Trade facilitation, transport costs and the price of trucking services in East Africa

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Abstract

We examine how increased trade facilitation affects the price for trucking services in East Africa. Using a combination of qualitative and quantitative data from primary and secondary sources we are able to provide a detailed account of the market structure of trucking services on a key trading route between Mombasa and Kampala, which is used by importers and exporters across the region. We find that trucking services on this route are provided on a competitive basis and that increased trade facilitation would lead to significantly lower transport prices. In total, we estimate that transport prices could fall by as much as 30% from their current levels through a combination of trade facilitation measures that reduce transit time and transit cost to a minimum.

Keywords: trade facilitation, transport corridors, East African Community, trucking

1 Introduction

Promoting trade is typically associated with tariff reduction or tariff removal, but many studies have also highlighted the fundamental role of trade facilitation (Behar & Venables 2011, Hartzenberg 2011, De Melo & Tsikata 2015). Trade facilitation is particularly relevant for regions that have historically suffered from high internal transport costs, such as sub-Saharan Africa. Freight costs as a share of import value are higher in sub-Saharan Africa than in any other region of the world, and have been increasing since the early 2000s (African Development Bank 2010). High transport prices reduce countries economic competitiveness (Macchi & Raballand 2009), hinder economies' participation in global production networks (Christ & Ferrantino 2011, Nordas et al. 2006), and undermine regional integration efforts with neighbouring countries. In the case of Africa, improving trade facilitation could thus be more effective in boosting trade than reducing tariff barriers (Portugal-Perez & Wilson 2009, Freund & Rocha 2011).

This paper examines the channels through which trade facilitation efforts can reduce the price for transporting goods between countries in East Africa. Specifically, we examine

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the market for overland cargo transport on the 1,169 km stretch of road between Mombasa, Kenya and Kampala, Uganda. This road segment belongs to the region's Northern Corridor. This key transnational infrastructure link provides vital access to the sea for East Africa's landlocked hinterland and serves as the main import/export route for goods entering or leaving Kenya, Uganda, Rwanda, South Sudan, and the eastern parts of the Democratic Republic of Congo.[1]

Trade facilitation plays a key role in reducing transport costs. It addresses delays caused by bottlenecks in transit (excessive numbers of roadblock, weighbridges) and at the borders (slow custom clearance, congestion), which contribute to higher yearly mileages (Raballand & Teravaninthorn 2009). It can also lower the prevalence of corrupt practices along trading routes which are often a major factor in determining not only transport costs but also pricing strategies and the choice of transport routes (Sequeira & Djankov 2014). Additionally, trade facilitation can reduce risks and uncertainty in transactions. These have been shown to have very negative effects on trade, especially for the landlocked countries (Arvis et al. 2007), and potential multiplying effects through entire value chains (Hummels et al. 2007).

Christ & Ferrantino (2011) highlight that investments in infrastructure have higher rates of return if they address 'soft' constraints through trade facilitation measures. This could explain why the literature finds uneven effects of infrastructure improvements on transport cost. For example, in a study conducted by Schürenberg-Frosch (2012), better infrastructure is found to lower transport costs, as the state of road infrastructure determines the life of trucks, maintenance costs and fuel consumption (Macchi & Raballand 2009, Raballand & Teravaninthorn 2009). However, in Ethiopia and Nigeria, Atkin & Donaldson (2015) find that intra-national transport costs remain high even when controlling for the quality and availability of roads. The impact of international aid on transport costs appears to be equally inconclusive. While foreign aid efforts to improve infrastructure on transport corridors have not produced a clear impact on transport prices (Raballand & Teravaninthorn 2009), other studies have found that aid for trade initiatives reduce trade costs (Cali & te Velde 2011).

Another key factor limiting the pass-through effect of declining transport cost on lower prices for transport services is the lack competition in transport services. Hummels et al. (2009), Francois & Wooton (2001), Fink et al. (2002) show that trade liberalization has limited effects if it is not combined with efforts to address restrictive business practices that limit competition.

Across East Africa, the strengthening of regional integration through the establishment of the East African Community (EAC) and the Common Market for Eastern and Southern Africa (COMESA), have facilitated the movement of goods along the Northern Corridor. Data from monitoring systems of freight forwarding companies that were gathered for the purpose of this study confirm that these efforts are already showing some positive results. Today, a Ugandan importer can expect a container to reach Kampala almost 10 days faster

[1] An alternative route to the Northern Corridor is the Central Corridor, which provides another regional transport link to the sea via the southern shores of Lake Victoria to Dar es Salaam. However, the route between Mombasa and Kampala is currently still being used by a larger number of countries to transport goods in the region. In 2015, the average monthly cargo throughput at the port of Mombasa was double that of the port of Dar es Salaam (Northern Corridor Transit and Transport Coordination Authority 2016, Central Corridor Transit Transport Facilitation Agency 2016).

from the moment it arrives at the port of Mombasa, compared to three years ago (Figure 1). Yet the same data also show that, although trade facilitation efforts have been particularly successful at the customs clearance stage, the reduction in cargo transit times between Mombasa and Kampala have been less impressive. Over the past three years, clearance times of imports with Kampala as their final destination have declined strongly both at the port of Mombasa and at the inland container depot in Kampala, while *en route* transit times have remained stagnant at around five to six days (Figure 1).

We examine how the failure to reduce transit times on East Africa's Northern Corridor contributes to higher prices of trucking services. We combine quantitative and qualitative data from both primary and secondary sources to shed light on the operating nature of the trucking services industry and establish the potential savings that would emerge from different trade facilitation measures. In doing so we develop an analytical framework that allows us to capture the economics of trucking on the Northern Corridor and to test the markets competitive nature. Our emphasis is on detail rather than sample size. This choice comes at the expense of representativeness in the statistical sense, but allows us develop an approach that (i) is able to provide detailed information on the operating nature of the transport sector, (ii) allows to assess the likely impact of trade facilitation measures on transport costs, (iii) is easily replicable, and (iv) only has very modest data requirements. These features make our approach particularly appealing from a policy-making perspective.

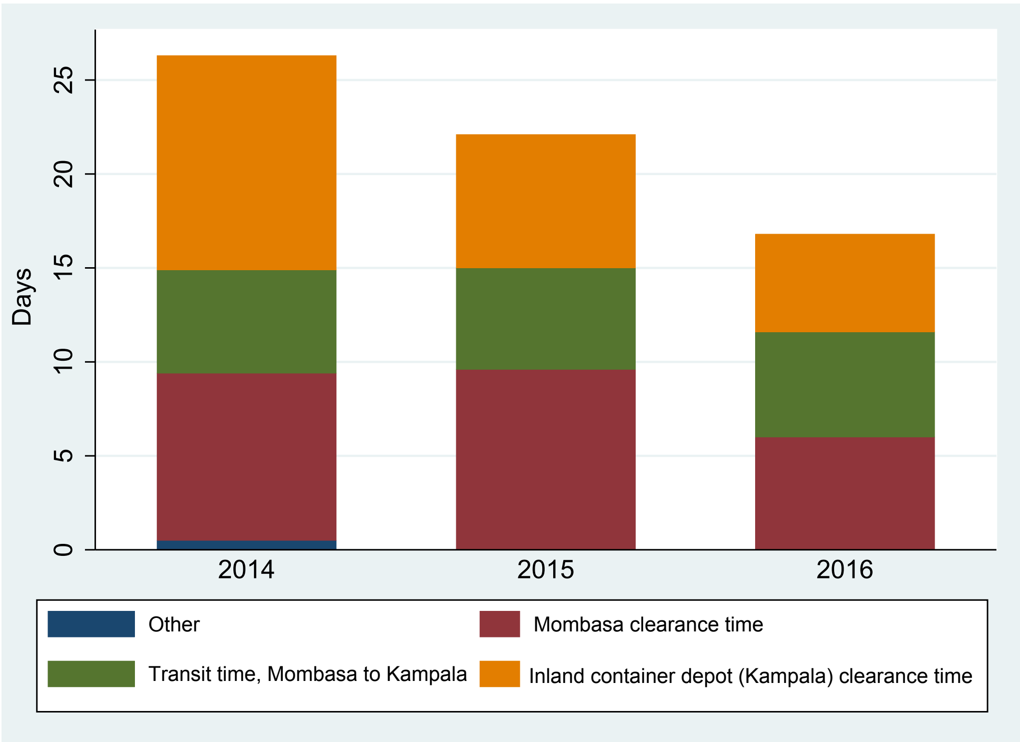

Figure 1: Time to import on the Northern Corridor

Note: Data based on average time to import containerised products from Uganda through the port of Mombasa. Source: Performance monitoring systems of interviewed freight forwarders.

Overall, we find that trade facilitation measures leading to a reduction in transit times have a higher savings potential than measures targeting direct pecuniary costs, such as bribery. At the margin, one additional day required to cover the route from Mombasa to Kampala leads to 6% higher transport prices. In total, we estimate that savings of up to 30% are attainable through a combination of several straightforward trade facilitation measures. The remainder of this paper is structured as follows. In Section 2 we account for our survey methodology and describe our data. Section 3 presents our analytical framework This is followed by a series of baseline estimations in Section 4, which provide a detailed account of the economics of trucking services in East Africa. In Section 5 we then assess the impact of trade facilitation costs and discuss our results. Section 6 concludes.

2 The EACs trucking industry

This study relies on primary data collected using quantitative and qualitative survey methods. In this section we set the scene by accounting for how our surveys were conducted, followed by a description of the key market characteristics of the EAC's trucking industry emerging from our data.

2.1 Data

An online survey targeting freight forwarders, transporters and manufacturers gave us an initial picture of the operating conditions of the EACs transport sector. The online survey examined the common overland routes used to ship goods within the EAC, the price structure of EAC transport services, and the trade facilitation constraints encountered when operating different EAC routes. We complemented the data from the online survey with information gathered in a series of qualitative interviews with transport and logistics employees and managers. Consistency across interviews was ensured by focusing questions on a benchmark service defined as the transport of a containerised product weighing 27 tonnes on a semi-trailer truck from Mombasa to Kampala.[2] This was necessary due to the varying nature of cargo transport services, which results in differing contractual conditions when transporting cargo of different weight and type.

We conducted interviews in Kampala and Mombasa, with interviewees selected from a range of backgrounds, including three senior managers of manufacturing firms with a regional presence; five senior managers of leading freight forwarding companies operating across the region; seven senior managers of trucking companies offering regional transport services; five senior truck drivers; and two senior managers of representative bodies. Interviews were structured into three sets of questions. First, we sought information on the operating nature of the transport sector in terms of transport capacity, technology, current prices for transport services and the structure of variable and fixed costs that transport firms face on the Northern Corridor. Second, questions were then asked about the current conditions of cargo transport along the Northern Corridor to understand the average transit times, average border crossing times, and the likelihood of delays. Third, we asked respondents about their views on the overall EAC integration process.

[2] The semi-trailer is the most common transport vehicle on the Northern Corridor. It can carry a maximum load of up to 27 tonnes as a result of the current EAC axle load regulations.

In addition to these primary data sources, we also relied on secondary data, including official government statistics which we downloaded from the respective websites of central banks and statistics offices. In addition to these, we used data provided by the Northern Corridor Transport Observatory, an online platform that provides information on transport volumes, costs and times along the Northern Corridor.[3] Finally, we also downloaded data from an online second-hand exchange platform to collect information on the prices for second-hand trucks.[4] This information was used to estimate the rate at which trucks depreciate in value. A summary of all figures and data sources used for our analysis in subsequent sections has been included as a table in Annex 1.

2.2 Industry characteristics

Most of the cargo transport between Mombasa and Kampala occurs in an outbound direction, i.e. typically, trucks driving towards Kampala are fully loaded while trucks driving in the direction of Mombasa are often empty. This has important implications for the market structure of transport services on the Northern Corridor. On the one hand, it implies markedly different prices for transport services depending on the direction of travel. Hiring a semi-trailer truck to transport a containerised maximum load of 27 tonnes costs US$ 2,200 to US$ 2,300 from Mombasa to Kampala, whereas the same load would cost about half of that when travelling in the opposite direction. On the other hand, it results in Kenyan trucking firms dominating the market for Northern Corridor transport services, given that most of the trucking business originates from Mombasa.[5] In addition, truckers face asymmetric road user charges depending on the country of registration of their vehicle. For example, Ugandan truckers face a user charge of US$ 249 every time they cross into Kenya, while the user charge applied by Uganda to Kenyan trucks is only US$ 50. Together with Mombasa's lower fuel prices, these factors put Ugandan truckers at a disadvantage, making it very difficult for them to compete with Kenyan trucking firms. As a result, Ugandan truckers are typically active on routes going west or northwards from Kampala, leaving the eastward routes between Kampala and Mombasa to Kenyan truckers.

Kenyan transporters prefer more expensive Mercedes trucks for their operations due to their greater reliability, longer life expectancy, and higher fuel efficiency. A new Mercedes truck is estimated to cost about US$120,000, excluding the necessary trailer which can be bought for an additional US$ 30,000. By contrast, Ugandan transporters preferred cheaper trucks (often imported from China) which can be acquired at a significantly lower price of about US$ 65,000 excluding the trailer. We interpret this difference in truck preferences as a further indication of the different industry maturity in the transport sectors of both countries, with Ugandan truckers not able to afford more modern technology under current market circumstances. On average a semi-trailer truck is expected to burn 50 litres of fuel

[3] More information is available here: http://top.ttcanc.org.

[4] This platform can be accessed here: https://www.olx.co.ke

[5] In a presentation at the SSTAP Africa Transport Policy Programme annual meeting Hartman (2013) sets the number of Kenyan trucking companies at almost 1,600 with a total fleet of over 17,000 vehicles in 2012. In the same year Tanzania had only 732 companies with over 12,000 vehicles, and Rwanda had 220 companies with over 400 vehicles. For more information, see: http://www.ssatp.org/sites/ssatp/files/publications/HTML/Conferences/Dakar13/Presentations/Dec-11/Dec\%2011-PM-Olivier\%20Hartmann-EN.pdf

for each 100 km. For each leg of a return trip between Mombasa and Kampala, a truck will thus require 585 litres of fuel. In addition, trucks are typically operated by a driver and an assistant, who receive an average monthly base salary of US$ 330 and US$ 172, respectively. In addition, truck drivers receive an allowance on every trip between Mombasa and Kampala of about US$ 250, which is expected to cover all *en route* expenses, including road usage charges, parking fees, fines, bribes, and accommodation expenses.[6]

Trucking companies and freight forwarders expect road cargo to reach Kampala in 5-6 days once it leaves the port of Mombasa. This is long amount of time for a trip of 1,169 km, and implies that cargo moves at an average speed of only 8 to 10 km per hour. Truck drivers we interviewed, estimated that when driving a fully loaded truck, they are only moving 36% of the time. 30% of the time is spent resting at night or taking breaks throughout the day. The remaining 34% of the time is attributed to waiting time at the border, queueing at weighbridges, roadblocks, and other unforeseen circumstances.

When comparing market conditions over time, interviewed freight forwarders and manufacturing firms stressed that, overall, charges to import a container into Kampala through the port of Mombasa had declined significantly over the last five years, from US$ 4,000-4,500 to US$ 3,000-3500, including clearance, port and transport charges (excluding sea freight charges). This reduction was, by and large, attributed to a decline in the cost of inland transport on the Northern Corridor. Figure 3 illustrates this using data from the Northern Corridor Transport Observatory, with the price charged by trucking companies to ship a reference cargo load of 27 tonnes from Mombasa to Kampala declining by over 25% between 2013 and 2016. Interviewees stressed that this reduction in trucking prices was predominantly on account of lower fuel prices and a lower demand for transport services owing to a slowdown in imports- a fact that we were able to confirm when using official sources for trade statistics and fuel prices (see Figures 2 and 3).

[6]Ugandan truck owners generally have to pay higher allowances of up to US$ 450 due to the higher road usage charges they face when travelling into Kenya.

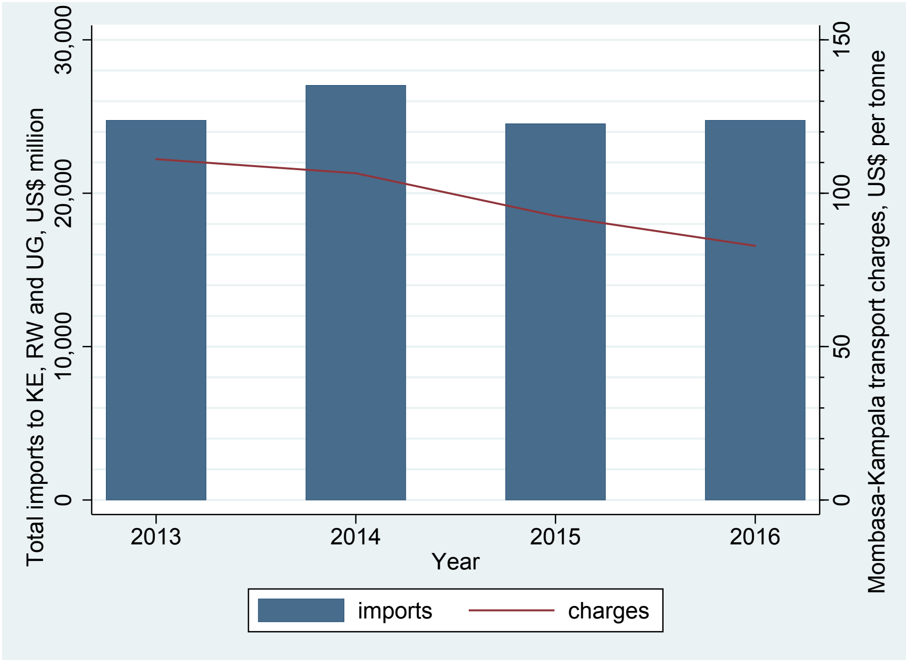

Figure 2: Declining imports and transport charges and falling total in imports, 2013-2016
Source: Interviews with truck drivers, Northern Corridor Transport Observatory and respective central banks of each country.

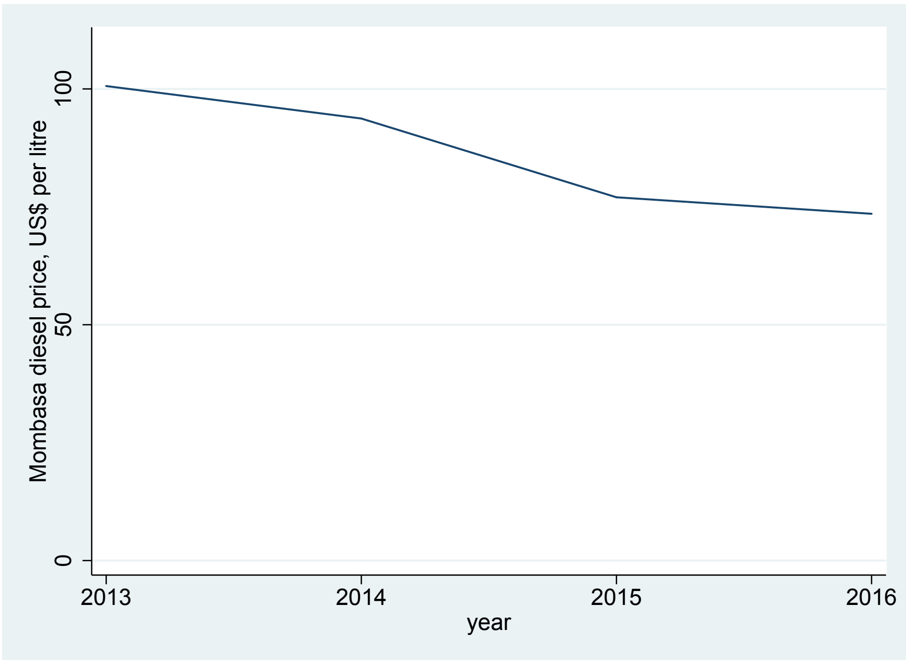

Figure 3: Declining fuel prices in Mombasa, 2013-2016
Source: Energy Regulatory Commission of Kenya.

3 Analytical framework

coWe develop an analytical framework that mimics the operating conditions of the trucking industry in the EAC as described in Section 2. Our point of departure is to assume a representative truck owner i specialised in offering cargo transport services on a given route j in the EAC; and operating in a competitive environment with constant returns to scale and constant average cost functions in the number of trucks owned.[7] Total annual profits of this trucking firm can be represented as:

$$\Pi_{ij} = p_j n_i X_{ij} - n_i C_{ij}, \tag{1}$$

where n_i stands for the number of trucks owned by i, X_{ij} for the number of separate cargo loads delivered by each truck of company i in a given year on route j, and C_{ij} for total cost faced by each truck of company i in delivering a single cargo load on route j. The first and the second term in equation (1) represents firm i's total revenue and total cost, respectively, in a given year. Equation (1) implies that the profit of any single truck owned by company i is:

$$\Pi_{ij}/n_{ij} = \pi_{ij} = p_j X_{ij} - C_{ij}. \tag{2}$$

Furthermore, we assume that the market structure of the trucking industry is competitive and that firms are not able to exert any influence over the price of trucking services. The number of cargo loads X_{ij} that a truck delivers in a year depends on the efficiency of trucking services, i.e. the number of trips that a truck can undertake in a given year. Hence,

$$X_{ij} = T_i/t_j, \tag{3}$$

where T_i is the total number of days firm i decides to operate on route j in a given year, and t_j is the number of days required to process a cargo load *en route* j (i.e. the total transit time required to cover a return trip on route j plus any additional time required to secure a new order). We show below that T_i will either be set to zero or the maximum possible amount of 365 days, implying that trucks will either operate at full capacity or not at all.

Total costs C_{ij} are assumed to exhibit positive marginal cost and decreasing average cost. Specifically, we assume that C has a variable cost component which depends on the number of cargo loads X_{ij} and a fixed component comprised of the truck driver salary, the annual depreciation of the truck, and the opportunity cost of capital in the region:

$$C(X_{ij}) = \omega_j X_{ij} + \rho_j X_{ij} + W_i + (\delta + r)K_i. \tag{4}$$

ω_j are the direct pecuniary costs involved when a cargo load is transported on route j covering for *en route* expenses, accommodation of drivers, and other incidental cost; ρ_j is the total cost of fuel required for a return trip on route j; and W_i is the annual cost of labour to operate a truck. $(\delta + r)K_i$ represent the user cost of initially invested capital K_i, with δk_i standing for the annual depreciation of a truck and rK_i the risk-adjusted opportunity cost of owning a truck. We thus define rK_i as a term including both the opportunity cost of capital as well as the truck owners opportunity cost of time.

[7] Raballand & Teravaninthorn (2009) finds that the EAC trucking industry operates in a competitive climate. We validate this assumption in Section 4 below.

Therefore, firm i's profit maximisation problem can be characterised as involving two sequential decisions. First, firm i will have to decide how many trucks n to own in any given year, by setting n to satisfy $p_jX_{ij} = C_{ij}$. This means that it will set marginal revenue generated by truck equal to the marginal cost incurred by a truck. Second, it will have to decide how many days T to operate each truck throughout the year by maximising:

$$\pi_{ij} = p_jT_i/t_j - [(\omega_j + \rho_{ij})T_i/t_j + W_i + (\delta + r)K_i]. \tag{5}$$

This sequential decision problem has several implications. First, $p_jX_{ij} = C_{ij}$ is only satisfied if $p_j > \omega_j + \rho_{ij}$. Hence, over the course of a year, the price for transporting a single cargo load on route j will have to be higher than the marginal cost of doing so. Otherwise, firm i would be making a loss on the marginal truck and thus decide to sell part or all of its fleet. Second, T will always be set at the highest possible level, as long as $p_j > \omega_j + \rho_{ij}$. Thus, independent of the number of trucks owned, company i will always choose to operate at full capacity as long as the market price for transporting a single load on route j covers at least the marginal costs of operating on route j. Third, the size of the trucking industry will depend on the average costs per trip over the course of a year defined as:

$$\overline{C_{ij}} = (\omega_j + \rho_{ij}) + (W_i + (\delta + r)K_i)/(T_i/t_i) \tag{6}$$

Firms will increase their trucking fleet when p_j is larger than $\overline{C_{ij}}$ and will reduce it when p_j is smaller than $\overline{C_{ij}}$. In a competitive equilibrium, the overall capacity of the trucking industry will adjust so that the market price for transporting a single cargo load on route j will equal the average costs of operating a truck in a given year on route j, satisfying:

$$p_j = (\omega_j + \rho_{ij}) + (W_i + (\delta + r)K_i)/(T_i/t_j). \tag{7}$$

Equation 7 shows how in a competitive equilibrium there are two channels through which improvements in trade facilitation along route j have an impact on p_j. The first channel comprises a direct reduction in *en route* costs ω_j, a reduction in road user charges, bribes, and overnight security cost among others. The second channel is indirect and involves a reduction in t_j, i.e. the number of days required to cover route j. A reduction in overall transit times, for instance, would allow increasing the number of round trips per year and allow firms to use their trucking fleet more efficiently, which would in turn put downward pressure on the market price p_j.

4 The economics of trucking services in the EAC

In this section we present a set of baseline calculations to provide a comprehensive picture of operating conditions in the EACs trucking industry. First, we conflate our survey results and the analytical framework presented in Section 3, and conduct a series of stylized calculations on operating conditions in terms of profit margins, turn-over and costs. Second, we compare this information over time to test the industrys competitive climate.

4.1 Baseline operating conditions of the EAC's trucking industry

In line with the general market characteristics described in Section 2 above, we set route j to a return trip with a one-way load of 27 tonnes transported from Mombasa to Kampala.

Table 1: Annual operating costs

Component description	Variable	Imputed value (in US$)
Annual *en route* expenses	$\omega_j X_{ij}$	9,484
Annual fuel cost	$\rho_j X_{ij}$	32,255
Annual cost of labour	W_i	3,961
Annual depreciation	δK_i	7,197

Specifically, we use equation 4 to guide our calculations of transport cost on this route. Our survey data provide us with direct measures for most of the variables affecting total annual cost $C(X_{ij})$. As discussed, when trucks operate in a competitive climate, they will operate at full capacity. At current transit times, a newly acquired truck will thus service the route between Mombasa and Kampala 38 times per year, if we assume a competitive behaviour of trucking firms.[8] Hence, an average fuel efficiency of 50 litres per 100km suggested in interviews implies total annual fuel expenses of US$ 32,255 when operating at full capacity.[9] Meanwhile annual *en route* expenses paid out in allowances to truck drivers will amount to US$ 9,484. The total annual wage bill, calculated as the sum of base salaries of truck driver and assistants over the course of a year, stands at US$ 3,961. Hence, variable *en route* costs play a much less important role in the trucking industrys overall cost structure, which are predominantly driven by fuel prices. A summary of these different cost components is included in Table 1.

A key piece of information that we are not able to establish directly from the interview responses is the rate at which the value of trucks depreciates. Therefore, in order to estimate the annual depreciation rate of a truck, we use asking prices for second-hand semi-trailer Mercedes trucks advertised on a Kenyan online platform. Advertisements do not include data on truck mileage, which typically correlates strongly with truck prices. Instead each advertisement is accompanied by a photograph showing the condition of the truck and its number plate. With pervasive odometer fraud prevalent across much of East Africa, number plates are typically used as a more objective source of information for the valuation of trucks on the second-hand market.[10] We use the number plate to establish the years since the trucks registration and estimated the following linear regression model:

$$\mathsf{TruckPrice}_k = \alpha_0 + \alpha_1 \mathsf{Age}_k + \epsilon_k, \tag{8}$$

where $\mathsf{TruckPrice}_k$ is the asking price of truck k and Age_k is the number of years elapsed since truck k's registration; and ϵ_k is an error term. Figure 4 illustrates this regression estimation graphically.[11] The estimated value of α_1 is -7,197, which implies that a truck depreciates by US$ 7,197 each year, equivalent to 4.8% of the initial value of the truck. The intercept α_0 has a value of 103,150, which is significantly less than the

[8]This implies an average of 3-4 trips per month, which was confirmed in interviews.

[9]The per litre fuel price for this calculation was set to US$ 0.765. This is the Mombasa per litre Diesel prevailing at the time of our interviews in December 2016. See Table A1 in Annex I for a full set of data assumptions

[10]See for example: Kiberenge & Gitonga (2014), Huduma Bora (2011).

[11]A full set of regression results is reported in Annex II.

cost of a new semi-trailer truck, which our interviewees estimated at US$ 150,000. This is unsurprising, as our interviews confirmed that many imported trucks enter the EAC as used, and not as new trucks.

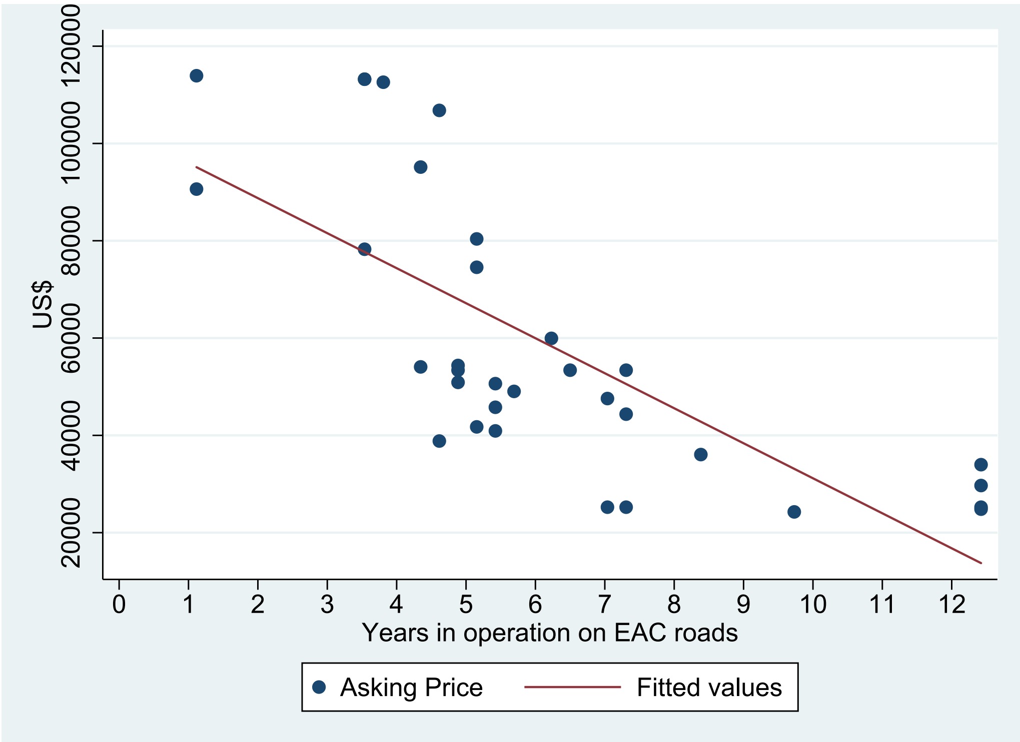

Figure 4: Depreciation of semi-trailer trucks operating on EAC roads

We are now able to estimate the risk-adjusted opportunity cost of owning a truck defined as r, as shown reported in Table 2. We first establish a trucks yearly revenue, which at a price of US$ 2,237 per round trip, currently generates US$ 85,201. Second, given the assumption of a competitive market we set $\pi_{ij} = 0$ and solve equation 5 for rK_i. The resulting annual risk-adjusted opportunity costs of owning a truck thus become US$ 32,304, which is 21.5% of the initial cost of a new truck of US$ 150,000. We can also interpret this as the return to investment in a competitive setting with zero profits.

Although these figures represent averages for the entire industry based on a highly simplified analytical framework, our results do not appear to be far off from reality. For instance, our calculations imply that the annual pre-tax cash flow (excluding depreciation) of operating a truck is US$ 39,500, meaning that it takes 3.8 years to recover the cost of our reference truck valued at US$ 150,000. This corresponds well with information gathered in qualitative interviews, which suggests that under normal circumstances, cost recovery of a new truck is achieved in 3-4 years. Moreover, an annual return on investment of r=21.5%, aligns well with returns on physical capital that have been reported to often exceed 20% in sub-Saharan Africa (see Grimm et al. (2011), Siba (2015), Bigsten et al. (1998)).

Table 2: Opportunity cost of capital

Component description	Variable	Imputed value (in US$)
Annual revenue	$p_j X_{ij}$	85,201
Annual operating costs	$(\omega_j + \rho_j)X_{ij} + W_i + \delta K_i$	52,897
Risk-adjusted opportunity cost of capital	rK_i	32,304

4.2 Competition in the EAC's trucking industry

Our baseline calculations assume a competitive behaviour between trucking firms. In a recent comparative study of trucking services across major transport corridors in sub-Saharan Africa, Raballand & Teravaninthorn (2009) conclude that transport services along the Northern Corridor are provided on a relatively competitive basis. Yet, their assessment is based on indicative measures of market competition, such as the EACs relatively high truck mileage per year and low levels of market concentration, rather than a more formal test of market structure.[12]

In this study, we assess the trucking industrys competitive climate by comparing the evolution of prices for trucking services on the Northern Corridor in response to changes in input costs. Specifically, we interpret a high response of prices to changes in input costs, as an indication for the prevalence of a relatively competitive environment among EAC trucking companies. This approach stands in the tradition of a method first proposed by Rosse & Panzar (1977), later formalised in Panzar & Rosse (1987), which has found widespread application in the empirical literature on market structure (Bikker et al. 2012). Panzar & Rosse (1987) show that summing over a firm's revenue elasticities with respect to input prices delivers different values depending on the degrees of competition in any given market.[13] Most studies that have applied the Panzar-Rosse test build on large data sets tracking many firms in an industry over several years (Carbó et al. 2009, Tsutsui & Kamesaka 2005, Claessens & Laeven 2004, Fischer & Kamerschen 2003).In our case, however, data constraints imply that our approach is purely comparative and non-parametric.

Equations 6 and 7 establish how the price for price trucking services should relate to input costs in a competitive environment. Specifically, we would expect an increase in average per trip cost $\overline{C_{ij}}$, established in equation 6, to translate into a one-to-one proportional increase in the transport price p_j, a proposition that we are able to test with our data. Assuming that the user cost of capital $(\delta + r)K_i$ remains at its 2016 level calculated above, we examine how predicted price changes in trucking services due to changes in average cost $\overline{C_{ij}}$, compare with actual changes in prices charged by trucking companies between 2013 and 2016. Figures 5 and 6 illustrate these results.

[12]Specifically, Raballand & Teravaninthorn (2009) report that the largest truck companies account for only 20% of the market share, a figure similar to relatively competitive trucking industries in Europe or North America.

[13]Specifically, they show that a negative sum of elasticities is consistent with a neoclassical monopoly or a collusive oligopoly, a value between 0 and 1 with monopolistic competition, and a value of 1 with perfect competition.

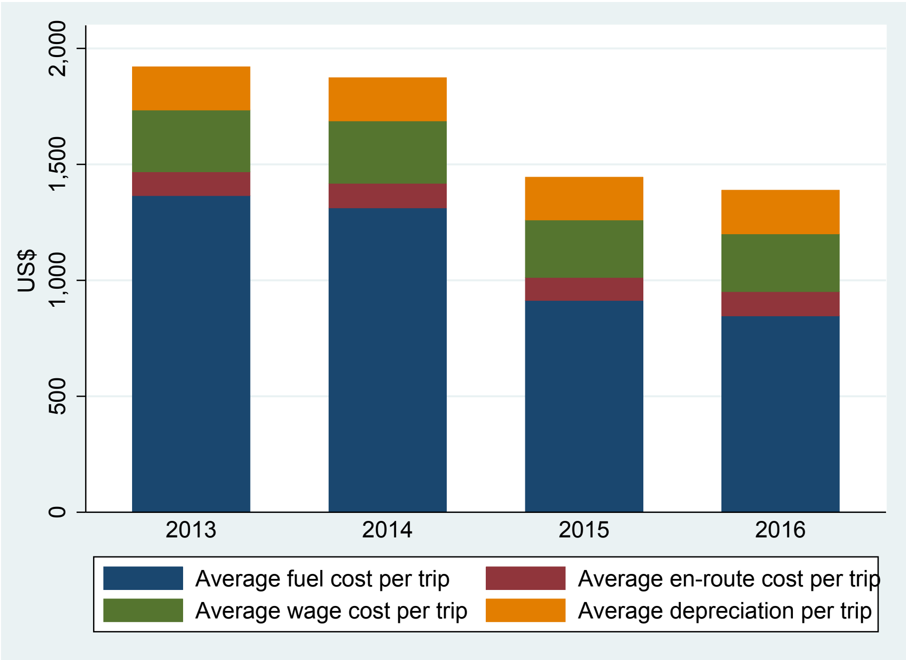

Figure 5: Evolution of average cost per trip by different cost components (in US$)

Note: Figures based on operating a single new semi-trailer truck with a driver and an assistant on the MombasaKampala route at maximum capacity (27 tonnes per trip). Source: Authors own calculations based on interview data and several secondary sources.

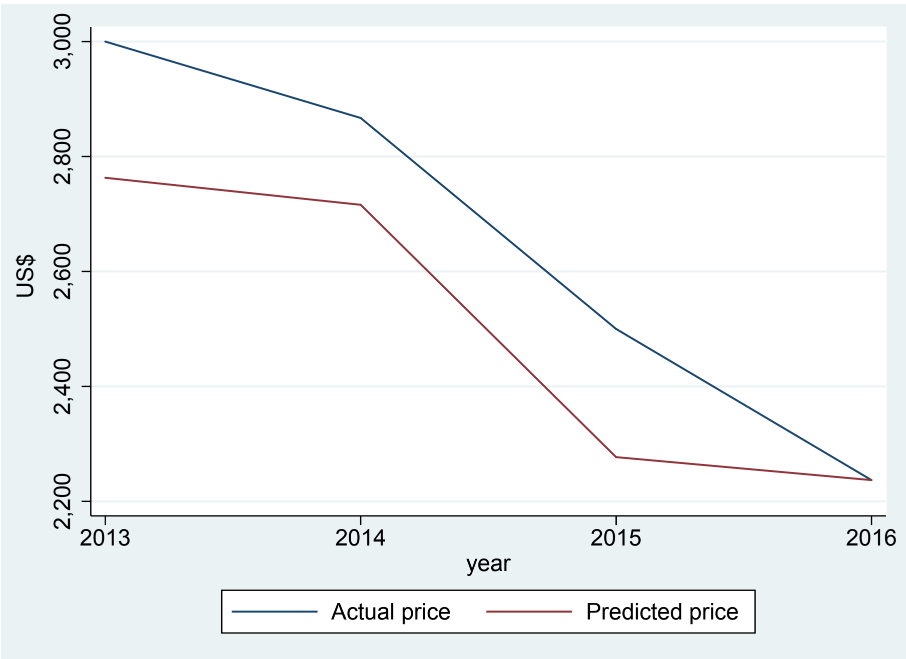

Figure 6: Predicted vs actual price changes for trucking services (in US$)

Note: Figures based on operating a single new semi-trailer truck with a driver and an assistant on the MombasaKampala route at maximum capacity (27 tonnes per trip). Source: Authors own calculations based on interview data and several secondary sources.

Overall, we find that trucking prices correlated strongly with changes in input costs. Between 2013 and 2016, input cost of a truck fell by 27.7%, driven by a large reduction in fuel prices, as shown in Figure 5. This coincided with a very similar decline in the price charged for transporting one metric tonne from Mombasa to Kampala, which fell by 25.4%. This decline in prices also coincided with a 11.2% reduction in the value of goods imported by Kenya, Rwanda and Uganda which could have led to a lower demand for transport services (see Figure 2 above). The confluence of both lower imports and lower input costs complicates our ability to infer the degree of competition in the trucking market. In the presence of market power, theory would predict prices to respond to changes in demand but not to respond so much to changes in input costs. Meanwhile, a competitive environment would imply prices to respond to both changes in input costs and demand. Hence, if the decline in prices were to be merely reflecting demand side factors, we would not be able to conclude whether the trucking industry operates in a competitive climate or not. Yet, given the much larger relative reduction in prices than in imports, transport prices do indeed appear to be influenced by input costs. This interpretation is line with several interview respondents, who attributed the decline in transport prices to the fall in fuel prices observed in recent years.

Moreover, we find that the magnitude of the reduction in trucking prices predicted by our competitive model in response to observed changes in input cost, comes close to the actually observed decline in the price for trucking services. Compared to the 25.4% drop in trucking prices actually observed in the data, our analytical framework predicts a 19.0% reduction between 2013 and 2016. The fact that our analytical frameworks under-predicts the actual decline in prices is consistent with the fact that in addition to the change in input costs the market also experienced lower demand, which is not captured by our calculation of predicted prices. Overall, it thus appears that changes in input cost do lead to changes in trucking prices. Although we are not able to proof causation in the statistical sense, we believe that, together with the responses to our qualitative interviews, our results are strongly suggestive of the existence of a competitive market along the Northern Corridor.

5 The impact of trade facilitation barriers

In this section, we investigate the impact of a reduction in trade facilitation barriers under perfect competition on the price of trucking services in the EAC. Equation 7 establishes that in a competitive equilibrium, the price of trucking services is driven by two components: (i) a variable component determined by the cost of fuel and direct pecuniary cost; and (ii) a fixed component that depends on the number of trips carried out over the course of a year. Direct pecuniary trade facilitation barriers such as bribes or road usage charges impact the former variable component. Indirect trade facilitation barriers that result in higher transit times affect the latter fixed component. We examine each of these two channels in turn.

5.1 The cost of pecuniary trade facilitation barriers

Pecuniary trade facilitation barriers are represented by ω_j in equation 7. They have a direct impact on the marginal cost of trucking. Hence, in a competitive market an increase in ω_j results in a one-to-one increase in the price for trucking services. On a return trip between

Mombasa and Kampala ω_j amounts to US$ 249, which is the total allowance a truck driver receives to cover *en route* expenses. We asked truck owners and their respective drivers to split this sum into its different components. Out of the total allowance of US$ 249, 34% is typically used for personal expenses such as food and accommodation, 20% to cover road usage charges in Uganda, 13% to pay for bribes, and 9% to meet security expenses and parking fees. The remaining 23% is used as a buffer for unforeseen circumstances and minor *en route* repairs of the truck.

From a policy perspective the elimination of road usage charges, bribes, and security expenses would represent the more obvious trade facilitation policy. We consider these three scenarios in which each of these trade facilitation barriers is removed, the results of which are reported in columns two to three in Table 3. The calculations make clear that the savings from these policies would be relatively moderate: jointly eliminating all road usage, bribery, and security costs would reap only 5% lower transport prices relative to their current level.

5.2 The cost of trade facilitation delays

Most trade facilitation barriers are felt in the form of longer cargo transit times. These have an indirect impact on transport cost, as they reduce the number of round trips a truck can undertake in a given year, resulting in higher average cost $\overline{C_{ij}}$. On the contrary, shorter cargo transit times allow for spreading the fixed costs of a truck over a larger number of trips t_j, causing trucking prices to fall, if markets are competitive. Using equation 7 we can estimate the marginal impact of one additional hour spent in transit on the price of trucking services. For each additional hour, the price for trucking services augments by US$ 5.33 or 0.24% relative to the current price of US$ 2,237. According to our interviews, the current value of t_j for a return trip with a one-way cargo load of 27 tonnes between Mombasa and Kampala, is 9.6 days or 230 hours. This includes 5.6 days needed to complete the outbound trip from Mombasa to Kampala when the truck is loaded, 3 days for the return trip back to Mombasa, and one-day turnover time between trucking orders.

Interviewed truck drivers specified that 34% of the outbound transit time of 5.6 days is lost while waiting at key transit points such as weighbridges, roadblocks and the border. Several surveys looking at the border and weighbridge crossing times allow us to accurately establish these delays. For instance, a 2016 border crossing survey conducted at the main border post for cargo traffic between Kenya and Uganda in Malaba, shows that it currently takes 22 hours to cross the border into Uganda due to the slow customs processing and overall congestion at the border (Kuria 2016). The time lost at weighbridges is more difficult to establish because it depends on the type of weighbridge in use. More modern weigh-in-motion technology have resulted in much shorter waiting times of less than 10 minutes at some weighbridges. Yet only four of the seven fixed weighbridges between Mombasa and Kampala are equipped with this technology. In addition, there are also mobile weighbridges that are placed randomly throughout the route that would add to the journey time. In total, interviewed truck drivers estimated that they expect to encounter up to 10 weighbridges. According to the data, our best guess is to allow for an average of 30 minutes per weighbridge, which would bring the total time lost due to the existence of weighbridges to five hours per trip (assuming that trucks are compliant with axle load regulations). Taking the total time lost at the border and time spent at weighbridges, we are only able to account for about 27 hours of the total 46 hours of delays truck drivers report. This highlights that there are other important sources of delays such as roadblocks and congestion, which can also increase overall transit times.

For illustrative purposes, we compare three additional scenarios. In all three scenarios, we hold the current work to resting time ratio of 0.43 constant. This implies that on a typical day *en route*, a truck driver works 13.7 hours and rests 10.3. Therefore, a reduction in *en route* delays reduces total transit times directly, but also reduces transit times indirectly due to less resting time needed while *en route*. Our first scenario assumes the elimination of all delays occurring at the border between Kenya and Uganda due to the existence of a hard border. This would result in a decline of total transit times on the Northern Corridor by 31.6 hours (i.e. 22 hours due the elimination of delays and 9.4 hours due to a reduction in required resting time). The second scenario eliminates all weighbridges, which would result in a decline of total transit times by 7.1 hours (i.e. 5 hours due to the elimination of delays and 2.1 hours due to reduced resting time). In the third scenario, we eliminate all unaccounted delays, which would reduce the total transit time by 26.1 hours (i.e. 18.3 hours directly, and 7.8 hours due to reduced resting time). The results are shown in columns five to seven of Table 3.

5.3 Discussion

Our results show that delays generally impose a larger cost of the transport of goods in the EAC than direct pecuniary measures. For example, in policy circles, bribes and additional payments made *en route* are often attributed a key role in explaining high transport costs. However, the results in Table 3 show that even if all of these payments were to be eliminated, the total savings would only amount to 1.5% of the current price of transport services. By contrast, addressing the trade facilitation barriers responsible for delays would reap higher benefits. For instance, a 7% reduction in cargo transport prices could be achieved by speeding up clearance of cargo at the border.

It is important to note, however, that completely eliminating all of these cost factors is unfeasible. A limited number of weighbridges will have to remain to ensure trucks comply with axle load regulations and preserve precious road infrastructure. Road usage charges may also play an important role in financing new infrastructure, which could be equally cost reducing. Yet it remains that there are potentially large savings emanating from increased trade facilitation to be made. Rather than focusing on a single trade facilitation measure, it is possible to benchmark current transit times against transit times that would be achieved, if trucks were to travel at higher average speeds. Interviewed truck drivers disclosed that they only spend about 36% actively driving when in transit. This implies that the average trucking speed when moving amounts to only 28 km per hour, which is possibly due to the inadequate infrastructure and congestion around major urban settlements and when approaching the border.

We thus consider a final scenario in which we allow travel speeds to increase to 40 km per hour, as reported in the last column of Table 3. To remain as realistic as possible, we allow for delays of three hours and assume a constant work to resting time ratio, as above. We also eliminate all payments for bribes and security from this final scenario. We find

Table 3: Impact of different trade facilitation measures on the Mombasa - Kampala route

	Baseline	Scenario 1 No road usage charge	Scenario 2 No security expenses	Scenario 3 No bribes	Scenario 4 No border	Scenario 5 No weigh-bridges	Scenario 6 No other delays	Scenario 7 Overall savings potential
Total transit time, t_j (hours)	230.0	134.0	134.0	134.0	102.6	126.9	107.9	113.0
Driving time (hours)	89.7	89.7	89.7	89.7	89.7	89.7	89.7	70.4
Resting time, outbound (hours)	71.1	71.1	71.1	71.1	61.7	68.9	63.2	44.7
Delays (hours)	45.2	45.2	45.2	45.2	23.3	40.2	27.0	3.0
Turnover time (hours)	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Implicit average speed when driving (km/hour)	24.1	24.1	24.1	24.1	24.1	24.1	24.1	40.0
Fuel cost, ρ_j (US$)	847	847	847	847	847	847	847	847
Allowance cost, ω_j (US$)	249	199	227	216	249	249	249	166
Fixed cost, $(W_i + (\delta + r)K_i)/(T_i/t_j)$ (US$)	1,141	1,141	1,141	1,141	984	1,106	1,012	561
Price for trucking services, p_j (US$)	2,237	2,187	2,215	2,203	2,080	2,202	2,107	1,573
Savings relative to actual	-2.24%	-0.98%	-1.50%	-7.01%	-1.57%	-5.79%	-29.66%	

that in this scenario, the total transit time on a return trip would fall to 116 hours almost half the current transit time of 230. Direct pecuniary cost would decline too, by US$ 88 on each trip, resulting in overall savings of over 29% relative to current prices.

Our results are very similar to estimates provided elsewhere. In a previous study on transport logistics along the Northern Corridor, Arvis et al. (2007) provide a rough savings estimate of US$ 130 for each one-day reduction in truck transit times. Although they do not provide a methodology of how they reach this figure, our calculations come remarkably close to their estimate, with daily cost savings of US$ 128 implied by our results.[14] In another study, Djankov et al. (2010) estimate the impact of time costs on export volumes using a dataset compiled from freight-forwarding companies worldwide. They find that that a one-day increase in the time it takes to move an export container from the factory to the nearest port is equivalent to extending the median distance between factory and port by about 70 km. Although our work aims to establish the impact of time delays on transport cost rather than trade volumes, a similar calculation using our data results in a very similar figure: With a one-day cost savings estimates of US$ 128 a truck would be able to travel 67 km further for the same price, if we hold our reference per km trucking price of US$ 1.91 constant.[15]

We note that we may well be underestimating the impact of lower transit times on transport costs. For example, we assume pecuniary trade facilitation barriers represented by ω_j to be independent of the total transit time. Yet, to the extent that the amount of money required for eating and accommodation falls with the total transit time, the savings impact of lower transit times may be even larger. Similarly, a reduction in delays and overall congestion may increase fuel efficiency and thus result in a greater overall impact. Moreover, our estimates in Table 3 do not consider the increases in transit predictability that may come hand in hand with the elimination of transit barriers. In fact, Arvis et al. (2007) argue that the benefit derived from halving the inventory level caused by the high variability in transit times can result in a much higher reduction in overland transport cost than the mere reduction of delays.

6 Concluding remarks

Trade facilitation, transport costs and trucking prices intertwine in East Africa. Our analysis sheds light on the market for trucking services on the key trading route between Mombasa and Kampala, which is used by importers and exporters across the region. Combining qualitative and quantitative data from primary and secondary sources, we are able to provide a detailed account of the costs of trucking services on this route. We find the market to be largely competitive. Moreover, we find that trade facilitation barriers play a key role in the continuing high prices charged for cargo transport in the region. Our results suggest that trade facilitation barriers that delay the movement of cargo are particularly costly. Direct pecuniary costs faced by truckers when transporting goods, such as bribery or security expenses, also contribute to higher prices but to a lesser extent. In total, we es-

[14] For each additional hour, the price for trucking services augments by US$ 5.33 (see Section 2.2) implying that an additional day in transit increases the price for trucking services by US$ 127.92.

[15] Despite the similarity of these figures, these comparisons ought to be treated with care given the strong differences in methodology used in this paper and in Djankov et al. (2010).

timate that transport prices could fall by as much as 30% from their current levels through a combination of trade facilitation measures that reduce transit time and transit cost to a minimum. Improvements in trade facilitation across East Africa could thus go a long way in increasing the economic competitiveness of the region and allow for better integration of the EAC's regional production centres with global value chains.

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Annex 1

Table A1: Current market conditions for trucking services

Indicator	Assumed baseline figure	Supporting evidence
Reference route	Mombasa port to Kampala (1,169 km)	Distance figure taken from the Norther Corridor Transport Observatory (NCTO) of the Northern Corridor Transit and Transport Coordination Authority (NCTTCA).
Reference vehicle	Semi-trailer carrying up 27 tonnes	The semi-trailer is the most common transport vehicle on the Northern Corridor. It can carry a maximum load of up to 27 tonnes due to current EAC axle load regulations.
Cost of semi-trailer	US$ 150,000	Interviews with truck owners provided details about the costs of a semi-trailer depending on the brand. Most truck owners identified Mercedes trucks (Actor and Axor types) as their preferred choice, costing about US$ 120,000 when new on the local market. The price of a trailer was quoted to amount to about US$ 30,000.
Annual rate of depreciation	US$ 7,197	This was established using asking price data for second hand trucks (only Mercedes Actor or Mercedes Axor were considered) sold in Kenya (retrieved from `www.olx.co.ke` in January and February 2017). Price data was then regressed on the number of years since the trucks registration in Kenya. This allowed generating average annual depreciation rates of trucks when operating on EACs roads.

Table A1: Current market conditions for trucking services

Indicator	Assumed baseline figure	Supporting evidence
Average fuel consumption for return trip	50 litres per 100 km	Interviews revealed that a return trip from Mombasa to Kampala will require 950-1250 litres depending on the load and the age of the truck. Given the assumption of a maximum load (27 tonnes) and the relatively new trucks assumed for the purpose of this exercise, an average fuel consumption of 50 litres per 100 km is stipulated, implying a total fuel consumption of 1169 litres for each trip.
Hiring cost of semi-trailer carrying a maximum load of 27 tonnes for Mombasa Kampala route	US$ 2,237	The qualitative interviews showed that transport cost for shipping cargo from Mombasa to Kampala varied strongly with type and weight of container. Hence the collected information was used to estimate the hiring price for a fully loaded semi-trailer (max of around 27 tonnes due to axle load regulations) on the MombasaKampala route, which was estimated between US$ 2,000 and US$ 2,500 (excluding shipping line charges and cargo clearing charges). This is in line with the average 2015 price of US$ 2,237 suggested by the most recent NCTTCA survey. This figure was used for the calculations.
Driver base salary per month	US$ 330	Interviews provided details about truck drivers salaries, which varied according to the type of company and the experience of the truck driver. US$ 330 corresponds to the average salary provided by all truck owners interviewed in Mombasa. Assistant base salary US$ 172 Industry interviews revealed that truck drivers operating the MombasaKampala route are typically accompanied by a truck driver assistant. Average base salaries for truck driver assistants were reported at US$ 172.

Table A1: Current market conditions for trucking services

Indicator	Assumed baseline figure	Supporting evidence
Drivers allowance for each trip (direct transit cost)	US$ 249	The qualitative industry interviews revealed that drivers get a lump sum for every trip. A Kenyan truck driver would receive about US$ 249 for a return trip between Mombasa and Kampala. Drivers reported that the allowance is used for truck maintenance (18%), parking fees and security (9%), personal expenses for accommodation and food (34%), bribes and extra official fines (13%), road usage charges (20%), and other miscellaneous expenses (5%).
Cost of fuel	US$ 0.765 per litre	It is assumed that the truck refuels in Mombasa, where fuel is cheapest. Average pump price of fuel in the first two weeks of December 2016 was KHS78.79 (`http://www.erc.go.ke/index.php/option=com_content&view=article&id=162&Itemid=666`).
Overall transit time outbound from departure in Mombasa to arrival in Kampala	134 hours	The qualitative interviews revealed that trucking between Mombasa and Kampala currently takes about 5-6 days. This was corroborated by the KPIs availed by Bollore (in October 2016, it took 5.8 days to transport a container from Mombasa to Kampala). A recent GPS survey by the NCTTCA revealed that transit times from Mombasa to Kampala stood at 137.5 hours on average between October 2015 and March 2016. It should be noted, however, that this an average figure, which is likely to disguise some variation depending on whether customs clearance (different from transit clearance) takes place at the border or not (i.e. goods cleared under the Single Customs Territory are cleared at the port of entry, other goods are cleared either at Kampalas Inland Container Depot or at the border of Malaba or Busia).

Table A1: Current market conditions for trucking services

Indicator	Assumed baseline figure	Supporting evidence
Average border crossing time on outbound trip	22.0 hours	A baseline time and traffic survey was conducted at Malaba border post in 2016, reporting an average border crossing time of 21.95 hours.
Average time spent at weighbridges	5.0 hours	Stakeholder interviews revealed that truck drivers can expect up to 10 weighbridges between Mombasa and Kampala (five and two fixed weighbridges in Kenya and Uganda, respectively; and three mobile weighbridges placed randomly on the route). We assume 30 minutes per weighbridge. This allows for the smaller crossing times for weigh in motion weighbridges (e.g. Mariakani and Webuye) that have recently been confirmed in GPS surveys conducted by the NCTTCA and somewhat higher for static weighbridges.
Average time spent resting	40.2 hours	Interviewed truck drivers estimated that on average, they spend 30% of the total transit time either resting, eating or doing other personal activities.
Average time spent driving	48.6 hours	Interviewed truck drivers estimated that on average they spend 36% of the total transit time driving.
Average time spent on unaccounted activities	18.3 hours	Time spend on miscellaneous activities was calculated as a residual subtracting border crossing times, weighbridge crossing times, driving times and resting times from the total transit times.

Table A1: Current market conditions for trucking services

Indicator	Assumed baseline figure	Supporting evidence
Overall transit time return to Mombasa from Kampala	72.0 hours	An empty truck is assumed to return to Mombasa at an average speed of 40 km per hour driving for 12 hours a day. Allowing for some minor delays at the border, this implies an approximate transit time of 72 hours for the return trip. Truck idle time after each return trip 24.0 hours A truck is assumed to stand still for 24 hours between every trip, allowing for repairs and maintenance and turnover of jobs.

Annex II

Table A2: Regression results

VARIABLES	(1) Full sample	(2) Full sample	(3) Restricted sample	(4) Restricted sample
Age	-7,197***	-0.131***	-5,438**	-0.112**
	(1,215)	(0.0184)	(2,140)	(0.0380)
Constant	103,150***	11.67***	86,643***	11.46***
	(8,271)	(0.125)	(16,049)	(0.285)
Observations	33	33	14	14
R-squared	0.531	0.619	0.350	0.418

Notes: Dependent variable in columns (1) and (3) is asking price of second hand trucks. Dependent variable in columns (2) and (4) is asking price of second hand trucks expressed in logs. The independent variable Age is defined as the number of years since the trucks registration on Kenyan roads. Full sample results in columns (1) and (2) include information from all adverts, where the prices of trucks advertised without trailer are adjusted upwards. The adjustment is calculated by comparing the price of trucks of the same age which are advertised with and without trailer. The restricted sample results are based only on trucks advertised with trailer. Standard errors are reported in parentheses, where ***, **, * imply significance at the 1%, 5% and 10% respectively.