Strategic interactions in the provision of public infrastructures: Evidence from Economic and Monetary Community of Central Africa (EMCCA) countries

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Abstract

Using a spatial autoregressive model, this paper highlights the issue of strategic interactions in the provision of public inputs, which is an important dimension of territorial competition within a developing economic integration area. The results of the estimations, carried out using the maximum likelihood method in panel data, show that the countries of the Economic and Monetary Community of Central Africa (EMCCA) are developing strategic behaviours in the supply of public inputs, particularly in the public infrastructure sector. Consequently, EMCCA countries need to be aware of the existence of this phenomenon in order to improve their public input supply strategies, and also to improve their positioning on the international market for the location of economic activities.

Keywords

EMCCA, public infrastructure, strategic interactions, territorial competition

Classification JEL: H41, H54, H77

Introduction

Economic integration zones are areas where the harmonisation of economic policies is very often the rule. But this harmonisation does not always exclude the idea of a real willingness for self-determination for governments. In fact, it can be observed that, in terms of infrastructure[1], governments wishing to position their countries in the vast market for the location of economic activities tend to set their levels of infrastructure supply according to the levels of infrastructure development of neighbouring (competing) territories. This brings back to the forefront the phenomenon of strategic interactions which is a dimension of territorial competition and whose foundations can be found in the theory of fiscal federalism (Tiebout, 1956, Zodrow and Mieszkowski, 1986; Wilson, 1986, 1999; Salmon, 1987; Besley and Case, 1995).

According to the theory of fiscal federalism, strategic interactions between territories reflect a situation in which governments act in a non-cooperative manner, where each provokes or suffers, without intending to compete, the actions of its rivals (Brueckner, 2003; Leprince et al, 2005; Birkelöf, 2009; Costa et al, 2013; Ega, 2007) in terms of offering locational advantages. In other words, the territories behave like economic agents competing with each other to attract and retain tax bases, through differentiated and competitive offers of public inputs.

Largely conducted at local level in a context of fiscal decentralisation, studies on the evaluation of the extent of strategic territorial interactions (Ermini and Santolini, 2010; Agostini et al, 2011; Foucault et al, 2008 ; Costa et al, 2013; Birkelöf, 2009; Yanquing, 2015; Hanes, 2002) have also been the subject of research at national level, particularly within regional economic groupings (Bénassy-Quéré et al, 2007; Ega, 2007; McGarvey and Walter, 2004; Hamadou et al, 2014; Wang, 2018).

The choice of an economic integration zone is revealing because it is still expected that the coordination of public policies in certain areas of economic activity could lead to the convergence of economies. However, the territories in question are very often heterogeneous in both structural and macroeconomic terms (Avom et al, 2015). In such a situation, by giving each territory the opportunity to accurately measure the level of relevance of its economic policy measures, territorial competition within an economic integration zone makes it possible to refine the order of priority of a territory in terms of the offer of locational advantages, based on its real level of potential.

While a recent study (Mimboe and Fambon, 2019) was able to prove the existence of strategic fiscal interactions within the Central African Economic and Monetary Community, it must be said that no such assessment has yet been made in terms of infrastructure provision. Therefore, the objective of this paper is to analyse the extent of strategic interactions between countries of the Economic and Monetary Community of Central Africa (EMCCA)[2], particularly

[1] In Marxist theory, infrastructure is the economic basis of a mode of production. According to Gianpiero (2009), it refers to :

- public capital, in the sense that it is derived from investment expenditure and is characterized by long duration, technical indivisibility and a high capital-production ratio ;
- public good, not necessarily in the sense that it belongs to the public sector but rather in the sense that it meets the criteria of non-exclusion and non-rivalry in consumption.

[2] CEMAC was born from the ashes of the former Central African Customs and Economic Union (CACEU) in 1964, preceded by the Equatorial Customs Union (ECU) in 1959. With an estimated population of 51.8 million inhabitants and a GDP of around US$76.307 billion (WDI, 2017), it currently comprises six countries: Cameroon, Gabon, Congo, Equatorial Guinea, Chad, and Central African Republic. The variation in the rate of public investment from one state to another through the implementation of large-scale projects (transnational roads,

in the provision of public infrastructure. Presented as a prerequisite for economic development, public infrastructure has a positive impact on economic growth in general and private sector productivity in particular (Aschauer, 1989a, 1989b, 1989c). From the point of view of the New Economic Geography, investments in infrastructure are likely to promote regional development through effects on business location decisions and agglomeration economies (Fujita et al, 1999). In this study, we consider only four infrastructure sectors: *water and sanitation, information and communication technology, electricity and transport*.

The rest of the article focuses on three main points. Section 2 presents some stylized facts on the state of infrastructure development in EMCCA. The empirical model and data are discussed in Section 3. The results are discussed in Section 4 before the conclusion (Section 5).

2. Stylized facts

In EMCCA as a whole, the level of infrastructural development is still low, beyond the differences observable from one country to another.

2.1 Public investment and trends in infrastructure development

2.1.1 Public investment in the EMCCA region

Overall, public investment in sub-Saharan Africa is still lagging behind in terms of efficiency. The efficiency of public investment is an indicator for assessing the qualitative management of public investment. It refers not only to the existence but also to the use of the regulatory framework[3]. Studies show that the efficiency of public investment in sub-Saharan Africa is lower than in other regions of the world (IMF, 2018)[4]; at the level of classification by economic block, EMCCA scores the lowest (Table 1).

'Table1 here'

However, beyond this limited efficiency, two major phases of overall public investment can be distinguished in the EMCCA zone (Figure 1):

'Figure 1 here'

- **1981-2003**: public investment rates are essentially low, 3% of GDP on average. This period is characterised by a major event: the deterioration in the terms of trade that provoked the economic crisis of the second half of the 1980s, deprived countries of a large part of the foreign currency needed to finance their economies. This has considerably reduced the capacity for public investment.

- **2004-2013**: it is considered as an expansion phase in terms of overall public investment. During this phase, public investment rates reach more than 8% of GDP. It should be remembered that most countries are gradually emerging from the constraints linked to external shocks and are devoting themselves more to the exploitation of their natural resources, particularly oil (Chad, Equatorial Guinea). This improvement will provide them with foreign currency and increase their investment capacity.

motorways, ports, hydroelectric dams, solar power plants, gas power plants, special economic zones, etc.) is aimed at increasing the stock of public capital with a view to improving the productivity of the private sector.

[3] i.e. budgetary rules, national and sectoral planning, coordination of administrations, management of public-private partnerships, regulation of enterprises, multi-year budgeting, comprehensiveness of budgeting, budgetary cohesion, project evaluation and selection, investment protection, availability of financing and transparency of execution, project management and monitoring of assets (IMF, 2018).

[4] Sub-Saharan Africa ranks last after Latin America and the Caribbean and emerging or developing Asia.

2.1.2 Infrastructural development in EMCCA

According to the African Development Bank (AfDB, 2018), Central Africa is the part of the continent where the level of infrastructural development is still low. It ranks last in the ranking after Northern Africa, Southern Africa, West Africa and East Africa. However, although still limited, the level of infrastructural development shows an overall increasing trend in Central Africa in general, and in the EMCCA region in particular. Figure 2 distinguishes between two major groups of countries in terms of infrastructure development in EMCCA: countries with a high level of infrastructure development (Gabon, Cameroon, and Equatorial Guinea) and countries with a low level of infrastructure development (Rep. of Congo, Central African Republic, Chad). From a sectoral point of view, the trends are asymmetrical. Four major infrastructure sectors have been identified :

- ✓ *Transport*
- ✓ *Electricity*
- ✓ *Information and communication technologies*
- ✓ *Water and sanitation*

Of all these sectors, *water and sanitation* scores the highest in terms of infrastructure, followed by *transport* and *electricity*. Infrastructure development in *information and communication technologies* is still limited (Figure 3). However, the trends remain asymmetrical from one country to another. In terms of *transport* infrastructure, only Gabon achieves high scores (above the EMCCA average) between 2003 and 2018 (Figure 4). The situation is almost similar to that of *electricity* infrastructure, except in 2018, when Equatorial Guinea joins Gabon in the group of countries that score above the community average (Figure 5).

'Figures 2, 3 & 4 here'

In the area of *information and communication technologies*, it is only from 2011 that EMCCA will begin a decisive turning point in its infrastructural development in the sector. Between 2012 and 2018, at least two countries score above the Community average (Figure 6). Finally, all countries score significantly higher in the *water and sanitation* infrastructure sector. However, only Gabon, Cameroon and Equatorial Guinea score above the EMCCA average (Figure 7).

'Figure 6 & 7 here'

Among other peculiarities emanating from the above, there are a number of dissimilarities between countries, thus confirming a situation of discrepancies in the stock of public inputs that should also be analysed.

2.2 Territorial dissimilarities and presumption of strategic interactions

2.2.1 Territorial dissimilarities on the infrastructural level

The different graphs presented above show that all EMCCA countries do not show the same intensity of activation of territorial resources. With regard to the dynamics of infrastructure supply, even if we distinguish two groups of countries in terms of infrastructure development, significant differences are perceptible within each group. The group whose performance is above the community average is made up of Gabon, Cameroon and Equatorial Guinea. However, among the latter, only Gabon achieved the best scores over the entire period, with the other two countries competing alternately for second place. Similarly, the group of countries whose performance is below the EMCCA average (Rep. of Congo, Central African

Republic, Chad) has performance gaps in infrastructure development. Chad, for example, shows the weakest performance over the entire period (Figure 2). Differences can also be observed at the sectoral level. The pace of development of *transport*, *electricity*, *ICT* and *water and sanitation* infrastructure shows different trends from one country to another. In terms of *transport* and *electricity* (Figures 4 and 5), for example, Gabon stands out considerably from the other countries, which in turn show significant levels of differentiation between them. This allows us to evoke a situation of presumption of strategic territorial interaction in terms of infrastructure supply.

2.2.2 Presumption to strategic infrastructural interactions

The strategic infrastructural interaction reflects a situation of territorial competition where the supply of public inputs of a given country is a function not only of its own socio-economic realities, but also of the levels of supply of public inputs from neighboring countries. The confirmation of such a phenomenon essentially involves the estimation of a spatial autoregressive model which we shall subsequently carry out. But so far, the analysis of the graphical elements simply allows us to speak of a presumption of strategic infrastructural interaction. Indeed, in a context of economic integration, one would have expected the coordination of national economic policies to be operationalized. However, the discrepancies observed in the implementation of public investment policies and the resulting stocks of public inputs encourage the hypothesis of strategic territorial interactions around the infrastructure offer. Moreover, Figure 8 shows that from year to year, all countries tend to increase their stocks of public capital.

'Figure 8 here'

3. Empirical model

3.1 Model specification

The strategic infrastructural interactions discussed here are those observed between the central governments of EMCCA countries. In spatial econometrics, the analysis of such phenomena is generally done in several ways: either using a spatial autoregressive model with a lagged endogenous variable, or using a cross-regressive model with a lagged exogenous variable, the combination of the two making it possible to obtain the spatial Durbin model. Another way of analysing spatial interdependence is through the specification of a spatial process for errors.

However, Gibbons and Overman (2012) show that spatial interaction is best understood through spatial shifts in the explanatory variables from neighbouring jurisdictions rather than through spatial shifts in the endogenous variable. However, in this study, as we do not have the data on exogenous variables that may be subject to spatial shifts in order to better understand the phenomenon of strategic infrastructural interactions between EMCCA countries, we will limit ourselves to the spatial autoregressive model with a shifted endogenous variable.

Indeed, to speak of strategic infrastructural interaction is to say that the level of infrastructural development of a country i depends not only on its intrinsic socio-economic characteristics, but also, and more importantly, on the levels of infrastructural development of neighbouring competitor countries. In this situation, governments act in an uncooperative manner, where each provokes or suffers, without intending to compete, the actions of its rivals. In this respect, the infrastructural reaction function of a country i is given by the relationship (1).

$$G_{it} = R_i(G_{-it}, X_{kit}) \quad (1)$$

Where G_{it} represents the vector of public investment in infrastructure or simply the levels of infrastructural development from country i to period t; X_{kit} the vector of other economic and socio-demographic characteristics (control variables) of country i at date t. G_{-it} represents the vector of average rates of public investment or infrastructure development in neighbouring countries j ($j \neq i$) at date t; weighted by a matrix of spatial interactions W, we obtain the average weight of the rates of public investment or infrastructural development of the neighbouring countries; $G_{-it} = \sum_{j \neq i} w_{ij}\, G_{jt} = WG_{jt}$ and the equation (1), becomes:

$$\boldsymbol{G_{it} = \beta_0 + \lambda_2 \sum_{i \neq j}^{n} w_{ij}\, G_{jt} + \beta_k X_{kit} + \varepsilon_{it}} \quad (2)$$

Où λ_2 represents the spatial autoregressive parameter, i.e. the slope of the best infrastructure response function. The value and sign of λ_2 will indicate respectively the existence or not of strategic infrastructural interactions between EMCCA countries, and the meaning of these interactions; ε_{it} is the term of error.

Estimation technique

Since the rate of public investment in infrastructure in country i over a period depends on the level of public investment in territory j over the same period and vice versa, countries have reciprocal reaction functions. As a result, the term WG_{jt} is endogenous to the model and correlated with the error term:

$$E\,(\varepsilon_{it} WT_{jt}) \neq 0 \quad (3)$$

In this case, the econometric consequences of the presence of spatial interactions are not only limited to the explained variable (spatial self-correlation), but also concern the random part of the model (spatial self-correlation of residuals).

To avoid incorrect conclusions and to test separately the presence of the two spatial phenomena it is generally recommended to model explicitly the fact that the residuals can be linked between territorial authorities according to the following relationship:

$\varepsilon_{it} = \lambda W \varepsilon_{it} + \mu_{it}$ (4) in matrix form, $\varepsilon = \lambda W \varepsilon + \mu$ (5)

With λ the coefficient of spatial self-correlation and μ white noise of the error term, assumed i.i.d. [5].

The correlation between the errors and the levels of public investment in neighbouring territories implies that the estimation of the best infrastructure response functions cannot be carried out by the ordinary least squares (OLS) method and requires the use of methods capable of estimating models in which the explained variable depends at each point on its values at other points in space (spatial auto regression).

To obtain efficient and unbiased estimators, estimation techniques such as the maximum likelihood method, the instrumental variable technique (Cliff and Ord, 1973; Anselin, 1988; Kelejian and Robinson, 1993; Kelejian and Prucha, 1998), the generalized method of moments and the generalized double least squares method (Kelejian and Prucha, 1999, 2006) are more appropriate. It should be noted, however, that some of them, notably double least squares, instrumental variables and generalised moments, have been the subject of much criticism (Gibbons and Overman, 2012) to the point where Lyytikäinen (2012) establishes that these standard methods tend to overestimate the degree of territorial interdependence. In this study, we will use the maximum likelihood method, which has not only been less criticised but also

[5] Independent and identically distributed

inspired a number of authors in this respect, Case et al (1993), Besley and Case (1995), Brueckner (2003), Ega (2007), Foucault et al (2008), among others.

Spatial specifications

As a reminder, the modelling of spatial interaction involves the construction of a spatial interaction matrix W. It is a square matrix with as many rows as columns as there are geographical areas. This construction is generally done according to several criteria (Hamadou et al, 2014). However, within the framework of this study, taking into account the significance of the results and the availability of data, four types of constructions were selected: two weight matrices developed according to the economic criterion (GDP and GDP per capita), a weight matrix obtained by calculating distances and a contiguity matrix.

The Bird's-eye View Distance Matrix (W^D)

According to the distance criterion, it is assumed that the intensity of interdependence between two countries i and j depends on the distance between the centroids of these countries (here the different capitals). Thus the matrix W^D is a matrix such as,

$$w_{ij}^{d} = \begin{cases} \frac{1}{d_{ij}} if i \neq j \\ 0 \quad otherwise \end{cases} \tag{6}$$

According to NIC estimates [6], d_{ij} represents the distance as the crow flies.

The contiguity matrix (W^C)

The contiguity matrix W^C is a matrix such as,

$$w_{ij}^{c} = \begin{cases} 1 \; if \; i \; and \; j \; are \; neighbours \\ 0 \quad otherwise \end{cases} \tag{7}$$

The economic criterion based on GDP (W^{GDP})

The construction of this matrix is based on the average GDP of each country between 1981 and 2013 for overall public investment and between 2003 and 2013 for infrastructure development. Thus, W^{GDP} is a matrix such as,

$$w_{ij}^{gdp} = \frac{\frac{1}{|GDP_i - GDP_j|}}{\sum \frac{1}{|GDP_i - GDP_j|}} \tag{8}$$

The economic criterion based on GDP per capita (W^{GDPPC})

The matrix W^{GDPPC} is constructed on the basis of the average GDP per capita of each EMCCA country between 1981 and 2013 for overall public investment; then between 2003 and 2013 for infrastructural development as,

[6] National Institute of Cartography (Cameroon))

$$w_{ij}^{gdppc} = \frac{\frac{1}{|GDPpc_i - GDPpc_j|}}{\sum \frac{1}{|GDPpc_i - GDPpc_j|}} \quad (9)$$

For reasons of simplification, these different matrices will be represented as follows:

W^{PIB} = W1; W^{PIBPT} = W2; W^{D} = W3; W^{C} = W4 (10)

3.2 Nature and sources of data

The data used in this study are panel data. These data have the advantage of providing a wide range of information on several points in space. This increases the degrees of freedom while reducing the effect of collinearity between the explanatory variables, in order to make efficient estimates.

These data cover the six countries of the EMCCA space for a period from 1981 to 2013 for public investments, and from 2003 to 2013 for levels of infrastructure development. The data on public investment in infrastructure are taken from the Government Finance Statistics (GFS) of the International Monetary Fund services. The data on infrastructure development in the different countries come from the African Development Bank (ADB, 2018), while the WDI database (2017) provides data on economic and socio-demographic control variables.

3.3 Description of variables

3.3.1 The dependent variable (G_{it})

The variable of interest consists mainly of data on levels of infrastructure development grouped into four main sectors in addition to overall public investment. These include:

- ✓ ***Global public investment (INVPUB) of each EMCCA country (as a percentage of GDP)***
- ✓ ***Transport Composite Index (TCI)*** : total roads paved (Km per 10,000 inhabitants), total road network in Km (per Km^2 of exploitable land area)
- ✓ ***Electricity Index (EI)*** : net generation (Kwh per inhabitant)
- ✓ ***ICT Composite Index (ICTCI)*** : total phone subscriptions (per 100 inhabitants), number of internet users (per 100 inhabitants), fixed (wired) broadband internet subscribers (per 100 inhabitants), international internet bandwidth (Mbps)
- ✓ ***Water and Sanitation Composite Index (WSCI)*** : improved water source (% of population with access), improved sanitation facilities(% of population with access)

3.3.2 Independent variables (WG_{jt} and X_{kit})

The lagged endogenous variable (WG_{jt})

It is the average of the infrastructural development levels of neighbouring countries (j) (j≠i), for the four infrastructural sectors

Economic and demographic variables ($\sum_{k=1}^{n} X_{kit}$)

- The size of the market captured by the GDP of each EMCCA country, and expressed in current US dollars (GDP) (in logarithm and difference of order 3).

- The total population (POP), which measures the demographic weight of each country (and makes it possible to capture the potential size of the market in another way) (in logarithm and second difference).

- GDP per capita expressed in current US dollars (GDPPT), which is equal to GDP/POP (in logarithm and first difference).

- The global public investment of each country expressed as a percentage of GDP (GPINV) (first difference).

- Population density (DENSPOP): the number of inhabitants per square kilometer (in logarithm and second difference).

4. Analysis of the results

A country's infrastructural development depends largely on its level of public investment. In this respect, the intensity of the strategic interactions around this variable was analysed first, before looking specifically at the situation in the different infrastructure sectors. The results of the estimates are summarised in Table 2. The full results can be found in the annex.

The global public investment

The results obtained with the different weighting matrices W1, W2, W3 and W4, confirm the presence of strategic interactions on overall public investment in EMCCA. With a statistical significance rate of 5%, the value of the autoregressive spatial parameter obtained with the weighting matrix W1 shows that each EMCCA country tends to increase (decrease) global public investment by 0.21% in response to a 1% increase (decrease) in neighbouring countries. Thus, from the point of view of macroeconomic characteristics in terms of GDP, each country works to improve its public capital by competitively increasing the level of public investment. On the other hand, in terms of GDP per capita (matrix of weight W2), it is rather observed that each country tends to reduce (increase) its overall public investment rate by 0.38% following an increase (reduction) of 1% in neighbouring countries. This simply means that the share of public investment aimed at improving the standard of living of inhabitants can be strategically reduced under the assumption that individuals can benefit from neighbourhood effects.

In terms of the characteristics related to distance (matrix of weight W3) and contiguity (matrix of weight W4), in each country there will be trends of reductions (increase) in public investment rates of about 0.60% and 0.34% respectively, in response to an increase (reduction) of 1% in neighbouring countries. Indeed, from the point of view of the physical connectivity of territories, the realisation of public investments in certain countries can lead to situations of positive externalities for a given country. From this perspective, some countries may, at a given time, consider it inappropriate to increase their levels of public investment and benefit from neighbourhood effects.

By way of illustration, the construction of a transnational road or any other type of infrastructure with cross-border implications may lead a State to limit its level of public investment in this sector in order to take advantage of investments made by neighbouring countries, for the transport of its export products for example.

The analysis of the phenomenon of strategic interactions around public investment certainly reveals trends in the degree of strategic infrastructural interactions between EMCCA countries, but an appreciation of the phenomenon by infrastructure sector provides a fairly accurate reading of the phenomenon.

Transport sector

The phenomenon of strategic infrastructural interactions is analysed through an index called *Transport Composite Index (TCI)*.

The values taken by the spatial autoregressive parameter in the transport sector are all different from zero. This is a proof of the existence of strategic infrastructural interactions between the countries of the EMCCA space. The degree of statistical significance of the results is 1% for the weight matrices W2 and W3, and 10% for the matrices W1 and W4. With the matrices of weight W2 and W3, the autoregressive spatial parameter displays values of -1.434 and -1.714 respectively. For the first case, each EMCCA country will reduce (increase) its level of infrastructure development in the transport sector by 1.43% in response to a 1% increase (reduction) in neighbouring countries. The reduction (increase) will be 1.71% for the second case. In terms of explanations, we can mention the neighbourhood effects generated by the construction of transport infrastructure within a Community area. Indeed, the level of development of transport infrastructure in some countries is likely to have positive repercussions on another country, which will find it rationally advisable to strategically limit its public investment in this sector, in order to take advantage instead of the positive externalities arising from the efforts of other countries. Cameroon and Congo, for example, have joined forces to build the transnational road Sangmélima-Ouesso (700 km). However, it must be noted that the Congolese part of the project has been completed, while Cameroon is still lagging behind in finalising the 322 km section for which it is responsible. One can read there a purely strategic behaviour, which in reality obliges Cameroon to prioritize at a given time the development of other infrastructure sectors rather than the construction of transnational roads. It is very clear that coordination does not seem to be taking over in the pace of operationalisation of projects with a community vocation, in a perspective of sub-regional economic integration.

Electricity sector

In this sector, the phenomenon of strategic infrastructural interaction is analysed by means of ***Electricity Index (EI)***; and at this level, the autoregressive spatial parameter shows a value of -3.027 with the W2 matrix, for a statistical significance rate of 1%. This result shows that each CEMAC country tends to reduce (increase) its investments in the electricity sector by 3.03% in response to a 1% increase in neighbouring countries. It should also be recalled that during this period, many of these countries have not yet recovered from the consequences of the economic crisis of the 1980s, which considerably reduced their public investment capacities.

Information and communication technologies (ICT)

The assessment indicator here is ***ICT Composite Index (ICTCI)***. In this sector, the slopes of the infrastructural reaction functions are all positive. The results are statistically significant at 1%. For the matrix of weight W1, the autoregressive spatial parameter shows 0.682, to say that each CEMAC country will increase (decrease) its investments in the ICT sector by 0.68% in response to an increase (decrease) of 1% in neighbouring countries. Considering the weight matrices W2, W3 and W4, the increases (reductions) will be 0.54%, 0.80% and 0.90% respectively. Thus, in view of the major role of ICTs in the process of activating territorial resources, each country tends to strategically increase its level of infrastructural development in this sector.

Water and Sanitation sector

Based on the ***Water and Sanitation Composite Index (WSCI)***, it comes that, on the whole, the autoregressive spatial parameter is different from zero. This proves that the EMCCA countries are in a situation of strategic interactions with regard to the construction of infrastructures in the water and sanitation sector**.**

The results obtained with the W3 weighting matrix show that each EMCCA country will increase (decrease) infrastructure supply by 0.93% in response to a 1% increase (decrease) in neighbouring countries. In fact, the weight matrix in question is constructed from the distances between the capitals of each country. However, these capitals are also major centres of agglomeration of economic activities which develop reciprocal influences between them. Thus, the level of infrastructural development in a given capital is linked to the infrastructural advances made by neighbouring capitals. In this sense, any positive change in public investment from neighbouring conurbations will lead to an increase in public investment in a given conurbation.

Conclusion

Observation of the results of the estimates made by the Maximum Likelihood Panel method shows that the EMCCA countries are developing strategic interactions among themselves in terms of offering locational advantages. These strategic interdependencies are first observed at the level of overall public investment, then at the level of the different infrastructure sectors. It has been observed that each country undertakes public policy actions not without taking into account the actions undertaken by neighbouring countries; but the nature and extent of the interactions vary according to the different weighting matrices considered. This gives rise to particular interpretations depending on the case.

As far as economic policy implications are concerned, EMCCA countries will have to become aware of the existence of such a phenomenon in order not only to perfect their public inputs supply strategies, but also to improve their positioning on the international market for locating economic activities. In fact, while at the local level inter-jurisdictional competition is likely to improve the adequacy of the supply of public goods and services to the preferences of the population (Tiebout, 1956; Oates, 1972), territorial competition within an economic integration zone in terms of the supply of public inputs is aimed at matching the infrastructure supply to the socio-economic forces and opportunities that each territory must take advantage of. Secondly, while it is likely to stimulate the search for efficiency by local governments (Salmon, 1987; Besley and Case, 1995) at the local level, it appears that, at the sub-regional level, territorial competition is likely to improve the strategic positioning of each country in the vast market for the location of economic activities. In this respect, each country should have national centers for strategic infrastructure and marketing monitoring, in order to refine the order of priority of public interventions in the field of infrastructure supply, with a view to a better visibility of its territorial influence.

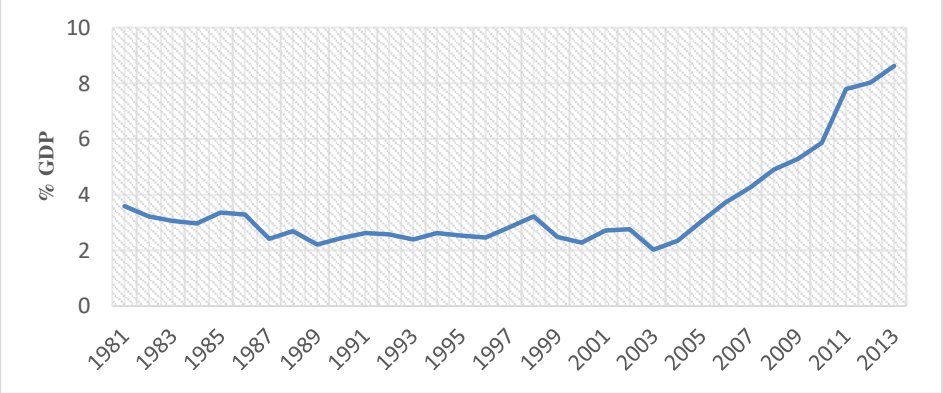
Table 1. Average public investment efficiency score by economic block

Economic blocks	Physical infrastructure	High quality infrastructure	Hybrid indicator
Sub-Saharan Africa	**0.460**	**0.803**	**0.642**
EMCCA	**0.305**	**0.625**	**0.511**
EAC	**0.487**	**0.874**	**0.735**
WAEMU	**0.369**	**0.814**	**0.619**

Note: EMCCA = Economic and Monetary Community of Central Africa; EAC = East African Community; WAEMU = West African Economic and Monetary Union

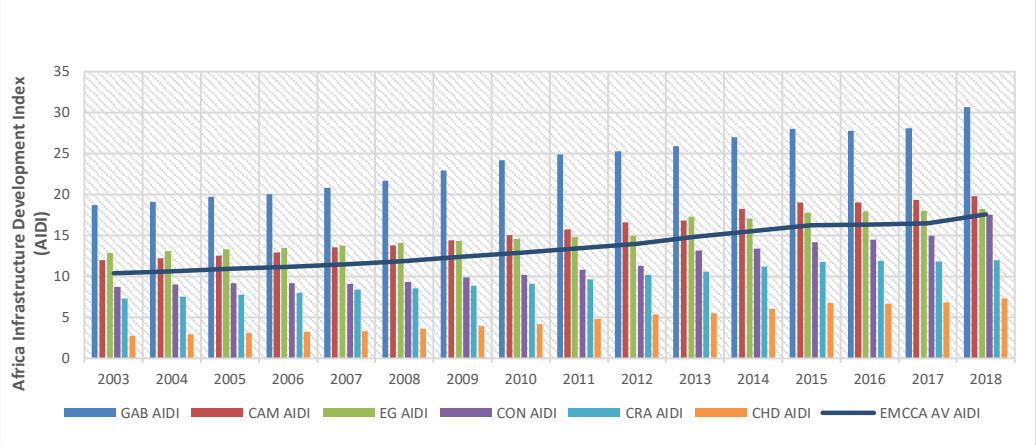
***Source** : FMI (2018).*

Figure 1. EMCCA: change in the overall public investment rate between 1981 and 2013



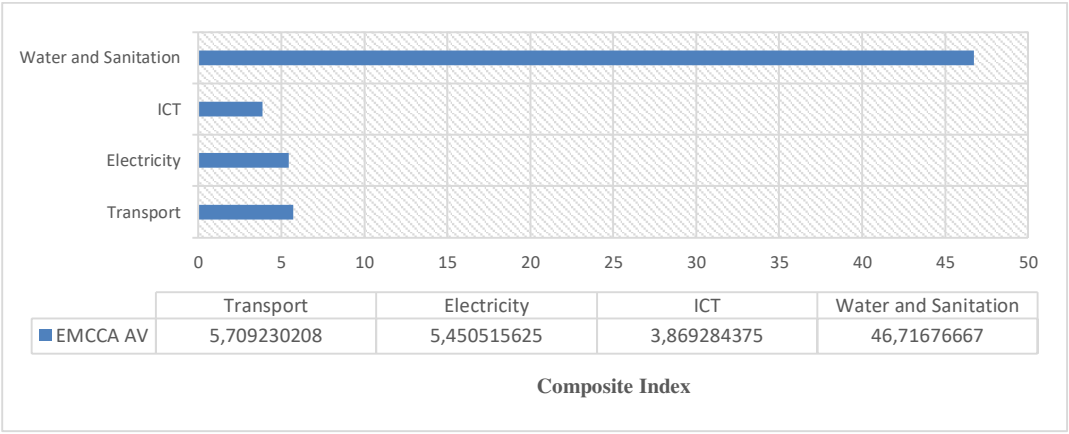
***Source:** Author, IMF Government Finance Statistics (GFS) data (2017)*

Figure 2. EMCCA: change in the infrastructure development index between 2003 and 2018



Note: GAB = Gabon; CAM = Cameroon; EG = Equatorial Guinea; CON = Rep. of Congo; CAR = Central African Republic; CHD = Chad; EMCCA AV = EMCCA Average; AIDI = Africa Infrastructure Development Index.
Source: Author, AfDB data (2018)

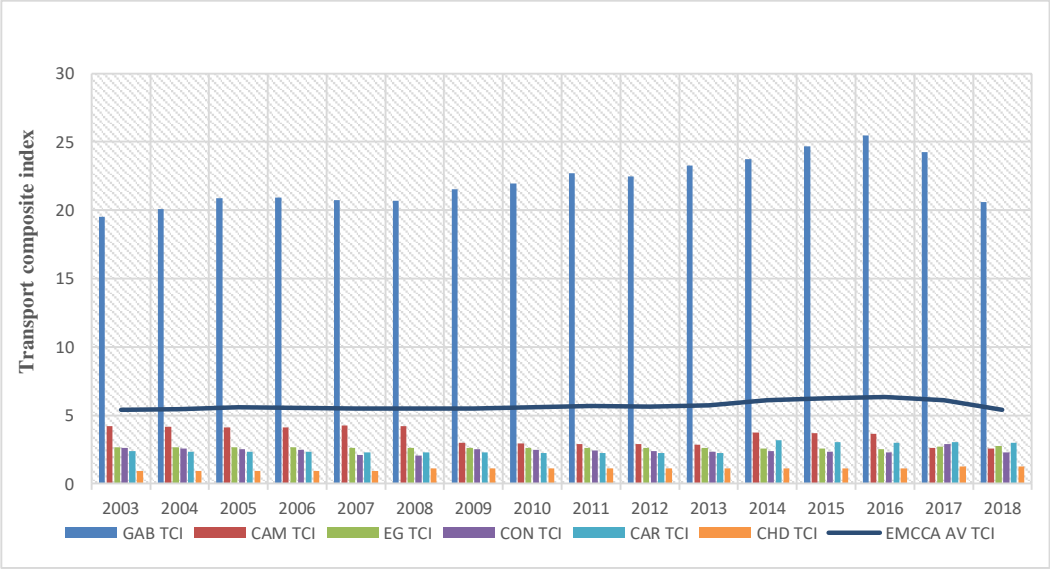
Figure 3. EMCCA: average level of infrastructure development by sector, 2003-2018



Note : EMCCA AV = EMCCA Average; ICT = Information and Communication Technologies

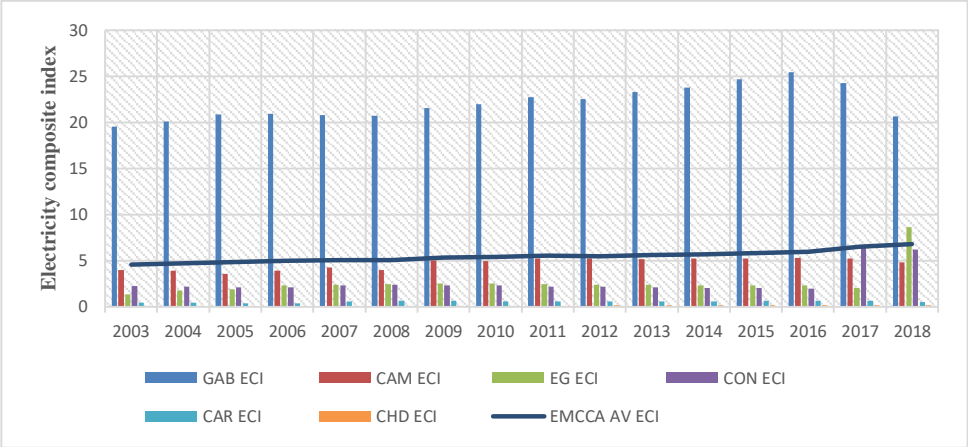
***Source** : Author, AfDB data (2018)*

Figure 4. EMCCA: state of transport infrastructure between 2003 and 2018



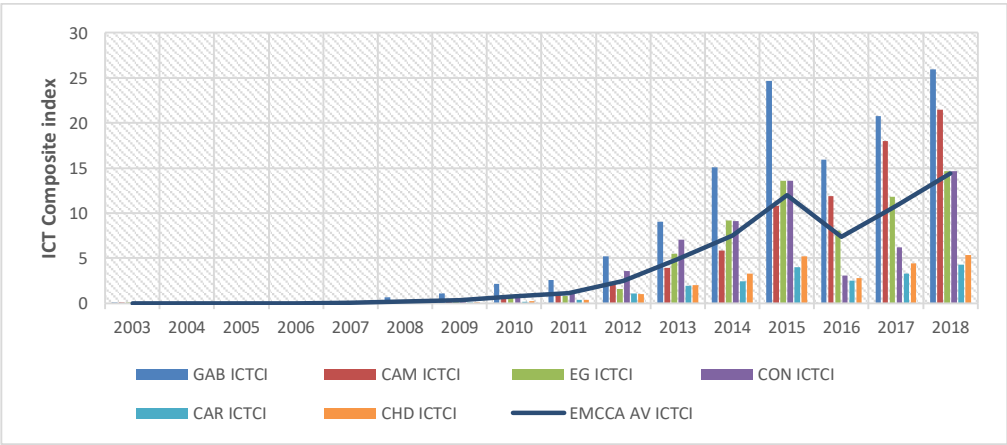
Note: GAB = Gabon; CAM = Cameroon; EG = Equatorial Guinea; CON = Rep. of Congo; CAR = Central African Republic; CHD = Chad; EMCCA AV = EMCCA Average; TCI = Transport Composite Index.
Source: *Author, AfDB data (2018)*

Figure 5. EMCCA : level of development of electricity infrastructure between 2003 and 2018



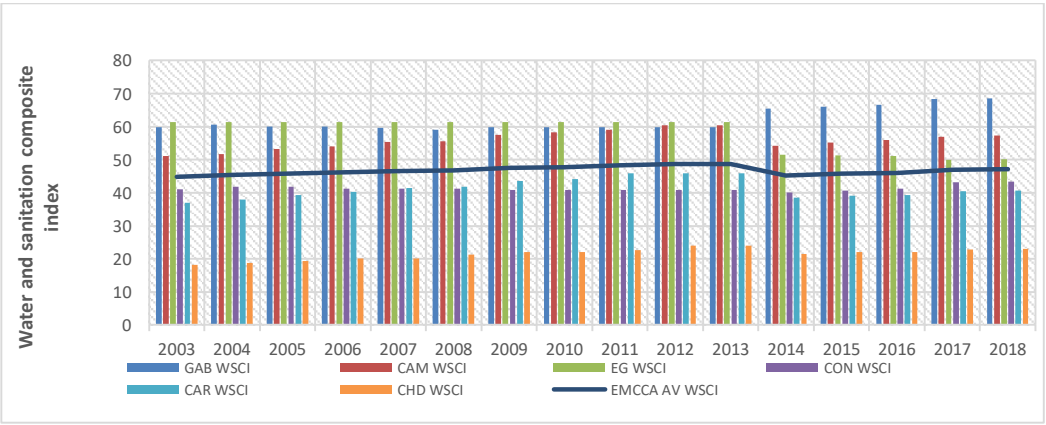
Note: GAB = Gabon; CAM = Cameroon; EG = Equatorial Guinea; CON = Rep. of Congo; CAR = Central African Republic; CHD = Chad; EMCCA AV = EMCCA Average; ECI = Electricity Composite Index
Source: *Author, AfDB data (2018)*

Figure 6. EMCCA: level of ICT infrastructure development between 2003 and 2018



Note: GAB = Gabon; CAM = Cameroon; EG = Equatorial Guinea; CON = Rep. of Congo; CAR = Central African Republic; CHD = Chad; EMCCA AV = EMCCA Average; ICTCI = ICT Composite Index
Source: *Author, AfDB data (2018)*

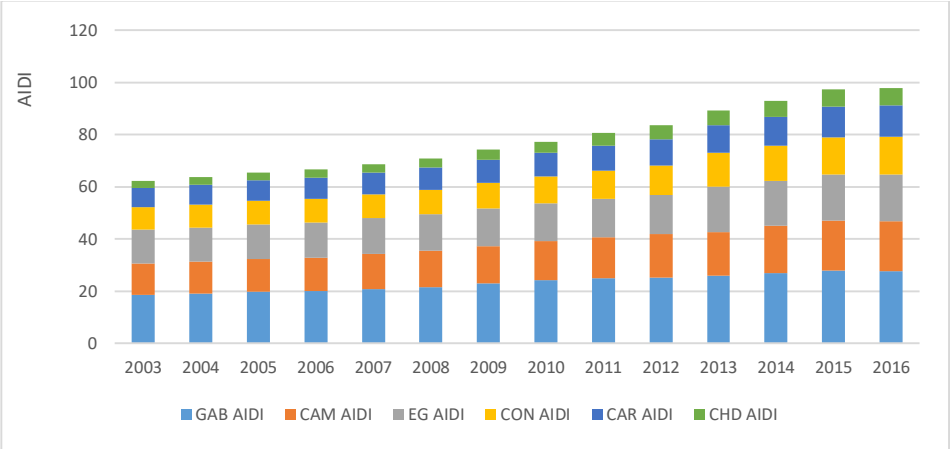
Figure 7. EMCCA: level of development of infrastructure in the water and sanitation sector



Note: GAB = Gabon; CAM = Cameroon; EG = Equatorial Guinea; CON = Rep. of Congo; CAR = Central African Republic; CHD = Chad; EMCCA AV = EMCCA Average; WSCI = Water and Sanitation Composite Index

Source: *Author, AfDB data (2018)*

Figure 8. EMCCA: level of infrastructural development by country, 2003-2018



Note: GAB = Gabon; CAM = Cameroon; EG = Equatorial Guinea; CON = Rep. of Congo; CAR = Central African Republic; CHD = Chad; AIDI = Africa Infrastructure Development Index.
Source: *Author, AfDB data (2018)*

Table 2. Results of estimates of equation (2) using the maximum likelihood technique

Dependent variable	Value of the spatial autoregressive parameter (λ_2) according to the different weight matrices			
	W1	W2	W3	W4
GPINV	0.215 (2.21)**	-0.383 (3.85)***	-0.601 (4.66)***	-0.341 (3.32)***
TCI	-0.687 (1.85)*	-1.434 (13.58)***	-1.714 (7.43)***	-0.709 (12.42)**
EI	-1.062 (1.59)	-3.027 (23.75)***	0.250 (0.66)	-1.274 (1.49)
ICTCI	0.682 (9.28)***	0.542 (5.98)***	0.801 (10.32)***	0.904 (13.81)***
WSCI	-0.105 (0.51)	0.504 (3.27)***	0.928 (6.47)***	0.502 (1.10)

**p<0.1 ; ** p<0.05; *** p<0.01*

Note : TCI = transport composite index ; EI = electricity index ; ICTCI = ICT composite index ; WSCI = water and sanitation composite index ; GPINV = global public investment; W1 et W2 = weight matrices constructed on the basis of economic criteria (GDP and GDPPC) ; W3 et W4 = weight matrices constructed on the basis of the criteria of distance as the crow flies and contiguity.

Source *: Autor's estimations*

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ANNEXES

Table 3. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Overall public investment: 1981 - 2013 period					
Global public investment (GPINV)	198	3.531394	3.243296	.1105	25.11
GDP	198	6.17e+09	6.76e+09	3.67e+07	3.23e+10
GDP per capita (GDPPC)	198	2389.432	4050.315	136.0106	22742.38
Population (POP)	198	5152581	5201975	270063	2.17e+07
Population density (DENSPOP)	198	12.94691	10.90598	2.901335	45.81184
Infrastructure side: 2003 - 2013 period					
Africa Infrastructure Development Index (AIDI)	66	12.15121	5.90764	2.73	25.9
Transport composite index (TCI)	66	2.685061	1.038232	.915	4.536
Electricity index (EI)	66	5.134848	7.461392	.054	23.271
ICT composite index (ICTCI)	66	.9011667	1.755007	0	9.035
Water and sanitation composite index (WSCI)	66	46.93411	14.28346	18.098	61.373

***Source**: Author, data from the International Monetary Fund (IMF, 2018), the African Development Bank (AfDB, 2018), and the World Bank (WDI, 2017).*

Table 4. Estimation results

Estimation results from equation 2				
	Matrixes			
	W1	**W2**	**W3**	**W4**
	Global public investment			
λ_2	0.215 (2.21)**	-0.383 (3.85)***	-0.601 (4.66)***	-0.341 (3.32)***
DlnGDP	0.000	0.000	0.000	0.000

	(6.83)***	(8.58)***	(9.36)***	(8.49)***
DlnGDPPC	-0.000	-0.000	-0.000	-0.000
	(2.94)***	(3.34)***	(3.30)***	(2.98)***
D2lnPOP	-0.000	-0.000	-0.000	-0.000
	(2.61)***	(3.26)	(4.13)***	(3.50)***
D2lnDENSPOP	-0.081	-0.043	-0.068	-0.075
	(1.11)***	(0.58)***	(1.18)	(3.01)
_cons	3.212	4.630	5.331	4.816
	(4.00)***	(5.05)***	(6.96)***	(5.75)***
sigma _u _cons	1.103	1.656	1.126	1.312
	(2.13)**	(2.64)***	(2.70)***	(2.65)***
sigma _e _cons	2.334	2.250	2.240	2.288
	(19.28)***	(19.43)***	(19.50)***	(19.46)***
Obs.	198	198	198	198
	Transport			
λ_2	-0.687	-1.434	-1.714	0.709
	(1.85)*	(13.58)***	(7.43)***	(1.86)*
DlnGDP	-0.000	-0.000	0.000	-0.000
	(0.37)	(2.16)**	(0.30)	(0.88)
DlnGDPPC	0.000	0.000	0.000	0.000
	(0.53)	(1.50)	(1.48)	(0.45)
D2lnDENSPOP	-0.009	-0.063	-0.017	0.015
	(0.22)	(6.45)***	(5.67)***	(0.33)
D2lnPOP	-0.000	0.000	-0.000	-0.000
	(0.83)	(6.93)***	(0.68)	(0.67)
_cons	5.319	5.943	9.240	5.328
	(3.57)***	(21.82)***	(6.27)***	(3.72)***
sigma _u _cons	1.026	0.053	3.228	1.048
	(2.73)***		(3.35)***	(2.76)***
sigma _e _cons	0.593	0.401	0.157	0.609
		(11.24)***	(10.92)***	
Obs.	66	66	66	66
	Electricity			
λ_2	-1.062	-3.027	0.250	-1.274
	(1.59)	(23.75)***	(0.66)	(1.49)
DlnGDP	0.000	0.000	0.000	0.000
	(1.87)*	(9.47)***	(2.96)***	(2.00)**
DlnGDPPC	-0.000	-0.000	-0.000	-0.000
	(0.60)**	(3.14)***	(0.85)**	(1.05)
D2lnDENSPOP	-0.014	-0.279	-0.091	0.157

	(0.06)	(8.96)***	(1.38)	(0.55)
D2lnPOP	-0.000	0.000	-0.000	-0.000
	(1.52)	(0.57)	(0.81)	(1.60)
_cons	13.040	20.477	32.129	13.729
	(2.84)***			(2.69)***
sigma _u _cons	5.023	0.641	28.170	4.950
	(3.18)***	(1.82)	(3.40)***	(2.98)***
sigma _e _cons	3.045	0.817	0.429	2.815
		(10.13)***	(10.93)***	
Obs.	66	66	66	66
	Information and Communication Technologies			
λ_2	0.682	0.542	0.801	0.904
	(9.28)***	(5.98)***	(10.32)***	(13.81)***
DlnGDP	0.000	0.000	0.000	0.000
	(6.09)***	(5.26)***	(4.76)***	(4.89)***
DlnGDPPC	-0.000	-0.000	-0.000	-0.000
	(4.11)***	(1.86)*	(2.41)**	(2.49)**
D2lnDENSPOP	-0.003	-0.026	-0.037	-0.033
	(0.20)	(1.36)	(2.52)**	(2.72)***
D2lnPOP	-0.000	-0.000	-0.000	-0.000
	(4.51)***	(3.47)***	(3.16)***	(2.81)***
_cons	0.548	0.424	0.621	0.345
	(2.18)***	(1.37)	(2.63)***	(1.77)
sigma _u _cons	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)
sigma _e _cons	0.912	11.115	0.857	0.702
	(11.49)***	(11.49)***	(11.49)***	(11.49)***
Obs.	66	66	66	66
	Water and Sanitation			
λ_2	-0.105	0.504	0.928	0.502
	(0.51)	(3.27)***	(6.47)***	(1.10)
DlnGDP	0.000	-0.000	0.000	0.000
	(1.18)	(2.83)***	(2.14)**	(0.31)
DlnGDPPC	-0.001	0.000	-0.001	-0.001
	(1.49)	(0.90)	(3.32)***	(1.05)
D2lnDENSPOP	0.644	0.326	0.045	0.675
	(1.73)*	(2.31)**	(0.28)	(1.74)*
D2lnPOP	-0.000	0.000	-0.000	-0.000
	(1.27)	(3.00)***	(2.12)**	(0.87)
_cons	49.167	10.743	7.656	18.509

	(3.56)***	(0.80)	(1.30)	(0.79)
sigma _u _cons	9.065 (2.43)**	28.981 (3.32)***	3.463	10.200 (2.83)**
sigma _e _cons	5.044	1.105 (10.91)***	1.812 (9.40)***	5.377
Obs.	66	66	66	66

**p<0.1 ** p<0.05; *** p<0.01*

Note: *DlnGDP = logarithm of gross domestic product in first difference; DlnGDPPC = logarithm of gross domestic product per capita in first difference; D2lnPOP = logarithm of population in second difference; D2lnDENSPOP = logarithm of population density in second difference.*

Source: *Author*