What Factors Drive Transport and Logistics Costs in Africa ?

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Abstract

We analyze the domestic transport and logistics costs of importing a 20-foot container into Africa. We run regressions on a panel of 50 African countries for the period 2006-2014 using the RE-2SLS estimator. Distance from port of arrival to the point of delivery is an important explanatory factor of cost. Time-varying variables yield additional and valuable information. Reducing processing times and adjusting the ratio of the PPP conversion factor to the market exchange rate would contribute to save on the cost to import.

Keywords: Cost of transport and logistics, Africa, processing time, PPP conversion factor, transaction costs.

JEL: L92, 055, H54, N7, N77, R4

Highlights

- Distance matters in domestic transport and logistics costs in Africa
- Cost to import is sensitive to processing times and prices
- Institutions and organizations are drivers of cost reduction
- Significant cost savings can be achieved through time-varying variables

What Factors Drive Transport and Logistics Costs in Africa?

1. Introduction

Transport and logistics are a crucial component of competitiveness. In Africa, where these costs account for 15-20% of the CIF value of imports, they are three to four times higher than elsewhere in the world (Raballand and Teravaninthorn 2009), and are a major obstacle to diversifying the productive base (Alfonso and Vergara, 2019; Eifert *et al*, 2008; Hoekman and Nicita, 2011). Given the fragmentation of production processes (Feenstra, 1998; Radelet & Sachs 1998), trade costs strongly influence the profitability of producing tradable goods, thus hampering the emergence of African manufacturing. This is especially true for goods, which are part of global supply chains where each phase of production faces narrow profit margins (Christ and Ferrantino, 2011). Limao and Venables (2001) have established that ground transport costs are 7 times higher per unit of distance than sea transport costs. Sea transport accounts for over 80% of Africa's external trade. Apart from remoteness from developed economies, many other factors, at seaports as well as along the continent's roads, impede Africa's competitiveness (see Radelet and Sachs, 1998; Clark, Dollar and Micco 2004; Iwanow and Kirkpatrick, 2009). This paper focuses on the domestic costs of delivering an imported container from its arrival at an African seaport to its final destination.

Our analysis differs on several points from Limao and Venables (2001), who consider total transport and logistics costs, including both maritime and land components. First, we do not take into account the cost of sea transport, which is volatile and depends on factors such as the nature of the good, the port of departure, and the shipping route. Second, we adopt a continent-wide perspective by considering a nearly exhaustive set of African countries for the

period 2006-2014 (Appendix 1). Data about costs of importing are from the *Trading Across Borders* section of the World Bank's Doing Business report (*DB*). This includes all costs incurred from the landfall seaport to a warehouse in the importing country's capital or principal city (Appendix 2). For each country, DB identifies a pair of origin and destination cities. In the case of landlocked economies, the fastest and most used transit corridor is considered. On average, if more than 80% of Africa's exports are in bulk or liquid form, more than 50% of the continent's imports are containerized.

To the best of our knowledge, transport and logistic costs have not been investigated so systematically for Africa as a whole. Besides the role of physical geography, our regressions consider two time-varying-country-specific factors sensitive to public and private behaviors. On the one hand, we account for the *processing time* of the container, which is influenced by market or organizational failures as well as the poor quality of the hard infrastructure. On the second hand, we introduce the price level ratio of PPP conversion factor (GDP) to the market exchange rate as a proxy of price differences of non-tradable goods between African countries. Regression results show that *Distance*- i.e., kilometers between port of entry and point of delivery, is statistically significant and proves to be the major source of international cost differences. Beyond the impact of this geographical factor, abnormal processing times matters for most sub-regions, especially for Central Africa. The role of relative prices is also statistically significant, especially for Central Africa. This result suggests strengthening competition to make cheaper the non-tradable services underlying transport and logistics activities.

The rest of the paper is organized as follows: Section 2 reviews the main factors driving transport and logistics costs in Africa. Section 3 specifies the model and uses econometric regressions to estimate the respective impact of explanatory factors. Section 4 checks the

robustness of main empirical results. Section 5 concludes and outlines policy implications of the analysis.

2. Determinants of transport and logistics cost

The explanatory variable refers to a 20-foot container containing imported dry cargo weighing 10 tons, with a CIF value of US $20,000. The cost of delivering does not take account of tariffs nor sea transport, but includes fees for documents, customs inspection and clearance, customs brokerage, port charges, and inland transport. Two categories of factors cause prices of inland transport and logistics to vary across countries. The literature emphasizes time-invariant factors, largely based on geography. One novelty of this empirical work is to pay attention to time-varying-country-specific determinants.

Factors with low or no variance over time

Among geographical factors, *distance*-i.e. kilometers from the gateway port to the delivery point is the most obvious source of heterogeneity across countries. The *landlocked* situation is also a factor considered in the literature (Arvis, 2010). The most direct route may require more than 1,000 kilometers. The longest continental corridors are between Harare (Zimbabwe) and Durban (South Africa): 1,678 km, Ndjamena (Chad) and Douala (Cameroon): 1,600 km, Kigali (Rwanda) and Dar es Salaam (Tanzania): 1,418 km, Juba (South Sudan) and Mombasa (Kenya): 1,338 km (see Appendix 2). The case of *island* countries is ambiguous. Small islands generally use a foreign hub for trans-shipment, with feeder vessels conveying the cargo to a national port and conducting customs brokerage and freight forwarding, which increases import cost. Country size and trading volume probably affect the impact of being an island. Limao and Venables (2001) find this feature to be a cost-

reducing factor. Climate may also affect the cost to import with a big difference between the arid areas of North Africa and the dense, humid forests of Central Africa. The vector of regional dummies captures this impact.

The quality of the hard infrastructure is also important, and depends on the influence of climate, and public policy through the regular maintenance of the stock and the effectiveness of regulations (e.g. axle load rules) (François and Manchin, 2013). Portugal-Perez and Wilson (2012) raise the point that hard and soft infrastructure complement each other and sometimes self-reinforce in a dynamic process. Creating infrastructure without addressing policy and institutional shortcomings underlying its use, contributes to high transport costs. Maintenance expenditure is generally under-budgeted, and this budget item is often the first to be cut in times of severe financial constraints (see Adam and Bevan, 2014). *Infrastructure quality* of roads and ports is measured from the components of the World Bank's Logistics Performance Index (LPI, 2014). The same statistical source is also used to capture the structural efficiency of *customs clearance* procedures. The low variance over time of this factor goes hand-in-hand with the inertia in customs officers' behavior, which is unlikely to change as quickly as reforms expect. Finally, we test country risk via the Fund for Peace's *Fragile States Index* (*FSI*)[i]. Based on 12 political, social and economic indicators, the FSI combines quantitative information and expert judgment. The higher the index, the greater a country's vulnerability.

Time-varying determinants

We explore the influence of the *relative prices* and the *Processing time*. The Purchasing Power Parity conversion factor (*PPP CF*) tells us the number of units of a country's currency required to buy the same amount of goods and services in the domestic market as a U.S. dollar would buy in the United States. By dividing *PPP CF* to the market exchange rate of the dollar (*NER*),

under the hypothesis that productivity level in the services sector is homogeneous across the continent, we get a proxy of the relative price of non-tradable goods between African countries. For a country *j* and a year *t*, this indicator (hereinafter referred to as the "relative price"), comes as follows:

$$Relative\ Price_{jt} = (PPP\ CF/NER)_{jt} \quad (1)$$

The higher this ratio, the more expensive the cost to import a container. Domestic competition level is one reason of cost differences. In some countries, bilateral agreements set quotas for transit freight. While this procedure supports the domestic transporters of landlocked countries, it does it against the interest of the final importer who pays more than he should. According to Raballand and Teravaninthorn (2009), truckers have big profit margins in Central and West Africa, from 60% to 160%. One of the most expensive corridors is between Ngaoundéré (Cameroon) and Moundou (Chad). Other researchers emphasize the rents received throughout the logistics' chain that benefit shippers and haulers, chambers of commerce, managers of warehouses or dry ports, and customs officials who solicit bribes. Negotiations between stakeholders raise transaction costs. In 2008, along the Tema (Ghana) – Ouagadougou (Burkina Faso) corridor, the average bribe to customs officers on a 20-foot imported container amounted to 8.2% of CIF value. Robbery and theft added less than 1% to cost.

With respect to the time to import, the *DB* data encompass time spent on customs clearance, inspection, handling, storage at terminals, and transport of a container from landfall port to point of delivery. By processing time, we mean the number of days above the “normal” time (i.e. average continental days) required to convey a container from the port to the point of delivery by road. A wide array of factors underlie delivery delays including the quality of roads, weather conditions, congestion, roadblocks, political vulnerability, and border crossing

procedures (Hummels and Schaur, 2013). To break down the time to import of the *DB* into 2 components, the following econometric method is used. By the regression (2), we assess the impact of the distance (θ), which is then subtracted to the *Time to import* of the *DB* to identify the *Processing time* (3).

$$Time\ to\ import_{jt} = \theta\ Distance_j + \delta + \varepsilon_{jt} \quad (2)$$

$$Processing\ time_{jt} = Time\ to\ import_{jt} - \theta\ Distance_j \quad (3)$$

Here Table 1

For two sub-periods, Table 1 provides statistical information about time-varying variables including the cost to import. We divide the 50 African countries into 5 regions with differing numbers of countries. The cost to import depends on the distance and the time the container has to travel. North Africa is at an advantage in this respect as capital cities are close to the port of arrival and the delivery point. This is not the case for West Africa and Southern Africa where a significant percentage of countries are landlocked, 19% for West Africa and 50% for Southern Africa, with a capital far from the port of arrival (see Appendix 2). Geography influences the time to import but distance is not the only fact to consider. A continental ranking clearly emerges with *Processing time*, which account for about 50% of the time to import. This percentage is consistent with the average of 20 days that Raballand et al (2012) report for the whole continent. For the 2010-2014 period, it takes 34 days to process a container in Central Africa with little change from the previous sub-period, compared to just over 14 days in North Africa. Relative prices may also partly explain differences in cost to import. In Central Africa, the cost of living is only 50% lower than in the United States at the official exchange rate, while it is 70% lower in the middle-income countries of North Africa.

3. Specification of the model and regression results

By estimating the cost to import (*Cjt)* on a panel of 50 African countries observed on the 2006-2014 period, we have to take into account heterogeneities across countries and years. The pooled OLS regression neglects the panel character of the dataset. The fixed effects estimator (FE) is an option. Using only the *within* variation, leads to less-efficient estimation, and an inability to estimate coefficients of time-invariant regressors. The *random effects model* (RE) is efficient, reducing the variance of estimates of coefficients as long as individual effects are not correlated with the regressors. *Processing times* are likely to be problematic. Bribes affect *Processing times* in different ways according to importers who strive to limit time spent with customs officials and other uniformed personnel (Hallward-Driemeier and Pritchett, 2015; Freund, Hallward-Driemeier, and Rijkers, 2014). If *Processing time* depend on importers' willingness to pay, the aforementioned estimators (OLS, FE, RE) are biased, none of them providing information about causal relationships. The Hausman-Wu (1978) test did not reject the presence of endogeneity.[ii] Table 2 presents the main empirical results by considering the broadest specification of the model.The linear form simplifies economic interpretation of regression coefficients, and log-log or semi-log specifications did not provide better fits. Equation (4) is the random effect estimator that proved to be the most appropriate. Subscripts *j* and *t* are country and year, respectively.

$$C_{jt} = \alpha + \mu\, Distance_j + \beta\, Relative\ price_{jt} + \omega\, Processing\ time_{jt} + \delta' Z_{jt} + \tau' D + \eta_t + \lambda_{jt} \quad (4)$$

$j = 1\ldots50$, and $t = 2006\ldots2014$, with $\lambda_{jt} = \gamma_j + \varepsilon_{jt}$

Beside *Relative price* and *Processing time*, because of the dominant impact on the dependent variable, we separate *Distance* (i.e. kilometers) from the Z-vector of other determinants with a limited time variance: *infrastructure, customs,* and *Fragile States Index. D* is the matrix of dummy variables for *regions, landlocked, island*; α is the intercept; η_t are

year fixed effects; λ_{jt} is the error term with γ_j specific effects by country, uncorrelated with the independent variables; and ε_{jt} is the idiosyncratic error. In other words:

$$E(\gamma_j) = E(\varepsilon_{jt}) = 0;\ E(X'\gamma_j) = E(X'\varepsilon_{jt}) = 0;\ \text{and}\ E(\lambda_{jt}, Processing\ time_{jt}) \neq 0.$$

To get an unbiased coefficient for *Processing time*, we use 3 instruments which meet the exclusion restriction. *Population size* is correlated with infrastructure quality and port economies of scale. Jedwab and Storeygard (2017) find that large African countries build relatively more infrastructure in order to improve internal communication. Correlation with *cost to import* is only indirect, through the productivity effect. We add 2 instruments, not correlated with each other, that reflect the role of institutions. The longer it takes to *resolve insolvency* of firms, the longer the time required to manage containers. We also introduce the processing time of bordering countries. By using this variable, adjusted for the distance impact, we hypothesize that sub-regional behavior is similar to the characteristics of logistics in the country under study. For landlocked economies, to prevent direct correlation with C_{jt} we remove the transit country from the list of neighbors.[iii]

Here Table 2

In Table 2, the Hausman test between the FE and RE estimators does not reject the hypothesis that the variations across countries are random, uncorrelated with the regressors. In this case, the RE-2SLS is the most efficient (*Reg* 6), the instrumented regression about the *Processing time* being given in Table 3. Table 2 shows that 5 variables are statistically relevant including the 2 time-varying variables: *Relative price* and *Processing time*. If the dominant impact of *distance* is shown, the island characteristic also matters. The regional dummy for Central Africa varies from the average regression result with an extra cost estimated at about 1,000 US dollars. More comments about the coefficients of the main variables are provided with the

parsimonious specification (Table 3). For now, let us observe that some variables, such as the landlocked characteristic, are not significant.

Prima facie, when we account for distance variation across countries, the "border effect", which is collinear with the landlocked feature, no country has more than one border to cross, is not as costly as generally assumed (Limao and Venables 2001, Christ and Ferrantino, 2011). However, this result has to be qualified. The correlation with *Processing time* may explain the non-significance of the landlocked coefficient. A long trip and a border crossing generate uncertainty and dispersion around the conventional costs and time that the DB hypothesizes. The Abidjan-Ouagadougou corridor illustrates the dispersion of costs interacting with import time. In 2016, the *Conseil Burkinabé des Chargeurs* evaluated the average time at 17 days, within a range of 5 to 32 days. This includes 1 to 18 days for document preparation, customs clearance, inspection, and port and terminal handling; 2 to 8 days for land transport; and 2 to 6 days for container processing. To some extent, the DB ignores this dispersion effect, which may particularly impact landlocked economies. No specific contribution arises in the explanation of the dependent variable with the 3 following variables: *Infrastructure*, *customs* services, and the *Fragile State Index (FSI)*. We may assume that *Processing time* captures the impact of these phenomena.

Table 3 focuses on the parsimonious empirical model that only accounts for statistically significant variables (*Reg 7*). Based on the F-test, we keep regional and year dummies to identify non-observable heterogeneities. The first stage regression of the RE-2SLS estimator is proposed on the right-hand side. The set of instruments proves significant. The F-value of this first stage regression is 78.2, far above the threshold of 10 for weak instruments (Stock and Yogo, 2005). In addition, the Sargan test of overidentifying restrictions does not reject the null hypothesis, which means that our instruments are adequate. In the cost to import regression, *distance* remains a major component. The coefficient yields

a marginal cost 16.8 US cents per ton-kilometer, higher than reported in previous African case studies. However, the *DB* assumes a container with a 10-ton load. Most container are more heavily loaded. For example, on the Dakar (Senegal)-Bamako (Mali) corridor, rice containers vary between 20 and 25 tons (ADB, 2015), which makes for a big difference between the *DB* convention and actual values (Hallward-Driemeier and Prichett, 2015). Per ton-kilometer, the market price for standard products varies from 4 US cents in Kenya and Zambia (close to the price in European and Asian countries), to 11-15 US cents in some landlocked countries, such as Burundi, Chad, Central African Republic and Niger (Raballand and Teravaninthorn, 2009; Gwilliam, 2011; Osborne, Pachon and Araya, 2014). If we raise the 10-ton load to 20 tons, the coefficient is about 8.4 US cents per ton-kilometer, close to what Raballand and Teravaninthorn (2009) observe. Being an *island* is a cost saving characteristic of US $580. Nonetheless, it is important to be careful in interpreting this coefficient. The sub-sample of islands is a small one, and 71% of observations are for middle-income countries, a distribution that differs from the per capita income criterion for the whole continent (51%).

Table 3 here

Given the *Processing time* coefficient, the marginal cost of an extra day is US $33.9. It means that over the period 2010-2014, the average cost of *Processing time* ranges from US $498 per TEU in North Africa (33.91x14.7) to US $1,272 in Central Africa (33.91x37.5). To evaluate the potential cost savings attached to this variable, all things being equal, the actual number of days can be compared to a benchmark. The distribution's fourth quintile (i.e., 7.18 days for 2010-14) seems attainable, achieved by 17 countries at least once during the 2006-2014 period. Applying this rule, Central Africa has the most to gain, especially DR Congo (US $1,392). West Africa and Southern Africa follow with potential cost savings of US $491 and US $337, respectively. What about the impact of the *relative price? The PPP CF/NER*

ranges between 0 and 1. The upper limit means that, at the official exchange rate, the local currency's purchasing power equals that of the US dollar in the United States. In other words, assuming similar productivity levels between two African countries, *Reg 7*, Table 3 shows that a difference of 20% of this indicator means an additional import cost of US $311 (0.2 x 1,557). Some countries such as Angola can reduce the relative prices of transport and logistics, either by increasing the productivity level through a stronger competition in the production of non-tradable services or by adjusting the exchange rate of their national currency.

Robustness checks and policy implications

So far, some institutional factors, whose impact is qualitative and difficult to measure, have been left aside. This is the case of the property rights structure, especially the influence of the private management of public services, and the market competitive pressure. Although the Hausman test did not reveal a specific problem in that respect, omitted variables could affect the coefficient of time-varying variables. Regression results may also be sensitive to regions, or per capita income levels heterogeneities (Appendix 1).

Assessing the impact of institutional reforms

Four private international operators manage port terminals over the continent. Bolloré, the leader in transport and logistics, combines a wide range of services and promotes a *door-to-door* strategy, from maritime shipment to warehouse delivery. Competing firms are also moving to multimodal services (APM, MSC, CMA-CGM). In 2014, while private firms had already long-standing involvement in the management of port terminal activities (Tanzania, Cameroon, Côte d'Ivoire and Egypt), very few African countries did not trust in the private operators yet (South Africa, Namibia, Sudan, Mauritius, etc.).

We define several variables reflecting institutional changes: (i) First, we differentiate countries according to whether they have a private port operator. For a long time, pilotage,

towing, mooring, dredging, and cargo handling were a public monopoly. In this context, a wide array of stakeholders colludes to extract rents pushing the cost of services up. A private operator is expected to cut these economic inefficiencies. (ii) Second, we ask whether the number of years of private management makes prices lower keeping in mind that the port is only one segment of the domestic cost to import. Door-to-door services are quite limited. Private international operators are far from providing integrated services on the whole transport and logistic chain. (iii) Third, we conduct a before/after analysis by restricting the sample to countries that awarded, during the period, a concession contract for the port to a private group. (iv) Finally, we test direct and indirect competition by introducing the number of port terminal operators and the presence of a railway. Along a corridor, competition and/or complementarity between rail and road may optimize freight movement and reduce costs. Rail is a safer mode of transport because it is not subject to unexpected charges such as roadblocks. Rail transport is less expensive than road at market prices and even more when economic prices are considered, i.e. taking into account externalities. Multimodal transport can be an option but is penalized by additional fixed costs resulting from loading and reloading activities.[iv]

Of these additional variables, only the number of years of private management is significant with a counter-intuitive sign (*Reg 9*). Several reasons may underlie this result. First, private port services are only one component of the cost to import. No clear conclusion arises without breaking down the cost into port and road services. Secondly, regulatory agencies may have failed to promote fair sharing of economic surplus between consumers and producers. In this case, the private firm maintains high prices and captures the efficiency gains to accelerate its investment payback. Finally, there is a possibility for a more optimistic interpretation that we cannot check - higher prices of transport and logistics are positively

correlated with a higher quality of services. In any case, time varying variables keep their strong explanatory power and coefficients remain reasonably stable.

Table 4 here

Sensitivity of regression results to sample size

To examine the heterogeneity of slope coefficients, we rerun regression 7 (Table 3), by modifying the sample size. First, we separate middle- from low-income countries (Appendix 1). We conduct a second sensitivity test by eliminating income distribution tails. This means dropping North African countries from the sample. Due to being close to Europe, these countries are more integrated into global value chains, and their costs are more subject to competitive pressure. Then we also drop Central African countries, which suffer from the strong influence of geographical variables.

Table 5 here

Table 5 shows that regression coefficients remain quite stable across per capita income categories. This is especially true for variable under the influence of public policy or organizational behavior (*Relative price* and *Processing time*) that can change import costs quickly. A similar outcome occurs when we remove the tails of the statistical distribution.

4. Concluding remarks

High domestic transport and logistics costs impede African countries' ability to diversify and participate in global value chains. However, the situation is far from homogeneous across Africa. These services in Central Africa are expensive compared to those in middle-income North African countries. Geographical remoteness, market failure, and weak institutions, bear the responsibility for these excessive costs. The paper has focused attention on two time-

varying factors, two non-exclusive options to improve competitiveness of transport and logistics services: the reduction of the processing time of the container and the relative price of non-tradable goods as measures by the price level ratio of PPP conversion factor to market exchange rate.

Our analysis has yielded a set of main empirical conclusions. First, after accounting for *distance*, landlocked status is not statistically significant. No country crossing more than one border, being landlocked correlates perfectly with the border effect. Second, hidden transaction costs reflected in the processing time offer a great opportunity for reducing costs in the line of what is expected by the Trade Facilitation Agreement (WTO, 2017). All things being equal, an additional day in delivery costs about US $34 per container. Within the continent, Central Africa has the most to gain, especially DR Congo (US $1,392). Third, relative prices also matter. One way to have an impact on them is to strengthen competition among producers of non-tradable services contributing to transport and logistics. For landlocked economies, strengthening the competitive market structure proved beneficial in East Africa (Kunaka, Raballand, Fitzmaurice, 2016). In Congo (RDC), the use of the Luanda (Angola)-Kinshasa (RDC) corridor as an alternative to the traditional one from the national port of Matadi also contributed to reduce prices and profit margins. The adjustment of the nominal exchange rate of the domestic currency can be an alternative option to reach this objective. However, the efficiency of the exchange rate instrument is conditional on the ability to get a long-term impact on the real economy. This hypothesis is unlikely for some countries where it proves difficult to get an income redistribution. Fourth, cost to import was not found to be sensitive to the number and the presence of private operators in port terminals. This conclusion must be interpreted cautiously as we have no information about the quality of services. This one may have increased with the participation of the private sector.

Table 1. Domestic transport and logistics costs in Africa: time-varying variables

	Mean		Median		Standard deviation	
	2006-2010	2010-2014	2006-2010	2010-2014	2006-2014	2006-2014
North Africa (4)						
Cost to import	1,087	985.6	1,000	915	352.5	212.9
Time to import	23.2	18.6	22.5	17	4.70	4.419
Processing time	19.3	14.7	21.7	14.4	6.5	7.6
Relative price	0.32	0.32	0.34	0.32	0.19	0.05
West Africa (16)						
Cost to import	1,723.1	1,910.7	1,363.0	1,521.5	882.2	1,001.6
Time to import	37.8	32.8	35.0	32.0	13.9	12.1
Processing time	32.5	27.5	31.7	28.8	9.1	9.2
Relative price	0.38	0.41	0.38	0.41	0.07	0.06
East Africa (14)						
Cost to import	2,080.0	2,236.3	1,815	1,925	1,194.4	1,272.6
Time to import	39.9	30.5	36.0	28.0	20.5	12.5
Processing time	25.8	16.4	24.4	17.7	13.2	9.6
Relative price	0.38	0.39	0.38	0.38	0.09	.077
Central Africa (8)						
Cost to import	2,809.2	3,852.9	2,201.0	2,625.0	1,704.0	2,695.5
Time to import	52.5	50.5	53.5	49.5	24.9	24.9
Processing time	39.4	37.5	37.2	34.1	13.3	13.8
Relative price	0.46	0.479	0.45	0.47	0.07	0.06
Southern Africa (8)						
Cost to import	2,243.37	3,084.25	1,950	2,482	845.74	1,544.901
Time to import	45.47	40.9	46	36.0	15.9	16.8
Processing time	26.7	22.1	21.5	20.0	14.4	12.5
Relative price	0.44	0.47	0.44	0.46	0.08	0.09

N.B. For the sources and main variables, see Appendix 2. *Processing time* is calculated as mentioned in section 2, relations (2) and (3). On the left hand side column, in bold characters the number of countries is indicated for each region. The *Cost to import,* -i.e. the dependent variable, refers to a container and is expressed in US dollars. *Time to import and Processing time* are expressed in a number of days. The relative price is defined by the ratio of PPP conversion factor to the market exchange rate. This indicator of relative price of non-tradable goods ranges between (0-1).

Table 2. Regression results of transport and logistics costs in Africa (2006-2014)

	Reg 1 OLS	*Reg 2* FE	*Reg 3* RE	*Reg 4* 2SLS	*Reg 5* FE 2SLS	*Reg 6* RE 2SLS
Distance	3.040***		3.200***	2.557***		2.693***
	(0.332)		(0.876)	(0.404)		(0.868)
Relative price	1,532***	1,184*	1,458**	1,189**	1,160*	1,366**
	(534.1)	(627.8)	(606.9)	(573.5)	(682.5)	(644.9)
Processing time	26.77***	-0.519	7.264*	44.85***	30.38	32.84**
	(3.381)	(3.979)	(3.792)	(8.711)	(25.17)	(15.83)
Island	-533.4***		-1,085***	-575.0***		-956.0***
	(155.4)		(382.9)	(162.0)		(354.3)
Landlocked	-1,194***		-893.0	-1,162***		-989.1
	(285.0)		(772.4)	(295.5)		(705.7)
Infrastructure	-487.2***	-148.7	-182.5	-533.7***	-127.2	-188.7
	(181.8)	(153.1)	(154.4)	(189.4)	(167.2)	(165.1)
Customs	40.64	-12.52	-62.72	121.2	-22.00	-51.76
	(201.8)	(154.6)	(158.0)	(212.0)	(168.2)	(170.0)
Fragile States Index	9.769***	-22.28**	3.409	-0.791	-21.04*	-2.787
	(3.779)	(9.893)	(6.831)	(6.085)	(10.80)	(8.884)
Southern Africa	386.4**		686.3	161.1		324.0
	(190.4)		(465.4)	(220.8)		(480.4)
Central Africa	694.5***		1,602***	461.8**		1,016*
	(201.5)		(467.5)	(232.6)		(526.9)
East Africa	-20.60		388.9	-43.88		219.0
	(159.9)		(416.2)	(165.9)		(387.9)
West Africa	-198.2		162.8	-279.6*		-64.05
	(146.3)		(384.9)	(155.7)		(369.6)
Constant	-97.54	3,759***	463.2	206.1	2,210	212.2
	(501.9)	(961.5)	(738.4)	(536.9)	(1,624)	(730.5)
Observations	393	393	393	393	393	393
R^2	0.776		0.730	0.763		0.764
Sargan p-value				0.000	0.53	0 .38
Hausman p-value			1.00			1.00
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes

N.B. The Hausman P-value compares FE- 2SLS and RE- 2SLS specifications. North Africa is the reference. Standard errors in parentheses: *** p <0.01; ** p <0.05; * p <0.1. For the instrumentation of the *Processing time*, the right hand side regression in Table 3 has been considered. Sources. See Appendix 2

Table 3. Transport and logistics costs determinants and instrumentation of the *Processing time*

	Reg 7 RE- 2SLS	*Processing time* First stage regression
Distance	1.683***	0.0251***
	(0.352)	(0.002)
Relative price	1,557**	-0.275
	(608.3)	(7.125)
Processing time	33.91***	
	(11.21)	
Island	-579.6**	0.152
	(272.7)	(3.652)
Resolving Insolvency		-0.245***
		(0.057)
Processing time of neighbours		0.128*
		(0.070)
log (population)		3.999***
		(0.719)
Southern Africa	62.63	18.84***
	(378.0)	(4.220)
Central Africa	758.0	26.51***
	(465.2)	(4.382)
East Africa	138.0	10.23*
	(344.5)	(3.824)
West Africa	-66.41	12.18***
	(330.8)	(3.749)
Constant	-651.0	-35.54***
	(450.1)	(13.76)
Observations	450	450
Wald P-value	0.00	0.00
F-test		78.2***
R-squared	0.78	0.64
Year Dummies	Yes	Yes
Hausman P-value	1.000	
Sargan P-value	0.613	

N.B. The right hand side column is for the instrumented variable of the *Processing time* that we use to explain the cost to import on the left hand side. The Hausman P-value compares FE- 2SLS and RE- 2SLS specifications. North Africa is the reference. Standard errors in parentheses: *** p <0.01; ** p <0.05; * p <0.1.

Table 4. Transport and logistics costs:
Private management and competition in port terminals

	Reg 8 RE-2SLS	*Reg 9* RE-2SLS	*Reg 10* RE-2SLS
Distance	1.697***	1.654***	1.189***
	(0.359)	(0.327)	(0.422)
Relative price	1,489**	1,372**	1,896**
	(613.2)	(587.4)	(784.5)
Processing time	32.02***	27.00***	32.07**
	(11.76)	(9.821)	(12.63)
Island	-524.2*	-346.9	-686.6*
	(291.4)	(277.6)	(371.7)
Private management (years)		76.60***	
		(19.26)	
Number of port operators	67.50	-32.44	88.98
	(154.9)	(144.4)	(231.2)
Private operator	72.44		
	(112.9)		
Private port *(before/after)*			109.8
			(129.9)
Railway	30.31	220.0	40.26
	(200.7)	(188.3)	(255.7)
Southern Africa	152.9	295.7	288.5
	(421.1)	(375.1)	(461.8)
Central Africa	806.9*	892.7**	710.2
	(486.2)	(430.5)	(570.5)
East Africa	162.5	34.66	293.5
	(370.1)	(343.9)	(465.4)
West Africa	-67.06	55.29	17.69
	(343.4)	(307.3)	(382.0)
Constant	-708.2	-455.9	-815.6
	(495.9)	(434.4)	(561.8)
Observations	450	450	315
R^2	0.78	0.78	0.66
Sargan P-Value	0.72	0.96	0.96
Hausman P-Value	1.00	1.00	1.00
Year dummies	Yes	Yes	Yes
Number of countries	50	50	35

Sources. See Appendix 2. North Africa is the reference. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 5. Sensitivity of regression results to regions and per capita income levels

	Reg 11 RE-2SLS	*Reg 12* RE-2SLS *Less NAF*	*Reg 13* RE-2SLS *Less NAF/CAF*	*Reg 14* RE-2SLS *LIC*	*Reg 15* RE-2SLS *MIC*
Distance	1.683***	1.731***	1.623***	1.784***	2.036***
	(0.352)	(0.358)	(0.314)	(0.563)	(0.510)
Relative price	1,557**	1,496**	1,976***	2,171**	1,815**
	(608.3)	(638.8)	(552.0)	(935.4)	(914.3)
Processing time	33.91***	31.87***	36.59***	38.92**	26.96**
	(11.21)	(11.23)	(10.77)	(15.79)	(10.63)
Island	-579.6**	-601.3**	-163.3	11.52	-901.6***
	(272.7)	(282.2)	(287.8)	(518.7)	(273.8)
Southern Africa	62.63	136.9	122.8	255.4	-34.40
	(378.0)	(249.2)	(217.2)	(730.3)	(379.4)
Central Africa	758.0	861.0***			863.9**
	(465.2)	(308.0)			(393.5)
East Africa	138.0	201.0	124.6	-84.57	353.7
	(344.5)	(218.5)	(191.9)	(319.1)	(353.4)
West Africa	-66.41				116.7
	(330.8)				(327.9)
Constant	-651.0	-658.0	-1,004*	-1,128*	-467.7
	(450.1)	(524.2)	(517.3)	(673.5)	(468.4)
Observations	450.00	414.00	342.00	216.00	234.00
R^2	0.78	0.78	0.76	0.85	0.60
Sargan p-value	0.64	0.57	0.85	0.51	0.65
Hausman p-value	1.00	1.00	1.00	1.00	1.00
Year dummies	Yes	Yes	Yes	Yes	Yes

Sources. See Appendix 2. Reg 11 is the same as Reg 6, Table 3. In Reg 12, we drop the North African countries (NAF) and in Reg 13, we also remove Central African countries (NAF, CAF). In Reg 14 and Reg 15, we focus on low (LIC) and middle-income (MIC) countries. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Appendices

Appendix 1. Africa by region and income level countries

Southern Africa	Central Africa	East Africa	West Africa	North Africa
South African Rep	Central African Rep	Burundi	Benin	***Algeria***
Angola	***Cameroon***	Comoros	Burkina-Faso	***Egypt***
Botswana	***Congo***	***Djibouti***	***Cape Verde***	***Morocco***
Lesotho	***Gabon***	Ethiopia	***Côte d'Ivoire***	***Tunisia***
Namibia	***Equatorial Guinea***	***Kenya***	Gambia	
Swaziland	R.D of Congo	Madagascar	***Ghana***	
Zambia	***Sao Tomé & Principe***	Malawi	Guinea	
Zimbabwe	Chad	***Mauritius***	Guinea -Bissau	
		Mozambique	Liberia	
		Rwanda	Mali	
		Seychelles	***Mauritania***	
		Sudan	Niger	
		Tanzania	***Nigeria***	
		Uganda	Senegal	
			Sierra Leone	
			Togo	

Note. Income level categories. Bold and italics relate to upper and lower middle-income countries as defined by the World Bank in June 2018. The other countries are low-income economies.

Appendix 2. Domestic transport and logistics in Africa (2014)

Countries	Distance (Km)	Relative price	Processing time	Years with a private port operator	No of private port operators	Port of arrival
Angola	27	0.71	42.3	8	1	Luanda
Burundi	1419	0.37	8.8	15	1	Dar-es-Salaam
Benin	6	0.45	26.8	6	2	Cotonou
Burkina Faso	944	0.42	24.2	11	3	Abidjan
Botswana	917	0.45	10.9	0	1	Durban
Central African Republic	1404	0.59	18.1	11	2	Douala
Côte d'Ivoire	23	0.47	33.4	11	3	Abidjan
Cameroon	15	0.47	24.6	11	2	Douala
Congo, DRC	327	0.58	54.4	0	1	Matadi
Congo, Rep	560	0.50	39.3	7	2	Pointe Noire
Comoros	2	0.57	23.9	3	1	Moroni
Cabo Verde	6	0.57	17.8	0	1	Praia
Djibouti	11	0.55	17.7	9	2	Djibouti
Algeria	7	0.39	26.8	7	1	Alger
Egypt, Arab Rep,	224	0.32	9.1	11	2	Alexandria
Ethiopia	864	0.38	21.3	9	2	Djibouti
Gabon	18	0.55	21.5	8	1	Libreville
Ghana	36	0.35	41.0	11	2	Tema
Guinea	27	0.44	30.3	4	2	Conakry
Gambia, The	2	0.27	18.9	0	1	Banjul
Guinea-Bissau	8	0.44	21.8	0	1	Bissau
Equatorial Guinea	7	0.58	43.8	0	1	Malabo
Kenya	481	0.46	13.4	7	1	Mombasa
Liberia	10	0.54	28.7	4	1	Monrovia
Lesotho	549	0.41	18.6	0	1	Durban
Morocco	337	0.42	6.1	8	2	Tangiers
Madagascar	356	0.31	11.6	10	1	Toamasina
Mali	1093	0.42	6.3	8	2	Dakar
Mozambique	14	0.55	24.6	7	1	Maputo
Mauritania	16	0.35	37.6	7	1	Nouakchott
Mauritius	5	0.53	8.9	0	1	Port Louis
Malawi	948	0.31	14.1	7	1	Beira
Namibia	394	0.53	9.6	0	1	Walvis Bay
Niger	1021	0.45	35.2	6	2	Cotonou
Nigeria	11	0.52	32.7	9	3	Apapa Tin Can
Rwanda	1418	0.42	-7.2	15	1	Dar-es-Salaam
Sudan	831	0.49	24.2	0	1	Port Soudan
Senegal	17	0.45	14.5	8	2	Dakar
Sierra Leone	8	0.40	29.8	4	1	Freetown
South Sudan	1338	0.55	94.9	7	1	Mombasa
São Tomé and Príncipe	3	0.60	27.9	0	1	Sao
Swaziland	539	0.42	8.8	0	1	Durban
Seychelles	0	0.59	17.0	0	1	Port Victoria
Chad	1642	0.47	54.9	11	2	Douala
Togo	8	0.45	28.8	5	3	Lome
Tunisia	13	0.38	16.6	0	1	Rades
Tanzania	5	0.38	30.9	15	1	Dar-es-Salaam
Uganda	1145	0.41	2.9	7	1	Mombasa
South Africa	570	0.50	6.0	0	1	Durban
Zambia	1051	0.45	25,4	7	1	Durban

Zimbabwe	1678	0.52	27,0	7	1	Durban

Sources. Cost to import, distance, the port of arrival, and time to import from which the processing time is calculated are from the *Doing business*, World Bank, different years. For landlocked economies, the port referred to is that of the *Doing Business*. The relative price is calculated through the ratio of PPP conversion factor to the nominal exchange rate of the dollar. This information comes from the World Development Indicators of the World Bank. The Logistics Performance Index (LPI) and its components: Customs or Infrastructure have been downloaded from the World Bank website (https://lpi.worldbank.org). The Fragile States Index refers to the Fund for Peace (http://fundforpeace.org/fsi). Private port operators, number of port operators are gleaned from different sources including Proparco, the French Development Agency (AFD): *Secteur Privé et développment, le secteur portuaire en Afrique, plein cap sur le développement*, March-May 2017. The database is available on request from the author.

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[i] The *Fragile States Index* is based on a conflict assessment framework, designed to measure vulnerability in pre-conflict, active conflict and post-conflict situations. The methodology can be found at //fundforpeace.org/fsi/indicators/

[ii] The Hausman-Wu (1978) test about potential endogeneity of the *processing time* and the *relative price* were implemented. Endogeneity is not rejected only for the former variable. Empirical results of the test are not incorporated in the text, but are provided on request.

[iii] The country of transit contributes to the price of the imported container, meaning that time spent in the port or along the corridor can be a source of endogeneity.

[iv] Central Africa has very high transport and logistics costs. In Cameroon, the distance between the port of Douala and the capital city (Yaoundé), 230 km, is relatively short, and transport of containers by rail is marginal. It is more developed for longer trips to the hinterland (Chad and Central African Republic), but service quality is poor. In Gabon, Libreville is close to the port of Owendo. However, 95% of containers from Libreville to Franceville go by rail. In the Democratic Republic of Congo (DRC), Katanga province receives container traffic from South Africa, Namibia and Mozambique. Containers move up the Congo and Kasaï rivers to Ilebo, whence they proceed to Katanga by rail.