ERASMUS UNIVERSITEIT ROTTERDAM
ERASMUS SCHOOL OF ECONOMICS

PUBLIC-PRIVATE PARTERNSHIPS IN TRANSPORT INFRASTRUCTURE

A study into the cost and time performance of transport corridors in Sub-Saharan Africa and their PPP models

ABSTRACT

This Master's Thesis examines the relationship between Public-Private Partnership (PPP) models of transport corridor actors in Sub-Saharan Africa and their cost- and time performance. Through a cross-sectional regression analysis of 20 corridors throughout the continent, it is determined that, in contradiction of World Bank policy notes - advising infrastructure privatisation as the way to go for development - there currently exists no relationship between corridor PPPs and their performance in Sub-Saharan Africa. A lack of adequate regulatory regimes and organisational inadequacy in government institutions is identified as one of the possible reasons for the absence of this relationship, thus putting forward the need for improvement on the latter field before being able to reap any benefits from privatisation. Finally, some evidence is found for the relevance of the direction of development (outside-in v/s inside-out) in relation to corridor performance.

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1 INTRODUCTION

'The real costs of trade, i.e. the transport- and other costs of doing business internationally, are important determinants of a country's ability to fully participate in the world economy. Remoteness and poor transport and communications infrastructure isolate countries, inhibiting their participation in global production networks (Limao & Venables, 2001)'.

Reading the above statement, a solution to the misfortune of the less developed countries in the world seems straightforward: improve their transport infrastructure, and their competitiveness will improve automatically. However, many factors are of influence on the road to achieving a good transport infrastructure. For instance, institutional arrangements can have great influence on the quality of transportation in a country (Estache & Serebrisky, 2004). The optimisation of such institutional arrangements often comes in the form of Public-Private Parternships (PPPs). The latter, especially in developing countries, are often employed with the aim to reduce the burden to the national treasury (Estache & Serebrisky, 2004). Additionally, PPP implementation is usually justified with the argument of improved performance levels – bluntly said: private companies' aim of retrieving economic rent from their activities allegedly brings in the know-how and motivation to operate the object more efficiently and at a lower cost so as to improve profitability. However, public involvement is needed to ensure this happens such that it benefits society (Kwak et.al., 2009). Thus, implementation of privatisation through PPP in transport infrastructure of developing countries seems the way to go, and is advised by Foster & Briceno-Garmendia (2010) in a publication on the topic by the World Bank.

Through a review of existing literature on the topic, Estache and Serebrisky (2004) attempted to evaluate the truthfulness of the above-mentioned claim concerning improved efficiency of transport infrastructure objects under PPP, reaching a timid conclusion that there seems to be evidence in favour of the statement. However, the authors acknowledged the absence of sufficient studies addressing the subject. Today, nearly 10 years later, it is still hard to find such studies, especially focused on the continent with the largest number of under-privileged countries - Africa. A few recent papers have focused on institutional aspects of transport network development, such as Monios and Wilmsmeier (2012), who compare regionalisation strategies within Europe and the USA. Furthermore, Beresford et.al. (2012), highlight the development paths of Chinese dry ports, and Monios & Wang (2013) discuss the performance of Chinese dry ports in relation to sea ports through the principle of outside-in v/s inside-out development. While these papers do touch upon the subject of the optimal institutional arrangement for transport network development, none employed quantitative methods to reach reliable conclusions and all focused on a small sample of cases. On another note, while the concept of private involvement in transport infrastructure may have proven itself many real-life instances in developed countries (Foster & Briceno-Garmendia, 2010), one may pose the question whether this still holds in a continent where the functioning of national politics is very dissimilar to the established democracies in Europe and North America. PPIAF (2007) confirm this concern, as they note that the root of failure in PPP projects often lies in the (dis-)organisation of the relevant governmental institutions.

Therefore, in order to fill the gap mentioned above and contribute to thoughts about the improvement of developing countries' transport infrastructure, this master's thesis aims at investigating the influence of differing PPP arrangements on the performance of transport in countries of Sub-Saharan Africa. Thus, 20 important transport corridors have been selected throughout the continent, for which data was available from the USAID research institute**.** A corridor was taken to be an important transport route running from a given sea port until a given 'distant' dry/inland port (Roso et.al., 2009); so as to envelop an important part of the local transport infrastructure and honour the fact that transport chains are more and more integrated with each other (e.g. Robinson, 2002). Hereby, a dry/inland port is considered to be any terminal in the hinterland that acts as a final node for cargo coming in from a sea port and which offers at least the services of trans-shipment and cargo storage. Performance in this thesis is regarded as the cost- and time performance of transport from the start until the end of each corridor. The choice for these performance measurements is justified in the next chapter, and was partially driven by the non-availability of a wider range of possible performance measurements. Thus, through statistical regression- and descriptive- analysis of constructed variables for PPP – i.e. the PPP models of the sea port terminal, the inland transport actor and the dry/inland port - and their influence on cost- and time performance, this Master's thesis will answer the following question:

'Do PPP models of actors within a transport corridor affect corridor performance in Sub-Saharan Africa?'

In the process of answering this research question, Chapter 2, as a literature review, will provide the theoretical framework for the Master's thesis, so as to establish the added value of this Master's thesis and justify the methodology employed in it. Following this, Chapter 3 will elaborate upon the methodology employed for the study in relation to the literature review; with the aim of convincing the reader of the methodology employed in this chapter. In Chapter 4, the results will be presented, which will be discussed and put in relation to the general consensus of development institutions active in Africa. Finally, Chapter 6 will give the conclusions and limitations of the study, along with recommendations for further research.

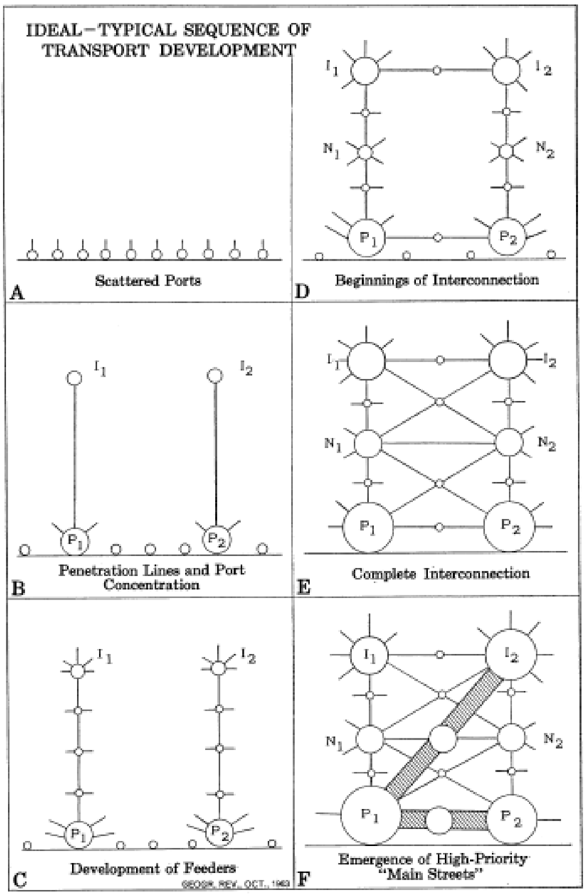
2 LITERATURE REVIEW

2.1 THE IMPORTANCE OF HINTERLAND ACCESS FOR SEA PORTS

2.1.1 The basics

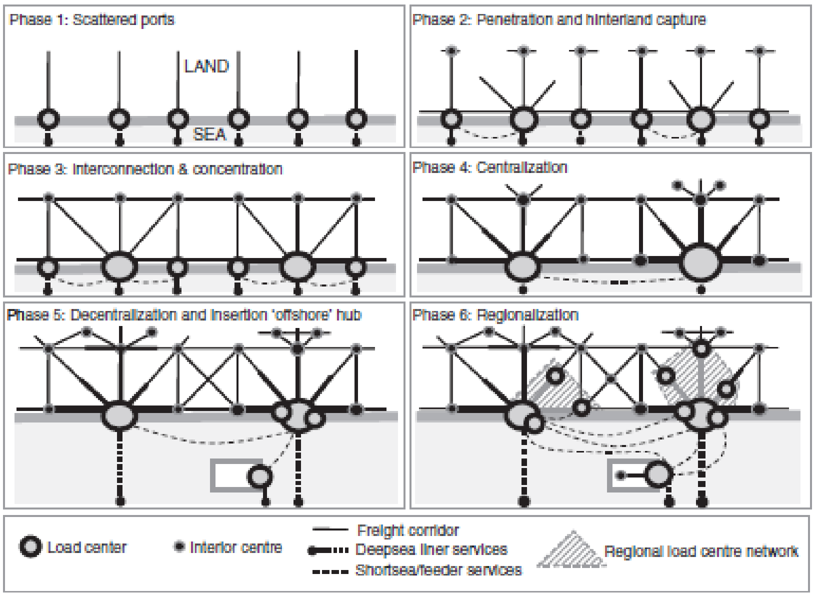
In essence, the importance of a port's hinterland for the success of that port is portrayed by transport geographic literature on the development of transport networks. One of the most widely cited models in this respect is that of Taaffe, Morril and Gould (1963), as shown in Figure 1. In their model, the authors start from a situation where no hinterland transport network exists - as in pre-colonial Africa - with a multitude of small, scattered fisher's ports. It is shown very clearly how the first ports to develop connections with locations further inland obtain a head start over the other small ports. From this, they grow further as these hinterland connections develop and establish connections with other inland locations, capturing the originally potential market for the initial competing ports. Thus, a clear advantage is present for those ports that manage to capture a larger hinterland for themselves to the detriment of competing ports.

Figure 1: Ideal-typical sequence of transport development (Source: Taaffe et.al., 1963)



Other models on the emergence of leading ports have focused more on changes within the port itself. For instance, Hayuth (1981) proposed a model where the adoption of container technology was identified as the main driver of the dominance of certain ports, similar to Bird's Anyport model (Bird, 1963), where successful ports specialize into specific cargo types such as different types of dry bulk, liquid bulk etc. In the model of Hayuth (1981), certain ports emerge as 'load centres', on which other, smaller ports become dependent for cargo flows via feeder services.

Figure 2: Spatial development of a port system, including regionalization (Notteboom & Rodrigue, 2007)



As an expansion on the earlier models, Figure 2 shows the spatial development of a port's network, including the phase of port regionalization according to Notteboom and Rodrigue (2007). The first phases are clearly similar to the model of Taaffe et.al., but also show similarities to that of Hayuth discussed above as connections are established between sea ports as well as the hinterland. What is new is phase 6 of Figure 2, where sea ports achieve further integration with hinterland transport nodes that are located relatively close by, moving certain activities to these nodes. The regionalization phase involves strong interdependency between the sea port and the relevant inland nodes. Sometimes, joint development of load centres and/or multimodal logistic platforms in the hinterland is undertaken as well. This ultimately leads to the creation of 'regional load centres', which envelop the port and the inland transport nodes in the nearby hinterland. The emergence of this phase of port development is often favoured by two different groups of factors (Notteboom & Rodrigue, 2007):

- Local constraints (e.g. diseconomies of scale, lack of available land, environmental constraints etc.) can be externalized to other locations
- Global changes: globalization has led to fragmented production and consumption systems, leading to a more and more complex distribution system. Port regionalization contributes to better dealing with these changes.

Consequently, the notion of port regionalisation indeed goes further than the older models in acknowledging the importance of a port's hinterland. Where the older models simply saw hinterland connections as serving to capture a larger market share for the port, port regionalisation also sees the hinterland as having a functional role, i.e. of taking over certain port functions and thus generally making the transport chain more efficient. However, the ultimate goal is the same: achieving competitive advantages over other ports.

While the above model described by Notteboom & Rodrigue certainly gives an interesting view on the emercence of transport nodes and the success drivers of a sea port and its hinterland, it does not fit the aim of this master's thesis entirely, as it concerns close by inland nodes that mainly serve to solve local constraints and to facilitate complex logistics processes in supply chains. In contrast, this master's thesis is concerned with the performance of transport infrastructure on longer distances, i.e. corridors, for which Roso et.al. (2009) provide and interesting discussion to distinguish between close, midrange and distant dry/inland ports, as follows:

- Close dry/inland ports mainly serve to solve local traffic problems due to high traffic volumes generated by the sea port, as well as they solve the sea port's capacity problems. These dry ports fit quite well into the regional load centre networks discussed above.
- Midrange- and distant dry ports are located further away from the sea port and serve as terminal to cargo destined for their region, or for transshipment further inland. Roso et.al. define midrange dry ports as those that are within range of both road and rail, while distant dry ports are only served by rail.

While it may not be entirely applicable, as most inland locations on the African continent are served both by road and rail, Roso et.al.'s (2009) concept of distant and midrange ports - acting mainly as freight handling nodes that serve their close by clients further inland - fits most to the conception of inland transport corridors for the current master's thesis, i.e. as running from the sea port to a distant/midrange inland freight handling node (to be referred to as dry/inland port from this point) that is served either by rail or by road, or both.

From the above, it becomes clear that sea ports and their hinterland, forming transport corridors, are dependent on one another for successfully performing their tasks. Consequently, it seems logical that relevant actors pursue the development of well-functioning hinterland transport systems and integrate their services. In the spirit of the global changes and local constraints influencing the development of hinterland transport systems, several other authors have put forward drivers of hinterland nodes that can roughly be classified within these concepts.

- Global changes :
    i. Robinson (2002) puts forward the notion that ports have become elements in value-driven chains. It is argued that, due to the more and more complex global supply chains, scattered all over the world, efficiency and reliability in supply chains have become more and more important in global logistics and transport. Consequently, a successful port will ensure that its services are fully aligned with the needs of both its hinterland and its foreland. The latter can be achieved by vertical integration: (cost) efficiency is gained by reducing the 'transaction costs' (Panayides, 2002) which are involved when dealing with multiple actors (e.g. negotiation costs, information costs, enforcement costs of contracts …). Consequently, as the competitiveness of a port depends on the extent to which they represent the most efficient option for the movement of shipper's goods (Notteboom & Winkelmans, 2001), there is much to gain for a port's actors to further integrate vertically.
    ii. Establishing a larger captive hinterland. For instance, Monios and Wang (2013) describe the manner in which the ports of Tianjin and Qingdao, which generally serve the same hinterland, have started investing heavily in inland freight handling nodes to capture as much hinterland as possible away from each other.
- Local constraints
    i. Facilitation of intermodal transport development (e.g. Jarzemskis & Visiliauskas, 2010; Hanoaka & Regmi, 2011). Intermodal transport can be a solution to congestion in ports and to environmental problems that arise from such congestion.
    ii. Facilitation of customs clearance. While most dry/inland ports seem to not fulfil such a function yet, this does represent one of the great potentials involved with them (Veenstra et.al., 2012).

This is especially true in developing economies, where customs procedures remain very cumbersome and cause congestion in ports.

Additionally to the point of improving port competitiveness and hinterland access, dry/inland ports are often developed by local authorities for reasons of economic development. For instance, Do et.al. (2011), in a paper on dry port developments in Indochina, conclude that a successful dry ports system could increase the competitive position of the local sea ports by increasing capacity, reducing congestion due to increased inter-modality, and in the passing increasing the economic competitiveness of Indochina as a whole by improving transport efficiency and decreasing transport costs. Otherwise, it is intuitive that dry ports have the potential to bring economic benefits to whatever region they are located in: if certain port functions are moved towards such an inland location, other economic activities may follow and jobs are created.

2.1.2 Outside-in v/s inside-out

It has become clear that there are many reasons to invest in inland transport. As will be seen in the following sections, a large range of actors have the potential to invest in inland freight handling nodes and hinterland accessibility. Monios and Wang (2013) define two different 'directions' in which inland node development can happen, which also provides a good framework for classifying the different actors:

- Outside-in: Mostly related to the local constraints and global changes discussed above. Outside-in actors are sea-port based, i.e. port authorities, port terminal operators and even maritime shipping companies that initiate and/or take a stake in a dry/inland port. Interestingly, it is found by Monios and Wang that outside-in investments in China are always done by port authorities, while in Europe terminal operators and maritime shipping companies can also be involved.
- Inside-out: Mostly related to the economic aspects related to the presence of a dry port. Inside-out actors are often local authorities and/or national governments that initiate the creation of an inland node so as to attract economic activities to their city or region. This does not always align with the needs of sea ports (Monios & Wang, 2013), and thus may not necessarily achieve its goal. Alternatively, other land-based actors such as rail operators could also be involved in inside-out developments.

Practical examples of outside-in investments are found extensively, along with the Chinese example discussed above. In the Netherlands, for example, European Container Terminals (ECT), part of Hutchison Port Holdings, has started a policy of strong hinterland penetration, with dry ports (or 'extended gates', in their terminology) located in Amsterdam, Moerdijk, Venlo, Duisburg and Willebroek; where customers can pick up or leave their goods as though to an actual sea-port (Veenstra et.al., 2012). Interestingly, the case of ECT presents involvement of both the port authority and the container terminal as Mainport Holding Rotterdam, which is the investment branch of the Rotterdam port authority, holds a minority share (Notteboom et.al., 2013). It is further known that the Mainport Holding Rotterdam has participations in several inland ports throughout Europe. It is also known that the large, French Africa-based terminal operator Bollore Africa Logistics operates their own inland dry port networks throughout Africa[1].

In terms of inside-out dry port developments, it is known that many dry ports are developed in this manner, where the local or even national government decides on developing a dry port in a location in need of an economic boost. Meanwhile, other land based actors such as rail operators may be involved as well (Monios & Wilmsmeier, 2012). For instance, the municipality in Falkoping, Sweden has developed an inland terminal with the aim to achieve integration with the port of Gothenburg. This is also an example of inside-out developments not being as competitive due to a mismatch with the needs of a sea port, as the Falkoping inland terminal's relation with the Gothenborg port is not very successful. Similarly, the Italian hinterland is characterised by strong inside-out development of 'freight villages' which are very effective from a logistics point of view, but tends to lead to difficult relations with sea ports and thus the implementation of a dry port concept. The Rivalta Scrivia freight village in the hinterland of the port of Genoa is then the exception that confirms the rule, as the Genoa port needs the inland port for alleviation of its congestion problems. Table 1summarizes the examples of inside-out and outside-in dry port developments discussed here, their drivers and whether the driver is public or private. Interestingly, the outside-in examples are all integrated with the port through either ownership or shareholding, while the inside-out examples are only linked to the port by contracts (Monios & Wilmsmeier, 2012). It can thus be expected that outside-in investments lead to stronger integration of the port and its hinterland transport network, which may have an effect on the performance of the port and its transport network. This is confirmed by Monios and Wang (2013), who state that those Chinese dry ports that are driven inside-out may have a competitive disadvantage compared to those that are driven outside-in.

[1] See the Bollore Africa Logistics website: http://www.bollore-africa-logistics.com/ports-et-terminaux/nos-ports-secs.html

Table 1: Examples inside-out/outside-in dry port investments and their drivers

Country/region	Driver	Name of driver	Public/private?	Direction
Netherlands	Port terminal operator	ECT (HPH)	Private	Outside-in
Netherlands	Port Authority investment fund	Mainport Holding Rotterdam	Public	Outside-in
Sub-Saharan Africa	Terminal operator and forwarder	Bolloré Africa Logistics	Private	Outside-in
Sweden	Municipal government	Falkoping municipality	Public	Inside-out
Italy	Regional private party	Rivalta Scrivia	Private-Public	Inside-out

2.2 OWNERSHIP AND CONTROL

2.2.1 Public Private Partnerships in transport infrastructure

As seen in Table 1, many different organisations may act as owners and/or drivers of transport infrastructure development. The same type of infrastructure may be owned and operated by completely different types of organisations across different ports around the world. This is due to differences in Public Private Partnership (PPP) policies. Several reasons exist for government bodies to resort to PPPs to implement infrastructure projects, including but not restricted to (UNESCAP, 2011):

- Enhancement of the supply of infrastructure services
- Reduction of the necessity for spending government funds
- Reduction of cost of design and construction
- Transfer of risks to the private sector
- Promise of better project design, choice of technology, construction, operation and service delivery.

Consequently to the above, many governments worldwide have adopted the notion of PPPs as a way to implement infrastructure projects. The forms in which this is done are manifold. The World Bank (2001) defines four different forms of PPP for sea ports: Service port, Tool port, Landlord port and Private port.

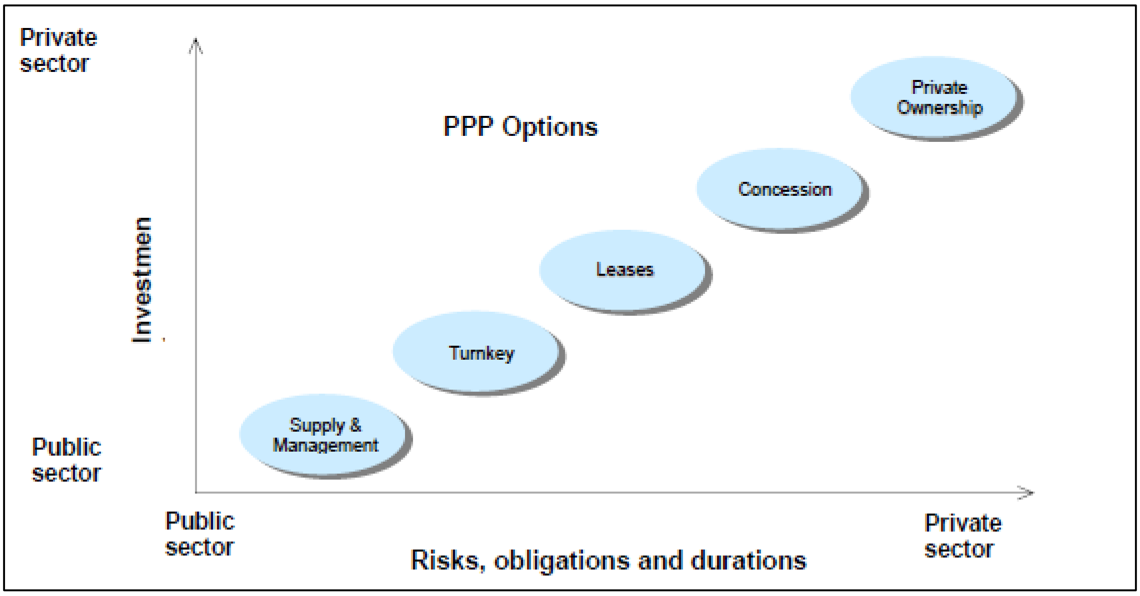
Table 2: Classification of ports (World Bank, 2011)

Model	Service port	Tool port	Landlord	Private port
Ownership and control waterways	Government	Government	Government	Government
Ownership land	Government	Government	Government	Private owner
Ownership equipment	Government	Government	Private lessee	Private owner
Port operations	Government	Private operator	Private lessee	Private owner

Table 2 describes the above-mentioned PPP forms in more detail, including the ownership structure of relevant assets and operations. As dry ports are in fact meant to fulfil the same functions as sea ports, it can be argued that these PPP forms are applicable to dry ports as well. Tongzon & Heng (2005) provide for a slightly more narrow distinction - where the port authority acts as regulator, regulator & landlord, or as regulator, landlord and operator. This could partially be considered an addition to the World Bank definition, as it takes into account the important role of the regulator in ports' functioning. However, these distinctions may be considered too narrow as more detailed gradations exist in the extent of public/private involvement. It is intuitive that these models can be applied to inland ports as well, because their nature is quite similar to that of ports: they can be subdivided into the same levels of infrastructure ownership, land ownership, equipment ownership and operation rights.

UNESCAP provides a more detailed distinction between different PPP forms for transport infrastructure projects in general. These are shown in Figure 3 by level of investment done by the public and the private sector. Generally, in the case of the *supply and management model*, a private entity is contracted by the government to take over the entire - or a part of the - daily management of the organization, and is paid a fee for its services. In case of the *turnkey model*, a private entity is contracted to design and build the relevant piece of infrastructure. After completion, the ownership and operation is then transferred back to the government. Next, the *affermage/lease model* basically entails that an existing facility is leased out to a private entity, for which either a fixed lease payment is made to the government (lease), or part of the revenue is shared with the government (affermage). The private party generally is not required to invest, and the contract length is relatively short. It is, however, possible for the private entity to agree investing in the leased object, given that the lease period is lengthened to such an extent that it becomes profitable to do so. These first three PPP models still involve large risks and financial burden to the government, as the contract length is relatively short and full ownership of the assets remains with the government. However, the complexity of these constructions is quite low, and the time span needed to implement them is relatively short, reducing the chance of problems along the way. In relation to the Port PPP model description given in Table 2 these models can be said to fit the Toolkit port to a certain extent.

Figure 3: Forms of PPP (UNESCAP, 2011)



The *model of concessions*, then, tends to better fit the landlord port model (though toolkit constructions can also be thought of). Specific rights are given to the concessionaire to invest in- and operate the relevant facility. The length of contract is usually quite long, varying between 5 and 50 years, and the investments done by the concessionaire are significant. Consequently, a significant share of the financial risks involved in such an agreement are transferred away from the government. Efficiency gains are quite likely, as it is in the concessionaire's interest to ensure efficient operations and good quality investments. However, the complexity of such transactions is very high, and the implementation takes up quite a long time. Also, the long length of such contracts entails that the government loses a significant amount of control over their infrastructure. Strong regulatory supervision may be thus crucial to avoid unwanted situations.

Finally, comparable to the model defined by the World Bank, there is the *model of private ownership.* All rights of ownership, design, development and operation of the infrastructure are transferred to a private party. The latter is responsible for the successful implementation of the project but also bears the financial risk. Here, the government often has to step in as guarantor of the loans necessary for the private party to make such a significant investment. Efficiency gains are quite likely in all phases of the project - from design to operation of the facility – because of the private actor's strong incentives to ensure good quality of its assets and operations so as to achieve an acceptable return on investments.

2.2.2 Performance in transport infrastructure

2.2.2.1 Corridor research

Unfortunately, specific studies on the performance of transport corridors in relation to PPP models has not been done before. However, some have discussed the development patterns of transport corridors, which give a good framework for the methodology of the collection of corridor-specific information. Additionally, some have qualitatively touched upon performance in the matter as well. Table 3 summarizes the relevant papers, which will be discussed below.

Table 3: Summary of previous research in transport corridors

Author	Subject	Methodology for information collection	Results w.r.t. performance
Monios & Wilmsmeier, 2012	Institutional aspects of spatial regionalisation in Europe and US	Case studies by means of interviews, field visits, desk research	-
Monios & Wang, 2013	Conflicting models of development ports v/s inland actors	Secondary data from literature, websites, company publications, news srouces and e-mail contact with actors	Outside-in developed corridors are more competitive
Beresford et.al., 2012	Development paths of Chinese dry ports	Interviews and follow-up questionnaires.	Lack of institutional coordination leads to bad performance

To start with, Monios and Wilmsmeier (2012) compared regionalisation strategies in Europe to those in the USA, with the goal of highlighting institutional aspects of spatial development patterns. Through case studies of load centres and intermodal corridors, the institutional characteristics, i.e. the involvement of public v/s private actors, were identified. These case studies were carried out by means of semi-structured interviews during field visits, complemented with desk research on the relevant cases. Meanwhile, Monios and Wang (2013) take a similar approach in comparing observed issues in customs clearance and intermodal transport so as to discuss conflicting models of development based on priorities of ports and inland actors. A comparison was made between China as a focus area and known examples on the continents of Africa, North America and Europe. These authors used secondary data from literature, websites, company publications, news sources and e-mail contact with relevant actors so as to obtain the necessary data on ownership, investment models, customs clearance processes, rail services and logistics provision on site. Through a spatial analysis establishing the geographical distribution of inland ports w.r.t. the major sea ports, they established that outside-in developed corridors, i.e. with sea-port based actors involved in development, operation and ownership, are more competitive than their inside-out counterparts. Finally, Beresford et.al. (2012) performed a number of case studies in order to highlight the development paths of Chinese dry ports, including interviews and (follow-up) questionnaires. They conclude that there is a lack of institutional coordination within China, which leads to bad performance of rail transport in connection with the inland ports. They conclude that what China needs is a unified top-down institutional approach, so as to maximise performance. This research points out the importance of well-functioning institutions in establishing effective transport networks. It suits the notion established thus far from the available literature, that there is a role to play for the public sector, at least in regulation.

2.2.2.2 Public Private Partnerships in transport infrastructure and performance

On the performance of transport actors in relation to public-private involvement, academic literature is again rather scarce. Monios and Wang (2013) do make mention of the advantage in competitiveness of dry ports that are outside-in driven. This because outside-in driven corridors would be better integrated with the needs of sea ports and their cargo. In order to provide a good framework for performance measurement for the purposes for this study, a few other papers will thus be discussed with a focus on the influence of PPP models on rail and port actors, complemented by similar research in non-transport industries. These papers are summarized in Table 4. While previous research on performance of dry/inland ports is absent, one can expect the influence of PPP to be similar to sea ports, as the basic services provided by each are very similar (e.g. Woxenius et.al., 2004).

From a first look at Table 4, it seems clear that those papers focusing on performance in transport tend to employ variations of production frontier modelling. Indeed, Estache & Serebrisky (2004) state that the latter is the best methodology for performance measurements in transport infrastructure, as it measures the efficiency of transport infrastructure and operations according to the inputs used compared to the output produced. Examples of input in this case would be the capital employed, for instance, or the number of employees. Examples of output would then be the total throughput or number of kilometres travelled.

Table 4: Previous research concerning performance comparison and PPP

Author	Subject	Methodology	Effect of privatisation on performance (P = positive, N = negative, U = unclear)
Estache et.al., 2002a	Ports privatisation in Mexico	Production frontier analysis before & after	P
Estache et.al., 2002b	Rail privatisation in Argentina and Brazil	Factor productivity computing since de-regulation	P
Friebel et.al., 2008	Rail reforms in Europe	Production frontier analysis before and after	P
Reeves & Palcic, 2004	Companies privatised in Ireland	Descriptive analysis of financial performance before & after privatisation (e.g. turnover, ROCE…)	N
Cowie, 2010	Rail privatisation in England	Translog. cost function	P
Pham & Carlin, 2008	Companies privatised in Vietnam	Time series analysis of financial performance	U
Tongzon & Heng, 2005	Port ownership and performance	Stochastic production frontier & supporting cross-sectional regression analysis	P
Feng et.al., 2007	Port performance comparison China v/s UK	Questionnaires and descriptive statistics	n/a
Cullinane et.al. 2002	Port ownership and performance in Asia	Stochastic production frontier	P

Notably, Tongzon & Heng (2005) discuss the quantitative relationship between port ownership and port performance using a stochastic frontier model, complemented with cross-sectional regression analysis. In terms of port ownership, they distinguish between the following models, which show strong similarity to the World Bank (2001) framework discussed above:

- Absent from all involvement, even leaving regulation to the private sector (3/3 private involvement)
- Mere regulator, leaving the rest to the private sector. (2/3 private sector)
- Regulator and landowner, leaving operations to the private sector (1/3 private sector)
- Regulator, landowner and operator (0/3 private sector)

It was concluded from the statistical analysis between several proxies for port performance measuring tools, that it is most effective for the port authority to limit itself to regulating the port, while landownership and operations are left to private parties. Similarly, Cullinane et.al. (2002), employing the stochastic frontier model focusing on Asia, find results that suggest greater efficiency from greater privatisation and/or deregulation. Similar results are found with the same methodology by Estache et.al. (2002a) concerning port privatisation in Mexico.

Looking into rail performance, the production frontier analysis is again used by Friebel et.al. (2008) in a comparison of performance before and after rail privatisations throughout Europe. The authors also find clear evidence that privatisation of rail leads to better performance in this respect. Slightly differently, but still focusing on productivity, Estache et.al. (2002b) - investigating rail privatisations in Argentina and Brazil - again confirm positive effects from privatisation.

Moving on to slightly different methodologies, Cowie (2010) uses a translog cost function to establish whether rail privatisation actually did lead to lowered costs. Thus, we move from efficiency to costs as a proxy for performance. Cowie finds that privatisation lowered transport costs on the rail for both passengers and freight. On a different note, Reeves & Palcic (2004) and Pham & Carlin (2008) investigated the effects of the privatisation of a range of companies in different industries in Ireland and Vietnam, respectively. Both measure performance using financial data such as the turnover rate and ROCE amongst others. Reeves & Palcic limit themselves to a descriptive analysis of these data, and find no evidence of improved performance after privatisation. Pham & Carlin (2008), through time series statistical analysis of financial performance figures, find more mixed results as different financial measurement tools either increased or decreased after privatisation.

In conclusion, the tone seems to be set such that privatisation leads lead to improved operating efficiency, reduced costs and improved general performance. While the last two papers discussed did not support this view, it must be kept in mind that they analysed financial performance data of the years before and after privatisation to draw their conclusions, and it seems rather intuitive that a company that has just changed hands from a public to a private owner would perform slightly less well in the few years after as reforms are being put in place.

2.2.2.3 Tools for performance measurement

The performance measurement tools commonly employed in comparable research will now be discussed. Appendix 2 summarizes these measurement tools, of which the most illustrative will be discussed in this section. The most common studies concerning performance of public private partnership projects usually focus on transport costs - such as handling charges (Tongzon & Heng, 2005; Cullinane et.al., 2002) and costs of shipping services (Feng et.al., 2007) - but also on time – such as speed of cargo handling (Feng et.al., 2007) and average delayed time (Tongzon & Heng, 2005)- and on throughput – passengers and tons transported per km and total kilometres travelled (Friebel, 2003), and number of direct liner calls (Tongzon & Heng, throughput in containers (Cullinane et.al., 2002). Finally, as discussed earlier, some papers employed financial performance measurement tools, such as turnover, Return On Capital Employed (ROCE), sales efficiency, Profit Before Interest and Taxes (PBIT), amongst others.

So as to not digress into too much detail concerning performance measurement tools that are not relevant to the current research, this section limits itself to a brief discussion of the above performance indicators. Other papers discussed in the previous section had measurements tools similar to one or more of the above discussed ones. De Langen et.al. (2007) discuss the fact that throughput volumes as a performance indicator has the important limitation that it is more dependent on macro-economic factors and international trade flows than it is on the management of a port. Therefore, a port would perform better when the countries in its hinterland have a stronger economy, thus generating larger transport volumes. A side note is that one could still state that ports serving the same hinterland can be compared to each other in this way, as the largest volumes would go through the port that offers the best cost- and time efficiency. Transport costs and time both are strongly related to efficiency, as supported in Clark et.al. (2004) and Sanchez et.al. (2003), who find that efficiency at port level is an important determinant of the total transport costs and transit time in international trade. Finally, financial performance could be an important performance measurement tool as well for including an aspect of economic sustainability of a transport firm. This is confirmed in Foster and Briceno-Garmendia (2010), who describe how several rail corridors throughout Africa have been privatised but only two of them - i.e. Sitarail Ivory Coast/Burkina Faso and Camrail in Cameroon - make modest operating profits. It is then intuitive that some corridor's private operators would get in trouble due to poor financial performance, even if efficiency did improve with their stepping into the business.

3 METHODOLOGY

This section aims to establish the methodology for the present Master's thesis. First, a short description will be given of the data. Afterwards, an explanation will be given of the research set up and the statistical methods to be used.

3.1 DATA

For the purposes of this study, 21 different transport corridors were selected across the African continent, with the following criteria, as shown in the Appendix 1 table:

- The corridor represents a transport leg between a sea port and an inland port, where goods are stored or trans-shipped towards their final customer.
- For the sake of comparability, data was collected from studies done by one specific organisation, i.e. USAID (2010a; 2010b; 2011; 2012).
- The corridor covers at least 300 km. Thus, all corridor dry/inland ports can be considered a midrange or distant dry/inland port following Roso et.al. as discussed earlier (2009)

Appendix 1 also describes the nature of the data collected and the (non-)availability of necessary information for each corridor.

3.1.1 3.1.1. Corridor information

The information concerning the PPP structures of each corridor, the direction of development and the available services in the corridors was collected from online newspaper articles, websites of relevant actors and national policy papers. The resulting information on each corridor was checked for recognition by a number of expert consultants who have extensive experience in African hinterland transportation. Consequently, it is safe to assume the correctness of said information.

Concerning the PPP structures present in each corridor, the actors were subdivided in three different groups, as described below. The exact method of classification into different PPP models will be explained later in this paper. While these groups are not necessarily exhaustive, the subdivision was decided upon based on the availability of information. While many intermediate actors that are active in hinterland transport - such as shipping agents, third party logistic providers amongst others - are not considered in this manner, it is safe to state that these are the actors that are involved in managing, operating and controlling transport infrastructure. In considering Public-Private Partnerships, they are thus the most relevant factors to consider.

- Sea port actors (port authority and terminal operator)
- Inland transport actors (i.e. ownership & maintenance of the rail & of equipment, rail operator; ownership & maintenance of the roads and of equipment, road operator).
- Dry port actors (dry port authority and terminal operator)

This information was collected for each cargo type for which the performance data described in the next sub-section was available. For instance, a corridor transporting containers was considered to start at the container sea terminal, while a corridor transporting bulk cargo was considered to start at the relevant bulk cargo terminal. Concerning the other information present in Appendix 1, some more explanation is required concerning the direction of development, which was defined as follows:

- A corridor where the dry port was fully owned and operated by inland actors (e.g. local government, inland transport operator) was considered to qualify as inside-out.
- A corridor where the dry port was fully owned and operated by sea-port actors (e.g. sea port terminal operators, port authorities and maritime carrier lines), was considered to qualify as outside-in.
- A corridor where the dry port was owned and operated by a combination of inland and sea-port actors was considered to qualify as a combination of outside-in and inside-out.

A few interesting observations already arise from observing the information in Appendix 1, which will be discussed in the next chapter as an introduction to the results of the analysis. It is important to keep in mind that the sample of corridors forms an incomplete cross section of the Sub-Saharan African countries. Most originate in the ports of Mombasa or Dar Es Salaam, while the other sea ports only form the origin of one single corridor. This will create biased results, due to the large portion of the sample taken up by two single ports and countries, thus making their performance the most important determinant of the final result. Additionally, the countries of Tanzania and Kenya - but also Uganda and Rwanda as transit countries for a large number of sample corridors - are over-represented in the sample. Other countries in the sample, except for South Africa, are all located in Western Africa. Consequently, another issue is the fact that the sample available for this research is not representative of the whole continent of Sub-Saharan Africa. A more even distribution of the corridors over different countries, and the inclusion of countries in Central and South Western Sub-Saharan Africa would have led to more representative a sample. However, as always in academic research, one is limited to the amount of good quality data that is available. The availability of performance data, to be discussed in the next section, was the restrictive factor in constructing the sample.

3.1.2 Corridor performance data

Data on the performance of each corridor was collected from several studies conducted by USAID (2010a; 2010b; 2011; 2012) throughout the continent, providing information on the following factors:

1. Total cost of transport in each corridor (in ton.km)
2. The total average transit time (in hours/km)

As already discussed in Chapter 2, transport costs and transit time are performance indicators that have been used before in academic research concerning the PPP models of transport actors in relation to their performance. Additionally, they are a good proxy for general operating efficiency, as the latter is an important determinant of shipping costs and lead time (Clark et.al.,2004; Sanchez et.al., 2003). Of course, it would have been ideal to include more variables for measuring performance. For instance, the fact that many privatised rail corridors function at an operating loss (Foster & Briceno-Garmendia 2010) suggests that it would have been interesting to include financial performance indicators such as operating profit/losses, return on capital invested etc. However, not only was this type of information not available for a sufficient number of actors, it would also have been difficult to construct a reliable aggregate of such figures for the combination of corridor actors, as they often include different companies and countries. Throughput volumes were not available, but as discussed before this is less of a loss, as they are influenced more by the course of international trade routes than by PPP models. Generally speaking, it can be trusted that with the two chosen performance indicators the most important performance measurements for the Sub-Saharan Transport sector have been captured due to these variables also representing the most acute problems there (Foster & Briceno-Garmendia, 2010).

The performance measurement variables' values are representative for the transport leg over the full corridor, from the relevant sea port until the dry/inland port. The information for these data was obtained by the USAID

(2010a, 2010b, 2011, 2012) researchers through interviews with corridor stakeholders, such as transporters, forwarders/customs brokers, shipping line representatives, shipper's councils, private companies and business associations. From the data obtained through these interviews, the researchers took the most plausible answers and thus concluded approximate values for the factors given above. Consequently, it has to be borne in mind that for the reliability of the data used in this master's thesis we are dependent on the fair judgment of the USAID researchers who obtained the data and on the truthfulness of the stakeholders that they interviewed. As the cost figures taken from the presently discussed papers were given in dollars while they were collected at different moments in time, a correction was included such that all values were given in July 2013 figures.

Some important limitations apply to the chosen performance measures, which will be accounted for in the statistical analysis through control variables to be discussed later on in this chapter:

i. Transport costs are subject to scale economies, especially for rail transport (Roso et.al., 2009), but also for transport nodes (Notteboom, 2010). This means that those corridors that do not possess any strong economic activities along the way may perform worse simply because of small volumes, making it more difficult for the different actors involved to achieve an operating profit without demanding high prices. However, it can also be said that a transport corridor that is operated effectively will attract the necessary volumes, thus achieving scale economies.
ii. Transport costs, especially in sub-Saharan Africa, may be increased significantly by informal costs such as bribes (USAID, 2010). In the same way, transit time may be affected as well due to delays at checkpoints along the road and/or customs at the border. It is intuitive that this can't be allocated to the PPP model of a transport corridor. However, these informal costs are included in the total cost figures used for this analysis.

3.1.3 Data comparability

The adaptations made to the data are explained further in Appendix 3, but should be discussed shortly. As mentioned earlier, the data for the present research was collected from different studies which, though done by one and the same institution, were not carried out at the same point in time. Consequently, the data collected for the cost of transport, all given in U.S. Dollars, suffered from a bias due to different exchange rates between the local currency of each corridor and the U.S. Dollar. All the transport cost figures were thus expressed in 2013 dollars, according to the average exchange rate of July 2013.

Additionally, both the figures for transport cots and transit time were given as total figures for each corridor. As each corridor is of different length, it is obvious that taking these figures as they are would not lead to reliable results, as one can expect a longer corridor to have higher total transport costs and transit time. Consequently, adaptations were made as follows:

- Total transport costs were expressed in costs/ton.km. This means that the original figure was divided by the total length of the corridor (in km), and then again by the number of tons transported per unit.
- Total transit time was divided by the total length of the corridor in kilometres.

After the above adaptations, it can be said with confidence that the data employed for this research are comparable to each other. However, in order to construct the cost/ton.km figure, an assumption had to be made for the weight per unit of cargo transported on the Mombasa and Dar Es Salaam corridors due to the fact that it was not specified in the data for the latter. This was done on basis of the fact that the nature of the goods transported was similar to the other corridors, where unit weights were also comparable across corridors. Consequently, while it is possible that the assumption made is wrong, it seems safe to assume the correctness of it.

3.2 RESEARCH SET-UP

This section aims to establish the research set-up used to answer the main research question of the current master's thesis by putting forward the hypotheses to be tested and the statistical methodology employed for that goal. To recapitulate, the main research question is as follows:

'Do PPP models of actors within a transport corridor affect corridor performance in Sub-Saharan Africa?

3.2.1 Hypotheses

In order to answer the main research question mentioned above, 3 main hypotheses were tested, both through descriptive statistics and regression analysis, as will be outlined in the sections below. Each hypothesis is tested according to performance in terms of costs/ton.km and hours travelled per km.

1. More public involvement in the sea port worsens the transport corridor's performance in terms of:
   a. Costs/ton.km.
   b. Hours travelled per km.

2. More public involvement in inland transportation worsens the transport corridor's performance in terms of:
    a. Costs/ton.km.
    b. Hours travelled per km.
3. More public involvement in the dry port worsens the transport corridor's performance in terms of:
    a. Costs/ton.km.
    b. Hours travelled per km.

Finally, in order to expand the scope towards a slightly different institutional aspect that may be of influence in the case of transport corridors (e.g. Monios & Wang, 2013), a fourth hypothesis was included, concerning the direction of development:

4. More outside-in development significantly improves the transport corridor's performance in terms of:
    a. Costs/ton.km.
    b. Hours travelled per km.

The latter hypothesis should allow to give an idea of whether other aspects of institutional organisation play a possibly stronger role than public-private participation. This is of interest for further research, as it would indicate a direction to take when further investigating the optimal institutional arrangements for the African transport sector.

3.2.2 The statistical regression analysis

3.2.2.1 Descriptive analysis

A general descriptive analysis as well as a discussion of the data should give some first conclusions and possibly some insights that may support the regression analysis to be done afterwards and/or explain certain discrepancies. The data was analysed in terms of descriptive statistics of each variable, along with the identification of trends in scatter plots of the PPP variables in relation to the performance indicators. Thus, a first idea was given of the relations that do exist between the variables. However, no fully reliable conclusions can be pulled yet from such an analysis, as the relations found may be explicable by other factors that are not accounted for.

3.2.2.2 Methodology

From the discussion of methodologies employed in previous research, it became clear that using a production frontier analysis would be the optimal methodology to assess the performance of transport corridors (Estache et.al., 2004), as it is also one of the most widespread methods for this type of analysis. However, employing such a methodology would necessitate the availability of data concerning both input factors and output factors of each corridor. Examples of input factors would be labour input and capital invested, where examples of output would be the turnaround time of vehicles operated on the corridor, or the throughput volumes. While some output factors would have been available assumptions would have had to be made on the full range of input factors. This would not have lead to reliable results. Another option for analysis that came forward from the literature review is the analysis of the financial performance of corridor actors. An average financial performance indicator could have been constructed from the individual actor's performances for the entire corridor. However, not only would the latter have resulted in figures that are difficult to interpret, the financial performance of a firm does not necessarily translate into the firm's operational performance and only shows the profitability of the firm.

With the data available for this research, a cross sectional regression analysis was thus the best option available to perform a quantitative analysis that goes further than simple descriptive analysis. While it is not the most sophisticated of research methodologies, it is a good tool for establishing the existence of a relationship between different factors of relevance. Additionally, it has been used in previous research, as Tongzon & Heng (2005) used it as a supporting analysis to their production frontier model. Thus, in the current Master thesis' situation of limited data availability, the proposed methodology seems to be the best that is available. Consequently, two models were constructed, i.e. one for each of the two performance indicators used for this research as dependant variables. As explanatory variables, the information concerning the PPP models for each actor in the sample corridors was used to construct relevant variables as discussed in section 3.2.2.3 hereunder. Section 3.2.2.4 will then explain the control variables employed in the analysis.

3.2.2.3 PPP variables

Tongzon & Heng (2005), discussed in Chapter 2, classified different models of PPP for their stochastic production frontier analysis as follows:

- Absent from all involvement, even leaving regulation to the private sector (3/3 private involvement)
- Mere regulator, leaving the rest to the private sector (2/3 private sector)
- Regulator and landowner, leaving operations to the private sector (1/3 private sector)

- Regulator, landowner and operator (0/3 private sector)

This provides a good framework for expressing the PPP models of the sea port, inland transport and inland port actors such that they can be taken up as a variable in a statistical analysis. However, the World Bank (2011) offers slightly more detailed a division of PPP models, thus allowing for more variation in the PPP models. Additionally, there are no known cases of a private regulator in the selected corridors of Sub-Saharan Africa as suggested by the 3/3 private involvement defined by Tongzon & Heng. Thus the Tongzon & Heng PPP model distinction does not seem as well suited to the current research. The World Bank PPP model distinction seems more adequate, as they assumption is implied that regulation always is in public hands. This assumption will be held in the context of the current Master's thesis. The UNESCAP (2011) distinction between different PPP models of operation - discussed in Chapter 2 - may have still more accurate, as it distinguishes between the different contracts forms present in PPP for transport infrastructure. However, accurately collecting the information necessary for making such a distinction was beyond the means of the author if this Master's thesis, as it would have involved field research and interview with local actors in each transport corridor.

As was discussed in the literature review concerning PPP/ownership structures, the World Bank (2001) model for port PPPs is quite comparable to what could be expected in dry ports, as they represent much the same type of actors and activities. However, the comparability becomes more difficult for the inland transport actors. Consequently, a few adaptations were made to the World Bank model, so as to enable the comparison aimed at in this master's thesis. This is shown in Table 5 and *Table 6,* including the extent of public participation assigned to each model.

Table 5: Adapted model PPP sea ports and dry ports

Extent of public participation	0/4	1/4	2/4	3/4	4/4
Ownership and control of waterways/local infrastructure	Private	Public	Public	Public	Public
Ownership of land	Private	Private	Public	Public	Public
Ownership of equipment	Private	Private	Private	Public	Public
Control of port operations	Private	Private	Private	Private	Public

Table 6: Adapted model PPP inland transport

Extent of public participation	0/4	1/4	2/4	3/4	4/4
Ownership of road/rail infrastructure	Private	Public	Public	Public	Public
Control of maintenance	Private	Private	Public	Public	Public
Ownership of vehicles	Private	Private	Private	Public	Public
Control of operations	Private	Private	Private	Private	Public

As can be seen, the adaptation for the sea port/inland port table represents the addition of a 5th model where even the waterways are controlled and owned privately. This was necessary due to the fact that, while this is merely a theoretical possibility in the case of river- and sea routes, it actually does occur for their equivalent in land-based transport, i.e. roads and rails; where private parties invest in- and own the railways or roads; e.g. in South Africa[1]. Thus, so as to construct a classification of PPP models that can be applied to all actor groups selected for this analysis, the different levels of public-private involvement were changed from the port PPP model distinction (World Bank, 2011) to fit inland transport according to the following assumptions:

- Ownership and control of the waterways is the equivalent of ownership and control of the rail/road infrastructure
- Ownership of land is the equivalent of the responsibility for the maintenance of the rail/road, as is the case for RVR in Kenya, who do not own the Kenyan and Ugandan rail but do have the responsibility for maintenance of the rail (USAID, 2011).
- Ownership of equipment is the equivalent of ownership of the trucks/trains, as the latter represents the equipment of inland transporters
- Port operations is the equivalent of train/truck operations.

3.2.2.4 Control variables

In order to ensure that the relation –or absence thereof – to be established between the corridor cost- and time performance and their PPP models is correct, it is necessary to include a few control variables into the statistical regression model. This section will describe and justify the control variables used for the analysis.

Direction of development

[1] See the N3 concession website <http://www.n3tc.co.za/index.php?cmd=sm&SubPage_ID=11>

This variable is not only included for the purpose of acting as a control variable, as we are also interested in checking the outside-in/inside-out concept (Monios & Wang, 2013) discussed earlier on the African continent, so as to answer the fourth hypothesis in this thesis. However, its function as a control variable is not to be neglected either, as it may capture the effects of different levels of integration within the corridor, which is also likely to affect performance (Panayides, 2002). This variable was constructed similarly to the PPP model variables (*Table 5* & *Table 6*), such that it represents the portion of outside in involvement in the corridor. It was thus assumed that a fully inside-out controlled corridor has 0/2 outside-in involvement. When there was a combination of inside-out and outside-in involvement, the ratio was assumed to be 1/2, i.e. half controlled by the inside-out actors and the other half controlled by the outside-in actors. Finally, a fully outside-in controlled corridor was assumed to take value 2/2. It has to be acknowledged that the variable for the combined control is an aggregate, as the division will not always be half each. However, no reliable data was available on the real ratio for each corridor. Consequently, the assumptions made should be considered to be the best option available.

Transport mode dummy

As will be shown later on in this paper, there is a clear difference between road and rail in terms of their performance on cost and time within the sample selected for the statistical analysis. The top performing road corridors perform worse than the top performing rail corridors on costs per ton.km, while the opposite is the case for hours spent travelling per kilometre. Consequently, including a dummy variable for the transport mode - where the variable takes value one when it is a rail corridor and value zero when it is a road corridor - seems of crucial importance as not doing so could clearly lead the other variables included in the model to capture variances that are not attributable to them, but simply to the modality employed.

Country dummies

As was discussed earlier, here are many complex details that may influence transport performance, such as corruption, the quality of the infrastructure, administrative hurdles, the structure of the transport industry, the national economic situation etc. (Limao & Venables, 2001). As it would be very hard to include all the factors of influence on transport performance into one model, it was decided to use country dummies. Such a dummy takes value one when the corridor passes through the relevant country, and value zero when it does not. In so doing, those factors that are specific to the different countries included into the sample - but that are hard to specify - can be expected to be taken into account.

Type of cargo transported

As was mentioned in the beginning of this chapter, the data set contains data for bulk cargo and container cargo, which show differences in transport costs and transport time. Generally speaking, it is given that especially the handling of containers is significantly more complicated than the handling of bulk goods, due to the necessity for more extensive logistic capabilities for storage and transit of the cargo. Consequently, it can be expected that corridors where bulk is transported would show differences in performance merely due to the differences in the type of cargo transported. The inclusion of a dummy for this factor would solve the risk of biased results as a consequence of this difference.

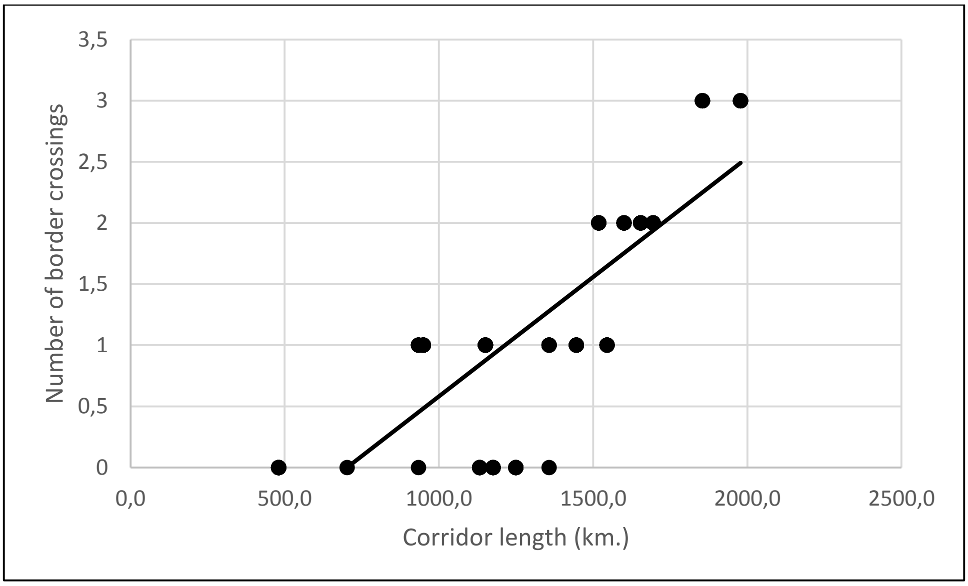
Corridor length instead of the number of border crossings

Border crossings are one of the main bottlenecks in inland transportation on the African continent, due to corruption and cumbersome bureaucratic procedures (e.g. USAID, 2011; Foster & Briceno-Garmendia, 2010). Consequently, it is intuitive that a large number of border crossings on one specific corridor would increase both the transport time and the costs made on every trip due to cumbersome bureaucratic procedures and corruption, amongst others (e.g. USAID, 2010). This was already discussed earlier as a limitation of the time and cost performance indicators used for the current study, as the informal costs and time losses suffered in these bottlenecks are included in the data.

Adding the number of border crossings on the corridor into the statistical model could thus be a very effective way to control ensure that any effects captured by the PPP model variables actually can be attributed to themselves. In addition, the inclusion of the border crossings variable will be useful in testing the 4th hypothesis, i.e. the influence of the direction of development. This because of the fact that most outside-in corridors are those without border crossings. Thus, if border crossings drive up costs and time, the variable for outside-in developed corridors would automatically be shown to improve performance, simply due to the sample characteristics.

Unfortunately, during the construction of the statistical models, it was found that the variable constructed for the number of border crossings was endogenous with the country dummies, as a corridor crossing several borders would also get as many country dummies with value one attached to it. Consequently, an alternative had to be found. Figure 4 shows that the number of border crossings, as is to be expected, is strongly correlated with the length of the corridor. Thus, the inclusion of corridor length as a control variable instead of border crossings would be the way to go. The inclusion of the corridor length variable is justified further by Merge Global (2008), who discuss that as the length of a specific transport trip increases, a relatively large amount of time is spent travelling outside congested areas, which would automatically improve performance due to faster progress per km and lower average fuel use outside congested areas.

Figure 4: Relation between the number of border crossings and the corridor length in km.



*Correlation of border crossings with corridor length is 0,83.

4 RESULTS

1.1 DESCRIPTIVE ANALYSIS

4.1.1 Data description

Table 7: Data description

Variable	# of observations	Mean	Minimum	Maximum
Costs/ton.km (U.S. $)	106	0,1138679	0,01	0,31
Time/km (hours)	100	0,3369	0,11	0,86
Direction of development	106	0,2641509	0	1
Corridor length	106	1270	480	1978
Sea port PPP	106	0,716911	0,5	1
Inland transport PPP	106	0,4551887	0	0,75
Dry/inland port PPP	106	0,8372642	0,25	1
Type of cargo dummy	106	0,6415094	0	1
Transport mode dummy	106	0,2358491	0	1
Rwanda dummy	106	0,2830189	0	1
Ghana dummy	106	0,0471698	0	1
South Africa dummy	106	0,009434	0	1
Burkina Faso dummy	106	0,1037736	0	1
Senegal dummy	106	0,0566038	0	1
Tanzania dummy	106	0,3207547	0	1
Mali dummy	106	0,0566038	0	1
Uganda dummy	106	0,3962264	0	1
Kenya dummy	106	0,509434	0	1
D.R.C. dummy	106	0,1698113	0	1
Burundi dummy	106	0,1132075	0	1
South Sudan dummy	106	0,0566038	0	1
Togo dummy	106	0,0566038	0	1

Table 7 gives an overview of the data, with a few observations that certainly are important to keep in mind. For instance, a clear difference can be seen in the mean value of public involvement in the three components analyzed for transport corridors. Indeed, inland transport actors in the selected corridors are clearly more privately owned, tending towards private operation and public ownership and maintenance of the rail infrastructure, as the latter model takes value 1/4 in *Table 6* of Chapter 4.2.2.2 discussed earlier. None of the inland transport actors is actually fully publicly owned, as the maximum value of this variable is 3/4. Meanwhile, the PPP models of sea ports vary between that of public control of waterways and land to full public control, while dry/inland ports also show a few cases where public ownership is limited to local infrastructure, and private parties actually own the land. The data set seems quite well balanced in terms of the type of transport, with slightly more container transport than bulk transport, judging from the the mean value of the relevant dummy being 0,64 (value 1 for containers). The mean value of the direction of development shows that the majority of corridors are developed inside-out, as the variable takes value 0 when developed inside-out, value 0,5 when it is a combination and value 1 when it is developed outside-in.

Importantly, the country dummy means clearly show the fact that a large number of the corridors in the sample run through a small number of countries, where Kenya accommodates half of them, closely followed by Uganda, Tanzania, Rwanda and slightly further on the Democratic Republic of Congo (D.R.C.). Thus, except for the fact that not all relevant regions of Sub-Saharan Africa are represented, the sample clearly is most representative of these Eastern African countries. Additionally, the fact that none of the rail actors are fully under public control raises similar concerns of representativeness, as a large number of countries on the continent do still have full public control of the railways (Foster & Briceno-Garmendia, 2010).

4.1.1.1 PPP models

Sea ports

Concerning the PPP models within the different corridors, it is flagrant to see the confirmation of the popularity of the landlord model (public control of inland waterways and land) and the service port model (the fully public model) as stated by e.g. Foster & Briceno-Garmendia (2010) in Table 8. All sea port terminals are either the one or the other. If one takes into account the fact that Mombasa is the sea port for a large number of the corridors selected for this study, and all Mombasa terminals qualify as fully public, it becomes apparent that a large number of sea ports around the African continent are actually organized according to the landlord model, provided the sample is representative for the whole continent.

Inland transport

Concerning the inland transport PPP models, most also qualify as ‘landlord’ (public control of infrastructure and its maintenance), while some are fully private (full private control) or nearly private (public control of infrastructure only). The latter is the case mostly for the rail corridors, where private consortia are responsible at least for operations (e.g. Kenya & Uganda), or even for maintenance and operations together (Senegal-Mali). Additionally, both Mozambique and South Africa have toll roads, to which the rights are fully owned by a private company under concession who is responsible for maintenance as well. Interestingly, most rail corridors also have private actors - usually the concessionaire of rail operations - involved in maintenance of the infrastructure. This is the case in both Kenya and Senegal. Generally speaking, it can be said that inland transport PPP models are quite similar across the continent. However, it remains interesting to see whether there is any statistical difference between the respective PPP models, keeping in mind that low variance may not lead to the most reliable results.

Table 8: Excerpt from Appendix 1: PPP models

<table>
<tr><th>Sea port</th><th>Inland port</th><th>Sea port PPP</th><th>Inland transport PPP</th><th>Dry/inland port PPP</th></tr>
<tr><td rowspan="9">Mombasa</td><td>Nairobi</td><td rowspan="9">4/4</td><td rowspan="7">2/4</td><td>4/4</td></tr>
<tr><td>Kampala</td><td>3/4</td></tr>
<tr><td>Kigali</td><td>2/4</td></tr>
<tr><td>Bujumbura</td><td>4/4</td></tr>
<tr><td>Nimule</td><td>4/4</td></tr>
<tr><td>Kasindi</td><td>4/4</td></tr>
<tr><td>Goma</td><td>4/4</td></tr>
<tr><td>Nairobi</td><td rowspan="2">1/4</td><td>3/4</td></tr>
<tr><td>Kampala</td><td>3/4</td></tr>
<tr><td rowspan="7">Dar Es Salaam</td><td>Mwanza</td><td rowspan="7">2/4</td><td rowspan="2">1/4</td><td>4/4</td></tr>
<tr><td>Kigoma</td><td>4/4</td></tr>
<tr><td>Bamako</td><td rowspan="5">2/4</td><td>2/4</td></tr>
<tr><td>Mwanza</td><td>4/4</td></tr>
<tr><td>Goma</td><td>4/4</td></tr>
<tr><td>Kigali</td><td>2/4</td></tr>
<tr><td>Bujumbura</td><td>4/4</td></tr>
<tr><td>Lomé</td><td>Ouagadougou</td><td>2/4</td><td>2/4</td><td rowspan="2">3/4</td></tr>
<tr><td>Tema</td><td>Ouagadougou</td><td>2/4</td><td>2/4</td></tr>
<tr><td>Durban</td><td>Nelspruit</td><td>4/4</td><td>0/4</td><td>3/4</td></tr>
<tr><td rowspan="2">Dakar</td><td rowspan="2">Bamako</td><td rowspan="2">2/4</td><td>1/4</td><td rowspan="2">2/4</td></tr>
<tr><td>1/4</td></tr>
</table>

Dry port

Most dry ports have a rather large public involvement, with only a few exceptions such as Bamako where a private party (Bollore Africa Logistics) operates the terminal under the landlord model. Consequently, as with the inland transport actors, there is not much variation in the PPP models for this class of corridor actors. Thus, even though the basic activities undertaken by sea ports and dry ports are quite similar, i.e.

load/unloading, transshipment and storage of cargo, one may expect the statistical results to indicate differing effects of PPP models. This needs to be kept in mind when analyzing the results.

4.1.1.2 Direction of development

Table 9: Excerpt from Appendix 1: Direction of development

Sea port	Inland port	Modality	Direction of development	Border crossing (Y/N)
Mombasa	Nairobi	Road	O-I	N
	Kampala	Road	C	Y
	Kigali	Road	I-O	Y
	Bujumbura	Road	I-O	Y
	Nimule	Road	I-O	Y
	Kasindi	Road	I-O	Y
	Goma	Road	I-O	Y
	Nairobi	Rail	I-O	N
	Kampala	Rail	I-O	Y
Dar Es Salaam	Mwanza	Rail	O-I	N
	Kigoma	Rail	O-I	N
	Bamako	Rail	C	Y
	Mwanza	Road	O-I	N
	Goma	Road	I-O	Y
	Kigali	Road	I-O	Y
	Bujumbura	Road	I-O	Y
Lomé	Ouagadougou	Road	I-O	Y
Tema	Ouagadougou	Road	I-O	Y
Durban	Nelspruit	Road	I-O	N
Maputo	Nelspruit	Road	I-O	Y
Dakar	Bamako	Road	C	Y
		Rail	C	Y

To start with, one flagrant detail from appendix 1, as shown in Table 9, is the fact that the great majority of the selected corridors presents cases of inside-out development, where a local government usually initiates and owns the dry port. Only a few corridors present full inside-out development. An example of a clear outside-in development is that of the Kenya Ports Authority, which controls the sea port of Mombasa and also controls and operates the Nairobi ICD, and another one in Kisumu near Lake Victoria. A good example of combined development, where both inside-out and outside-in actors are involved, is the dry port of Bamako, where Bolloré Africa Logistics operates several dry ports around the city in co-operation with the local government institutions. What is also interesting but intuitive is that most inside-out dry ports are located in landlocked countries. The only cases of outside-in involvement in a landlocked country are that of Bamako (Mali), discussed above, and of Kampala (Uganda), where different companies are jointly active. It is certainly understandable that a public institution such as a port authority is unlikely to invest in another country as this could be perceived as a loss of sovereignty by the receiving country's authorities (Veenstra et.al., 2012). In any case, the fact that outside-in developed corridors are not very strongly represented in the sample needs to be kept in mind in interpreting the statistical results, as it may imply biasedness.

4.1.2 Costs per ton.km descriptive results

Figure 5: PPP influence on costs/ton.km

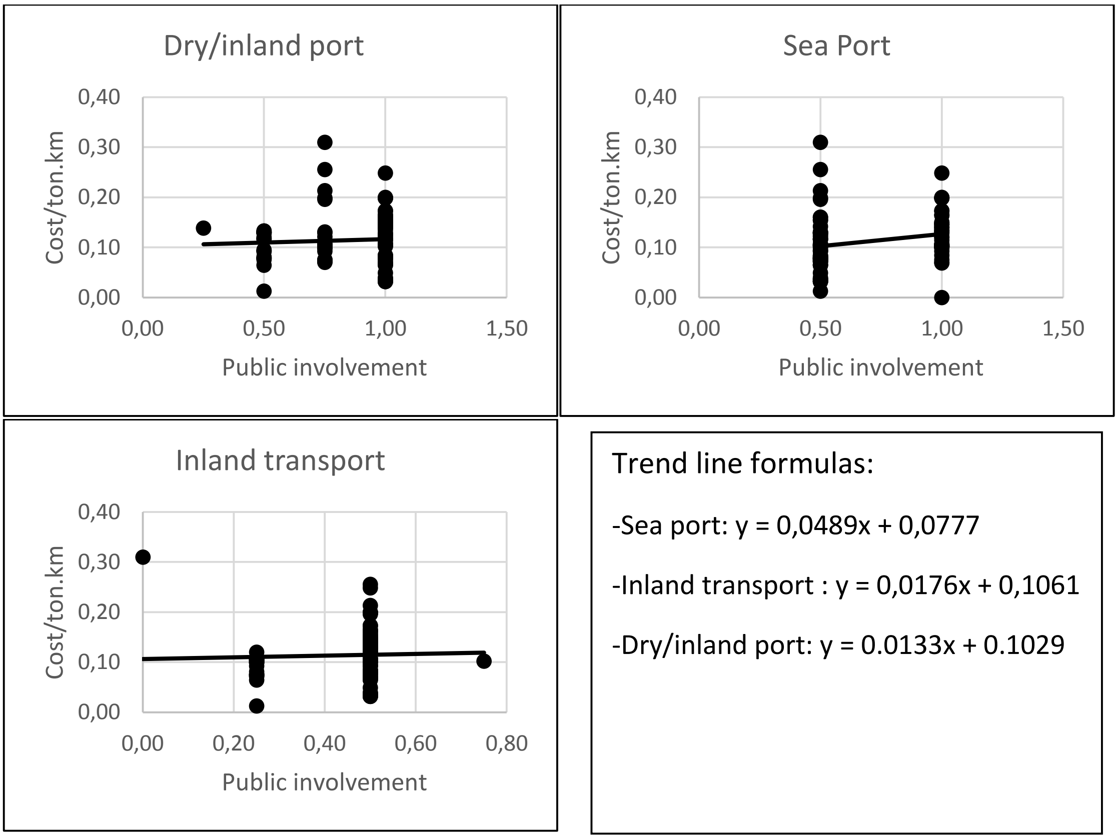


Figure 5 shows the descriptive results of the influence of PPP models on the performance of a corridor on costs per ton.km with 1 graph for each of the three respective groups of corridor actors. These simple graphs give a first idea of the influence of more public influence on costs/ton.km, i.e. that the first increases the latter.

This effect is clearly strongest for sea ports if one looks at the slope of the trend line, while it is very similar for inland transport and dry/inland ports. Thus, one would make a preliminary conclusion that transport costs on a corridor are influenced most strongly by the sea port's PPP model, followed by inland transport and dry/inland port PPP models, respectively.

It is interesting now to translate the slopes of the trend lines found here into interpretable results. As the variables for PPP basically have 4 possible values, i.e. 0/4, 1/4 , 2/4 , 3/4 or 1, the actual increase of transport costs for a change of PPP model is smaller than the coefficients given for the trend lines. Consequently, the change of transport costs/ton.km between different models is equal to ¼ of each given coefficient. The influence of an increase of public control in any of the corridor actors is then such as given in Table 10

Table 10: Effects of a change in PPP model towards more public control for each corridor actor: transports costs

PPP model	Δ Cost/ton.km	Δ Total cost/ton*	Δ total cost/ ton as % of average cost/ton**
Δ Sea port model	0.012 US$	15,20 US$	10%
Δ Inland transport model	0,004 US$	5,08 US$	3,3%
Δ Dry/inland port model	0,003 US$	3,8 US$	2,5%

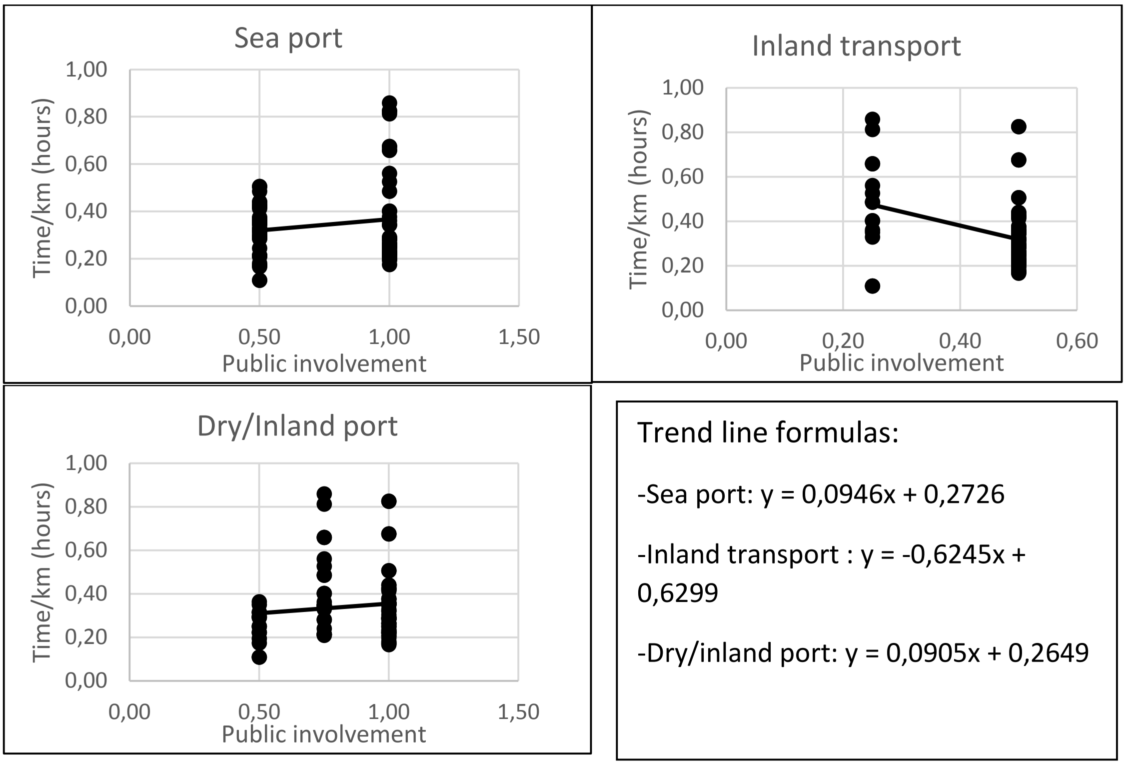
*On basis of average corridor length of 1270 km.
**On basis of average total costs in the sample corridors of 152 US$

If these results are indeed fully attributable to the PPP model of the different corridor actors, the differences can be considered no less than substantial for all three groups of actors considering the percentage changes given in Table 10. However, caution needs to be taken as other factors may be at work here. The statistical analysis in Chapter 5.2 will have to provide further insights in the case.

Figure 6 now shows the results for time/km. The results are similar in to costs/ton.km for sea ports and dry/inland ports time/km increases when more public involvement is present in these transport nodes. However, in the case of inland transport, there suddenly seems to be a benefit from more public influence on time/km, i.e. the latter decreases when the first increases. This even happens quite strongly, with a coefficient of the trend line as large as -0,6 hours/km.

4.1.3 Time/km descriptive results.

Figure 6: PPP influence on time/km



Similarly to the previous section, one can thus say that a change in PPP model would lead to changes in transport time, as shown in Table 11. Again, the effects seem rather substantial, though again caution needs to be taken in drawing conclusions. Especially the effect of inland transport PPP model is hardly plausible, as it is not only extremely large but also implies an improvement of the situation in case of more public involvement.

Table 11: Effects of a change in PPP model towards more public control for each corridor actor: transports time

PPP model	Δ Time/km	Δ Total time*	Δ total time % of average time**
Δ Sea port model	0,024 hours	30,04 hours	10%
Δ Inland transport model	-0,156 hours	-198,28 hours	-3,3%
Δ Dry/inland port model	0,023 hours	28,73 hours	2,5%

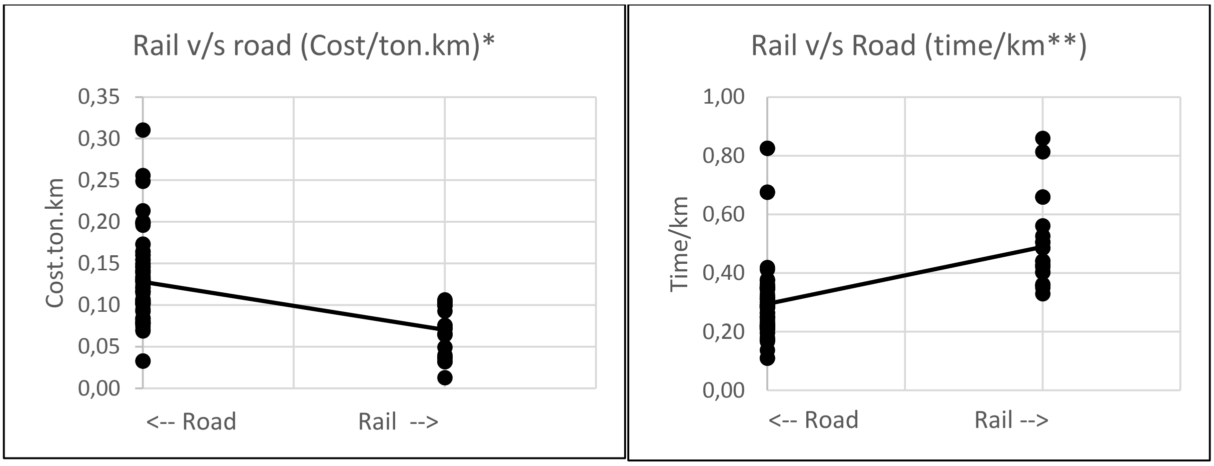
*On basis of average corridor length of 1270 km.

** On basis of average sample corridor total time of 431,8 hours

4.1.4 Rail v/s road:

Figure 7 shows an interesting point about the transport modes in the sample, i.e. road and rail and the cost/ton.km difference between the two. It is shown very clearly that rail is cheaper than road in this case, with a coefficient of the trend line as big as -0,0577, which means that rail is 0.0577 US$ cheaper per ton.km. In a similar calculation as done in Table 10, that means that, on average, rail is 48,2 % cheaper than the total corridor's average in the sample of corridors chosen for this paper. Interestingly, the opposite is true in terms of time/km, as rail clearly performs worse than road transport, with a coefficient of 0,1952 (meaning rail takes 0.1952 hours longer than road on average), which translates average rail transit time being 57,4% longer than the total corridor's average. It is thus clear that the control variable for modality that will be included in the statistical analysis is necessary, as there is a large difference in performance between rail and road.

Figure 7: Relation between difference in modality and transport costs and time

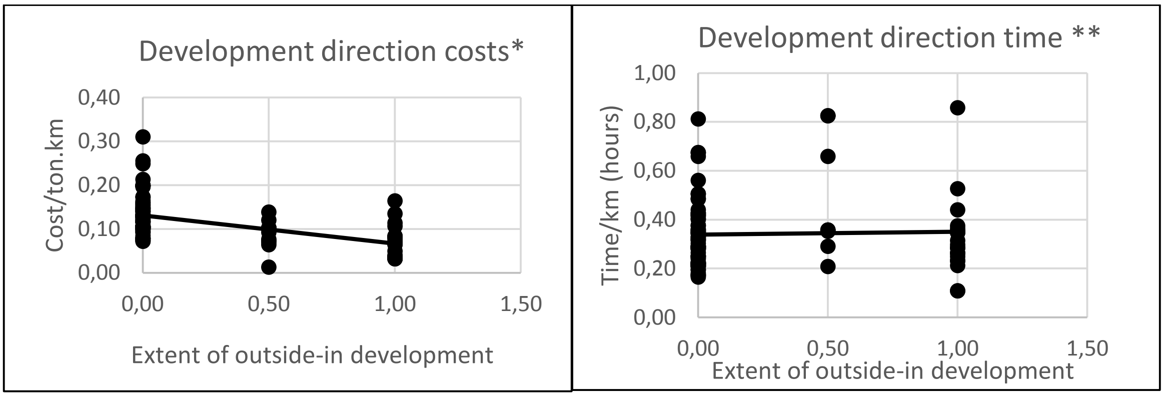


*Trend line equation: y = -0,0577x + 0,1277
** Trend line equation: y = 0,1952x + 0,2942

4.1.5 Development direction

Figure 8 now shows the effect of development direction on the costs per ton.km and the time/km in the corridor sample. There does seem to be a reduction in costs per ton.km as outside-in actors get a stronger involvement in the transport corridor. However, the opposite is true for time/km. In any case, not much can be said about this before testing it through the regression analysis to be done in chapter 5.2, as it is also true that most corridors that have outside-in developments are those that do not have many border crossings, and if they do, it does not exceed a single crossing. Meanwhile, one may expect that border crossings strongly increase costs, due to necessary bribes and time lost in bureaucratic procedures. Consequently, instead of being due to reduces costs from outside-in involvement, the negative slope of the cost/ton.km curve in Figure 8 may actually be due to reduced costs following a reduced number of border crossings.

Figure 8: Development direction influence on costs and time



*Trendline equation: y = -0,065x + 0,1312

** Trendline equation: y = 0,0117x + 0,3391

4.2 4.2. STATISTICAL MODEL

4.2.1 Statistical description of the model

The results from the statistical analysis can be seen in Table 13 below for the performance in terms of costs/ ton.km, while Table 14 shows the results in terms of time/km. Meanwhile, Table 12 shows a summary of the set-up of the models. For each of the two dependant variables of Table 13 and Table 14, respectively, the same set of exogenous variables have been used in accordance with the discussion had in the methodology chapter earlier in this Master's thesis. In order to establish the robustness of the models, but also to discern certain interactions between the variables, four different models, referred to as A, B, C and D, have been built including different sets of control variables. The country dummies and the transport mode dummy have been included in each model, as their influence on the dependant variables is indisputable: it was established that a clear difference is present in the performance of rail v/s road, where rail clearly performs better than road in terms of costs, the opposite being true in terms of time performance. Not including that variable would thus certainly lead to biased results. The same can be said for the country dummies, as they are meant to control for all country specific factors that may influence the performance of the transport sector without being specifically attributable to the PPP model of the transport actors. Therefore, model A represents the results including only the PPP models and these groups of dummies. Models B, C and D then show the results with the inclusion of the other three control variables as marked in Table 12. As a final remark, it should be specified that all statistical models suffered from heteroskedasticity according to the Breush-Pagan/Cook-Weisberg test, thus necessitating the use of robust/white standard errors.

Table 12: Summary of variables

	Variable	Explanation	Exogenous variables used per model			
			A	B	C	D
Dependant variables	Cost/ton.km	US$				
	Time/km	Hours				
PPP model exogenous variables	Sea port	Table 6	x	x	x	x
	Inland transport	Table 7	x	x	x	x
	Dry/inland port	Table 6	x	x	x	x
Control exogenous variables	Development direction	0 = inside-out, 0,5 = combination, 1 = outside-in		x	x	x
	Corridor length	Length in km.			x	x
	Dummy cargo type	1 = container, 0 = bulk				x
	Dummy for transport mode	1 = rail, 0 = road	x	x	x	x
	Dummies for: Rwanda, South Africa, Burkina Faso, Tanzania, Uganda, Kenya, DRC, Burundi, South Sudan, Togo, Mali, Senegal, Ghana	1 = corridor crosses country, 0 = corridor does not cross country	x	x	x	x

4.2.2 Costs/ton.km results

The results in Table 13 give some very interesting food for thought. The results are robust across models A, B and C, with coefficients for the PPP models that do not change sign after the inclusion of an extra exogenous variable and magnitudes that change only slightly. Most of the country dummies keep their sign in a similar manner, with a few exceptions such as Uganda and Burundi.

Across the first three models, more public involvement in the sea port seems to have a clear increasing impact on the costs/ton.km with a coefficient as large as 0,07 - which is more than half of the mean value of the cost/ton.km variable (i.e. 0,11) – and significance at the 1% level. However, the inclusion of the dummy for the type of cargo transported (i.e. bulk or containers) changes this completely, as the coefficient loses its magnitude and the P-value shoots up significantly, leaving the impression that this difference between cargo types transported is of much large importance than the PPP model of the sea port. Meanwhile, the cargo type dummy suggests that containers are significantly more expensive to handle and transport than bulk with a significance level at 1%.

Concerning the other two groups of actors, i.e. inland transport and dry/inland port, the results suggest that their PPP models are of no statistically significant influence on transport costs. This is especially the case for inland transport, which shows statistically insignificant results across the board. In the case of the dry/inland ports, a negative and statistically significant coefficient is seen in model A, but this significance reduces steadily as more control variables are added, with statistical significance completely disappearing beyond model B.

Table 13: Results costs/ton.km[1]

Dependant: Cost/ton.km	Model A		Model B		Model C		Model D	
# of OBS: 106	**Coefficient**	**P-value**	**Coefficient**	**P-value**	**Coefficient**	**P-value**	**Coefficient**	**P-value**
Sea port PPP	0,070	0,000***	0,070	0,000***	0,070	0,000***	0,004	0,720
Inland transport PPP	0,039	0,489	0,056	0,334	0,003	0,955	0,036	0,305
Dry/inland port PPP	-0,133	0,000***	-0,091	0,021**	-0,046	0,291	-0,017	0.383
Development direction	Excluded		-0,022	0,193	-0,036	0,025**	-0,046	0,000***
Corridor length			Excluded		0,000	0,010***	0,000	0,000***
Cargo type dummy					Excluded		0,041	0,000***
Transport mode dummy	-0,021	0,059*	-0,025	0,019**	-0,037	0,003***	-0,032	0,007***
Rwanda dummy	-0,031	0,003***	-0,032	0,002***	-0,064	0,000***	-0,063	0,000***
South Africa dummy	0,231	0,000***	0,211	0,000***	0,241	0,000***	0,254	0,000***
Burkina Faso dummy	0,075	0,018**	0,046	0,252	0,079	0,058*	0,057	0,073*
Tanzania dummy	0,033	0,071*	0,018	0,352	0,036	0,072*	0,018	0,136
Uganda dummy	-0,023	0,011**	-0,022	0,018**	-0,103	0,001***	-0,103	0,000***
Kenya dummy	0,043	0,015**	0,024	0,259	0,106	0,005***	0,114	0,000***
DRC dummy	0,090	0,000***	0,068	0,002***	0,018	0,504	0,004	0,132
Burundi dummy	0,074	0,000***	0,052	0,014**	-0,013	0,686	-0,027	0,397
South Sudan dummy	0,085	0,000***	0,063	0,005***	0,018	0,526	0,005	0,730
Togo dummy	0,019	0,610	0,019	0,598	0,015	0,681	0,014	0,672
Mali dummy	Omitted due to colinearity							
Senegal dummy								
Ghana dummy								
*** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level								

[1] An interaction was also tried between the cargo type dummy and respectively the variables of Sea port PPP, Inland transport PPP, dry/inland port PPP, development direction and corridor length, due to the strong influence of the latter dummy variable on the total results. However, doing this led to completely confused results. The current data set thus does not allow for such extra statistical control tools to be used, with the main reason being the small sample size.

Across the board, the transport mode dummy confirms the analogy made in the descriptive analysis that rail is significantly cheaper than road. The variable is significant in all models, though the inclusion of the corridor length significantly improves its significance. This is to be expected as the longer corridors are usually served by road in the sample employed for this research. Meanwhile, the direction of development also shows that more outside-in involvement leads to better performance, with a significant negative coefficient in models C and D at 5% and 1% respectively, though the coefficient is insignificant at the 10% level in model B. This is again explicable by the inclusion of the variable for corridor length, as most outside-in corridors are relatively short, meaning that corridor length is relevant for the value of the development direction variable. This is clearly in accordance with the observations made in the descriptive analysis. Finally, the corridor length has a significant increasing influence on the costs/ton.km, though with a very small coefficient in both model C and D. In any case, there is clearly some endogeneity between the variables for transport mode and development direction and the variable for corridor length.

4.2.3 Time/km results

The results of the statistical analysis of time/km as a dependant variable again give some interesting insights. Again, the results are quite robust across the board, with coefficients that do not change much w.r.t sign, magnitude and statistical significance. This is even true for all country dummies except for DRC and South Sudan.

More public involvement in sea ports seems to have a clear positive effect on time/km, i.e. the time/km travelled on a corridor increases as public involvement increases. The magnitude and statistical significance of the coefficient remains equal in models A,B and C, and only slightly reduces with the addition of the cargo type dummy. Thus, in contrast to the costs/ton.km, the PPP model of the sea port clearly does have an influence on the performance in terms of time/km. The magnitude of this coefficient -being more than half of the mean value of time/km (i.e. 0,33) in all four models- also suggests that this effect is not to be neglected. In the case of inland transport, more public involvement seems to reduce time/km, judging from its large magnitude and negative and statistically significant sign in models A and B. However, the addition of other control variables steadily reduces the coefficient's significance, with significance reduced to the 10% level in model C and disappearing in model D. Consequently, the conclusion might be similar to the previous section – there is no statistically significant effect of the PPP model in the case of inland transport actors. The diagnosis is much the same in the case of the dry/inland port, where more public involvement seems to have a positive impact with high magnitude and significance on time/km, meaning that performance is reduced. However, the significance of this coefficient is lost in the more extended models C and D.

Table 14: Results time.km (hours)[1]

Dependant: Time/km (hours)	Model A		Model B		Model C		Model D	
# of OBS: 100	**Coefficient**	**P-value**	**Coefficient**	**P-value**	**Coefficient**	**P-value**	**Coefficient**	**P-value**
Sea port PPP	0,232	0.001***	0,232	0,001***	0,232	0,001***	0,181	0,017**
Inland transport PPP	-0,364	0.001***	-0,346	0,000***	-0,216	0,059*	-0,170	0,132
Dry/inland port PPP	0,167	0.035**	0,242	0,006***	0,126	0,148	0,130	0,166
Development direction	Excluded		-0,036	0,238	-0,003	0,035**	-0,007	0,832
Corridor length			Excluded		0,000	0,018**	0,000	0,012**
Cargo type dummy					Excluded		0,032	0,063*
Transport mode dummy	0,047	0,145	0,238	0,254	0,067	0,035**	0,074	0,029**
Rwanda dummy	0,012	0,400	0,254	0,254	0,063	0,016**	0,064	0,015**
Ghana dummy	0,120	0,000***	0,119	0,000***	0,138	0,011**	0,114	0,044**
Senegal dummy	-0,135	0,000***	-0,094	0,000***	Omited due to colinearity			
Tanzania dummy	0,144	0,000***	0,167	0,000***	0,210	0,000***	0,191	0,000***
Uganda dummy	-0,300	0,000***	-0,297	0,000***	-0,159	0,027**	-0,153	0,024**
Kenya dummy	0,263	0,000***	0,279	0,000***	0,216	0,011**	0,214	0,010*
DRC dummy	-0,051	0,155	-0,089	0,034**	0,014	0,786	0,013	0,815
Burundi dummy	-0,094	0,006***	-0,133	0,002***	-0,004	0,943	-0,004	0,947
South Sudan dummy	-0,054	0,118	-0,092	0,025**	0,000	1,000	-0,002	0,972
Togo dummy	Omited due to colinearity				0,028	0,475	0,007	0,864
South Africa dummy	Omitted due to colinearity							
Burkina Faso dummy								
Mali dummy								
*** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level								

Concerning the transport mode, the effect is as expected in the descriptive analysis: rail performs worse than road in terms of time/km. While the statistical significance of this variable is absent in the first two models A and B, it regains significance in the more extended models C and D. Thus, the same case is visible as with the cost/ton.km model, that the transport mode variable shows some endogeneity with the variable for corridor length. The development direction's effect on time/km is not as clear. More outside-in development seems to improve the performance of a corridor judging from its negative sign. However, its magnitude is relatively small and its significance is only present in model C, suggesting again the endogeneity with corridor length. However, looking at model D as the most extended one, the variable loses its effect on time/km due to

[1] The same interaction as with the cost/ton.km was tried out in this model as well, with the same conclusion

inexistent statistical significance. The corridor length acts as expected, increasing time/km as it increases itself with significance at the 5% level.

4.2.4 Country dummies' influence on performance

Concerning the country dummies, some interesting points come through as well. Their influence on performance is mostly similar on each of the two different dependant variables, which is why they shall be discussed jointly. The 5 countries that are most strongly represented in the sample should be discussed.

Kenya, with more than half of the sample corridors passing through its sea port and hinterland, has a significant positive (increasing) effect on transport costs and time performance across the board, except for model B in the cost performance model. As Kenya's sea port is also fully public, this fits entirely with the results for the sea port PPP model that it would negatively affect performance. Uganda has a significant and negative relation to costs/ton.km in all models, while its dry/inland port and inland transport actor both have private involvement, as was seen earlier in Table 8. Tanzania, then, does show a positive relation to costs/ton.km, but with a coefficient that has limited to no statistical significance. However, in the case of time/km, this relation does become significant. As Tanzania houses the largest number of rail corridors - which perform less well in terms of time and better in terms of costs - the insignificance in the cost performance model and the significance and positive sign of the coefficients in the time performance model make perfect sense. Meanwhile, Rwanda has a negative influence on the dependant variable for costs, meaning it shows relatively good performance in terms of transport costs. However, Rwanda seems to perform less well in terms of time performance. Finally, the DRC has a positive influence on costs/ton.km, which becomes insignificant after the inclusion of the corridor length. As the corridors reaching the DRC are also among the longest corridors in the sample, this may thus be a partial explanation for its coefficient. In terms of time performance, the DRC does not seem to have much influence at all judging from its coefficient.

Generally, the country dummies' coefficients and significance are sometimes confusing. As these variables are meant to capture various country specific factors, not much can be concluded from their coefficients. However, the fact that their sign is not always what one would expect calls for wariness concerning omitted variable bias. However, the main results of the model for costs/ton.km do give some good food for thought, and the implications for this thesis' hypotheses will be discussed in the next chapter.

5 DISCUSSION

5.1 THE VERDICT ON PPP MODELS IN TRANSPORT CORRIDORS AND PERFORMANCE

Following the results of the analysis above, some conclusions certainly can be made while keeping a certain wariness regarding limitations present in the current research. The latter shall be discussed in the next chapter. The current section will discuss each hypothesis separately on basis of the results presented in the previous chapter. In all cases, the descriptive analysis proved quite predictive of the statistical results, which increases confidence in the robustness of these results.

5.1.1 Hypothesis 1

5.1.1.1 Hypothesis 1a:

Hypothesis 1a stated that more public involvement in the sea port worsens the transport corridor's performance in terms of costs/ton.km. To start with, the descriptive analysis did point in the direction of accepting this hypothesis, as simply plotting the sea port PPP variable against cost/ton.km gave a strongly upwards sloping trend line, implying that more public involvement would increase transport costs significantly. It was even calculated that, according to these results, one step up in the PPP model towards public involvement would increase transport costs by 10% compared to the sample average. This impression remained present after the cross-sectional regression analysis until the addition into the model of the type of cargo transported. As soon as this happened, the initially statistically significant and large impact of the sea port PPP model on transport costs became much smaller and lost all significance. Thus, the final and most extensive model constructed to test the current hypothesis leads us to reject hypothesis 1a. It is clear that not the PPP model, but country specific factors and the means available are of influence on performance. The specifically strong impact of the type of cargo may be explained by the fact that container handling in sea ports is certainly more complicated to do in an efficient manner compared to the much more simple bulk goods. For instance, handling containers requires more logistic know how and IT systems to be available. Thus, while this would need to be researched better, one may conclude that it is more a lack of means than the PPP model affecting the sea ports performance in terms of costs. Additionally, other factors such as levels of corruption and bureaucratic hurdles, captured by the country dummies, may also be at stake here rather than the PPP model.

5.1.1.2 Hypothesis 1b

Hypothesis 1b stated that more public involvement in the sea port worsens the transport corridor's performance in terms of time/km. Again, the descriptive analysis pointed in the direction of accepting this hypothesis. Similarly to the cost/ton.km analysis, a change of one model up towards public involvement would lead to a 10% increase of time/km compared to the sample average. This time, the first impression was proved to be right, both in terms of coefficient and statistical significance. The sea port PPP model's coefficient did not budge with the addition of more and more control variables. Even the addition of the type of cargo transported only slightly reduced the variable's relation to cost/ton.km. Consequently, there is no reason to reject hypothesis 1b, meaning that the sea port's PPP model indeed does seem to have an influence on time performance of a transport corridor. Meanwhile, however, the type of goods transported does also have a strong influence, leading to a similar thought as discussed for hypothesis 1a.

5.1.2 Hypothesis 2

5.1.2.1 Hypothesis 2a:

Hypothesis 2a stated that more public involvement in inland transport worsens the transport corridor's performance in terms of costs/ton.km. This hypothesis has to be rejected without doubt. The descriptive analysis did imply that some influence may exist, where more public involvement lead to higher costs, but no justification for confirming this first observation was found in the statistical cross section analysis. Other factors clearly are at stake here, such as the transport mode, the quality of the road/rail infrastructure, corruption levels, and other local factors.

5.1.2.2 Hypothesis 2b:

Hypothesis 2a stated that more public involvement in inland transport worsens the transport corridor's performance in terms of time/km. In this case, some reasons initially exist to accept this hypothesis, as more public involvement leads to improved time performance. However, significance reduced importantly when adding the variable for corridor length and that for the type of cargo, implying, again, that other factors are clearly more important. Thus, this hypothesis also has to be rejected.

5.1.3 Hypothesis 3:

5.1.3.1 Hypothesis 3a:

Hypothesis 2a stated that more public involvement in the dry/inland port worsens the transport corridor's performance in terms of costs/ton.km. This hypothesis also has to be rejected, judging from the fact that no significant coefficient was found after constructing the full extended statistical model. The effect already seemed small relative to the other two PPP variables in the descriptive analysis. The cross-sectional regression analysis, with the inclusion of the important control variables, concludes that no statistically significant effect is present for the dry/inland ports' PPP model on costs/ton.km.

5.1.3.2 Hypothesis 3b:

Hypothesis 2a stated that more public involvement in the dry/inland port worsens the transport corridor's performance in terms of time/km. The conclusion is much the same as with hypothesis 3a, i.e. that no significant influence can be discerned after inclusion of all control variables in the cross sectional regression analysis. Also similarly to hypothesis 3a, the descriptive analysis already found a relatively small effect.

In rejecting hypotheses 3 and 4, one has to keep in mind the data limitations that may influence this rejection. As both the inland transport and the dry/inland port variables do not vary much across the line – most inland transport corridors have value 2/4, while most dry/inland ports have value 4/4, with some 2/4 and 1/4 dry/inland ports (see Table 5 and Table 6 for a description of these values) – one may expect that the absence of significance for these corridor actor's PPP models would have been different if more actual differences existed in the PPP models across the sample.

5.1.4 Hypothesis 4

Due to the very similar results found for hypotheses 4a and 4b - i.e. that more outside-in development significantly improves the performance of a transport corridor in terms of costs/ton.km and time/km, respectively – can be discussed jointly for the sake of conciseness. The direction of development shows slightly confused relations to cost and time performance in the descriptive analysis. More outside-in involvement seems to improve cost performance, but slightly worsen time performance.

Assuming that the statistical regression results for the influence of the development direction on cost and time performance are reliable, hypotheses 4a and 4b are not rejected as their coefficients are statistically significant with a negative effect on costs and time, meaning the performance is improved as more outside-in development is present. However, there were some concerns of biasedness due to the fact that most outside-in developed corridors in the sample are relatively short and do not cross any borders, with the exception of Dakar-Bamako which only has one border crossing. However, with the inclusion of the corridor length as a control variable, which ensures that the length of the corridor was controlled for, it should be safe to conclude that the statistical regression results are at least somewhat reliable. Unfortunately, a variable representing the exact number of border crossings suffered from endogeneity with other variables and thus had to be replaced by the corridor length variable even though it qualifies as second best in this case as some countries are larger than others, but the border crossings are the point where the main costs and time losses are made (USAID 2010).

5.1.5 Do PPP models of actors within a transport corridor affect corridor performance in Sub-Saharan Africa?

Finally, the main research question can be answered following the results of this master's thesis' analysis. In short, the rejection of all but one of the hypotheses concerning the influence of PPP models on performance leads to a straightforward 'no' as answer. The only part of the transport corridor where some apparent influence was found is the sea port, but even there the relation only kept its strength in the case of time performance. Other factors, notably the type of cargo transported, proved to be of strong influence on the corridor performance, taking significance away from the actor PPP variables.

Therefore, one could weakly state that more public involvement in the sea port leads to reduced time performance of the entire corridor. However, the absence of any such relation in the other parts of the corridor and for the cost performance variable suggests that this result may be statistically biased due to an omitted variable, for instance. The influence of the type of actors controlling the transport corridor should not be discarded completely though, as the direction of development was found to have a significant influence, with more outside-in influence having a positive effect on performance. Consequently, the insight obtained by Monios & Wang (2013) - that outside-in development is of positive influence on corridor performance - is confirmed by the current research. Thus, rather than emphasizing public private partnerships as a tool for improving performance, the background of the actors investing in hinterland access should be kept in mind as well.

5.2 Development research institutions' findings

The findings of the current master's thesis, concerning the absence of influence on performance from differing PPP models, are not entirely out of line with the recommendations from world development institutions such as the World Bank (WB), the Agence Francaise de Developpement (AFD) and the African Development Bank (ADB) amongst others, who have done extensive research into the situation of the transport sectors throughout the African continent. While none state that the introduction of private participation in the transport sector would structurally not have any positive effects – some even recommend it -, a clear set of other factors of importance comes forward from analyzing their policy papers. Theravininthorn & Raballand (WB, 2009), in an analysis of road transport costs in African transport corridors, conclude that the main determinants of transport costs are the age of the truck fleet and the low utilization rate of vehicles. This can be pulled further towards rail transport as Foster & Briceno-Garmendia (WB/AFD, 2010) make a similar statement about the train vehicles, where an additional problem is the lack of the necessary volumes to make rail transport viable. Theravininthorn and Raballand also state that the road conditions are not necessarily a critical factor in transport costs. More importantly, they find that road transport costs are not even that abnormally high compared to the rest of the world, but the existence of cartels in the transport market allows carriers to charge monopolistic prices thus also eliminating the incentives to improve efficiency. Additionally, World Bank (2013) find that the main factor in inland transportation costs is the fragmentation of the supply chain, i.e. the lack of integration between the different inland transport actors, leading to high costs of interaction between these actors. They thereby also identify the lack of a well-functioning customs transit system at the border crossings.

Ocean Shipping Consultants (WB/ADB/others, 2009), in a more technically based analysis, find that one of the large issues throughout the African continent is inadequate infra- and superstructure. This is especially found to be the case for the container market, which was the main cargo type in the sample of this master's thesis. It is then intuitive that this technical deficiency acts as an important component of inefficiencies in the African transport sector, along with sheer lack of capacity in sea ports which was also found throughout the continent. The authors do put faith in the landlord port model, with public ownership and control of waterways and land and private terminal investment and operation. They are supported by Foster & Briceno-Garmendia (2010) in this faith. However, the latter also indicate the importance of adequate regulation, whereby an independent regulating body is seen as the first step – this is currently only present in one African country, i.e. South Africa. The reason for the importance of the regulatory regime is manifold. To start with, private ownership and control can certainly lead to improved efficiency, but when not controlled properly it may lead to abuse of power by the private operator in case it is left with the opportunity to adopt monopolistic behavior, for instance. However, this also applies to a public operator as the latter may also abuse monopoly powers. Additionally, profits from publicly owned institutions may be employed to compensate losses in other areas instead of re-investment in the transport infrastructure. Regulation is also important in the case of inland transport, as the same may happen in the case of rail transport operators (Foster & Briceno-Garmerndia, 2010) and road operators in the form of cartel formation (Theravininthorn & Raballand, 2009).

The lack of adequate equipment, specifically for container handling, fits the findings of the current Master's thesis, as the dummy for cargo type had a significant influence on both time and cost performance, where corridors transporting containers performed significantly worse. That lack of equipment could then be an important reason for the significance of this variable. Additionally, the proxy for border crossings – i.e. the corridor length - also had an increasing and statistically significant effect on both time and cost performance, though the effect wasn't very large. However, this partially does confirm that the longer corridors, with more border crossings, perform worse overall, implying that indeed the customs practices are an important determinant of corridor performance. The organizational proficiency of the relevant government bodies in charge of the PPP projects was not tested for in this study, but the low performance of most countries in the corridor on the transparency index of Transparency International[1] suggests that this might be an important factor in the absence of benefits from private participation in the selected corridors.

5.3 POLICY IMPLICATIONS

PPIAF (2007) provide for an effective bridge between the above discussion and the results of this Master's thesis. They identify the main ingredient for failure of a PPP program as inadequate organization of the relevant government institutions. In this view, inherent government failures such as the lack of transparency,

[1] See the 2012 results of Transparency International: http://cpi.transparency.org/cpi2012/results/

coordination between institutional bodies, adequate regulation, and even the lack of commitment are often the cause of PPP program failure in the view of PPIAF. In this spirit, the previous section wakes the impression that, indeed, the ground conditions for reaping positive benefits from Public Private Partnerships have not (yet) been met in most African countries. There is need of an adequate regulatory regime that sets the right incentives for all actors involved. This includes setting up adequate PPP contracts between the relevant actors, such that each party follows up on its obligations. Similarly, the opportunities for monopolistic behavior and cartelization should be eliminated as much as possible. Thus, the findings of the current Master's thesis are quite in accordance with the views of the leading development research institutions; as the absence of any influence from differences in PPP models across the continent can be explained by the lack of the above discussed factors. Therefore, there is an important role for the national governments to reorganize themselves and their regulatory activities in such a way that the basic conditions are met before any benefits from PPP in the African transport sector can become visible. Previous academic research focusing on other parts of the world did establish a relationship between privatization and transport infrastructure performance, so the concept should not be rejected directly.

Finally, the findings concerning the direction of development suggest that policy makers should also aim at stimulating hinterland access development to be done from the sea port side, thus achieving outside-in integration of the transport corridors. This means that one should give preference to sea ports actors, such as port authorities, port terminal operators or even maritime carriers to develop activities inland, such as taking a stake in dry/inland ports and participating in inland transport.

6 CONCLUSION & LIMITATIONS

6.1 CONCLUSION

This Master's thesis has aimed at answering the question whether different forms of Public-Private Partnerships have a significant influence on the performance of transport corridors in Sub-Saharan Africa; specifically focused on dry ports, inland transport and sea ports. Through a cross-sectional regression analysis of transport corridors in Sub-Saharan Africa, it was established that no clear relationship currently exists between the PPP models of the respective corridor actors and their cost- and time performance. The only statistically significant result that was found was that more public involvement in the sea port would lead to worsened time performance. As previous academic research focusing on other parts of the world did establish the existence of a positive relation between privatization and performance it is possible that some relation does exist, but that it is crowded out by the institutional organization issues that exist in the transport sectors of Sub-Saharan Africa according to a large array of development research institutions. There is need of an adequate regulatory regime that sets the right incentives for all actors involved. This includes setting up adequate PPP contracts between the relevant actors, such that each party follows up on its obligations. Similarly, the opportunities for monopolistic behavior and cartelization - currently widely practiced on the continent - should be eliminated as much as possible. Generally speaking, inadequate organization of relevant governing bodies is an important reason for the low performance of transport corridors in Sub-Saharan Africa. Solving this inadequacy will potentially set the playing field to truly reap the benefits of private involvement in transport corridors. Generally, this Master's thesis has contributed to academic literature in several manners:

- A quantitative approach was added to previous research on transport corridor performance, which mostly limited itself to qualitative analysis until now. Taking a full transport corridor as a unit of study for transport performance measurement was not done before either. Thus, this master's thesis contributed to transport infrastructure performance measurement by introducing a more integral approach. As transport chains are more and more integrated with each other (e.g. Notteboom & Rodrigue, 2005), this seems the way to go; because the performance of each actor within transport chains is more and more dependent on the performance of the rest of the chain.

- Any previous research on this topic has focused on the main economic powers in the world, located in North America, Europe and Asia. The African continent has received limited attention in this respect, while it is potentially the most important beneficiary of improved transport. This Master's thesis has thus added to existing literature by opening the door towards a new geographical area of research.
- Concerning the direction of development, put forward mainly by e.g. Monios and Wang (2013), the latter's demand for further research was partially honored. Further, more focused research is needed,

6.2 LIMITATIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

The (non-)availability of data limited the possibilities in terms of methodology, leading to the use of cross-section analysis instead of the more widely used production frontier analysis – generally seen as one of the best options available for such research as the present one (Estache et.al., 2004). More generally, the data constraints are such that not all relevant countries could be included in the analysis to reach a fully representative sample of Sub-Saharan Africa. However, within the means available for the elaboration of this Master's thesis, it can be said with full confidence that the maximum result was achieved, considering the important contributions to academic research mentioned in section 6.1.

Further research should focus on deepening the analysis of the current thesis, by expanding the sample geographically, and continuing on the line of more integral performance analysis by taking transport corridors as a unit of study. However, this deepening of the sample will only be possible by means of thorough field research in order to collect the necessary data.

Finally, the findings concerning outside-in v/s inside-out development should be investigated further, as it does seem to be a relevant factor in corridor performance. This was confirmed by the present Master's thesis and previous academic research (notably Monios & Wang, 2013).

7 REFERENCES

Beresford, A., Pettit, S., Xu, Q., & Williams, S. (2012). A study of dry port development in China. Maritime Economics & Logistics, 14(1), 73-98.

Bird J H, 1963 The Major Seaports of the United Kingdom (Hutchinson, London)

Bullock, 2009. "Taking Stock of Railway Companies in Sub-Saharan Africa." Background Paper 17, Africa Infrastructure country Diagnostic, World Bank, Washington, DC.

Boardman, A. E., Laurin, C., Moore, M. A., & Vining, A. R. (2009). A cost-benefit analysis of the privatization of Canadian national railway. Canadian Public Policy, 35(1), 59-83.

Collier, 2007: The bottom Billion

Cowie, J., 2010. Productivity and performance in the British rail freight industry since privatisation.

Cullinane, K., Song, D. W., & Gray, R., 2002. A stochastic frontier model of the efficiency of major container terminals in Asia: assessing the influence of administrative and ownership structures. Transportation Research Part A: Policy and Practice, 36(8), 743-762.

Do, N. H., Nam, K. C., & Le, Q. L. N., 2011. A consideration for developing a dry port system in Indochina area. Maritime Policy & Management, 38(1), 1-9.

Estache, A., & Serebrisky, T., 2004. Where do we stand on transport infrastructure deregulation and public-private partnership?. World Bank Policy Research Working Paper, (3356).

Estache, A., González, M., & Trujillo, L., 2002a. Efficiency gains from port reform and the potential for yardstick competition: lessons from Mexico. World Development, 30(4), 545-560.

Estache, A., González, M., & Trujillo, L., 2002b. What does "privatization" do for efficiency? Evidence from Argentina's and Brazil's railways. World Development, 30(11), 1885-1897.

Feng, M., Mangan, J., & Lalwani, C., 2012. Comparing port performance: Western European versus Eastern Asian ports. International Journal of Physical Distribution & Logistics Management, 42(5), 490-512.

Foster, V & Briceno-Garmendia, C, 2010. Africa's Infrastructure, a Time for Transformation. The International Bank for Reconstruction and Development / The World Bank

Friebel, G., Ivaldi, M., & Vibes, C., 2008. Railway (de) regulation: a European efficiency comparison. Economica, 77(305), 77-91.

Gouvernal, E., & Daydou, J., 2005. Container railfreight services in north-west Europe: diversity of organizational forms in a liberalizing environment. Transport Reviews, 25(5), 557-571.

Hanaoka, S., & Regmi, M. B., 2011. Promoting intermodal freight transport through the development of dry ports in Asia: An environmental perspective.IATSS Research, 35(1), 16-23.

Hayuth, Y., 1981, Containerization and the load centre concept. Economic Geography, 57(2), 160–176

Jaržemskis, A., & Vasiliauskas, A. V., 2007. Research on dry port concept as intermodal node. Transport, 22(3), 207-213.

Merge Global, 2008. Lifting the veil of value in truckload. American Shipper, 50(11).

Monios, J., & Wang, Y., 2013. Spatial and institutional characteristics of inland port development in China. GeoJournal, 1-17.

Monios, J., & Wilmsmeier, G., 2012. Giving a direction to port regionalisation.Transportation Research Part A: Policy and Practice, 46(10), 1551-1561.

Notteboom, T. and Winkelmans, W., 2001, Structural changes in logistics: how do port authorities face the challenge? Maritime Policy & Management, 28, 71–89.

Notteboom*, T. E., & Rodrigue, J. P., 2005. Port regionalization: towards a new phase in port development. Maritime Policy & Management, 32(3), 297-313.

Notteboom, T. E., 2010. Concentration and the formation of multi-port gateway regions in the European container port system: an update. Journal of Transport Geography, 18(4), 567-583.

Notteboom, T., De Langen, P., & Jacobs, W., 2012. Institutional plasticity and path dependence in seaports: interactions between institutions, port governance reforms and port authority routines. Journal of Transport Geography.

Ocean Shipping Consultants Ltd., 2009: Beyond the Bottlenecks: Ports in Africa [online] Available at <http://infrastructureafrica.org/system/files/BP08_Ports_maintxt_new.pdf>

PPIAF, 2007: Designing and using public-private partnership units in infrastructure. [online] Available at <http://www.ppiaf.org/sites/ppiaf.org/files/publication/Gridlines-27-PPP%20Units%20in%20Infra%20-%20ASanghi%20A%20Sundakov%20DHenkinson.pdf>

Pham, C. D., & Carlin, T. M., 2008. Financial Performance of Privatized State Owned Enterprises (SOEs) in Vietnam. Available at SSRN 1131542.

Sanghi et.al., 2007: Designing and using Public-Private Partnership units in infrastructure, Lessons from case studies around the world. Gridlines, Public Private Infrastructure Advisory Facility, 27

Reeves, E., & Palcic, D., 2004. Privatization policy and enterprise performance: the case of Ireland. Annals of Public and Cooperative Economics,75(4), 525-548.

Robinson, R., 2002, Ports as elements in value-driven chain systems: the new paradigm. Maritime Policy & Management, 29, 241–255.

Rodrigue, J. P., & Notteboom, T., 2009. The terminalization of supply chains: reassessing the role of terminals in port/hinterland logistical relationships.Maritime Policy & Management, 36(2), 165-183.

Roso, V., Woxenius, J., & Lumsden, K., 2009. The dry port concept: connecting container seaports with the hinterland. Journal of Transport Geography, 17(5), 338-345.

Taaffe, E. J., Morrill, R. L., & Gould, P. R., 1963. Transport expansion in underdeveloped countries: a comparative analysis. Geographical Review, 53(4), 503-529.

Theravininthorn & Raballand, 2008: Transport prices and costs in Africa: A review of the international corridors.[online] Available at:

<https://openknowledge.worldbank.org/bitstream/handle/10986/6610/461810PUB0Box3101OFFICIAL0USE0ONLY1.pdf?sequence=1>

Tongzon, J., & Heng, W., 2005. Port privatization, efficiency and competitiveness: Some empirical evidence from container ports (terminals).Transportation Research Part A: Policy and Practice, 39(5), 405-424.

UNESCAP, 2011: A guidebook on Public-Private Partnership in Infrastructure. [online] Available at: <http://www.unescap.org/ttdw/common/TPT/PPP/text/ppp_guidebook.pdf>

USAID 2010a: Dakar-Bamako Corridor Cost of Transport Analysis. [online] available at: < http://www.borderlesswa.com/sites/default/files/resources/jan13/USAID%20PCE%20Dakar%20Bamako%20Corridor%20Cost%20of%20Transport%20Analysis.pdf>

USAID 2010b: Transport and Logistics costs on the Tema-Ouagadougou corridor. [online] available at: <http://www.watradehub.com/sites/default/files/resourcefiles/apr10/reduced-road-transport-costs-tema-ouagadougou-2010.pdf>

USAID 2011: Corridor diagnostic study of the Nothern and Central corridors of East Africa: Draft action plan. [online] available at: <http://www.joyhecht.net/East%20Africa%20Climate%20Change/Nathan%20Assoc%20East%20Africa%20Transport%20Corridors%20Diagnostic%20Study%202011.pdf>

USAID 2012: Transport and logistics costs on the Lomé-Ouagadougou corridor. [online] available at: <http://www.watradehub.com/sites/default/files/resourcefiles/apr12/jan-2012-rev-final-corridor-ii-lome-ouaga-transport-and-logistics-costs-study.pdf

Veenstra, A., Zuidwijk, R., & van Asperen, E., 2012. The extended gate concept for container terminals: Expanding the notion of dry ports. Maritime Economics & Logistics, 14(1), 14-32.

Wilmsmeier, G., Monios, J., & Lambert, B., 2011. The directional development of intermodal freight corridors in relation to inland terminals. Journal of Transport Geography, 19(6), 1379-1386.

World Bank, 2001: “Port Reform Toolkit”, [online] Available at: www.worldbank.org/transport/ports/toolkit.htm

World Bank, 2013: Improving Trade and Transport for Landlocked Developing Countries. [online] Available at: <http://siteresources.worldbank.org/INTRANETTRADE/Resources/Improving_Trade_Transport_for_Landlocked_Countries.pdf>

Woxenius, J., Roso, V., & Lumsden, K.. 2004. The dry port concept–connecting seaports with their hinterland by rail. In ICLSP Conference Proceedings (pp. 305-319).

8 APPENDIX

APPENDIX 1: DATA DESCRIPTION

The following points are if importance concerning this appendix:

1. All information has been deduced from online newspaper articles, websites of port- and transport authorities and national policy papers.
2. As it is unknown how the rail port of Kampala is organised, it is assumed that it is similar to the road terminal.
3. Goma and Kasindi represent more of a border customs control node than real terminals.
4. For the dry port of Nelspruit, nothing can be found on ownership specifically. However, Cronje et.al. (2009), discussing the City Deep terminal of Johannesburg, do state that ownership is similar in all South African dry ports, with public ownership and some, but not all, private operation. It is thus somewhere between a Tool port model and a Service port model.
5. As no mention was found of a dry port operator in Bujumbura, the assumption was made that it is organised publicly, thus giving it a ‘service’ status.

Direction of development	
O-I	Outside-in
I-O	Inside-out
C	combination
Availability	
✓	Available
✗	Non available

				Data availability									PPP info (See Table 5&6)				Dry port roles					
#	Sea port location	Dry port location	Modality	Different goods containers	Light containers	Heavy containers	Different types bulk	Dry bulk	Liquid bulk	Data cost	Data time	Data rebliability	Sea port	Inland transport	Dry port	Direction of development	Customs	transshipment	Storage	Consolidation	empty container storage	container maintenance & repair
1	Mombasa	Nairobi	Road	✗	✓	✓	✗	✓	✓	✓	✓	✓	4/4	2/4	4/4	O-I	✓	✓	✓	✓	✓	✗
2	Mombasa	Kampala	Road	✗	✓	✓	✗	✓	✓	✓	✓	✓	4/4	2/4	3/4	C	✓	✓	✓	✓	✓	✗
3	Mombasa	Kigali	Road	✗	✓	✓	✗	✓	✓	✓	✓	✓	4/4	2/4	2/4	I-O	✓	✓	✓	✓	✓	✗
4	Mombasa	Bujumbura	Road	✗	✓	✓	✗	✓	✓	✓	✓	✓	4/4	2/4	4/4	I-O	✓	✓	✓	✗	✗	✗
5	Mombasa	Nimule	Road	✗	✓	✓	✗	✓	✓	✓	✓	✓	4/4	2/4	4/4	I-O	✓	✓	✓	✗	✗	✗
6	Mombasa	Kasindi	Road	✗	✓	✓	✗	✓	✓	✓	✓	✓	4/4	2/4	4/4	I-O	✓	✓	✓	✗	✗	✗
7	Mombasa	Goma	Road	✗	✓	✓	✗	✓	✓	✓	✓	✓	4/4	2/4	4/4	I-O	✓	✓	✓	✗	✗	✗
8	Mombasa	Nairobi	Rail	✗	✓	✓	✗	✓	✓	✓	✓	✓	4/4	1/4	3/4	I-O	✓	✓	✓	✓	✓	✗
9	Mombasa	Kampala	Rail	✗	✓	✓	✗	✓	✓	✓	✓	✓	4/4	1/4	3/4	I-O	✓	✓	✓	✓	✓	✗
10	Dar Es Salaam	Mwanza	Rail	✗	✓	✓	✗	✓	✓	✓	✓	✓	2/4	2/4	4/4	O-I	✓	✓	✓	✗	✗	✗
11	Dar Es Salaam	Kigoma	Rail	✗	✓	✓	✗	✓	✓	✓	✓	✓	2/4	2/4	4/4	O-I	✓	✓	✓	✗	✗	✗
12	Dakar	Bamako	Rail	✓	✗	✓	✗	✓	✗	✓	✗	✗	2/4	1/4	2/4	C	✗	✓	✓	✓	✓	✗
13	Dar Es Salaam	Mwanza	Road	✗	✓	✓	✗	✓	✓	✓	✓	✓	2/4	2/4	4/4	O-I	✓	✓	✓	✗	✗	✗
14	Dar Es Salaam	Goma	Road	✗	✓	✓	✗	✓	✓	✓	✓	✓	2/4	2/4	4/4	I-O	✓	✓	✗	✗	✗	✗
15	Dar Es Salaam	Kigali	Road	✗	✓	✓	✗	✓	✓	✓	✓	✓	2/4	2/4	2/4	I-O	✓	✓	✓	✓	✓	✗
16	Dar Es Salaam	Bujumbura	Road	✗	✓	✓	✗	✓	✓	✓	✓	✓	2/4	2/4	4/4	I-O	✓	✓	✓	✗	✗	✗
17	Lomé	Ouagadougou	Road	✓	✗	✗	✓	✗	✗	✓	✓	✓	2/4	2/4	3/4	I-O	✗	✓	✓	✓	✓	✗
18	Tema	Ouagadougou	Road	✓	✗	✗	✓	✗	✗	✓	✓	✓	2/4	2/4	3/4	I-O	✗	✓	✓	✓	✓	✗
19	Durban	Nelspruit	Road	✓	✗	✗	✓	✗	✗	✓	✗	✗	4/4	0/4	3/4	I-O	✗	✓	✓	✓	✓	✗
20	Dakar	Bamako	Road	✗	✓	✓	✗	✓	✗	✓	✗	✗	2/4	1/4	2/4	C	✗	✓	✓	✓	✓	✗

APPENDIX 2: PERFORMANCE INDICATORS USED IN DISCUSSED PAPERS

Author	Performance indicator
Tongzon & Heng, 2005	Average delayed time of ship (reliability)
	Total number of liner services direct calls
	Extent of satisfaction of customer's demand (adaptability to changing environment)
	Investment levels in marketing
	Input factors : terminal quay length, terminal surface and number of quay cranes (port terminal operation efficiency)
	Port cargo handling charges
	Depth of navigation channel
Cullinane et.al., 2002	Quantification of efficient use of labour, land and equipment
	Throughput in number of containers (output)
	Monetary value of quay movements indicated by the revenue associated with them (output)
	Combined value of buildings and equipment (capital input)
Feng et.al. , 2007	Price of shipping services
	Handling charges (port/terminal, warehousing etc.)
	Feeder connections to deep sea ports and major shipping lines
	port/shipping services is on cheapest overall route to destination
	speed of port cargo handling
	congestion, risks and other risks
	security/safety
	technical infrastructure (ICT)
	proximity of port to customers and/or sources of supply
	availability of skilled employees
	quality of landside transport links
	availability and quality of logistic services

	government supports for logistic activities and new developments in the regions
De Langen et.al., 2007	Throughput volumes
	Value added of port
	Investment level in port
	Market shares in hinterland regions
	Number of "first port of call services"
	Value of goods passing through the port
	EDI use in port
	Modal split hinterland traffic
	Index of port dues at 'real prices'
	Custom revenues from port
	Warehouse surface area
	Time to major consumer markets

APPENDIX 3: COMPARABILITY OF DATA

8.2.1 Exchange rates:

- For the Lomé Ouagadougou corridor, an exchange rate of 451FCFA for 1 USD was used (USAID 2012)
- For the Tema Ouagadougou corridor, an exchange rate of 420FCFA for 1 USD was used (USAID 2010b)
- For the Dakar-Bamako corridor, and exchange rate of 516FCFA for 1 USD was used (USAID 2010a)
- For the Northern and Central corridor, exchange rates were not given. However, the paper (USAID 2011) uses data for 2010, meaning that the exchange rates were be taken by USAID (2011) as those of 2010. It was assumed that costs were calculated according to Kenyan Shillings in case of the Northern Corridor and Tanzanian Shilling in case of the Central corridor.
- For the Durban-Nelspruit corridor and the Maputo-Nelspruit corridor, exchange rates were not given either, but as these data were found in the Lomé Ouagadougou report (USAID 2012), exchange rates will be taken for the same period of time: october 2009-september 2010

As the data found were given for different periods of time, the exchange rates were all equalised to USD exchange rates as of July 2013, as shown in

Exchange rate conversions done to equalise the data[1]

	Currency	Period of data gathering & currency USD	USD-local currency at moment of data gathering	July 2013
Maputo-Nelspruit	Mozambique New Metical	10-2009/09-2010	31,1383	29.73
Durban-Nelspruit	South African Rand	10-2009/09-2010	7.4515	9,92
Lomé Ouagadougou	BCEAO CFA	10-2009/09-2010	451,53	501,67
Tema Ouagadougou	BCEAO CFA	06-2008/09-2008	420	501,67
Dakar-Bamako	BCEAO CFA	Unknown	516	501,67
Northern Corridor	Kenyan Shilling	2010	76,1787	85,54

[1] For those corridors where the exchange rate was not given in the research methodology of the relevant paper, while the dates of the data were known, the corresponding exchange rates were taken from <http://www.oanda.com/currency/historical-rates/>

Central Corridor	Tanzanian Shilling	2010	1419,03	1587,72

8.2.2 Units of measurement

The data found for different corridors was given for different products with different weights. For the transport costs, this means that the figures were not comparable in their original form. Consequently, the products had to be made comparable to each other. A unit of comparison that is often used is that of ton.km, i.e. the average cost of transporting one ton over 1 km. In order to achieve this, the total transport prices had to be divided by the total ton per unit, thus obtaining the transport cost per ton. Finally, the latter were divided by the total number of kilometres travelled so as to obtain the ton.km travelled. For some of the corridors, this was straightforward, as the type of product transported was specified, along with the weight per shipment. However, in the case of the Northern and Central corridor data, and the data for the Durban-Nelspruit ad Maputo Nelspruit corridors, this information was not available. Consequently, a few assumptions had to be made:

- The difference between a 'light container' and a 'heavy container' was determined using internet sources of private actors active on the African continent[1], mainly from a shipping agent in South Africa. The latter state that the normal maximum load of a 20' container amounts to 21670 kg (21,7 tons), while the maximum load for a containers that have been strengthened to carry heavier weight is considered to be 30480 kg (30,5 tons). Consequently, it was assumed that :
    - A 'heavy' container corresponds to an average of 26075kg ((21670+30480)/2), thus 26,1 tons. This fits the weight of a 20 TEU container filled with rice transported on the Dakar-Bamako corridor.
    - A 'light' container corresponds to the average of the maximum weight allowed to a normal 20 TEU container and the lowest tonnage found for such a container, i.e. cotton transported in a container from Bamako to Dakar. It would be implausible to take into account the average between a weight of 0 and the maximum, as we are working with full- and not empty- containers. Consequently, the weight of a 'light' container was assumed to be 15835

[1]http://www.interfreight.co.za/container_information.html#standard.

kg, or 15, 8 tons. This corresponds with the weight of textiles and nuts transported in the Lomé-Ouagadougou corridor.

- The weight of a bulk shipment on the Northern and Central corridors was taken as the average of the weight of bulk shipments in the other corridors, i.e. 36,8 tons. (40 tons for rice and sugar in Lomé-Ouagadougou; 40 tons for sugar and 34 tons for shea- and cashew nuts in Téma-Ouagadougou; 30 tons for rice in Dakar-Bamako).
- Whenever it was unclear whether a container was 'heavy' or 'light', the average between the two was considered, i.e. 21 tons.
- Real values were kept for those corridors for which the tonnes was known, i.e. the West-African corridors.

APPENDIX 4: STATA OUTPUT

8.2.3 Models for cost/ton.km as dependant variable

8.2.3.1 Model 1a:

Exluding the variables for development direction (devdir), corridor length (totallength) and type of goods transported (bulkbox)

```
. reg  costtnkm seaport  inlandtransport dryport mode rwanda1 ghana1 southafrica1 burkinafaso1 senegal1 tanzania1 mali1 uganda1 kenya1 congor
> epublic1 burundi1 southsudan1 togo1, robust
note: ghana1 omitted because of collinearity
note: senegal1 omitted because of collinearity
note: mali1 omitted because of collinearity

Linear regression                                      Number of obs =     106
                                                       F( 13,    91) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.6853
                                                       Root MSE      =  .03043
```

costtnkm	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
seaport	.0702222	.0106862	6.57	0.000	.0489953	.0914491
inlandtran~t	.0390655	.0562923	0.69	0.489	-.0727522	.1508832
dryport	-.1329906	.0282958	-4.70	0.000	-.1891967	-.0767844
mode	-.0205145	.0107365	-1.91	0.059	-.0418413	.0008122
rwanda1	-.0312557	.0101118	-3.09	0.003	-.0513416	-.0111698
ghana1	(omitted)					
southafrica1	.2314813	.0296941	7.80	0.000	.1724977	.2904649
burkinafaso1	.0751064	.0312958	2.40	0.018	.0129411	.1372717
senegal1	(omitted)					
tanzania1	.0332967	.0182072	1.83	0.071	-.0028696	.0694629
mali1	(omitted)					
uganda1	-.0233783	.0089792	-2.60	0.011	-.0412144	-.0055422
kenya1	.042898	.0173274	2.48	0.015	.0084793	.0773167
congorepub~1	.0897485	.0144418	6.21	0.000	.0610616	.1184353
burundi1	.074064	.0120455	6.15	0.000	.0501371	.097991
southsudan1	.0848617	.0150766	5.63	0.000	.0549138	.1148096
togo1	.0186199	.0363703	0.51	0.610	-.0536252	.0908651
_cons	.1080394	.0223901	4.83	0.000	.0635642	.1525145

8.2.3.2 Model 1b:

Including the variable for development direction (devdir), excluding corridor length (totallength) and type of goods transported (bulkbox)

```
. reg  costtnkm seaport  inlandtransport dryport mode rwanda1 ghana1 southafrica1 burkinafaso1 senegal1 tanzania1 mali1 uganda1 kenya1 congor
> epublic1 burundi1 southsudan1 togo1  devdir, robust
note: ghana1 omitted because of collinearity
note: senegal1 omitted because of collinearity
note: mali1 omitted because of collinearity

Linear regression                                      Number of obs =     106
                                                       F( 14,    90) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.6882
                                                       Root MSE      =  .03046
```

costtnkm	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
seaport	.0702222	.0105767	6.64	0.000	.0492099	.0912346
inlandtran~t	.0562572	.0579064	0.97	0.334	-.058784	.1712983
dryport	-.0913735	.0390328	-2.34	0.021	-.1689191	-.013828
mode	-.024947	.0103999	-2.40	0.019	-.0456083	-.0042857
rwanda1	-.0324694	.0101802	-3.19	0.002	-.0526942	-.0122446
ghana1	(omitted)					
southafrica1	.2113336	.0297076	7.11	0.000	.1523143	.2703529
burkinafaso1	.0455033	.0394878	1.15	0.252	-.0329461	.1239527
senegal1	(omitted)					
tanzania1	.0182357	.0194863	0.94	0.352	-.0204773	.0569486
mali1	(omitted)					
uganda1	-.0219918	.0090956	-2.42	0.018	-.0400618	-.0039217
kenya1	.0241249	.0212261	1.14	0.259	-.0180444	.0662943
congorepub~1	.0680212	.0210206	3.24	0.002	.0262601	.1097822
burundi1	.0517469	.0205804	2.51	0.014	.0108603	.0926334
southsudan1	.0631004	.0220983	2.86	0.005	.0191983	.1070025
togo1	.0194795	.0367986	0.53	0.598	-.0536274	.0925864
devdir	-.0216148	.0164626	-1.31	0.193	-.0543206	.011091
_cons	.0969743	.0222095	4.37	0.000	.0528512	.1410974

8.2.3.3 Model 1c:

Including the variables for development direction (devdir) and corridor length (totallength), excluding the type of goods transported (bulkbox)

```
. reg  costtnkm seaport  inlandtransport dryport mode rwanda1 ghana1 southafrica1 burkinafaso1 senegal1 tanzania1 mali1 uganda1 kenya1 congor
> epublic1 burundi1 southsudan1 togo1  devdir totallength, robust
note: ghana1 omitted because of collinearity
note: senegal1 omitted because of collinearity
note: mali1 omitted because of collinearity

Linear regression                                      Number of obs =     106
                                                       F( 15,    89) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.7038
                                                       Root MSE      =  .02985
```

costtnkm	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
seaport	.0702222	.0106362	6.60	0.000	.0490884	.0913561
inlandtran~t	.0034178	.0609274	0.06	0.955	-.1176436	.1244793
dryport	-.0459514	.0432376	-1.06	0.291	-.1318636	.0399607
mode	-.0369817	.0122971	-3.01	0.003	-.0614158	-.0125477
rwanda1	-.0639268	.0173678	-3.68	0.000	-.0984363	-.0294174
ghana1	(omitted)					
southafrica1	.2414695	.0292358	8.26	0.000	.1833786	.2995604
burkinafaso1	.0793399	.0413073	1.92	0.058	-.0027368	.1614166
senegal1	(omitted)					
tanzania1	.0364016	.0200051	1.82	0.072	-.0033481	.0761514
mali1	(omitted)					
uganda1	-.1031482	.0295347	-3.49	0.001	-.1618329	-.0444634
kenya1	.1058861	.0370021	2.86	0.005	.0323638	.1794084
congorepub~1	.0178736	.0266239	0.67	0.504	-.0350275	.0707747
burundi1	-.0130297	.0320949	-0.41	0.686	-.0768016	.0507422
southsudan1	.0181091	.0284751	0.64	0.526	-.0384703	.0746885
togo1	.015081	.0365846	0.41	0.681	-.057612	.0877739
devdir	-.0358108	.0157184	-2.28	0.025	-.067043	-.0045786
totallength	.0001098	.0000415	2.64	0.010	.0000273	.0001923
_cons	-.0442991	.0552411	-0.80	0.425	-.1540619	.0654638

8.2.3.4 Model 1d :

Including the variables for development direction (devdir), corridor length (totallength) and type of goods transported (bulkbox)

```
. reg  costtnkm seaport  inlandtransport dryport mode rwanda1 ghana1 southafrica1 burkinafaso1 senegal1 tanzania1 mali1 uganda1 kenya1 congor
> epublic1 burundi1 southsudan1 togo1 bulkbox  devdir totallength, robust
note: ghana1 omitted because of collinearity
note: senegal1 omitted because of collinearity
note: mali1 omitted because of collinearity

Linear regression                                      Number of obs =     106
                                                       F( 16,    88) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.8241
                                                       Root MSE      =  .02313
```

costtnkm	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
seaport	.0038259	.0106353	0.36	0.720	-.0173095	.0249613
inlandtran~t	.0364356	.0352912	1.03	0.305	-.0336983	.1065695
dryport	-.0174216	.0198745	-0.88	0.383	-.056918	.0220748
mode	-.0321299	.0067907	-4.73	0.000	-.045625	-.0186348
rwanda1	-.0634231	.0125487	-5.05	0.000	-.088361	-.0384852
ghana1	(omitted)					
southafrica1	.2539769	.0180152	14.10	0.000	.2181754	.2897783
burkinafaso1	.0565886	.0312064	1.81	0.073	-.0054276	.1186047
senegal1	(omitted)					
tanzania1	.0177482	.0117981	1.50	0.136	-.0056981	.0411945
mali1	(omitted)					
uganda1	-.1030739	.0203516	-5.06	0.000	-.1435184	-.0626294
kenya1	.1138935	.0251445	4.53	0.000	.0639241	.1638629
congorepub~1	.0041466	.0122326	0.34	0.735	-.0201631	.0284563
burundi1	-.026955	.0177429	-1.52	0.132	-.0622152	.0083052
southsudan1	.0054275	.0156859	0.35	0.730	-.0257449	.0365998
togo1	.0139307	.0327823	0.42	0.672	-.0512173	.0790787
bulkbox	.0414977	.004349	9.54	0.000	.032855	.0501404
devdir	-.0459988	.0089946	-5.11	0.000	-.0638738	-.0281239
totallength	.000112	.0000273	4.11	0.000	.0000578	.0001661
_cons	-.054824	.0369845	-1.48	0.142	-.1283229	.018675

8.2.4 Models for time/km (hours) as dependant variable

8.2.4.1 Model 2a:

Exluding the variables for development direction (devdir), corridor length (totallength) and type of goods transported (bulkbox)

```
. reg  timekm seaport  inlandtransport dryport mode rwanda1 ghana1 southafrica1 burkinafaso1 senegal1 tanzania1 mali1 uganda1 kenya1 congorep
> ublic1 burundi1 southsudan1 togo1, robust
note: southafrica1 omitted because of collinearity
note: burkinafaso1 omitted because of collinearity
note: mali1 omitted because of collinearity
note: togo1 omitted because of collinearity

Linear regression                                      Number of obs =     100
                                                       F( 12,    86) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.8243
                                                       Root MSE      =  .06966
```

timekm	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
seaport	.2315555	.0669629	3.46	0.001	.0984377	.3646734
inlandtran~t	-.3640662	.1045345	-3.48	0.001	-.5718738	-.1562586
dryport	.1672505	.0778852	2.15	0.035	.0124199	.3220811
mode	.0466027	.0317004	1.47	0.145	-.0164155	.1096209
rwanda1	.0121134	.0143248	0.85	0.400	-.0163633	.04059
ghana1	.1202033	.0293652	4.09	0.000	.0618271	.1785795
southafrica1	(omitted)					
burkinafaso1	(omitted)					
senegal1	-.1352039	.0331012	-4.08	0.000	-.201007	-.0694008
tanzania1	.1439849	.0187358	7.68	0.000	.1067393	.1812305
mali1	(omitted)					
uganda1	-.299807	.0473302	-6.33	0.000	-.3938962	-.2057177
kenya1	.2628026	.0621828	4.23	0.000	.1391872	.386418
congorepub~1	-.0507568	.035375	-1.43	0.155	-.12108	.0195665
burundi1	-.0939336	.0332448	-2.83	0.006	-.160022	-.0278452
southsudan1	-.0539564	.0341261	-1.58	0.118	-.1217968	.013884
togo1	(omitted)					
_cons	.1368175	.0779493	1.76	0.083	-.0181407	.2917756

8.2.4.2 Model 2b:

Including the variable for development direction (devdir), excluding corridor length (totallength) and type of goods transported (bulkbox)

```
. reg  timekm seaport  inlandtransport dryport mode rwanda1 ghana1 southafrica1 burkinafaso1 senegal1 tanzania1 mali1 uganda1 kenya1 congorep
> ublic1 burundi1 southsudan1 togo1  devdir, robust
note: southafrica1 omitted because of collinearity
note: burkinafaso1 omitted because of collinearity
note: mali1 omitted because of collinearity
note: togo1 omitted because of collinearity

Linear regression                                      Number of obs =     100
                                                       F( 13,    85) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.8252
                                                       Root MSE      =   .0699
```

timekm	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
seaport	.2315555	.0673045	3.44	0.001	.0977361	.365375
inlandtran~t	-.3456896	.0897	-3.85	0.000	-.5240373	-.167342
dryport	.2415429	.0856502	2.82	0.006	.0712475	.4118384
mode	.0371061	.0322788	1.15	0.254	-.0270727	.1012849
rwanda1	.0107712	.0143462	0.75	0.455	-.0177528	.0392952
ghana1	.1192845	.0294862	4.05	0.000	.0606579	.177911
southafrica1	(omitted)					
burkinafaso1	(omitted)					
senegal1	-.0939711	.0216393	-4.34	0.000	-.1369957	-.0509464
tanzania1	.1670486	.0268158	6.23	0.000	.1137315	.2203656
mali1	(omitted)					
uganda1	-.2966227	.0486387	-6.10	0.000	-.3933294	-.1999159
kenya1	.278627	.0587371	4.74	0.000	.161842	.3954121
congorepub~1	-.0887955	.0412591	-2.15	0.034	-.1708297	-.0067612
burundi1	-.1328718	.0408393	-3.25	0.002	-.2140713	-.0516724
southsudan1	-.0915382	.0400461	-2.29	0.025	-.1711606	-.0119158
togo1	(omitted)					
devdir	-.0361312	.0304363	-1.19	0.238	-.0966468	.0243843
_cons	.0719098	.0550608	1.31	0.195	-.0375658	.1813855

8.2.4.3 Model 2c:

Including the variables for development direction (devdir) and corridor length (totallength), excluding the type of goods transported (bulkbox

```
. reg  timekm seaport  inlandtransport dryport mode rwanda1 ghana1 southafrica1 burkinafaso1 senegal1 tanzania1 mali1 uganda1 kenya1 congorep
> ublic1 burundi1 southsudan1 togo1  devdir totallength, robust
note: southafrica1 omitted because of collinearity
note: burkinafaso1 omitted because of collinearity
note: senegal1 omitted because of collinearity
note: mali1 omitted because of collinearity

Linear regression                                      Number of obs =     100
                                                       F( 14,    84) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.8298
                                                       Root MSE      =  .06938
```

timekm	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
seaport	.2315555	.0678924	3.41	0.001	.0965442	.3665669
inlandtran~t	-.2156234	.1128593	-1.91	0.059	-.4400564	.0088097
dryport	.1258049	.0862274	1.46	0.148	-.0456678	.2972776
mode	.0674359	.0314662	2.14	0.035	.0048619	.1300098
rwanda1	.0628805	.0255197	2.46	0.016	.0121317	.1136292
ghana1	.1380766	.0530369	2.60	0.011	.0326068	.2435464
southafrica1	(omitted)					
burkinafaso1	(omitted)					
senegal1	(omitted)					
tanzania1	.2099929	.0298125	7.04	0.000	.1507075	.2692783
mali1	(omitted)					
uganda1	-.1587822	.0704166	-2.25	0.027	-.2988134	-.018751
kenya1	.2159449	.0833904	2.59	0.011	.0501138	.3817759
congorepub~1	.0142681	.0524641	0.27	0.786	-.0900625	.1185986
burundi1	-.0044418	.061405	-0.07	0.943	-.1265523	.1176688
southsudan1	.0000187	.0482816	0.00	1.000	-.0959946	.096032
togo1	.028372	.0395709	0.72	0.475	-.0503191	.107063
devdir	-.0032627	.0350825	-0.09	0.926	-.0730282	.0665028
totallength	-.0001923	.00008	-2.40	0.018	-.0003514	-.0000331
_cons	.2477844	.1097885	2.26	0.027	.0294579	.4661109

8.2.4.4 Model 2d:

Including the variables for development direction (devdir), corridor length (totallength) and type of goods transported (bulkbox)

```
. reg  timekm seaport  inlandtransport dryport mode rwanda1 ghana1 southafrica1 burkinafaso1 senegal1 tanzania1 mali1 uganda1 kenya1 congorep
> ublic1 burundi1 southsudan1 togo1  devdir totallength  bulkbox, robust
note: southafrica1 omitted because of collinearity
note: burkinafaso1 omitted because of collinearity
note: senegal1 omitted because of collinearity
note: mali1 omitted because of collinearity

Linear regression                                      Number of obs =     100
                                                       F( 16,    83) =   36.25
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.8373
                                                       Root MSE      =  .06824
```

timekm	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
seaport	.1805496	.074376	2.43	0.017	.0326188	.3284804
inlandtran~t	-.170076	.111933	-1.52	0.132	-.3927062	.0525541
dryport	.1302508	.093297	1.40	0.166	-.0553132	.3158148
mode	.0744548	.0334005	2.23	0.029	.0080224	.1408871
rwanda1	.0644402	.0258451	2.49	0.015	.0130353	.1158451
ghana1	.1143843	.0560331	2.04	0.044	.0029368	.2258319
southafrica1	(omitted)					
burkinafaso1	(omitted)					
senegal1	(omitted)					
tanzania1	.1909086	.0325777	5.86	0.000	.1261128	.2557044
mali1	(omitted)					
uganda1	-.1529285	.0666232	-2.30	0.024	-.2854394	-.0204176
kenya1	.2135355	.0814116	2.62	0.010	.051611	.37546
congorepub~1	.0133735	.0570224	0.23	0.815	-.1000417	.1267887
burundi1	-.004362	.065359	-0.07	0.947	-.1343585	.1256345
southsudan1	-.0018362	.0517899	-0.04	0.972	-.1048442	.1011718
togo1	.0070935	.0413354	0.17	0.864	-.075121	.089308
devdir	-.0074888	.0352938	-0.21	0.832	-.0776868	.0627092
totallength	-.0002008	.0000783	-2.57	0.012	-.0003565	-.0000451
bulkbox	.0318787	.0168964	1.89	0.063	-.0017276	.0654851
_cons	.2574231	.1115726	2.31	0.024	.0355098	.4793365