DOES THE CURRENT CONCESSIONING REGIME OF BORDER POSTS INFRASTRUCTURE YIELD OPTIMAL TRADE EFFICIENCY FOR AFRICA? LESSONS FOR COMESA

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Abstract

Africa intra-trade has been generally low overtime. High trade costs emanating from complex border posts crossing has been cited to be one of the major causes. In an endeavour to promote seamless flow of trade private sector financed border posts modernisation projects are being implemented. These modernisation projects covers physical infrastructure alone and the concessionaire recoups the investment through charging facilities user fees. The justification is that the additional costs (user charges) are offset by the resultant improvement in trade efficiency, the reduction in time to cross a border. Following the argument that border crossing infrastructure is not the only source of trade efficiency, this study sought to demonstrate the differential effects of border posts infrastructure and other soft reforms on trade efficiency with the intention to show that border infrastructure user charges that do not account for the net effect on trade efficiency border infrastructure investment tax other reforms areas outside the concession. The intention is to stimulate debate leading to revision of current concession design as COMESA countries get ready to implement the African Continental Free Trade Area (AfCFTA) Agreement. The Poisson Pseudo Maximum Likelihood (PPML) estimator was employed as an analytical tool. The overall finding of this paper is that border infrastructure alone do not yield an optimal trade efficient solution for Africa. Border infrastructure projects need to be implemented as a bundle of solutions including streamlining procedures with the aid of information communication technology. The finding that high levels of corruption facilitate hedging against border crossing time uncertainty, speaks to the theoretical arguments that firms pay bribes to be facilitated. In that vein, African firms are willing to pay border user fees when a bundle of solutions are implemented that reduce clearance time. The major policy implication that COMESA member states can draw from this study is that governments should seriously consider private sector as an important financial source to implement trade facilitation reforms at border posts and these include physical infrastructure, procedures and ICT. However, this funding can be unlocked only if the solutions implemented induce trade efficiency. This can be achieved by revising the current concessions structure limited to border infrastructure, extending them to cover procedures and ICT solutions and making trade efficient the pith of the concession agreement.

1.0 Introduction

Generally, Africa's merchandise trade is increasing. It rose fromUS$831.71 billion in 2017 to US$997.94 billion in 2018. The share of Africa's exports to the rest of the world ranged between 80 and 90 percent of total exports during the period 2000 to 2017. However, intra-African exports were only 16.6 percent in 2017 compared to 68.1 percent in Europe, 59.4 percent in Asia and 55 percent in America, (Economic Development in Africa Report, 2019). This shows that Africa is more remote to itself and therefore vulnerable to external shocks. The low intra-African trade is largely due to persisting high barriers to trade that make borders very difficult to cross.

The difficulty in crossing borders reduces the flow of traffic within Africa leading to high intra-trade transaction costs (Muluvi et al., n.d). AU (2014) noted that while it cost US$1500 to ship a car from Japan to Abidjan, shipping the same from Abidjan to Addis Ababa cost US$5000. It was again noted during the launch of Move Africa in 2016, in Kigali, Rwanda, that it was cheaper to buy passion fruit from China, transport it to Kenya, bottle and sell in Kenya than to buy it from next door Uganda. UNCTAD (2003) observed that border crossing delays in Africa result largely from inadequate physical infrastructure facilities and lack of coordination among the various agents working on a given side of the border and estimated that delays at major border posts in Southern Africa cost the region approximately US$48 million annually. OECD (2012) also argued that crossing border posts in Africa impose high costs on trading due to poor border/port infrastructure, cumbersome border procedures and limited application of ICT solutions. Contemporary business environment forcing firms to adapt to just-in-time production and management systems imply that flexibility, speed and reliability in delivery of goods have assumed significant importance. Thus, Africa needs to address border crossing bottlenecks in order to reduce trade costs and remain competitive.

The need to address border crossing bottlenecks have long been identified in Africa as articulated in the Agenda 2063 aspirations to have world class, integrative infrastructure that criss-crosses the continent; and that Africa be a continent of seamless borders, (AUC, 2015). Furthermore, Annex 4 on Trade Facilitation of the Agreement Establishing the African Continental Free Trade Area requires member states to ensure border agency cooperation, expedite clearance of perishable goods and implement risk management in an endeavour to speed up movement of goods in the continent and boost trade.

1.2 Problem statement

While the African Continental Free Trade Area (AfCFTA) agreement is expected to boost intra-African trade, border posts, as nodes along trade corridors across Africa has a deciding role in achieving high intra-Africa trade in raw materials, intermediate and finished goods. Whilst Jouanjean et al (2015) acknowledges the complexity of border crossing challenges and argues that hard and soft infrastructure are integral factors, Harmon (2011) observed that poor border/port infrastructure is often singled out as the most outstanding and easily noticeable border crossing challenge in African. Thus, huge projects to provide border infrastructure are being undertaken at the expense of soft infrastructure. Given that most African countries are financially constrained

they rely on grants, private capital or public-private-partnerships financing models for border infrastructure, (Pearson 2011). When private capital financing is used to construct border infrastructure, the concessionaire recoups the capital outlay through levying the border infrastructure users (traders). The justification is that the additional costs (user charges) are offset by the resultant improvement in trade efficiency, the reduction in time and costs to cross a border (Choi 2017 and Harmon, 2011). However, savings in time and costs to cross a border do not arise from infrastructure improvements alone. Improvements in clearance procedures and deployment of ICT solutions at border posts, among other reforms, also have a considerable impact on trade efficiency, (Harmon 2011). Thus, determining border infrastructure user charges on the basis of number of border users (average traffic volume), capital outlay and the concession period whilst ignoring the investment effect on trade efficiency leads to taxing efficiency induced by reforms outside the infrastructure concession, making the concessionaire reap where he/she did not sow. Thus, this study seeks to demonstrates that border infrastructure is not the sole source of trade efficiency and that its net effect on trade efficiency should be determined in determining user charges. Whilst this study focuses on African data, it is intended to draw lessons for COMESA as the block seeks to exploit trade opportunities availed by the AfCFTA.

1.3 Objectives of the study

The overall objective of this study is to demonstrate the differential effects of border posts infrastructure and other soft reforms on trade efficiency with the intention to show that border infrastructure user charges that do not account for the net effect on trade efficiency border infrastructure investment tax other reforms areas outside the concession.

1.4 Justification of the study

The timing of this study is relevant especially at the present moment where most African countries are bound by the provisions of the AfCFTA Agreement as well as the WTO Trade Facilitation Agreement. These agreements provide for the implementation of several trade facilitation measures intended to increase efficiency at border posts. This study will provide policy makers with the critical eye of evaluating border infrastructure concessions ensuring that the return on investment is proportionate with the efficient benefit to traders. Border efficiency in Africa is important as border posts form critical nodes along trade corridors which are central to boosting intra-African trade, one of major objectives of the AfCFTA. Border posts can act as constraints or facilitators to seamless flow of trade and people which is essential to creating regional value chains across the continent, thus promoting African industrialisation.

The rest of the paper is organised as follows: Section two gives background to the study. Literature is reviewed in section three while Section four outline the analytical methodology. Section five presents and discuss results. Section six concludes the study with a summary of findings and policy implications.

2.0 Background to the Study

2.1 Private Concessioning of Border Post Infrastructure

Border infrastructure is purely a public good characterised by non-excludability and non-rivalry when financed by a grant or from government treasury (Maur 2008). When private capital is used, the border infrastructure becomes a quasi-public good with total excludability, that is, user fees can be charged to finance their supply, (Maur 2008). Once the border infrastructure is provided, its use by one trader does not reduce the quantity available for use by other traders who can afford the user fees. Thus, a positive trade facilitation effect of financing border infrastructure with private capital only arise if the trade efficiency induced exceed the user charges paid by traders.

The desire to ensure seamless flow of goods across borders coupled with limited financial capacity of most African countries, (Foster & Briceño-Garmendia 2010), imply that private capital becomes an appealing option to supply border infrastructure in Africa and the COMESA region is not spared. In Zambia the government entered into an agreement with a private company to construct and manage five border posts (Harmon 2011). Literature has shown three of these border posts to be Kasumbalesa on the Zambian- DRC border, Nakonde on the Zambia-Tanzania border and Kazungula on the Zambia-Botswana border, (Harmon 2011, p. 14). The same company also built the DRC Kasumbalesa border terminal under a concession. It is also reported that the company negotiated with Tanzania to construct infrastructre for Tunduma border post opposite Nakonde border (Harmon 2011). At Kasumbalesa Border Post, the concessionaire charges US$19 per axle to cross the Zambian terminal and US$100 to cross the DRC terminal (Harmon 2011; Pearson 2011 and Mfune 2015). This means that a seven-axle interlink will pay US$233 in infrastructure user charges when crosing Kasumbalesa border from Zambia to DRC. Suppose the same charges are applied at Tunduma/Nakonde Border Post, a return trip between Dar es Salaam and Lubumbashi would cost US$932 in user fees alone (Harmon 2011).

Similarly, Zimbabwe has concessioned the construction of Beitbridge Border Post infrastructure to a private company under a Build, Operate and Transfer (BOT) concession, between Zimbabwe and South Africa along the North-South Corridor[1]. Tthe user charges to be levied at Beitbridge Border Post are not yet known. Another example of private sector financing of border infrastructure can be drawn from the N4 Toll Road from South Africa to Mozambique where the 30 year concession include construction of One Stop Border Post facililities, (Verougstraete, 2017).

Policy makers need to note that the added costs (user charges) are only justified if they can be offset by the reduction in border crosing time induced by improved infrastructure. However, the reduced border delays does not result solely from infrastructure improvement, but also from improved procedures and application of ICT solutions. The fact that the concessionaire is on physical infrastructure and not on the clearance procedures and/or on related ICT solutions, may fail to register a considerable reduction in border crossing time as there is assumed

[1] https://constructionreviewonline.com/2019/10/rehabilitation-of-beitbridge-modernisation-projects-in-zimbabwe-commences/

complementarity of physical infrastructure, use of ICT and clearance procedures at border posts, (Jouanjean et al., 2015).

2.2 Trade Efficiency

Africa has relatively poor trade efficiency as measured by time to trade. Data from the World Bank's Doing Business Report (2018) show that border compliances for exports in Sub-Saharan Africa take 60-80 percent more time than the regions of East Asia and Pacific, South Asia and Latin America and Caribbean as shown in Table 1.

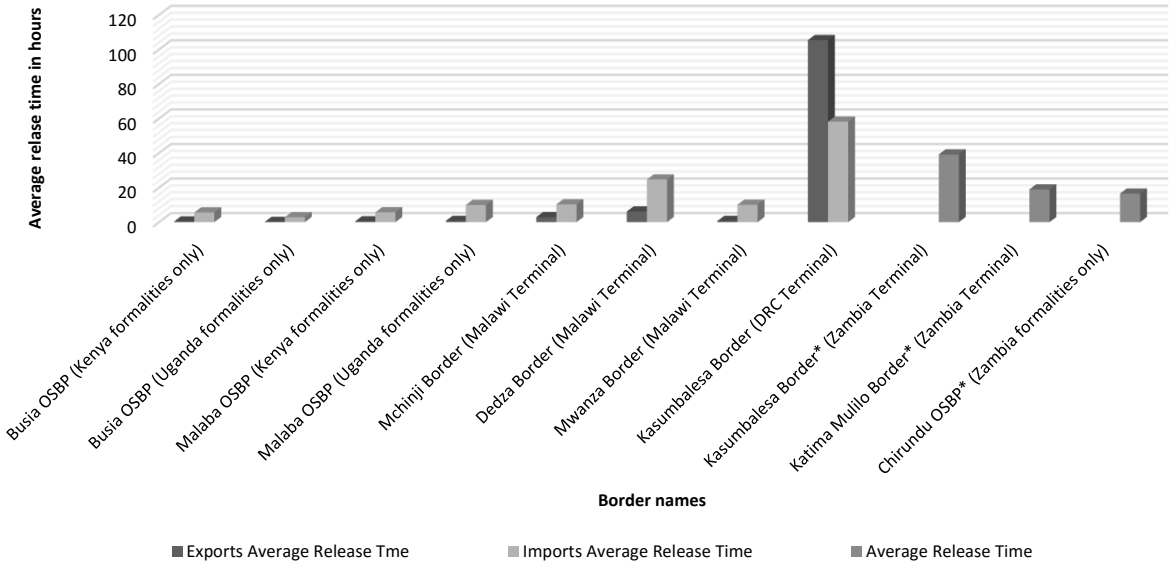
Table 1: Regional Trade Efficiency

Region	**Border Compliance**	
	Time to import (hrs)	Time to export (hrs)
East Asia & Pacific	70.5	55.9
Europe & Central Asia	25.9	28.0
Latin America & Caribbean	64.4	62.5
Middle East & North Africa	112.3	62.6
OECD high income	8.7	12.7
South Asia	113.8	59.4
Sub-Saharan Africa	136.4	100.1

Source: Trading Across Borders, World Bank Doing Business 2018

COMESA, like Sub-Saharan Africa, has low trade efficiency given by longer border dwell times. A comparison of border release times on selected border posts in COMESA member states given in Figure 1 shows that Kasumbalesa Border Post which is under infrastructure concession has the longest average release times of 105 hours for exports and 58.2 hours for imports on the DRC side whilst the Zambian side had a combined average of 39.18 hours for both exports and imports. This can be compared to high efficiency at border posts which are not under a concession like Malaba, Busia and Chirundu. Whilst it is undeniable that modernising border infrastructure improves the working environment for border officials, it is the trade efficiency that matters to traders and is the only factor that justifies paying facilities user fees.

Figure 1: Comparison of 2017 average border release times on selected borders in COMESA



Source: Author Compilation: Data obtained from the 2017 Report of the Regional Dissemination Workshop of the COMESA Time Release Study

* Export release times takes averages of local exports and outward transit times. Imports release times takes averages of local imports and inward transit times.

*Data on Zambia Border Terminals does not separate import release times from export release times.

Given the developments at Kasumbalesa Border Post and its relative performance presented in Figure 1, it is doubtful if the modernisation of Kasumbalesa border infrastructure managed to yield any efficiency gains. The ad hoc evidence could suggest that modernisation of border infrastructure is not a panacea to border crossing challenges.

Hoffman, Grater, Schaap, Maree, & Bhero (2016) identified southern Africa borders in COMESA that carry most traffic to include Beitbridge, Chirundu, Kasumbalesa, Kazungula and Nakonde. The average release time at the listed border posts are shown in the Table 2 and range between 24 to 46 hrs. It is again interesting to note that Kasumbalesa is already under infrastructure concession, an agreement to concession Nakonde and Kazungula infrastructure is said to have been signed, though no specific date was given, (Harmon, 2011). Beitbridge Border infrastructure is being developed under a 17 year concession arrangment. Given the long release times and the proposed concessions, one could conclude that infrastructure is considered the major bottleneck for seamless trade flows in Southern Africa. However, other factors such as clearance procedures, coordination and cooperation among border agencies, and application of ICT solutions among other reforms are also competing determinants of trade efficiency. The case study of Malaba OSBP between Kenya and Uganda shows that procedural reforms resulted in greater reduction in border crossing times before even modernising infrastructure, (Fitzmaurice & Hartmann, 2013). Thus, improving border

infrastructure alone without corresponding improvements in the border clearance processes will yield suboptimal economic benefits for Africa in terms of trade efficiency, the costs and times to cross a border post. Furthermore, the existence of multiple factors influencing trade efficiency at border posts dictates that the net trade efficiency effect of border infrastructure be accounted for when determining user charges in order to avoid taxing efficiency induced by reforms outside the infrastructure concession agreement. The present design of border infrastructure concessions is taxing unrelated areas, (Pearson, 2011), hence an alternative thinking is required and the objective of this paper is to stimulate debate that leads to exploration of new border reforms concession model.

Table 2: Average Release Times fo Southern African Borders along the North South Corridor

Border Post	Average relaese time (hrs)
Beitbridge	24.5
Chirundu	24.1
Kasumbalesa	39.4
Kazungula	42.3
Nakonde	46

Source: Hoffman, Grater, Schaap, Maree, & Bhero (2016)

Trade efficiency is the only thing that matters to a trader. If a concession induce trade efficiency, it makes business sense to a trader to pay infrastructure user fees. It is also important to decompose the efficient gains so that the concession does not tax unrelated source of efficiency. To support these arguments, this paper seeks to rely on empirical evidence to demonstrate that infrastructure development is not the sole contributor to trade efficiency at border posts. This exposition is aimed at persuading policy makers to ensure that trade efficiency becomes an integral contractual provision in future border reform concessions.

3.0 Literature Review

3.1 Theoretical Literature

Hummels & Schaur (2012) developed a theoretical model that recognises time as an observable attribute of product quality, holding other things constant, consumers derive higher satisfaction from a good that is delivered sooner rather than later. Thus, their theory translates time into delivered price of exports which in turn determine product demand. A longer transit time increases the delivered price and reduces demand or leads to loss of sales. Short transit time reduces the landing price and according to the law of demand boosts sales. In that regard, firms guard against loss of sales by paying a premium to ensure early delivery of their goods. Hummels & Schaur's (2012) model posits that time to trade internationally is a function of distance between exporter and importer, quality of infrastructure and the endogenous choice of firms to pay a premium for timely delivery.

Anderson, Larch, & Yotov (2015) developed a model of international trade in which the delivered price of exports/imports is argued to be a function of factory gate price in the exporting country and bilateral transaction costs between the exporting and importing country. Zaki (2010) presented a similar model and disaggregated the bilateral transaction costs to be a function of several factors that include time to trade. Zaki's (2010) model argued that time to trade is determined by bureaucracy (policies, rules and regulations), use of information communication technology, being landlocked, corruption by customs officials, state of a country's institutions and the reliance on customs duty as source of revenue which increases the probability of physical examination of goods. Other theoretical models also argue that trade liberalisation policies undertaken before addressing border bottlenecks lead to increased movement of cargo exceeding border capacities, which in turn increase border waiting time (Cudmore & Whalley, 2005). Akin to models by Hummels & Schaur (2012) and Cudmore & Whalley (2005), Zaki's (2010) model leads to the same conclusion that longer times to cross borders increase the landing price of exports which results in loss of sales.

When faced with border delays, firms that greatly value time to ship cargo to foreign markets tend to pay bribes to secure facilitated passage. The formal exposition of this hypothesis is given in the queueing theory of bribery which postulates that a client that values time, on arrival at the queue, would seek to minimise waiting plus service time through paying a bribe to queue servers who will in turn place the client ahead of those who would have not paid bribe or paid smaller bribe but behind those who would have paid larger bribe (Lui, 1985; Cudmore & Whalley, 2005). According to the queue model of bribery, the value of time to trade is the fundamental determinant of whether a firm that is engaged in international trade pays bribe or not when faced with delays. In present-day, lean retailing, just in time production, and participation in global and regional value chains make time a critical trade barrier. Here the importance of time is not seen only in terms of longer compliance times but also the great uncertainty that is introduced in the supply chain, (Ansón, Arvis, Boffa, Helble, & Shepherd, 2017). Thus, the ability to produce and ship cargo more quickly is commercially valuable to firms as they will be able to fully respond to demand shocks (Shepherd, 2009). However, customs bureaucratic procedures and gatekeeping philosophy are a bottleneck to the seamless flow of cargo resulting in firms incurring high production and shipping costs as they have to bribe customs officials to access quick passage. Central to arguments presented here is that firms are ready to pay bribes as long as it helps to reduce border crossing time.Thus, it is not corruption that exporting/importing firms want but the time reducing effect of corruption. In the same vein, firms are not interested in border infrastructure but in its time reducing effect. If border infrastructure do not reduce any time to cross the border, then firms are not interested to pay border infrastructure user fees. Two sources of delays at border post are suggested by the queueing theory and these are bureaucratic customs procedures and corrupt behaviour of customs officials. The theory also suggests that fear of punishment reduces corruption of border officials thus reducing the time-saving effect of corruption.

Ahsan (2015) proposed a theory which argued that bureaucracy creates bottlenecks at border posts, hence firms opt to bribe customs officials to ensure supply chain predictability. He posits that time spent by firms complying with customs formalities is a function of customs red tape and bribe rate. Suppose there is no bureaucracy, firms do not face any delay at border posts and there is no need

to pay a bribe as it can export all its products seamlessly. If there is bureaucracy, and bribe rate is zero, firms face delays as there is no room for paying a bribe to minimise the delay. Thus, firms face longer delays where customs officials thoroughly check the documentation and physically examine the cargo. This increases firms production and shipping costs and ultimately reduce exports. However, if there is bureaucracy and the bribe rate is greater than zero, then firms face customs red tape but can pay a bribe to minimise the delay. Again from this theory, complex customs procedures increase time to cross a border and traders are willing to pay any intervention that reduces time to cross a border – in the absence of trade facilitation interventions - corrupt border officials becomes a viable option for firms to get facilitated. It is the author's view that firms are not interested in corruption but they derive value in the trade efficiency (facilitation) effect of corruption. By transitivity, should there be other trade facilitation interventions that yields the same time-saving effects as corruption, traders are willing to pay for their supply. In the same vein, the interest of firms is not in having the infrastructure at border posts but the time-saving effect of the infrastructure is the aspect that create value to them. Analogy to the corruption models reviewed in this paper, firms that value time to cross a border are ready to pay user charges for border infrastructure if the provision of such infrastructure will reduce border crossing time.

Apart from exposing the determinants of time to cross a border, the reviewed theoretical constructs explicitly show that time to cross a border is very valuable to firms, the longer times and the resultant supply chain uncertainty are very costly to them such that they are willing to pay for any interventions that minimise such. This firm behaviour is important to note because it is indicative of the high propensity of private capital to finance border reforms that create value in terms of trade efficiency. Thus, in implementing the AfCFTA Annex 4 on Trade Facilitation, consideration to tap from private capital should be made to finance border posts reforms. However, it is further argued that the current design of private concessions focusing on physical infrastructure alone should be revised, (Pearson, 2011). This argument can be supported by the above reviewed theoretical arguments which have shown that time to cross a border can be expressed functionally as follows:

$$T_{it} = f(\text{Inf, ICT, Cus, Cor, Ac}) \qquad (3.1).$$

where T_{ij} - represents time to cross a border;

Inf - is border physical infrastructure;

ICT - ICT solutions at border Posts;

Cus - Customs Procedures and;

Cor - Corruption of border officials; and

Ac - Accountability of border officials

Equation (1) shows that infrastructure is not the only constraint for seamless flow of cargo at border posts. Since there are multiple factors, it also remains an empirical question as to which factor contribute most to time reduction. In East Africa, Malaba One Stop Border Posts (OSBP) along

Northern Corridor between Kenya and Uganda has remarkably managed to reduce time to cross the border from 48 hrs to less than 6 hours in 2012 generating an estimated value of US$70 million in savings, (Harmon, 2014). Interestingly, this reduction in time was achieved through employing soft reforms only, before the construction of OSBP infrastructure, (Harmon, 2014). The soft reforms employed at Malaba OSBP include joint operations, interfacing the two countries' customs IT systems enabling pre-lodgement of declarations and data sharing, and streamlining the flow of traffic. The Malaba case demonstrates that apart from physical infrastructure, other interventions are also critical in reducing time to trade. In practice, it has also been demonstrated that there is complementarity between physical infrastructure and customs procedures. The West African case of Cinkansé OSBP between Burkina Faso and Togo which was constructed in 2011 under a concession model indicated that though the infrastructural architecture was state of the art, functionality was poor as the facility was not compatible with clearance procedures. Thus, transporters were refusing to pay user fees as they did not realise any value from the facility, (Harmon, 2014). Complementarity of procedures and infrastructure can also be practically shown at Beitbridge border post between Zimbabwe and South Africa along the North-South Corridor where Zimbabwean customs automated risk management system separate cargo based on risk level into either red, yellow, blue or green lane. This separation of traffic remained virtual since the lanes are not supported by infrastructure as all commercial traffic use one lane, such that a green routed truck cannot secure free passage, (Willie & Chikabwi, 2017). Furthermore, the Zimbabwean and the Malaba cases demonstrate clearly that Customs, IT systems, procedures and infrastructure are complemented and should be harmoniously implemented. Including the complementarity argument in equation (1) we have:

$$T_{it} = f(\text{Inf, ICT, Cus, Cor, Ac, Cus*Infra, Cus*ICT, Cus*Infra*ICT}) \quad (3.2)$$

The argument we get from the interactions terms in equation (3.2) is that if there is complementarity among border infrastructure, customs procedures and ICT solutions, then optimal trade efficiency can be achieved if these solutions are provided at once. Given the foregoing discussion, this paper argues that the design of concessions at border posts reforms should provide a comprehensive bundle of solutions that together yields an optimal level of trade efficiency. Thus, it is proposed that border reform concessions should not be limited to infrastructure alone,but should extend to other areas as well that complement infrastructure. Should concessions be limited to infrastructure alone, then infrastructure elasticity of time to cross a border should be an integral part of user charges determination process, otherwise trade efficiency from areas outside the concession will be taxed. To cement the arguments presented in this paper, an empirical demonstration of the complementarity of infrastructure, procedures and ICT systems in reducing border crossing time shall be made, besides, individual elasticities of these three factors shall be estimated to show that reforming in one area may not be an optimal solution to achieve maximum trade efficiency.

3.2 Empirical Literature

Whilst the importance of time as a barrier to trade performance has been subjected to a number of empirical work, (Volpe, Carballo, & Graziano, 2013; Zaki, 2010; Willie & Chikabwi, 2017; Hillberry & Alcántara, 2015; Ansón, Arvis, Boffa, Helble, & Shepherd, 2017), there is still a paucity of work that interrogated factors determining trade efficiency as measured by border crossing time.

Zaki (2010) using a sample of 175 countries, with 48 of them being Africa countries, employed the Ordinary Least Squares (OLS) to estimate the determinants of time to export. Number of documents, internet use, corruption, landlockedness, procedures to start a business, and tariffs were used as determinants. The study established that being landlocked, requirement of more documents to trade and high corruption levels increase time to trade. The use of the internet was found to reduce time to trade.

Shepherd (2014) also employed the OLS technique to assess the impact of paperless reforms on time to trade in a sample of 29 countries drawn from the Asia-Pacific region. The study established that paperless trade reforms reduce time to trade.

Whilst the empirical work by Zaki (2010) and Shepherd (2014) form the basis of this study, there is a great difference in objectives, timing and variables used. Whilst this paper, like Zaki (2010) and Shepherd (2014), is interested in the coefficients of each individual time determinants, an interrogation of the complementarity of time determinants will be a novelty. Furthermore, both Zaki (2010) and Shepherd (2014) did not consider border infrastructure as a determinant of time to trade. In these studies time to trade was measured as the times required to move goods between the seller's factory or the buyer's warehouse and the sea vessel. The time variable employed in this study is measured as time spent complying with border formalities. This paper can be distinguished from the rest by not only analysing the complementarity effect of trade facilitation reforms on time to cross a border but also by extending the analysis to flagging out determinants of yet another critical time dimension pointed out in literature, the uncertainty of supply chains in Africa.

4.0 METHODOLOGY

The empirical approach followed draws from the literature reviewed in Section Three. To assess the determinants of trade efficiency as measured by time to cross a border, equation (3.2) was presented in an empirical form as follows:

$$Tx\_bc_{it} = exp(\beta_0 + \beta_1 Inf_{it} + \beta_2 ICT_{it} + \beta_3 Cus_{it} + \beta_4 Cor_{it} + \beta_5 Ac_{it} + \beta_6 Cus*Inf_{it} + \beta_7 Cus*ICT_{it} + \beta_8 Cus*Infra*ICT_{it} + \beta_9 d_i) + \mu_{it} \quad (4.1)$$

Where Tx_bc_{it} - Time to export, border compliance;

$Cus*Inf_{it}$ - interaction between customs procedures and border infrastructure;

$Cus*ICT_{it}$ - interaction between customs procedures and ICT solutions;

$Cus*Infra*ICT_{it}$ -interaction between customs procedures, ICT and border infrastructure;

d_i - Country fixed effects to control for unobserved heterogeneity;

μ_{it} - the error term and;

$\beta_0 - \beta_9$ -are parameters to be estimated.

To assess the determinants of border crossing time uncertainty, the following model was estimated:

$$Tx\_bc_{isd} = exp(\beta_0 + \beta_1 Inf_i + \beta_2 ICT_i + \beta_3 Cus_i + \beta_4 Cor_i + \beta_5 Ac_i + \beta_6 Cus*Inf_i + \beta_7 Cus*ICT_i + \beta_8 Cus*Infra*ICT_i + \beta_9 d_i) + \mu_i \quad (4.2)$$

Where Tx_bc_{isd} – is the standard deviation of time to cross a border. All other variables are as defined in equation (4.1).

4.1 Estimation Approach

Equations (4.1) and (4.2) were estimated in levels and in their multiplicative form using the Poisson Pseudo Maximum Likelihood (PPML) estimator, (Silva & Tenreyro, 2006). Data used to estimate equation (4.1) spans the period 2014 to 2018 and where gaps existed, interpolation was employed. The sample constituted of 49 African countries and the sample size was solely determined by availability of data. The dependent variable of equation (4.1) takes the average standard deviations of each country for the period 2014-2018 whilst the independent variables take on cross-sectional data for 2017.

4.2 Variable Definitions, Data measurement and Sources

Trade efficiency (Tx_bc_{it})

Trade efficiency is the time to cross a border. Data on time to trade (border compliance) was used as proxy for trade efficiency. It is measured in hours. The data was accessed for the World Bank's Trading Across borders database.

Border Infrastructure (Inf_{it})

The sub-component of LPI index, the quality of trade and transport infrastructure, was used as a proxy for border infrastructure. It is expected that the quality of infrastructure be negatively related to trade efficiency. The variable is rated from 1 (very low performance) to 5 (highest performance). Data was accessed from World Bank's Logistic Performance Index (LPI) database.

Customs procedures (Cus_{it})

Efficiency of customs and border management sub-component of the LPI index was used as a proxy for customs procedures. The variable is rated from 1 (very low performance) to 5 (highest performance). Complex border crossing procedures will keep trucks waiting at border posts for long time increasing the costs on doing business. Streamlining, standardization and harmonization of border crossing administrative formalities will reduce border waiting time. Data was accessed from World Bank's Logistic Performance Index (LPI) database.

ICT solutions at border Posts *(ICT_{it})*

Electronic Data Interchange (EDI) systems and Electronic Single Window (ESW) systems were used to proxy for ICT solutions. The data was accessed from the World Bank's Trading Across borders digital platform database. These took the value of 1 when implemented by a country and zero otherwise. These two ICT solutions are expected to reduce time to cross a border.

Corruption (Cor_{it})

Corruption of border officials was proxied by the corruption perception index data accessed from World Governance Indicators.

Accountability (Ac_i)

Accountability of border officials was proxied by the accountability index data obtained from World Governance Indicators.

5.0 Presentation and Discussion of Results

5.1 Descriptive Analysis

Table 3 describes the statistical properties of the data used in this study. The data shows that it takes on average 101 hours to comply with border formalities in Africa. The most worry is this time varies creating uncertainty in the supply chain as evidenced by a standard deviation of 78.5 hours with a range of 511 hours, (515-4). The score for customs procedures proxy averages 2.34 whilst that for border infrastructure averages 2.31. These variables are rated from 1 (lowest performance) to 5 (Highest performance). African scores are below the average signifying existence for greater scope for improvement. Worse still are the scores for corruption perception and accountability. Corruption perception averaged -0.705 and Accountability averaged at -0.58. These variables are scored from -2.5 (lowest score) to 2.5 (highest score). With a lower score for control of corruption, it indicative of the prevalence of high corruption levels at border posts in Africa. Having the lower average score for Voice and Accountability, it signals limited freedom of expression to report corruption in Africa, hence the high corruption levels. Thus the role of corruption as a facilitator of trade is expected to be thriving in Africa. It is also indicative that about 75% of African countries have implemented EDI systems such as the ASYCUDA World Systems whilst about 27 % of African countries have implemented electronic single window systems.

Table 3: Descriptive analysis

Variable	Mean	Std. Dev	Min	Max
Tx_bc	101.502	78.49747	4	515
Cus	2.336571	0.3626016	1.285714	3.714161
Inf	2.310434	0.370984	1.5	3.776261
Cor	-0.7049636	0.6010891	-1.845606	0.9273092
Vc	-0.5774071	0.7092523	-2.114793	0.9408962
EDI	0.755102	0.430907	0	1
ESW	0.2653061	0.4423999	0	1

Source: Author calculations

5.2 Correlation Analysis

A simple correlation analysis presented in Table 4 is suggestive that implementation of ICT solutions, improvement in border infrastructure and customs procedures reduce the time to cross a border. It is also shown that the proxy for infrastructure and customs procedures are highly correlated. It is interpreted that this point to the possibility of complementarity of these variables in reducing time to trade. The correlation analysis also seems to predict the validity of the role of corruption in facilitating trade in line with theoretical postulations.

Table 4: Correlation Analysis

Variable	Tx_bc	EDI	ESW	Cus	Inf	Cor	Vc
Tx_bc	1.0000						
EDI	-0.1237	1.0000					
ESW	-0.0980	0.3422	1.0000				
Cus	-0.1973	0.2640	0.0986	1.0000			
Inf	-0.1673	0.2352	0.1564	0.7746	1.0000		
Cor	-0.3589	0.3908	0.2991	0.4949	0.5087	1.0000	
Vc	-0.2702	0.4728	0.3268	0.4400	0.4855	0.7178	1.0000

Source: Author calculations

5.3 Main Econometric Analysis

Table 5 and 6 presents the main results of this study.

Table 5: Results of the determinants of time to cross a border

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	**Tx_bc**	**Tx_bc**	**Tx_bc**	**Tx_bc**	**Tx_bc**	**Tx_bc**	**Tx_bc**	**Tx_bc**
Inf	0.0511		0.0306	0.0318	0.0318	0.0563	0.0545	0.397
	(0.0464)		(0.0395)	(0.0394)	(0.0394)	(0.0416)	(0.0423)	(0.195)
Cus		0.0474	0.0329	0.0335	0.0335	0.0522	0.0521	0.368
		(0.0707)	(0.0776)	(0.0760)	(0.0760)	(0.0806)	(0.0805)	(0.229)
Cor				0.0233	0.0233	0.00846	0.0153	0.0510
				(0.154)	(0.154)	(0.160)	(0.151)	(0.151)
V&A							-0.0150	-0.00879
							(0.0505)	(0.0492)
EDI					-2.792***	-0.236**	-0.229**	-0.0490
					(0.175)	(0.113)	(0.103)	(0.103)
Cus*ESW*Inf						-0.0461*	-0.0454**	-0.0350*
						(0.0237)	(0.0227)	(0.0197)
Cus*Inf								-0.145*
								(0.0780)
Constant	3.715***	4.364***	3.692***	4.357***	4.493***	4.392***	4.400***	3.654***
	(0.0766)	(0.235)	(0.119)	(0.163)	(0.169)	(0.206)	(0.194)	(0.550)
Observations	245	245	245	245	245	245	245	245
R-squared	0.947	0.948	0.948	0.948	0.948	0.948	0.948	0.950

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

From Table 5, column 1 to 8 shows that infrastructure, customs procedures, corruption and accountability do not explain the time to cross a border. Electronic Data Interchange (EDI) systems are shown in column 5 to 7 that they reduce the time to cross a border. The test for complementarity

has shown that when customs procedures interact with infrastructure, the variable is statistically significant and carries the expected sign. The implication is that when infrastructure at borders is implemented together with streamlining of customs procedures, they reduce time to cross a border. Similarly, when customs procedures, infrastructure and electronic single window systems interact, the variable is statistically significant and carries the expected sign, column 6 to 8. These results communicate an important message that optimal trade efficiency is obtained when reforms are carried out together. Given the complementarity demonstrated, concessions that are limited to infrastructure alone are greatly expected to be taxing efficiency generated by other areas not covered by the concession. On that ground, this paper strongly proposes that African governments should consider adopting border reform concessions that cover a range of solutions besides infrastructure.

Table 6: Results of the determinats of uncertainty of time to cross a border

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	**Tx_bc$_{sd}$**	**Tx_bc$_{sd}$**	**Tx_bc$_{sd}$**	**Tx_bc$_{sd}$**	**Tx_bc$_{sd}$**	**Tx_bc$_{sd}$**
Inf	-1.426*	-0.182	16.21	16.16	15.92	17.39
	(0.842)	(2.063)	(8.462)	(8.182)	(8.336)	(8.762)
Cus		-1.220	10.99	10.72	10.44	11.30*
		(1.697)	(7.117)	(7.020)	(7.200)	(6.495)
Cor			-1.769*	-1.639*	-1.648*	-1.582*
			(1.007)	(0.935)	(0.961)	(0.852)
V&A						-0.402
						(0.614)
Cus*Inf			-5.849*	-5.696*	-5.575*	-6.060**
			(3.231)	(3.183)	(3.262)	(3.050)
Cus*ESW				-0.226		
				(0.167)		
Cus*Inf*ESW					-0.0866	
					(0.0728)	
Constant	6.107***	6.123***	-29.57	-29.32	-28.79	-31.92*
	(2.099)	(2.051)	(18.92)	(18.28)	(18.66)	(19.10)
Observations	20	20	20	20	20	20
R-squared	0.055	0.099	0.634	0.653	0.645	0.690

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

In Table 6, Colum 1 shows that infrastructure is statistically significant and negatively related to the standard deviation of border crossing time. Interestingly, when infrastructure interacts with customs procedures, they provide an optimal solution to solve border crossing time uncertainty. Column 3 to 6 show that the corruption indicator is negatively related to border crossing time uncertainty. This finding confirms the theoretical argument that high corruption facilitates border crossing and therefore reduce the unpredictability of the supply chain. The lower levels of control of corruption imply that the high corruption existing is acting as an option to facilitate border crossing. Column six shows an interesting result. Adding the accountability variable reduced the corruption coefficient and increases the coefficient of the interaction of infrastructure and customs procedures. The implication is that, the freedom of expression enables people to report corruption and this deters corruption which reduces the corruption facilitatory role which in turn boost the role of infrastructure and customs procedures as an alternative facilitatory option.

6.0 Conclusion and Policy Implications

6.1 Conclusion

This study interrogated the border posts infrastructure financing mechanism in Africa with the intention to assess the implications on trade efficiency. Econometric analysis has been employed as the principal method of analysis. The findings of this study clearly demonstrates that improving the quality of border infrastructure is not the sole contributor to trade efficiency. There exist complementarity between border infrastructure, customs procedures and ICT solutions. Given that African countries are constrained financially, they need a concession agreement that finance border infrastructure, customs procedures and ICT as a single bundle of solution to border crossing barrier in order to promote seamless flow of intra-African trade. Where the concession is restricted to border infrastructure alone, the net effect of border infrastructure on trade efficiency needs to be determined in order to inform facilities user fees determination and avoid taxing efficiency generated by reforms outside the concession agreement.

6.2 Policy Implications

Noting that border posts are critical notes in reaping trade benefits from the AfCFTA, the COMESA region can draw lessons from the findings of this paper that border infrastructure alone does not yield an optimal trade efficiency. Ensuring seamless border posts would require implementation of a bundle of solutions including procedures' streamlining with the aid of information communication technology to automate procedures together with infrastructure. COMESA member states should consider private sector as an important financial source to implement trade facilitation reforms at border posts and these should include physical infrastructure, procedures and ICT. However, this funding can be unlocked only if the solutions implemented induce trade efficiency. This can be achieved by making the concessions structure broad to include border infrastructure, procedures and ICT solutions. Trade efficiency should form the core of any border post trade facilitation reform concession in order to unlock private capital.

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