

# Heterogeneity of Inter-regional Efficiency of Education Public Spending in Fragile State: Evidence from Chad

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*Working Paper FW-005*

AFRICAN ECONOMIC RESEARCH CONSORTIUM  
CONSORTIUM POUR LA RECHERCHE ÉCONOMIQUE EN AFRIQUE



# **Heterogeneity of Inter-regional Efficiency of Education Public Spending in Fragile State: Evidence from Chad**

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**THIS RESEARCH STUDY** was supported by a grant from the African Economic Research Consortium. The findings, opinions and recommendations are those of the author, however, and do not necessarily reflect the views of the Consortium, its individual members or the AERC Secretariat.

Published by: The African Economic Research Consortium  
P.O. Box 62882 - City Square  
Nairobi 00200, Kenya

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# List of abbreviations and acronyms

ACS	Armed Conflicts Sequence
APEs	Associations des Parents d'Élèves (Parents' Associations)
CRS	Constant Returns to Scale
DEA	Data Envelopment Analysis
DMU	Decision Making Units
INSEED	National Institute of Statistics, Economics and Demographic Studies
FRM	Fractional Response Model
FSI	Fragility State Index
GDP	Gross Domestic Product
HRR	Head of Region Reshuffle
IMF	International Monetary Fund
MDGs	Millennium Development Goals
MENA	Middle East and North Africa
NGOs	Non-government Organizations
OECD	Organisation for Economic Co-operation and Development
SDGs	Sustainable Development Goals
UNDP	United Nations Development Programme
VRS	Variable Returns to Scale



# Abstract

This study analyses the inter-regional efficiency of education public spending in Chad, which is characterized by a long history of armed conflict. Specifically, we investigate the institutional, political, and security dimensions of fragility influencing the inter-regional education public spending efficiency for the period 2007-2016. The data used are from the Ministry of National Education and the National Institute of Statistics, Economics and Demographic Studies (INSEED) and cover 23 regions of Chad. The education public sector efficiency scores is estimated in the first stage using the Data Envelopment Analysis (DEA) approach, while in the second stage, the panel data Tobit regression is used to evaluate the determinants of the efficiency of the education public spending. The mean efficiency score is 0.96 in primary education and 0.90 in secondary education. This means that the better management of the education sector may allow reducing the amount of public education spending by 4% in primary education sector and 10% in the secondary education sector, given the actual level of the quality and the quantity of education. With regard to these results, the primary sector is more efficient than the secondary sector. The Tobit estimates suggests that efficiency is negatively associated to head of region reshuffle, armed conflicts sequence, and the number of parliament member, which capture, respectively, the institutional, security, and political dimensions of fragility. Based on our findings, it is recommended to the government to reduce the central government instability in general, and specifically the recurrent turnover of the head of region, these being the main determinants of public spending inefficiency in Chad.

**Keywords:** *Public spending; Efficiency; Fragile state; DEA; Panel data Tobit; Chad.*



# 1. Introduction

Chad is a landlocked fragile state<sup>1</sup> of 1,284,000 square kilometres based on 23 administrative regions. The country experienced more than four decades of civil war. Though the population has increased annually since 1993 at an annual rate of 3.6%, the country is sparsely populated with less than nine inhabitants per square kilometre (INSEED, 2009).] In addition, the population predominantly lives in rural areas (78%), and the country is among the lowest in human development indicators in the world (ranked 186 out of 188 countries [UNDP, 2016]).] These facts combined pose serious challenges for the supply of education in Chad. According to the 2016 State report on the national education system in Chad, education public spending has increased since 2003 due to the exploitation of oil. All the sub-sectors of education (primary, secondary, and tertiary) have seen an important improvement of their budgetary allowance. Between 2004 and 2016, the annual growth of the recurring public spending was between 16.3% and 24%. In comparison, the primary completion rate, which is an indicator toward the achievement of universal primary education, has slightly improved from 37.8% to 45.5% over the same period. In the same vein, the number of pupils per teacher in a school has enhanced but remains higher at about 57. Likewise, there are inter-regional differences in educational performance. Despite the improvement of input and output of education, the quantity and quality of education continue to be the two salient issues in Chad. These challenges question the efficiency of education public spending.

There has been considerable research done on the efficiency of education public spending (Tanzi & Schuknecht, 2000; Gupta & Verhoeven, 2001; Rayp & Sijpe, 2007; Afonso & Fernandes, 2008; Stichnoth & Van Der Straeten, 2013; Chan & Karim, 2012; Yotova & Stefanova, 2017; etc.). It's argued that, education public spending efficiency increases the level of human development, which contributes to the economic growth (Lucas, 1988). Most of these studies have highlighted several determinants of the education public spending efficiency including social, governance, political, and economic factors. However, among those factors, the institutional and security dimensions of fragility are regularly omitted by most of the researchers and policy makers as the key driver of the public spending efficiency. In addition, most of those papers do not first focus on the quality of education whereas the fourth Sustainable Development Goal (SDG4) explicitly aims to ensure inclusive and equitable quality education for all. Second, most of these studies do not analyse the inter-regional

efficiency of public spending in the case of African post conflict and fragile countries in general, and Chad in particular. Third, the previous studies do not compare the sub-level of education in order to enable policy makers to identify education sectors where local government spending is inefficient so as to allow them to reallocate their resources efficiently.

This study seeks to fill the gap observed in the literature and analyses the efficiency of local government spending and its determinants in fragile<sup>2</sup> state. The main objective of this study is, therefore, to highlight the heterogeneity of inter-regional efficiency of education public spending. Specifically, we explore the institutional, political, and security dimensions of fragility influencing the inter-regional education public spending efficiency. For this purpose, the method of Data Envelopment Analysis that can be classified as non-parametric is used to compute the efficiency scores. Also, the Tobit regression model is used to evaluate the determinants of education public spending efficiency.

The rest of this study is organized as follows. Section 2 provides a brief literature review; Section 3 gives an overview of the Chadian educational system; Section 4 proposes a methodology for assessing the efficiency of public spending and its determinants through the three dimensions of fragility (political, institutional, and security); Section 5 presents and discusses the results; and Section 6 concludes the paper.

## 2. Literature review

Literature on the efficiency of public spending in fragile state is rare. This study contributes to the literature on the efficiency of public spending, focusing on the role of the institutional, political, and security dimension of fragility factors.

There is an extensive literature that measure public spending efficiency and its determinants. Research findings have often varied based on the methodology used, due to the heterogeneity of the public spending efficiency factors and its mechanisms (Borger & Kerstens, 1996; Afonso et al., 2005; Afonso & Fernandes, 2006; Afonso et al., 2006; Haque & Osborn, 2007; Rayp & Sijpe, 2007; Afonso & Fernandes, 2008; Becker, 2008). The majority of these studies concentrate on public spending efficiency on education, social welfare, civil justice, investment, economic stability, and economic efficiency. But the results are not conclusive, which warrants more research, especially country case studies.

Before presenting some previous findings, we must clarify the concept of public spending efficiency. According to Chan and Karim (2012), public spending efficiency is defined as the ability of the government to maximize its economic activities given a level of spending, or the ability of the government to minimize its spending given a level of economic activity. Hence, public spending efficiency could be used as an indicator to evaluate the effectiveness of government policy implementation on social sector (education, health, and infrastructure), administration, etc. It is crucial for the government to spend the money collected from taxpayers efficiently, as it is accountable to its citizens. However, in the context of fragility, there is scarcity of resources, so it is essential to evaluate the allocation of resources to promote social public services deliveries. In this paper, we define efficiency as the ratio of observed output levels to the maximum level that could have been obtained for a given input level.

According to Maddl et al. (2008), public sector performance can be affected by various factors, like institutional and structural factors or other country-specific features. The OECD (2007) shows that institutional settings influence the efficiency of education spending. Wilson (2005) concludes that inefficiencies in transition economies might result from managerial ineptitudes or from other constraints outside authorities' direct control. Afonso et al. (2005) and Afonso and Fernandes (2008) argue that per capita income and education levels significantly affect government spending efficiency. These findings are supported by Borger and Kerstens (1996) and Rayp and

Sijpe (2007). Some studies illustrate that the public spending efficiency depends on the size of the public sector. Indeed, Afonso et al. (2005) argue that countries with a small public sector may appear to be more efficient. This finding is confirmed by Becker (2008), who shows that countries with obvious and citizen-friendly regulatory environments are relatively efficient in their public spending. Yogo (2015), in a recent study, examined the effect of ethnic diversity on the efficiency of public spending in a set of developing countries and found out that ethnic polarization is positively associated with higher efficiency.

The empirical literature on the efficiency of public spending in the education sector is consistent. In the case of African countries, Gupta and Verhoeven (2001) found that public spending on education positively affects the efficiency of public expenditure. In the same vein, Fenny and Rogers (2008) argue that literacy and school enrolment are the main determinants of public sector efficiency in small island developing countries. Brini and Jemmali (2015), in the case of MENA countries, use the Data Envelopment Analysis (DEA) and Tobit regression analysis to determine the impact of governance, political, and economic factors on the public spending efficiency. Their results show that there is heterogeneity between MENA countries in terms of the efficiency of public spending. The efficiency scores for the four main disaggregated accounts of public spending (administration, health, education, and infrastructure) perform differently from one country to another. In addition, their findings indicate that political stability, trade freedom, and economic growth, have a positive impact on public spending efficiency. Recently, Dobdinga et al. (2014), in the case of Central Africa countries, use the same methodology as Brini and Jemmali (2015) to analyse the efficiency of public spending in the education and health sectors. Their results confirm the heterogeneity of public spending efficiency between countries. Their results also indicate that the quality of budgetary and financial management has a positive and significant effect on efficiency, while corruption influences it negatively.

In the methodological approach, most of the studies measure the efficiency of public expenditure by using parametric and non-parametric methods. According to Yotova and Stefanova (2017), the main difference between the two methods is that the parametric methods require that the functional form of the efficiency frontier or, in other words, a specific functional form of the link between the inputs and outputs, be determined in advance. Non-parametric approaches, on the other hand, construct an efficiency frontier by using concrete empirical data on the inputs and outputs through mathematical programming. Grigoli (2014) argue that these methods have proven challenging. To overcome the difficulties of earlier studies, Grigoli (2014) use a hybrid approach to measure the efficiency of secondary education spending in emerging and developing economies. The approach accounts for the impact of the level of development on education outcomes by constructing different efficiency frontiers for lower- and higher-income economies. He finds evidence of large potential gains in enrolment rates by improving efficiency. These are largest in lower-income economies, especially in Africa. Reallocating expenditure to reduce student-to-teacher ratios (where these are high) and improving the quality of institutions (as measured by

the "governance effectiveness" indicator in the World Bank's Governance Indicators database) could help improve the efficiency of education spending. Easing access to education facilities and reducing income inequality (as measured by the Gini coefficient) could also help improve efficiency.

To the best of our knowledge, there is no study assessing the effect of institutional, political, and security dimensions of fragility on the efficiency of inter-regional public spending. In this line, we test the hypothesis, according to which a permanent local government reshuffle which capture the institutional dimension of fragility affects negatively the efficiency of public spending. In fact, during the three last decades, Chad has faced a permanent instability of central and local government. Government instability refers to the permanent government reshuffle. During the three decades, Chad changed successively 18 prime ministers and used more than 2,020 personalities as members of government (General Secretariat of Government, 2017). From 1990 to 2017, Chad registered 54 government reshuffles, an account of two reshuffles on average by year. In the same vein, the duration of local government (governor of region) do not exceed a year following the frequency of the central government reshuffle. In this sense, the optimal government duration is about six months; and the short duration of governor as head of region could contribute to the mismanagement of resources because he is the architect of authorization for expenditure. In the same vein, we assume that the sequence of armed conflict over the period 2007-2016, which is here the security dimension of fragility, could reduce the efficiency of public spending due to the fact that during the period of conflict, the priority of government is to provide security to its citizens. Finally, our hypothesis, based on the number of MPs at the local level measuring the political dimension of fragility, may affect negatively the efficiency of the allocated resources. This hypothesis comes to the fact that the competition for leadership among MPs at the regional level could lead to the fungibility of public spending. In fact, each MP tries to influence the local authority's objectives by matching their own political programme to the delivery of public services.

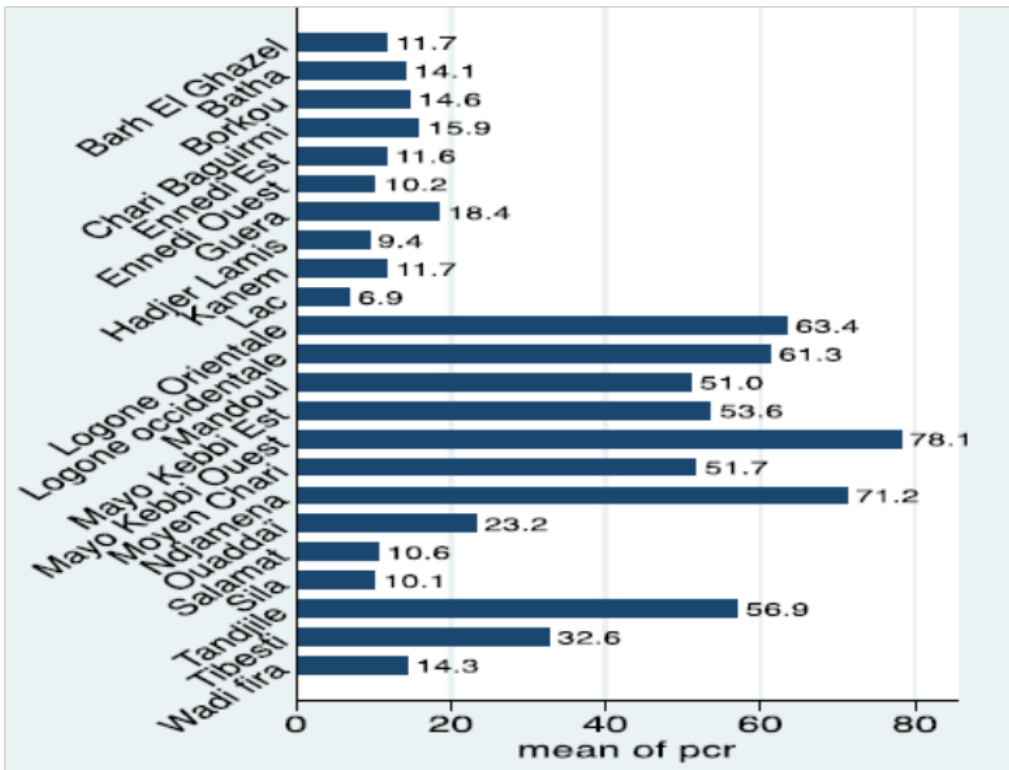
### 3. The Chadian educational system

The education system in Chad includes both formal and informal education. Formal education concerns the preschool, the primary education, the secondary education (general and technical) and the higher education. Formal education starts with the nursery school followed by six years of primary education, seven years of secondary education, and seven years of higher education. There are three types of schools in Chad: public schools, private schools mainly situated in urban areas, and community schools, for the greater part located in rural areas. It is worth noting that the community schools are directly created and managed by local communities (associations of parents) and welcomes any teacher profile. Those community schools benefit from the government support. Informal education includes literacy programmes as part of basic non-formal education. The literacy programmes are directed to the population of over 15 years old. The dropouts and unschooled from nine to 14 years old benefit from education programmes as a part of basic non-formal education, in order to help them to integrate in the formal system or to enter the labour force.

The Chadian education system uses officially two languages, which are French and Arabic. The use of Arabic is very limited. The diagnosis of the Chadian education system identifies the structural challenges. The main challenges identified in the basic education are the following: (i) Strong disparities are found: the gross school enrolment rate varies from 95% in the south to 20-40% in the north. Likewise, there are strong variations of the completion rate across regions: 78.1%, 71.2%, and 63.4%, respectively, in the West Mayo Kebbi, N'Djamena, and the Western Logone; and 10%, 9.4%, and 6.9%, respectively, for the Sila, the Hadjer Lamis, and the Lac (Figure 1). (ii) Repeated classes and dropouts remain high and may explain the stagnation of the primary completion rate. The repetition rate reaches 22% for the whole primary education (25.3% in the first year and 24.3% in the 5th year of primary school). (iii) An uneven distribution of the supply of education services: (a) more than 51% of primary schools are financed by the communities, especially in rural areas; (b) the community teachers represent 74% of the total number of teachers in public and community schools.



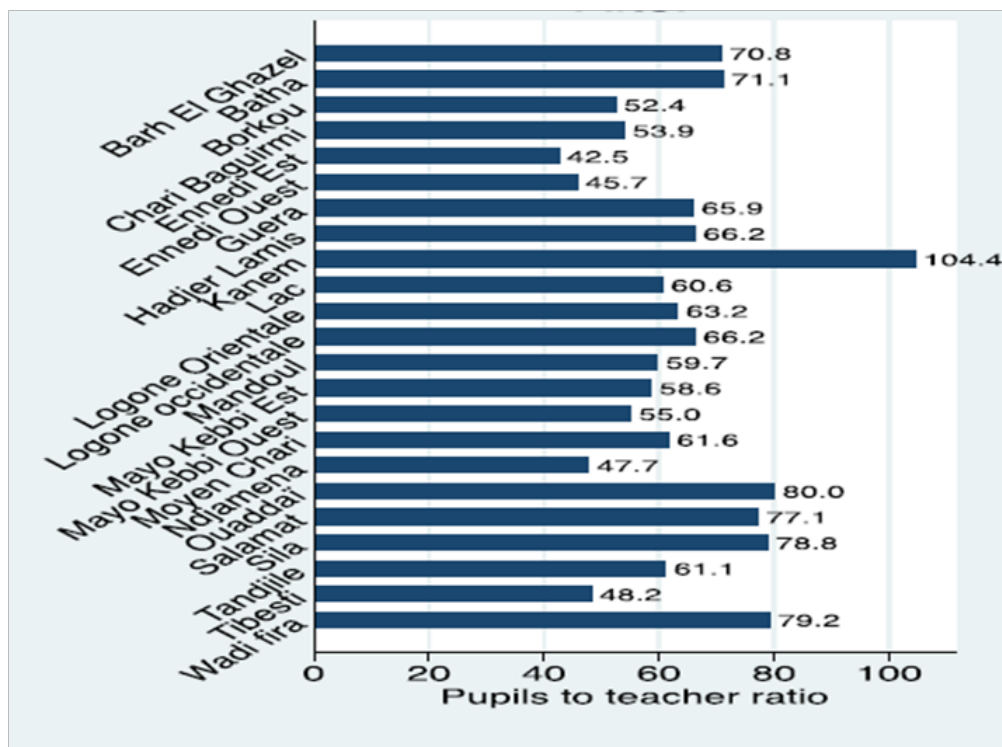
Figure 1: Primary completion rate, 2007-2016



Source: Authors.

In order to appreciate the quality of education, Figure 2 reports the pupils to teacher ratio. There is a significant improvement of the quality of education as measured by the pupils to teacher ratio. However, Figure 2 shows a strongly heterogeneous relationship across regions. For example, regions such as Tibesti witnessed a significant drop from 71 pupils per teacher to 48 pupils per teacher. In contrast, in the Kanem region, this ratio is 104.4. This ratio clearly suggests that other factors came into play and may explain these differences.

Figure 2: Pupils to teacher ratio, 2007-2016



Source: Authors.

## **4. Methodology and data**

### **Data**

The study use panel data covering 23 administrative regions in Chad. The regional dimension is chosen for comparative purpose. Data used in this research cover the period 2007-2016, and are drawn from the ministries of education and finance and from General Secretary of Government. Some additional data are from National Institute of Statistics, Economics and Demographic Studies (INSEED). The choice of the period depends on the availability of the data and takes into account the effectiveness of the administrative decentralization.

### **Measuring the efficiency of regional education public spending**

Measuring efficiency is based on the ratio of observed output levels to the maximum level that could have been obtained for a given input level. This maximum level is considered as the efficient frontier that will be the reference position for assessing the relative efficiency of public spending. Various methods have recently been applied to examine the efficiency of productive unit. The most used can be classified into parametric and non-parametric approaches (Herrera & Pang, 2005). The non-parametric approach developed by Farrell (1957), often assimilated to the Data Envelopment Analysis (DEA) method, uses linear programming to estimate the production boundary without any restriction on the functional form of the model. However, it attributes any deviation between the observed production and the frontier to inefficiency. In contrast, the parametric approach uses econometric tools and imposes specific assumptions, both for the functional form of the relationship between the input and the output, and for the inefficiency term calculated as the deviation of the observed values from the frontier.

The empirical literature is controversial about the choice between these two approaches to estimating technical efficiency. The choice depends on the research objectives and the availability of data. In our study, we use a non-parametric approach based on the Data Envelopment Analysis method inspired by Chan and Karim (2012) to estimate the ratio of efficiency for each region. The advantage of DEA compared

to other statistical efficiency measurement methods is that it is easy to incorporate several inputs and outputs into the analysis (Dobdinga et al., 2014). [ It measures efficiency in the context of the distance function, which does not require the imposition of behavioural assumptions for Decision Making Units (DMUs) or information on the prices of inputs and/or outputs. This makes DEA particularly useful in assessing the efficiency of organizations that are characterized by a non-profit objective (Wang & Eskander, 2011). Hence, in this research, the DEA framework has been used since it also facilitates comparisons among peers hence a systematic way of measuring relative efficiency within the sample used.<sup>3</sup> To capture the regional public spending efficiency, the non-parametric technic may allow deriving the efficiency score for each region.

Following Agasisti (2014), DEA mathematical formulation can deal with both constant returns to scale (CRS) and variable returns to scale (VRS). In a CRS model, the single DMU's dimension has no importance in defining efficiency performance, that is, DMUs face the same efficiency frontier, independently of their relative size. The VRS results can be derived by introducing the dimension factor in DEA modelling: each unit is analysed with respect to another of the same "relative" size. Both CRS and VRS efficiency can be calculated for each unit. In this study, we used VRS formulation to take into account the different relative size of the regions. In the same vein, DEA model present generally two specifications: input-oriented and output-oriented. In this paper, the input-oriented is used to consider that the government maximizes output in this sector given an amount of spending in primary and secondary education. Moreover, there is consensus on the importance of the education in economic performance. Globally, education has gained attention due to the MDGs and SDGs. It's argued that education help to promote achievement of reducing poverty. Since 2003, the education sector constitutes the priority of Chadian Government.

Banker et al. (1984) developed the following equation that we adopt to compute the technical efficiency.

$$\begin{aligned}
 & \max \varphi \\
 & \text{subject to} \\
 & \sum_{j=1}^n \gamma_j x_{ij} \leq x_{ik} \quad i = 1, 2, \dots, m \\
 & \sum_{j=1}^n \gamma_j y_{rj} \geq \varphi y_{rk} \quad r = 1, 2, \dots, s \\
 & \sum_{j=1}^n \gamma_j = 1 \\
 & \gamma_j \geq 0 \quad j = 1, 2, \dots, n
 \end{aligned}$$

The DEA method requires an empirical data containing inputs and outputs of a number of Decision Making Units (DMUs). Where,  $\varphi$  represents the efficiency,  $X_{ik}$  and  $y_{rk}$  are the  $i^{\text{th}}$  input and  $k^{\text{th}}$  output.  $\gamma_j$  is an unknown weight,  $j = 1, 2, \dots, n$  represents the number of DMUs. In this study, DMUs represent the 23 regions of Chad. The optimal value of  $\varphi^*$  represents the distance of each sector from the efficient frontier. Hence, the most technical efficient sector will have  $\varphi^* = 1$  and the inefficient sector shows  $\varphi^* < 1$ . By solving the above mathematical programming problem, we are able to get public spending efficiency scores in the two levels of education for each region over the period 2007-2016.

Coming up to the inputs and outputs to measure efficiency, we follow Agasisti (2014), Sutherland et al. (2009), and Afonso et al. (2005) by considering two types of education public spending: primary and secondary education. As output of primary and secondary education, we consider both the quality and quantity aspects of education proxies, respectively, by pupils-teacher ratio, success rate at the examination, gross enrolment and completion rate. The choice is justified by the fact that these indicators are the key targets in the education sector in Chad and match with the Sustainable Development Goals (SDGs). One measure of education quality is the pupils-teacher ratio—the number of pupils per teacher in a school. The importance of pupils-teacher ratio is to make personalized teaching as close as possible so that the teacher will give each child maximum attention. The higher the number of pupils in a class, the lesser the amount of attention each child will get. The quantity of education output measures for elementary and secondary schools typically include a physical volume measure, such as number of students. The school achievement rate is chosen as output of the quantity of education. It measures the percentage of children who have completed the whole cycle of primary and secondary school in the previous year. Also, the school enrolment as a measure of quantity education outputs is used.

## **Fragility factors influencing the efficiency of the inter-regional education public spending**

After computing efficiency scores for each region, we investigate the influence of the three dimensions of fragility (institutional, political, and security) on the efficiency of each education level spending. The choice of institutional fragility as the main interest variable is motivated by the fact that the head of region reshuffle is recurrent and is supposed to affect negatively the public spending efficiency as discussed in the literature review. To assess these impacts, we consider the efficiency score as the dependent variable of the model. Given that efficiency scores ranges between 0 and 1, panel Tobit regression model is appropriate. To check the robustness of Tobit regression, we use fractional logit to directly estimate the fractional outcome “efficiency score” per region which falls in the unit interval [0,1]. The fractional response model (FRM) developed by Papke and Wooldridge (1996, 2008) provides an effective approach to deal with the challenges posed by bounded dependent variables.

The variables that are naturally bounded between a minimum and a maximum as the case of efficiency score are subject to floor and ceiling effects and display non-constant responses to changes in the predictors as they approach the bounds (Papke & Wooldridge 1996). In this concern, the FRM estimates are robust.

The equation to be used is specified as follow:

$$Effscore = F(\textit{institution}, \textit{ethnic diversity}, \textit{density of population}, \textit{student education expenditure}, \textit{political fragility}, \textit{security fragility})$$

Where,  $Effscore_j$  is the efficiency score derived from each region  $j$ , ( $j= 1, 2, \dots, 23$ ); fragile *Institution* is captured here by the reshuffle of the head of region observed annually since 2007 in Chad. Contrary to the previous empirical studies which use various proxy of institution such as the economic freedom index, the political constraints index, the corruption perceptions index and the worldwide governance indicators which refers to the formal institutions (Dunning & Lundan, 2008; Meyer et al., 2009), we use the reshuffle of head of regions. This variable reflects the perceptions of the likelihood that the governor of the region might be changed. This variable is used as the proxy of institution's quality;  $X$  is a vector of control variables, which include the ethnic diversity measured as the number of ethnicities in the region and the logarithm of density of the population, the logarithm of per student education expenditure, and the political situation in the region. The political fragility proxy, captured here by the number of members of parliament (MPs) in the region  $j$ , measures the political situation. The use of ethnic diversity as control variable can be justified by the fact that it may make people less supportive of redistributive policies, implying a decrease of public spending (Stichnoth & Van der Straeten, 2013). The authors suggest that the mechanism through which ethnic diversity affect social spending is individual's preferences. In Chad, the supply of education service delivery remains weak. Therefore, Chadian families seized the organization of the primary schooling by recruiting and by paying themselves the teachers of their children. Of this remarkable mobilization, it results that in 2014-2015, 74% of the teachers of the primary school were "community teachers" that was recruited and paid by families. If this strong implication of families can be seen in a positive way, it can also contribute to the efficiency of education public spending. In this sense, we take into account the community financing of education. We introduce a dummy variable to measure the security's instability (the sequence of armed conflict in Chad) to measure the security fragility. This variable takes the value of 1 if there is armed conflict in region  $j$  over the period 2007-2016, and 0 otherwise. The time to attend school (mm) is also included as control variable to test the hypothesis that, the far the school, the less important are the success rate of examination, the enrolment rate or the school completion rate.

## 5. Empirical results and discussions

### Technical efficiency of inter-regional education's public spending

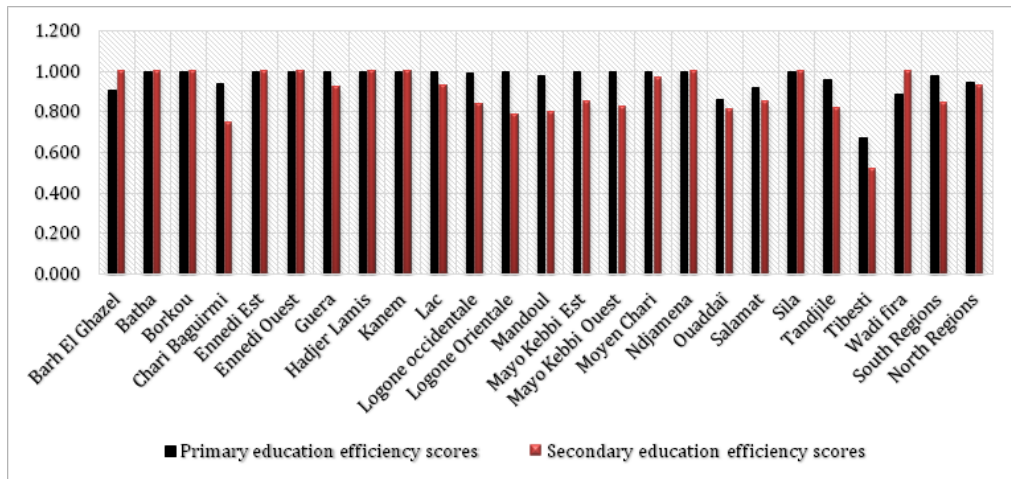
The DEA constructs input-oriented efficiency data from all the regions of a sample. The frontier is constructed in two steps. The first step use the education public spending per student as input and the multi-outputs of education by taking into account the success rate at the examination, pupils-teacher ratio, gross enrolment, and the completion rate. The second step focus on the issue of qualitative and quantitative education outputs, considering both primary and secondary education dimensions. We make use of variable returns to scale assumption because each unit is analysed with respect to another of the same “relative” size. The results are shown in tables A1 and A2 (in the appendix).

Figure 3 present the efficiency scores of education public spending both in primary and secondary education. The figure shows that education public spending are efficient in most of the regions considered as DMU, except the region of Tibesti where the efficiency score lies down for both primary and secondary education spending. This low efficiency in Tibesti could be explained by the geographical position (far north) and the recurrent political instability of the region. The recurrent armed conflict and the desert makes the living conditions difficult for the teaching staff, which often refuses to report to their posts. The socio-cultural constraints do not allow maintaining children at school in general and girls in particular. Most of the time children help their family to look after livestock and often engaged in the rebels groups despite the important education spending (construction of new schools and classrooms, textbooks, school canteen, etc.).<sup>4</sup>

The mean efficiency score is 0.96 in primary and 0.90 in secondary education. This means that the better management of education sector may allow reducing the amount of education public spending by 4% in primary sector and 10% in secondary sector, given the actual level of the quality and the quantity of education. The computation of efficiency score suggests that the primary sector is more efficient than the secondary sector. Figure 3 shows also that, on average, the south regions perform better in terms of the education public spending efficiency in primary sector and the north regions are more efficient in secondary sector. The difference between the north and south regions in secondary sector is explained by the recent physical

(construction of several modern schools) and human resources investment by the government in northern part of the country.

**Figure 3: Technical efficiency of primary and secondary education spending**



Source: Authors.

Figures 4 and 5 present the efficiency of the education public spending in terms of qualitative and quantitative education outputs, respectively. Figure 4 shows that there are some disparities across regions. The regions of Lac and N'Djamena are efficient in terms of qualitative primary education outputs (the success rate at the examination, pupils-teacher ratio) and Borkou, Ennedi Est, Logone Orientale, Mayo Kebbi Ouest, and Moyen Chari are the efficient regions in terms of education quantity (gross enrolment and completion rate). Coming up to the efficiency of secondary education spending, Figure 5 shows that Barh El Gazal, N'Djamena, Sila and Wadifira perform well in terms of education quantity. In the same vein, Salamat and Chari Baguirmi are efficient when considering the quality of education. However, the efficiency score is very low in Mayo Kebbi, Tandjilé and Logone orientale in terms of quantity of education.

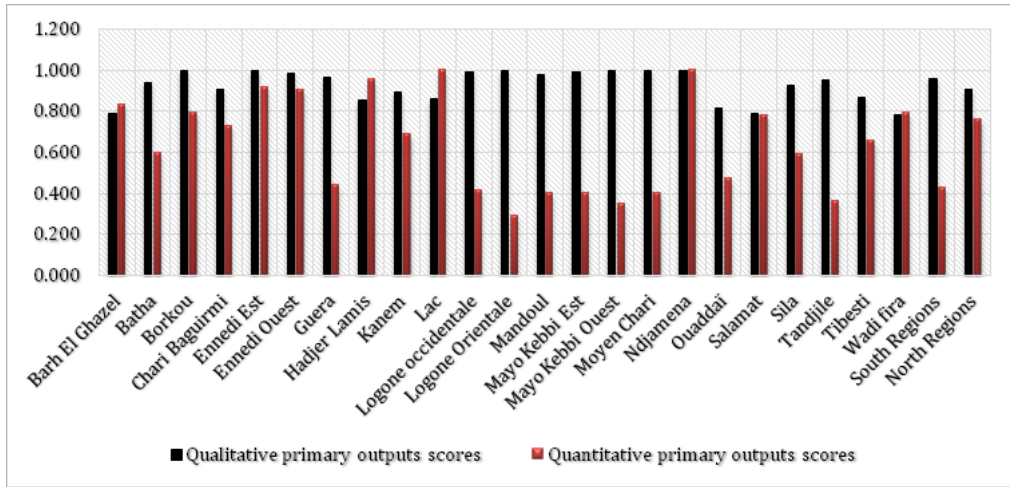
Chad is historically subdivided in three main geographical zones: a desert zone in the north, an arid Sahelian belt in the centre, and a more fertile Sudanese savanna zone in the south. These three zones present some difference in terms of education outputs mainly explained by the predominance of Arabic-Muslim culture in the north and Sahelian zone, and the Christian culture in the south. From the independence to 1990, most of the parents in the north and the Sahelian zone are in favour of Arabic schools and in the south there is prevalence of French schools. In the perspective of comparative analysis of education spending efficiency, we take into account the disparities between the two major zones in terms of quantitative and qualitative education outputs.



Analysing the efficiency of education public spending in terms of quantitative education outputs, we focused on the enrolment and completion rate as earlier explained. The results of the computation of efficiency scores show that the northern and Sahelian regions perform better than the southern regions. The technical efficiency of education spending are 0.757 and 0.695 in northern regions against 0.425 and 0.272 in southern regions, respectively, in primary and secondary education. The difference is explained by the management of the sector which is characterized by numerous challenges including uneven and suboptimal allocation of human and material resources to schools, insufficient capacity and funding, highly centralized sector management, and lack of data driven policy making. In addition, we must note that in the south there is a large implementation of community, confessional and private schools as opposed to the north regions which deeply depends on the central government.

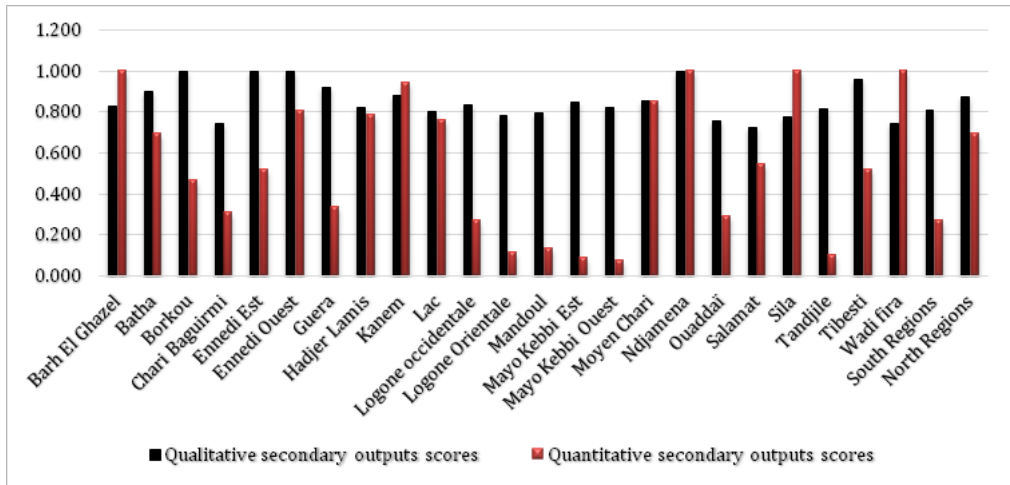
Regarding the efficiency of education public spending in terms of qualitative education outputs, we used the pupils-teacher ratio and the success rate of examination as outputs. The efficiency scores computed indicates that the southern regions are efficiently better in primary sector and the northern regions are better in secondary sector as illustrated in figures 4 and 5. The main explanation is that the primary schools in the south regions are largely community, confessional (catholic and protestant) and private, and are viewed to be a response to the low quality of public schools. Specifically, it's important to highlight the role played by the Parents' Associations (Associations des Parents d'Eleves, APEs) in the south regions. APEs were formed in the 1960s during the civil war following independence and played a key role in provision of education in the absence of a functioning state which was unable to respond to demand for education. Today, they continue to support the sector and are involved in construction of classrooms and community schools, the recruitment and management of community teachers (who work in both public and community schools), the collection of student fees, and the provision of financial and in-kind support to schools in their communities. Community teachers account for 60% of the total primary level teaching force in the country. The increased number of community teachers in the south regions makes better the pupils-teacher ratio and improves the success rate of examination. By contrast, in the north regions, the better efficiency in secondary education is mainly explained by the supplement efforts in terms of the supply of the quality of secondary education (such as the reduction of distance to school, effective presence of teachers, and facilities condition) during the last decade. In addition to the central government efforts, we must say that the participation of NGOs contribute also to the quality of secondary education, which hire additional teachers in science subjects.

**Figure 4: Technical efficiency of qualitative and quantitative primary education spending**



Source: Authors.

**Figure 5: Technical efficiency of qualitative and quantitative secondary education spending**



Source: Authors.

Based on the computation of efficiency scores, it's prudent to identify the key factors explaining the primary and secondary education spending efficiency. The next section highlights the determinants of the inter-regional efficiency of education public spending by exploring the effects of three dimensions of fragility (i.e., institutional, political, and security).

## **Effects of fragility factors on the inter-regional efficiency of education spending**

Table 1 report both the estimation results of the factors that influence the inter-regional efficiency of education public spending in primary and secondary sectors in Chad. Our interest variables, which are the institutional fragility (head of region reshuffle [HRR]), the security fragility (armed conflicts sequence [ACS]) and political fragility (the number of parliament member [MPs]), contribute to reduce the efficiency of public spending in the education sector. The panel Tobit and fractional Logit estimation results are presented. The estimates results of panel Tobit in columns 2 and 4 show that the three dimensions of fragility affect negatively the efficiency of education spending. The effects are significant at 5% for the reshuffle of the head of region and armed conflicts sequence, and at 1% for the number of parliament member in both primary and secondary education. This implies that the governor turnover, which captures the institutional dimension of fragility, leads to the mismanagement of public spending and the leakage of public resources. In addition, the recurrent prevalence of armed conflicts in Chad played an important role in public spending efficiency drop. This result shows that, during the period of conflict, the social spending are not the great concerns of the government. The big challenge of central and local government is to restore peace and to provide security to the population. This result is in line with those obtained by Gates et al. (2012). The negative effect of the number of parliament member, which measures the political dimension of fragility, suggests that an increase of the number of parliament member in the region increases the inefficiency of public spending in the education sector. This finding explains that the competition for leadership among MPs at the regional level could lead to the fungibility of public spending. In fact, each MP tries to influence the local authority's objectives by matching their own political programme to the delivery of public services.

Besides, the results suggest that the per student education expenditure exhibit a robust negative relationship with education spending efficiency. In fact, richer regions are less efficient given the higher level of revenue in these regions. These results are in line with those obtained by Yogo (2015), where an increasing per capita GDP harms the public efficiency.

**Table 1: Determinants of primary and secondary education spending efficiency**

Variables	Efficiency Scores of Primary Education Spending		Efficiency Scores of Secondary Education Spending	
	Panel Tobit	Fractional Logit	Panel Tobit	Fractional Logit
Ln(Head of region reshuffles)	-0.0273984** (0.0109738)	-0.19156** (0.0756168)	-0.02547** (0.0100098)	-0.1227293** (0.062153)
Armed conflicts sequence	-0.001814** (0.0132338)	-0.2374464** (0.0974511)	-0.031964** (0.013676)	-0.0996093** (.0785696)
Ln(Number of parliament member)	-0.152608*** (0.0358018)	-1.501598*** (.1824861)	-0.09365*** (0.0324209)	-0.8917772*** (0.1628197)
Ln(Density of population)	-0.0024126 (0.0154111)	-0.1591483*** (0.060045)	-0.0194818 (0.0075861)	-0.0541243** (0.0516967)
Ln(Ethnic diversity)	-0.051346 (0.0581612)	-0.0540175 (0.0988396)	-0.0279844 (0.0511895)	-0.1624276 (.0891414)
Ln(Per student education expenditure)	-0.0109123** (0.0083969)	-0.1006747** (0.0470998)	-0.01948*** (0.0075861)	-0.0612069* 0.0388457
Ln(Time to attend school)	-0.0151762 (0.0217323)	-0.4171625*** (0.0812811)	-0.0031084 (0.0193122)	-0.1230037** (0.0565535)
Constant	0.9338313*** (0.2561636)	4.76867*** (0.6080789)	1.149299*** (.225317)	3.855974*** (0.5318081)
Number of obs	230	230	230	230
Wald chi2(7)	37.13	228.60	56.12	183.30
Prob > chi2	0.0000	0.0000	0.0000	0.0000
Log likelihood	207.9815	-133.57214	229.70166	-145.78678

Notes: Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

To check for the robustness, the results of the fractional Logit model, presented in columns 3 and 5, are quite consistent in terms of signs with those of the Tobit estimation technique. The results suggest a negative and statistically significant effect of head of region reshuffle (HRR), armed conflicts sequence (ACS), and the number of parliament member (MPs) in both primary and secondary education spending efficiency. The results reveal also that the efficiency is negatively associated with the density of population (DS) and time to attend school (TAS). An increase of the population in a region causes the installation of corruption and consequently leads to the misappropriation of public resources and then to the inefficiency. The negative effect of time to attend school on efficiency is tied to the fact that fare to the school is a less important education output as success in examination rate, enrolment and completion rate. In general, fragility in Chad captured by head of region reshuffle, armed conflict, and number of parliament member, carries a significant and negative effect in the basic models discussed in the foregoing.

The marginal effects, presented in Table 2, are all significant except those related to the “ethnic diversity” variable. The marginal effects of the density of the population variable are negative and significant for all the models regressed albeit the coefficients of these variables are not significant for Tobit estimates in primary and secondary sectors as indicated in Table 1. The results are quite in line with the coefficients in terms of signs. Indeed, an additional of head of region reshuffle, armed conflict sequences or number of parliament member decreases the efficiency by 3%, 0.1% and 20% in primary sector and by 2.7%, 1.1% and 13% in secondary sector, respectively.

**Table 2: Marginal effects**

Variables	Efficiency Scores of Primary Education Spending		Efficiency Scores of Secondary Education Spending	
	Panel Tobit	Fractional Logit	Panel Tobit	Fractional Logit
Ln(Head of region reshuffles)	-0.0297302*** (.01105)	-.0389875*** (.01359)	-.026646*** (.0101)	-.0348238** (.01363)
Armed conflicts sequence	-0.0009713*** (.01325)	-.002265*** (.01675)	-.01156*** (.01217)	-.0174542*** (.01688)
Ln(Number of parliament member)	-.20464*** (.03104)	-.28107*** (.01926)	-.129678*** (.03439)	-.2839236*** (.0227)
Ln(Density of population)	-.0001529*** (.00004)	-.0001898*** (.00002)	-8.04e-06** (.00005)	-.0001085*** (.00001)
Ln(Ethnic diversity)	-.0123011 (.04422)	-.0172773 (.01946)	-.0399038 (.05649)	-.0581975*** (.02135)
Ln(Per capita education expenditure)	-.0172944** (.00851)	-.0342811*** (.00809)	-.021452*** (.00771)	-.0293929*** (.00908)
Ln(Time to attend school)	-.0279884 (.02172)	-.0786012*** (.01393)	-.002786 (.01969)	-.0231081* (.01312)

Notes: Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

With regard to the results obtained, the fragility in its three dimensions as measured above is harmful for per capita education spending efficiency in Chad.

## 6. Conclusion

This study highlights the heterogeneity of inter-regional efficiency of public education spending in Chad. Specifically, we explore the institutional, political, and security dimensions of fragility influencing inter-regional public education spending efficiency. For this purpose, efficiency is scored in a sample of 23 regions using data from 2007 to 2016. By employing the DEA in the first stage estimation, and in the second stage the Tobit and fractional Logit regression technic, the study suggests that the mean efficiency score is 0.96 in primary and 0.90 in secondary education sectors, respectively. This means that the better management of education sector may allow reducing the amount of public education spending by 4% in primary sector and 10% in secondary sector, given the actual level of the quality and the quantity of education. With regard to these results, the primary education sector is more efficient than the secondary education sector. The results suggest also that, on average, the south regions perform better in terms of education public spending efficiency in primary education sector and the north regions are more efficient in secondary education sector. The difference between the north and south regions in secondary education sector is explained by the best allocation of resources (human and capital) and investment in infrastructure in secondary education in the northern part of the country. The Tobit estimates suggests that efficiency is negatively associated to head of region reshuffle, armed conflicts sequence, and the number of parliament member which capture the institutional, security, and political dimension of fragility, respectively. In addition, the wealth measured by the per student education expenditure influences negatively the efficiency. The fractional Logit estimates reveal also that the density of population and time to attend school affects negatively the efficiency in primary and secondary education sectors. The improvement of the efficiency of public education spending features highly on the fragility. In this sense, it is recommended to the government to reduce the central government instability in general, and specifically the recurrent turnover of the head of region, these being the main determinants of public spending inefficiency in Chad.

## Notes

1. Rank 8 out of 178 countries (FSI, 2018).
2. According to the OECD's fragility framework, fragility is understood as "the combination of exposure to risk and insufficient coping capacity of the state, system, and/or communities to manage, absorb, or mitigate those risks." It differentiates the levels and types of fragility across five dimensions: political, societal, economic, environmental, and security.
3. However, the key weaknesses of the DEA are due to the fact that it does not measure "absolute" efficiency. Also, the basic statistical tests are not applicable; and above all, DEA method can suffer from measurement errors (Dobdinga et al., 2014).
4. It is one of the regions that still benefit from the school canteen for the simple reason to get the children back to school.

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# Appendix

**Table A1: Technical efficiency score of primary education spending (VRS)**

Regions	Qualitative Primary Outputs Scores	Quantitative Primary Outputs Scores	Global Primary Outputs Scores
Barh El Ghazel	0.794099	0.832694	0.910337
Batha	0.943538	0.598498	1.000000
Borkou	1.000000	0.789333	1.000000
Chari Baguirmi	0.910543	0.723842	0.939909
Ennedi Est	1.000000	0.915801	1.000000
Ennedi Ouest	0.986437	0.903423	1.000000
Guera	0.965517	0.441837	1.000000
Hadjer Lamis	0.859002	0.955624	0.997805
Kanem	0.895848	0.684254	1.000000
Lac	0.866032	1.000000	1.000000
Logone occidentale	0.992527	0.413165	0.992754
Logone Orientale	1.000000	0.288885	1.000000
Mandoul	0.978834	0.399133	0.981339
Mayo Kebbi Est	0.991085	0.398927	1.000000
Mayo Kebbi Ouest	1.000000	0.349868	1.000000
Moyen Chari	1.000000	0.401213	1.000000
Ndjamena	1.000000	1.000000	1.000000
Ouadaï	0.818618	0.472801	0.862140
Salamat	0.793164	0.781797	0.920353
Sila	0.930693	0.591397	1.000000
Tandjile	0.951975	0.363607	0.959062
Tibesti	0.869425	0.656896	0.671611
Wadi fira	0.784179	0.790436	0.888461
South Regions	0.963124	0.425327	0.982443
North Regions	0.9080327	0.757412	0.951025
Mean score	0.927457	0.641453	0.961903

**Table A2: Technical efficiency score of secondary education spending**

<b>Regions</b>	<b>Qualitative Secondary Outputs Scores</b>	<b>Quantitative Secondary Outputs Scores</b>	<b>Global Secondary Outputs Scores</b>
Barh El Ghazel	0.830935	1.000000	1.000000
Batha	0.904613	0.695521	1.000000
Borkou	1.000000	0.462725	1.000000
Chari Baguirmi	0.744755	0.311752	0.744755
Ennedi Est	1.000000	0.520909	1.000000
Ennedi Ouest	1.000000	0.801891	1.000000
Guera	0.923227	0.337316	0.923227
Hadjer Lamis	0.827051	0.784190	1.000000
Kanem	0.885544	0.938582	1.000000
Lac	0.807681	0.761202	0.928547
Logone occidentale	0.837920	0.271645	0.837920
Logone Orientale	0.785624	0.115083	0.785624
Mandoul	0.798956	0.133297	0.798956
Mayo Kebbi Est	0.850584	0.089009	0.850584
Mayo Kebbi Ouest	0.826588	0.073263	0.826588
Moyen Chari	0.853814	0.849311	0.966668
Ndjamena	1.000000	1.000000	1.000000
Ouaddaï	0.757766	0.288242	0.811971
Salamat	0.723386	0.546780	0.848682
Sila	0.778760	1.000000	1.000000
Tandjile	0.816457	0.098940	0.816457
Tibesti	0.962756	0.519295	0.519295
Wadi Fira	0.745252	1.000000	1.000000
South Regions	0.812328	0.272445	0.841342
North Regions	0.878234	0.695423	0.929423
Mean score	0.854855	0.547780	0.898229

**Table A3: Descriptive statistics, education efficiency regression**

<b>Variables</b>	<b>Obs</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min</b>	<b>Max</b>
Primary education spending efficiency scores	230	0.6944442	0.173271	0.401391	1
Secondary education spending efficiency scores	230	0.611985	0.1719655	0.343462	1
Ln(Number of head of region reshuffles )	230	0.5859734	0.5543278	0	1.791759
Armed conflicts sequence	230	0.3434783	0.4759051	0	1
Ln(Number of parliament member)	230	1.902064	0.4855157	0.6931472	2.995732
Ln(Population density)	230	2.524984	1.733517	0	7.914966
Ln(Ethnic diversity)	230	3.848233	0.3971374	3.044523	4.330733
Ln( Per student education expenditure)	230	9.150086	1.132172	7.059618	11.9635
Time to attend the school	230	3.703161	.4796415	2.564949	4.61512

Notes: This is the minimum number of observations used in regressions. All the negative values of the density of population obtained after the log are transformed in 0.



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