highest utilization rates, and lowest average costs. In addition, although mono-truck

[20] Estimated financing costs were included for trucks purchased within the past five years as the interest times the purchase price if the purchase was not financed from internal resources. In addition, firms were asked to include financing costs in their total operating costs, which would therefore include interest paid on short term and other credit. To ensure that full depreciation was included, we estimated depreciation using the same methodology used in Teravaninthorn, S. and G. Raballand (2009). The method assumes a logarithmic drop in the truck resale value over time which differs for new versus second hand vehicles so that the residual value of 50 percent is reached after 4 years for new trucks and 5 years for secondhand trucks. The precise formulas are: Depreciation for new vehicles = minimum(logarithm(Years of use / 4 * (exponential(0,5)–1)+1);1). Depreciation of secondhand trucks=minimum(logarithm(Years of use / 5 * (exponential(0,5)–1)+1);1). Finally, we adjusted fuel costs to better reflect costs based on self-reported mileage, kilometers traveled, and local fuel prices.

[21] Fuel costs in the survey appeared to be understated, so we estimated them from firms' reported mileage, utilization, and local fuel prices at the time, which per gallon were approximately USD 4.24 in Costa Rica and Panama, 3.85 for Guatemala, 4.25 for El Salvador, 4.28 for Nicaragua, and 4.18 for Honduras.

[22] It was not possible to cleanly differentiate between vehicle operating cost (VOC) and overhead, or fixed versus variable costs. Because some cost categories, such as labor costs and "other" costs, cannot be broken down into vehicle operating costs, or into variable versus fixed costs, we do not attempt to distinguish between these cost categories, but instead use average total "direct" costs.

[23] For some firms, because financing cost adjustments were made for financed truck purchases only, *ADC* may exclude financing costs associated with fixed capital assets such as land or warehouses.

operators compete on markup to some extent, there are relatively few new entrants in the sample, and newer entrants do not appear to provide downward pressure on reduce costs.[24]

TABLE 12: COSTS OF SERVICE DELIVERY AND PRICES ON MAIN TRADE ROUTES IN US CENTS PER TON-KM

Country of Firm Location	Unweighted Mean Average Direct Cost	Median	Mean Direct Cost (Using mono versus non- mono weights)	Minimum ADC	Maximum ADC	Standard Deviation
Costa Rica	4.8	3.7	5.3	2.0	30.1	4.3
El Salvador	7.3**	6.0	5.3	3.1	25.3	5.0
Guatemala	5.4	5.8	5.4	2.1	9.9	2.2
Honduras	6.4*	4.5	5.7	1.8	37.3	6.3
Nicaragua	5.2	3.8	6.0	1.8	25.7	4.4
Panama	6.2	5.1	8.5	2.2	18.0	3.5
Region	5.9	4.5	5.7	1.8	37.3	4.6

*Denotes statistically significant difference with lowest cost country at 5 percent level. **At 10 percent level.

TABLE 13: CONTRIBUTION OF COST COMPONENTS TO AVERAGE DIRECT COSTS IN REGION (US CENTS PER TON-KM)

	Maintenance	Fuel	Tires	Wages	Security	Insurance	Other costs*	ADC
	0.39	**2.74**	**0.80**	**0.98**	**0.16**	**0.10**	**0.71**	**5.87**
(Percent)	**6.6%**	**46.7**	**13.6%**	**16.7%**	**2.7%**	**1.7%**	**12.1%**	

*Other costs including financing and depreciation of trucks.

FIGURE 11: DISTRIBUTION OF AVERAGE DIRECT COSTS, REGION

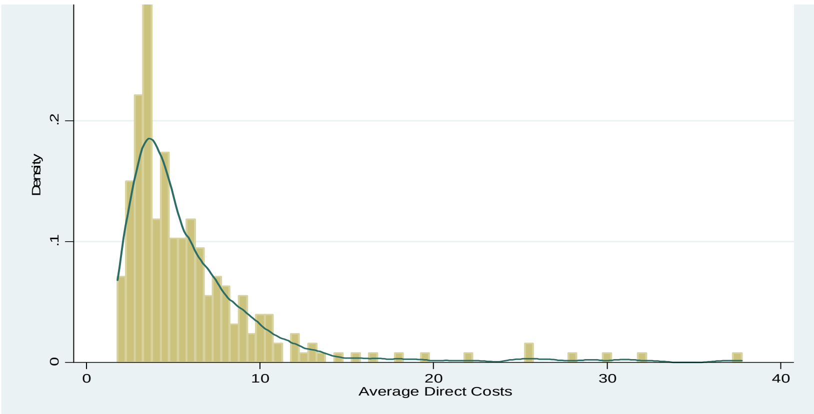
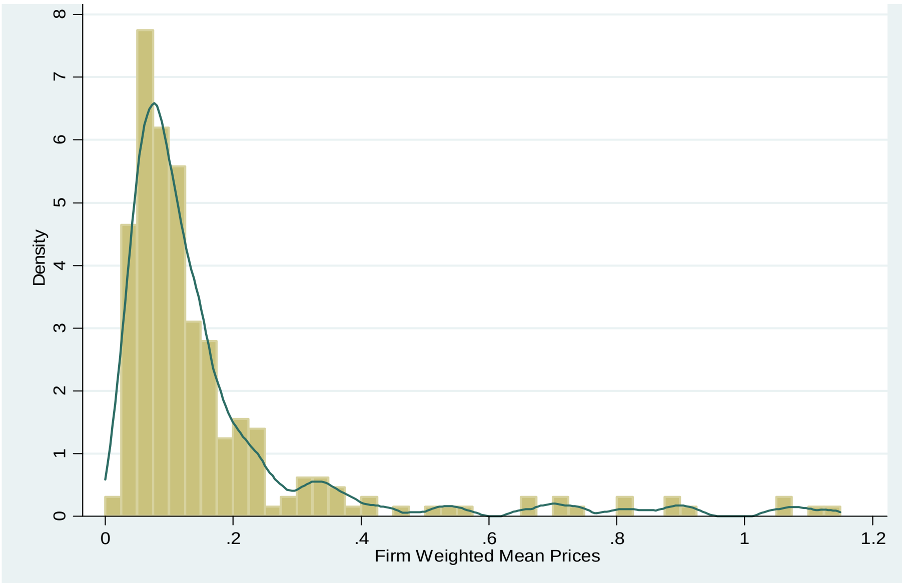


Table 15 shows mean prices and the average markups over *ADC* by country. Average prices are high relative to *ADC*, with average markups exceeding 100 percent of costs. Despite the lack of disparity between countries in costs, prices are markedly higher in Panama than in the rest of the region. As shown in Figure 12, the average firm-level price distribution is skewed, with most firms charging average prices

[24]As shown in Section 4, firm age is not correlated with costs, once one accounts for fleet size and firm and route characteristics. Of the 13 percent of sampled firms which were less than 5 years old, only 3 had over 20 trucks – one in El Salvador and two in Honduras.

below 20 cents per ton-kilometer. Although extreme outliers were excluded from the sample, there are a few firms in Panama and Honduras that reported charging over $1.00 per ton kilometer, in some cases for short routes to or from the airport.[25]

FIGURE 12: FIRM LEVEL AVERAGE PRICE DISTRIBUTION (US CENTS PER TON-KM)



The disparity in prices and markups between national and international routes is striking. As shown in Table 16, prices on national routes average approximately 35 cents per ton kilometer relative to prices on international routes of approximately 10 cents. Although *ADC* is slightly higher for firms with more of their business on national routes (with the exception of Costa Rica and Panama), this difference is small relative to the disparity in prices. For all countries markups over *ADC* are substantially higher on national routes. In the next section, we will explore the empirical relationships between costs and prices further and test whether markups on national routes are the result of imperfect competition.

TABLE 14: MEAN INDICATORS BY FIRM SIZE CATEGORY

	1 Truck	2-5 Trucks	6-20 Trucks	> 20 Trucks
Average Direct Costs	7.73***	5.40	6.13**	4.05
Price per ton-kilometer	15.08	18.07	20.35	13.41
Price-ADC Markup	7.35	12.67	14.22	9.36
Utilization (Average kilometers per truck)	50,621	54,611	56,412	70,400
Percent Business International	0.55	0.50	0.45	0.49
Firm Age	10.67	14.93	17.11	18.83
Fleet Age	18.35	13.64	12.08	10.50

***Difference in ADC with mean for large firms significant at 1 percent level. ** at 5 percent level.

[25]Note that results are reported below are not driven by airport routes, which compromise only price 20 observations out of 1400.

TABLE 15: ROAD FREIGHT PRICES IN CENTRAL AMERICA (FIRM MEANS BY COUNTRY IN US CENTS PER TON-KILOMETER)

Country	Mean	Min	Max	Avg markup over ADC
Costa Rica	10.9	2.9	38.2	6.1
El Salvador	15.6	4.5	53.9	8.3
Guatemala	16.4	4.1	88.9	11.0
Honduras	15.7*	3.6	114.0	9.3
Nicaragua	11.3	3.3	81.2	6.1
Panama	33.2**	2.9	111.0	27.0
TOTAL	16.9	2.9	114	11.0

Notes: Means are simple firm means, calculated from frequency-weighted route-firm prices*Difference with Costa Rica statistically significant at 5 percent level **Difference with all other countries significant at 1% level.

TABLE 16: COSTS AND PRICES ON NATIONAL AND INTERNATIONAL ROUTES (US CENTS PER TON-KILOMETER)

	National Routes			International Routes		
Country of Firm	**ADC**	**Price**	**Markup**	**ADC**	**Price**	**Markup**
Costa Rica	3.4	24.9	21.5	5.2	8.3	3.1
El Salvador	11.8	26.0	14.2	6.8	13.5	6.7
Guatemala	5.5	22.1	16.6	5.4	8.9	3.5
Honduras	7.3	22.5	15.2	4.9	10.7	5.9
Nicaragua	7.1	17.5	10.4	4.0	7.3	3.3
Panama	6.0	62.0	56.0	8.3*	7.8	-0.5
Total	6.4	35.0	28.6	5.4	9.9	4.5

*Sample size of 4 firms only.

Note: Since ADC is only available at the firm level, ADC for national versus international "routes" are computed for firms with more or less than 50 percent of business on such routes. Average firm prices are route-level prices for national routes versus international routes weighted by ton-kilometers served.

3. ANALYSIS OF TRUCKING COSTS AND PRICES

Given the nature of the data, our empirical analysis is based on a single snapshot of market outcomes. The market is not static – firms enter, exit, invest, and choose routes and clients on an ongoing basis given perceived opportunities for future profit. However, because recent entry is minimal – only 5 firms in the sample are less than two years old, we can assume that the current market structure and firm capacity primarily reflect entry and investment decisions made in prior years. Conditional on these prior decisions, we estimate short run costs and firm pricing behavior. We first provide a simple theoretical motivation for the empirical model.

Theory and Empirical Model

We suppose that firms, indexed by i, simultaneously choose route-specific prices P_{ir} where routes are indexed by r, and total output, Q_i, as the sum of quantities on each route, q_{ir}, to maximize the discounted sum of current and expected future profits, given the market structure, M_r, where Q_i in the current period can be written as:

$$Q_i = \sum_r q_{ir}(P_{ir}(F_i, v_{ir}, M_r, D_r))$$

Here F_i represents fixed costs and v_{ir} represents firm *i*'s average variable cost of serving route r. Quantity, q_{ir} also depends on market structure, M_r and demand D_r on route r. Market structure is related to the number and size of competitors a firm currently faces on a route, which is a function of previous entry decisions by firms and regulatory restrictions to entry on that route. Market structure and demand, M_r and D_r may influence both P_{ir} and q_{ir}.

Short run average total costs, c_i, per ton-kilometer can be written as follows:

$$c_i = \frac{F_i}{Q_i} + v_i$$

Given firms' choice of Q, firms utilize fixed and variable inputs to minimize the average total cost of serving this volume, given regulatory constraints on employment, vehicle standards, and other factors which may vary by country or route type. Thus c_i represents firms' short run minimum cost per ton-kilometer, which depends on input prices, p, route characteristics on firm i's routes, R_i, and a technology choice set, T, which is common to all firms.

$$c_i = c^*(p, R_i, T)$$

Because current and future profits depend on current and future M and D, and because some fixed costs were determined by prior decisions, there is no guarantee that firms attain long run minimum efficient scale in the current period. Moreover, in some models of imperfect competition, investment in over capacity is a means to deter entry in uncompetitive markets. In addition, regulatory barriers to entry, particularly on national routes by foreign firms, reduce the scope for achieving economies of scale and scope for current and future entrants. However, if costs are minimized, differences across firms in short run input choices should not affect ATC.

We allow the functional relationship P_{ir} to reflect either perfect competition or general forms of imperfect competition among firms who maximize the value of their expected lifetime profits. The exact relationship between M_r and P_{ir} depends on market behavior by all firms, including possible strategic interactions and threats of competitive retaliation in subsequent periods by current firms as well as the possibility of entry on the route by current or future trucking firms. At the same time, market structure, M_r, differs by route, whether due to greater restrictions on entry or differential restraints on competition. Although in principle domestically owned firms can compete freely on national routes, domestic actors with the capability to compete may be limited, and informal barriers to entry may also be present. Models of imperfect competition do not require explicit cartels to sustain anti-competitive behavior over time.[26] Theory also suggests that it is generally easier to sustain anti-competitive behavior when firms have some basis to believe in a threat of future "retaliation" (through predatory pricing, for example) in the future if some firms attempt to compete more aggressively,[27] and reputations for retaliatory behavior may be easier to sustain among a smaller group of nationally owned firms. Indeed, the threat of retaliation for violating implicit anti-competitive agreements on national routes may include predatory competition on the violator's international routes. Although it is not possible to differentiate between models of imperfect

[26] See, for example, Kreps and Scheinkman (1983) or Van Damme, E. (1987)
[27] See, for example, Rosenthal, R. and H. Landau (1979).

competition using the data available, one can test whether the price outcomes are consistent with general forms of anti-competitive behavior.

To assess the impact of various factors on costs and prices, we estimate the following equations:

$$ADC_i = \alpha + \beta X_i + \delta p_i + \theta R_i + \partial u_i + \varepsilon_i$$

$$u_i = a + bX_i + cR_i + e_i,$$

$$P_{ir} = \tilde{\alpha} + \tilde{\beta} ADC_i + \gamma r_{ir} + \theta \widehat{M}_r + \epsilon_{ir}$$

Here, ADC_i represents firm i's average direct costs per ton-kilometer as described above. Because the survey did not allow for a clean separation between fixed and variable costs, we must combine them into one cost measure. ADC differs from average total cost (c) in that it excludes the economic opportunity cost of capital, or a normal return on equity. According to this simple model, c will be affected by previous firm investments, or fixed costs, as will ADC through the company's fixed assets – in particular truck fleet. Therefore, X_i represents observed firm characteristics, including fleet composition, size, and average vehicle age, use of various technologies, including fuel-efficient technologies, and special quality or training requirements.

The vector p_i represents variable input prices – in particular, salaries for different types of workers, fuel prices, and interest rates on bank loans.[28] R_i captures weighted average route-level characteristics as firms report them on each of the main routes they serve, denoted r_{ir}, and weights each value using the percentage of total firm volumes reported on the same type of route. The vector R comprises average wait times, quality of roads, informal payments, average travel speeds, route length, and empty backhaul rates. Because costs are typically not linearly related to scale of operation, we include a quadratic term for both fleet size and utilization. ∂u_i is the quadratic term in the firm's average truck utilization in kilometers (denoted u_i.) The estimated coefficients on these variables provide a measure of the degree to which firms achieve economies of scale.

We also attempted to identify indirect effects on costs through truck utilization. Firms with higher truck utilization may also be those which are otherwise more cost-efficient, so that they can charge lower prices and attract more business. We estimated a first stage equation for u with potential instruments to address possible simultaneity bias, as well as to better understand correlates with utilization. However, estimates in the main cost equation were unaffected by the use of 2SLS, and therefore we report only the OLS estimates.[29]

Results of Cost Analysis

Table 17 shows the results of the ADC equation estimation. Some variables which were insignificant in the cost equation were excluded from the final specification, but are also shown in order to highlight these findings as well. As shown, the sector exhibits economies of scale. Because firms do not choose

[28]Because fuel prices were only available at the country level, we could not include them in the estimation. However, when substituting fuel prices for country dummies, fuel prices were not statistically significant.
[29]For an instrument we used the fraction of trips to the capital city, since this was not significant in the *ADC* equation.

quantities to minimize short run average total costs, ATC, but rather expected lifetime profits, utilization and fleet size will differ from the level which minimizes long run minimum ATC, as demonstrated by the significant coefficients on the fleet and utilization variables. Firms with larger fleets and higher truck utilization rates have lower average direct costs, all else equal. Average costs are also significantly related to a number of exogenous constraints and factor prices – i.e., wage levels, the percentage of workers that are temporary, average wait times, informal payments, and overload weight, which is typically higher where enforcement is more lax.[30] However, once these factors are taken into account, the average age of the vehicle fleet and age of the firm are not significant. In addition, the firms' participation in international routes – i.e., the percentage of service to national versus international routes – is not significantly related to average direct costs. This casts additional doubt on the ability of modest cost differentials to explain price disparities across these market segments.

No measures of firm technology choice – age of fleet, use of fuel-efficient practices and technologies, or use of used tires – were significant. This does not mean that technology choices do not affect costs of all firms. Rather, it is consistent with the standard economic theory that firms optimize input choice in the short run given the specific routes, input prices, and constraints they face. Input choices differ, but do not explain variation in average total cost. Optimum average cost, c, is affected only by exogenous constraints or predetermined factors.

Among the average route-characteristic variables, R, only wait times, informal payments, and mean overloading were statistically significant in explaining average firm costs. In addition, the only unobserved country effect that was significant was for Costa Rican firms, suggesting that overall cost variables that differ systematically by country are already captured in the other regressors.

Perhaps one surprising finding is the apparent lack of direct impact of road quality – surface condition and width as rated by the trucking firms themselves – on average costs. In principle this could be due to the relatively high quality of roads on main trading routes; however, there is substantial variability in the reported quality of these roads. The mean reported road quality is 7.4 out of a 0 to 11 point scale, and has a standard deviation of 3.0.[31] Although the coefficient on firm average road quality may be attenuated due to measurement error, we tried a variety of ways to capture this, and it was not significant in any of these attempts. In order to further explore the role of road quality, we also examined whether it was related to average speeds, conditioning on other likely correlates with speed, and found that it does have a statistically significant and positive effect on average travel speed. Other variables with statistically significant coefficients on travel speed are shown in the lower panel of Table 18. Although the estimated coefficients may not represent unbiased treatment effects, this suggests that road quality and width has an indirect effect on costs through the effect on travel speeds and therefore utilization. At the same time, the

[30]Because overloading of trucks causes road damage, and therefore costs to society, this paper does not discuss increasing overloading as a means to reduce costs.

[31]The road quality measure was constructed as an interaction between the surface type – paved or not – and the user's perception of its width and maintained surface condition as follows: quality=0 when the road is gravel, narrow, and the quality is considered bad, quality=1 for gravel narrow and acceptable quality, quality=2 for gravel wide and bad quality, quality=3 for mixed surface/width and quality is considered bad, quality=4 when the surface is bitumen and the quality is considered bad, 5 when it is gravel narrow and the quality is good, 6 for gravel, wide, acceptable quality; 7 for mixed and acceptable quality; 8 for bitumen and acceptable quality; 9 for gravel, wide and good quality; and 10 for mixed type with the quality considered good; and 11 for bitumen and the quality is considered good.

contribution of road quality is small, suggesting that other determinants of speed (such as traffic congestion, and possibly road geometry and geography) not captured in the survey are more important determinants of speeds.[32] [33]

Table 18 reports the statistically significant correlates of average truck utilization, u. As one might expect if time-related factors directly constrain utilization at least some of the time for some firms, those firms experiencing higher average speeds and lower waiting times achieve higher utilization rates on average. In addition, trips to congested national capitals reduce average utilization.

Estimation of the ADC equation provides estimates of the marginal effects of various constraints in the operating environment, given routes served, input prices, and firm characteristics. However, some additional constraints may be important for all firms without being well captured in the estimation. Some variables may be captured with a high degree of measurement error. Cost shifters, R_i are reported by firms as averages of true, time-varying, factors, r_{irt}, as reported by survey respondents, and the route weights applied to r_{ir} used to compute average firm-level route characteristics, R_i, are inexact. Thus measurement error could have introduced attenuation bias in some of the variables.

In addition, some important cost shifters cannot be included as firm or route-specific constraints in the cost estimation either because they do not vary between firms or because they are captured in the cost accounting and simply included in ADC by construction. One important example is the cost of crime and insecurity. Although direct outlays for security are included in ADC, the determinants of higher firm-level security costs are not captured in the survey. Nor are the other costs of other adapting to insecure circumstances. Thus, the .2 US cents per ton-kilometer of direct costs is likely to greatly understate the true costs. Another example is that of empty backhaul. Although the variation in empty backhaul across firms does not explain average costs to a statistically significant degree on average, it likely raises average costs across the board.

In addition to these issues, informal payments directly contribute to firm costs, and as we will see in the price estimation, are shifted entirely to customers of the trucking companies. Figure 13 shows a range of informal payments are made along international routes. The highest payments on these routes are made by Costa Rican and Salvadoran firms. On national routes, as shown in Figure 14, informal payments are highest for Panamanian and Honduran firms. Moreover, based on survey responses, the main issues on international routes appear to be with border authorities, and on national routes with police.

Fuel Efficiency Issues

Perhaps surprisingly, neither the adoption of fuel-efficient practices nor technologies was a significant variable in the ADC equation. Moreover, neither the number of fuel-efficient practices, the number of fuel saving technologies, nor any individual practice or technology is associated with lower fuel costs per ton-kilometer, once other factors were taken into account. With estimated fuel costs average 2.7 cents per ton-kilometer, or approximately 47 percent of total direct costs, fuel costs would seem to represent an area

[32] In a separate analysis of the determinants of maintenance expenditures alone, road quality is significant, along with the use of fuel efficient practices. However, because maintenance costs are a small fraction of total costs, these factors are not statistically significant in explaining ADC differentials.

[33] Based on a comparison of coefficients from the various regressions, road quality explains only 9 percent of the effect of average speeds on utilization.

of potentially important cost savings. Yet many firms do not report using any fuel-efficient practices or technologies. Only 52 percent of sampled firms claimed to use at least one fuel-efficient practice (such as compliance with recommended tires and tire pressure, fuels and maximum loads; incentive programs, and regular truck maintenance) and 33 percent used fuel-efficient technologies (such as improved tire and wheel technologies, idling reduction technologies, aerodynamic equipment, and emission control technologies).[34] One reason for the failure to adopt such practices may be the difficulty of implementing them in a manner which significantly cuts fuel costs – for example, of enforcing unobserved driver behavior. Moreover, many such technologies entail up-front investment costs, which may not be offset with likely fuel savings.

To explore this issue further, we estimated a two stage model relating average fuel costs per ton-kilometer on a set of firm characteristics plus either the number of fuel-efficiency practices used or the number of fuel-efficient technologies used. In order to address possible simultaneity between fuel costs and adoption of these practices, we first modeled the firms' choice of the number of fuel-efficient practices and technologies and used predicted values of fuel-efficient practices in the fuel cost equation.[35] Among the factors statistically significantly associated with the use of these technologies and practices are truck utilization rates: firms who use their equipment more fully would benefit more from fuel efficiency investments. In addition, firms which had recently borrowed to finance a truck purchase were more likely to adopt fuel efficient technologies, as were firms required to utilize specific equipment or follow certain training.[36] In addition, mono truck operators were significantly less likely to use these practices. In the second stage estimation of the correlates with fuel costs showed either a positive effect on fuel costs of using these technologies or no significant effect at all. Although fuel-efficient practices are not clearly associated with reduced fuel costs, they are associated with lower maintenance costs. Recent truck purchases, a crude measure, is almost significant, and as Teravinthorn and Raballand (2009) have pointed out the tradeoff between the high capital costs of newer trucks and greater fuel efficiency depends upon utilization.

Based on the foregoing analysis, the main channels for improving fuel efficiency at the market level appear to be through reductions in traffic congestion, empty backhaul, and wait times, which have a direct effect on fuel efficiency. In addition, steps to liberalize entry further may enable the emergence of a more efficient market structure, with higher truck utilization rates, which would make it possible for firms to better offset the costs of investing in fuel-efficient trucks and technologies.

[34]We did not include reduction of empty backhaul as part of the category of fuel efficient practices, because this practice is also associated with more general attempts to increase profitability.
[35]We added the number of such practices or technologies adopted and estimated an ordered probit model.
[36]Because more detailed questions on credit access were not included in the survey, one cannot draw any clear inferences from this that credit access is a factor, particularly since profits are not significantly affected by fuel-efficiency investments.

TABLE 17: ANALYSIS OF DRIVERS OF FIRM LEVEL AVERAGE DIRECT COST (US CENTS PER TON-KILOMETER)

Independent Variable	Coefficient	Robust Standard Error
Fleet size	-0.03554***	(0.01252)
Fleet size squared	1.36e-04***	(4.14e-05)
Driver salary	0.29581*	(0.15651)
Other worker salaries	0.00346*	(0.00204)
Percentage used tires	-0.00643	(0.00589)
Use of FE practices	-0.36015	(0.43747)
Use of FE technologies	-0.29203	(0.44764)
Percentage of workers temporary	-.2.19701**	(1.03832)
Utilization per truck (1,000 km)	-0.09916***	(0.02312)
Utilization squared	4.35e-04***	(1.22e-04)
Interest rate on bank loans	0.01705	(0.02243)
Average wait time per ton-km.	147.3966**	(58.11952)
Mean overload weight	-0.15855***	(0.0501)
Mean empty backhaul	-0.00623	(0.0043)
Mean informal payment per ton-km	0.8096***	(0.1068771)
Quality/training requirements=1	0.84421	(0.57148)
Panama	0.46891	(0.56898)
Costa Rica	-1.07811*	(0.57373)
El Salvador	1.35624	(0.86242)
Guatemala	1.26533	(0.72399)
Nicaragua	0.82172	(0.97676)
Percentage fleet truck	-1.57503	(3.68608)
Percentage fleet tractor	-3.72497	(3.4932)
Percentage of volume on international routes	n.s./excluded	
Mean kilometer length of routes	n.s./excluded	
Age of firm	n.s./excluded	
Fleet age	n.s./excluded	
Mean quality road used	n.s./excluded	
Average speed	n.s./excluded	
Bank primary source of finance=1	n.s./excluded	
Constant	10.54082***	(3.30802)
Observations	225	
R-squared	0.5961	

*** p<0.01, ** p<0.05, * p<0.1

TABLE 18: STATISTICALLY SIGNIFICANT CORRELATES OF TRUCK UTILIZATION (1000 KILOMETERS PER YEAR)

Significant variables for Utilization	Coefficient
Hours of wait time per ton-kilometer	-1,256*
Speed (km/hour)	1.95***
Fleet age	1.13**
Percentage of trips to national capital city	-29.30**
Panama=1	-26.35***
Significant Variables for Average Speeds (kilometers per hour)	
Percentage of tires used tires	-0.0464*
Road type/quality (0 worst 11 best)	1.09***
Competitors=2-5	-11.59***
Competitors > 5	-9.56***

***=significant at 1 percent level; **=5 per cent level; *=10 percent level, ~=almost significant

FIGURE 13: AVERAGE INFORMAL PAYMENTS PAID ON INTERNATIONAL ROUTES BY TYPE OF REQUESTER (US CENTS PER TON-KM)

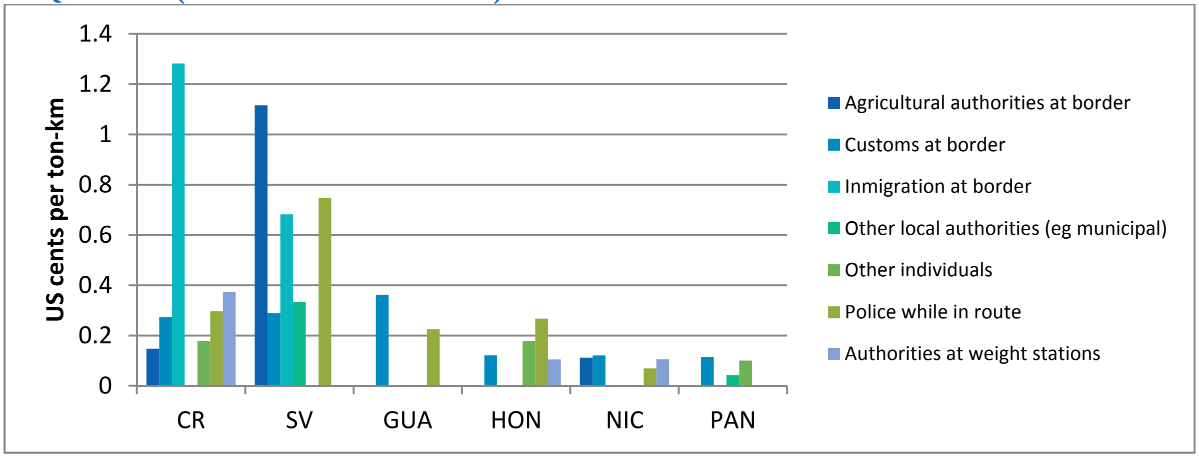
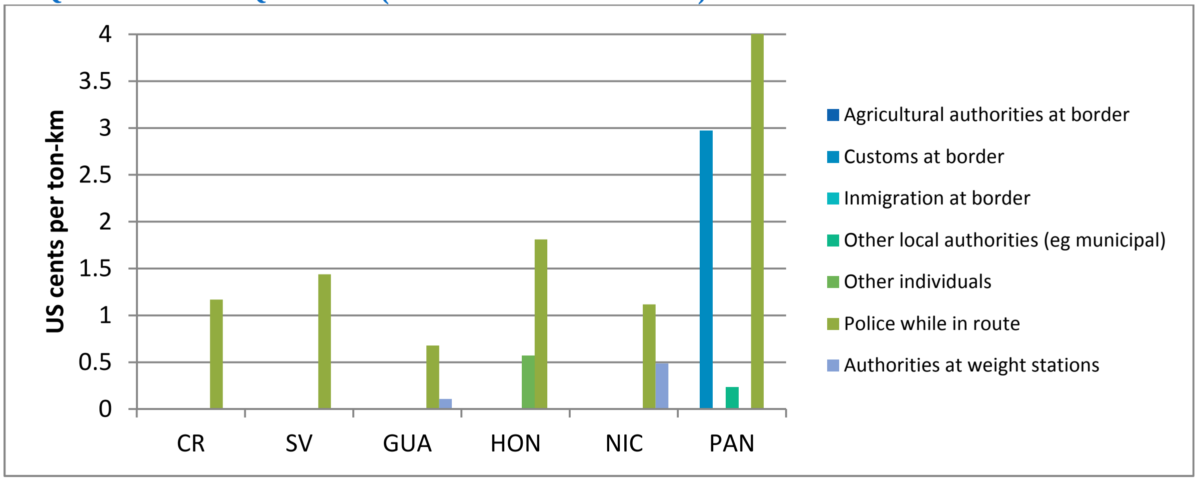


FIGURE 14: AVERAGE INFORMAL PAYMENTS ON NATIONAL ROUTES BY TYPE OF REQUESTER IF REQUESTED (US CENTS PER TON-KM)



Note: The value of payments to police in Panama this was truncated, and equals 11 US cents per ton-kilometer.

Market Behavior, Regulation, and Pricing

We now turn to estimation of the price equation, reproduced below:

$$P_{ir} = \tilde{\alpha} + \tilde{\beta} ADC_i + \gamma r_{ir} + \theta \widehat{M}_r + \epsilon_{ir}$$

In addition to firm level average costs, we include route-level characteristics, r_{ir}, as potential cost shifters which may not be well captured in ADC_i. We allow the estimate of $\tilde{\alpha}$ to capture average unobserved fixed costs and interpret $\tilde{\beta}$ as the normal markup over average firm costs in the region. Although in perfectly competitive markets prices for the same routes and service quality would not differ between firms, this specification allows firms to shift some of their costs to customers, possibly in connection with service type or quality differentiation.

We test for the effect of market structure or M_r in three different ways. In all cases, because the structure of the trucking market is systematically different in Panama, we estimate the equations with and without Panama included. The first test (Equation 1) is to simply estimate the equation setting $\widehat{M_r}$=1 if the route is a national route, given restrictions on entry on those routes. We augment this with another indicator if the route is a Panamanian national route in the case where Panama is included. In some specifications we also include as a control for total demand the number of trips performed on the route by other firms.[37] In the second specification (Equation 2), we include in the vector of $\widehat{M}_r$ variables (along with the dummy for national routes) the estimated number of firms serving route *r* per number of total monthly trips performed by sampled firms on route *r,* denoted *Nfirms/trips*. In most models of imperfect competition (Bertrand, Cournot, Stackleberg, and others), the number of competitors in a market is inversely related to price. Although we do not observe the true number of firms serving each route, we consider this a reasonable proxy. We also include this variable for national and international routes separately (by interacting it with the appropriate indicator variables) to test whether their responsiveness to competition differs. The differences are statistically significant at the 5 percent level. In robustness checks, we also include other variables which may affect costs, including the length of the route, and these do not affect our results.

As mentioned, *Nfirms/trips* is a proxy for the true value, since it is not based upon a full listing of firms serving each route. Moreover, for a variety of other reasons – including simultaneous determination of market structure, unobserved costs, and prices, the identifying assumption that $Cov(\frac{Nfirms}{trips}, \epsilon_{ir}) = 0$ may be violated. Therefore, in the third specification (Equation 3) we instrument for *Nfirms/trips* using as potential instruments a subset of potentially exogenous route characteristics – route length, road quality, and the indicator "national" for whether or not the route is a national route. For the full sample, as well as the sample excluding Panama, we select two of the three potential instruments on the basis of statistical tests of their validity; in particular, the "national" dummy and the length of the route (in kilometers), and the "national" dummy and *road quality*, respectively.[38] The results of the first stage are shown in Table 19. The sign of the coefficient on *national* is negative, as expected. The sign on *kilometers* is positive, and on *road quality* is negative. All coefficients on the instruments are significant, and the F statistics

[37] We subtracted the firms' own trips to mitigate simultaneity issues.
[38] In Equation 3, we also exclude potentially endogenous variables related to contracting behavior.

from a test of their joint significance are high, as shown. Therefore, one can reject the null of no significance of the instruments, and there is no reason for concern that the instruments are weak.

Since we control for costs through inclusion of ADC and firm-route characteristics and allow the normal markup to be captured as a linear function of costs, a test of the significance of $\hat{\theta} = 0$ (where $\hat{\theta}$ represents the estimated coefficient(s) on $\widehat{M}_r$) is a test of the null hypothesis of no effect of market structure on prices. In the first specification, the identifying restriction for testing the null is that there are no unobserved costs which systematically differ between national and international routes. In the second and third specifications, the key identifying assumption is that market concentration – i.e., $Nfirms/trips$ – is not correlated with unobserved costs.

The results are shown in Table 20 for the region as a whole and Table 21 shows the results with Panama excluded. Using the estimation for the whole region, the estimated average proportional ("normal") markup over direct costs is centered at approximately 14 percent, and ranges from 4.6-27 percent. This appears to be reasonable to cover unobserved capital costs and business risks. The null hypothesis of no effect of market structure on prices is rejected in all cases. In particular, the average excess markup on national routes from Equation 1 is estimated to be 8 US cents per ton-kilometer, and 32 cents per ton-kilometer for Panama. In addition, as shown in the results for Equation 2, more competition – a greater *Nfirms/trips* – is associated with lower prices on both national and international routes. Moreover, the sensitivity of price to additional competition is greater on national routes, where there is less competition.

Significant route-specific price shifters which we interpret as shifting costs are average speed, wait times, and informal payments. The coefficient on speed is large and negative, and this finding is somewhat inconsistent with the findings from the ADC equation estimation. This is most likely due to congestion on specific routes which is not adequately captured in firm-level (weighted) average speed. Our findings are further supported by the fact that the same firms charge very different prices on national versus international routes. As we saw in Section 2, although the regional trucking market is segmented, most firms serve both national and international routes. Firms reporting that they serve only national routes have higher costs, as shown in Table 22. However, the differences across this group of firms and firms serving international routes are not statistically significant. At the same time, firms serving *both* national and international routes charge significantly higher prices on their national routes than on their international ones.

The estimation results presented above are evidence that firms charge higher prices on national routes primarily because competition on those routes is restrained. Although costs are slightly higher on national routes due to increased congestion and wait times, even when shifting these costs fully to customers, the markup over costs is higher on national routes, particularly those with fewer competitors relative to demand.

TABLE 19: FIRST STAGE NUMBER OF FIRMS PER ROUTE EQUATION

	Region	Excluding Panama
CR	0.101***	0.154***
	(0.0142)	(0.0173)
SV	0.088***	0.0633***
	(0.0149)	(0.0185)
GUA	0.0752***	0.110***
	(0.0162)	(0.0202)
HON	0.0420***	0.0389***
	(0.0149)	(0.0176)
PAN	0.0275	
	(0.0316)	
National	-0.0235*	-0.163**
	(0.0117)	(0.0124)
Kilometers	0.000288***	
	(1.25e-05)	
Road quality	-0.00779***	-0.00862***
	(0.00125)	(0.00195)
Percentage empty backhaul	.0001	-.0004***
	(0.0001)	(0.00013)
Informal payments per t-k	-0.341	-0.649
	(0.255)	(0.419)
Wait time (hours per t-k)	2.055***	1.426
	(.724)	(.932)
Speed	-0.0002	-0.0001
	(0.00029)	(0.00047)
Overload	-0.00182	-0.00019
	(0.00182)	(0.0032)
Mono trucking firm	0.0431***	0.0302*
	(0.0125)	(0.0162)
Panama*national	-0.0642*	
	(0.0329)	
Constant	0.151***	0.187***
	(0.027)	(0.0401)
Observations	1,136	949
R-squared	0.6054	0.315
F-stat 2 instruments	399.3	98.74

***p<0.01, ** p<0.05, * p<0.1

TABLE 20: PRICE EQUATION ESTIMATION BY FIRM-ROUTE (IN USD PER TON-KILOMETER)

		Equation (1)	Equation (2)				IV Equation (3)
Firm level Costs per ton-km	Firm ADC	1.225***	1.046***	1.144***	1.272***	1.142***	1.264***
		(0.377)	(0.359)	(0.370)	(0.379)	(0.373)	(0.376)
Tests of imperfect competition	N firms/trips international		*-0.135****	*-0.125****	*-0.218****	*-0.0948****	-0.380***
			(0.0278)	(0.0278)	(0.0538)	(0.0303)	(0.0675)
	N firms/trips national		*-0.638****	*-0.626****	*-0.243***	*-0.509****	
			(0.181)	(0.177)	(0.104)	(0.180)	
	National	0.0792***	0.142***	0.140***		0.137***	
		(0.0216)	(0.0472)	(0.0467)		(0.0467)	
	Panama national routes	0.242***	0.254***	0.227***	0.238***	0.180***	0.280***
		(0.0595)	(0.0654)	(0.0664)	(0.0575)	(0.0669)	(0.0616)
	Mono truck firm	-0.0763**		-0.0739**	-0.0713**	-0.0695**	-0.0430**
		(0.0342)		(0.0330)	(0.0336)	(0.0331)	(0.0248)
Route-level cost factors	Wait time (hours / ton-km)	12.31***	13.01***	12.87***	12.66***	12.47***	13.33***
		(4.012)	(4.155)	(4.205)	(4.127)	(4.150)	(4.177)
	Speed	-0.00655***	-0.00733***	-0.00744***	-0.00681***	-0.00660***	-0.00752***
		(0.00108)	(0.000906)	(0.000921)	(0.00110)	(0.00108)	(0.001)
	Overload	-0.00992***	-0.0135***	-0.0134***	-0.0114***	-0.0110***	-0.0154***
		(0.00378)	(0.00389)	(0.00384)	(0.00381)	(0.00387)	(0.0038)
	Percent empty backhaul	0.000302	0.000171	0.000204	0.000290	0.000245	0.00019
		(0.000221)	(0.000220)	(0.000222)	(0.000225)	(0.000221)	(0.0002)
	Bribes per ton kilometer	4.833***	4.755***	4.678***	4.723***	4.719***	4.660***
		(1.590)	(1.527)	(1.565)	(1.607)	(1.599)	(1.579)
Contracting arrangements	Direct contact	-0.000190	-2.58e-05	-0.000228	-0.000209	-0.000262	
		(0.000378)	(0.000336)	(0.000391)	(0.000382)	(0.000386)	
	Contract	0.000422	0.000542	0.000360	0.000409	0.000407	
		(0.000457)	(0.000430)	(0.000458)	(0.000463)	(0.000461)	
	Multiyear contract	-0.0660***	-0.0703***	-0.0805***	-0.0716***	-0.0745***	
		(0.0160)	(0.0151)	(0.0164)	(0.0166)	(0.0168)	
Unobservable country effects	CR	0.0304*	0.0333*	0.0263	0.0551***	0.0385**	0.0692***
		(0.0180)	(0.0185)	(0.0189)	(0.0198)	(0.0192)	(0.022)
	SV	0.0408**	0.0501**	0.0443**	0.0467**	0.0470**	0.0534***
		(0.0204)	(0.0209)	(0.0210)	(0.0208)	(0.0208)	(0.0231)
	GUA	0.0311	0.0439	0.0386	0.0494	0.0401	0.0891
		(0.0412)	(0.0419)	(0.0409)	(0.0434)	(0.0408)	(0.0486)
	HON	-0.0234	-0.0246	-0.0236	-0.00590	-0.0213	-0.0095
		(0.0252)	(0.0256)	(0.0255)	(0.0244)	(0.0253)	(0.0258)
	PAN	0.0929***	0.0873**	0.109***	0.120***	0.112***	0.0926***
		(0.0351)	(0.0391)	(0.0397)	(0.0399)	(0.0379)	(0.0444)
Demand proxy	Trips per month, other firms	0.000294***			0.000251***	0.000247**	
		(9.41e-05)			(9.64e-05)	(9.65e-05)	
	Constant	0.467***	0.579***	0.610***	0.569***	0.516***	0.667***
		(0.102)	(0.0821)	(0.0882)	(0.115)	(0.107)	(0.0993)
	Observations	1,132	1,132	1,132	1,132	1,132	1,136
	R-squared	0.448	0.443	0.445	0.450	0.456	0.4235
F-Statistic OID test							0.00

***** p<0.01, ** p<0.05, * p<0.1**

TABLE 21: PRICE AND MARKUP ESTIMATES BY FIRM-ROUTE (IN USD PER TON-KILOMETER), EXCLUDING PANAMA

		Equation (1)	Equation (2)		IV Equation (3)
Firm level Costs per ton-km	Firm ADC	1.543***	1.490***	1.440***	1.572***
		(0.322)	(0.317)	(0.312)	(0.326)
Tests of imperfect competition	N firms/trips international		*-0.110****	***-0.114****	-0.297***
			(0.0234)	(0.0234)	(0.063)
	N firms/trips national		*-0.404***	***-0.399***	
			(0.200)	(0.199)	
	National	0.0950***	0.127**	**0.126****	.0410**
		(0.0191)	(0.0493)	(0.0492)	(.017)
	Mono truck firm	-0.0412	-0.0401		-0.0185
		(0.0336)	(0.0349)		(0.023)
Route-level cost factors	Wait time (hours / ton-km)	6.748***	7.167***	**7.193*****	7.458***
		(2.013)	(2.172)	(2.130)	(2.125)
	Speed	-0.00291***	-0.00288***	**-0.00278*****	-0.00287***
		(0.00104)	(0.00109)	(0.00106)	(0.001)
	Overload	-0.00540**	-0.00577**	**-0.00594****	-0.00559**
		(0.00257)	(0.00260)	(0.00267)	(0.00256)
	Percent empty backhaul	0.000469***	0.000401***	**0.000385*****	0.00038**
		(0.000149)	(0.000145)	(0.000142)	(0.0001)
	Bribes per ton kilometer	3.684***	3.431***	**3.513*****	3.375***
		(0.622)	(0.675)	(0.692)	(0.652)
Contracting arrangements	Direct contact	-0.000173	-0.000189	-8.93e-05	
		(0.000368)	(0.000395)	(0.000323)	
	Contract	0.000214	0.000221	0.000314	
		(0.000425)	(0.000445)	(0.000398)	
	Multiyear contract	-0.0363***	-0.0453***	**-0.0390*****	
		(0.0129)	(0.0151)	(0.0132)	
Unobservable country effects	CR	0.0451**	0.0452***	**0.0490*****	0.0787***
		(0.0216)	(0.0169)	(0.0163)	(0.0194)
	SV	0.0504***	0.0559***	**0.0586*****	0.0721***
		(0.0191)	(0.0193)	(0.0192)	(0.0182)
	GUA	0.0465	0.0530	0.0559	0.0936**
		(0.0374)	(0.0388)	(0.0402)	(0.0428)
	HON	0.00959	0.0150	0.0148	0.0275
		(0.0219)	(0.0241)	(0.0242)	(0.0215)
Demand proxy	Trips per month, other firms	0.000274			
		(0.000243)			
	Constant	0.175*	0.234**	0.214**	0.256***
		(0.0962)	(0.103)	(0.0940)	(0.0755)
	Observations	949	949	949	949
	R-squared	0.296	0.306	0.304	0.288
	F	50.76	49.62	52.92	61.07
	F-stat OID test				0.00

***** p<0.01, ** p<0.05, * p<0.1**

TABLE 22: DIRECT COSTS AND PRICES FOR FIRMS SERVING ONLY INTERNATIONAL ROUTES, NATIONAL ROUTES, AND BOTH, CENTRAL AMERICA (EXCLUDING PANAMA)

	Average Direct Costs		Average price per ton-km		Number of Observations
	Mean	St. Dev.	Mean	St. Dev.	
International Routes Only	5.9	4.0	10.2	9.1	49
International and National	5.3	3.5	13.0*	12.4	145
On International Routes			11.7		
On National Routes			18.5**		
National Only	7.3	6.7	32.5**	44.7	59

Note: ADC is only available at firm level, and here is computed for national/international routes using firms with more than 50 percent of business on such routes. Average firm prices are route-level prices weighted by ton-kilometers served.
*=statistically significant difference with preceding category at 5 percent level. **=statistically significant difference with preceding category at 1 percent level.

4. ECONOMIC SIGNIFICANCE OF POTENTIAL PRICE REDUCTIONS

The effects of the inefficiencies in the Central American trucking services market identified in this paper are economically significant. Figure 15 illustrates the level of average direct cost savings potentially achievable through improvements to each of the statistically significant factors either in the *ADC* equation or (in the case of travel speeds) the price equation. The potential for reducing each (statistically significant) cost factor is computed by multiplying regression coefficients by 1/3 of the respective variables' standard deviation in the data. The figure shows the indirect effect of road quality on speed as it affects utilization, and these factors are then subtracted from the direct effect on utilization to avoid double counting. As shown, if this level of reduced congestion were feasible, this would have an impact on prices of almost 1 US cent per ton-kilometer on average. In addition, improving utilization rates would have a major effect, followed by reducing informal payments, increasing fleet sizes, reducing wait times, greater use of temporary labor, and improved road quality. Cumulatively, these improvements would bring average costs down from 5.9 cents to 3.1 cents per ton-kilometer.

Achieving such dramatic savings across all countries and routes may require large investments and difficult changes in the operating environment. Trade volumes and patterns, geography, infrastructure and the performance of other parts of the region's transport and logistics system all affect firms' costs and are beyond the trucking operators' control. In contrast, reducing restrictions on cabotage and changes in market structure would create greater opportunities and incentives to increase fleet utilization, optimize fleet sizes, and even improve fuel efficiency. Figure 16 shows the changes in prices on both national and international routes possible due to increased competition on national routes and potential cost savings as estimated in Figure 15. On national routes, a reduction of 8 cents in five of the countries and 32 cents in Panama (given its greater share of ton kilometers) would lead to an average reduction of 15 cents per ton kilometer, resulting in an average price drop from 35 to 16 cents. Normal markups over costs on international routes would fall with costs by approximately .4 US cents on top of the cost efficiency gains predicted, resulting in a decline in price from 10 to 7 cents.

To see how economically significant these savings could be for the region's trade, we calculated the percentage of average cargo values that main road corridor transport represents of average cargo values. As shown in Table 23, these changes it constitutes a significant amount of the value of traded goods, and a higher percentage of export values, since these values are generally lower. In regional trade-weighted terms, it averages as high as 7 percent of this value for some trading pairs.

Based on standard elasticity estimates of transport costs with trade flows of between 1 and 3 percent, halving trucking prices on domestic routes could reduce total transport costs by between 13 and 22 percent, which would increase trade volumes by a similar percentage. On intra-regional freight routes, decreasing costs by one third for example would have a similarly large impact on intra-regional trade. As shown, even though Panama's domestic route markups are dramatically higher than for the other five countries, as a fraction of the value of freight traded, the high price of trucking services in Panama is much less economically significant, because travel distances are shorter and cargo values are higher.

FIGURE 15: ILLUSTRATIVE FIRM AVERAGE DIRECT COST REDUCTIONS RESULTING FROM 1/3 STANDARD DEVIATION IMPROVEMENT IN SIGNIFICANT COST DRIVERS

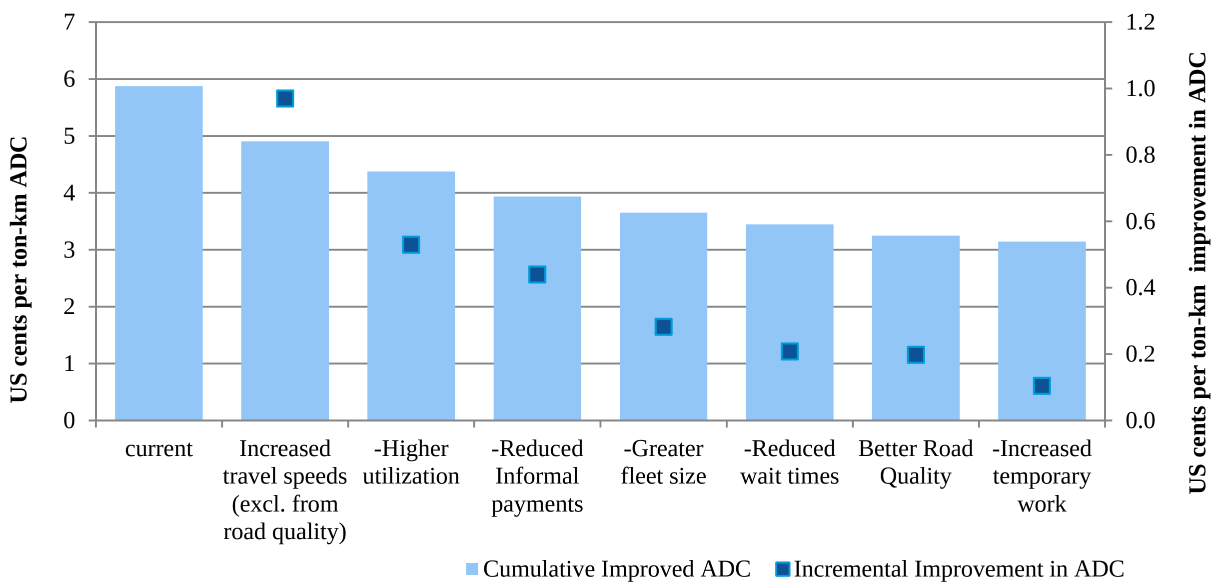


FIGURE 16: ACTUAL AND POTENTIAL PRICES, NATIONAL AND INTERNATIONAL ROUTES (US CENTS PER TON-KILOMETER)

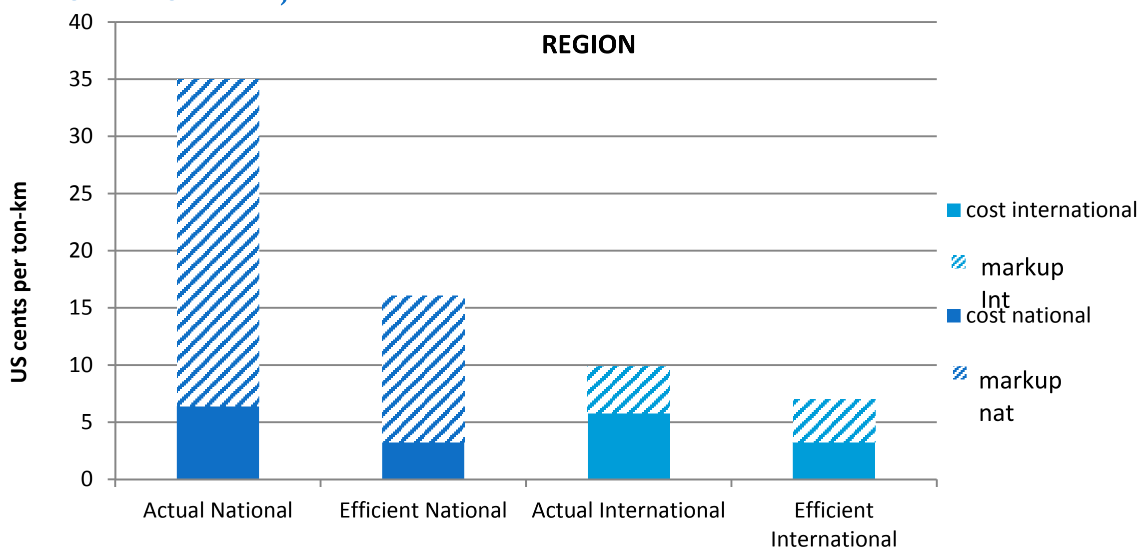


TABLE 23: ROAD FREIGHT CHARGES ON MAIN OVERLAND LEG AS A PERCENT OF FREIGHT VALUES

Origin/Destination Country	Trading partner	Percent of Imports value	Percent of Export value
Costa Rica	Central America	5.9%	4.6%
	Rest of World	5.2%	2.9%
El Salvador	Central America	4.6%	6.8%
	Rest of World	3.4%	7.0%
Guatemala	Central America	4.8%	2.1%
	Rest of World	2.9%	2.5%
Honduras	Central America	7.3%	5.5%
	Rest of World	3.5%	3.7%
Nicaragua	Central America	4.8%	3.9%
	Rest of World	3.7%	6.9%
Panama	Central America	1.3%	5.4%
	Rest of World	0.2%	0.4%

Author's calculations using trucking survey and WITS database.

CONCLUSIONS

Using detailed data on firm costs and characteristics and route-firm-specific data on prices and frictions along main land corridors for international trade in Central America, we estimate firm-level short run cost and price functions in the presence of constraints that trucking firms face. In doing so, we estimate the quantitative impact on prices of constraining factors such as traffic congestion (average speeds), road quality, wait times, empty backhaul, and informal payments. The results show that traffic congestion, high wait times, and informal payments are significant contributors to high costs in the region.

We find surprisingly little evidence of effects of road quality on the costs of service on main trading corridors. Poor road conditions or inadequate road linkages may cause important economic losses in transporting goods from producers – especially agricultural producers – to market, or consumption goods to smaller towns and villages. However, we are able to find no evidence that on the whole improving roads serving main trade corridors would have a sizeable direct effect on overland freight prices in Central America. There is one exception. Although lower average travel speeds do not affect average firm costs, routes with slower average travel speeds are priced higher, probably due to congestion which increases labor and fuel costs. Speeds are in turn affected by road quality as measured in the survey – in particular width and surface conditions – as would be expected. Thus although wholesale investment in improving the roads forming main trading routes would not result in appreciably lower prices, well targeted investments in road works may be worthwhile as part of a package of solutions to reduce traffic congestion where major bottlenecks are found.

In addition to route-level frictions, trucking firms are currently unable to reap economies of scale. Fleet sizes are smaller than optimal for minimizing costs, yet at the same time fleet utilization is low. Whereas high wait times, congestion, and other constraints contribute to low fleet utilization, they do not fully explain it. Market structure and segmentation appear to be important factors as well. Firms serve too few routes and clients, and load dispatch does not respond competitively and flexibly to demand, given market segmentation.

Frequently, observations about the Central American trucking sector focus on the existence of small, informal firms which are believed to be inefficient. Although larger firms are more cost efficient, fleet age is not associated with high private costs of service provision. Although fuel efficiency is very poor, under the market's current structure and low utilization rates of fleets, it is not optimal for many firms to invest in newer trucks. Doing so does not reduce their average costs once one accounts for fixed financing and depreciation costs. Moreover, the current market structure appears to discourage firms from competing for new customers and routes.

In addition to an understanding of the main cost drivers in the market, this paper also analyzes price setting. In particular, we estimate a general model of prices which accounts for costs while also allowing us to test for anti-competitive pricing. We find evidence of uncompetitive pricing on national routes, which are key to delivering the 84 percent of the region's traded merchandise to and from airports and seaports. In particular, we find that the presence of more firms on a route per number of total trips by all firms on that route reduces prices, particularly on national routes. On average, the excess markup on national routes excluding Panama is 8 cents per ton-kilometer. In Panama, the excess markup is 32 cents; however, given the high cargo values and short distances involved in Panama, the economic significance of Panama's high markups is less than it is in the rest of the region. Competition on international routes also has a mild effect on prices but appears to be sufficiently robust to bring prices more in line with costs.

We also find that dramatically fewer firms serve equivalent demand on national routes. It is likely that limitations on entry, particularly prohibitions on cabotage, help perpetuate anti-competitive pricing on these routes. As in other countries and regions which have relaxed geographic or nationality restrictions on entry, including Mexico, the U.S., Southern Africa, and the European Union, an opening to greater international competition would likely reduce markups and induce cost savings on all routes.

References

Aghion P., Blundell R., Griffith R., Howitt P. and Prantl S. (2003) "Entry and Productivity Growth: Evidence from Micro-Level Panel Data," *Journal of the European Economic Association, Papers and Proceedings*, Vol.2, pp.265-276.

Aghion P., Blundell R., Griffith R., Howitt P. and Prantl S. (2009) "The Effects of Entry on Incumbent Innovation and Productivity," *Review of Economics and Statistics*, Vol. XCI, Issue 1

European Parliament (2013) " Development and Implementation of EU Road Cabotage" Directorate General of Internal Policies. Policy Department: Structural and Cohesion Policies.

Inma Martinez-Zarzoso, Eva María Pérez-García, and Celestino Suárez-Burguet. "Do Transport Costs Have a Differential Effect on Trade at the Sectoral Level?" *Applied Economics* 40.24 (2008): 3145-3157.

Kreps, D. and J. Scheinkman (1983). "Quantity Precommitment and Bertrand Competition Yield Cournot Outcomes: Bell Journal of Economics 14: 326-37.

Limão, N. and A. Venables (2000). " Geographical Disadvantage, Transport Costs and Trade." Unpublished working paper.

Londoño-Kent, P. (2007). "Road Freight Transport Industry in Low and Middle-Income Countries." Draft,World Bank,Washington, DC.

Marcelo Gordillo, D., A. Stokenberga, and J. Schwartz (2010). "Understanding the Benefits of Regional Integration to Trade: The Application of Gravity Model to the Case of Central America." Policy Research Working Paper 5506.

Martínez-Zarzoso, I., C. Suárez-Burguet, "Transport Costs and Trade: Empirical Evidence for Latinoamerican Imports from the European Union," (undated unpublished draft)

Novy, Dennis (2012). "Do falling trade costs benefit all countries equally?" VOX: Research based policy analysis from leading economists (October).

OECD. "Liberalisation in the Transportation Sector in North America" (1997)

Raballand, G., C. Kunaka, B. Giersing (2008). "The Impact of Regional Liberalization and Harmonization in Road Transport Services: A Focus on Zambia and Lessons for Landlocked Countries." The World Bank. Policy Research Working Paper 4482.

Raballand, G. and . Macchi (undated). "Transport Prices and Costs: The Need to Revisit Donors' Policies in Transport in Africa," World Bank unpublished manuscript.

Rosenthal, R. and H. Landau (1979). A Game Theoretic Analysis of Bargaining with Reputation. *Journal of Mathematical Psychology* 20: 233-55.

Scheinvar, Isaac. Las carreteras y el sistema portuario frente a las reformas económicas en México" Serie Reformas Económicas. CEPAL (1999)

Teravaninthorn, S. and G. Raballand (2009). *Transport Prices and Costs in Africa: A Review of the Main International Corridors.* Africa Infrastructure Country Diagnostic. World Bank. July.

Van Damme, E. (1987). *Stability and Perfection of Nash Equilibrium*. Berlin: Springer-Verlga.

Winston, Cliffors, et.al. (1990), *The Economic Effects of Surface Freight Deregulation.* Washington DC., Brookings Institute.

World Bank (2012). "Logistics in Central America: The Path to Competitiveness" Economics Unit, Latin America and Caribbean Sustainable Development Department. June.

Ying, John. "The Inefficiency of Regulating a Competitive Industry: Productivity Gains in Trucking Following Reform" in Review of Economics and Statistics, 72(1990): 191-201.

ANNEX A: Trucking Survey Methodology

During the months of September 2011 and March 2012, an independent consulting firm hired by The World Bank conducted a survey directed to trucking companies and operators in Central America countries. The survey implemented follows similar methodologies and questionnaires to previous World Bank surveys in other regions. This is the first of this type conducted in Latin America and the Caribbean than enables cross-country and cross-region comparisons. It serves as data gathering tool for helping to identify bottlenecks affecting the transport of goods in the region, the trucking survey also allows for an in-depth micro-level analysis of the determinants of transport costs and prices, and firm behavior.

Survey Implementation

The survey carried out by a consultant on behalf of The World Bank and was conducted in the following phases:

- Survey design and tools development, including the review and finalization of the questionnaire, the design of a sampling plan, the identification of a sample frame, the establishment of logical checks for data cleaning, the preparation of an enumerator training guide, and the preparation of a training questionnaire;
- Retention of the services of trainers, enumerators, and appointments bookers in all countries. A screening procedure was designed to ensure that all team members had the requisite skills to carry out the tasks and were available throughout the survey period. Those retained were invited to participate in a formal training program and pilot.
- Survey implementation and continuous control in the field, including callbacks to 95% of respondents.
- Data entry, control and final reports: Data entry took place in the field and at the consulting firm's headquarters. Data was checked for the presence of data entry errors and inconsistencies according to procedures presented during the survey design and tools development phase. The errors and inconsistencies were flagged and appropriate checks were conducted including when required, callbacks to respondents.

Sample Selection

The sample was selected based on a comprehensive data set of trucking companies/ operators in each country, provided by the main trucking associations in the region and by drawing lists from publically available documents (e.g., phone books).

Once the lists were built a screener administered a filter to include only the companies which transported internationally traded goods and could provide information during interviews on up to 4 routes to neighboring countries with border crossings, routes to and from major international ports or airports, as well as routes to and from major border posts. The information obtained from the master lists was used to compute the population size, to draw a random sample, and to contact the enterprises to be surveyed.

The eligible population is summarized in the following table.

TABLE 24: ELIGIBLE POPULATION

Country	Trucking Companies	Truck Operators	Total
Costa Rica	75	26	101
El Salvador	60	22	82
Guatemala	75	18	93
Honduras	79	30	109
Nicaragua	108	48	156
Panama	105	50	155

The sampling strategy included a straightforward approach:

- A drawing from the sample frame. All units of the sample were assigned a unique number or identifier. A refusal rate of 45% was estimated and an average coverage of routes per respondent was estimated, such that entities were drawn randomly.
- The units were ordered by sequence number and contacted for appointments. As soon as a refusal was registered after 3 consecutive trials, including at least one trial by the Country Manager, or Assistant Country Manager, the appointment takers moved to the next on the list.

Sample Characteristics

The sample targeted 120 data points on routes in each country, for a total of 120 vectors of information (or O-D combinations), as shown in the table below, with a minimum of 15 trucking firms and a maximum of 30 truck drivers (or owner operators). Although the sampling strategy was to stratify by mono-truck operators and trucking companies with more than one truck, with more mono-truck firms included than non-mono truck firms, this became impractical. Individual truckers often change their cell phone number and do not have or disclose land lines. Access to lorry parks with no prior appointment is also very restricted. Consequently the participation rate of independent truckers in some countries was very low (i.e. El Salvador and Guatemala).

TABLE 25: SAMPLE SUMMARY

	Country	Trucking Companies	Truck Operators
No. Respondents	Costa Rica	34	10
No. Routes	Costa Rica	105	15
No. Respondents	El Salvador	30	7
No. Routes	El Salvador	113	17
No. Respondents	Guatemala	35	2
No. Routes	Guatemala	116	8
No. Respondents	Honduras	37	14
No. Routes	Honduras	11	32
No. Respondents	Nicaragua	35	15
No. Routes	Nicaragua	93	27
No. Respondents	Panama	37	5
No. Routes	Panama	116	13
No. Respondents	Total	208	53
No. Routes	Total	554	112