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The Impact of Demand on Cargo Dwell Time in Ports in SSA

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Abstract

Long cargo dwell times in ports are a critical issue in Sub-Saharan African countries since they result in slow import processes and are bound to dramatically reduce trade. The main objective of this study is to analyze long dwell times' causes in ports in Sub-Saharan Africa from a shipper's perspective. The findings point to the crucial importance of private sector practices and incentives. The authors argue in the case of Sub-Saharan African countries that private operators, rather than being advocates of reforms in this area, might be responsible for the failures of many of these initiatives. It seems that in Sub-Saharan Africa importers' and freight forwarders' professionalism, cash constraints and operators' strategies are some of the factors that have a major impact on cargo dwell time. Low competency, cash constraints and low storage tariffs explain why most importers have little incentive to reduce cargo dwell time since in most cases, this would increase their input costs. However, monopolists/cartels may have a stronger incentive to reduce cargo dwell time but only in order to maximize their profit (and would not adjust prices downward).

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Produced by the Research Support Team

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1. Introduction

In recent years, there has been renewed interest in understanding the nature of constraints that freight costs impose on trade, investment, and growth, especially in landlocked countries in Sub-Saharan Africa (SSA). There is a consensus about the need for African countries to have an efficient and low cost transport system in order to become competitive in the global market, even though this does not guarantee successful exportations. Longer transport time which leads to slow import processes, dramatically reduces trade (Hummels and Schaur, 2012). The delays and the unpredictability increase inventories and result in uncompetitive exports. In the case of ports, long cargo dwell times (CDT) are a critical issue. More than half of the time needed to transport cargo from port to hinterland cities in landlocked countries in SSA is spent in ports for land transport to landlocked countries (Arvis *et al.*, 2010).

Over the last decade, the international donor community has been investing in projects that facilitate trade and improve trade logistics in the developing world. These projects have assumed incorrectly that customs, terminal operators and other controlling agencies are solely responsible for the long delays in ports, with infrastructure coming in second. In reality, customs' responsibility (especially for month-long delays) may not be as important as usually perceived and in-depth data collection and objective analysis are required to determine the actual drivers of long cargo delays. Such analysis has been lacking so far.

This study is part of a larger project conducted by the World Bank in 2011 which made possible the collection of data from firm surveys in several SSA countries. The paper analyzes cargo delays in ports based on data collected from the surveys conducted in Kenya, Nigeria[2], South Africa, Uganda, and Zambia. The surveys were conducted from March to July 2011. Each of these surveys includes about 100 observations. Importers - manufacturers and retailers - from the most important sectors have been covered. The ports covered are (South Africa), Mombasa (Kenya), and Lagos (Nigeria). The eligibility condition to qualify for the survey was that the firms import containerized cargo.

The study attempts to identify shippers' demand and practices related to cargo dwell time and perception and how it is linked to private sector market structure.

The findings indicate that several factors have a major impact on cargo dwell time, such as importers and customs and freight forwarders' (C&F) professionalism, cash constraints and strategies. This is actually a strong specificity in SSA. Market structure of the private sector also seems to explain the hysteresis of cargo dwell time.

C&F concentration has two main adverse effects on dwell times: the first one is the low negotiating power of clients with the main C&F agents that leads to low level of service, the second is the development of low cost unprofessional C&F agents that have no choice but to compete on price at the expense of quality for the rest of the market and allow to keep a system based on rent accumulation by public and private agents.

[2] Nigeria was selected because it undertook a major port reform but has continued to suffer from long dwell time. It is one of the most important African economies.

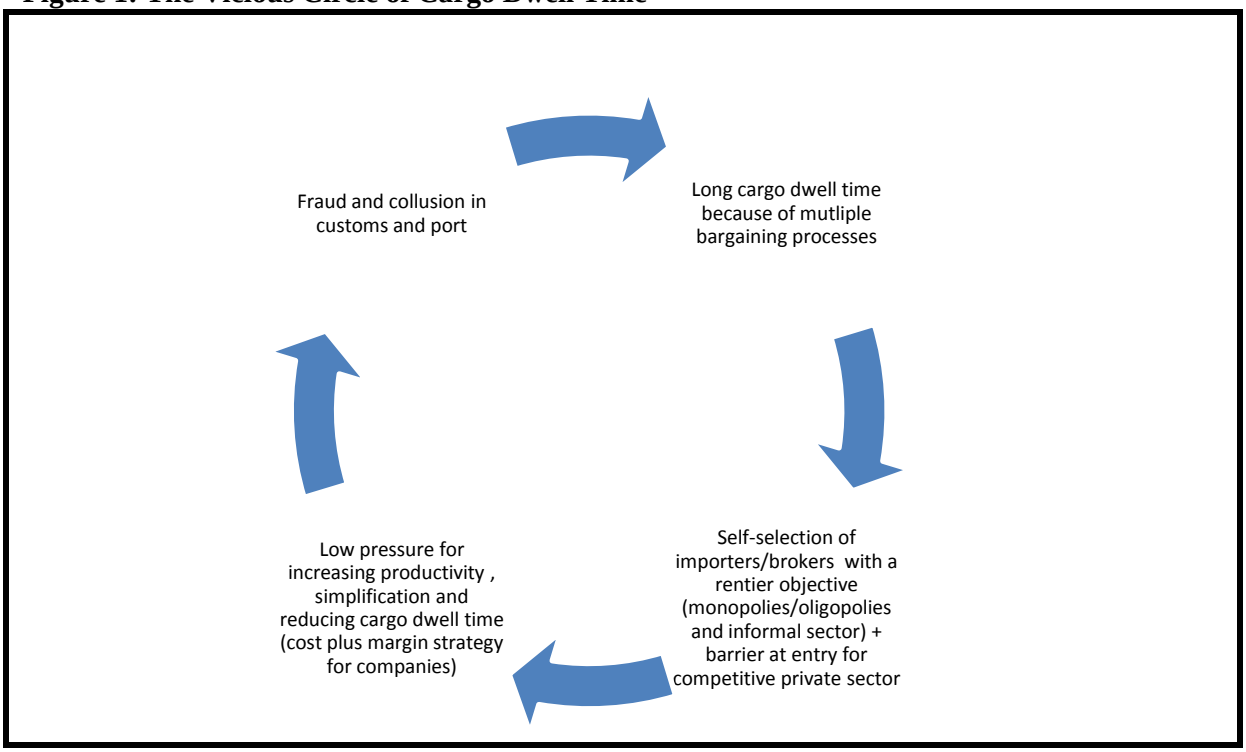
The analysis also demonstrates how weak logistics skills and cash constraints explain why most importers have no incentive to reduce cargo dwell time: in most cases, doing so would increase their input costs. Monopolies and cartels appear to have a stronger incentive to reduce cargo dwell time but in order to maximize their profits (and would not adjust prices downwards).

Moreover, importers from landlocked countries are even more potential victims of long cargo dwell times, and this because of even lower volumes and lower professionalism. Despite the fact that cargo dwell time for transit flows should be lower than for domestic flows, this explains rationally why in reality transit cargo dwell time is longer than domestic ones. Brokers and importers from landlocked countries are more likely to look for cost minimization strategies, which lead to behaviors perceived as irrational. However, inventory management for them is absent in their business strategy.

In most ports in SSA a vicious circle (Figure 1) in which long cargo dwell time (two to three weeks) benefits incumbent traders and importers as well as customs agents, terminal operators or owners of warehouses, constitutes a strong barrier at entry for international traders and manufacturers (Figure 1).

This also explains why cargo dwell time has not decreased substantially for years: The market incentives are not strong enough in most cases, and importers can secure revenues by avoiding competition. This circle has been broken in Durban by the presence of a strong domestic private sector interested in global trade and public authorities willing to support them.

Figure 1: The Vicious Circle of Cargo Dwell Time



Source: Authors'.

This exercise is, to our knowledge, the first of its type and does not answer all of the questions raised in this field. However, it demonstrates the crucial importance of studying private sector practices and incentives before designing any program aiming to reduce dwell time. The assumption that "importers are the victims of long container dwell time" is likely to be wrong in the case of many ports in SSA,

which probably explains the multiple failures of many initiatives in this area. Only a couple of importers may be on the side of reform.

2. An Analytical Demand Model – Some Theoretical Considerations

Long dwell times (which account for a large share of containers in terminals) are one of the key issues that needs to be addressed (probably across the continent) and are related mostly to factors under the control of shippers. This confirms one of the initial hypotheses of this analysis, which is that the behaviors and strategies of shippers have an impact on dwell times in ports. Demand by importers for port dwell time beyond the time required to complete port operations and transactions seems to be related mainly to inventory management and the "business model" used (including the extent of informal practices).

Due to the fact that the demand from importers seems to explain a large part of long dwell cargo, in this section we present theoretical foundations explaining current demand issues in SSA and then present some empirical analysis, based mainly on firm surveys.

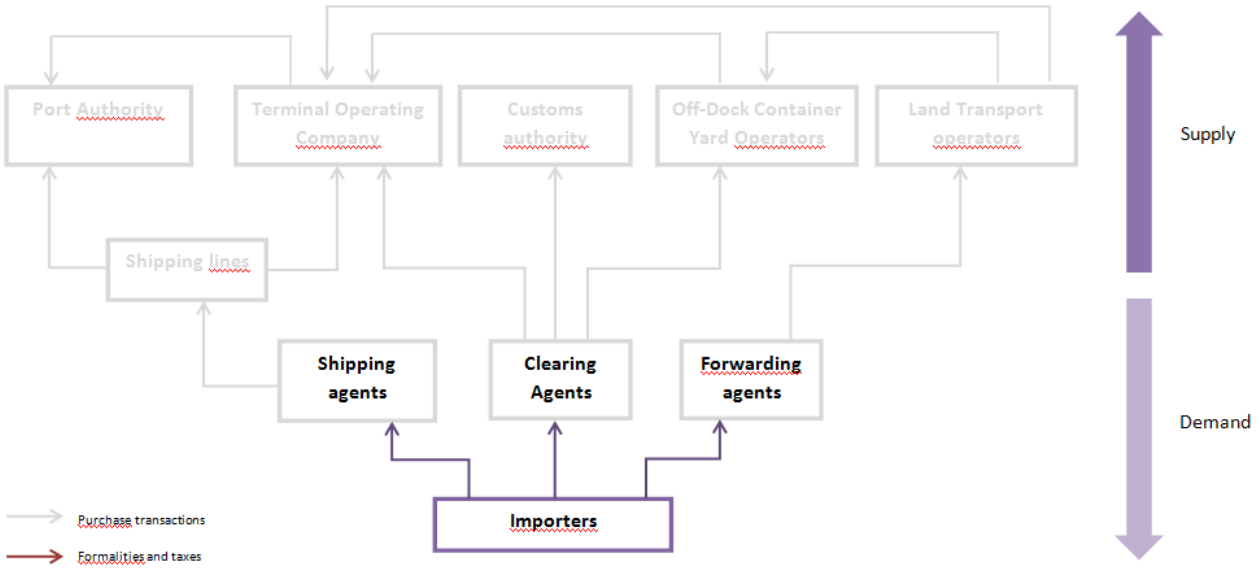
The model examines cost minimization strategies and profit maximization strategies. Coupled with various market structures, it seeks to explain why behaviors that are perceived as irrational, such as leaving cargo in the port are the best option for an importer. It describes the economic foundations of rational decisions with regard to container storage in port terminals and off-dock container yards (ODCYs).

Storage operations can be defined as a subcomponent of an international logistics pathway that starts with loading containers in the supplier's facilities and ends with unloading them in the customer's facilities. We define the logistics pathway as "a sequential set of logistics operations, warehousing, depot operations, port operations, trucking, and freight forwarding, which deal with the end-to-end movement of freight" (Magala and Sammons, 2008). In addition, we focus on containerized trade only, specifically containerized trade through international ports.

When deciding to import a certain quantity of containerized cargo, shippers have to choose either directly or indirectly (through contracted shipping and freight forwarding agents or logistics providers) what logistics pathway to use. This is an informed supply chain decision that is generally based on a combination of rational criteria such as cost, delivery time, frequency, and risk as well as some behavioral patterns (for example, repeat-buyer behaviors).

Our objective is to model how shippers make rational decisions about logistics pathways and, more specifically, what are the drivers of demand for storage in port terminals or ODCYs. Figure 2 presents the set of players involved.

Figure 2: Demand System for Container Imports



Source: Authors'.

By adopting a demand approach, we assume here that importers are the leading decision-makers in the selection of the logistics pathway and that they rationally select a logistic pathway based on maximization of their utility. These assumptions are relaxed later on.

We construct our demand model by adopting an abstract mode—an abstract commodity—approach that describes freight and storage alternatives by a vector of attributes rather than physical reality (Quandt and Baumol, 1969). Likewise, commodities are defined by a set of characteristics such as unit price or packaging and not by the commodity itself.

In the abstract mode approach, two shipping alternatives that share the same attributes relevant to shippers (for example, transit time, cost, level of service) are considered equal. And shippers arguably do not distinguish between two such shipping options because they are generally chosen by carrying and forwarding (C&F) agents and shipping lines with little information along the maritime transport route (e.g. survey results confirm shippers have little info about the transshipment hub used for their cargo).

A shipping alternative is therefore specified as a vector $X_i = X_{i1}, X_{i2},\ldots, X_{in,}$ where the element X_{ij} is the value of the *j*-th variable (for example, daily storage cost) characterizing shipping alternative *i*.

Likewise two commodities that share common characteristics (density of value, packaging) can be considered identical from a logistics view point and are referred to using an equivalent vector $Y= Y_{i1}, Y_{i2},\ldots, Y_{im}$.

We start by formulating total logistics costs associated with the selection of a logistics pathway and then construct a deterministic decision-making model based on minimization of these total logistics costs. Next, we look at profits rather than costs, and at how profit maximization strategies translate into the selection of a logistics pathway. Then we extend the analysis to a nondeterministic context in which model inputs cannot be precisely estimated *ex ante*. The nondeterministic model is especially

attractive for its ability to explain non-optimality. We finish by offering some concluding remarks and relax, in particular, the assumption of perfect rationality.

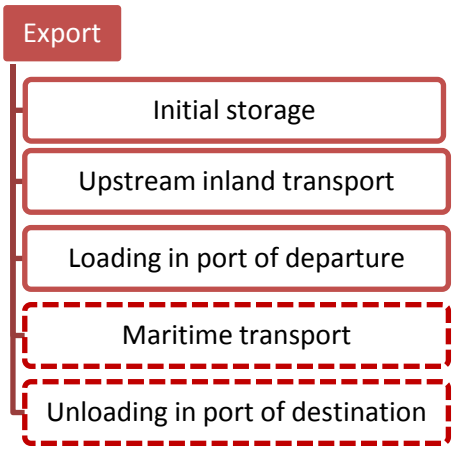
Cost Minimization Strategies

Total Logistics Cost Formulation in a Scenario of Perfect Certainty

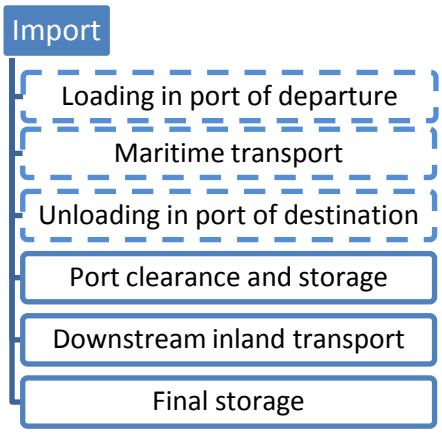
The logistics pathway depicted in Figure 3 for an international container trade operation consists of the sequence of an export and an import operation. The exporter (supplier) and the importer (customer) are both referred to as "shippers" because they are involved in selecting an international shipping alternative. A large set of international commercial terms (Incoterms) define precisely what the responsibility is of each player. Without loss of generality, we can assume that the typical split of responsibilities is as shown in Figure 3, with some variation for operations in the dotted boxes.

Figure 3: Typical Sequence of Operations under the Responsibility of Exporters and Importers for International Container Trade

a. Responsibility of exporters



b. Responsibility of importers



In this section, we formulate total logistics costs (TLC) for a standard import operation and model the choice of a logistics pathway by importers as the deterministic output of the minimization of this TLC. We therefore focus only on the sequence of operations described in Figure 3, panel b.

We start by defining a fixed container handling cost, $r_{h,}$ that encompasses both loading operations in the port of departure and unloading in the port of destination (terminal handling charges, transfer cost).

Maritime transport is defined by two variables: (a) a shipping rate, r_m, and (b) maritime transit time, t_m. The port clearance and storage leg comprises all fees and procedures attached to port clearance and storage in a port or an off-dock container yard before loading on a truck or train for final transport to the customer's facility. Let us define u_p as the variable port clearance cost (mainly storage cost, per storage day). Imported containers transiting through a given port of destination generally spend a number of days, t_p, in this port or its dependencies (ODCYs) that is the sum of three components:

- t_1 = transfer time (to unload the container from the vessel and transfer it to the yard)
- t_2 = storage time spent in the container terminal or ODCY before loading it onto a truck or train
- t_3 = procedural time (for clearance procedures and controls).

t_1 is a port attribute that we assume is identical for all shippers and is insignificant with respect to t_2 and t_3,[3] while t_2 and t_3 are specific attributes depending on both the commodity and the shipper.
We also use other attributes of the commodities:

- T = total quantity of commodity Y that is imported yearly
- V = unit value of commodity Y
- b = depreciation rate (interest plus obsolescence)
- s = mean interval between reorders (in years)
- r_d = rate for duties and taxes.

Whatever the final use of the commodity imported (production input, consumer goods), we consider here that the importer has estimated his total quantity of imports T for the ongoing year and has opted for some fixed-interval fixed-quantity replenishment strategy. Other replenishment strategies can be considered later as derived from this simplified case.
We then define the following:

- a = cost of ordering and processing a new reorder
- d = discount rate
- i_p = average inventory level in the port or ODCY storage facility
- i_f = average inventory level in the private storage facility

Inland transport is defined by freight rate, r_i, and freight transit time, t_i. Final storage is available at variable cost u_f, with storage time t_f.

Let us then formulate the total logistics cost, C, of our shipper with regard to imports of commodity Y in the ongoing year:

TLC = ordering cost + maritime shipping costs + port clearance cost
+ inland transport cost + final storage cost + financial cost **(1)**

We consider these six terms one at a time:

1. Ordering cost = cost per reorder x number of reorders = a/s
2. Maritime shipping cost = shipping rate x total quantity shipped = $r_m T$
3. Port clearance cost = fixed clearance cost + variable clearance cost, where fixed clearance cost = fixed container handling cost x amount shipped = $r_h T$, and variable clearance cost = cost per unit of time x storage time x inventory level = $u_p t_p i_p$
4. Inland transport cost = freight rate x total quantity shipped = $r_i T$
5. Final storage cost = cost per unit of time x storage time x inventory level = $u_f t_f i_f$

[3] Typical value for t_1 is less than one day, while t_2 and t_3 have typical values of five to 40 days.

6. Financial cost = taxes + depreciation + cost of capital, where taxes = rate for taxes and duties x unit value x amount shipped = $r_d VT$, depreciation cost = depreciation rate x unit value x amount shipped x total transit time = $bVT(t_m + t_p + t_i + t_f)$, and cost of capital = discount rate x total early payment x coverage time.

Early payment consists of the payment of all taxes, duties, charges, and fees to agents in charge of shipping and clearance operations as soon as cargo exits the port. Coverage time is time between this payment and the effective sale and is thus equal to t_f. We therefore have the following:

Cost of capital = $dt_f(r_m T + r_h T + u_p t_p i_p + r_i T + r_d VT)$. (2)

We now combine the six elements of the cost function (functions 1–6) to obtain:

$$TLC = {}^{a}/_{S} + (1 + dt_f)(r_m T + r_h T + u_p t_p i_p + r_i T + r_d VT) + u_f t_f i_f + bVT(t_m + t_p + t_i + t_f) . \quad (3)$$

Cost Minimization in a Scenario of Perfect Certainty

In function 3, there are seven alternative variables for shipping, r_m, r_h, t_1, t_m, t_i, u_p, and u_f, and nine commodity- or shipper-specific variables, a, s, T, t_2, t_3, t_f, r_d, r_i, and V. The two inventory-level variables, i_p and i_f, are a function of transit time and order quantity.

We now consider different situations that confront shippers, depending on the storage facilities available before final delivery. From a logistical point of view, shippers can be split into two limit cases: shippers who use their private facilities or third-party storage facilities outside the port as their main warehouse and shippers who use the storage services of the port and its dependencies as their primary warehouse.[4] This segmentation is a critical dimension of logistics chains in Africa when it comes to port dwell time in container terminals, and it goes back to the differentiation between "bottleneck-derived terminalization," in which the port terminal is essentially a source of delay and a capacity constraint in the shippers' supply chains, and "warehousing-derived terminalization," in which the terminal replaces warehousing facilities of the shippers and gradually becomes a strategic storage unit (Rodrigue and Notteboom, 2009). We show here that this "warehousing-derived terminalization," together with the cost minimization and profit maximization strategies of shippers, is the main explanation for long dwell times in African ports.

Shippers without private storage facilities

We start by looking at the cost minimization behavior of shippers who do not have private storage facilities and who have to leave their cargo in the port storage area until final delivery to clients or production facilities. For those shippers, we have

$i_f = 0$ and $t_f = 0$. (4)

The only inventory hold is therefore ip (inventory in port or ODCY), and in a scenario of perfect certainty average inventory level is

[4] In practice all shippers can be grouped into one of the two categories according to the importance of port and warehouse storage time.

$$i_p = {Ts}/{2}\,. \qquad (5)$$

Equation 3 therefore becomes

$$TLC = {a}/{s} + T\,(r_m + r_h + {1}/{2}\,u_p t_p s + r_i + r_d V + bV(t_m + t_p + t_i)) \qquad (6)$$

Total logistics cost is therefore strictly growing with respect to all time markers t_m, t_p, and t_i, and a rational cost-minimization behavior would therefore lead shippers to minimize transit and dwell times.

Shippers now must determine the optimal replenishment interval, s. Cost minimization with respect to s leads to

$$\partial TLC/\partial s = -a/s^2 + u_p t_p T/2 = 0, \qquad (7)$$

so that

$$s = \sqrt{\frac{2a}{u_p t_p T}}. \qquad (8)$$

For example, if we set

- Cost per reorder: $a = \$400\ /TEU$; (20-foot equivalent unit)
- port storage cost u_p: 2 weeks free time ; $u_p = \$20/day$ for the next two weeks; $u_p = \$40/day$ thereafter
- $t_p = 25\ days$
- Annual quantity imported T = 200 TEU

The optimal interval time *s* would be equal to 52 days and there would be seven reorders per year.

The optimized interval between reorders is inversely proportionate to t_p, which is the time to perform all physical operations, controls, and procedures in the port. An inefficient port clearance system with very long clearance time would therefore encourage shippers to have shorter replenishment intervals and split their annual orders into smaller and more frequent delivery batches.

Shippers can also act on their Economic Order Quantity (EOQ denoted Q) as well, in order to minimize their total logistic cost. By assuming that the annual imported quantity is the result of the multiplication of the number of deliveries per year and the economic order quantity, then

$$T = Q/s \qquad (9)$$

Therefore cost minimization with respect to Q leads to

$$\partial TLC/\partial Q = -aT/Q^2 + u_p t_p T/2 = 0\ , \qquad (10)$$

So that,

$$Q = \sqrt{\frac{2aT}{u_p t_p}} \qquad (11)$$

If we take the same previous example, the Economic Order Quantity would be equal to around 28 TEU.

The EOQ is inversely proportionate to t_p. An inefficient port clearance system with very long clearance time would therefore encourage shippers to have smaller delivery batches and therefore

shorter replenishment intervals and more frequent orders. This deduction is inline with the previous one (equation 8).

Shippers with private storage facilities

Let us now consider shippers who possess or have access to some storage facilities outside the port. Assumption 3 is no longer valid.

As soon as clearance procedures and controls are completed, shippers choose between the two storage options: leaving cargo inside the container terminal or ODCY and clearing it and storing it in their own storage facilities. Let us analyze these two options:

$$\Delta TLC = {}^{1}/_{2}\, Ts\, \tau\, (u_f - u_p) + T\tau^2\, d(r_m + r_h + r_i + r_d V), \qquad (12)$$

where τ is the additional number of days that the cargo would have to stay in the port in the first option.

The condition for this difference to be negative is therefore

$$\Delta TLC < 0 \iff u_f < u_p - {}^{2d}/_{S}\,(r_m + r_h + r_i + r_d V). \qquad (13)$$

In other words, if the extra financial cost subsequent to an early clearance of cargo from the port outweighs the potential savings in storage cost, there is no benefit to clearing the cargo from the expensive port storage area and moving it to cheaper storage facilities outside the port.

Despite potential savings in inventory holding costs, shippers might therefore be willing to leave their cargo in the container terminal or ODCY because they cannot pay all of the port clearance charges and fees in advance. Instead, they wait until they have sold the cargo to pay these expenses.

For example, if we set the unit cost per TEU as follows:

- port storage cost u_p: 2 weeks free time; $u_p = US\$20/day$ for the next two weeks; $u_p = US\$40/day$ thereafter
- private storage cost: $u_f = US\$15/day$;
- shipping rate: $r_m = US\$1200$
- container handling charge: $r_h = US\$300$
- freight rate $r_i = US\$75$
- rate for taxes and duties: $r_d = 20$ percent
- discount rate: 12 percent per year (0,032 percent per day)
- interval between orders s $s = 1/4$ (one order every three months)
- cargo value: V = US$20,000 per TEU

We get ${}^{2d}/_{S}\,(r_m + r_h + r_f + r_d V) = \text{US\$15},$ and condition B.10 would therefore happen only after four weeks. In this scenario, the shipper would leave the container in the port for a full month even if cargo were cleared more quickly.
In reality, we get a very important justification for long dwell times: clearance is cash-eager.

In our example, the shipper would have to pay US$5,575 in advance to clear his cargo from port, which is a significant amount of money that he might not have in hand before concluding the sale. The financial cost for early clearance (US$15 per TEU) is valued more heavily if the shipper faces cash constraints, as is often the case with imports of commodity products or with new producers, and

clearance from port would be even more delayed in such a case. As we see later, many importers eventually abandon their cargo in the port because they cannot afford these advance payments.

Profit maximization strategies

Our analysis so far has assumed that shippers make logistical decisions by trying to minimize total logistics costs. This is a rational, though partially inaccurate, assumption. It is more accurate to state that shippers make logistical decisions by trying to optimize profits. Now the reality is that, in a perfectly competitive market, prices are exogenous, and the final price of commodity *Y* is therefore independent from the logistical decisions of individual shippers. Because profits equal revenues minus costs, optimizing profits equals minimizing costs in these situations.

But if we assume that the price of commodity *Y* is affected by the logistical decisions of shippers, we have a different situation. Let us use π to define profits and *R* to define revenues. We have revenues equal unit price times total sales:

$$R = p\,T \qquad (14)$$

where *p* is the unit price of commodity *Y*.

The price of commodity *Y* can be affected at different levels by market conditions and the logistical decisions of shippers. Let us analyze an alternative pricing scenario before coming to any conclusions about the potential outputs of profit maximization strategies.

Pricing Strategies of Monopolists

We begin by analyzing which alternative pricing strategies a monopolist can adopt. Monopolies are very particular situations, in which a single firm accounts for the total sales of a given product *Y*. In such a context, this firm can arbitrarily set the price *p* of product *Y*, and customers will have no choice but to purchase the product at that price or to refuse to purchase it.

A monopolistic position is advantageous because the firm has very strong market power. However, the profit that this firm would make in alternative pricing scenarios also depends on market demand, and despite its power to set the price *p* at any desired level, the firm cannot force customers to purchase the product.

If we have a smooth demand function *D* as in Figure 3b, for any given annual level of output T_e, we can demonstrate that there is a unique optimal price p_e that would optimize profits of the monopolist firm. This price is the unique solution of the following equation:

$$\partial\pi/\partial T = 0 \iff \partial R/\partial T - \partial TLC/\partial T = 0, \qquad (15)$$

which we can also write as $MR = MC$, where MR is the marginal revenue $\partial R/\partial T$ and MC is the marginal cost $\partial TLC/\partial T$.

In this case, the optimal price p_e is higher than the equilibrium price that would be observed in a competitive market and the corresponding annual level of output T_e is lower. In other words, the monopolist sells less, but at a higher price than companies in free competition.

Formula (15) leads to the calculation of the optimal price as the following:

$$p_e = (r_m + r_h + 1/2\, u_p t_p s + r_i + r_d V + bV(t_m + t_p + t_i)) \qquad (16)$$

Therefore, the profit of the monopolist will become:

$$\pi = pT - TLC = T(p - p_e) - \frac{a}{s} \quad (17)$$

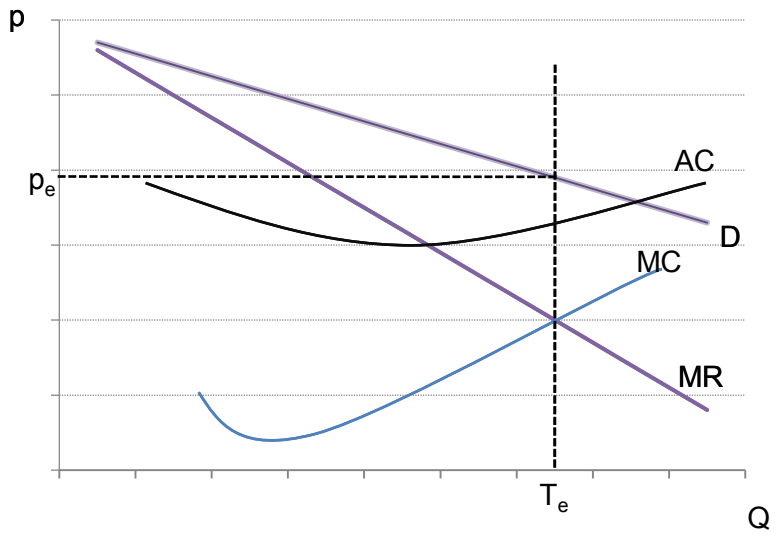
If the market price is stable and not highly volatile, it clearly appears that the monopolist would prefer to leverage its supply chain decisions by increasing the re-order interval. By introducing the formula (8), the profit can be expressed with regards to the dwell time as the following:

$$\pi = T(p - p_e) - a\sqrt{\frac{u_p t_p}{2a}} \quad 18)$$

Monopolist profit is then affected by longer dwell time.

Figure 4 presents the equilibrium that is reached when a monopolist has U-shape costs and linear demand.

Figure 4 Monopoly Equilibrium



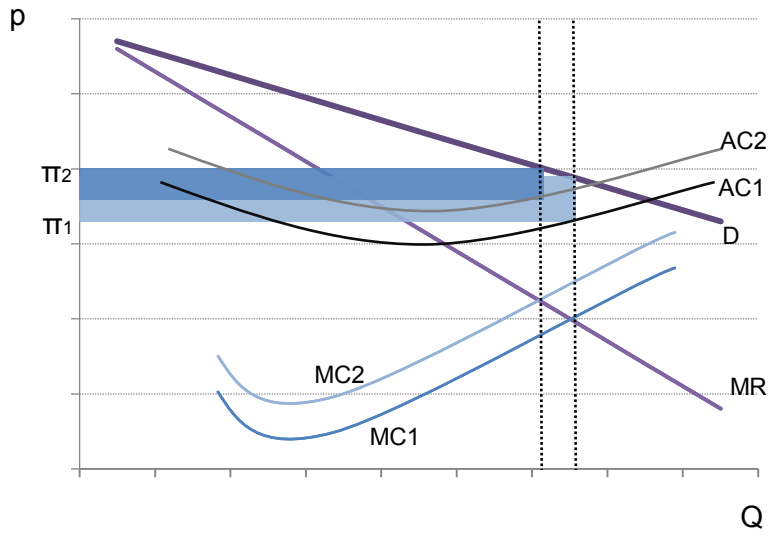
Source: Authors.

Now let us return to the issue of dwell time. We have demonstrated that, except for some specific cases where port storage is a cheaper option than private storage, longer port dwell time generally translates into higher total logistics costs. Higher port dwell time in Figure 4 would shift the MC curve upward.

The new equilibrium price that would optimize profits of the monopolist firm would therefore be superior to p_e, and the corresponding output level, T_e, would be lower. In short, the company facing longer dwell times would sell even fewer units, but at an even higher price. This is evident in the trade of consumer goods in the countries under consideration (low demand and high prices).

But we can demonstrate analytically that, in general, this results in a net loss for the monopolist company because the higher price does not make up for the lost sales (in Figure 5, the darker $\pi 2$ section is smaller than initial profits $\pi 1$).

Figure 5 Translation of Monopoly Equilibrium and Profit Variation in the Scenario of Higher Dwell Time



Source: Authors.

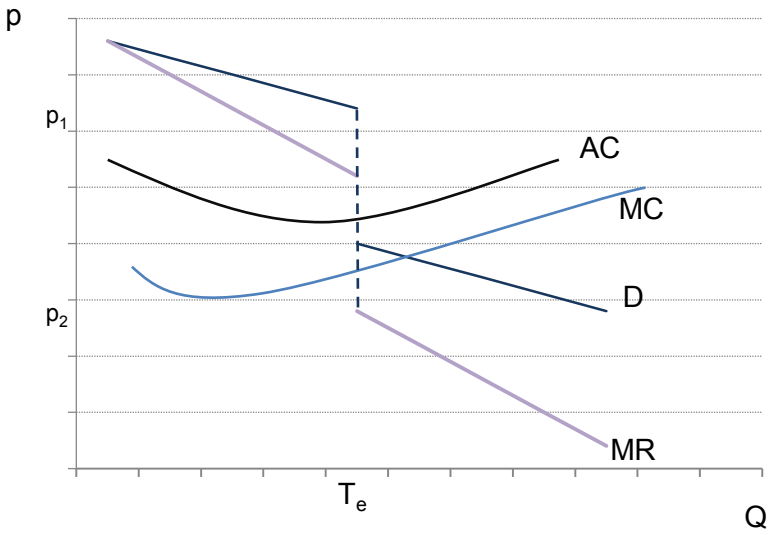
Therefore, a rational monopolist that charges the profit-maximizing price will seek to reduce port dwell times to optimize profits. However, other pricing behaviors of monopolist companies seem to contradict this conclusion.

A few traders operating in monopolistic situations, especially in landlocked countries, set their prices such that their profits are not affected by adverse logistics conditions, such as delays in delivery and congestion in ports. They just calculate their total logistics costs for each operation after delivery and apply a constant markup to set the final selling price (cost-plus strategy). These traders seem to be indifferent to longer dwell times because their margins and profits are unaffected and they pass on to their customers any extra logistics costs due to longer dwell time.

However, if we try to project this situation, we reach a different conclusion: higher marginal costs would normally lead to different monopoly equilibrium, with a higher selling price, but also lost sales. If the company manages to keep its total profits unaffected by a price rise, the demand curve will be different from the one depicted in Figure 5.

In this case, we have a situation close to the one depicted in Figure 6, where demand is inelastic to price, at least for reasonable price variations. Very desirable products, such as critical production inputs or indispensable food supplies or drugs, perhaps would be purchased by customers at any price, unless their price reaches unaffordable levels or becomes so high that the customer would bear the consequences of not buying the product. We can represent demand in this context by a vertical line or a kinked curve of the kind shown in Figure 6.

Figure 6 Monopoly Equilibrium with a Kinked Demand Curve (Inelastic Demand between Two Price Boundaries *p*1–*p*2)

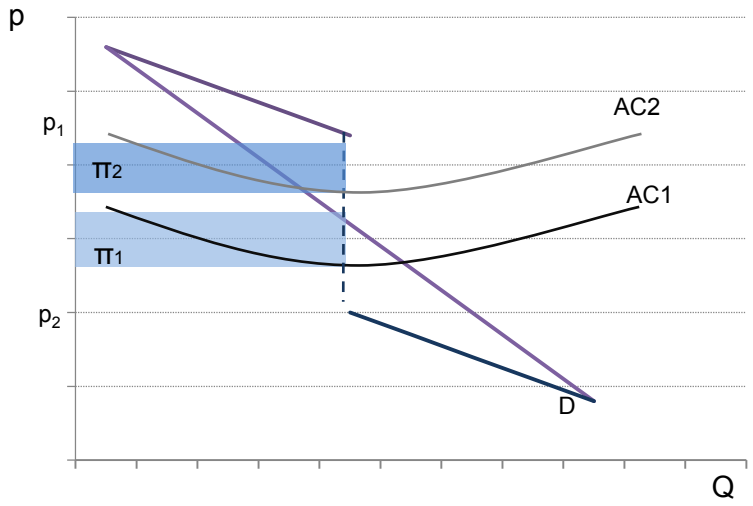


Source: Authors.

Demand for product *Y* is normally equal to T_e in this scenario, which would be, for example, the total number of people affected by a given disease every year who absolutely need to purchase medication. However, if the price reaches a superior boundary p_1, some of these patients will not be able to afford this medication and will not purchase it. If the price is as cheap as p_2, some healthy people will rush to purchase the drug at this competitive price, either to use it or to resell it later. In between these two boundaries, all normal users will be willing to purchase the drug, regardless of the price. The monopolistic traders choose to apply a constant markup to keep their profits unaffected, even in the case of higher total logistic costs.

In Figure 7, the darker π_2 section is equal to initial profits, π_1, despite the net increase in average cost. In addition, in this case the cost-plus pricing strategy is not the profit-maximizing strategy (a price of p_1 would optimize profits in both cases). But it might be a better strategy in the long term, because charging the maximum price, p_1, to all customers willing to pay a price between p_2 and p_1 might lead to a significant amount of lost sales if market demand evolves toward a continuous demand curve between the two price segments observed. Said differently, the inelastic demand function observed here is very likely to be elastic in the long term, because customers would find substitutes. The monopolistic trader therefore prefers to raise his prices to reflect higher logistics costs but to lower the price when logistics costs fall again. However, it is socially impossible to charge very high prices for necessity goods, and a monopolist would therefore face social unrest and public regulation if he were to raise his prices to the profit-maximizing price in all situations.

Figure 7 Translation of Monopoly Equilibrium and Profit Variation in the Scenario of Higher Dwell Time and Cost-Plus Pricing Strategy



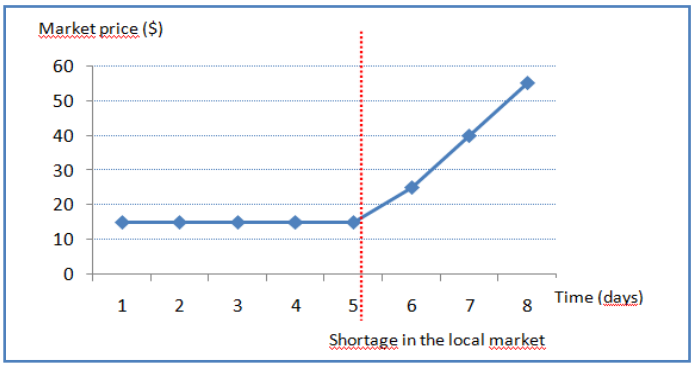
Source: Authors.

The second conclusion is therefore that a monopolist who opts for a cost-plus pricing strategy when demand is inelastic to price will not be affected in the short term by higher logistics costs and will make no effort to reduce dwell times in case of a punctual congestion or punctual inefficiencies of port operators. Such a scenario is likely to happen for cyclical patterns of demand that are elastic to price only in the long term (food supplies, drugs, equipment).

A third pricing behavior derived from this situation of inelastic demand and observed among monopolistic companies is opportunistic pricing. Such traders use, for example, the pretext of higher logistics costs to increase substantially their selling prices. It is especially the case for category C (landlocked countries traders) during rainy seasons or port congestion periods. For example, a 10 to 20 percent increase in total logistics costs might translate into a 30 percent increase in price. If we refer back to Figure 7, traders would charge price p_2 as soon as any difficulty is noticed in the port or along the transport corridor.

Another example of opportunistic behavior is when shippers prefer leaving their cargo in the port until the price peaks in an upward season. They create an artificial shortage in the local market and delay early deliveries until market prices rise. For example, in a situation similar to the one depicted in Figure 8, deliveries will be postponed for at least six or seven days. This is a very particular situation, where rising costs do not constitute a sufficient incentive to accelerate the clearance of goods because expected profits more than balance the extra costs.

Figure 8 Price Hike in a Shortage Situation



Source: Authors.

Uncertainty about future profits or market risks generally leads traders to behave on the basis of expected expenses and returns rather than absolute levels. The three pricing strategies just discussed (monopoly equilibrium pricing, cost-plus pricing, and opportunistic pricing) are thus complemented by an analysis of expected profits and costs in the next section.

Regulation and market controls such as import quotas, price ceilings and floors, or taxation tools also affect pricing decisions of monopolists.

Pricing Strategies of Oligopolies

Oligopolies are situations in which a few firms account for the totality of the sales of product *Y*. Although economic theory generally leaves the oligopoly situation aside and starts by studying the theoretical aspects of free competition and monopolies, the prevalent competitive context of most market segments, especially in Sub-Saharan African countries, is arguably the oligopolistic context.

In this context, firms cannot neglect the market power of competitors, which is negligible in both the competitive and monopolistic situations. Price is affected by the moves of other firms and is not exogenous, and some competitors have a non negligible size in relation to the total size of the market, which gives them substantial market power.

This distribution of market power in the hands of a few firms can lead to several typical situations and strategies, and economists generally distinguish between the following ones:

- Cartels
- Leader-followers
- Price war (Bertrand competition)
- Nash equilibria–Cournot competition
- Kinked oligolopy.

Cartels and Leader-Followers

Cartels act as a virtual monopolist company: market players agree on prices so that they maximize profits in a consensual manner. In leader-follower situations, a single company, usually the biggest market player, imposes its pricing strategy on the other market players, who avoid any competitive move that would upset the leader. In short, the leader acts as a virtual monopolist, and followers are subject to its pricing strategy. These first two oligopolistic situations therefore lead to situations comparable to the monopolistic situation:

- It is in the general interest of profit-maximizing firms to reduce dwell times.

- In particular situations with inelastic demand, higher costs might have no noticeable impact on profit levels, and traders will be indifferent to higher dwell times.
- Opportunistic pricing strategies are used punctually by traders to charge higher prices and increase their profits, despite longer dwell times and higher logistics costs.

Price War

Price war is the particular consequence of a duopolistic or oligopolistic situation where firms refuse to cooperate and favor short-run selfish interests. Firms act as price takers and compete by setting prices simultaneously so that the competitive equilibrium is reached despite the limited number of firms. In this context, companies end up pricing goods at marginal cost, and higher dwell time simply translates into higher marginal costs but does not affect the competitive equilibrium: all companies try to reduce dwell time and logistics costs to optimize profits. This is sometimes observed in the trade of second-hand products such as fabrics, electronics, and cars, where some companies are as efficient in terms of cargo clearance time as the largest companies operating in the market, simply because they are trying to win any marginal competitive advantage over their few competitors.

Nash Equilibrium

A third interesting situation in which firms try to optimize their profits given the decision of other players leads to what is known as Nash equilibrium. It is the most documented scenario and has been deeply analyzed using the powerful body of knowledge of game theory. There is a large set of possible strategies, including collusion, Cournot pricing, or good-faith behavior, but the most important conclusion for our analysis is that cooperative behaviors are generally preferred because they are most profitable for all players.

We are interested here in possible reactions to rising total logistics costs as a consequence of higher dwell times. We can expect in this context that cooperative pricing strategies will not challenge existing price equilibriums and will lead either to limited price adjustments to outweigh additional costs or to relatively stable prices to avoid the risk of lost sales.

Kinked Oligopoly

Finally, the interesting kinked demand curve theory also helps to explain why prices are quite stable in oligopolistic situations and why discrete price adjustments are more frequent than continuous variations. The fear of the unpredictable consequences of price changes is instrumental in discouraging the few players to undertake any disequilibrating price move. Short-term variations are seldom envisaged, and there is a threshold phenomenon where all companies keep prices stable despite variable logistics costs. This is observed in the consumer goods industry, where clients know prices because of advertising, and companies do not risk destabilizing the market even if they face higher logistics costs as a result of port congestion, for example.

The Issue of Uncertainty and Its Impact on Profits

In the first section of the model we present a cost-minimization model that leads to alternative strategies of operators who do and do not possess private storage facilities. These strategies explain the behavior of operators who generally intend to minimize the dwell time of their containers in port, except when they face cash constraints or prohibitive financial costs.

To construct the model, we make a very strong assumption that traders have a perfect certainty about market demand and dwell times. We relax this assumption here and address the impact of uncertainty from an inventory management perspective. Uncertainty also affects revenues to a larger extent

because of the possible impact on prices and thus revenues. We then address the issue of expected revenues and profits. We show that taking uncertainty into account does not change the dynamics of cost minimization or profit maximization; it actually strengthens the conclusions stated at the start of this paper.

Inventory Management and the Issue of Safety Stocks

We have assumed that transit times and demand forecasts are perfectly predictable. This is a strong assumption that does not match reality. In practice, shippers hold an extra amount of stock, known as safety stock that both covers risks and helps to prevent a shortage of stock in case of congestion, damage during transit, or unanticipated peak in demand.

There is a large set of inventory management practices, and proper dimensioning of safety stock is a painstaking task, especially for unreliable supply chains. The trade-off is to try and reduce, on the one hand, the level of safety stock to keep inventory costs low, but to have, on the other hand, enough extra stock to buffer against stockouts if actual demand exceeds expected demand, for example.

Let us calculate safety stock for these occurrences first—that is, demand forecast errors. A commonly used safety stock calculation is as follows: Safety stock = service factor x standard deviation of demand x lead time$^{1/2}$. For example, the service factor is 1.64 at the 95 percent satisfaction level, if we assume normal distribution of errors in demand forecast.

Standard deviation of demand should be estimated using approximated distribution based on empirical values. Let us assume, for example, that yearly demand of commodity *Y* is well approximated by a Poisson process of parameter *T*. The standard deviation in this case is $T^{1/2}$.

Different formulas are used for dwell time, depending on the shipper's aversion to risk (maximum lead time, minimum lead time, median value). In this case, we consider that the shipper has no ability to reorder during interval *s*. The maximum lead time in case of shortage is therefore the interval between two replenishments plus total transit time: lead time = s + $t_m + t_p + t_i$.

We, therefore, get the following formula for safety stock, *SL*, corresponding to an error in demand forecasts only:

$$SL = 1.64\sqrt{T}\sqrt{\mathrm{s} + t_m + t_p + t_i}\,. \qquad (19)$$

The safety stock corresponding to errors in forecast and uncertainty of transit time is given by a more developed formula:

Safety stock = service factor x (average lead time x standard deviation of demand^2 + standard deviation of lead time^2 x average demand).$^{1/2}$ (20)

The first term corresponds to shortages because of an error in forecast, while the second corresponds to shortages because of an uncertainty in lead times.

If we keep the same assumption of normal distribution of errors and Poisson processes (for both demand and transit times), we get the following:

$$SL = 1.64\sqrt{2\mathrm{T}\left(\mathrm{s} + t_m + t_p + t_i\right)} \qquad (218)$$

If we add the latter expression of safety stock level to the average stock in process *Ts*/2, we get a new average stock level:

$$i = {}^{Ts}/_{2} + 1.64\sqrt{2\mathrm{T}(\mathrm{s} + t_m + t_p + t_i)}. \qquad (22)$$

For example, if we set:

- Annual quantity imported, T = 200 TEUs
- Interval between reorders, s = 90 days
- Maritime transit time, t_p = 15 days
- Port dwell time, t_p = 25 days
- Inland transit time, t_i = 5 days,

We get an average stock level i = 45 TEUs, decomposed into 25 TEUs of strategic inventory and 20 TEUs of safety stock.

This stock is split between inventory inside the port storage facilities and inventory in private storage facilities. The previous conclusion on the arbitrage between both storage options is still valid: potential savings in inventory holding costs should outweigh financial costs to justify early clearance of cargo from the port.

The new total logistics cost becomes, however, nonlinear in s and is thus no longer solvable analytically. Because the average stock level is more important here than in the simplified case of perfect certainty, the conclusions on the relationship between port dwell time and reorder interval or total cost are still valid:

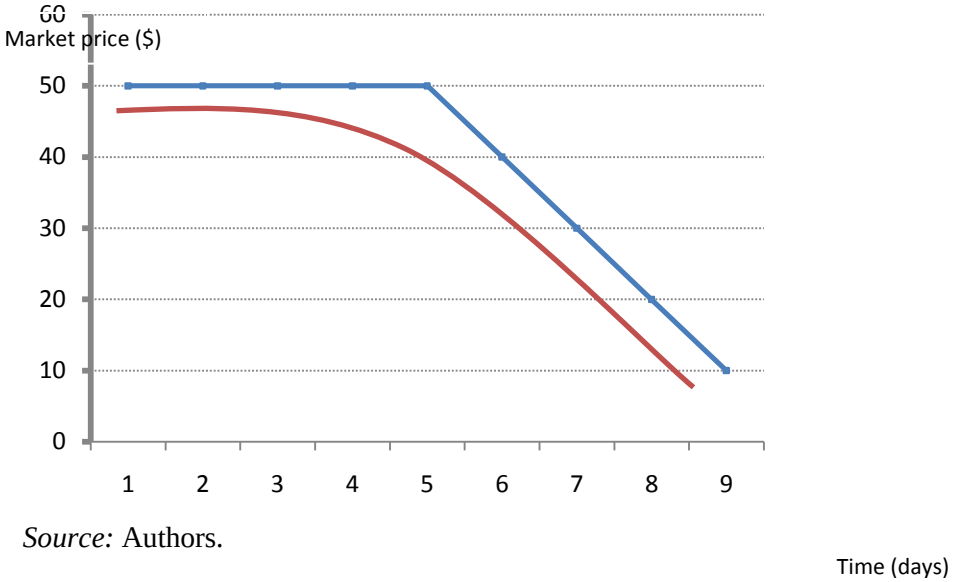
- A longer dwell time inevitably hampers the supply chain by increasing the immobilization cost, and shippers react by having more frequent deliveries of materials (s diminishes)
- A longer dwell time severely affects total logistics costs because of the additional storage and depreciation costs.

The Impact of Uncertainty on Revenues and Profits

We have defined two kinds of uncertainty: uncertainty attached to errors in demand forecasts and uncertainty in delivery times. Both uncertainties adversely affect total logistics costs because they induce higher inventory levels and thus higher storage costs and depreciation costs.

If we look at profit maximization rather than cost minimization alone, both uncertainties have a further impact. Uncertainty attached to delivery times has an impact on revenues if we consider the negative impact of late shipments. In general terms, late shipments induce customer dissatisfaction and the possibility of lost sales (if the customer turns to another supplier or cancels his order) of the kind depicted by the solid line in Figure 9. If shipment arrival is not deterministic but follows some probabilistic distribution, the revenue profile becomes of the kind depicted in the dashed line because of the uncertainty of lead times. There are extra losses due to uncertainty since the customer will turn more rapidly to other sources of supply than in deterministic scenarios, and prices will fall more rapidly in the event of logistics congestion. In conclusion, uncertainty affects both revenues and profits in a negative way.

Figure 9: Uncertain Delivery Times and Revenue



Source: Authors.

Uncertainty in demand forecasts also leads to uncertainty in expected revenues due to the direct relation between revenue and sales. With expected values of the demand distribution being lower than the corresponding deterministic demand because of uncertainty, revenues are, in general, lower if there is some risk of errors in forecasts.

Risks attached to any attribute (maritime transit time, dwell time, total sales) of the profit function lead to probabilistic formulations that generally have an adverse impact on absolute profit levels but do not change the strategies of market players. In a comfortable price-setting scenario, experience suggests that market players tend to be overcautious and to "build delay time into their production planning" to prepare for the worst situation. If the container happens to arrive on time, they just delay the shipment until they need it (Wood et al. 2002, 169). This hedging behavior is therefore another justification of why "shippers are biased in favor of utilizing the port facility as much as possible" (UNCTAD 1985).

3. An Empirical Analysis of Demand: Lack of Competence or Purpose?

A key factor is the lack of competence and professionalism of small importers and customs brokers, who often do not exercise due diligence in the clearance process. This results in considerable delays in payment and slows down the entire logistics chain. The capacity and professionalism of the private sector have a large effect on the clearing process, even greater than expected. For instance, an analysis of Douala port by a major freight forwarder found that customs procedures cause only one percent of very long—20 days or more—cargo delays. The same analysis calculated that lack of or erroneous documentation by the importer or delays by the pre-inspection company are far more time-consuming than customs procedures.

Findings from firms' surveys

By using data from firm surveys launched in five SSA countries - Kenya, Nigeria, South Africa, Uganda, Zambia we attempt, through statistical analysis, to validate some of the theoretical assumptions presented in the previous section. The main objective of the analysis of firm surveys is to

identify shippers' demand and practices related to perceived and actual cargo dwell time and how they are linked to private sector market structure.

The surveys were conducted in five Sub-Saharan African countries—Kenya, Nigeria, South Africa, Uganda, and Zambia—from May to July 2011. Each of the surveys includes about 100 observations (per country), yielding 506 validated records. Participants in the survey are shippers importing containerized cargo through the ports of Durban (for South African and Zambian importers), Mombasa (for Kenyan and Ugandan importers), and Lagos (for Nigerian importers). Both manufacturers and retailers in the most important sectors are represented in the survey.

Data Collection Problems Encountered during Fieldwork

Several problems were encountered while collecting data in the field. In many instances, the respondents were not able to answer all of the questions, mostly because they did not have the information (they had to check with other employees or the forwarding agents). For example, many respondents did not know clearance times in harbor or customs, as clearance procedures are generally handled by their C&F agents, who do not necessarily share the information with them. Many shippers were only concerned with the final on-site delivery dates. Some respondents did not understand the questions, even though pilot surveys had been conducted to eliminate this problem[5]. These issues reveal the information asymmetry problem between importers and their C&F agents, owing mainly to the lack professionalism and transparency of C&F agents, who do not provide feedback about their work or exchange information about the clearance process with their shippers.

Another issue, particularly in Kenya, Nigeria, and Uganda, is that some of the potential respondents were suspicious about the survey and not willing to participate in studies of this nature. They considered the questionnaire to be seeking sensitive or private information.

However, several respondents, mostly in South Africa, felt that the interview was interesting and expressed appreciation that it survey was being conducted because they felt that something needed to be done to "improve the red-tape of getting goods out of the harbour in time".

Data collection issues demonstrate two major problems that inhibit change: lack of information and low expectations.

Dwell Time Statistics and Expectations

The perception about what is "normal" cargo dwell time varies between countries and regions. Refas and Cantens (2011) present a detailed discussion regarding what is considered "normal" dwell time in SSA. According to them, it is around 11 days (close to the free time period) in Douala and in most ports in SSA. This is a particularity of the region, because the dwell time perceived as "normal" in most international ports in East Asia or Europe is around four days.

Dwell Time as Reported by Shippers

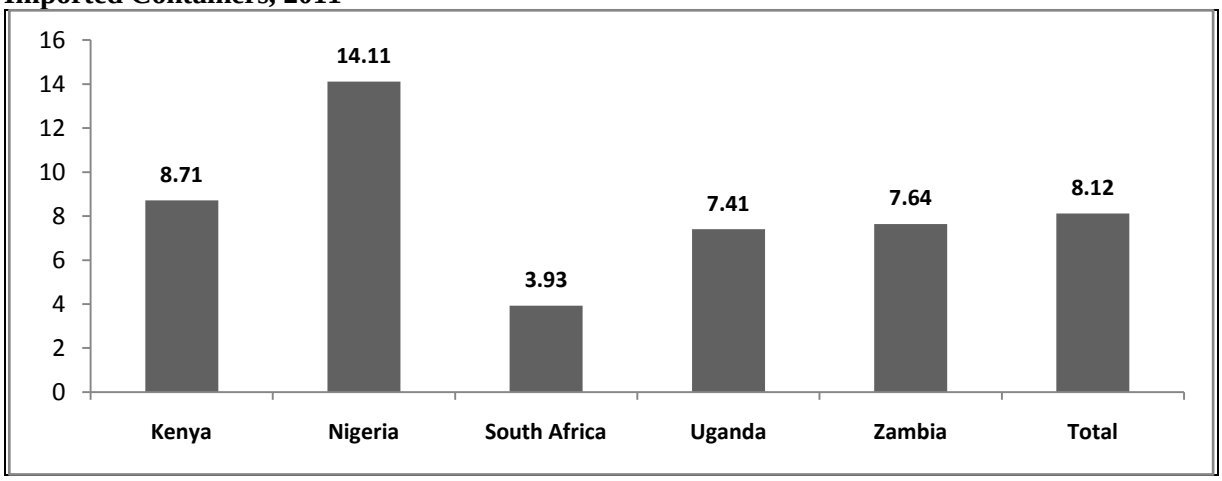
[5] In Kenya, pilot surveys were conducted in order to check whether the questions were understood by the interviewees and to verify the length of the questionnaire.

In the surveys, two variables were used to measure cargo dwell time: (a) the average dwell time measured in days and (b) the distribution of dwell time, by length of time: 0–5 days, 6–10 days, 11–20 days, 21–40 days, 41–70 days, and more than 70 days.[6]

The average cargo dwell time (measured in days) by country, weighted by the number of imported containers, is shown in Figure 10. South Africa has the shortest dwell time, as expected, close to what is identified as "normal" in Europe or Asia. Nigeria has the longest. The average dwell time of the total five countries sample is around eight days.

These figures should be viewed with caution, because they are not necessarily representative and are less reliable than customs data. Data collected in firm surveys should only be used as a complement to customs data on dwell time.

Figure 10: Cargo Dwell Times in Select African Countries, Weighted by the Number of Imported Containers, 2011



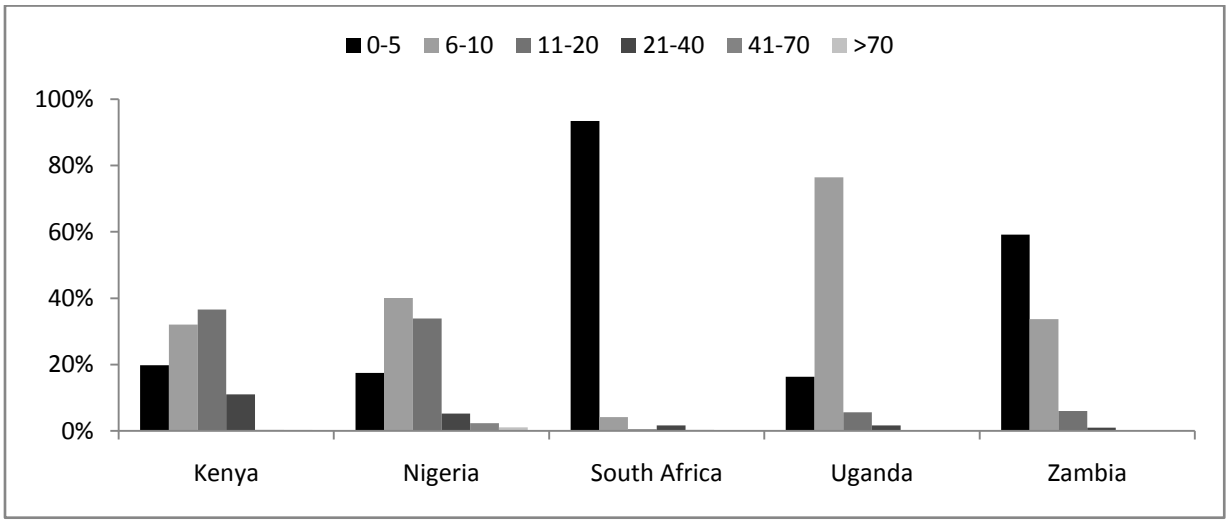
Source: Authors based on firm surveys.

It is also interesting to analyze the distribution of dwell time by country (Figure 11). In South Africa 93 percent of imported containers have a dwell time between 0 and five days, which is expected, since the average is very low (3.93 days) compared to the other countries. In Kenya and Nigeria 69 percent and 74 percent respectively of their imports need between six and 20 days to be cleared; this is consistent with the average dwell time of around nine days for Kenya and fourteen days for Nigeria.

In Zambia, most of the imported containers (59 percent) have a dwell time between zero and five days; hence average dwell time is almost the same in Zambia (7.64 days) as in Uganda (7.41 days), even though only 16 percent of containers in Uganda have average dwell time of zero to five days, while 76 percent have average dwell time of six to eleven days. Zambian importers benefit from the relatively good performance of Durban port, which shows that tackling performance issues in a port has a positive spillover effect on landlocked countries.

[6] This measures the proportion of containerized imports with a dwell time of 0–5 days, 6–10 days, 11–20 days, 21–40 days, 41–70 days, and more than 70 days.

Figure 11: Cargo Dwell Time in Select African Countries, by the Percentage of Containers, 2011



Source: Authors', based on firm surveys.

Comparison with Shippers' Perception of Dwell Time

When importers' perceptions of cargo dwell time are compared with actual dwell time in Sub-Saharan African countries, the latter is higher than expected in Kenya and Nigeria, which means that importers here are likely to want to reduce dwell time and might exert pressure to do so.

On the contrary, in South Africa, Uganda, and Zambia, the perception of normal cargo dwell time is higher than the estimated normal dwell time, meaning that there may not be strong pressure to lower it; importers might be satisfied with experiencing a shorter dwell time than expected. In both cases, average dwell time is lower in Durban than in the other ports studied, which may explain the relatively low expectations.

These differences between countries suggest that dwell time is also about perception and information (Table 1). Shippers may not understand the significance of dwell time and may not have accurate information on it (dwell time statistics are often unknown and incorrect).

Table 1: Average Dwell Time and the Perception of Normal Dwell Time in Select African Countries, 2011
dwell time (number of days)

Indicator	*Kenya*	*Nigeria*	*South Africa*	*Uganda*	*Zambia*
Port	Mombasa	Lagos	Durban	Mombasa	Durban
Actual average cargo dwell time	8.71	14.11	3.93	7.41	7.64
Perception of "normal" average cargo dwell time	7.7	11.2	6.5	8.7	14.1

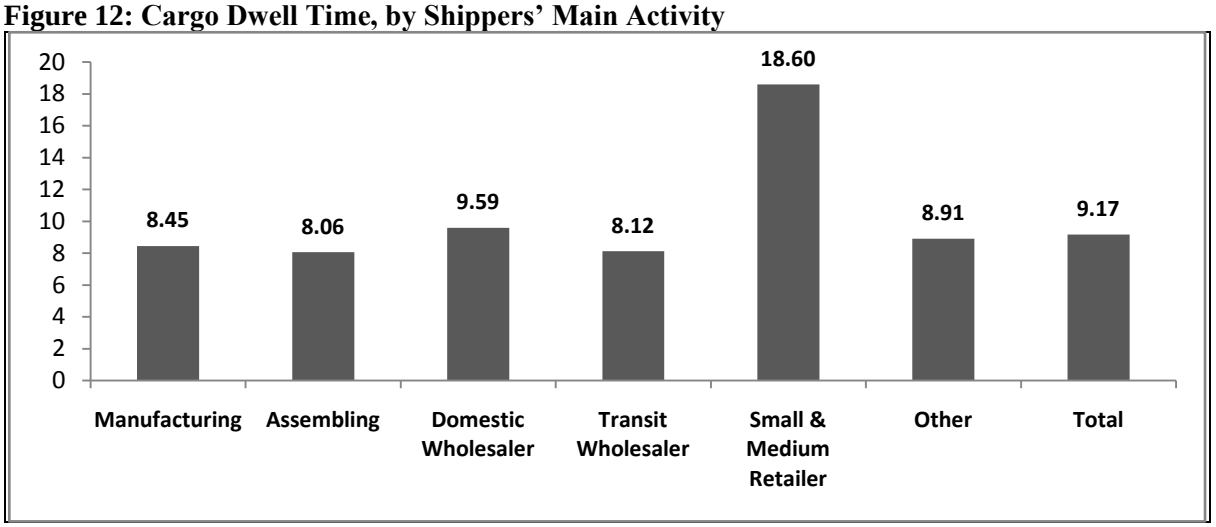
Source: Authors based on firm surveys.

Analysis by Importers' Characteristics

Main activity

The analysis of average dwell time with regard to the shippers' main activity indicates that manufacturers perform better than traders overall (Figure 12). Moreover, manufacturers have a significant lower average dwell time – one day lower – than the other importers (t(313.826) = 1.679; p = 0.047) [7] . They appear to be more efficient and should be the primary counterparts of Customs/Terminals in contractualization initiatives because they master their logistics (raw materials or intermediary products) and can reach top performance by implementing efficient processes.

Figure 12: Cargo Dwell Time, by Shippers' Main Activity



Source: Authors based on firm surveys.

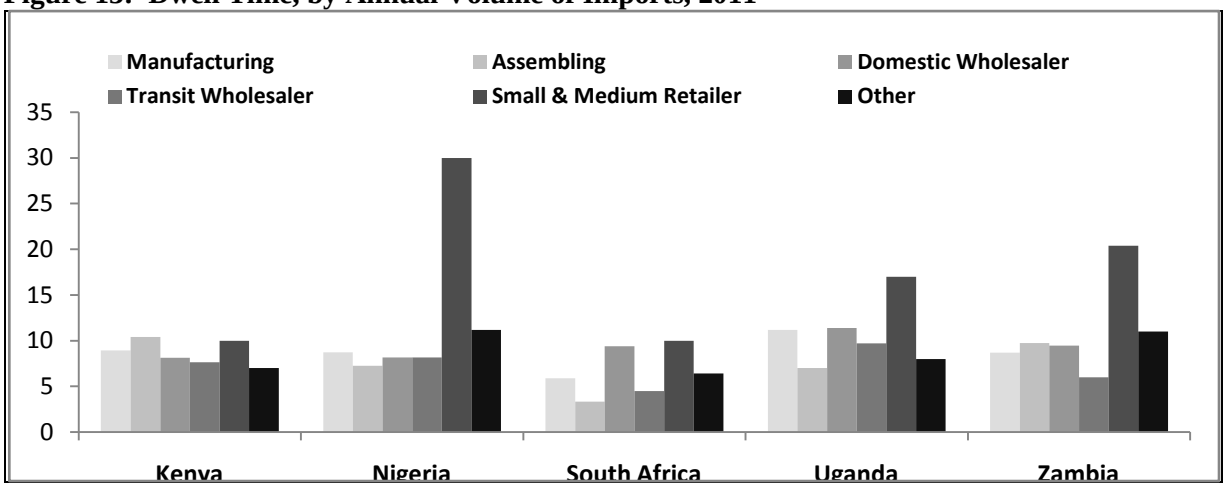
Furthermore, small and medium retailers experience the longest dwell time. They have a significant longer dwell time than the other importers– around 10 days longer (t(9.056) = 1.7991; p = 0.05)). This is not surprising: small retailers generally do not have their own warehouse and probably use the port as a storage facility; they may also experience a slower clearance process than larger shippers[8]. This may be due to informal practices and possible "negotiations" with regard to lowering tariff duties and thus the cost of imports. These findings are consistent with the assumption of the theoretical model (presented in section 2), which posits that companies intentionally leave their cargo in ports since these are cheap storage units.

The analysis by country illustrates that small and medium retailers are more likely to experience long dwell times in Nigeria, Zambia, Uganda, and, to a lesser extent, South Africa, which confirms our assumptions (Figure 13).

The preponderance of trading is self-reinforcing: retailers have longer dwell times, and this makes port dwell time longer for everyone. This constitutes a barrier to assembling industries, which then paves the way for retailers to constitute a large share of port users.

[7] All t-tests in this chapter are run on groups with unequal variances, thus Satterthwaite's approximation is computed instead of the usual degree of freedom.
[8] The alternative for them is to rent warehouses spaces from warehouses operators.

Figure 13: Dwell Time, by Annual Volume of Imports, 2011

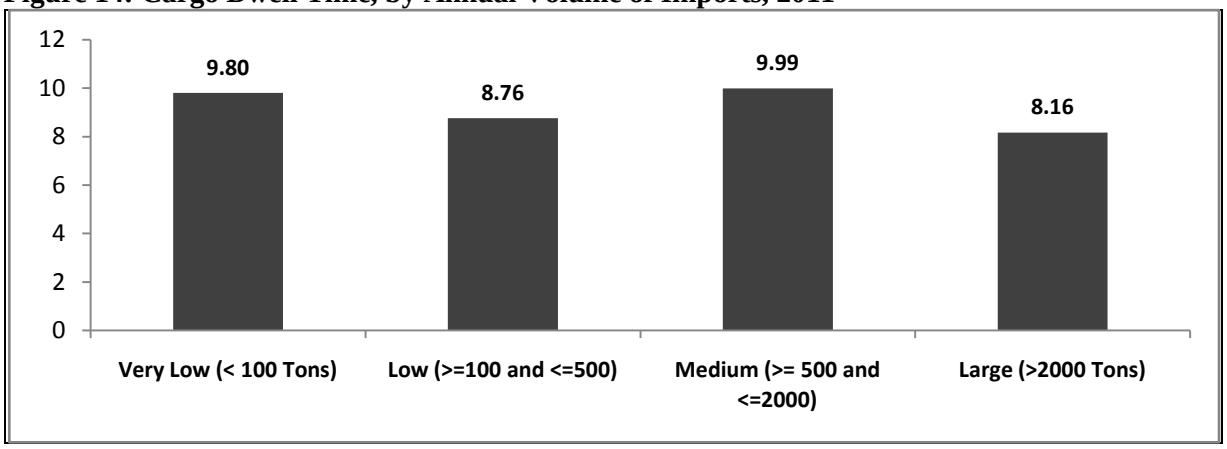


Source: Authors based on firm surveys.

Volume of importations

Contrary to the common belief that the volume of imports is an important determinant of cargo dwell time, in SSA the volume of imports is not correlated with dwell time (Figure 14). Hence, shippers that import medium volumes seem to have significant longer dwell time – about one day longer – compared to shippers that import very low, low and large volumes ($t(212.253) = 1.669$; $p = 0.048$). And shippers importing large volumes seem to have significant shorter dwell time – approximately one day shorter – than all the other shippers ($t(268.041) = 2.218$; $p = 0.013$).More than the size of the company, the type of company and its business model are what matter the most.

Figure 14: Cargo Dwell Time, by Annual Volume of Imports, 2011

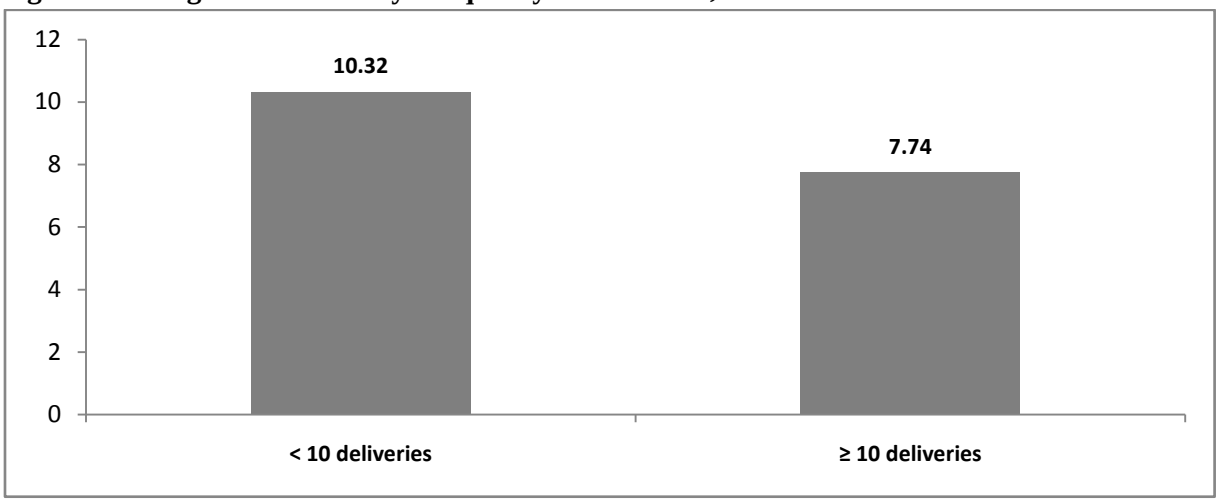


Source: Authors based on firm surveys.

Frequency of Deliveries

A very important relationship to test through data analysis is the one between dwell time and the frequency of deliveries. It seems that more frequent deliveries - more than 10 deliveries (figure 15) result in about more than two days significant shorter dwell time ($t(273.202)= 3.562$ $p = 0.0002$). This reflects the dominant situation of importers in Sub-Saharan African countries who have on average less than 10 deliveries every year and do not have real logistic strategies in place.

Figure 15: Cargo Dwell Time by Frequency of Deliveries, 2011

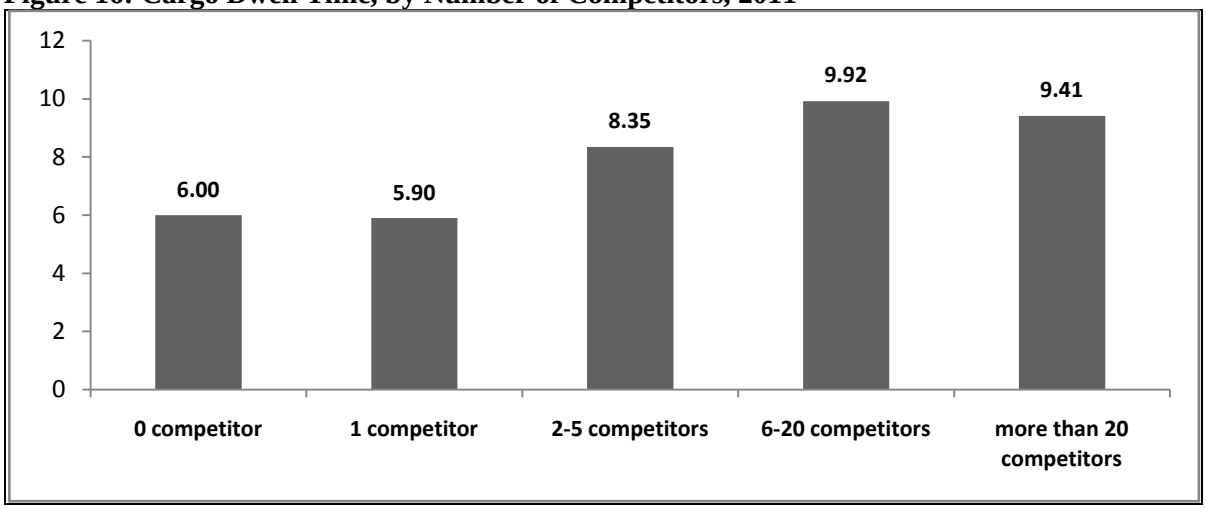


Source: Authors based on firm surveys.

Analysis by Market Structure

Figures 16 and 17 present dwell time by the level of competition in the sector. In Figure 17, the categories 0, 1, and 2–5 competitors are aggregated into "monopoly-oligopoly," and the categories 6–20 and more than 20 competitors are aggregated into "competition." Importers in monopoly-oligopoly situations experience a two days significantly shorter dwell time than importers in competitive situations (t(223.564) =2.694; p = 0.003).[9]. In fact, rational importers in monopoly-oligopoly situations are likely to have shorter dwell time because they seek to minimize their logistics costs (long dwell time generally translates into higher logistics costs) in order to optimize their profits.

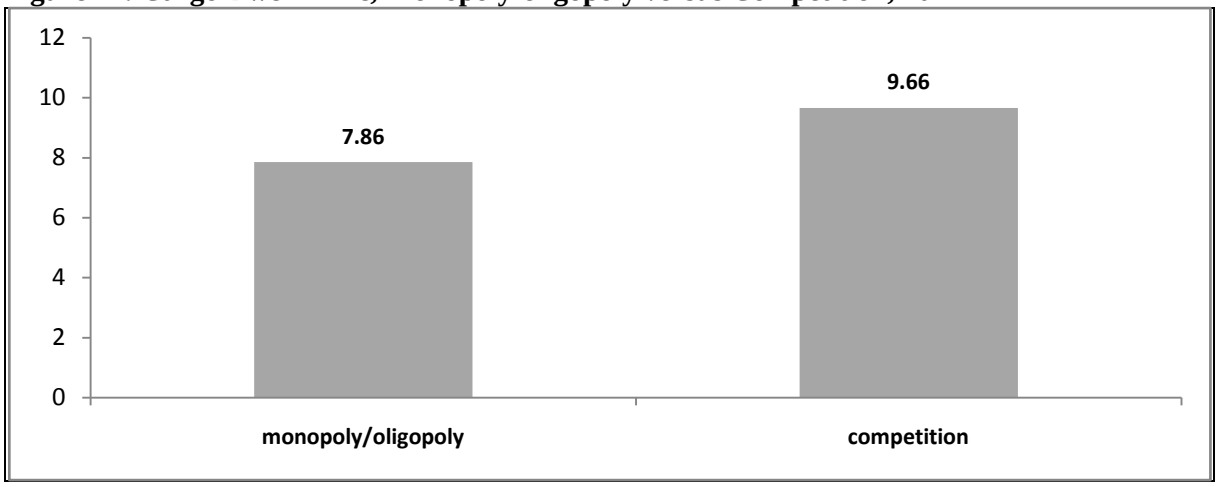
Figure 16: Cargo Dwell Time, by Number of Competitors, 2011



Source: Authors based on firm surveys.

[9] This also holds when comparing average dwell time of each category of competitors with the highest next category: shippers that do not have competitors have a three days shorter dwell time than those that have more than 1 competitor (t(14.426) = 4.346; p = 0.0003); shippers that face 1 competitor experience a three days shorter dwell time than those that have more than 2 competitors (t(10.568) = 2.735; p = 0.01); and shippers with 2-5 competitors have a one day shorter dwell time than shippers with more than 5 competitors (t(150.772) = 1.749; p = 0.041).

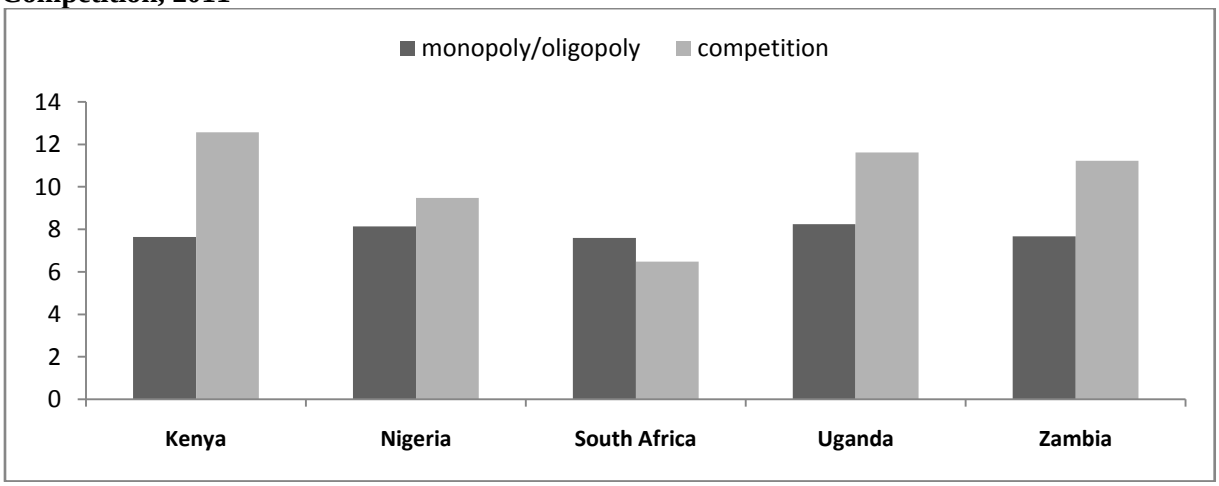
Figure 17: Cargo Dwell Time, Monopoly-oligopoly versus Competition, 2011



Source: Authors based on firm surveys.

In all countries except South Africa, monopoly-oligopoly situations are likely to keep cargo dwell times lower (Figure 18). However, shorter dwell time does not necessarily translate into lower prices, since the main objective is to maximize profits. Only in South Africa does the high degree of competition play an important part in keeping dwell time lower: since importers in a competitive situation cannot afford to reflect the costs of delays in their prices because they are afraid of losing customers, they protect the customers from price increases due to cost increases. These findings can be explained by the maturity of the South African economy.

Figure 18: Cargo Dwell Time in Select African Countries, Monopoly-oligopoly versus Competition, 2011



Source: Authors based on firm surveys.

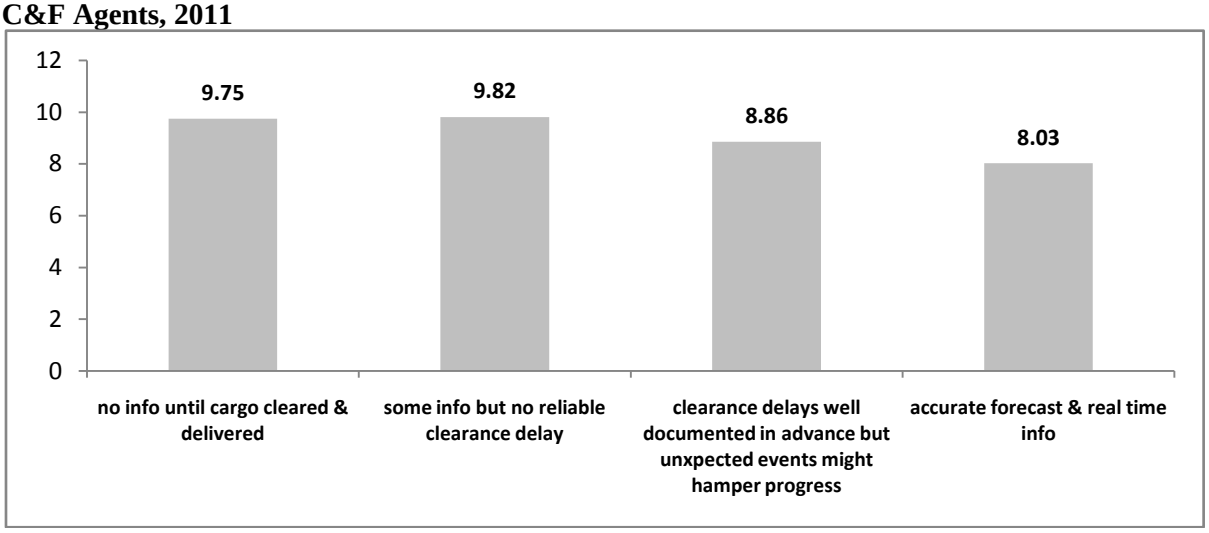
Analysis by C&F Agents' Professionalism

Level of Information Provided by C&F Agents about the Clearance Progress

Overall, when C&F agents provide accurate forecasts and real-time information about progress or delay in the clearance process well in advance (even if unexpected events might arise), dwell time is shorter (Figure 20) – one day significantly shorter when real-time info is provided $t(184.615) = 2.242$; $p = 0.013$); and less than one day when clearance delays are well documented in advance, though this

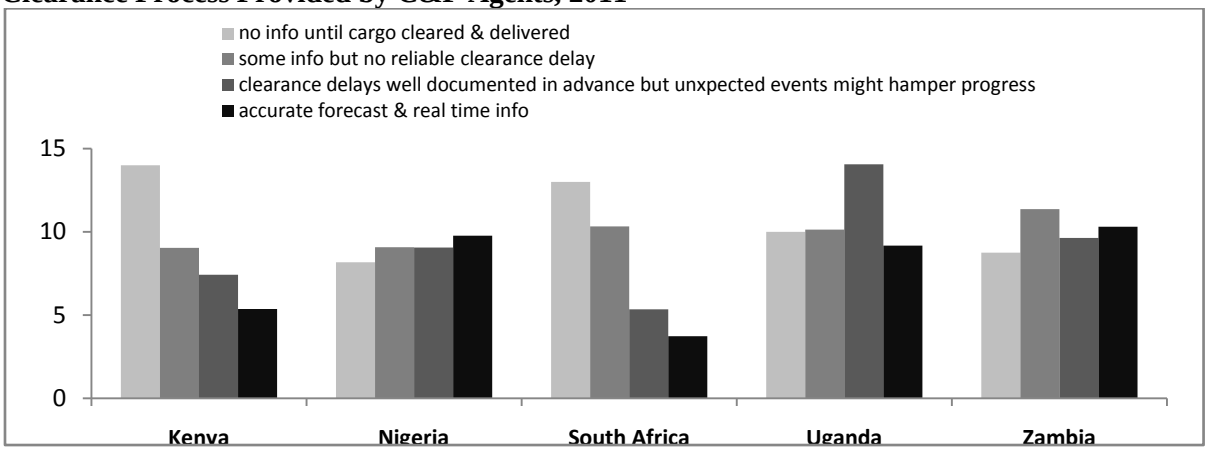
is not significant (t(157.338) = 0.535; p = 0.296). Shippers who master their logistics seem the most efficient. The information appears to be the key to improve performance (Figure 19). These findings hold for Kenya, South Africa, and, to a lesser extent, Uganda (Figure 20).

Figure 19: Cargo Dwell Time, by Level of Information about the Clearance Process Provided by C&F Agents, 2011



Source: Authors based on firm surveys.

Figure 20: Cargo Dwell Time in Select African Countries, by the Level of Information about the Clearance Process Provided by C&F Agents, 2011



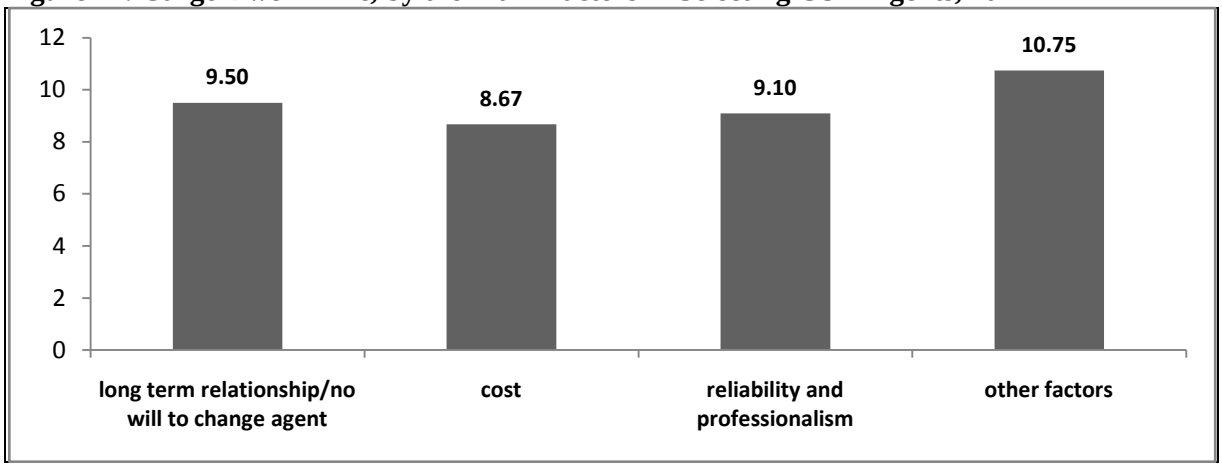
Source: Authors based on firm surveys.

Main Determinants in the Selection of C&F Agents

When shippers select C&F agents based on their professionalism, cargo dwell time is likely to be shorter than in the case of a selection based on the long term relationship with the agent (Figure 21). Hence costs remain the selection criterion that reflects in the lowest dwell time in the Sub-Saharan African countries analyzed.[10] However, the picture is not clear when looking at the data by country and may reflect a misunderstanding of the questions asked (Figure 22).

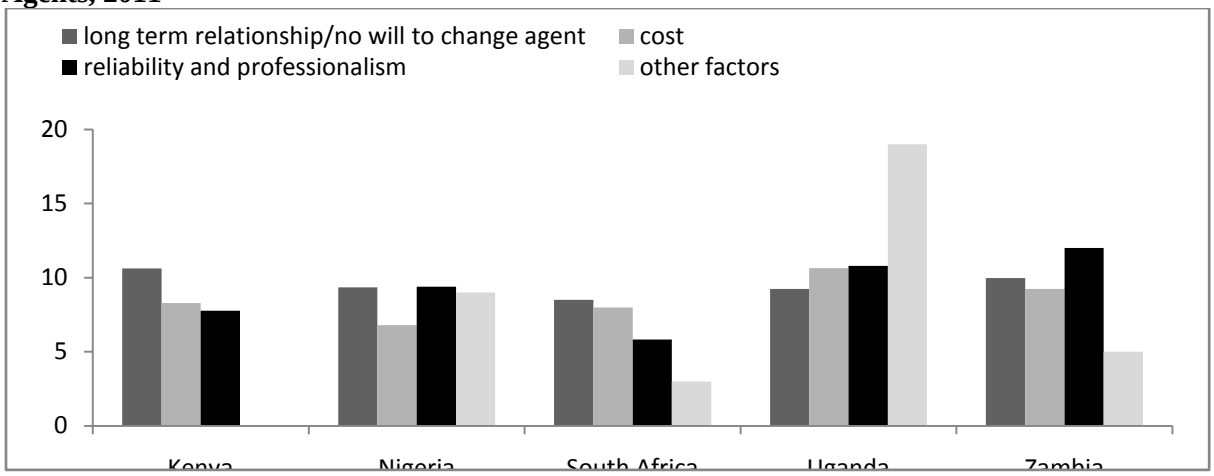
[10] T-tests are not shown here since none of them is statistically significant.

Figure 21: Cargo Dwell Time, by the Main Factors in Selecting C&F Agents, 2011



Source: Authors based on firm surveys.

Figure 22: Cargo Dwell Time in Select African Countries, by the Main Factors in Selecting C&F Agents, 2011



Source: Authors based on firm surveys.

Analysis by Product Category

The overall distribution of imports by category, shown in Table 2, indicates that machinery and electrical products are the largest category (27 percent), followed by chemicals and allied industries (14 percent) and transportation (13 percent).[11] Machinery and electrical is the largest category in Nigeria, South Africa, and Uganda and the smallest in Zambia. While the distribution of most product categories is rather balanced among countries, important differences are evident for transportation, which accounts for 30 percent of imports in Zambia, but only five percent in South Africa. The differences are also important for textiles, which account for only zero to four percent of imports in all countries, except South Africa (16 percent).

[11] We use 11 categories based on the 15 standard categories (using two-digit Harmonized System codes). We aggregate some of the categories because they are too small, but some still account for less than 5 percent of the total volume of imports. This might explain the problem of selection bias.

Table 2: Imports in Select African Countries, by Product Category, 2011
% of all imports

Product category	*Total*	*Kenya*	*Nigeria*	*South Africa*	*Uganda*	*Zambia*
Chemicals and allied industries	14	18	15	11	12	11
Foodstuffs	9	10	15	5	7	7
Machinery and electrical	27	25	32	30	30	18
Mineral products and metals	9	12	17	9	4	5
Miscellaneous	4	4	0	9	5	4
Plastics and rubbers	6	6	3	9	7	2
Service	2	4	0	2	1	0
Stone and glass	7	2	7	4	10	16
Textiles	5	4	0	16	4	2
Transportation	13	6	10	5	15	30
Wood and wooden products	4	8	2	0	5	5

Source: Authors based on firm surveys.

This might explain a certain selection bias in favor of equipment, but also a higher level of professionalism (in South Africa compared to the other four countries) and therefore might depict the situation as better than it is in reality. Moreover, the category of service products is small overall (two percent) and nonexistent in Nigeria and Zambia.

Average dwell time varies significantly across categories and countries (Table 3). For example, stone and glass products remain in port terminals for about 12 days. They are cleared more rapidly in South Africa (4.5 days) than in Zambia (14 days), which may explain differences in the degree of competition in Zambia and South Africa.

Table 3: Cargo Dwell Time in Select African Countries, by Type of Product, 2011
number of days

Product category	*Total*	*Kenya*	*Nigeria*	*South Africa*	*Uganda*	*Zambia*
Chemicals and allied industries	9.94	10.44	9.33	8.83	8.90	12.33
Foodstuffs	7.65	5.89	7.67	5.00	9.33	11.00
Machinery and electrical	9.03	7.68	9.32	8.35	10.56	8.80
Mineral products and metals	7.94	7.18	8.10	5.40	7.00	15.33
Miscellaneous	11.93	12.25	—	11.80	10.75	14.00
Plastics and rubber	8.89	6.60	9.50	3.60	14.83	10.00
Service	7.17	6.50	—	14.00	3.00	—
Stone and glass	12.28	10.00	9.75	4.50	13.75	14.33
Textiles	6.53	6.50	—	5.11	10.00	9.00
Transportation	9.21	13.20	8.67	3.67	11.83	7.35
Wood and wooden products	8.27	8.29	7.00	—	7.25	10.00

Source: Authors based on firm surveys.
Note: — = Not available.

Moreover, while textiles take 6.5 days to clear on average, they take only five days in South Africa and 10 days in Uganda. These findings confirm that the type of commodity is an important determinant of cargo dwell time.

4. Conclusion

Finally, Table 4 summarizes the main assumptions of the theoretical model and the findings of the statistical analysis.

Table 4: Theoretical Assumptions and Findings from the Statistical Analysis

Theoretical assumptions	*Survey findings*
Warehousing-derived terminalization: terminals are cheap storage units for shippers.	Verified. Small and medium retailers are likely to use the port as a cheap storage facility.
Product characteristics and market structure are the main determinants of dwell time.	Verified for market structure. Monopolies are time-efficient in Kenya, Nigeria, Uganda, and Zambia, but competition is time-efficient in South Africa. Hence low dwell time is not necessarily reflected in lower prices in the case of monopolies-oligopolies (which might seek to maximize profits); however, it might keep prices low in competitive situations (South Africa). Verified for product category. Important differences are found in cargo dwell time among product categories.
Dwell time is also about perception and information. In uncertain contexts, shippers build delay into their production schedule to plan for the worst. Dwell time statistics are often unknown or incorrect.	Verified. When the dwell time perceived as "normal" is higher than the actual dwell time (Kenya, Nigeria), shippers are likely to exert pressure to shorten it; if the perceived dwell time is higher than the actual dwell time (South Africa, Uganda, Zambia), there might be no pressure to shorten it. Communicating reliable information about dwell time is key to avoid ill-adapted strategies and stimulate time performance of customs brokers.

Source: Authors based on firm surveys.

This exercise is, to our knowledge, the first of its type and does not answer all of the questions raised in this field. However, it demonstrates the crucial importance of studying private sector practices and incentives before designing any program aiming to reduce dwell time. The assumption that "importers are the victims of long container dwell time" is likely to be wrong in the case of many ports in SSA, which probably explains the multiple failures of many initiatives in this area.

This kind of study should be expanded to other countries, and some issues, such as the impact of market structure on pricing strategies or the impact of information asymmetry should be investigated further.

Bibliography

Arvis, Jean-François, Gael Raballand, and Jean-François Marteau. 2010. *The Cost of Being Landlocked.* Washington, DC: World Bank.

Hummels, David, and Georg Schaur. 2012. "Time as a Trade Barrier." NBER Working Paper 17758, National Bureau of Economic Research, Cambridge, MA. http://www.nber.org/papers/w17758.

Magala, Mateus, and Adrian Sammons. 2008. "A New Approach to Port Choice Modeling." *Maritime Economics and Logistics* 10 (1-2): 9–34.

Quandt, R. E., and W. J. Baumol. 1969. "The Demand for Abstract Transport Modes: Some Hopes." *Journal of Regional Science* 9 (1): 159–62.

Refas, Salim, and Thomas Cantens. 2011. "Why Does Cargo Spend Weeks in African Ports? The Case of Douala, Cameroon." Policy Research Working Paper 5565, World Bank, Washington, DC.

Rodrigue, Jean-Paul, and Theo Notteboom. 2009. "The Terminalization of Supply Chains: Reassessing Port-Hinterland Logistical Relationships." *Maritime Policy and Management* 36 (2): 165–83.

UNCTAD (United Nations Conference on Trade and Development). 1995. *Strategic Port Pricing.* UNCTAD/SDD/PORT2. New York: UNCTAD.

Wood, Donald F., Anthony P. Barone, Paul R. Murphy, and Daniel L. Wardlow. 2002. *International Logistics*, 2d ed. San Francisco: AMACOM Books.