Why are African domestic transport and logistics so costly?

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Abstract

We analyze the domestic transport and logistic costs of importing a cargo container in Africa. We begin by exploring the impact of physical geography via regressions on a panel of 51 African countries over the period 2006-2014. Distance from port of arrival to the container's destination is an important explanatory factor of cost. Extension of the empirical model to economic policy variables yields additional information with robust results. Beyond distance, excess time spent in travel and compliance procedures (e.g., transaction and hidden costs) is the most important determinant of cost. The real exchange rate, a proxy for the difference of input prices across countries, also matters. Compared to "best African practice," average excess cost by region ranged from 17% of effective domestic cost (North Africa) to 37% (Central Africa).

Keywords: Cost of transport and logistics, Africa, infrastructure, physical geography, real exchange rate, transaction costs, rent seeking.

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

Highlights

- Distance matters in costs of domestic transport and logistics in Africa
- The cost of importing is sensitive to domestic prices of transport and logistics
- Institutions and organizations are powerful drivers in cost reduction
- Significant cost savings are possible without further investment in hard infrastructure

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1. Introduction

In December 2012, *Time* magazine chronicled economic growth in Africa with a cover page headline that pronounced, "Africa Rising." Notwithstanding evidence of the continent's emergence, there are also good reasons to temper any optimism. Africa as a whole represented 7.3% of worldwide exports in 1948, but only 3% in 2014. The composition of Africa's external trade remains what it was in the 1950s. Promises of industrialization have not been fulfilled, and above all, several writers point to premature deindustrialization as a major risk (McMillan, Rodrik and Verduzco-Gallo, 2014; Rodrik, 2014, 2015, McMillan and Harttgen, 2014).

One cause of the continent's relative marginalization is the high level of transaction costs and trade barriers, including inefficient transport and logistics (Eifert et al, 2008, Hoekman and Nicita, 2011). Given fragmentation of production processes (Feenstra, 1998; Radelet & Sachs 1998), trade costs strongly influence the profitability of tradable goods and hamper the emergence of manufacturing, especially in regard to goods forming part of global supply chains where each production phase faces acute competitive pressure for narrow profit margins (Christ and Ferrantino, 2011). This hindrance is accentuated by remoteness, which generally proves to be an accurate predictor of transport and logistic costs. The greater the distance to markets, the higher the costs and obstacles to participating in the global economy.

In an influential paper, using a sample of developed and developing countries, Limao and Venables (2001) demonstrate this negative effect. In their analysis, ground transport costs prove seven times higher per unit of distance than sea transport, which accounts for over 80% of Africa's external trade. Hard and soft infrastructure contribute jointly to this result; both are prominent factors in seaport costs, along with road transport and logistics. (See Radelet and Sachs, 1998; Clark, Dollar and Micco 2004; Iwanow and Kirkpatrick, 2009).

This paper focuses on domestic transport and logistic costs of importing a container, from arrival at a port in Africa to a final destination, which for landlocked countries requires passage through a transit

country. Our analysis differs on two points from that of Limao and Venables (2001) who consider total transport and logistic costs, breaking them down into maritime and land components. First, we do not consider sea transportation. Costs associated with these services are volatile, depend on the port of departure and shipping routes, as well as competition among service providers, and other factors including customer size. Second, we adopt a continent-wide perspective considering a nearly exhaustive African sample over the period 2006-2014. Although some parameters vary little over time, the panel dimension allows for assessing progress in economic and institutional domains. We draw data from the *Trading Across Borders* section of the World Bank's *Doing Business* report (hereafter referred to as *DB*). Domestic transport and logistic costs include all costs incurred from the seaport of landfall to a warehouse in the importing country's capital or main city. For each country, the *DB* identifies an appropriate pair of origin and destination cities, which in the case of landlocked economies comprises the fastest available corridor. On average, more than 80% of Africa's exports are in bulk or liquid form, while more than half of the continent's imports are containerized.

To the best of our knowledge, transport and logistic costs have not been investigated as systematically for Africa as a whole as is done in this paper (Map of Africa in appendix). We address the empirical question by using panel data analysis. First, we explore the role of physical geography. We focus on the impact of time-invariant exogenous factors, and then we extend the model's specification by accounting for stylized costs associated with input prices, quality of institutions, and infrastructure.

Our results display the heterogeneity of continental costs. North African countries outperform the other regions, especially Central Africa, where costs are highest. Distance, as measured by the number of kilometers between port of entry and delivery location, is statistically significant and proves to be a major source of cost differences across countries. Beyond the impact of this geographical factor, we find that transport and logistics are sensitive to input prices as proxied by the ratio of the Purchasing Power Parity conversion factor to the official exchange rate. They are also influenced by the efficiency

of institutions, measured by the time taken to comply with required procedures (i.e., excluding the direct impact of distance).

For the continent as a whole, about 80 % of potential cost savings arise from reduction of processing times. Best continental practice involves pursuing a market-based exchange rate, together with reducing the time spent on red tape and logistics. In Central Africa this could save US $860 on the domestic cost of importing a container. During 2010-2014, average excess cost by region ranged from 17% of the effective domestic cost (North Africa) to 37% (Central Africa).

The rest of the paper is organized as follows. Section 2 reviews the set of cost components that make transport and logistics so expensive in Africa. Section 3 uses regressions to estimate the role of each component. Section 4 conducts a robustness check of our empirical results. Section 5 concludes and outlines policy implications.

2. Factors underlying stylized costs

Salient features and dominant explanation

Transport and logistics account for 15-20% of the CIF value of Africa's imports, which is three to four times higher than elsewhere in the world (Raballand and Teravaninthorn 2009). Table 1's column 1 combines the effective cost of documents, fees for customs clearance and inspection, customs broker fees, port charges, and costs of inland transport and logistics, excluding customs tariffs. The cargo is a twenty-foot equivalent unit container loaded with 10 tons and valued at US $20,000.

Distance (i.e., road mileage) is an obvious source of cost differences across countries.[i] In some cases, the gateway port is over a thousand kilometers from point of delivery. Column 2 gives the normal cost for Africa as defined by the regression line. In other words, over the full sample, effective domestic costs are regressed on road distance from gateway port to point of delivery. For country (*j)*, the estimated constant, plus the β-coefficient (average continental cost per kilometer) multiplied by the specific distance, provide the cost that should be incurred in the light of continental standards. The difference

between columns 1 and 2 is a measure of cost deviation (column 3). In column 4, cost performance (*CP*, as a percentage) ranges between the "worst" performance (0) and the "best" African practice (100), on the hypothesis that the deviation from the minimum is attributable solely to inefficiency of the country's transport and logistics. We get this efficiency index from (3) and (4), with *min* e_{jt} denoting the lowest cost over the sample.

$$\ln(Cost)_{jt} = \beta \ln(Distance)_j + \alpha + e_{jt} \quad (1)$$

$$e_{jt} = \ln(Cost)_{jt} - [\ \beta \ln(Distance)_j + \alpha] \quad (2)$$

$$\hat{u}_{jt} = [e_{jt} - min(e_{jt})] \quad (3)$$

$$CP_{jt=}\ e^{-\hat{u}_{jt}} \times 100 \quad (4)$$

Table 1 here

Column 1 shows costs in North Africa during the first period to be only about one-third of those in Central Africa. The gap grows in the second period. Except in one region, costs in current dollars increase everywhere. Adjusting figures for normal costs reduces absolute gaps. Unlike in Central Africa, no North African country is landlocked and points of delivery are generally close to port of entry. Correcting for distance marginally modifies relative *Cost Performance* (*CP*, Col 4). From one period (2006-2010) to the next (2010-2014), Central Africa's performance is 49.3% and 36.5% of North Africa's.[ii]

Table 2 sheds light on relative domestic and international transport and logistics costs. The first column gives the cost of domestic services in 2014. To make regional comparisons relevant, the average impact of distance is removed from costs by using the β-coefficient estimated from (1). In other words, this assessment combines the cost of logistics and abnormal costs of transportation. Column 2 gives maritime costs from Antwerp and Shanghai, the most frequently used departure ports.[iii] Shipping costs from Shanghai are lower for East than for West Africa; the opposite applies to Antwerp. Traffic volume also

influences freight rates. Sending a container to southern African countries from Antwerp costs less than sending it to West Africa. Column 3 shows that, for three regions, the price of domestic transport and logistics, net of the average cost for land distance, exceeds maritime shipping cost from Antwerp. Technological innovation, notably creation of the container and increasing size of container ships, has played a major role in the evolution of maritime traffic, contrasting with the situation in Africa's trucking industry, where innovation has been limited for various reasons, including road constraints (i.e., quality, topography).

Table 2 here

Deficient infrastructure, ambiguity of solutions

Poor infrastructure rather than geography *per se* is sometimes depicted as the major source of land transport costs. François and Manchin (2013) find that low quality of infrastructure and weak institutions hamper access to northern markets. Portugal-Perez and Wilson (2012) share this view, but argue that hard and soft infrastructure complement each other. Building infrastructure without addressing policy and institutional failures is part of the excess cost of transport.[iv] One cannot look only at the financial side of infrastructure investment. The problem is often poor operation and maintenance of equipment, highlighting the difficulty of striking a balance between maintenance and expansion. Not only is maintenance under-budgeted, it is also the first expenditure to be cut in times of hard budget constraints (see Adam and Bevan, 2014).[v]

Private concessions can be seen as one way of combining efficiently investment and maintenance. Valid for port terminals, this option is hypothetical for roads. For a toll-road concession to be financially sustainable, some studies have shown that traffic must reach a minimum of 10,000 vehicles per day (Gwilliam, 2011). This threshold is high for Africa, although it may be attained in international corridors or on congested roads serving ports. Overall, soft infrastructure is at least as important as investment. Raballand et al (2012) claim that capacity and container management in the port of Durban (South Africa) can be improved with no additional physical infrastructure.

Speeding up customs clearance is a true challenge. It involves the use of scanners to reduce physical inspection at ports, and electronic transmission of documents to reduce bribery. If tackling rent-seeking behavior can be a significant source of cost saving, even benevolent states with strong willingness in that direction face practical issues. Devarajan (2012) sees lengthy cargo storage as one facet of a more general problem in Africa, where growth is slowed by the fact that some actors benefit from delays.

Vertical unbundling of transport and logistical services

In assessing the issue of soft infrastructure (i.e., economic governance, including the regulatory environment), the inland transport and logistics chain can be unbundled into three main segments: international shipping costs, port activity, and inland transport.

Competition in international shipping has increased progressively. Market rules now replace longstanding maritime conferences, where cartel members colluded in setting freight rates. In a competitive market, long-term prices evolve downward. They respond to technological progress,[vi] while short-term prices fluctuate according to market conditions. The Baltic Dry Index (BDI) of the London-based *Baltic Exchange* reports daily price movements of raw materials transported by sea. Freight rates fluctuate according to demand for shipping and supply of dry bulk carriers.[vii] This market mechanism contrasts with practices underlying port services and trucking prices.

Seaports figure prominently in import costs (Nordas and Piermartini, 2004; Blonigen and Wilson, 2008; François and Manchin, 2013)[viii]. African ports have traditionally conformed to the public service or tool port model outlined in the World Bank's *Port Reform Toolkit* (2007). Until recently, public monopolies were in charge of pilotage, towing, mooring, dredging, cargo handling and customs clearance. In this institutional context, a wide range of stakeholders, including government staff, acquire rents. This model has gradually disappeared. Port authorities now intervene as landlords and/or regulatory agents. They negotiate access to public space, leaving it to private actors to finance investment and manage operations.

Under public ownership and management, productivity gains have been limited, with little or no positive impact on prices or quality of port services. Except for Durban and Port Said, half the time in moving

cargo from port to final warehouse is spent within port areas. Average cargo storage lasts around 20 days in Africa, compared to an international standard of 3 to 7 days (Raballand *et al* 2012). Decreasing storage time and improving logistics require not only investment, but also countering imperfect market structure and public-private collusion.

Both public and private ports in Africa operate far below international standards. Average container storage time is 6 days in South Africa, and 12 to 15 days in East and West Africa. Gateway container handling charges, about US $100 per 20-foot dry container in developed countries, are a multiple of that in Africa. Improving service requires greater competition and better enforcement of rules by regulatory bodies, along with fewer procedures, less corruption and faster customs clearance.[ix]

Turning to road transport, freight traffic is sometimes allocated in response to interests of small operators. In some countries, the position of vehicles queuing at a dispatch point determines traffic assignments. In others, bilateral agreements set quotas for transit freight between coastal and landlocked countries.[x] Broadly speaking, imperfect markets and regulatory or organizational defects lead to high road freight tariffs. Per ton-kilometer, the market price (U.S dollars) varies from 4 cents in Kenya and Zambia (close to the price in European and Asian countries), to 11 to 15 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). Two paradigms compete in the literature regarding those who benefit from high prices.

(i) Truckers reap high profits. According to Raballand and Teravaninthorn (2009) profit margins range from 60 to 160 percent in Central and West Africa, one of the most expensive corridors being between Ngaoundéré (Cameroon) and Moundou (Chad). Wages and fixed costs are a small part of operating costs. Vehicles are old, generally fully amortized. Variable costs comprise mainly fuel and lubricants (rarely bought at official prices), tires, and spare parts (Gwilliam, 2011). Direct payments at roadblocks are not the financial burden so often mentioned. In this paradigm, trucker profits are therefore the root of high prices.

(ii) An alternative explanation is that high prices reflect "hidden costs." The hypothesis of excessive profit margins seems incompatible with the existence of an over-supply of small independent truckers unable to renew their fleet and bypassing official axle load limits in order to survive. Under this second paradigm, rents are distributed throughout the chain of stakeholders: shippers and haulers, chambers of commerce, managers of warehouses or dry ports, and of course customs officers who solicit bribes. Along the Tema (Ghana)-Ouagadougou (Burkina Faso) corridor in 2008, the average bribe on a 20-foot imported container amounted to 8.2% of its value. Less than 1% was attributed to robbers or poachers, the remainder going to customs officers.[xi]

The truth is, no doubt, somewhere in between these two competing paradigms, the business model of some large international groups shedding light on this issue. Given excess capacity of container ships, the worldwide economic downturn in 2008 lowered both freight rates and profit margins. *Bolloré,* the French company of transportation, anticipated this change. In 2006, the group partly withdrew from this business segment and strengthened its participation in domestic transport and logistics (freight, port handling, rail operation, management of inland terminals). By door-to-door services, the group integrates transactions and captures some of the rents previously distributed over a wide range of stakeholders. Such a strategy is potentially good for firm profitability, but do not necessarily enhances lower service prices in a context of low competition.[xii]

3. Identification of stylized cost determinants

Specification of the model

Domestic transport and logistic costs of a 20-foot imported container refer to dry cargo weighing 10 tons and valued at US $20,000. Costs include fees for documents, customs clearance and inspection, and customs brokers, as well as port-related charges and inland transport. Customs tariffs and sea transport are excluded. If the main expected difference of costs across countries results from distance travelled (kilometers) by the most direct route from gateway port to warehouse, geography also plays a role via climate diversity, which ranges from the arid Sahel to the dense and humid forest of Central Africa. We expand the aforementioned cost components in two ways.

First, input prices such as labor, capital, spare parts and fuel should be taken into account. However, information is not available for all countries and all inputs over the entire period. In addition, some of these input prices are endogenous. For example, some countries subsidize diesel to lower transport costs. To address these issues we apply the Purchasing Power Parity conversion factor. We assume that it reflects the domestic price of transport and logistics. The World Bank's indicators (WDI) define this expression as 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. If the ratio of this conversion factor to the official exchange rate (hereinafter called the real exchange rate or RER) equals one, costs are similar to those in United States. A ratio lower or higher than one implies an undervaluation or overvaluation of the country's currency, yielding a lower or higher cost of transport and logistics. The US dollar being the currency of reference allows continent-wide comparisons.

Second, market imperfections and institutional shortcomings are a source of high transaction costs. We account for this phenomenon by estimating the time needed to comply with all required procedures. The *DB* provides this information, consolidating average time needed to (a) clear customs and inspection, and cover handling and storage at terminals, and (b) transport a container from landfall port to place of delivery. As we did earlier for costs (Table 2, column 1), to avoid double counting of distance, *Time* is made independent of it by using the average linear relation between these two variables over the full sample.

Table 3 breaks down the *Time* variable. Column 1 gives data provided by the *DB*. Column 2 shows time taken for port handling and customs clearance, as well as time lost in domestic transport due to road quality and border crossing procedures. In other words, this variable, independent of distance at the average per ton/km cost over the continent, is the *Time* variable used in our regressions. Column 2 accounts for about 50% of total time and reflects the 20 days mentioned by Raballand *et al* (2012). The longest time is for Central Africa, with little improvement (5%) recorded over the two periods: 39.4 to 37.5 days, far below the 28% improvement observed in East Africa.

Table 3 here

The quality of hard infrastructure is captured by information we gleaned from the World Bank's Logistics Performance Index (LPI). Its evaluation is based on a questionnaire administered to each country's transport and logistics users. We use two of the LPI's six dimensions potentially correlated with *Time*: quality of transport infrastructure *(Infra*), notably roads and ports, and efficiency of customs and border clearance (*Customs).*

Additional variables are also tested, such as port volume, measured by the annual number of loaded and unloaded containers (*Traffic).* Ports can experience increasing returns to scale. Management of heavy traffic and large ships with modern handling, lifting and storage equipment enhances productivity. Non-linearity is possible, as congestion may offset positive effects inside and outside the port area. However, this phenomenon is not limited to large ports. Even small vessels may encounter delayed access to berths or warehouses.[xiii] The external trade balance may also affect trade costs. As mentioned earlier, a minor portion of African exports is containerized. Raw materials, such as minerals, fuel and agricultural commodities are transported in bulk. The low probability of return freight raises the cost of importing, as fixed costs are not spread over two trips. To proxy this impact, we introduce the ratio of imports to potentially containerized exports.[xiv] The higher this ratio, the higher the domestic cost of transport and logistics.

Along a corridor, competition or complementarity between rail and road may optimize freight movement and reduce costs. Rail offers more security, especially for cross-border traffic. Moreover, while containers transported by rail are rarely opened and cargo stolen, truckers can deviate from their assigned routes, be arrested for various reasons, or be assessed unexpected charges.[xv] Given the cost of loading and reloading, multimodal transport offsets the inefficiency of trucking over long distances. It is not easy to determine the distance threshold for rail to reduce transport and logistic costs. Taking a pragmatic approach, we test different thresholds by stretches of 100 kilometers from the port of arrival.[xvi] Finally, the impact of risk, not reflected in the *Time* variable, has been tested through the Fund for Peace's

Fragile States Index (FSI). Based on twelve political, social and economic indicators, this index combines quantitative information and expert judgment.[xvii]

We test the model's broadest specification for 51 African countries over the 2006-2014 period. The panel's unbalanced character results from Sudan's split into two countries in July 2011. The model's linear form simplifies economic interpretation of the regression coefficients. Alternative forms, including log-log or semi-log models, do not provide better fits. Given our interest in identifying time-invariant coefficients, we retain the static econometric relationship and do not introduce country fixed effects in the specification. *Distance*, *RER*, and *Time* (independent of normal cost of distance) are defined above; *Z* is the vector of other determinants: *traffic, rail, infrastructure, customs, trade balance,* and *Fragile States Index. D* is a matrix of dummy variables for *regions, island, landlocked,* and *years*; f_{jt} is the error term, and α is the constant.

$$C_{jt} = \mu Distance_j + \beta RER_{jt} + \omega Time_{jt} + \delta' Z_{jt} + \tau' D + f_{jt} + \alpha \quad (7)$$

$$j = 1 \ldots 51, \text{ and } t = 2006 \ldots 2014$$

Regression results

We begin by exploring the impact of variables that proxy the effects of geography on African trade costs (Table 4). Then, in line with previous comments, the model's specification is extended to economic and institutional variables. In doing so we investigate to what extent there is room for tackling the impact of physical geography. The regional dummy coefficient for Central Africa suggests that the cost of importing there is double that in North Africa (Reg 1: US $2,319 versus 1,039, constant term). Regressions 3 and 4 extend the specification to (a) landlocked and (b) island states.

Variable (a) increases trade costs while (b) is potentially ambiguous. Organized as hub and spokes, small islands use a foreign hub for transshipment, with feeder vessels conveying the cargo to a national port and conducting customs brokerage and freight forwarding.[xviii] In Limao and Venables (2001) insularity reduces costs. In our case, eight islands save an average of US $1,100 that drops to US $650 after accounting for distance (Reg 5). Unlike what Limao and Venables (2001) find, the sign of the landlocked

regression coefficient is negative with increasing statistical significance when we drop regional dummies. At first glance, this seems to suggest that the "border effect" is not crucial in the explanation of import costs (Reg 5 and 6). Such a result surely needs to be qualified in the light of Christ and Ferrantino (2011)'s paper emphasizing that uncertainty about transport costs and time delays are substantially higher for landlocked countries.

Unfortunately, the *DB* refer to a stylized cost and does not account for uncertainty, which is a component of transaction costs. Long trips and border crossings generate a higher degree of dispersion around expected times and costs. We illustrate this phenomenon with reference to the Abidjan-Ouagadougou corridor. For 2016, in close cooperation with the *Conseil Burkinabé des Chargeurs*, we explored three activities (i.e., discharge of cargo and exit from port of arrival, land transport, and container processing at final delivery point). The average total delivery time is 17 days, fluctuating between 5 to 32 days, which 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.

Table 4 here

The distance from port of entry to cargo delivery at a warehouse is a major component of import cost. The regression coefficient yields a marginal cost of US 24 cents per ton-kilometer. This is higher than reported in African case studies. However, the *DB* assumes a container with a 10-ton load. Effective loads are substantially higher. For example, on the Dakar (Senegal)-Bamako (Mali) corridor, rice containers vary between 20 and 25 tons (ADB, 2015). This difference reflects a gap between posted and actual values (Hallward-Driemeier and Prichett, 2015). Compared with the *DB*'s standard load of 10 tons, the tariff per ton-kilometer falls to US 12 to 9.5 cents, still high compared with usual figures for Africa (Raballand and Teravaninthorn, 2009).

The year dummies are informative (2006-2014). Except for North Africa, dummy coefficients in current US dollars have risen continuously since 2009. Several not mutually exclusive factors, including profit rates, may explain this evolution. The rising price of fuel--a barrel of oil rose from US $50 in 2005 to

$100 in 2014—has substantially increased transport cost. *Dutch disease* may also figure. The "super cycle" of raw materials stopped only in 2012, raising prices of non-tradable goods, including domestic transport and logistics. However, price evolution has varied. In their analysis of main East African corridors, Kunaka *et al* (2016) note that, over the period 2011-2015, prices dropped by 30% and 26% from Mombasa to Kigali and Kampala, respectively. In contrast to these declines, prices in the corridor Dar es Salam to Kampala and Kigali increased by 79% and 36%, respectively. One way of extending our knowledge of import costs is to expand the model's geographical specification with variables sensitive to economic policy.

The *Time* variable considered above is impacted by bribes, which vary both by importer and the nature of imported goods. According to the "grease the wheels" argument, firms strive to limit time spent with officials (See Hallward-Driemeier and Pritchett, 2015; Hallward-Driemeier and Rijkers, 2014). If time depends on users' willingness to pay, we suspect endogeneity, as official transport and logistic prices may incorporate anticipated abnormal costs including bribes.[xix] To obtain unbiased coefficients, we resort to instrumental variables, using three instruments that meet the exclusion restriction.

Population size is correlated with *Time* through infrastructure quality, as well as technical efficiency and port economies of scale. Jedwab and Storeygard (2017) find that larger, more populous African countries build more infrastructure in order to improve internal communication. The correlation with import cost is only indirect, through the productivity effect underlying *Time*. We add two 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 *Time* spent in neighboring countries. By using this variable, net of the impact of distance, we hypothesize that sub-regional behavior is close to the quality of logistics in the country under study. To prevent direct correlation with import cost, for landlocked economies we remove the transit country from the list of neighbors.[xx] We see no reason why these instruments would directly influence import cost.

To have an efficient 2SLS estimator, the F-test of the first regression must be good as is the case here where the F value is 25.5, above the threshold of 10 commonly used to determine whether an instrument

is weak (Stock and Yogo, 2005). The Sargan test of overidentified restrictions does not reject the null hypothesis. Beside *Time*, The *RER* can also be endogenous. Domestic transport and logistics account for a significant part of import costs obtained via the Purchasing Power Parity (PPP) conversion factor. Sequeira and Djankov (2014) note that these expenditures account for 15-20% of South African GDP. In addition, we keep in mind that transport and logistic costs are one reason why the absolute version of the PPP theory does not hold in the long run. Unlike for Time variable, the Hausman test has rejected the endogeneity hypothesis, predicted values of the RER being obtained by regressing the variable on the per capita GDP used as instrument (i.e., the Balassa - Samuelson PPP bias), and the vector of exogenous variables of the model (See, Rodrik, 2008, and Appendix 6). [xxi]

Table 5 here

Table 5 provides the main results. Compared to the regression shown in Table 4, the R-square improves modestly. Except for Central Africa, regional dummies lose their explanatory power in favor of variables sensitive to economic policy. Regressions 7 and 8 refer to OLS estimations, with inconsistent parameters in Reg 7. Use of 2SLS reduces the impact of the predicted *Time* by 20 percent. The coefficient placing the cost of an extra day at about US $24 (Reg 10) varies according to the specification accompanying a parallel variation in sample size.

On a slightly smaller sample (398 versus 452 observations), when we control for the infrastructure component, significant at 95 %, this coefficient stands at US $22.5 (Reg 15). From regression 10 and *Time* data of Table 3, over the period 2010-2014, the average cost of time spent in bureaucratic and logistical hurdles varies from US $351 per TEU in North Africa (23.87*14.7) to US $895 in Central Africa (23.87*37.5). Within the latter group, in Chad in 2014 it took 55 days to comply with all formalities and overcome extraordinary hurdles along the Douala-Ndjamena corridor. A loss of US $1,313 results from this statistic. Infrastructure quality accounts for part of the delay. In this regard, the South African Republic (SAR) tops the list of African countries in the 2014 LPI-World Bank database, with quality measured at 3.79 on a scale of 1 (low) to 5 (high). At the opposite end of the spectrum, the

lowest rating is for DR Congo (1.27). All things being equal, the cost saving would be US $1,529 (Reg 15) if Congo succeeded in acquiring the same quality of infrastructure as SAR.

The 2SLS procedure affects the regression coefficient of distance, bringing the ton/kilometer price closer to average figures for Africa. The price ranges from US 7 to 9 cents on the hypothesis of a load of 25 or 20 tons, respectively. The 2SLS procedure marginally modifies the real exchange rate (*RER*) coefficient. For African countries, this variable is distributed between 0 and 1. The upper bound figure means that at the official exchange rate, the local currency's purchasing power equals that of the US dollar in the United States.[xxii] In other words, between two African countries with a *RER* differing by 20 percentage points, the cost of importing a container differs by US $518 (Reg 10, 0.2 *2.593). Given a "diversion effect" between *rail* and road, indirect competition reduces the price by about US $256 in Reg 10, but with a coefficient that is barely significant, and only for a distance exceeding 400 kilometers.[xxiii] Below this threshold, coordination of services makes competition unlikely because of the cost of loading and reloading. Port size as measured by container traffic does not bring out economies of scale, and use of a quadratic form rejects congestion phenomena.[xxiv]

4. Robustness checks and policy implications

Thus far we have ignored both private management and competition at port level. This may be a source of endogeneity bias. Second, regional dummies may be insufficient to tackle heterogeneity across countries. It is worth questioning the sensitivity of results to sample composition based on regions or per capita income. Third, based on the baseline regression, how much can a country reduce costs via economic policy variables?

Assessing the impact of structural reforms

Four private international operators have been the main actors in port terminals. The *Bolloré group* is the leading player in African transport and logistics. Present in sixteen countries, the firm combines a wide range of services and promotes a *door-to-door* strategy, from maritime shipment to warehouse delivery. *Bolloré*'s competitors also provide multimodal services. These operators include APM, present in ten countries; MSC, which manages six terminals; and CMA CGM, which runs two terminals. In

2014, when some African countries remained outside private management of port activity (SAR, Namibia, Sudan, Mauritius…), others had long experience in this domain (Tanzania, Cameroon, Côte d'Ivoire and Egypt).

Analyzing the impact of private activity and competition across the continent is not easy; the three variables we test here represent a first attempt. *(i)* First, the impact of number of years with at least one private terminal operator is considered by country. *(ii)* Second, we introduce a vector of year dummies to distinguish countries that have had a private operator for at least five years. In doing so, we suggest that a five-year period reflects the time needed for institutional reform to benefit users, given the length of time for tangible and intangible investments to yield results. *(iii)* Last, we introduce the number of port terminal operators, on the hypothesis that competition correlates with lower costs.

Regression results should be interpreted cautiously. At port level, the duopoly market, the most common situation in West and Central Africa, does not approximate the paradigm of competitive market structure. In addition, while some private international groups are moving to door-to-door services, this strategy is recent and limited. Accordingly, international private operators are still far from filling integrated services covering the entire domestic transport and logistic chain.

At first glance, the number of port terminal operators is not statistically significant. However, especially during the period 2011-14, the number of years in private management is correlated with higher prices, especially when this management is over 5 years old. Different interpretations may explain this counterintuitive effect of private management. First, non-observable information may matter. For example, the model does not account for lower dispersion around *DB* posted values. In addition, customs officials affect port services. We control for this phenomenon only via the World Bank's qualitative LPI information (C*ustoms*).

Secondly, weakness of competition and regulatory agencies enables private profit to cover inefficient use of resources, such as payment of rents to stakeholders in the transport and logistics chain, which

accelerates private investment payback. In this scenario, regulatory structures fail to ensure fair distribution of any efficiency surplus between consumers and producers.

Third, a more satisfactory explanation for the collectivity as a whole is that the quality of services has increased parallel with prices. Factors underlying the *Time* variable (Reg 20 to 22, Table 6) shed light on this issue. In our OLS regressions, neither year dummies for countries with a private terminal, nor the number of years of private management, are statistically significant. Thus, insofar as the phenomenon is accurately measured, we reject the hypothesis that the increasing participation of private operators to the management of transport and logistics drove lower prices and higher service quality than public management.

Table 6 here

Sensitivity of results to the sample size

So far we have assumed the homogeneity of slope parameters across countries. This assumption may be restrictive and easily tested when the panel is large in the two dimensions (Pesaran, Shin, and Smith, 1999). To investigate the issue of potential heterogeneity we re-run the main regressions (Reg 16, Table 6) by modifying the empirical sample. First, we separate countries of middle and low per capita income. In a second sensitivity test, we drop North African countries from the sample. Close to Europe, these countries are relatively more integrated into global value chains, thus exerting competitive pressure on transport and logistic costs and quality. In a second round, we drop Central African countries suffering from weaker competition, remoteness from international markets, and strong influence of geographical variables.

Table 7 here

In these two variants of sensitivity analysis, Table 7 shows that regression coefficients remain remarkably stable across the two per capita income categories, especially for the two policy variables

expected to reduce import costs quickly (*RER* and *Time*). Coefficients prove also stable when we drop the observations of the two most different sub regions as regard the transport and logistics performance.

Simulation of potential cost savings

In the short-to-medium term, transportation and logistic costs can be reduced in different ways. Landlocked economies, where containers must travel long distances, can promote effective or potential competition between international corridors. For example, different roads serve the hinterlands of Mali, Burkina Faso and Niger. Traffic shares have changed in response to changing prices and risks, especially in the 2000s with the political conflict in Côte d'Ivoire. Competition has also proven beneficial in East Africa, given heterogeneity across corridors (Kunaka, Raballand, Fitzmaurice, 2016). In Congo (RDC), use of the Luanda-Kinshasa corridor has recently increased dramatically at the expense of the higher-cost traditional domestic corridor starting at Matadi.[xxv]

Competition reduces profit margins, improves technical efficiency and strengthens professional competence to the benefit of importers. Beyond the specific case of landlocked economies, one way to save on import cost is to vary the *Time* and *RER* variables. Table 8's scenarios do not take into account informal costs, including bribes, which are idiosyncratic to the transactions where they occur.

Regarding *RER*, public authorities may target the Purchasing Power Parity equilibrium exchange rate, after taking into account the impact of productivity bias on domestic price levels (i.e., the Balassa-Samuelson effect). GDP per capita is a proxy for productivity after removing rents. This treatment is appropriate for African countries with high per capita GDP due to rents, as in the case of Equatorial Guinea. For country *j* and product *k* (i.e., oil, natural gas, coal, minerals, and forest products), the percentage of rents is defined with the *World Development Indicators* as the difference between world market price (P_{kt}) and unit domestic production cost (CM_{jkt}). These differences are weighted by product *k*'s contribution to GDP in year *t*, giving the percentage of rents in domestic activity (θ_{jt}).

$$\text{With } \theta_{jt} = \sum_{k=1}^{n} \left(P_{kt} - CM_{jkt}\right)\mu_{jkt} \qquad \theta_j \in [0,1] \qquad (8)$$

Taking a worldwide sample over the period 2006-2014, we regress the real exchange rate (*RER*--i.e., the ratio of PPP conversion factor to the nominal exchange rate) on the productivity indicator (Appendix 6). Equations (9) and (10) below estimate the impact of relative prices via the difference, i.e. misalignment (*MIS*), between actual *RER* and the Balassa-Samuelson adjusted rate (Rodrik, 2008).

$$RERjt = (PPP\ CF/NER)_{jt} = \alpha + \sigma * \left((1 - \theta_{jt}) * per\ cap\ GDP_{jt}\right) + u_{jt} \qquad (9)$$

$$MIS_{jt} = (RER_{jt} - \widehat{RER_{jt}}) \qquad (10)$$

With regard to Time variable adjusted for distance, for each country, it is compared to a benchmark value. *Time ref* corresponds to the fourth quintile of the shortest time for distribution in Africa over each sub-period, i.e., 13.75 days for 2006-10 and 7.18 days for 2010-14. This quintile is regarded as achievable, since it was met by 17 countries in at least one year during the whole period.[xxvi] For countries doing better than these targets for *RER* or *Time*, we keep their specific figures.

$$Trade\ cost\ savings_{jt} = \upsilon\,[MIS_{jt}] + \chi\,[Time_{jt} - Time\ ref] \qquad (11)$$

Table 8 here

Using the baseline regression coefficients in Table 5 (Reg 10), Table 8 displays potential cost savings by region and sub-period and Appendix 7 provides this information by country. The use of African benchmarks means that the indicated performances are *a priori* achievable in the medium run. Figures are in US $ or percentages of domestic transport and logistic prices. Central Africa has considerable room for improvement. Simulations suggest a potential cost saving of US $868 for the most recent period, i.e. about 37% of the domestic cost of importing a container. Specifically, in 2014 it took 55 days to move a container from Douala to Bangui. Transport itself took 8 days. Most of the additional time was associated with bureaucratic delays, "red tape," and rent-seeking along the logistic chain, starting with customs. Soft infrastructure is therefore important, suggesting that costs can be cut without huge investments in the hard infrastructure.

Only North Africa does better than the continental benchmarks for *RER* and *Time*. This explains the negative sign of the cost saving. South Sudan (US $2,229), Angola (US $1,556) and Congo (RDC) (US $1,460) feature the highest potential cost savings: 24%, 56% and 39%, respectively. Finally, although trade costs are correlated with the *RER*, it is worth noting that focusing on *Time* proves more effective than changing relative prices. For the five African regions, more than 80% of potential cost saving comes from *Time*.

5. Concluding remarks

High domestic transport and logistic costs impede African countries' ability to diversify and participate in global value chains. But the situation is far from homogenous across Africa. Middle-income North and Central African countries display significant differences in transport and logistic costs. Geographical remoteness, along with market failure and weak institutions, bears responsibility for the excessive cost of importing a container.

Our analysis yields five main conclusions. First, while shipping costs showed a decreasing trend across the continent, the dollar cost of domestic transport and logistics increased during 2006-2014. The price of diesel probably explains at least part of this rise. Second, after accounting for distance, a country's landlocked status loses statistical significance. The absence of "border effect" likely results from unobservable information (i.e., informal costs and uncertainty about effective costs and delivery times that increase with distance and border crossings). Third, hidden transaction costs reflected in the time spent in transport and logistics offer the greatest potential cost savings. All things being equal, each additional day costs US $24. Fourth, relative prices matter, especially in countries where raw material rents are a source of price distortions. A good example of this is Angola, where transport and logistic costs are among Africa's highest, although the country is coastal. Fifth, during 2006-14, the domestic cost of importing a container did not evolve differently in countries that promoted private port management or competition among port operators. More work is required to understand better what happened in a context with limited competition. Moreover, our estimates do not account for informal costs or some components of service quality, e.g. lesser dispersion around average delivery times.

We have explored two main options for reducing import costs, assuming government is committed to improving the sector's efficiency. The first channel assumes an exchange rate policy that reduces the relative prices of non-tradable goods which are part of the cost components of the transport and logistics. This may involve changing the nominal exchange rate, or strengthening competition through structural reforms. The second channel, interacting with the first, involves reducing time spent on red tape and logistics, in the spirit of WTO's 2017 *Trade Facilitation Agreement* (*TFA*). Here the main challenge is to improve the quality of infrastructure, but also to have the political will to tackle rent-seeking behavior along the logistics chain. In the five African regions, wasted time accounts for about 80% of the excess domestic cost of an imported container.

Tables

Table 1. Costs of domestic transport and logistics in Africa (2006-2014)

	Average 2006-2010				Average 2010-2014			
	1-Effective inland cost	*2-Normal inland cost*	*3 = 1 – 2*	*4 = CP (%)*	*1-Effective inland cost*	*2-Normal inland cost*	*3 = 1 - 2*	*4 = CP (%)*
North Africa	1,087	1,490	- 403	59.4	986	1,698	- 712	63.0
West Africa	1,730	1,594	130	33.6	1,911	1,846	64	29.0
East Africa	2,080	2,338	- 155	36.7	2,432	2,903	-389	34.0
Central Africa	2,809	2,190	620	29.3	3,853	2,687	1166	23.0
Southern Africa	2,243	2,646	- 403	43.0	3,084	3,328	- 244	34.0

Note. Except for the cost performance *(CP)*, column 4, in percentages, all figures are in current US dollars. Source: Data and information regarding port of entry are from the *Doing Business*. Appendix 2 provides average figures by country over the whole period.

Table 2. Road versus shipping costs: regional transport and logistics in Africa (in US dollars)

	Cost of domestic transport and logistics, (*net of the normal cost of distance, 2014)* (1)	Cost of maritime freight, 2016		Percentage of the gap	
		Antwerp	Shanghai	Antwerp	Shanghai
		(2)		[(1) / (2)]*100	
North Africa	525	751	700	70	75
West Africa	1,431	1,223	1,738	117	82
East Africa	879	1,730	1,242	51	71
Central Africa	2,525	1,976	2,883	128	83
Southern Africa	1,012	941	858	108	118

Source. From the World Bank's *Doing Business.* Cost of maritime freight rates have been collected by *Isys Logistique*, Roissy (France) for transportation from Antwerp and Shanghai.

Table 3. Time for transport and logistics in Africa: adjusted or not for distance (days)

	Average 2006-2010		Average 2010-2014	
	1-Effective *Time*	2-*Time* adjusted for distance	1- Effective *Time*	2-*Time* adjusted for distance
Northern Africa	23.2	19.3	18.6	14.7
West Africa	37.8	32.5	32.8	27.5
East Africa	39.9	25.8	33.3	18.6
Central Africa	52.5	39.4	50.5	37.5
Southern Africa	45.5	26.7	40.9	22.1

Note. *Time to import* from the *DB* is regressed on kilometers from port of arrival to final warehouse. The difference between columns 1 and 2 is the number of kilometers times the average estimated cost per kilometer over the whole sample.

Table 4. Import costs of the container and physical geography determinants
(in US dollars, OLS estimator)

	Reg 1	Reg 2	Reg 3	Reg 4	Reg 5	Reg 6
Southern Africa	1,613***	1,613***	209.2	373.9**	400.7**	
	(164.4)	(166.8)	(171.6)	(162.7)	(168.0)	
Central Africa	2,319***	2,319***	1,758***	2,102***	1,693***	
	(280.5)	(282.4)	(221.1)	(213.1)	(176.1)	
East Africa	1,225***	1,219***	394.2***	804.4***	522.8***	
	(142.8)	(153.2)	(112.0)	(127.5)	(125.8)	
West Africa	774.0***	774.0***	352.7***	471.8***	731.3***	
	(93.74)	(111.4)	(89.00)	(89.83)	(111.9)	
Landlocked			2,247***	1,983***	-302.9*	-584.7**
			(126.6)	(125.7)	(183.4)	(245.6)
Island				-1,114***	-649.5***	-429.6***
				(133.9)	(97.44)	(76.13)
Distance					2.458***	2.734***
					(0.181)	(0.242)
Year = 2007		7.280	7.280	7.280	7.280	7.280
		(215.0)	(141.6)	(135.9)	(125.7)	(137.4)
Year = 2008		0.480	0.480	0.480	0.480	0.480
		(218.2)	(143.2)	(136.0)	(123.8)	(137.6)
Year = 2009		267.2	267.2*	267.2*	267.2**	267.2**
		(223.3)	(149.1)	(139.8)	(116.0)	(131.2)
Year = 2010		319.9	319.9**	319.9**	319.9***	319.9**
		(229.5)	(152.6)	(143.4)	(114.2)	(130.2)
Year = 2011		510.4*	510.4**	510.4***	510.4***	510.4***
		(270.0)	(202.3)	(192.0)	(157.1)	(183.1)
Year = 2012		520.3*	520.3***	520.3***	520.3***	520.3***
		(270.9)	(200.6)	(190.1)	(154.7)	(180.6)
Year = 2013		706.0**	678.0***	675.1***	668.0***	663.7***
		(300.2)	(223.9)	(213.1)	(180.0)	(199.4)
Year = 2014		789.5**	761.5***	758.6***	751.4***	747.2***
		(309.6)	(225.8)	(215.4)	(180.5)	(200.9)
Constant	1,039***	692.0***	698.2***	698.8***	343.4**	996.3***
	(49.87)	(173.0)	(132.1)	(129.0)	(139.6)	(103.2)
Observations	452	452	452	452	452	452
R-squared	0.161	0.195	0.565	0.613	0.745	0.660

Sources. *Doing Business* website or reports, various years See Appendix 3. Robust standard errors in parentheses with *** p<0.01, ** p<0.05, * p <0.1.

Table 5. Determinants of domestic transport and logistics costs in Africa (in US dollars)

	Reg 7 OLS	Reg 8 OLS	Reg 9 2SLS	Reg 10 2SLS	Reg 11 2SLS	Reg 12 2SLS	Reg 13 2SLS	Reg 14 2SLS	Reg 15 2SLS
Southern Africa	-103.9	-243.3	-218.6	-120.7	-8.325	6.029	-17.81	94.43	-85.50
	(417.3)	(313.3)	(329.2)	(329.1)	(287.9)	(288.5)	(316.4)	(503.6)	(282.6)
Central Africa	1,187***	670.9**	762.3*	793.9*	665.6	672.8	694.5	654.9	675.6
	(382.0)	(314.2)	(409.0)	(410.8)	(418.4)	(437.2)	(434.6)	(432.5)	(416.8)
East Africa	249.7	86.94	115.8	203.2	75.81	73.37	84.92	58.77	-80.19
	(307.2)	(226.2)	(244.3)	(244.4)	(251.0)	(253.0)	(250.1)	(269.6)	(218.7)
West Africa	462.1	131.2	189.8	195.7	65.65	68.39	68.08	61.88	27.55
	(293.1)	(244.7)	(274.9)	(262.5)	(270.4)	(278.8)	(273.6)	(289.3)	(225.1)
Landlocked	-169.2	-8.883	-37.29	-10.91	20.63	25.72	7.035	-320.0	-304.8
	(374.1)	(373.6)	(382.3)	(364.3)	(359.6)	(352.4)	(364.9)	(637.2)	(465.3)
Island	-643.9***	-477.8***	-507.2***	-575.6***	-591.4***	-571.2***	-633.2***	-635.7***	-588.8**
	(216.7)	(184.4)	(185.8)	(190.2)	(184.0)	(193.6)	(203.9)	(182.2)	(300.2)
Distance	2.456***	2.338***	1.791***	1.741***	1.747***	1.730***	1.711***	2.031***	1.951***
	(0.347)	(0.321)	(0.471)	(0.442)	(0.427)	(0.409)	(0.474)	(0.628)	(0.515)
RER	3,106***	2,540***	2,641***	2,593***	2,311***	2,269***	2,200***	2,179***	2,058**
	(992.2)	(625.7)	(703.6)	(719.4)	(755.7)	(716.5)	(792.3)	(724.4)	(864.9)
Time		26.32***							
		(7.535)							
Time *instrumented*			21.66**	23.87**	24.08**	24.43**	26.16*	20.77*	22.51*
			(10.63)	(10.35)	(9.976)	(9.959)	(14.67)	(11.04)	(11.69)
Railways				-256.1	-257.4	-257.8	-236.7	-142.2	-156.7
				(173.4)	(173.2)	(172.2)	(183.6)	(203.8)	(225.3)
Port Traffic					-0.000113	-4.25e-05	-0.000108	-0.000174	-7.37e-05
					(7.19e-05)	(0.000318)	(7.47e-05)	(0.000117)	(8.52e-05)
(Port Traffic)²						-0			
						(8.59e-11)			
Fragile States Index							-1.906		
							(9.392)		
Infrastructure									-607.0**
									(304.9)
Customs									140.3
									(259.8)
Trade Composition								-3.615	
								(3.477)	
Constant	-512.6	-961.4***	-882.2***	-921.9***	-668.2*	-688.5*	-558.2	-420.2	516.0
	(377.4)	(326.6)	(337.5)	(309.9)	(365.8)	(372.6)	(573.6)	(451.5)	(932.9)
Observations	452	452	452	452	452	452	443	405	398
R-squared	0.765	0.803	0.802	0.807	0.809	0.809	0.809	0.812	0.805
Country FE	No	No	No	No	No	No	No	No	No
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cragg-DW F-stat			38.14	43.72	43.91	44.98	22.78	39.51	48.18
Hansen P-val			0.617	0.527	0.484	0.465	0.415	0.649	0.250

Sources. See Appendix 3. Notes. In regression 7, *RER* is the price level ratio of PPP conversion factor (GDP) to market exchange rate. In regression 8, *Time* is the observed variable net of the impact of the distance at the average continental per ton/km price. For the other regressions, predicted values of *Time* are derived from the 2SLS regression, Appendix 5. All regressions include year fixed effects. Robust standard errors are provided in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 6. Transport and logistics: Private management and competition at port level

Cost to import (from Reg 16 to 19) and Time to import (from Reg 20 to 22)

	Reg16	Reg17	Reg18	Reg19	Reg20	Reg21	Reg22
	2SLS	2SLS	2SLS	2SLS	OLS	OLS	OLS
Southern Africa	-8.325	130.7	118.3	-79.41	11.30	11.38	11.80*
	(287.9)	(304.8)	(306.7)	(344.8)	(7.066)	(7.130)	(6.541)
Central Africa	665.6	610.3	717.3*	685.3*	17.03***	17.22***	16.48***
	(418.4)	(398.6)	(428.8)	(412.6)	(6.421)	(6.566)	(6.323)
East Africa	75.81	-62.24	60.74	-81.82	2.410	2.493	2.277
	(251.0)	(241.6)	(241.0)	(206.4)	(3.853)	(3.903)	(3.863)
West Africa	65.65	49.55	102.2	54.14	11.47***	11.54***	9.895**
	(270.4)	(258.1)	(267.0)	(225.1)	(3.902)	(3.965)	(4.426)
Landlocked	20.63	-9.513	-10.98	-420.3	-8.827	-8.696	-4.089
	(359.6)	(321.8)	(346.3)	(409.8)	(6.100)	(6.067)	(5.701)
Island	-591.4***	-402.5**	-503.1***	-587.5*			
	(184.0)	(169.4)	(195.0)	(346.2)			
Distance	1.747***	1.754***	1.794***	1.887***	0.0295***	0.0294***	0.0232***
	(0.427)	(0.380)	(0.436)	(0.523)	(0.00642)	(0.00640)	(0.00625)
Time_*instrumented*	24.08**	21.30**	21.54*	29.31			
	(9.976)	(9.604)	(11.18)	(18.95)			
RER	2,311***	2,451***	2,168***	1,702**			
	(755.7)	(727.7)	(718.9)	(846.0)			
Railways	-257.4	-119.9	-218.3	-60.53			
	(173.2)	(189.4)	(181.2)	(217.1)			
Port Traffic	-0.000113	-0.000143*	-0.000132**	-6.27e-05			
	(7.19e-05)	(7.95e-05)	(6.67e-05)	(7.86e-05)			
Fragile States Index				-10.25			0.284**
				(12.59)			(0.117)
Infrastructure				-736.9**	-6.157**	-5.113	
				(297.6)	(2.874)	(3.842)	
Customs				171.7		-1.505	
				(269.9)		(3.966)	
Private management (years)		52.35**					-0.245
		(20.61)					(0.600)
Number of port operators		13.22					-0.816
		(108.9)					(1.920)
Document to import					1.449***	1.444***	1.044*
					(0.481)	(0.483)	(0.604)
LPI score							-5.399
							(3.864)
More than 5 years			-84.77	-225.0			
			(227.6)	(330.2)			
More than 5 years in 2007			14.36	110.6	2.781	2.751	4.390
			(59.46)	(113.8)	(4.504)	(4.501)	(4.461)
More than 5 years in 2008			-62.56	116.2	4.130	4.052	5.262
			(116.1)	(175.3)	(3.276)	(3.280)	(3.618)
More than 5 years in 2009			36.15	282.8	2.426	2.303	3.379
			(152.6)	(238.3)	(3.354)	(3.345)	(3.692)
More than 5 years in 2010			159.9	417.2	1.228	1.052	2.616
			(162.7)	(256.2)	(3.512)	(3.542)	(3.803)
More than 5 years in 2011			446.9**	587.0*	0.775	0.708	2.767
			(222.4)	(303.0)	(3.105)	(3.111)	(3.744)
More than 5 years in 2012			449.6**	516.4*	0.368	0.366	3.278
			(225.0)	(292.8)	(3.033)	(3.038)	(3.903)
More than 5 years in 2013			518.3**	597.1*	-0.0496	-0.0179	2.836
			(245.2)	(310.6)	(3.247)	(3.262)	(4.127)
More than 5 years in 2014			669.6**	815.9**	-0.488	-0.424	2.387
			(260.4)	(340.8)	(3.306)	(3.326)	(4.421)
Constant	-668.2*	-669.4*	-503.1	1,584			
	(365.8)	(369.3)	(324.2)	(1,171)			
Observations	452	452	452	393	397	397	392
R-squared	0.809	0.815	0.816	0.811	0.688	0.689	0.717
Country FE	No	No	No	No	No	No	No
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cragg-DW F-stat	43.91	56.04	42.94	23.35			
Hansen P-val	0.484	0.325	0.464	0.459			

Sources. See Appendix 3. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. *Time to import*, the dependent variable from regression 20 to 22 is the information as provided by the World Bank's *Doing Business*.

Table 7. Sensitivity of the regression results to the sample size and income levels

	Reg 23	Reg 24	Reg 25	Reg 26	Reg 27
	2SLS	2SLS excluding NAF	2SLS excluding NAF and CAF	2SLS-LIC	2SLS-MIC
Southern Africa	-120.7	-336.7	-261.7		
	(329.1)	(271.1)	(266.3)		
Central Africa	793.9*	574.2**			
	(410.8)	(259.7)			
East Africa	203.2	-8.607	12.46		
	(244.4)	(184.7)	(181.6)		
West Africa	195.7				
	(262.5)				
Landlocked	-10.91	-62.42	233.4	-647.8	-270.7
	(364.3)	(373.8)	(308.0)	(592.4)	(517.4)
Island	-575.6***	-568.3***	-332.1	-389.6***	-451.4**
	(190.2)	(189.3)	(205.0)	(149.6)	(221.0)
Distance	1.741***	1.816***	1.502***	2.188***	2.324***
	(0.442)	(0.444)	(0.379)	(0.685)	(0.630)
RER	2,593***	2,763***	2,604***	3,114***	3,566***
	(719.4)	(775.7)	(891.9)	(959.5)	(959.1)
Time_*instrumented*	23.87**	23.35**	25.36***	23.76**	22.46**
	(10.35)	(10.04)	(8.807)	(11.57)	(9.245)
Railways	-256.1	-259.5	-350.2*	-32.94	-636.3*
	(173.4)	(173.3)	(200.3)	(167.6)	(347.2)
Constant	-921.9***	-812.0**	-792.4**	-982.8***	-1,010**
	(309.9)	(375.7)	(401.3)	(358.6)	(429.2)
Observations	452	416	344	216	236
R-squared	0.807	0.805	0.798	0.863	0.647
Country FE	No	No	No	No	No
Year Dummies	Yes	Yes	Yes	Yes	Yes
Cragg-DW F-stat	43.72	46.12	36.90	15.61	41.48
Hansen P-val	0.527	0.524	0.996	0.370	0.733

Sources. See Appendix 3. Predicted values for the time variable are from regression 3, Appendix 5. Reg 23 is the same as Reg 10, Table 5. In Reg 24 we drop the North African countries (NAF) and in Reg 25 we also give up Central African countries (NAF, CAF). In Reg 26 and Reg 27, we focus on low-income level countries and middle-income economies, respectively. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 8. Simulation of savings on domestic cost of transport and logistics

	Average 2006-2010				Average 2010-2014			
	RER	*Time*	Total		RER	*Time*	Total	
	Dollars		Dollars	(%)	Dollars		Dollars	(%)
Northern Africa	0	157	157	16	0	184	184	17
West Africa	22	447	469	34	33	486	519	34
East Africa	45	312	357	22	48	251	299	20
Central Africa	107	613	720	32	145	723	868	37
Southern Africa	80	321	401	20	143	358	501	18

Sources. See Appendix 3. Results are from Regression 10, Table 5 or Regression 23, Table 7. The percentage is expressed relatively t the average domestic cost of the imported container

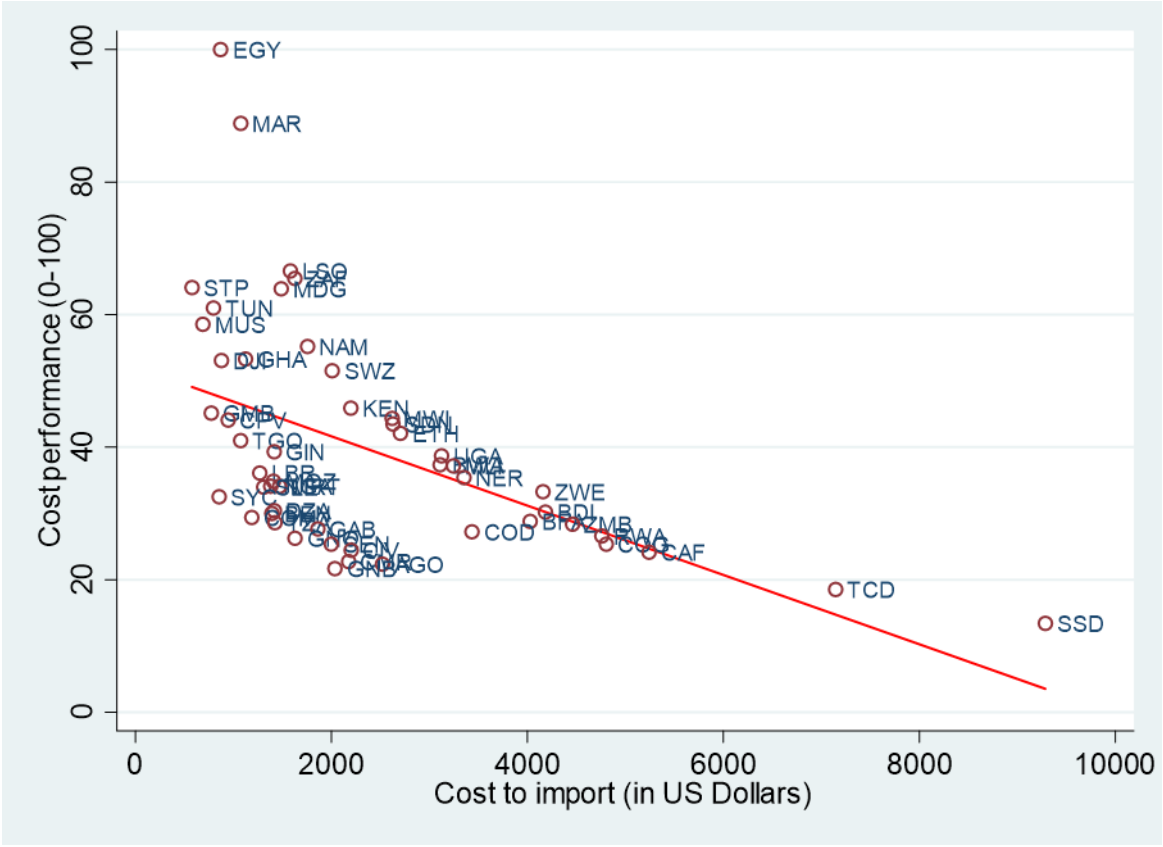
Appendix 1. Africa by region and income level countries

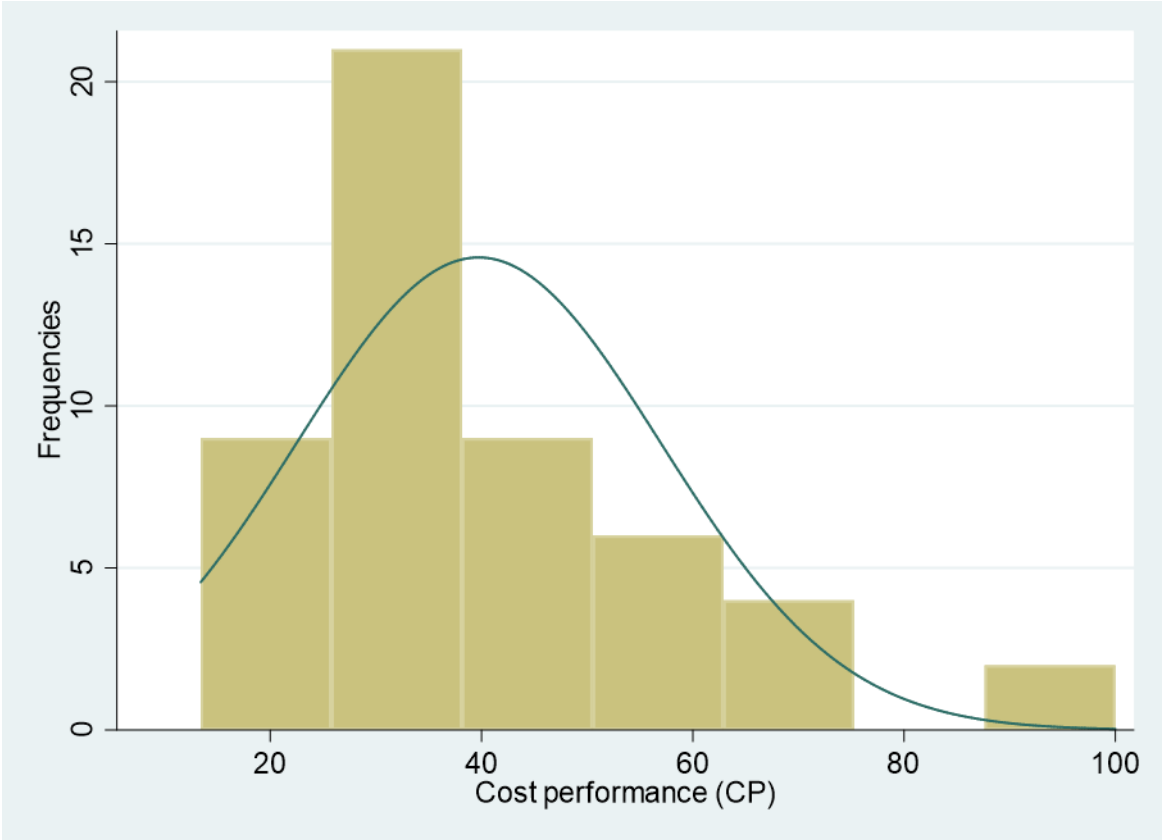
Southern Africa	**Central Africa**	**East Africa**	**West Africa**	**North Africa**
South African Rep	Central African Rep	Burundi	Benin	***Algeria***
Angola	***Cameroon***	Comoros	Burkina-Faso	***Egypt***
Botswana	***Congo***	**Djibouti**	***Cape Verde***	***Libya***
Lesotho	***Gabon***	Ethiopia	***Côte d'Ivoire***	***Morocco***
Namibia	***Equatorial Guinea***	**Kenya**	Gambia	***Tunisia***
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	
		South Sudan	***Nigeria***	
		Tanzania	Senegal	
		Uganda	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. Performance of the transport and logistics in Africa

51 African countries, average over the period 2006-2014





Appendix 3. Domestic transport and logistics in Africa

(Figures refer to 2014 unless otherwise specified)

Countries	Distance (Km)	Misalignment 2014	RER 2014	Time to import net of Km	Port, yearly container traffic (in thousands)	Years with private port operators	Nber of private port operators	Port of arrival
Angola	27	0.22	0.71	42.3	630	8	1	Luanda
Burundi	1419	-0.08	0.37	8.8	476	15	1	Dar es Salaam
Benin	6	-0.01	0.45	26.8	340	6	2	Cotonou
Burkina Faso	944	-0.02	0.42	24.2	550	11	3	Abidjan
Botswana	917	-0.09	0.45	10.9	3200	0	1	Durban
Central African Republic	1404	0.14	0.59	18.1	340	11	2	Douala
Côte d'Ivoire	23	0.02	0.47	33.4	550	11	3	Abidjan
Cameroon	15	0.01	0.47	24.6	340	11	2	Douala
Congo, Dem, Rep,	327	0.15	0.58	54.4	46	0	1	Matadi
Congo, Rep,	560	0.03	0.50	39.3	440	7	2	Pointe Noire
Comoros	2	0.11	0.57	23.9	10	3	1	Moroni
Cabo Verde	6	0.07	0.57	17.8	10	0	1	Praia
Djibouti	11	0.08	0.55	17.7	740	9	2	Djibouti
Algeria	7	-0.12	0.39	26.8	361	7	1	Alger
Egypt, Arab Rep,	224	-0.17	0.32	9.1	3600	11	2	Alexandria
Ethiopia	864	-0.07	0.38	21.3	740	9	2	Djibouti
Gabon	18	0.02	0.55	21.5	110	8	1	Libreville
Ghana	36	-0.11	0.35	41.0	750	11	2	Tema
Guinea	27	-0.01	0.44	30.3	135	4	2	Conakry
Gambia, The	2	-0.18	0.27	18.9	10	0	1	Banjul
Guinea-Bissau	8	-0.02	0.44	21.8	10	0	1	Bissau
Equatorial Guinea	7	-0.03	0.58	43.8	10	0	1	Malabo
Kenya	481	0.00	0.46	13.4	770	7	1	Mombasa
Liberia	10	0.09	0.54	28.7	53	4	1	Monrovia
Lesotho	549	-0.04	0.41	18.6	3200	0	1	Durban
Morocco	337	-0.06	0.42	6.1	1900	8	2	Tanger
Madagascar	356	-0.14	0.31	11.6	146	10	1	Toamasina
Mali	1093	-0.04	0.42	6.3	415	8	2	Dakar
Mozambique	14	0.09	0.55	24.6	106	7	1	Maputo
Mauritania	16	-0.11	0.35	37.6	85	7	1	Nouakchott
Mauritius	5	-0.04	0.53	8.9	350	0	1	Port Louis
Malawi	948	-0.14	0.31	14.1	106	7	1	Beira
Namibia	394	0.02	0.53	9.6	220	0	1	Walvis Bay
Niger	1021	0.00	0.45	35.2	340	6	2	Cotonou
Nigeria	11	0.06	0.52	32.7	1350	9	3	Apapa Tin Can
Rwanda	1418	-0.04	0.42	-7.2	476	15	1	Dar Es Salaam
Sudan	831	0.02	0.49	24.2	565	0	1	Port Soudan
Senegal	17	-0.01	0.45	14.5	415	8	2	Dakar
Sierra Leone	8	-0.06	0.40	29.8	75	4	1	Freetown
South Sudan	1338	0.09	0.55	94.9	770	7	1	Mombasa
São Tomé and Príncipe	3	0.13	0.60	27.9	10	0	1	Sao
Swaziland	539	-0.08	0.42	8.8	3200	0	1	Durban
Seychelles	0	-0.05	0.59	17.0	10	0	1	Port Victoria
Chad	1642	0.01	0.47	54.9	340	11	2	Douala
Togo	8	-0.01	0.45	28.8	350	5	3	Lome
Tunisia	13	-0.12	0.38	16.6	600	0	1	Rades
Tanzania	5	-0.08	0.38	30.9	476	15	1	Dar es Salaam
Uganda	1145	-0.05	0.41	2.9	770	7	1	Mombasa

South Africa	570	-0.03	0.50	6.0	3200	0	1	Durban
Countries	**Distance (Km)**	**Misalignment 2014**	**RER 2014**	**Time to import net of Km**	**Port, yearly container traffic (in thousands)**	**Private of port operators (years)**	**Nber of Private Port operators**	**Port of arrival**
Zambia	1051	-0.01	0.45	25,4	3200	7	1	Durban
Zimbabwe	1678	0.05	0.52	27,0	3200	7	1	Durban

Sources: *Distance*, *Time*, *Cost to import and the port of arrival* are from the *Doing Business* website. *Time to import* is independent of the distance at the average per ton/km continental cost. This variable consolidates port handling, customs clearance and border agencies, as well as excess time spent during inland transport due to road quality and procedures at border crossings. The Real Exchange Rates (*RER*) are from the World Bank's *World Development Indicators*. The authors have collected years with private port operators, the number of port operators, the port traffic, and the railway network. This information is mainly derived from PROPARCO, the French Development Agency (AFD): *Secteur Privé et développment le secteur portuaire en Afrique, plein cap sur le développement*, March-May 2017. For landlocked economies: port of arrival, and number of operators managing port terminals refer to the transit country. Logistic Performance Index and its components: *Customs* or *Infrastructure* are from the World Bank website. The Fragile States Index is based on conflict assessment framework, designed to measure vulnerability in pre-conflict, active conflict and post-conflict situations: //fundforpeace.org/fsi/indicators/.

Appendix 4. From maritime cost to domestic cost of transport and logistics

Dollars per TEU	2009	2010	2011	2012	2013	2014	2015
Maritime cost of a container from Shanghai							
Shanghai-West Africa (Lagos)	2247	2305	1908	2092	1927	1838	1449
Shanghai-South Africa (Durban)	1495	1481	991	1047	805	760	693
Domestic cost of transport and logistics in Africa							
North Africa	1014	1014	983	970	973	988	
West Africa	1830	1854	1877	1855	1892	2076	
East Africa	2194	2209	2169	2219	2760	2756	
Central Africa	2996	3089	4018	4018	4032	4107	
Southern Africa	2606	2769	3069	3093	3199	3291	

Source: Review of Maritime transport, 2016 UNCTAD; *Doing Business*, the World Bank, issues from 2008 to 2015.

Appendix 5. Instrumentation of the *Time* variable

	Reg 9, Table 5 Cost to import	**First stage regression** *Time instrumented*
Resolving Insolvency		***-0.257****
		(0.0809)
Time of neighbors		***-0.132****
		(0.139)
log (population)		***2.794****
		(0.910)
Southern Africa	-218.6	7.531***
	(329.2)	(6.890)
Central Africa	762.3***	20.92***
	(409.0)	(7.065)
East Africa	115.8	7.076***
	(244.3)	(5.380)
West Africa	189.8	11.47***
	(274.9)	(5.121)
Landlocked	-37.29	0.0622
	(382.3)	(5.150)
Island	-507.2***	-1.986
	(185.8)	(4.220)
Distance	1.791***	0.0250***
	(0.471)	(0.00524)
RER	2,641***	20.71***
	(703.6)	(14.17)
Time *instrumented*	21.66***	
	(10.63)	
Constant	-882.2***	-14.41*
	(337.5)	(17.76)
Observations	452	452
R-squared	0.802	R-squared = 0.47
		F = 25
Country FE	No	No
Year Dummies	Yes	Yes
Cragg-DW F-stat	38.14	
Sargan Statistics	3.048	Sargan statistics:
Sargan P-val	0.218	$S = nR^2 = 3.048$

Sources. World Development Indicators and *DB*, World Bank.
Time of neighbors is net of the impact of the distance in kilometers
N.B. Instruments for *Time* are provided in bold italics. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix 6. Real Exchange Rate (RER) misalignments

Appendix 6a. Ratio of conversion factor to nominal exchange rate:
Regression on per capita GDP and year dummies *(2006-2014, 190 countries)*

Variables	Coefficients linear model	Coefficients log linear model
[GDP – Rents] per capita	1.23e-05***	0.207***
	(2.05e-07)	(0.00422)
Year dummies	0.00310**	0.00829***
	(0.00152)	(0.00259)
Constant	0.427***	-2.387***
	(0.00880)	(0.0371)
Observations	1,629	1,620
R-squared	0.690	0.605

N.B. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

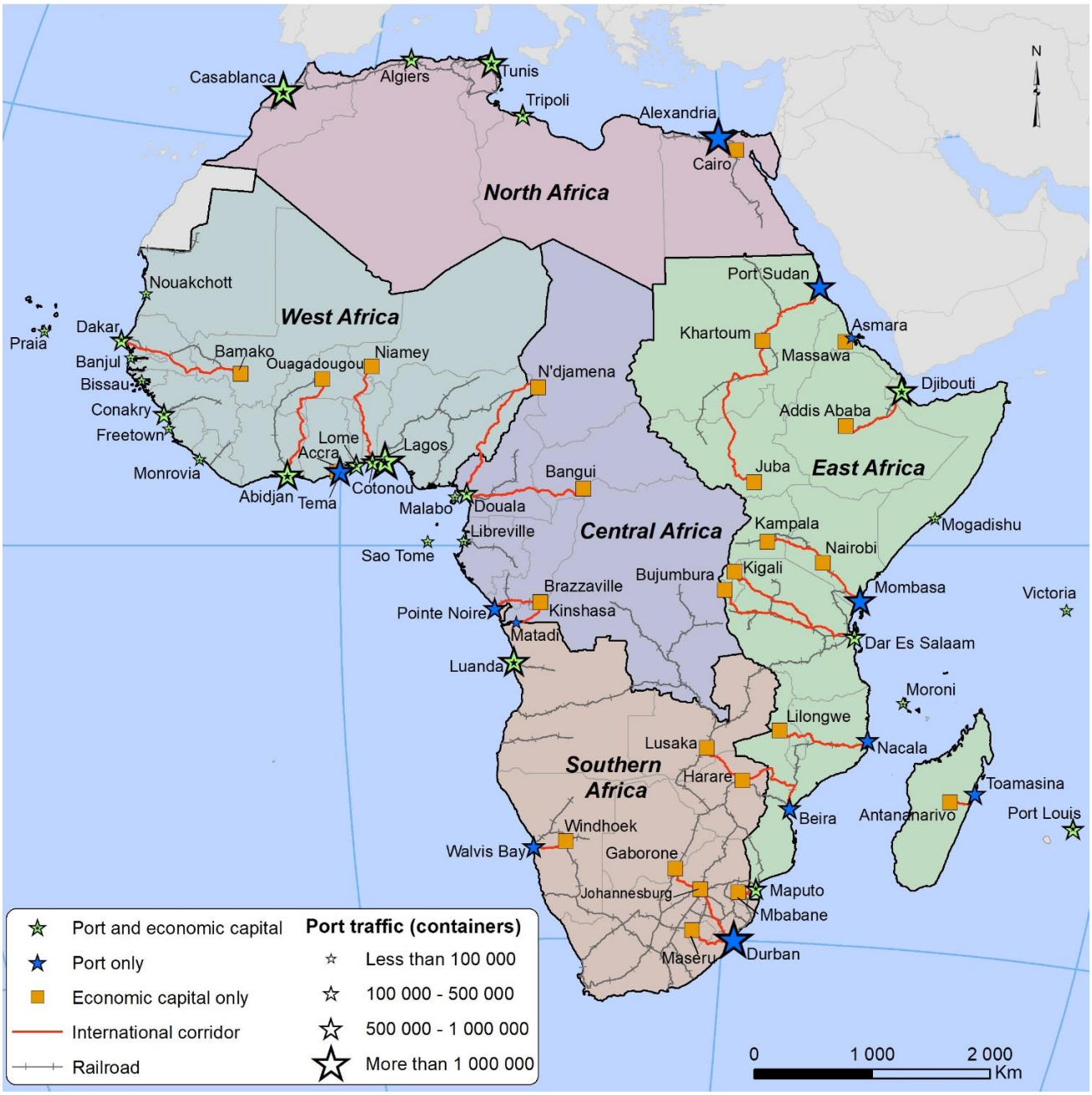
Appendix 6b. Sample of countries to adjust the real exchange rate for productivity

Regions	Number of countries	Income groups	Number of countries
East Asia & Pacific	28	High income: OECD	31
Europe & Central Asia	49	High income: non OECD	23
Latin America & Caribbean	34	Low income	36
Middle East & North Africa	20	Lower Middle income	51
North America	3	Upper Middle income	49
South Asia	8		
Sub-Saharan Africa	48		
Total	190	Total	190

Appendix 7. Domestic transport and logistics in Africa: simulation of cost savings

	Trade cost savings, in US$ (2006-2010)				Trade cost savings, in US$ (2010-2014)			
	RER	Time	Total cost saved		RER	Time	Total cost saved	
	Amount	Amount	Amount	(%)	Amount	Amount	Amount	(%)
AGO	329,42	1062,68	1392,11	61,74	593,67	961,89	1555,56	55,95
BDI	0,00	424,79	424,79	10,55	0,00	209,43	209,43	5,11
BEN	0,00	541,15	541,15	42,08	0,00	554,93	554,93	37,40
BFA	0,00	345,14	345,14	8,94	0,00	397,12	397,12	9,54
BWA	0,00	109,03	109,03	3,96	0,00	184,88	184,88	5,45
CAF	171,79	348,26	520,05	10,86	225,82	395,46	621,28	10,91
CIV	0,00	649,85	649,85	30,64	26,42	654,09	680,51	29,90
CMR	10,13	416,16	426,29	20,48	6,03	425,17	431,20	18,98
COD	219,73	1027,56	1247,29	40,20	331,88	1127,28	1459,16	39,22
COG	168,86	800,47	969,34	39,53	211,56	919,29	1130,84	19,58
COM	253,18	242,89	496,07	43,52	271,22	399,90	671,12	54,54
CPV	285,64	149,68	435,32	45,52	227,29	254,17	481,46	52,05
DJI	93,55	160,87	254,42	30,15	179,11	251,04	430,15	47,23
DZA	0,00	206,34	206,34	14,28	0,00	430,18	430,18	32,51
EGY	0,00	105,28	105,28	9,76	0,00	60,35	60,35	7,50
ETH	0,00	123,13	123,13	4,55	0,00	337,42	337,42	12,59
GAB	166,02	185,13	351,15	20,35	180,39	342,14	522,53	26,19
GHA	0,00	718,09	718,09	77,52	0,00	736,65	736,65	57,56
GIN	0,00	418,19	418,19	30,82	0,00	570,43	570,43	38,52
GMB	0,00	209,47	209,47	26,11	0,00	299,64	299,64	41,36
GNB	0,00	229,59	229,59	11,87	0,00	348,40	348,40	16,35
GNQ	0,00	698,06	698,06	42,71	0,00	878,94	878,94	54,15
KEN	0,00	271,27	271,27	12,39	0,00	123,77	123,77	5,47
LBR	0,00	419,29	419,29	34,50	178,61	523,78	702,39	53,02
LSO	43,03	497,05	540,08	39,38	34,81	377,17	411,97	23,50
MAR	0,00	60,97	60,97	4,06	0,00	0,00	0,00	0,00
MDG	0,00	369,68	369,68	28,26	0,00	173,41	173,41	10,97
MLI	0,00	397,19	397,19	13,77	0,00	24,48	24,48	0,78
MOZ	252,55	454,98	707,53	55,68	217,22	473,54	690,76	45,29
MRT	0,00	616,04	616,04	43,30	0,00	744,40	744,40	48,88
MUS	0,00	0,00	0,00	0,00	0,00	44,74	44,74	6,45
MWI	0,00	352,19	352,19	13,97	0,00	318,23	318,23	12,07
NAM	172,64	0,00	172,64	10,49	225,47	58,91	284,38	15,23
NER	0,00	607,23	607,23	19,65	1,20	735,59	736,79	20,86
NGA	0,00	752,85	752,85	61,00	66,74	733,21	799,96	53,40
RWA	0,00	506,36	506,36	12,27	0,00	0,00	0,00	0,00
SDN	0,00	654,62	654,62	30,74	0,00	405,83	405,83	13,99
SEN	73,20	209,63	282,83	14,45	23,63	175,67	199,30	9,89
SLE	0,00	463,51	463,51	41,05	0,00	520,26	520,26	35,32
SSD	0,00				135,55	2093,38	2228,92	24,01
STP	0,00	361,62	361,62	62,67	129,81	504,30	634,11	109,90
SWZ	0,00	49,79	49,79	2,53	0,00	101,76	101,76	4,86
SYC	32,52	124,79	157,32	17,96	0,00	248,38	248,38	29,95
TCD	116,72	1068,07	1184,78	20,00	78,27	1191,65	1269,92	15,76
TGO	0,00	425,32	425,32	43,19	0,00	501,17	501,17	44,56
TUN	0,00	255,10	255,10	37,12	0,00	245,01	245,01	28,54
TZA	0,00	494,03	494,03	41,17	0,00	531,69	531,69	35,11

UGA	0,00	192,73	192,73	6,54	0,00	0,00	0,00	0,00
ZAF	92,71	149,72	242,43	17,67	132,47	173,77	306,24	16,73
ZMB	0,00	421,35	421,35	13,96	30,41	492,42	522,83	10,09
ZWE	0,00	276,90	276,90	8,68	126,54	510,29	636,83	12,20


N
North Africa
West Africa
East Africa
Central Africa
Southern Africa
Casablanca
Algiers
Tunis
Tripoli
Alexandria
Cairo
Nouakchott
Dakar
Praia
Banjul
Bissau
Conakry
Freetown
Monrovia
Bamako
Ouagadougou
Niamey
Lome
Accra
Lagos
Abidjan
Tema
Cotonou
Malabo
Douala
Libreville
Sao Tome
N'djamena
Bangui
Port Sudan
Khartoum
Asmara
Massawa
Djibouti
Addis Ababa
Juba
Kampala
Nairobi
Kigali
Bujumbura
Mombasa
Mogadishu
Victoria
Dar Es Salaam
Moroni
Lilongwe
Nacala
Brazzaville
Kinshasa
Pointe Noire
Matadi
Luanda
Lusaka
Harare
Beira
Toamasina
Antananarivo
Port Louis
Windhoek
Walvis Bay
Gaborone
Johannesburg
Maputo
Mbabane
Maseru
Durban
Port and economic capital
Port only
Economic capital only
International corridor
Railroad
Port traffic (containers)
Less than 100 000
100 000 - 500 000
500 000 - 1 000 000
More than 1 000 000
0
1 000
2 000
Km

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[i] As noted by Freund and Rocha (2011), the difference between travel time according to GPS and *Doing Business* data is that the former are based solely on distance and estimated duration of travel. GPS data do not take account of delays due to border crossing, security, or road conditions.

[ii] For 2006-2010, [29.3/59.4]*100; for 2010-2014, [23/63]*100.

[iii] N.B. Data for 2016 was obtained from shipping agents and transit brokers. Maritime freight rates were provided for shipment from Antwerp and Shanghai by *Isys Logistique*, Roisssy (France). As with *Doing Business*, data on imported products exclude hazardous and military items, as well as goods requiring refrigeration or another special environment. Likewise, no account is taken of special phytosanitary or environmental safety standards. For two destinations, Shanghai-Durban and Shanghai-Lagos, Appendix 4 also gives data from the *Review of Maritime Transport*, UNCTAD, 2016, for the period 2009-2015.

[iv] For an interesting discussion on the "big push" for African countries, see Cadot and de Melo (2014). According to *Transparency International*, cited by Collier, Kirchberger and Söderbom (2015), the public works and construction sectors feature the highest incidence of bribery of officials.

[v] One reason is that politicians prefer "visible" actions, i.e., those most conducive to reelection (Lindsay, 1976). Building a new road is politically more rewarding than maintaining the quality of existing ones. This opens an intertemporal dilemma in resource allocation between maintenance and extension of the road network (Foster and Briceno-Garmendia, 2010). In a sample of 45 developed and developing economies, Battacharya and Collier (2011) found that natural resource rents are associated with lower stocks of public capital, especially in countries exploiting minerals, oil and gas, as opposed to countries with larger agricultural and forestry sectors. They interpret this negative correlation as evidence of governments plundering natural resources instead of converting them into productive assets.

[vi] Fink *et al* (2002) have regressed freight rates for US seaborne imports on the presence of (1) maritime cartels (i.e., shipping conferences), and (2) restrictive regulations applied to shipping (cargo reservation schemes) and port operations. They found evidence that cartels pushed up freight rates by about a third, however the evidence on restrictive regulations was inconclusive. See also Cadot and de Melo (2014).

[vii] On the supply side, a notable event in competition among shipping companies was the 2016 bankruptcy of Hanjin Shipping. Holding a 2.9% share of the global container market, this Korean firm was the seventh largest shipping line. Its bankruptcy was the biggest to hit the container industry in its over 50 years of existence.

[viii] From data on US imports and associated costs, Blonigen and Wilson (2008) create series across ports, products, and time. Building a gravity trade model, they find that a 10% difference in port efficiency corresponds to a 3.2% difference in trade between country pairs.

[ix] In the mid-2000s, container handling in Africa involved 10 to 20 moves per crane hour, compared with 25 to 30 moves elsewhere (Foster and Briceno-Garmendia, 2010). Against a standard time of one hour for a truck to deliver and pick up a container at terminal, effective times vary between 4 to 6 hours in East and southern Africa, and exceed 10 hours in West Africa.

[x] For example, Ivoirian transporters are allowed to carry only one-third of traffic to Ouagadougou (Burkina Faso), and can carry loads back to Abidjan only under case-by-case agreements. Anti-competitive regulations are also present in East Africa. Trucks serving the Mombasa-Kigali corridor may not carry freight on the return trip (Raballand and Teravaninthorn, 2009). These restrictions reflect conflicting economic and distributional objectives. The rules give every trucker a modicum of business, at a cost to competition and efficiency. To overcome these constraints, some medium-size firms combine transport and logistics in their operations. In a market-friendly environment lacking opportunism and uncertainty, some transactions would be outsourced (Williamson, 1975, 1985, 2000).

[xi] In the Abidjan-Ouagadougou corridor, where "coxers" pair shippers with carriers, their commission could be reduced with greater efficiency and a more transparent freight market. Commissions now vary between 100,000 and 200,000 CFA francs, or $160-320 US, more than 10% of the cost of domestic transport. Roughly the same fees are paid to customs agents in Abidjan.

[xii] "Door to door" refers to transport from the point of shipment to the final destination, i.e. from the seller's door to the place of delivery. Accordingly, door-to-door involves multimodal transport.

[xiii] Seven African ports have traffic exceeding 1 million containers: Alexandria, Damietta, Port Said, Tangier Med, Durban and Apapa Tin Can. Twenty-five years ago, only Durban exceeded 250,000 TEUs. Today, twenty-eight ports meet or exceed this volume.

[xiv] Potentially containerized exports equal total exports less oil, natural gas, coal, other minerals and forest products.

[xv] In addition, rail is less polluting and cheaper, since a train can carry 2,000 to 3,000 tons while a truck csrries only one or two containers.

[xvi] Central Africa has very high transport and logistic 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.

[xvii]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/.

[xviii] Maritime relationships between Douala (Cameroon) and Malabo (Equatorial Guinea) illustrate these complementarities.

[xix] Sequeira and Djankov (2014) identify three types of agents involved in the clearance process: customs officials, port/border operators and clearing agents.

[xx] 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.

[xxi] The Hausman-Wu test for *Time* and *RER* are not in the text but can be provided on request.

[xxii] In fact, the upper bound may exceed 1. This is the case for some Northern European countries. For example, in terms of purchasing power parity, Iceland's currency is overvalued by 32% *vis-à-vis* the US dollar.

[xxiii] Different distances have been tested but without greater success. The possibility of cost reduction by promoting transport multi-modality may also exist. We do not consider this effect as *Doing Business* assumes delivery by trucks.

[xxiv]Trade composition between exported and imported containers proved statistically significant in only one case and with a restricted sample (Reg 15, Table 5). Data on Africa's outgoing containers is not available by country, hence our proxy fails to capture the phenomenon.

[xxv] From Matadi to Kinshasa, the trucking industry pays a wide range of taxes and receives public services of poor quality. Trucks are assessed a road toll of $460 US per round trip. The paved road from Luanda is in good condition and free. On the Luanda-Kinshasa corridor, where port costs are reputed to be excessive, roadblocks comprise acute rent seeking in RD Congo. The 400 km. corridor from Luanda (Angola) to Lufu, at the Congolese border, features only one roadblock, compared with ten along the 200 km. from the frontier to Kinshasa. The presence of undeclared imports from Luanda is not the sole factor underlying these roadblocks.

[xxvi] According to Freund and Rocha (2011), customs, ports procedures and inland transport take on average three times longer in Africa than in OECD countries, while documentation procedures take four times longer.