Evaluating the Relationships between Transportation Infrastructure and Regional Economic Activity: Evidence from the Port of Abidjan in West Africa

Abstract
This research paper aims to study the correlation between the transportation infrastructure and regional economic activity. It emphasizes on the seaport activity and the activities of the different services sectors. By comparing trends between them and analyzing the causality relationships between the port traffic and the other economic sectors, our study tends to present how the activity of the Port of Abidjan could have a decisive effect not only on the local economy but also on West Africa regional economy especially in the WAEMU zone. To meet our objectives, correlation analysis and statistical test tools Eviews and other techniques have been run with data provided by local transport agencies and port authority. By doing so, our research study found that there is existing correlation between port activity as an economic infrastructure and the activities generated by the other services sectors and its contribution can accelerate the regional economic growth.

Keywords: Correlation; Infrastructure; Regional Economic Activities; Port Activity; Tertiary Sectors; Traffic.

1. Introduction
The global analysis of regional trade with movement of goods that include commodities exports has identified ports as major players in regional trade where their stage of industrialization plays a crucial role in economic integration and accentuates the mutual co-dependence with other sectors of the economy. This relationship of the port regarded as transport infrastructure with its complexes of vicinity with other sectors generate business creation that create significantly conditions for local, national and regional economic growth. The expansion of the tertiary sector that classically involves mainly business services such as banking, insurance, trade, transportation, communication and other services sectors providing service to non-merchants, remains the backbone and the most contributor of GDP creation during 20 years (1992 to 2011) in Cote d'Ivoire which however affect the WAEMU countries. As the economic engine, the Port of Abidjan contributed to more than the 82% of the customs taxes collection and constitutes the major gateway and hub of seaborne trade in the sub-region of West Africa with more than 80% of the regional trade exchange (M. Gossio, 2010). Consequently, this port supports the business development of the tertiary sector and informal business services in Burkina Faso, Mali, Cote d'Ivoire and in some extent Niger, which by its functions contributes to the development of government revenues and incomes that constitute its budget consolidation. (N. Essoh, 2012). Accordingly, the structure of the port of Abidjan allows many firms to operate and provide services in terms of cargo handling, consignment, pilotage, towage, shipping and transit, loading/unloading and transportation. Oum and Park
(2004) identify among other factors that, transport linkage, airport, port and intermodal transport facilities are among the most important factors that attract foreign direct investment in the northeast Asian region. However, a few researches have investigated their emergence, impact and contribution to economic development in the African context. Rather all studies that took place, have addressed a little estimation of these activities as indicators of the port development in regional studies. However, exploring the concept of transportation infrastructure and its basic activities and its relationship with other economic activities is to shift from the microeconomic point of view to a macroeconomic assessment which attempts to involve the aggregate effects of the relationships on economic growth and integration.

By emphasizing the case of seaport as an important economic and transportation infrastructure in this paper, we examine the correlations between the port activity and the other services sectors of the economy. We study the causality between the port and the other economic sectors and finally we figure out whether the port activity could have impact on the whole economy and influence the WAEMU countries integration. Although correlations do not imply causality, they do help to identify relationships that may be worth analyzing more deeply in future studies.

This paper is organized in 4 parts. The section 2 tends to highlight the concept of relationship, correlation and causality. The section 3 describes the methodology and data, and presents the computed correlations and evaluation methods using econometric models with a tool to test the hypotheses involved in our study. Section 4 presents the analysis of the results and findings, and section 5 ends the paper with conclusion.

2. Literature and Identification of Concepts

Much of prior analysis regarding transport and economic infrastructure has focused on the aggregate effects of public investment on growth or development either at national or at state level. But all the modeling attempted efforts might not consider the important information necessary for decision-making such as econometric or statistical and causal relationships between port activity especially the traffics and the economic activities of the other sectors at regional level. The first recent study examining the role of capital infrastructure on economic growth was Aschauer (1989), which found a positive relationship between infrastructure investment and economic productivity. Gramlich (1994) identifies infrastructure capital as large capital intensive natural monopolies such as transportation facilities, water and sewer lines and communication systems. However, a few researches have investigated their emergence, impact and contribution to economic development in the African context.

2.1 Literature on Relationship of Regional Port and Economic Activities

Since our study tends to highlight the existing relationship between the port activity and other sectors of service, it is relevant to investigate insights of concepts such port activity and as correlation, dependence, causality and find the economic meaning of their relationships with other economic sectors. And later studies find in statistics term and view point, the notion of correlation and causality which constitutes more a notion of degree rather a nature.
The functional structure of the port of Abidjan allows many firms to operate and provide services in terms of cargo handling, consignment, pilotage, towage, shipping and transit, loading/unloading and transportation and dealing with capital transfer, worker remittances and exchange transactions, all constitute the overall economic activities that could affect and impact the national and regional economic growth. Oum and Park (2004) identify among other factors that, transport linkage, airport, port and intermodal transport facilities are among the most important factors that attract foreign direct investment in the northeast Asian region. The assertion follows the Steven K. (2008) study of transportation infrastructure investment that may impact on economic activity based on the nature of the causal relationship. NR. Smith and D. Guemes-Castorena (2005) in their cross observation study of logistics capabilities, reveal that the correlation between number of ports and the economic indicators suggest that the utilization of port is a more important factor in economic development of State of Mexico while arguing that there is a strong correlation between flow and industrial GDP. Although there are similarities in the definition of seaports, many researchers have developed different opinions and views on the concept of ports in leading textbooks of port economics. However, port activities can be introduced in two main categories that explain the port community as the whole of the economic activity. The first activities known as authority consist in administrating the police and planning of nautical and land infrastructures. The second are business or industrial activities that handle operations generating profits by providing services. However, the concept of port industry and its activity varies according to the geographic, economic and institutional approaches. For Martin Stopford (1997), port is just a geographic area that facilitates the berthing of ships while he limits the definition of port to a location for loading/unloading ships. Other definition from leading encyclopedia considers port as a facility which is built for receiving ships and transferring cargo (Wikipedia, 2012). In the geographic sense, port is defined as a space designed for receiving and dwelling ships. P. W. Langen and M. Nijdam (2006) argues that ports often attract economic activities that benefit from the geographic proximity to cargo flows and by comparing ports to airport and train station, he develops that port is a transport node that has three basic functions: transfer point in a transport chain, a place for temporary storage and a node of consolidation. But in the economic approach, port is seen as a complex system of materials and immaterial elements as well as physical equipments used to provide services to ships, goods and cargos. While in institutional sense, it is considered as a resourceful institution organized or a non-structured legal entity authorized to exercise simultaneously competencies of operations, public works and police function. In summary we consider port industry as the whole of the economic activity which is strictly port-related: port authorities, pilots, stowage, tub boats, custom, police and shipping agents: Port Community.

3. Methodology and Data

3.1 Data Source and Specification
The sources of the time series data used concern fundamentally the port activities and other macroeconomic data and indicators that are the observations pooled over the period of 1992 to 2012. The following Table 1 shows the sources of data collected from main economic
department and national statistics authorities. Theoretically, highlighting the causal relationships between these economic variables provides us some thoughts and favourite insights to understand the economic phenomenon.

Table 1: Data source and specification

<table>
<thead>
<tr>
<th>Variables Identification</th>
<th>Specification of Variables</th>
<th>Sources of data</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT</td>
<td>Port traffic</td>
<td>Department of Statistics, Economic Studies Port Authorities - PAA (Port of Abidjan)</td>
</tr>
<tr>
<td>RGDP</td>
<td>Real GDP</td>
<td>Department of Statistics and Economic Studies</td>
</tr>
<tr>
<td>NGDP</td>
<td>Nominal GDP</td>
<td>Department of Taxation</td>
</tr>
<tr>
<td>GDP-A</td>
<td>GDP for Agriculture</td>
<td>Ministry of Economy and Finance</td>
</tr>
<tr>
<td>GDP-T</td>
<td>GDP for Trade</td>
<td>National School of Statistics and Applied Economics (ENSEA)</td>
</tr>
<tr>
<td>GDP-I</td>
<td>GDP for Industries</td>
<td></td>
</tr>
<tr>
<td>GDP-S</td>
<td>GDP for Services</td>
<td></td>
</tr>
<tr>
<td>GDP-BI</td>
<td>GDP for Banking and Insurance</td>
<td></td>
</tr>
<tr>
<td>GBP-TT</td>
<td>GDP for Transport and Telecommunication</td>
<td></td>
</tr>
<tr>
<td>F_I</td>
<td>Fiscal Income and Taxes collection</td>
<td>General Department of Economic Affairs Department of Taxation and Fiscal Administration</td>
</tr>
</tbody>
</table>

3.2 Data Analysis and Tool for Testing

To study the different relationships that exist between the port activity and other variables of the economy, we can simply proceed to the correlations analysis. Statistical methods are used to fit the mathematical functional form to the data. With the software EVIEWS version 5, the ordinary least square (OLS) model has been run to estimate the causal relationships between these variables. To reach our objective with strategic verification of our hypothesis, different tests are run in order to identify and find out the existing cointegrating relationships between the model variables, the Johansen (1988) cointegration test is run. Error-correction Model (ECM) is necessary for series that are non-stationary and cointegrated. For example Engel and Granger demonstrated that all the cointegrated series can be represented by an ECM (1969). However, our target is to reveal prominently the relationships between these variables and also figure out if the port activity can affects the other variables and obviously have direct or indirect impact on the whole economy. The unit root tests also would allow to highlight the nature of stationarity or whether there is no at all by determining the deterministic or stochastic trend of the a constant. Other test such as Dickey-Fuller test, the Augmented Dicky-Fuller (ADF) test, and the Phillips-Perron test will allow identifying the stationarity or the non-stationarity of a series.

3.3 Mathematical Formulation

It is paramount to know that the ADF test has been run by taking into account the three following models:

Model 3: This is model with constant and trend
\[ X_t = C + \beta t + \psi X_{t-1} + e_t, \]  
(3.1)

Model 2: It is a model with constant but without tendency

\[ X_t = C + \psi X_{t-1} + e_t, \]  
(3.2)

Model 1: is the model without constant and trend

\[ X_t = \psi X_{t-1} + e_t \]  
(3.3)

In such models stationary test is required and is about to run the null hypothesis and nonstationary test \( \rho = 0 \) against the alternative hypothesis \( \rho < 0 \) by referring to the values tabulated by Dickey and Fuller.

Applying the cointegration model will allow us to correct false or fallacious regression or just we do not have it at all. The theory of cointegration tries to estimate the long-run relationship using the nonstationary series themselves, rather than their first differences. Engel and Granger have demonstrated that when we have two non-stationary variables . 

\( (Y_t \sim I(1) \text{ and } X_t \sim I(1)), \) we can have the following one:

\[ Y_t - aX_t - b = \varepsilon_t \sim I(1) \text{ or } aX_t - b = \varepsilon_t \sim I(0). \]

The purpose for underlying the cointegration is that for a short term, \( X_t \) and \( Y_t \) can present a divergent trend but they will be trending upwards together in long run as far as both are nonstationary. Therefore, it is clear that there is a stable relationship in a long run between \( X_t \) and \( Y_t \). This long term relationship is called cointegration and can be given as follow:

\[ Y_t = aX_t + b \]  
(3.4)

The disadvantage of the Engle and Granger (1987) method is that it does not allow distinguishing several cointegrating relationships. When we study simultaneously the variables \( N \) where \( N > 2 \), we can have \((N-1)\) cointegrating relationships. The Engle and Granger method (1987) does allow us to get just only one cointegrating relationship. This is why for bringing solution to that difficulty, Johansen (1988) has proposed a methodological approach.

Johansen method is a multi various approach of cointegration which is based on the method of maximum likelihood estimation (MLE).

In this method, Johansen sequence test consists in finding the number of cointegrating relationships \( r \), so that we can use the method of maximum likelihood estimation. In clear, it is a convenient and worthy method that allows giving us the number of the cointegrating relationships that has been estimated.

4. Analysis of Results and Findings

4.1. Correlation between Port traffic and primary sectors: Case of Cote d'Ivoire

The global analysis of the export of West African countries especially Cote d'Ivoire's commodities export through the port to other countries in Europe and Asia is characterized by
food and agricultural products and highlights which support the primary sector. International
demand for cocoa beans and other West African crops indicating the pricing power and
export taxes affects also the shipping market of the port of Abidjan. All these commodities
with high volume and composition contribute directly or indirectly to the economic growth
and the trend of exports of these products has a decisive positive impact on the national and
regional growth. Representing almost 40% of the country’s total export and 50% of the
agricultural exports, Cocoa plays a major role in the Ivoirian’s economy and its production
impact on the market of all the sectors. Beside, other commodities such as coffee, cotton,
pineapple, banana, rubber, and canned fish, are among the West African products. And log
timber, sawn timber, cashew nuts, shear nut, cotton fiber and seed exported by the
neighbouring countries are handled and exported by the Port of Abidjan. By increasing
steadily, they represented 57% of the total agricultural production in 2009 as against 43% in
2002, an increase of 12% in five years. This was due to the increase in commodities price,
favorable weather and better yield with improved methods of Agriculture. It is worth taking a
closer look at the traffic of these commodities because of the important role they play in the
countries’ GDP formation.

Indeed the globalization with its all international trade exchange related to agricultural products has
impacted the primary sector in West Africa region. In Cote d'Ivoire with an increase of 3.8
percent of the value added which draws a growth of 1.4 percent in 2010, the economic
performance is mainly supported by improvement of the special crops and commodities
production but also is due to the intensive and beneficial port operations reforms
implemented ever since. As we observe, the illustration of the Figure 1 shows the trend of the
two variables in time period.

The value of 0.91 as the coefficient of the correlation that has been calculated between the
share of primary sector production in the total production of gross domestic production of
agriculture (GDP-A) and the port traffic (PT). We can therefore assert that there is a linear
relationship between the two variables.

4.2. Port traffic and the Secondary Sector

The value score of the coefficient of correlation is 0.94. This value is calculated between the
share of the industrial sector production and the port traffic. Since the value is positive, we
can then presume that there is a linear correlation between the two variables (refer to Table
2).

The relationship of the two variables (Port traffic and production of industrial sector) is due
to the increasing demand for shipping services of geological resources such as crude oil,
mines, petroleum products and gas.

Although the activity of industrial sector has reasonable size in the regional market, the oil's
export of West Africa and its shipment to foreign countries in Europe and North America is
handled at the port. Additionally, treatment of transformation of 1 percent of Nigerian crude
oil is made by the Société Ivoirienne de Raffinerie, SIR (National Company of Oil Refinery)
and transited through the port of Abidjan. This in return proceeds to the shipment and
distribution in most of West African countries. The overproduction of oil observed in Nigeria
with a population of more than 158 million is an influential factor for the port. That
consequently arises the share of crude oil exporters and contributed in creating an economic
potential not only for Nigeria but also for its neighbouring countries in West Africa. In this purpose, there are more opportunities and possibilities for reinforcing the industrial sector at the port level which offers in return its traffic growth. The positive results of economic growth known in the last ten years could lead to an increase of the consumption of goods and services as well as of equipments. The industrialization of the port of Abidjan in its logistics and the investment in handling facilities justify also the rapid development of the industrial sector.

Another factor remains in the support from foreign direct investment in the industrial sector having relations with the port activities namely the distribution and transit of oil tank to the dry ports in landlocked and hinterlands countries. The Petroleum code of 1996 that offers important advantages to petroleum companies wishing to operate in this sector in the sub-region both on concession and production contract basis has facilitated the foreign direct investment and increased since ever the port traffic in exporting petroleum products to foreign countries.

As we can observe, the Figure 2 describes the gradual trend of the relationship between the industrial production and the port traffics.

4.3. Port traffic and the Service Sectors

As defined in the literature, services can be considered as the non-physical or immaterial economic goods that are produced and consumed simultaneously. The service sector constitutes the group of activities that are non-industrial and agricultural. However, this sector includes other production services that may constitute agricultural and industrial activities. Banking organizations, insurance firms, trade businesses, transport services, telecommunication and other related services. The regime of free zone for ICT and Biotechnology adopted by law, grants important tax and customs revenues to the operating companies and firms that improve their service delivery in the sector of communication. In overall, since fifteen century Cote d'Ivoire and major ECOWAS countries is participating to the international trade exchange and as we will observe in the following work how the trend of the trade structure and port traffic explain the correlation between the two activities identified as variables.

4.3.1. Relationships between Port Activity and Trade

Economies of most of developing countries in the sub-Saharan Africa are strongly supported by the services activities sectors and Cote d'Ivoire and its neighbouring countries are not far from this economic reality.

Since as early as the 15th century, European sailors began trading along the coastal zone of West Africa, especially in former Gold Coast (present Ghana) and Ivory Coast (now Côte d’Ivoire). Ever since, commerce with the outside world has been an essential element of the region’s prosperity. By far the most important gateway for such trade over the past half century has been Port of Abidjan, which currently handles about 20 million tons of merchandise annually. Over the first two months of 2006 the traffic of the port of Abidjan
recorded a rise of 21.9 percent comparatively in the same period of 2005. This rise of the traffic is namely related to the petroleum products with more than 50% which imports is around 509,000 tonnes (8.8%) against exports of 1.2 million tonnes representing more than 106 percent.

However, the country's trade remains a sector that its activities generate value added and recorded in 2011 a growth of 6.9 percent exceeding the last 2010 with 4.7 percent, 5.2 percent for 2009 and 5.7 in 2008. (Refer to Figure 3). These respective growths have been possible because of the competitiveness improvement of the port of Abidjan with the growing needs of exports not only to outside the continent but also to its hinterland and landlocked countries of the sub-region of gulf of guinea. Re-exportation activities in West African region are some of the particularities of port activities and traffic that occupy today almost the 78 percent of foreign exchange. This demonstrates also the important cargo flux and traffic of imports from world market which are transited to landlocked countries and other countries like Guinea and Nigeria through transshipment means. Obviously these activities that we ignore or do not take into account their costs, generate also a lot of revenues, wealth and profits for imports and exports companies including the group of trade businesses and operators such as insurance brokers, shipping agents and forwarders, Dockers, that provide services in the fields of banking, packing, handling, shipping, etc. Additionally, a big part of gross profits of wholesalers from Mali, Burkina Faso, Niger, Guinea, even Nigerians from the neighboring countries of the West Africa sub-region, see the port of Abidjan as a focal point and core center of their provisions which in return grant to local workers the part of the profit for services delivery in transport, customs clearance, warehousing, black market for currency exchange, shipping agents etc. Consequently we can observe the direct impact of activities related to re-export through port to port that remains a competitive and efficient economic activity which obviously generate effect on the income of workers and population.

As indicates the Table 2, the coefficient of correlation is 0.96. Therefore, we can reach a conclusion that there is a correlation between the port activity and the trade sector.

4.3.2. Relationship between Port Activity and the Transport Sector

The natural and geographic location of Cote d'Ivoire with its two seaports made the country an excellent hub and gateway of West African commodities export to the outside world. With its privileged position and access to the Atlantic Ocean, the port of Abidjan by offering the hinterland countries such as Burkina Faso, Mali and Niger, a competitive trade market for their crops and commodities in the international exchange scene, has increased the demand of multimodal transport services especially in the urban area. With its modern infrastructure the port is linked to road network built to serve the merchandises flow. A road network of more than 80,000 km serviceable, more than 6000 km of paved roads, railways system of 660 km linking from Southern region to the North and roads linking to major cities especially to the two ports cities Abidjan and San-Pedro are served to the shipment of cargo. Forwarding of goods from the port to the their final destination, transportation and logistics companies are concerned about this activity sector. Forwarding agents and concessionaries collaborate with roads and rail transporters based on negotiation of hiring trucks, railway wagon or trailers for the physical transfer and shipment of the cargos and goods to their respective owners. As result, transportation of cargo remains one of the first categories of activities that support the
traffics of the Port of Abidjan. Observation of Figure 4 in appendix, obviously leads us to assert that a strong correlation exist between the two variables. The calculation of coefficient of correlation between the share of production of this sector and the port traffic gives a value of 0.99.

**4.3.3. Relationship between Port Activity and the Bank and Insurance**

The flow of cargos and other goods, especially the prohibited with high tax payment are mostly operated by exports and imports companies running in the port area and in other strategic zones of the port city. Legally registered these companies deal with exchanges transactions that are handled by banks and financial firms operating in the countries. Capital transfer, financial linkages and workers' remittances from and to hinterland are profitable to banking and insurance companies. Other goods such as second hand vehicle imported from Europe and Asia by local import and export companies generate a flow of liquidity at the level of the port (N. Essoh, 2013). Yet and now, these different players and sectors especially the trade sector deal with the port of Abidjan for their various foreign exchanges. Obviously the banking sector facilitates the money flow in port sector through the movement and flux of capital and funds in account transacted by these users and players. We can therefore confirm that there is a relationship between the port and the banks/insurance companies. (Refer to Figure 5 in appendix). The calculation of coefficient of correlation between the share of production of the trade sector and the port traffic gives a value of 0.97 while the correlation between the share of bank service in the total production and the port traffic computes a score of 0.96, which means that a linear relation does exist between them.

**4.4. Granger Causality Testing**

Study and estimation of Causality can be developed through various statistical tests. The Granger causality test is indentified as the last test that tends to make a comparison between two distinct models (R. Engle and Granger, 1987). In the first model Granger considers a simple autoregressive formulation of the process that has been studied. In the second model, Granger adds the explanatory variable that has been lagged over several periods. According to this, we could say that if the second model is statistically more significant than the first one, then the process X causes the process Y.

Applying EVIEWS version 5 software program enable us to specify the number of lags that we propose to integrate in the models for Granger causality testing. For our analysis, we propose to consider a sufficient number of lags regardless their high level that corresponds to the number of significant periods. We can choose a number of lags that is equal to 3 in the study. The results of the causality test are shown in the appendix (Table 3).

**4.5. Causality between Port Activity and Activities of Other Sectors of the Economy**

As illustrate the test results (in appendix) Table 3, the probability associated to the non causality test between the GDP-TT variable (GDP for Transport and Telecommunication) and the PT (port traffic) variable is bigger than 0.05 which means to accepting the null hypothesis of non-causality. The probability of non-causality test in the reverse direction is also bigger than 0.05 and gives the same conclusions. As fact, it is difficult to establish a significant relationship between the port traffic and the telecommunication sector. But it is
possible with the transport sector, simply if we realize in one hand the important personnel and human resources of firms operating in the port. We take also into account in the other hand the numerous temporary and permanents workers accessing to their businesses through the traffic of second hand vehicles and the unloading services of trucks and buses. Therefore, the trend of port traffic has an incidence on the transports and telecommunication since they constitute a small but considerable share of the money supply. On this account they could constitute a significant relevance of determining the explanatory factors of the economic growth.

The probability associated to the non-causality test between the GDP-S variable (GDP for other Services) and the port traffic is bigger than 0.05, the null hypothesis is more probable and can conclude by rejecting the causality between the GDP-S and Port traffic. But the reverse direction of the non causality test gives different results in which the probability associated to this test is smaller than 0.05. Then we accept the hypothesis that there is an existing causality between the port traffic and the other services sector. In other word, the trend of the other services sector could not be an explanatory factor of port traffic but rather the port traffic is an explanatory factor of the other services sector. (see Table 4).

The probability associated to the non causality test between the GDP-T variable (GDP for trade) and port traffic is bigger than 0.05. We retain the null hypothesis and reject the causality between the Trade GDP and the port traffic. The non causality test operated in the reverse direction provides us opposite results with the probability being smaller than 0.05. That means we accept the fact that there is existing causality between the port traffic and the Trade GDP. Therefore, the trend of trade has an incidence less significant on the trend of port traffic. And in the reverse direction the port traffic is an explanatory factor of trade. (Table 4).

The probability associated to the non causality test between the GDP-BI variable (GDP of Banks and Insurance) and the port traffic is bigger than 0.05 which means that the null hypothesis is more probable and can conclude by rejecting the causality between the other services and the port traffic. In the reverse direction, the application of the non causality test gives opposite results in which the probability associated is bigger than 0.05 but by considering a marginal error of 10%. Then the null hypothesis of non-causality is rejected. We can conclude by accepting the existing causality between the port traffic and the banks and insurances.

Table 2 in appendix by illustrating the coefficients between the different variables in function of the port traffic, summarizes the first hypothesis testing results.

The values and scores of the coefficients indicate that there are strong correlations between the port activities and the activities of the other sectors of the economy which naturally contribute to the economic growth. Therefore the hypothesis 1 ($H_1$) test has been verified.

The second hypothesis ($H_2$) introduces the Granger causality test and allows us not only to establish a causal relationship between two phenomenon but also to figure out the meaning of this relationship. As we have examined and identified in the estimation above, we can argue that in the long run purpose, causal relationships between the port activity and the activity of the other sectors of the economy are possible. Then our hypothesis ($H_2$) is verified.

5. Conclusions
In summary, we have analyzed the correlation and causality study between port traffic and economic sectors by identifying that they are interrelated. We have studied the variables used to measure the causality relationship between the port activity and other economic sectors. Different observations were made between the comparative trend of the port traffic and other sectors of the economy.

The Granger causality testing enable us to not only establish a causal relationship between two phenomena but also to determine the sense or meaning of this relation- ship. Therefore, based on our study, we can argue that it is possible to consider the causal relationships between the port activity and the activities of the other sectors of the economy. However, based on the results by running causality test in which all the hypotheses are tested, all the six variables selected such as LF_I, LGDPTT, LGDPS, LRGDP, LGDPT, LGDPBI are not the explanatory variables which mean that they could not be explanations of the port traffic, but rather in the opposite direction, the port traffic is an explanatory factor of them. As such, the port activity and its traffic growth could be converted into liquidity which can improve the fiscal income and accelerate the economic growth. And investment in port can be considered infrastructure planning as a capital formation (Kawakami and Doi, 2004) for regional economic development.

REFERENCES


M. Gossio, “Competitiveness of the Port of Abidjan: 25 Million Tonne of Cargo by the End of the Year,” Inter- view of Port of Authority at Africa, 24 October 2010.


**APPENDIX**

Figure 1: Comparative trend between agricultural production and port traffics (in tonnage)

![Figure 1](image1.png)

Figure 2: Comparative trend between industrial production and port traffics (in tonnage)

![Figure 2](image2.png)
Figure 3: Comparative trend between the trade GDP and port traffics (in tonnage)
Figure 4: Comparative trend between transport and communication production and port traffics (in tonnage)

![Figure 4: Comparative trend between transport and communication production and port traffics (in tonnage)](image)

Figure 5: Comparative trend between other sectors, trade and port traffic (in tonnage)

![Figure 5: Comparative trend between other sectors, trade and port traffic (in tonnage)](image)

Table 2: Linear coefficient between variables and the port traffic

<table>
<thead>
<tr>
<th></th>
<th>GDP for Agriculture (GDP-A)</th>
<th>GDP for Industry (GDP-I)</th>
<th>GDP for Transport &amp; Communication (GDP-TT)</th>
<th>GDP for other Services (GDP-S)</th>
<th>GDP for Trade (GDP-T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port traffic (PT)</td>
<td>0.91</td>
<td>0.94</td>
<td>0.99</td>
<td>0.96</td>
<td>0.97</td>
</tr>
</tbody>
</table>
Table 3: Results of Granger causality tests.

<table>
<thead>
<tr>
<th>Null Hypothesis:</th>
<th>Obs</th>
<th>F-Statistic</th>
<th>Probability</th>
</tr>
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<tbody>
<tr>
<td>LF_I does not Granger Cause LPT</td>
<td>20</td>
<td>1.66985</td>
<td>0.20544</td>
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<td>LPT does not Granger Cause LF_I</td>
<td>4.60111</td>
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<tr>
<td>LGDPTTT does not Granger Cause LPT</td>
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<td>0.00186</td>
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</tr>
<tr>
<td>LRGDP does not Granger Cause LPT</td>
<td>20</td>
<td>2.25274</td>
<td>0.11351</td>
</tr>
<tr>
<td>LTP does not Granger Cause LRGDP</td>
<td>3.43676</td>
<td>0.03654</td>
<td></td>
</tr>
<tr>
<td>LGDPT does not Granger Cause LPT</td>
<td>20</td>
<td>0.89313</td>
<td>0.46181</td>
</tr>
<tr>
<td>LPT does not Granger Cause LGDPT</td>
<td>3.81817</td>
<td>0.02591</td>
<td></td>
</tr>
<tr>
<td>LGDPT does not Granger Cause LPT</td>
<td>20</td>
<td>0.89313</td>
<td>0.46181</td>
</tr>
<tr>
<td>LPT does not Granger Cause LGDPT</td>
<td>3.81817</td>
<td>0.02591</td>
<td></td>
</tr>
<tr>
<td>LGDPB does not Granger Cause LPT</td>
<td>13</td>
<td>0.62471</td>
<td>0.61680</td>
</tr>
<tr>
<td>LPT does not Granger Cause LGDPB</td>
<td>3.21570</td>
<td>0.07573</td>
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</tr>
</tbody>
</table>

Table 4: Port Traffic (PT)

<table>
<thead>
<tr>
<th>Null Hypothesis: D(LPT,2) has a unit root</th>
<th>Exogenous: None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lag Length: 3 (Automatic based on AIC, MAXLAG=11)</td>
<td>t-Statistic</td>
</tr>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-6.543842</td>
</tr>
<tr>
<td>Test critical values:</td>
<td>1% level</td>
</tr>
<tr>
<td></td>
<td>5% level</td>
</tr>
<tr>
<td></td>
<td>10% level</td>
</tr>
</tbody>
</table>

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LPT,3)
Method: Least Squares
Date: 12/09/12 Time: 20:22
Sample (adjusted): 1992 2011
Included observations: 20 after adjustments

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>D(LPT(-1),2)</td>
<td>-3.421849</td>
<td>0.522911</td>
<td>-6.543842</td>
<td>0.0000</td>
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<tr>
<td>D(LPT(-1),3)</td>
<td>1.696643</td>
<td>0.402218</td>
<td>4.218212</td>
<td>0.0004</td>
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<tr>
<td>D(LPT(-2),3)</td>
<td>1.133528</td>
<td>0.278238</td>
<td>4.073945</td>
<td>0.0006</td>
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<tr>
<td>D(LPT(-3),3)</td>
<td>0.584374</td>
<td>0.168455</td>
<td>3.469018</td>
<td>0.0024</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.841527</td>
<td>Mean dependent var</td>
<td>0.014919</td>
<td></td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.817756</td>
<td>S.D. dependent var</td>
<td>0.279730</td>
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</tr>
<tr>
<td>S.E. of regression</td>
<td>0.119417</td>
<td>Akaike info criterion</td>
<td>-1.261376</td>
<td></td>
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<tr>
<td>Sum squared resid</td>
<td>0.285209</td>
<td>Schwarz criterion</td>
<td>-1.065034</td>
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</tr>
<tr>
<td>Log likelihood</td>
<td>19.13652</td>
<td>Durbin-Watson stat</td>
<td>2.237288</td>
<td></td>
</tr>
</tbody>
</table>