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EFFECTS OF SOCIO-ECONOMIC CONDITIONS ON THE RELATIONSHIP BETWEEN PUBLIC AND PRIVATE INVESTMENTS IN THE CEMAC ZONE

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ABSTRACT

This study aims at examining the effects of socio-economic conditions on the relationship between public investments and the productivity of the private sector in CEMAC countries between 1982 and 2016. Theoretical and empirical studies on this issue yield different results depending on the period and countries considered. After estimating an *ARDL* (*Autoregressive Distributed Lag*) model, we find that there exists a positive effect in the short and long run of public investment on private sector investments only in Congo, Gabon, the Central African Republic and Chad. We also find that in the short run, unlike in Cameroon, Equatorial Guinea, Chad and the Central African Republic where the socio-economic conditions reduce the level of public investments, they rather reinforce their contribution to private sector investment in Gabon and Congo. In the long run, they however improve the efficiency of public investments in Cameroon and Congo and reduce it in the Central African Republic. There is therefore a need to improve the quality of institutions in order to enable the development of the private sector.

Contribution/ Originality: This study contributes to the existing literature on the effects of public investment and the quality of institutions on private productivity in CEMAC zone using the ARDL techniques. This study is also one the few which has investigated on the issue in this zone giving sound recommendation to each country.

1. INTRODUCTION

The nature of the relationship between public and private investments has always been the subject of controversies in economic literature. Theoretically, public investment can affect private sector investment positively or negatively. In fact, an increase in public investments in the domain of infrastructures such as roads, ports, and railways improve the marginal productivity of capital in private sector companies (Cavallo and Daude, 2011). Moreover, Keynes (1936) highlights the multiplier effect of public investment on all the economy. Classical and neo-classical economists are not of this opinion. According to them, an increase in public investments supposes a reduction in the volume of savings available to the private sector and thus, an increase in the cost of capital which evicts the private sector.

In the same line of ideas, there is no consensus in empirical analysis between economists on this issue. In a study on 24 developing countries using data for 1971-1979, Blejer and Khan (1984) find that public investment in infrastructure is complementary to private sector investment. This conclusion is in line with that of Aschauer (1989) on the American population. Also, Erden and Holcombe (2005) find a positive correlation between public investment and private sector investment in 19 developing countries over the 1980-1997 period.

More recently, Cavallo and Daude (2011) develop a theoretical framework to evaluate the conditions under which public investment stimulates or deteriorates private sector investment. For a sample of 116 developing countries studied over the 1980-2006 period, they find an eviction of private sector investment by the public investment. In the same manner, Everhart and Sumlinski (2001) arrived at the conclusion that public investment evicts private sector investment in a study on 63 developing countries in the 1970-2000 period.

The majority of studies undertaken in developing countries that focus on the relationship between public investment and private sector investment are done using panel data under the assumption of homogeneity of the economic structures of the countries concerned. This assertion appears unrealistic since the socio-macroeconomic conditions are not always the same in the same monetary or economic union. This is same for institutional structures. Moreover, it can be shown that in the same monetary union, instability in a country slows down the evolution of the other countries.

In fact, the CEMAC sub-region is undergoing since mid-2014 a particularly difficult economic situation. This difficult economic situation has both endogenous and exogenous causes. As the endogenous causes of this crisis, we can cite the difficulty for the States to maintain public accounts which stops them from continuing to finance development projects and meet their current operating costs. Government capital expenditure dropped by 21,4% to equal 3639,2 billion CFA Francs (Multilateral Surveillance Report, 2016). As exogenous causes, we can cite the fall of the prices of raw materials, the oil crisis and the security shock which led to the displacement of people in and out of the national and regional borders.

Within this background, can the socio-economic conditions improve or deteriorate the relationship between public and private sector investments in CEMAC countries? The answer to this question requires that we review the literature on the relationship between public and private sector investments.

2. REVIEW OF THE LITERATURE ON THE RELATIONSHIP BETWEEN THE QUALITY OF INSTITUTIONS, PUBLIC INVESTMENT AND PRIVATE SECTOR PRODUCTIVITY

It should first of all be noted that both the theoretical and empirical literature are not unanimous on the relationship between public investment and private sector investment. For some authors, the increase in public capital expenditure leads to the eviction of the private sector. For others however, only public infrastructural investments are complementary to the economic activity of the private sector. However, little work has been done as concerns the effect of the socio-economic conditions on public investments and real economic growth.

Morrisson and Schwartz (1992) hold that differences in endowments in public capital contribute in explaining the differences between American states as regards advances in productivity in the manufacturing sector. Ram (1986); Guellec and Ralle (1996); Devarajan *et al.* (1996); Aschauer and Lächler (1998) are in favour of the existence of a causal relationship which goes from public capital towards private productivity. However, these authors affirm that if the public investment is financed by a levy on private agents, these agents can react by modifying their behaviour. They are less encouraged to have a productive activity since it is taxed. This disincentive undoubtedly produces negative effects on private sector investment. Other authors like Blejer and Khan (1984); Shafik (1992); Easterly and Rebelo (1993); Serven and Solimano (1993); Nazmi and Ramirez (1997); Morrison and Schwartz (1996); Devarajan *et al.* (1996) support the thesis of complementarity between the two types of investments. This idea is consolidated by certain case studies.

Rajaraman (2005) highlight the complementarity between public expenditure and private productivity in developed and developing countries. They hold that public expenditure is productive. In the same manner, Hjerppe et al. (2007) show that public expenditure on infrastructure, education and health contributes positively to the growth in the productivity of the private sector. The increase in public expenditure, according to Shelton (2007) is positively related to the openness of the economies of the various countries, particularly in the developed countries where expenditure is focused in the fields of social security, transport infrastructures, as well as wages of public agents at the national and local level. The results of Gemmell et al. (2008); Pugno (2006) confirm those of Schelton (op.cit) and highlight the positive effects of globalisation on certain categories of public expenditure.

Moreover, studies using the VAR methodology led by Erenburg (1993); Erenburg and Wohar (1995); Pereira (2001b) on the US economy; Otto and Voss (1996) in Australia confirm the positive effect of public investment on private sector investment. However, the study by Voss (2002) in the United States and Canada; Kawade et al. (2004) in Japan lead to an opposite result.

In fact, the majority of the studies provided use time series based on the function production approach. Among the studies which firm level data showing the role of public capital, we can cite: Aschauer (1989); Munnell (1990); Everhart and Sumlinski (2001); Rivera-Batiz (2003); Fernald (1999); Ligthart and Suárez (2011). Going from a study on productivity in the US economy, Aschauer (1989) explains why public capital stimulates private sector investment by varying its internal rate of return. The author finds that the estimated elasticity of public capital is 0,39.

Ligthart and Suárez (2011) examine the contribution of public capital to the productivity of the private sector using a panel of 49 countries. The results show that the elasticity of public capital is 0. 14. Everaert and Heylen (2001) analyse the effect of public capital on the productivity of the private sector in Belgium using an error correction model to verify the direction of causality. The results show a causality relationship going from public capital towards the productivity of the private factors. Using a multivariate VAR approach, Pereira and Andraz (2013) show that public expenditure of infrastructures has a positive effect on private sector investment. This result is in line with those of Erden and Holcombe (2005) and Afonso and Aubyn (2009).

Jerome et al. (2015) apply various linear empirical models to four OECD countries study the VAR model in which private sector investment, the growth of the gross domestic product and interest rates interact and are affected by public investment and the national debt, among others, to verify in which conditions the relationship between public and private investments varies in time and depends on the macroeconomic context. Moreover, they examine the international effects of an excess of public investment. The estimation results show that in France, the multiplier effect seems to overshadow the eviction effect while in the United States, an eviction effect emerges although it is weaker. No robust result arises from the German and British data. As in the former studies, they do not also take into account the socio-economic conditions in their analysis. However, institutions can have important effects on private sector investment. They are the institutions that protect and control the operation of the market, following the example of the protection of property rights, the reduction of barriers to international business through a fall in taxes and tariff barriers supposed to stimulate the private sector investments.

De Haan and Siermann (1998) compare several indices of economic freedom built by Scully and Slottje (1991); Gwartney et al. (1999). Their results show that the effect of institutions on real private activity depends on the measurement index used. Dawson (1998) uses the economic freedom index of Gwartney et al. (1999) and finds that institutions have positive effects on private sector investments. In the same manner, Vamvakidis (1998) having undertaken an analysis on eight African countries using the index of Gwartney, Lawson and Holcombe arrives at the conclusion according to which several macroeconomic variables including a set of measures of economic freedom are positively correlated with the contribution of private sector investment to GDP.

Cavallo and Daude (2011) estimate the equation of private sector investment for 116 countries between 1980 and 2006 using dynamic panel data models which take into account problems of unobserved components and

reverse causality. They find an average negative effect of public investment on private sector investment in developing countries: an increase of 1% in public investment (in % of the GDP) reduces private sector investment by 0,22%. This result suggests that the eviction effects of public investment in a country where public institutions are weak or loan restrictions are high tend to overshadow the multiplier effects related to an increase in the marginal product private capital.

Many studies examine the indirect effect of institutions on growth through private sector investments following the examples of Besley (1999); Dawson (1998); De Haan and Siermann (1998). This study however checks if the indicator of socio-economic conditions drawn from the ICRG (2017) can play the mediator role between public investment and the evolution of activity in the private sector in the six countries which make up the CEMAC zone.

3. METHODOLOGY AND DATA

In order to evaluate the effect of the socio-economic climate on the complementary or substitute relationship between public and private investment, we go from the model by Julio and Yook (2012) who analyse the influence of the political regime change on the correlation between public expenditure and private sector investment in of developing countries between 1980 and 2005. In our analysis, we integrate additional variables like the internal public debt and replace the change of the political regime by the socio-economic conditions. Moreover, we introduce the interactive variable between public investment and the socio-economic conditions $DPI_t * CSE_t$. We thus have the following function:

$$IPRI = f(DPI, DTPI, CE, IPC, CSE, DPI*CSE).. (1)$$

The linear form of the regression model is written as:

$$IPRI_t = \beta_0 + \beta_1 DPI_t + \beta_2 DTPI_t + \beta_3 CE_t + \beta_4 IPC_t + \beta_5 CSE_t + \beta_6 (DPI_t * CSE_t) + \varepsilon_t ....(2)$$

Where: $IPRI$ (private sector investments) the Gross Fixed Capital Formation (GFCF) of households and companies; DPI (public investment expenditure) which measures the Gross Fixed Capital Formation (GFCF) realized by the public sector; the ratio to the GDP of credit to the economy (EC) measures the real amount of loans granted by the banking and non-banking institutions to the private sector (its expected effect is positive); The socio-economic conditions represent the set of facilities (economic and legal) stimulating the creation of companies; $DTPI$ (internal national Debt) measures the amount of loans contracted by the State on the local market; IPC (Consumer price index) measures the effects of inflation on the entrepreneurial initiative of households and companies; the product $DPI_t * CSE_t$ makes it possible to capture the nonlinear effect of public investments on private sector investments determined by the socio-economic conditions which act as a variable of transition.

If the variables are stationary at levels I (0), at first difference I (1) or both at the same time, we use the ``Autoregressive Distributed Lag'' (ARDL) procedure of Pesaran and Shin (1999) and Pesaran et al. (2001). This brings us to write the following model:

$$\Delta IPRI_t = \alpha_0 + \alpha_1 DPI_t + \alpha_2 DTPI_t + \alpha_3 CE_t + \alpha_4 IPC_t + \alpha_5 CSE_t + \alpha_6 (DPI_t * CSE_t) + \delta ECT_{t-1} + \sum_{i=1}^{a} \alpha_{7i} \Delta DPI_{t-i}$$

$$+ \sum_{i=1}^{b} \alpha_{8i} \Delta DTPI_{t-i} + \sum_{i=1}^{c} \alpha_{9i} \Delta CE_{t-i} + \sum_{i=1}^{d} \alpha_{10i} \Delta IPC_{t-i} + \sum_{i=1}^{e} \alpha_{11i} \Delta CSE_{t-i} + \sum_{i=1}^{a} \alpha_{12i} \Delta (DPI_{t-i} * CSE_{t-i}) + \varepsilon_t ....(3)$$

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Where $\alpha_1, \dots, \alpha_6$ the coefficients of the long are run equilibrium and $\alpha_{7i}, \dots, \alpha_{12i}$ represent the coefficients of the short run dynamics. δ is the coefficient of the error correction term.

All the variables used in this analysis are taken in percentage of the GDP and the data is from secondary sources. The selected explanatory variables are socio-macroeconomic variables drawn from the literature. These are: the internal national debt (DTPI), credit to the economy (EC), consumer price index (IPC), which is the data extracted from the database of the World Bank (World Bank, 2017). The data on the national debt (DTPI), public investment expenditure (DPI) and the real private sector investments is from the database of the BEAC (2017). The data on the quality of institutions, whose proxy is ``*Socioeconomic conditions*'' (CSE) is from the ICRG (2017). These data cover the period going from 1982 to 2016. In this study, we carry out the estimation in each country because if we follow the reasoning of Afonso and Aubyn (2009) according to which the effects are heterogeneous when one considers the relationship between public and private investments at the individual level. We carry out all our estimations using the "Eviews9" software.

4. RESULTS

4.1. Unit Root Tests

A summary of these tests appears in Tables 1 to 6. We find that whatever the country considered, the results of the Augmented Dickey and Fuller (1979) and Phillips and Perron (1988) tests converge. In the CEMAC sub-region, Cameroon and Gabon are the two absurd cases as concerns the order of integration of variables. In Cameroon, only the tree variables of interest (DPI, IPRI, CSE) are stationary at first difference and the others stationary at levels. On the other hand, in Gabon the variables of interest DPI and IPRI are I(0). This is also the case for the exogenous variable DPUG. The other variables are I(1). The results are however convergent for the case of Congo, Equatorial Guinea, the Central African Republic and Chad. In these four countries, three variables are I(0) (DPI, IPRI, DTPI) and the others are I(1) (CE, CSE, IPC). Taking the first difference of all the variables, the results in Tables 1 to 6 show that they are all stationary, thus requiring the verification of the existence of a cointegration relationship between them.

Table-1. ADF and PP unit roots test (Cameroon).

Variables	At levels		Decision I(0)	At first difference		Decision I(1)
	Probability			Probability		
	ADF	PP		ADF	PP	
CE	0.0941	0.0812	Yes*	0.0000	0.0000	yes***
DPI	0.3144	0.3149	No	0.0001	0.0001	yes***
IPRI	0.5350	0.1200	No	0.0065	0.0000	yes***
CSE	0.6054	0.6172	No	0.0007	0.0000	yes***
IPC	0.0817	0.0916	Yes*	0.0018	0.0019	yes***
DTPI	0.0510	0.0583	Yes*	0.0000	0.0000	yes***

Note: *,**,*** represent significance at the 10%, 5% and 1% levels; ADF: Augmented Dickey-Fuller; PP: Philips Perron.

Table-2. ADF and PP unit roots test (Congo).

Variables	At levels		Decision I(0)	At first difference		Decision I(1)
	Probability			Probability		
	ADF	PP		ADF	PP	
CE	0.1569	0.1163	No	0.0003	0.0000	yes***
DPI	0.0113	0.0100	yes**	0.0000	0.0000	yes***
IPRI	0.0926	0.0820	yes*	0.0000	0.0000	yes***
CSE	0.1926	0.5484	No	0.0010	0.0017	yes***
IPC	0.9955	0.9913	No	0.0069	0.0078	Yes***
DTPI	0.0001	0.0001	yes***	0.0000	0.0000	yes***

Note: *,**,*** represent significance at the 10%, 5% and 1% levels; ADF: Augmented Dickey-Fuller; PP: Philips Perron.

Table-3. ADF and PP unit roots test (Gabon).

| Variables | At levels | | Decision I(0) | At first difference | | Decision I(1) |
| | Probability | | | Probability | | |
	ADF	PP		ADF	PP	
CE	0.0412	0.0314	yes**	0.0050	0.0001	yes***
DPI	0.0126	0.0210	yes**	0.0000	0.0001	yes***
IPRI	0.2012	0.1230	No	0.0073	0.0000	yes***
CSE	0.2850	0.2489	No	0.0000	0.0000	yes***
IPC	0.1446	0.1465	No	0.0029	0.0085	yes***
DTPI	0.0146	0.0213	yes**	0.0013	0.0015	yes***

Note: *,**,*** represent significance at the 10%, 5% and 1% levels; ADF: Augmented Dickey-Fuller; PP: Philips Perron.

Table-4. ADF and PP unit roots test (Equatorial Guinea).

| Variables | At levels | | Decision I(0) | At first difference | | Decision I(1) |
| | Probability | | | Probability | | |
	ADF	PP		ADF	PP	
CE	0.8853	0.3904	No	0.0000	0.0000	yes***
DPI	0.0012	0.0029	yes***	0.0000	0.0001	yes***
IPRI	0.0048	0.0023	yes***	0.0000	0.0000	yes***
CSE	0.0419	0.0417	yes**	0.0000	0.0000	yes***
IPC	0.9916	0.9918	No	0.0080	0.0076	yes***
DTPI	0.6371	0.5342	No	0.0000	0.0004	yes***

Note: *,**,*** represent significance at the 10%, 5% and 1% levels; ADF: Augmented Dickey-Fuller; PP: Philips Perron.

Table-5. ADF and PP unit roots test (Central African Republic).

| Variables | At levels | | Decision I(0) | At first difference | | Decision I(1) |
| | Probability | | | Probability | | |
	ADF	PP		ADF	PP	
CE	0.7719	0.9293	No	0.0150	0.0213	yes**
DPI	0.0144	0.0101	yes**	0.0000	0.0000	yes***
IPRI	0.0146	0.0133	yes**	0.0000	0.0000	yes***
CSE	0.6113	0.6217	No	0.0006	0.0005	yes***
IPC	0.8105	0.9502	No	0.0147	0.0167	yes**
DTPI	0.0085	0.0095	yes***	0.0000	0.0000	yes***

Note: *,**,*** represent significance at the 10%, 5% and 1% levels; ADF: Augmented Dickey-Fuller; PP: Philips Perron.

Table-6. ADF and PP unit roots test (Tchad).

| Variables | At levels | | Decision I(0) | At first difference | | Decision I(1) |
| | Probability | | | Probability | | |
	ADF	PP		ADF	PP	
CE	0.9587	0.9994	No	0.0000	0.0000	yes***
DPI	0.0125	0.0101	yes**	0.0001	0.0001	yes***
IPRI	0.0146	0.0104	yes**	0.0065	0.0000	yes***
CSE	0.9719	0.9989	No	0.0007	0.0000	yes***
IPC	0.8878	0.8400	No	0.0018	0.0019	yes***
DTPI	0.0005	0.0006	yes***	0.0000	0.0000	yes***

Note: *,**,*** represent significance at the 10%, 5% and 1% levels; ADF: Augmented Dickey-Fuller; PP: Philips Perron.

4.2. Pesaran et al. (1999) Cointegration Test

Also known as "*Bounds Cointegration test*", this test enables the researcher to know if there exists a long run relationship between the variables in the model. It consists in comparing the calculated value of the Fisher's F statistics to the critical intervals of Pesaran and Shin (1999) at the 1%, 5% and 10% significance levels. Table 7 below presents the converging results. In this table, we see that for all the countries, the Fisher value from the table is greater than the critical values at the 5% levels. This shows the existence of a long run relationship between private investment as measured by the variable IPRI and its determinants (DPI, DTPI, CSE, IPC, CE) in each of the CEMAC countries.

Tablea-7. Bounds cointegration test.

Country	Cameroon	Congo	Gabon	Equatorial Guinea	CAR	Chad
Calculated Fisher	4,0020	4,1706	4,0230	3,8642	3,957	4,0417
Significance level	10%			5%	1%	
	I(0)	I(0)	I(0)	I(1)	I(0)	I(1)
Bounds critical values	2,26	3,35	2,62	3,79	3,41	4,68

Source: computed by authors from E-views 9.

We therefore have enough evidence to reject the null hypothesis of absence of cointegration. We can therefore conclude on the existence of a long run relationship between the variables considered in the model used. Also, after having performed a regression at the level of each country using Ordinary Least Squares (OLS), we saved the residuals of each regression. The results of the unit root tests on these residuals show that they are all stationary at levels (I(0)). We therefore admit, following Pesaran and Shin (1999) that the variables of the model are cointegrated and there exists a long run relationship between them.

4.3. Correlation Matrices of the Variables

The correlation matrix gives a preliminary description of the relationships existing between the variables. We determine this matrix for each country of the CEMAC zone in order to better identify the specificities of each. The matrices are presented in Tables 8 to 14 below:

Table-8. Matrix of correlation between variables (Cameroon).

Variables	IPRICAM	IPCCAM	DTPICAM	DPICAM	CECAM	CSECAM
IPRICAM	1					
IPCCAM	0,4522	1				
DTPICAM	–0,4273	–0,4007	1			
DPICAM	–0,3740	0,0514	0,2289	1		
CECAM	–0,4292	–0,0097	0,0110	–0,3410	1	
CSECAM	0,7508	0,2159	–0,2902	–0,3715	–0,4598	1

Source: computed by authors from E-views 9.

Table-9. Matrix of correlation between variables (Congo).

Variables	IPRICOG	IPCCOG	DTPICOG	DPICOG	CECOG	CSECOG
IPRICOG	1					
IPCCOG	0,7029	1				
DTPICOG	0,7720	0,4268	1			
DPICOG	–0,1857	–0,0869	–0,4283	1		
CECOG	0,3551	0,0437	0,5098	–0,4157	1	
CSECOG	–0,0382	–0,2179	0,0255	0,2284	0,3099	1

Source: computed by authors from E-views 9.

Table-10. Matrix of correlation between variables (Gabon).

Variables	IPRIGAB	IPCGAB	DTPIGAB	DPIGAB	CEGAB	CSEGAB
IPRIGAB	1					
IPCGAB	–0,1469	1				
DTPIGAB	0,2066	0,2410	1			
DPIGAB	0,6571	–0,1394	0,2536	1		
CEGAB	0,6571	0,0821	0,3553	0,6854	1	
CSEGAB	0,3335	–0,1030	–0,2139	0,1453	0,0814	1

Source: computed by authors from E-views 9.

Table-11. Matrix of correlation between variables (Equatorial Guinea).

Variables	IPRIGE	IPCGE	DTPIGE	DPIGE	CEGE	CSEGE
IPRIGE	1					
IPCGE	0,4592	1				
DTPIGE	0,0658	0,1356	1			
DPIGE	-0,0949	-0,0744	0,4060	1		
CEGE	-0,4250	-0,5551	0,4847	0,3993	1	
CSEGE	0,3951	0,0961	-0,2956	-0,5090	-0,2961	1

Source: computed by authors from E-views 9.

Table-12. Matrix of correlation between variables (CAR).

Variables	IPRIRCA	IPCRCA	DTPIRCA	DPIRCA	CERCA	CSERCA
IPRIRCA	1					
IPCRCA	-0,0132	1				
DTPIRCA	-0,4654	0,1938	1			
DPIRCA	-0,4204	-0,0380	-0,1008	1		
CERCA	0,4987	-0,0210	-0,6683	-0,2398	1	
CSERCA	0,3951	-0,0017	0,2202	-0,7409	0,1212	1

Source: computed by authors from E-views 9.

Table-13. Matrix of correlation between variables (Chad).

Variables	IPRITD	IPCTD	DTPITD	DPITD	CSETD
IPRITD	1				
IPCTD	-0,2144	1			
DTPITD	0,1280	0,0547	1		
DPITD	-0,4647	-0,1779	-0,3235	1	
CETD	-0,3271	-0,2028	-0,4059	0,6455	
CSETD	0,5605	-0,0431	0,0269	-0,4970	1

Source: computed by authors from E-views 9.

From the tables above, we notice the existence of a negative relationship between public investment expenditure and private sector investments in all the countries of the CEMAC zone, except Gabon. However, Gabon, Congo and the CAR have the variable credit to the economy (EC) that is positively correlated with private sector investments. Gabon and Congo are the only countries of the CEMAC zone where the socio-economic conditions are positively related to private sector investments. We however notice all that there exists a weak correlation between the variables of the model. This observation enables us to eliminate any possibility of the existence of multicollinearity between the selected variables of the model.

A deeper analysis will enable us to determine the individual effects of the various determinants of private sector investments like their sensitivity, in order to draw a credible conclusion. We adopt an ARDL model which includes both I (0) and I (1) variables (Pesaran and Shin, 1999) and enables us to establish a short and long run relationship between private sector investment and its determinants.

4.4. Model Diagnosis and Estimation of the ARDL

In fact, we focus on the analysis of some determinants of private sector investments which are studied by regarding the socio-economic conditions as variables likely to significantly affect the level of private sector investment in CEMAC countries. A precondition to this estimation is the tests of detection and the determination of the optimum number of lags to be included in the model.

4.4.1. Test of Detection

Before carrying out any estimation, we examine the residuals resulting from the regression by OLS for each country of the CEMAC zone. To do this purpose, the results of the tests of autocorrelation, heteroskedasticity and normality converge. In Table 9, we see that the probabilities of the Fisher statistics for the various tests are all

higher than the 5% critical value and this confirms that our estimates are unbiased. We can therefore proceed to our estimation but we first need to determine the optimum lag of our ARDL.

4.4.2. Determination of the Optimal ARDL and Its Estimation

We use the method of "Akaïke Information Criterion" to do this. The optimum ARDL (a, b, c, d, e, f, g) selected is that for which this criterion is minimum. Obviously, the number of lags integrated in the estimation is not the same one for all the countries of the sub-region. We could retain an ARDL (1,1,0,0,0,0,0) in Cameroon; ARDL (1,1,1,1,0,0,0) in Congo; ARDL (1,1,1,0,0,1,0) in Gabon; ARDL (1,0,0,1,1,1,0) in Equatorial Guinea; ARDL (1,1,1,1,0,0,0) in the CAR; and ARDL (1,0,1,0,0,0,0) in Chad.

We summarise all the results in one table in order to facilitate any possible comparative analysis. This grouping was done in Table 14 below where we estimate the effect of the socio-economic climate and public investments on the productivity of the private sector:

Table-14. Summary of the ARDL results in each CEMAC country.

Independent variables		Dependent variable : $D(IPRI_t)$					
		Cameroon	**Congo**	**Gabon**	**Equatorial Guinea**	**CAR**	**Chad**
Short run dynamics	$D(CE_t)$	5,3467*** (9,4572)	6,9489 (1,1725)	2,1100 (1,4854)	-0,0448* (-1,8373)	-8,1216** (-2,1507)	0,0216* (2,0108)
	$D(DPI_t)$	0,2049 (0,4947)	**1,3186*** (3,4706)**	**1,0611*** (5,0324)**	0,4022 (0,4327)	**0,9885*** (6,0764)**	**0,9466*** (30,9944)**
	$D(CSE_t)$	-0,9754 (-0,8580)	0,2796 (0,5692)	0,1138 (0,3275)	1,0289*** (2,1796)	-1,3474** (-3,9105)	-0,2656 (-0,5235)
	$D(IPC_t)$	-2,1899* (-1,8182)	-0,0333 (-0,0752)	-4,7146* (-1,7492)	3,3224 (1,5531)	1,8612** (2,1444)	1,2132 (1,3693)
	$D(DTPI_t)$	0,0499 (0,7527)	-0,0025 (-0,3906)	-0,0022 (-0,5210)	-0,0075 (-0,8567)	0,0220*** (3,0786)	0,0039 (0,4596)
	$D(DPI_t * CSE_t)$	**-0,4312* (-1,8521)**	**0,1025* (2,001)**	**0,5019* (1,6819)**	-0,1073 (-0,9560)	**-0,2728** (-2,1100)**	**-1,0039** (-2,1502)**
	ECT	-0,4446** (-2,4077)	-0,546*** (-3,5055)	-0,2971* (-1,7375)	-0,5468*** (-2,8328)	-0,556*** (-4,1158)	-0,5062** (-2,2598)
Long run equilibrium	CE_{t-1}	6,7156*** (5,2312)	3,6375*** (2,9082)	1,9211 (1,1161)	0,0819 (1,6944)	-1,2875** (-2,3427)	0,0426 (0,0889)
	DPI_{t-1}	**-0,4609** (2,2276)**	**1,3877** (2,4108)**	**1,0538*** (9,7704)**	0,7354 (0,4801)	**1,0322*** (4,3577)**	0,9219*** (7,1499)
	CSE_{t-1}	2,1941* (1,8880)	1,0446* (1,9112)	0,3830* (1,9944)	1,0007*** (7,0440)	-1,037*** (-2,9221)	-0,5247* (-1,7063)
	IPC_{t-1}	-4,9260* (-1,6627)	-0,0610 (-0,0751)	-4,2643 (-1,0800)	-2,3896 (-1,2742)	3,3483** (2,6442)	2,3966** (2,0881)
	$DTPI_{t-1}$	0,1124 (0,7892)	-0,0046 (-0,3865)	-0,0074 (-0,4541)	0,0031 (0,1609)	0,0396** (2,4168)	0,0078 (0,4785)
	$DPI_{t-1} * CSE_{t-1}$	**0,6012* (1,7601)**	**0,0102* (2,0611)**	**-0,2148* (-1,6521)**	-0,1472 (-1,2567)	**-0,229*** (-3,9712)**	-0,1861 (-1,9781)
	Constant	2,4038** (2,6560)	-1,1303** (-2,1497)	-9,7530 (-1.1355)	6,6775 (0,5387)	4,5920* (1,7828)	-9,5047* (-1,7663)
R²		0,9291	0,9937	0,9984	0,9827	0,9680	0,9917
Adjusted R²		0,9075	0,9909	0,9977	0,9753	0,8972	0,9891
F-statistic		43,068	36,674	148,3288	132,8133	117,9253	391,4278
Durbin-Watson		1,9362	1,9828	2,0355	1,9199	1,9728	1,9047
Model diagnosis							
Breusch-Godfrey auto-correlation test $\chi^2(1)$		0,1837**	0,9943**	0,8387**	0,6831**	0,5155**	0,6849**
Jacque-Bera normality test $\chi^2(1)$		1,330 (P-value 0,513)	0,044 (P-value 0,978)	1,4385 (P-value 0,487)	0,4790 (P-value 0,787)	2,8530 (P-value 0,240)	1,0226 (P-value 0,599)
ARCH heteroscedasticity test $\chi^2(1)$		0,1016**	0,5945**	0,1127**	0,1215**	0,1300**	0,1034**

Note: ***, **,* show significance at the 1%, 5% and 10% levels respectively and the values in brackets are the student « t » statistics.

It arises from the estimation that results that the explanatory power of the models as given by the adjusted coefficient of determination varies between 0, 89 and 0, 99 depending on the country considered. Thus the model is good for purposes of forecasts and economic policy. Moreover, the Fisher F statistics are high in each country showing that the estimates are globally significant. The coefficient of adjustment between the short and the long run is negative and significant for all the countries. However, apart from the CAR where all the coefficients are surprisingly significant, the majority of the coefficients are non-significant when we observe the set of countries.

In the short run, Equatorial Guinea is the only country for which the socio-economic conditions have a positive and significant effect on private sector investments. However, in the CAR this variable has a negative coefficient but public investments contribute positively and significantly to private sector investments. Moreover, in Congo, Gabon and Chad, public investment has a positive and significant effect. In Cameroon and Equatorial Guinea, no significant effect is observed. This could be explained by the price level which has a negative and significant effect the 10% on private sector investment. Also, prices do not have any effect on private sector investment in Congo, Equatorial Guinea and Chad. However, its sign is positive and significant at the 5% level in the CAR. The CAR is also the only country where the internal national debt has a positive and very significant effect (at the 1% level) on private sector investment. This is likely the reason for which, in spite of the socio-economic climate, public capital expenditure has a positive and significant effect (at the 1% level) on private sector investments. We also find that in this country (CAR) and Equatorial Guinea, credit to the private sector negatively and significantly affects the economic activity of the private sector at the respective thresholds of 5% and 10%. These conclusions are contrary to the findings of former studies in the empirical literature like Kamajou (1980); Blejer and Khan (1984); Barro (1991;1997); Serven and Solimano (1993); Peltonen *et al.* (2012); Cavallo and Daude (2011) who conclude on a positive and statistically significant relationship between the availability of credit to the private sector and the private sector investment.

The long run results enable us to identify two groups of countries in which the effects of public capital expenditure on private sector investment is not identical. The first group is made up of Cameroon, Congo, Gabon and Equatorial Guinea which are countries in which the socio-economic conditions are favorable and enable public investments to have a positive and significant effect on private sector investments. The case of Cameroon is surprising because in spite of good institutions, public investments have a negative and significant effect on private sector investments. However, the coefficient of credit to the economy in this country is positive and significant at the 1% level. The CAR is the only country where the interior national debt has a positive and significant effect on private sector investment. The second group is of countries is made up of the CAR and Chad where the socio-economic conditions, though unfavourable, have public capital expenditure which is complementary to private sector investment (although the coefficients obtained are not significant). The level of inflation is controlled since the coefficients in the two countries are positive and significant in the long run on private sector investment.

As regards the effect of the socio-economic conditions on the relationship between public and private investment, the analysis of the interactive variables (DPI*CSE) enables us to observe that in the short run, an improvement in the socio-economic climate reinforces the positive and significant effect of public investments on the productivity of the private sector in Gabon and Congo. However, in Cameroon, Equatorial Guinea, Chad and the CAR, the socio-economic conditions deteriorate the contribution of public expenditure on the productivity of private investments. In the long run, the positive sign of the socio-economic climate comes to reduce the negative effect of public investments on private sector investment in Cameroon. In Congo, it comes to reinforce the positive and significant effect of public investments. However, the negative effect of the socio-economic climate of Gabon and the CAR reduce the effectiveness of public investment expenditure.

5. CONCLUSION AND RECOMMENDATIONS

This study contributes to the literature on the effects of public investment and the quality of the institutions on private productivity. This study is interesting given the number of statistical exercises which we carry out in our analysis. Using ARDL estimation, we find that: In the short run, public investments contribute to the productivity of the private sector in all the countries. However, this contribution is significant only in Congo, Gabon, the CAR and Chad. It is also the case in the long run, except that in Cameroon, public investment reduces the activity of the private sector significantly. A favourable socio-economic climate reinforces the effectiveness of public investments in the stimulation of private sector investment in the majority of CEMAC countries. In addition, the role of other macroeconomic variables like inflation, credit to the economy and internal national debt are non-negligible in the proper functioning of the private sector. It is important for all countries of the CEMAC zone to cleanse their public finances, control their level of internal debt and develop their financial markets to increase the possibilities of financing and stimulate the private sector.

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