Effects of Road Infrastructure on Economic Growth in CEMAC Member Countries

Sylvaniste ETSIBA[1]

[1] Laboratoire de Recherches et d'Etudes Economiques et Sociales (LARES), Faculté des Sciences Economiques, Université Marien Ngouabi de Brazzaville, Republic of Congo

Correspondence: Sylvaniste ETSIBA, Laboratoire de Recherches et d'Etudes Economiques et Sociales (LARES), Faculté des Sciences Economiques, Université Marien Ngouabi de Brazzaville, B.P. 69, Republic of Congo. E-mail: sylvanistetsiba@yahoo.fr

Received: November 5, 2022 Accepted: December 10, 2022 Online Published: December 31, 2022

doi:10.5430/rwe.v13n2p32 URL: https://doi.org/10.5430/rwe.v13n2p32

Abstract

The objective of this paper is to analyze the influence of road infrastructure on economic growth in the CEMAC zone. To do so, a two-step approach has been adopted. The first step consists in tracing the theoretical and empirical developments on the issue. The second is an empirical analysis that highlights the link between road infrastructure and economic growth by estimating the DOLS model. The data used are from the World Bank's WDI database. The results show that road infrastructure has a positive and statistically significant contribution to economic growth in the CEMAC countries. These results have led to some economic policy implications.

Keywords: public investment, economic growth, road infrastructure

JEL Classification: H54, O43

1. Introduction

Economic growth is part of economic policy objectives in both developing and developed countries. It remains one of the major contemporary economic problems, especially with the achievement of the sustainable development goals, which require a double-digit growth rate (UN, 2015). However, African countries in general, and those of CEMAC in particular, are experiencing low growth rates due to the economic crisis combined with the corona virus-COVID-19 health shock, with a real GDP growth rate of -2.1% in 2020 compared to 2.1% in 2019 (BEAC, 2021). But beyond these shocks, economic growth in this region of the world still seems to be penalized by infrastructure (World Bank, 1994), especially road infrastructure. Thus, in most African countries, particularly low- and middle-income countries, road infrastructure is one of the constraints to business development, lowering the productivity of firms, Escribano et al (2008). Currently, it is found that countries that increasingly attract foreign investors and labor are often endowed with quality and low-cost road infrastructure (OECD, 2009). These various facts found in the literature show the need to examine the relationship between road infrastructure and economic growth.

The relationship between public capital in terms of road infrastructure and economic growth has been hotly debated in the economic literature. First, road infrastructure does not necessarily have a positive effect on economic growth, because it is often financed by debt. A country's debt often grows at a much higher annual rate than economic growth. Indeed, the country's external borrowing is often not used to finance productive investments, but rather to cover road infrastructure expenditures, which are by nature unproductive in the short term. It is in this sense that Ricardian equivalence theory, notably with the work of Barro (1974), emphasizes that when the state chooses to borrow, agents are encouraged to work and consume all the more so than during the first period, when they anticipate working less and therefore consuming less when taxes are increased to ensure the repayment of the debt.

Then, the neoclassical current, with the Solow model (1956), explains growth by the amount of technical capital, but in order to better understand the problem of technical progress and its role in growth, Solow (1957) decomposes the growth rate of the economy in terms of the contributions of the factors of production (labour, capital) and produces a residual that is supposed to capture the externality of technical progress. Thus, he concludes that technical progress is the main factor of economic growth, unfortunately, he considers that this technical progress is an exogenous factor.

This consideration of technical progress as an exogenous factor by Solow (1957) will open the way to a wave of renewal of theories of economic growth. Finally, the emergence of endogenous growth theories, towards the end of the 1980s and beginning of the 1990s, truly renewed the indispensable role of public capital in the process of economic growth, starting with the work of Barro (1990). Indeed, Barro work (1990) highlighted the importance of certain public expenditures for a country's self-sustained economic growth through the construction of economic infrastructure, including road infrastructure.

Thus, on the empirical level, we have noted the existence of two types of results that are in opposition. On the one hand, there are the works that show that road infrastructures have positive and significant effects on economic growth, having used econometric techniques and different fields of investigation, such as: Aschauer (1989), Munnel (1990), Eisner (1991), Holtz-Eakin (1994), Evans and Karras (1994), Duggall, Saltzman and Klein (1999), Everaert and Heylen (2004), Demetriades and Mamuneas (2000), Calderón and Serven (2002), Dumont and Mesplé-Somps (2000), Dessus and Herrera (2000), KANE(2011), Bayoudh(2012) Oulmakki (2017), EL Moctar (2017), Etsiba (2018) and DjatchoSiefu (2022) and on the other hand, the works that argue that the effects of road infrastructure on economic growth are negative or marginal. These are the works of Banister and Berechman 2001; Boopen, 2006; Cantos et al. (2005), Demetriades and Mamuneas, (2000), Khanam (1999), Escribano et al. (2008), Garcia-Mila and McGuire (1992) and they have emphasized that road infrastructure has a negative effect.

Also, a study by Keho and Echui (2011) showed that despite the existence of a causal relationship, there is no effect of transport infrastructure on economic growth in the case of Côte d'Ivoire.

From this controversy, it appears that the debate on the effects of public capital, particularly road infrastructure, on growth is far from over. The effects highlighted in the various studies depend on the field of research, the use of the infrastructure, its mode of financing, etc. This is why road infrastructure in the member countries of the CEMAC zone is not without questions about its role in the process of economic growth and consolidation of economic activities. Thus, the CEMAC member countries constitute a particularly interesting field of investigation for at least three reasons.

First, because in Africa in general, road transport is the dominant mode of transport and accounts for more than 90% of interurban and inter-state traffic, ECA (2017). But the African continent is also characterized by low road density: 6.84 km per 100 km2 compared to 12 km per 100 km2 in Latin America and 18 km per 100 km2 in Asia, ECA (2017). Thus, this low level of road infrastructure observed in the continent is also very real in the CEMAC zone. It is in this sense that the ECA (2005) indicates that the main road network of CEMAC, which is 57,858 km long, is only 12% paved, and its road density, for the entire network, is 1.9 km/100 inhabitant, of which 0.24 km/100 inhabitant are paved roads.

Second, the CEMAC member countries have a regional economic program whose third strategic axis concerns the construction of economic infrastructure and land use planning. This strategic axis is justified by the fact that the low level of road infrastructure remains one of the main obstacles to economic growth.

Finally, the CEMAC road network is not of good quality. In 2005, the ECA estimated that 88% of the network was defective. The implementation by 2030 of the FTAA, to which the CEMAC countries are co-signatories since 2019, would be an opportunity for these countries to upgrade the infrastructure needed for the free movement of people and goods, in order to promote growth through trade.

In view of the above, the effects of road infrastructure on economic growth remain a matter of debate. The situation in CEMAC, from the point of view of road infrastructure, still maintains this uncertainty on the supposed effects of road infrastructure on economic growth. Consequently, the central question that structures the problematic of this research can be summarized as follows: what are the effects of road infrastructure on economic growth in the CEMAC zone? The objective of this paper is to analyze the influence that road infrastructure can have on economic growth in the CEMAC zone. Considering the efforts made by the various CEMAC countries over the last decade, we support the hypothesis that road infrastructure is not neutral in the performance recorded by the member countries of the CEMAC zone in terms of economic growth.

Notwithstanding the introduction and conclusion, the remainder of this paper is structured in two parts: section 2 methodological framework, and section 3 results and interpretation.

2. Methodology

2.1 Theoretical Model

The productive role of infrastructure was first treated in the primal form of the production function, from a theoretical point of view. This line of research relates to the work of Barro (1990) who formulated a model in which the production function depends on capital intensity and government spending where infrastructure capital is an input into aggregate output. This model implies a simple relationship between income and government spending on infrastructure. Our approach is based on the endogenous growth model of Barro (1990), which also draws on the empirical work of Aschauer (1989). The model we propose to use is as follows:

$$Y = PK^{\alpha}L^{\delta}G^{\gamma} \tag{1}$$

Y is real GDP, K is the total capital stock approximated by public road infrastructure investment in kilometers, L is labor, G is the set of other indicators capable of explaining the dynamics of economic growth, and P is a technological parameter. Assuming that the parameters α, δ and γ are supposed to verify the assumption of constant returns to scale, then $\alpha + \delta + \gamma$ =1.

To obtain a linear Cobb-Douglas type production function, we use the logarithmic operator in both members of equation (1), such that the coefficients in the model are interpreted as elasticities. Hence equation (1) becomes:

$$\ln Y_{it} = \ln P_0 + \alpha \ln K_{it} + \delta \ln L_{it} + \gamma \ln G_{it} \tag{2}$$

In the following sections, we estimate equation (3) below.

$$\ln Y_{it} = A_0 + \alpha \ln K_{it} + \delta \ln L_{it} + \gamma \ln G_{it} + \varepsilon_{it} \tag{3}$$

With $A_0 = \ln P_0$, is a constant, the coefficient α represents the elasticity of real GDP with respect to the stock of private investment, δ is the elasticity of real GDP with respect to labor, γ is the elasticity of real GDP with respect to the stock of road infrastructure, and ε represents the error term. Finally, the coefficients α+δ+γ must test the following hypothesis: $\alpha + \delta + \gamma$ = 1. We therefore chose to estimate an aggregate production function, in contrast to Canning (1999) and Boopen (2006) who chose to focus on functions per worker. This choice is justified by the fact that in a country with low population growth, only a change in real GDP is capable of reflecting the well-being of the entire population. Hence, the presentation of the model for estimation purposes in the next section.

2.2 Model Specification

The model for estimation purposes is written as follows

$$\ln \text{PIB réel}_{it} = A_0 + \alpha \text{Inf\_rou}_{it} + \delta \text{Main\_œuvr}_{it} + G_{it}\beta + \varepsilon_{it} \tag{3}$$

$$\text{avec } G_{it}\beta = \beta_1 \text{Vul\_écoq}_{it} + \beta_2 Util\_phon_{it}$$

Replacing $G_{it}\beta$ in relation (3), we obtain:

$$\ln \text{PIB réel}_{it} = A_0 + \alpha \text{Inf}_{\text{rou}_{it}} + \gamma \text{Inv}_{\text{priv}_{it}} + \delta \text{Main}_{\text{œuvr}_{it}} + \beta_1 \text{Vul}_{\text{écoq}_{it}} + \beta_2 Util_{phon_{it}} + \varepsilon_{it} \tag{4}$$

Where, $\beta_1 et \beta_2$, are the elasticities of real GDP with respect to the stock of economic vulnerability and telephone use, respectively. While Infr_rou, Main_œuv, Vul_écoq, and Util_pho represent the variables of road infrastructure, labor force, economic vulnerability, private investment, and telephone device use, respectively.

2.3 Presentation of Variables, Data Sources and Descriptive Analyses

2.3.1 Presentation of Variables

In light of the literature review and especially the unavailability of certain information in our database, the variables we have chosen for this study are listed below:

- Real GDP: This variable refers to the real gross domestic product. It represents our explained variable, and was used by Calderon and Serven (2004).
- Economic vulnerability indicator: This variable is defined as the probability that the economic development of a country can be hindered by unforeseen exogenous shocks (Guillaumont, 2008, 2009). This variable plays the role of control variable in this work.
- Invest.infra.road: This is our variable of interest. It represents the investments made in road infrastructure. It was the subject of a study conducted in the case of WAEMU countries by Kane (2011). Similarly, Barro (1990), Eastelly and Rebello (1993), Roller and Wavernan (2001), Caleron and Servenn (2003) and Etsiba (2018) have used this variable to analyze the link between infrastructure and economic growth. Like these authors and in line with our hypothesis, we expect GDP to be positively affected by road infrastructure.
- Telephone use: This variable plays the role of a control variable in this work and allows us to take into account the communications of economic entities. In the case of Mauritania, Mohamed (2017) used this variable to show that it contributes to economic growth by facilitating communication and reducing a number of costs, for both individuals and businesses. Also, this same variable was used by Youssef and M'Henni (2004) in the case of Tunisia where these authors found a positive effect of this variable on growth. This variable deserves to be observed for the CEMAC economies and is expected to have a positive effect on growth.
- Total labor: these are workers who sell their labor power to production structures (Chauvin and Plane, 2001). The amount of labor supplied in an economy is proportional to the population. Labor utilization also plays a role in the growth process OECD (2008). This variable is assumed to positively influence economic growth.

2.3.2 Data Sources and Descriptive Analyses

The data used in this paper covers only three (03) of the six (06) CEMAC countries. These are Congo, Chad, and Gabon. The other three CEMAC member countries (Cameroon, Equatorial Guinea, and CAR) are not included due to difficulties with data availability. These data cover the period 2009-2021 and are taken from the database of the World Development Indicator (WDI) website and from official publications of the relevant sectoral ministries. This gives us a total of 39 observations. This allows us to make statistical inferences.

The presentation of the analysis of the descriptive statistics is given in Table 1 below:

Table 1. Descriptive statistic

Variables		Mean	St-dev.	Mini	Maxi	Obser.
Real GDP (%)	All countries	23,153	0,158	22,754	23,41	N=39
	Within countries		0,151	23,013	23,313	n=3
	Between countries		0,097	22,894	23,256	T=13
Invest.infra.road (in US dollars)	All countries	3994,016	9751,891	-98,023	35606,08	N=39
	Within countries		6142,855	3,6275	11067,82	n=3
	Between countries		8323,516	-7166,1	28532,28	T=13
Telephone use (%)	All countries	13,516	16,005	0	48,052	N=39
	Within countries		15,576	2,874	31,394	n=3
	Between countries		9,496	-17,88	30,174	T=13
Total labor	All countries	0,841	1,28	-1,004	2,321	N=39
	Within countries		1,453	-0,796	1,978	n=3
	Between countries		0,439	-1,137	1,637	T=13
Economic vulnerability indicator	All countries	32,527	15,824	0	55,35	N=39
	Within countries		14,568	23,72	49,34	n=3
	Between countries		10,256	-16,82	38,53	T=13

Source: Author

Table 1 above presents a summary of the descriptive statistics for the variables selected. The results show, on the one hand, that real GDP, road infrastructure, the economic vulnerability index, technology use, and the labor force indicator, have overall averages in the three CEMAC countries of 23.15%, 3994.02 thousand dollars, 13.52%, 0.84%, and 32.53% respectively.

With respect to standard deviations, the table shows that real GDP, investment in road infrastructure, and the economic vulnerability index have a low concentration around the mean. While the communication technology use and the labor force indicator have a strong dispersion around it.

2.4 Estimation Process

In the estimation procedure, two essential tests are carried out, namely the stationarity tests of the different variables studied and the cointegration test in panel data.

With regard to the stationarity test, given the number of observations, it is not possible to perform this test, according to Mignon and Hurlin (2005). As for the test of cointegration of variables, it is presented in Table 2 below:

Table 2. Results of co-integration tests in panel for CEMAC

Statistques	Valeurs standardisées	
Panel: "Within"		
V-Statistic Panel	1,402*	-0,345
Rho-Statistic Panel	0,110	1,286
PP-Statistic Panel	-11,89***	-4,502***
ADF-Statistic Panel	-6,986***	-2,996***
Panel: "between"		
rho-Statistic Group	1,565	
PP-Statistic Group	-9,291***	
ADF-Statistic Group	-4,986***	

Source: Author

Notes: The significance levels used are 1% (***), 5% (**) and 10% (*) respectively.

The results of Pedroni's cointegration tests show that all the statistics are below the critical value of the normal distribution, for a threshold of 5% for the within panel (panel: rho, pp and adf), as well as for the beetwen panel (group: rho, pp and adf). These results confirm, on the whole, that there is at least a cointegration relationship. Thus, it should be noted that OLS estimation is not appropriate because it leads not only to non-convergent estimators, given the results of the cointegration tests, but also because of the presence of serial autocorrelation in the data due to the asymptotically skewed distribution (Pedroni, 2000 and Kao and Chiang, 2000).

However, apart from the OLS estimator which suffers from bias problems, for small finite samples, in the case of time series, there is the DOLS approach which was s uggested by Saikkonen (1991), in the case of time series, and then adapted by Kao and Chiang (2000) and Mark and Sul (2003), to the case of panel data. This technique consists in including advanced and delayed values of the different variables in the cointegration relation, in order to eliminate the correlation between the explanatory variables and the error term.

Furthermore, it should be noted that Kao and Chiang (2000) have investigated the finite sample properties of OLS, FM-OLS and DOLS estimators. Their study highlights the fact that the OLS estimator suffers from a significant bias problem and that the FM-OLS estimator does not substantially improve the OLS estimator. Finally, these authors chose the DOLS estimator which is also appropriate for small samples as it is the case in this work.

2.5 Presentation and Interpretation of the Results

Here we will present and interpret the results.

2.5.1 Presentation of Results

The results of the effects of road infrastructure on economic growth in the CEMAC countries are presented in Table 3 below.

Table 3. Results of model estimates

Coefficients long term model

Endogenious variable: Lreal GDP				
	Coefficients	St-dev.	t-Student	Prob.
Road infrastructure Invest.	4,36.10-6 ***	4,36.10-6	2,25	0,024
Total labor	0,020***	0,0009	21,06	0,000
Telephone use	0,226***	0,0220	10,28	0,000
Economic vulnerability indicat	0,010***	0,0012	8,00	0,003
lag=1 ; R2=0,93 ; Wald-chi2=1330,60 (0,000) ; i=3 ; t= 12				

Source: Author

Notes: The significance levels used are 1 % (***), 5 % (**) et 10 % (*).

2.5.2 Interpretation of the Results

Before proceeding to the interpretation of the results, it is essential to verify the validity of the model that has been estimated. This verification is done by means of two tests: the Wald test and the R2 test. The Wald test is conclusive at the 1% significance level while the R2 is equal to 0.93. These two tests suggest that the exogenous variables contribute jointly to the explanation of economic growth at 93%. The results also show that the control variables also positively and significantly explain economic growth in the CEMAC zone at the 5% level. This suggests that there is no carryover effect on our variable of interest. Given that the results are of good statistical quality, they are now open to interpretation.

Thus, from the estimated DOLS model, one main lesson can be drawn from the results obtained, namely that in the long run, road infrastructure has a positive and significant effect on economic growth at the 5% threshold. Indeed, one kilometer of paved road induces an economic growth of 4.36.10-6%. These findings corroborate the work of Eustache (2007), Kane (2011), Semedo (2013) and Djatch (2022), who have all emphasized that road infrastructure

plays a decisive role not only in the development of trade relations and the movement of people and their goods in an economic area, but also that its development remains essential to economic growth. The same is true of the work of Canning and Bennathan (2000) who, in analyzing the impact of paved roads on GDP in a panel of rich and poor countries, find significant positive effects. These results are consistent with the desire of the governments of the CEMAC member countries, which over the past 20 years have undertaken the construction of regional road transport infrastructure, with a view to building a unified, stable, and prosperous economic and political space.

From the point of view of economic theory, these results support the work of endogenous growth theories, in particular those of Barro (1990), which advocate the productive role of public capital in economic growth, as public goods essential to the exchange and mobility of factors of production.

3. Conclusion and Policy Implications

The objective of this paper was to analyze the effects of road infrastructure on economic growth in the CEMAC countries. The results obtained, based on the estimation of a DOLS model, reveal that in the long run road infrastructure has positive and significant effects on economic growth.

These results confirm the hypothesis formulated in our work and support the previous work of Barro (1990), Kane (2011) in the case of WAMU and Djatch Sief, D (2022) in the case of CEMAC.

In this paper, we have encountered some difficulties related to the availability of data from some CEMAC member countries.

Given that road infrastructure generates productivity gains and is a necessary condition for industrialization, commercialization, and labor mobility, we would like future research to focus on the role of road infrastructure in the industrialization process of CEMAC economies. Thus, we hope that future research will focus on the role that road infrastructure plays in the industrialization process of the CEMAC economies.

Our main economic policy implication is to suggest to the governments of CEMAC countries, which are facing the economic crisis, to set up public-private partnership (PPP) mechanisms in order to increase the production of road infrastructure for sub-regional integration, on the one hand, and to improve the management of infrastructure already acquired, on the other hand

References

Aschauer, D. (1989). Is Public Expenditure Productive?. *Journal of Monetary Economics, 23.* https://doi.org/10.1016/0304-3932(89)90047-0

Bakari, S., & Mabrouki, M. (2018). The nexus between industrial exports and economic growth in tunisia: empirical analysis. *Journal of Smart Economic Growth, 3*(2), 31-53.

Banister, D., & Berechman, Y. (2001). Transport Investment and the Promotion on Economic Growth. *Journal of Transport Geography, 9*, 209-218. https://doi.org/10.1016/S0966-6923(01)00013-8

Banque, M. (1994). Rapport sur le développement dans le monde: *Une infrastructure pour le développement,* 685-712.

Banque, M. (2017). Rapport sur l'Analyse de la Pauvreté Éducation, Emplois et Protection Sociale pour une Réduction Durable de la Pauvreté, République du Congo.

Barro. R. J. (1990). Government spending in a simple model of endogenous growth. *J Polit Econ., 98*(5), 103-126. https://doi.org/10.1086/261726

Bayoudh, M. (2012). Investissement en Infrastructures publiques et croissance économique en Tunisie: Une analyse en équilibre général calculable.

Boopen, S. (2006). Transport Infrastructure and Economic Growth Evidence from Africa Using Dynamic Panel Estimates. *The Empirical Economics Letters.*

Calderón, C., & Servén, L. (2002). How did Latin America's infrastructure fare in the era of macroeconomic crises. World Bank, Mimeo.

Calderón, C., & Servén, L. (2004). The Effects of Infrastructure Development on Growth and Income Distribution. World Bank, Mimeo. https://doi.org/10.1596/1813-9450-3400

Canning, D. (1999). Infrastructure's contribution to aggregate output. *Policy research working paper series 2246,* World Bank, Washington D.C. https://doi.org/10.1596/1813-9450-2246

Canning, D., & Bennathan, E. (2000). The social rate of return on infrastructure investments. World Bank Research Project, RPO, 680-89, Washington, D.C. https://doi.org/10.1596/1813-9450-2390

CEA. (2018). *Profil pays-République du Congo*. Addis-Abeba, Éthiopie.

Chauvin, V., & Plane, M. (2001). Population active et croissance économique. *Working paper /HAL-0101702.*

Demetriades, P., & Mamuneas, T. (2000). Intertemporal output and employment effects of public infrastructure capital: Evidence from 12 OECD economies. *The Economic Journal, 110,* 687-712. https://doi.org/10.1111/1468-0297.00561

Dessus, S., & Herrera, R. (2000). Public Capital and Growth Assessment. *Economic Developpment and Cultural Change, 48*(2), 407-418. https://doi.org/10.1086/452465

Djatch Sief, D. (2022). Infrastructures de transport routier: facteur de croissance économique et des échanges en zone CEMAC – cas Du Cameroun, du Congo et de la RCA de 1995 à 2017. *Revue Francaise d'économie et de gestion, 3,* 6.

Duggal, V., *et al.*. (1999). Infrastructure and productivity: A non linear approach. *Journal of Econometrics, 92,* 47-74. https://doi.org/10.1016/S0304-4076(98)00085-2

Dumont, J. C., & Mesplé-Somp, S. (2000). The impact of public infrastructure on competitiveness and growth: a CGE analysis to Sénégal, Mimeo. Université Laval, Québec.

Easterly, W., & Rebelo, S. (1993). Fiscal policy and economic growth: An empirical. *Journal of Monetary Economics, 32*(3), 417-458. https://doi.org/10.1016/0304-3932(93)90025-B

Eisner, R. (1991). Infrastructure and Regional Economic Performance. *New England Economic Review,* Federal Reserve Bank of Boston.

Etsiba, S. (2018). Investissement en Infrastructure de transport et croissance économique: Analyse des effets de seuil au Congo. *Annales de l'UMNG, 18*(2), 140-149.

Evans, P., & Karras, G. (1994). Are Government Activities Productive? Evidence from a Panel of U.S. States. *Review of Economics and Statistics.* https://doi.org/10.2307/2109821

Evaraert, G., & Heylen, F. (2004). Public capital and longterm labour market performance in Belgium. *Journal of polcy Modeling, 26*(1), 95-112. https://doi.org/10.1016/j.jpolmod.2003.11.002

Garcia-Mila, T., & McGuire, T. J. (1992). The contribution of publicly provided inputs to states economies. *Regional science and Urbain Economic, 22,* 229-241. https://doi.org/10.1016/0166-0462(92)90013-Q

Holtz-Eakin, D. (1994). Infrastructure in a structural model of economic growth. *NBER Working Paper 4824.* https://doi.org/10.3386/w4824

Kane, C. S. (2011). Infrastructures Physiques et croissance économique dans l'UEMOA. *Revue économique et monétaire,* No9-Juin.

Kao, C., & Chiang, M. H. (2000). On the Estimation and Inference of a Cointegrated Regression in Panel Data. In B. Baltagi (Ed.), *Nonstationary Panels, Panel Cointegration, and Dynamic Panels (Advances in Econometrics)* (pp. 161-178). JAI Press, Amsterdam.

Keho, Y., & Echui, A. D. (2011). Transport Infrastructure Investment and Sustainable Economic Growth in Côte d'Ivoire: A Cointegration and Causality Analysis. *Journal of Sustainable Development, 4*(6). https://doi.org/10.5539/jsd.v4n6p23

Mark, N. C., & Sul, D. (2003). Cointegration Vector Estimation by Panel DOLS and Long-Run Money Demand. *Oxford Bulletin of Economics and Statistics, 65,* 655-680. https://doi.org/10.1111/j.1468-0084.2003.00066.x

Mignon, V., & Hurlin, C. (2005). Une synthèse des tests de racine unitaire sur données de panel. *Economie et prévision, Programme National Persée, 169*(3), 253-294. https://doi.org/10.3406/ecop.2005.7023

Mills, P., & Quinet, A. (1992). Dépenses publiques et croissance. *Revue Française d'Economie, 7*(3), 29-60. https://doi.org/10.3406/rfeco.1992.1314

Mohamed, E. T. (2017). Les dépenses en infrastructures publiques et la croissance économique: Le cas de la Mauritanie. Thèse-université Normandie –CAEN.

Munnell, A. H. (1990). How does public infrastructure affect regional economic performance?. *N Engl Econ Rev., 25,* 2-22.

OCDE. (2008). Regards sur l'éducation: les indicateurs de l'OCDE.

Pedroni, P. (2000). Fully modified OLS for heterogeneous cointegrated panels. In B. H. Baltagi (Ed.), *Nonstationary panels, panel cointegration, and dynamic panels* (pp. 93-130). Elsevier, Amsterdam. https://doi.org/10.1016/S0731-9053(00)15004-2

Rodriguez, F., & Rodrik, D. (1999). Trade Policy and Economic Growt: A Skepic's Guide to cross-National Evidence. *Working Paper-7081*. https://doi.org/10.3386/w7081

Roller, L. H., & Waverman, L. (2001). Telecommunications infrastructure and economic development: A simultaneous approach. *The American Economic Review, 91*(4). https://doi.org/10.1257/aer.91.4.909

Saikkonen, P. (1991). Asymptotically efficient Estimation of cointegration regressions. *Econometric Théory, 7*(1), 1-21. https://doi.org/10.1017/S0266466600004217

Solow, R. (1956). Contribution à la théorie de la croissance. *Néo-classiques et Néo-keynésiens, Economica*, 39-67.

Solow, R. (1957). A contribution to the theory of economic growth. *Quartely Journal of Economics*, 65-94. https://doi.org/10.2307/1884513

Youssef, A. B., & M'Henni, H. (2004). Les effets des technologies de l'information et de communication sur la croissance économique: le cas de la Tunisie. *MPRA- Revue Région et Développement*, (19), 131-150.