# Is there a natural resources curse on educational inequality? Does political concentration matter? Empirical evidence in developing countries.

**Mondjeli Mwa Ndjokou Itchoko Motande**
FSEG, University of Maroua, Cameroon
Email : motande@yahoo.fr

**Soumtang Bime Valentine**
FSEG, University of Yaounde II-Soa, Cameroon
Email : valentinebime@yahoo.com

**Koumis Ngagni Agathe Cassandra**
FSEGA, University of Douala, Cameroon
Email: cassandrakoumis20@gmail.com

**Abstract**: There is a vast literature on inequality and the controversial effects of natural resources. However, despite the importance of inequality, little is known about the effect of natural resources on educational inequality and even less about the role of institutions in this relationship. This study fills this gap by assessing the role of political concentration in the relationship between natural resources and educational inequality. Using data from 81 developing countries from 1995 to 2019, we estimate a two-stage least squares model. The results show that while natural resources reduce educational inequality in DCs, political concentration tends to worsen this effect. This result partly explains the natural resource curse in developing countries. The results remain stable to additional factors, another measure of natural resources, and changes in estimation technique. We suggest that political power should be less concentrated and suggest more decentralization for a better allocation of rents in education systems.

**Keywords:** educational inequality, natural resources, political concentration, developing countries
**JEL Codes:** E02, D63, O13, Q32.

## 1. Introduction

Inequality of access to education has become a major concern for scholars and policy makers these last decades. In fact, although the literature recognizes the positive externalities of education, the issue of its distribution gained wider interest because educational inequality is accompanied by perverse effects, notably a reduction in the efficiency of workers (Nelson and Phelps, 1996), as well as a deterioration in health and governance conditions (Barro, 2001). This problem has given rise to a literature on the levers that should be used by policymakers to reduce disparities in educational attainment (Grewenig et al., 2021). Among them, economic factors such as gender gap and school achievement have been higlighted to explain educational inequality (Wiggan, 2007; Prasartpornsirichoke and Takahashi, 2012; Harahap et al., 2020). In addition, socio-cultural factors have been recognized as determinants of educational inequalitiy in the empirical literature, such as language (Tienda, 2009), race (Wiggan, 2007). Also, institutional factors such as governance conditions and political systems have also been identified as determinants of educational inequality (Al-Samarrai, 2009). However, the question of whether and to what extent natural resources can affect educational inequality remains under exploited. Intuitively, there are at least three reasons to believe that natural resources can explain educational inequality. First, natural resources generate additional revenues in a rich-abundance country. The allocation of these revenues in the sector of education can reduce educational inequality. Second, it has been documented that natural resources are often accompanied by political instability, conflicts, corruption, etc. (Tadadjeu et al., 2021). This poor institutional quality can have perverse effects on the educational equality of citizens. Third, natural resources generally crowdout from production sectors of the economy to rent-seeking activities which in turn accentuate educational inequality.

The effects of natural resources have been widely documented in the literature. The first strand of studies was focused on their growth effects. Since the seminal paper of Sachs and Warner (1995, 2001) highlighting the natural resources curse, many empirical papers have examined the relation between natural resources and economic growth with mixed results. For instance, while Sharma and Pal (2021) confirm the resource curse hypothesis, Arin and Braunfels (2018) demonstrate the blessing of natural resources. The second strand of papers analysed the effects of natural resources on many aspects of development, including wealth inequality (Njangang et al., 2022). As it's well known, wealth inequality is not the only one and can be a source of many other types of inequalities like educational inequality. Also, many studies have extended the resource curse to education expenditures (Gylfason, 2001; Stijns, 2006; Cockx and Francken, 2016; Okada and Samreth, 2021) with the implicit assumption of an increase of educational inequality. But the assumption of how natural resources affect educational inequality have not been, to the best of our knowledge, explicitly tested in the literature. Relying on the controversial findings on resource curse hypothesis, a third strand of scholars concentrated on the role of the quality of institutions (Mehlum et al., 2006; Mondjeli and Tsopmo, 2017; Belarbi et al., 2021).

This study extends this strand of the literature by providing empirical evidence on the role of political concentration on the effect of natural resources on educational inequality. We argue that political concentration, defined as the acquisition of political power by a single political party (Grunewald et al., 2020), affect the extent to which natural resources can reduce educational inequality. This purpose can be legitimate and justified theoretically.

Natural resources can create new opportunities that will increase household income, allowing them to invest more in children's education and reduce educational inequality. Also, these natural resources tend to induce rents that increase national incomes (Cavalcanti et al. 2019) and therefore investment in education, especially in terms of educational infrastructure. However, according to Stigler's (1971) theory of regulatory capture, political leaders can be selfish and self-interested, and natural resources induce patronage in the sense that political elites pay their supporters to stay in power, which leads to reduced accountability and misallocation of public funds (Kolstad and Soreide, 2009). Similarly, based on Ostrom's (1990) tragedy of the commons theory, political concentration will encourage political elites to use the rents from natural resource exploitation for their own personal interests. This action will encourage the disregard of the diverse interests of local populations in the process of sustainable natural resources management (Agrawal and Gupta, 2005). In this context, political concentration leads to a more opportunistic behavior of the political elite to use rents to bolster their political supporters in order to stay in power and secure re-election (Shaxson, 2007). Public funds used for patronage could be used in more socially productive ways, such as building schools in remote areas, training teachers, subsidizing school fees...

Nevertheless, Birdsall et al (2001) argue that political elites do not necessarily have an incentive to invest in education[1] beyond a certain threshold. This argument is based on the assumption

[1] The accumulation of education would make the population more thoughtful, which will prevent elites from remaining in power from one generation to the next.

that, consistent with Andersson and Berger (2018), political elites tend to use their influence to block the diffusion of mass education due to the low compatibility between agricultural work and education, or as a means to reduce the mobility of the rural labor force by limiting its external options. As a result, political concentration renders the allocation of natural resource rents inefficient and leads to differential preferences in income redistribution in terms of investment in education in particular, which contributes to increasing educational inequality.

On the basis of the underlying considerations, this article seeks to contribute to the existing literature at three major levels. First, it contributes on the empirical literature on the challenges of natural resources. Although several studies have shown the effect of natural resources on income inequality, this study provides, to the best of our knowledge, the first analysis of the effect of natural resources on educational inequality. Therefore, we fill the gap in the literature on the determinants of educational inequality by highlighting the effect of natural resource. In addition, this paper conducts an analysis in developing countries to shed light on the question of whether there is a natural resource curse with respect to educational inequality. Second, unlike the work of Mehlum et al. (2006) which argue that the natural resource curse only occurs in countries with low institutional quality, this paper specifically examines the conditions for the efficiency of natural resource rents by focusing on political concentration. As such, it contributes to the literature by providing a plausible explanation for the natural resource curse suffered by most resource-rich countries. Third, this paper analyzes natural resources by type. Indeed, several empirical works show that different types of natural resources have differential effects on economic and social development in general (Isham et al., 2005; Cockx and Francken, 2016; Tadadjeu et al., 2020; Avom et al., 2022). Thus, there is a possibility that different types of natural resources might also have different effects on educational inequality.

Apart from the contribution, the paper is mainly motivated by stylized facts. In this veine, statistics show that the level of educational inequality is high in developing countries (DCs). Indeed, according to the UN report (2020), the number of out-of-school children has increased from 55 million in 2012 to 57 million in 2020. Also, DCs contain the countries with the highest number of illiterates in the world, contrary to OECD countries whose rates are established at 5%. Nigeria and India are the most prominent examples with 20% and 37% of the population respectively (World Bank, 2020). Also, statistics reveal that the majority of DCs have a large endowment of natural resources. As an illustration, natural resource data shows that Venezuela has the largest oil reserves on the planet (Hooper, 2017). Moreover, the Democratic Republic of Congo (DRC) alone covers 34% of the continent's diamond production and 13% of copper. Similarly, the value of untapped minerals in the DRC is estimated at over $24 billion. Furthermore, the database of political institutions (2020) shows that most DCs have a high level of political concentration. This is the case, for example, of Angola and Senegal, Bhutan, Ukraine and Yemen which have levels of political power that tend towards 1, reflecting a high level of political concentration.

Beyond these statistics, the combined analysis identifies several cases. First, countries richly endowed with natural resources have high political concentration and high educational inequality. This is the case, for example, in Angola[2]. Second, countries richly endowed with natural resources can also be accompanied by low levels of educational inequality and political

[2] According to the political concentration, data for this country vary between 0.8 and 1 from 1975 to 2019. It has significant amounts of copper, iron and mercury (IRIS, 2018). And according to its Ministry of Education, 13. 4% of young people under the age of 18 have never attended school and only 13% of young people aged 18 to 24 have been able to complete secondary education.

concentration, as in the case of Eritrea[3]. Third, the analysis reveals countries with low natural resource endowments that have low levels of political concentration and educational inequality, such as Rwanda[4]. Fourth, there are countries with high levels of natural resources and political concentration, but low levels of educational inequality, such as Ukraine[5].

The remainder of the article is organized as follows. Section 2 presents the empirical strategy. In section 3, the basic results are presented and discussed. Section 4 is dedicated to the sensitivity tests. Robustness tests are conducted in section 5. Section 6 provides a conclusion.

## 2. Empirical strategy

### 2.1. Data and methodology

In this study, we use data from various sources for a sample of 81 developing countries from 1995 to 2019. The study period and sample size are chosen based on data availability.

#### *2.1.1. Dependent variable*

The main dependent variable, educational inequality (EI), is measured by the inverse of the education equality variable from the Vdem (2020) database. It is the extent to which quality basic education is guaranteed for all. It varies between 0 and 4; the value 0 reflects total inequality of access to basic education and the value 4 equal access to basic education. This variable is notably justified by its availability on a large panel. Moreover, the choice of inequalities linked to basic education is motivated by the conclusions of Teles et al. (2008). They postulate that basic education constitutes the essential component for social and demographic progress, sustainable economic development and equality in the world.

#### *2.1.2. The independent variables*

Natural resources and political concentration are the main explanatory variables. To capture natural resources, we use natural resource dependence measured by total natural resource rents as a percentage of GDP in line with the works of Kamguia et al. (2022) and Crivelli and Gupta (2014). This data is obtained from the World Bank (2021). Total resource rents are the sum of oil rents, natural gas rents, coal rents, mineral rents and forestry rents. There are two main reasons for choosing this measure, as opposed to others such as abundance. Firstly, total resource rents are widely available in all countries and for a long period of time; this minimises the risk of sample selection bias. Secondly, following Antonakakis et al (2017), it is argued that natural resource dependence is the most suitable variable to test the resource curse hypothesis as it captures the extent to which political elites exhibit rent-seeking behaviour. This argument is legitimate since the more an economy is dependent on its resources, the greater the likelihood that political elites will engage in rent-seeking behaviour (Sachs and Warner, 2001). We decompose this measure into five components, to examine how each of these components affects educational inequality.

We measure political concentration by the Herfindhal index, taken from the Political Institutions Database (PID, 2020). This indicator has been used by Amodio et al. (2022) and takes into account the seat shares of all political parties in the government of a country. The

[3] The school enrollment rate is 82% (GPE, 2019). According to a report (DB city, 2020), this country has a good number of natural resources within it.

[4] Data from IFAD (2020) show that Rwanda is poorly endowed with natural resources. According to the Education Science Review (2020), the Rwandan government has expanded access to education.

[5] For Ukraine, its level of political concentration has been around 1 for the last few years; according to franceinfo (2013), this country is highly rich in iron, gas, oil and many other types of natural resources. And statistics from the Ministry of Education reveal that the literacy rate in this country reaches almost 90%.

value of the index ranges from 0 to 1 and measure the degree to which all executive, legislative and judicial powers in an economy are held by a single political party (Belloc et al., 2014). The value is high when powers are less spread across parties and more concentrated. A low value reflects distribution of power within the government. The choice of this indicator is justified by the fact that it takes into account all political parties, its high reliability and its broad cross-country coverage (Aguileraa et al., 2020).

#### *2.1.3. Control variables*

We follow the literature on the determinants of education and inequality and select several control variables such as public expenditures, inflation, foreign direct investment, fertility, urbanization, and economic growth. Indeed, according to Muttaqin (2018), public expenditures measured by public spending on education as a percentage of GDP contributes to access to education and schooling, through teacher training or even the construction of appropriate infrastructure; this contributes to reduce educational inequality. The expected sign is therefore negative. With regard to inflation captured by the current annual rate of inflation, the literature suggests that high inflation leads to a progressive decrease in purchasing power. As a result, economic agents will no longer have enough income to access the education system, which has become too expensive for them (Bhattacharjee, 2017). This will increase educational inequality. The expected sign is therefore positive.

Foreign direct investment, measured by net inflows as a percentage of GDP, is also important as, according to Ashour and Fatima (2016), FDI can provide simple technology without spill over effects. Moreover, they are mainly attracted by low labour costs in host countries. Consequently, the employment opportunities created by foreign multinationals will not generate enough opportunities to promote schooling in these countries. The literature also shows that fertility, such as the number of births per woman, is important in explaining educational inequality. Indeed, in most low-income countries, since access to education imposes costs, the family has to make choices and prioritise who should go to school. This implies making sacrifices within a family and choosing the 'chosen' members to go to school (Checchi, 2006). Educational inequality will therefore be higher in households with many children.

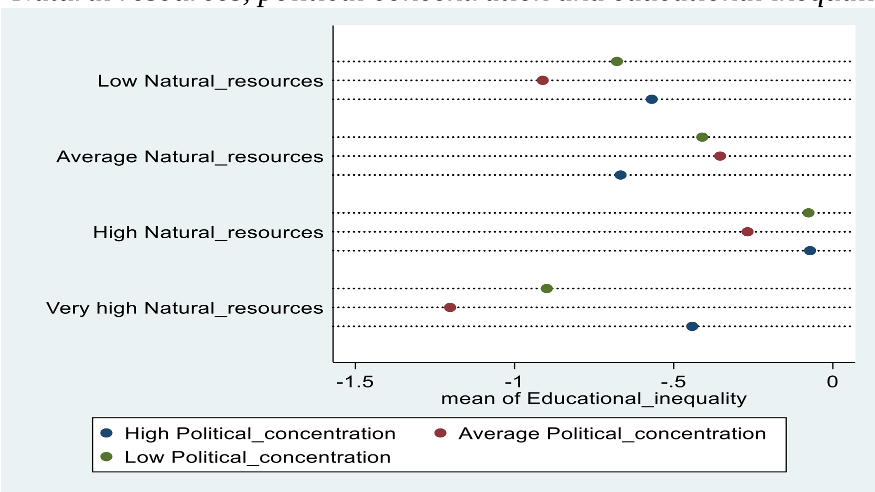
With regard to urbanization, studies show that the share of the urban population in the total population is essential as it increases the educational attainment of populations (Kamguia et al., 2022; Konuk et al., 2016). It therefore reduces educational inequality, as schools in urban areas are larger, have more infrastructure and more teachers than in rural areas (OECD, 2013). Finally, Christofides et al (2001) argue that the rate of GDP growth provides more means to invest in educational infrastructure on the one hand, and to pay school fees on the other. The expected sign in both cases is negative. These variables are taken from the World Bank (2020).

Table 1 presents the descriptive statistics of the variables used in the estimations. It shows that most of the countries in our sample have an unequal distribution of access to basic education, as indicated by the mean level of 1.44. A closer look at the data reveals that most of the countries at the lower end of the education inequality index are African countries. Statistics reveal that political power is highly concentrated in our sample, as shown by the average level of the political concentration index at 0.797 (which is very closed to the upper threshold); while natural resources remain on average quite low relative to GDP. Furthermore, Figure 1 presents the scatterplot between interest's variables in this study. We find that for most cases, regardless of the level of natural resources, the countries with the highest education inequality are those with very high political concentration. This means that an increase in political concentration is associated with higher educational inequality whatever the level of natural resource dependence. However, since correlation does not mean causality, this relationship will be evaluated empirically in the next section.

*Table 1: Descriptive statistics*

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Educational inequality | 2.106 | 1.443356 | .9974986 | -1.295 | 3.859 |
| Natural resources | 1896 | 9.037 | 10.167 | 0 | 81.95 |
| Political concentration | 1729 | .797645 | .2728546 | .0945476 | 1 |
| Public expenditures | 571 | 44.244 | 12.283 | 15.615 | 104.145 |
| Inflation | 1802 | 14.568 | 119.937 | -18.109 | 4145.106 |
| Foreign direct investment | 1893 | 3.494 | 6.234 | -37.173 | 103.337 |
| Fertility rate | 2024 | 4.33 | 1.496 | 1.078 | 7.725 |
| Urbanization | 2097 | 14.985 | 1.887 | 10.041 | 19.993 |
| Economic growth | 1982 | 4.054 | 5.031 | -46.082 | 35.224 |
| | | Robustness | | | |
| Oil | 1896 | 3.217 | 8.401 | 0 | 62.697 |
| Forest | 1907 | 4.102 | 5.648 | 0 | 40.408 |
| Coal | 1856 | .18 | 1.057 | 0 | 25.965 |
| Gas | 1893 | .516 | 2.712 | 0 | 57.834 |
| Mineral | 1907 | 1.013 | 2.683 | 0 | 27.66 |
| | | Sensitivity | | | |
| Ethnic | 1976 | .551 | .268 | .002 | .93 |
| Language | 1924 | .543 | .293 | .002 | .923 |
| Religion | 2028 | .432 | .245 | .002 | .819 |
| Distance to the equator | 2002 | 221.455 | 153.796 | 10.001 | 681.982 |

*Figure 1: Natural resources, political concentration and educational inequality in DCs*




*Source: Author's construction*

### 2.2.Model and estimation technique

In order to assess the role of political concentration on the natural resources and education inequality nexus, we specifiy a model as follows:

$$EI_{it} = \alpha + \beta NatRes_{it} + \delta PoCon_{it} + \gamma NatRes_{it} * PoCon_{it} + \vartheta X_{it} + p_t + \pi_i + \delta_t \quad (1)$$

$EI$ is educational inequality, $NatRes$ represents natural resources, $PoCon$ is the indicator of political concentration. $X$, $\delta_t$ and $p_t$ are respectively the vector of control variables, the error term and the time fixed effect. $NatRes * PoCon$ represents the combined effect of natural resources and political concentration. A negative sign of this coefficient indicates that political concentration allows natural resources to reduce educational inequality. On the contrary, a positive sign suggests that political concentration enables natural resources to further increase educational inequality.

For the estimation of our empirical model, we use the two-stage least squares (IV-2SLS) of Basmann (1957) and Theil and Nagar (1961). This estimator is useful to solve econometric problems such as heteroscedasticity and endogeneity. The estimator includes potential time invariant omitted variables in the estimation to account for some unobserved heterogeneity, which further controls for other forms of endogeneity. Moreover, it also considers the biases that appear due to country-specific effects. According to Baum et al. (2003), heteroscedasticity is an omnipresent problem in empirical studies and a more efficient way to handle it is to use the IV-2SLS. Theoretically, endogeneity may arise due to reverse causality, measurement errors, or omission of some relevant explanatory variables [6]. In fact, data on natural resources and political concentration may contain measurement errors, especially when we consider the series for developing countries. Also, omission bias is another source of endogeneity, as the specified econometric models may not consider all the determinants of educational inequality.

Moreover, this method consists in assigning to each variable suspected of suffering from an endogeneity bias at least one instrumental variable. According to Lewbel (2012), the choice of instruments is a crucial step in determining the outcome of the estimates. Indeed, the use of instrumental methods requires that appropriate instruments be available to identify the model, often through exclusion restrictions. These instruments must satisfy three conditions: *(i)* the orthogonality condition (the instrumental variable Z must be independent of the error term) *(ii)* it must be correlated with the variable X which is assumed to be endogenous *(iii)* the instrumental variable must be exogenous to the estimated model. However, finding appropriate instruments that simultaneously satisfy these three conditions is often problematic and constitutes the main obstacle to the use of IV-2SLS techniques (Lewbel, 2012).

Consistent with this, a portion of the literature has highlighted another type of so-called internal instrument that involves lagging the endogenous explanatory variable(s). Lagging overcomes potential endogeneity biases resulting from simultaneity and negative causality, since lagged political concentration is likely to be exogenous to economic variables (Islam, 2018). In addition, Bénassy-Quéré et al. (2007) point out that when panel data are used, the presence of country fixed effects automatically precludes the use of external instruments. Thus, they use the lag of their explanatory variable (institutional quality) as an instrument with panel data. Similarly, Li et al. (2018) use the lagged value of Transparency International's Corruption Perception Index (CPI), lagged by two periods, as an instrumental variable. Feldmann (2017) additionally argues that the use of lags increases the likelihood that his estimates reflect the influence of his explanatory variable rather than the other way around. Therefore, according to Mignamissi and Nguekeng (2022), Samba and Mbassi (2022) and Lewbel (2012), we use lagged explanatory variables as instruments. The results will be valid if the Hansen test is not significant, i.e., the instruments are not correlated with the error term on the one hand. On the other hand, the test for under-identification of the instruments given by the Kleibergen-Paap and Wald F statistic must be at least 10 for under-identification not to be considered a problem (Saadi, 2020).

[6] Samba et Mbassi (2022) argue through their study that unlike GMMs that deal with endogeneity in a global way, double least squares (IV-2SLS) have the particularity to deal with endogeneity problems in a specific way. Otherwise, double least squares (IV-2SLS) appear as a specific case of GMM.

## 3. Empirical results

### 3.1. Baseline results

This subsection presents the baseline results of the effect of policy concentration in the relationship between natural resources and educational inequality in DCs. The econometric model is estimated using the two-stage least squares and the results are summarized in Table 2. The regressions satisfy the hansen specification. Indeed, the hansen test statistic for the overidentifying restrictions is not significant. This result suggests that the set of instruments used satisfies the exogeneity condition required to obtain consistent estimates in the estimated models.

*Table 2: Effect of policy concentration in the relationship between natural resources and educational inequality in DCs*

| | Educational inequality | | | | | | |
|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
| **Natural resources** | -0.053** | -0.049*** | -0.052*** | -0.048*** | -0.045*** | -0.043*** | -0.042*** |
| | (0.024) | (0.015) | (0.013) | (0.013) | (0.014) | (0.015) | (0.016) |
| **Political concentration** | -0.150 | 0.100 | 0.064 | 0.190 | 0.105 | -0.073 | 0.005 |
| | (0.294) | (0.269) | (0.244) | (0.246) | (0.240) | (0.214) | (0.215) |
| **Natural resources *Political concentration** | 0.061** | 0.045** | 0.056*** | 0.053*** | 0.052*** | 0.057*** | 0.053*** |
| | (0.027) | (0.019) | (0.018) | (0.019) | (0.019) | (0.020) | (0.020) |
| **Public expenditures** | | -0.024*** | -0.028*** | -0.027*** | -0.028*** | -0.028*** | -0.030*** |
| | | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| **Inflation** | | | -0.031*** | -0.036*** | -0.032*** | -0.024*** | -0.025 |
| | | | (0.008) | (0.008) | (0.007) | (0.007) | (0.007) |
| **Foreign direct investment** | | | | -0.009 | -0.008 | -0.015*** | -0.013*** |
| | | | | (0.006) | (0.006) | (0.005) | (0.005) |
| **Fertility rate** | | | | | -0.034 | -0.114*** | 0.115*** |
| | | | | | (0.033) | (0.032) | (0.032) |
| **Urbanization** | | | | | | -0.232*** | -0.241*** |
| | | | | | | (0.026) | (0.026) |
| **Economic growth** | | | | | | | -0.003 |
| | | | | | | | (0.014) |
| **Constant** | -0.086 | 0.803** | 1.145*** | 1.090*** | 1.241*** | 5.222*** | 5.432*** |
| | (0.246) | (0.314) | (0.310) | (0.306) | (0.278) | (0.539) | (0.538) |
| **Observations** | 326 | 350 | 373 | 388 | 389 | 424 | 418 |
| **Country fixed effects** | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Time fixed effects** | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **R-squared** | 0.016 | 0.112 | 0.152 | 0.155 | 0.165 | 0.266 | 0.283 |
| **Hansen** | 0.141 | 0.660 | 0.776 | 0.896 | 0.729 | 0.655 | 0.723 |

*Source: Author's estimate*

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

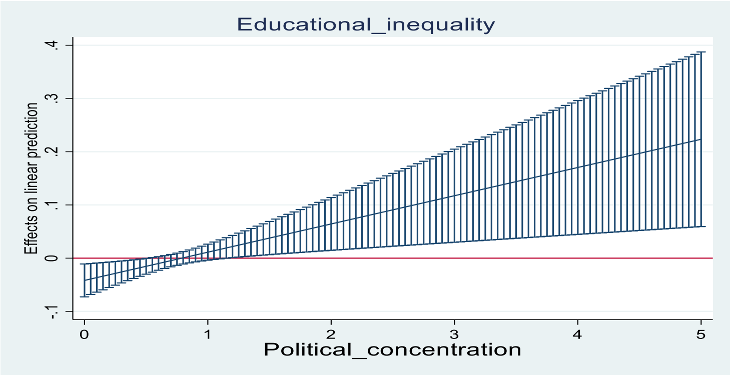
In column (1), the effect of policy concentration in the relationship between natural resources and educational inequality is tested without control variables. In columns (2) to (7), we introduce the control variables successively in the model. We find that the coefficient associated with the interaction between natural resources and political concentration is positive and statistically significant at the 1% level. This result remains consistent in all the estimations. Specifically, the results show that natural resource rents are a lever for reducing educational inequality in DCs. The discussion is focused on the results from the complete estimation of the model (see Column 7 in Table 2). The coefficient associated with natural resources is negative and is around 0.042. This means that a 1% increase in natural resources reduces educational inequality by 4.2%. This result disagrees with the work of Sun et al. (2018). One explanation for this result lies in the positive externalities of natural resource rents. Indeed, an increase in natural resource rents translates into an increase in disposable income, which therefore makes it possible to improve investment in education. Moreover, consistent with Akpa (2023), resource rents can reduce inequality, particularly by providing economies with enough income to invest in education, including training, and infrastructure. In addition, an increase in resource rents can also lead to greater purchasing power and a reduction in the costs borne by households.

Concerning political concentration, results indicate that political concentration does not directly affect educational inequality. Indeed, according to Stigler's (1971) theory of regulation, when power is concentrated in a country, policy makers do the will of a minority of people at the expense of the general interest. However, this structuring of power is only relevant when the country has enough income to direct their actions. Now, since developing countries are mostly low- or middle-income, political concentration is likely to have no effect on educational inequality. Moreover, results show that political concentration worsens the effect of natural resources on educational inequality in DCs. The interaction variable "*Natural resources*Political concentration*" is associated with a significant and positive coefficient of 0.053%. This implies that, taking into account political concentration, natural resources rather increase educational inequality. This result can be explained by the fact that when power is held by a minority of people, the externalities from natural resource rents do not affect all segments of the population. Such a situation can lead to a lack of resources to finance these discriminatory policies.

Also, the target can be modified because political concentration leads to a concentration of actions and infrastructures around the area that corresponds to political power. These revenues will only serve a part of the population and thus will lead to an inefficiency of redistributive policies. As a result, educational inequality will accentuate. In other words and consistent with Ostrom's (1990) theory, political concentration induces opportunistic behavior and subjectivity in income management. These lead to an inefficient allocation of natural resource rents and introduce differential preferences in educational investment in particular (Hollenbach, 2021), which ultimately leads to increased educational inequality. The beneficial effect of natural resources, due to poor performance in terms of governance, will then mutate into a negative effect, thereby translating the curse of natural resources for developing countries (Sachs and Warner, 2001).

However, in order to better analyze the effect of political concentration in the relationship between natural resources and educational inequality, an analysis by marginal effects seems appropriate. Figure 2 presents the evolution of the effect of natural resources on educational inequality as a function of political concentration. An increasing line suggests that as political concentration increases, natural resources positively affect educational inequality; while a decreasing line implies that natural resources reduce educational inequality with political concentration. Thus, according to this figure, the effect of natural resources on educational inequality tends to deteriorate with increasing political concentration. Moreover, when political concentration oscillates between 0 and 0.7, natural resources decrease educational inequality, but this reduction occurs at a decreasing rate. When the level of political concentration is above 0.8, natural resources significantly increase educational inequality. The effect of natural resources on educational inequality deteriorates as political power becomes more concentrated. We can therefore conclude that political concentration worsens the effect of natural resources on educational inequality in DCs. This result is consistent with the work of Tadadjeu et al. (2021) and Kamguia et al. (2022) who argued that the effect of natural resources on economic performance depends on the quality of institutions, so that the poorer the quality of institutions, the more adverse the effects of rents, leading to the natural resource curse.

*Figure 2: Marginal effects of the natural resource effect on educational inequality in DCs by policy concentration condition.*




*Source: Author's construction*

Regarding control variables, we note that on the whole they present the expected signs. More specifically, expenditures, foreign direct investment and urbanization contribute to significantly reduce educational inequality. First,the relation between expenditures and educational inequality is consistent with the work of Boyd (1988). Indeed, according to the latter, public sector spending creates a tendency for the distribution of national after-tax income to converge, so as to invest in large programs such as infrastructure that should have redistributive effects. Thus by allocating a portion of public funds in spending on social protection programs, government spending provides in-kind services and direct cash transfers that benefit a wide range of people, but especially the poor and less fortunate (Kollmeyer, 2015). Government spending, through spending on infrastructure and social security tends to promote better access to education (Gupta et al., 2002) and decrease educational inequality (Bradley et al., 2003; Kenworthy and Pontusson, 2005).

Second, the result on the effect of foreign direct investment is justified in the literature (Xu et al., 2021). Indeed, it is widely documented beneficial effects of FDI on growth (Asongu and Odhiambo, 2020). Moreover, economic growth is a driver of education on the one hand and a powerful lever for reducing inequality on the other (Rubin and Seagal, 2015). Thus, by promoting the sophistication of the economy and increasing the national income available for investment in social projects, foreign direct investment helps to reduce educational inequalities.

Third, regarding urbanization, this result corroborates the work of Kamguia et al (2022) who argued that an urban population contributes to increasing the level of education of the population. Also, urbanization plays a crucial role in the impact of social problems of public education in urban areas and helps solve the deep social challenges faced by rural students, including access to basic infrastructure, such as water and electricity. It thus helps to narrow the educational gap between the rich and the poor that was due to the initial socioeconomic conditions of the family (Sirin, 2005; Shankar-Brown, 2015). Therefore, differences in access to basic services between poor rural areas and urban areas could lead to unequal opportunities in terms of access to educational resources, thus widening the gap between rural and urban centers (Sule et al., 2022).

Moreover, results also show that the fertility rate increases educational inequality in developing countries over the period. This result is consistent with studies by Checchi, 2006. Indeed, fertility forces poor parents to focus on basic needs and they invest less in their children's education. In fact Nakagawa et al. (2022) argued that in limited-income households, investment in education is a function of the fertility and family size decision of these households. Given this assumption and their reduced economic capacity, all adult individuals choose to reduce their family size to meet the cost of future education. Conversely, in the case of high fertility, there is a cancellation of the child-rearing plan, resulting in an underinvestment in education in favor of immediate consumption expenditures. Furthermore, results also indicate that economic growth and inflation have no effect on educational inequality.

## 4. Sensitivity tests

To further control for variable omission bias, we incrementally take into account some economic and non-economic variables. To do so, we conduct three sensitivity tests related to culture and geography, to level of income, to country heterogeneity and to democracy.

### 4.1. Sensitivity to cultural and geographic variables

We introduce in our estimates socio-cultural and geographic factors in the econometric analysis. We control for the importance of socio-cultural variables inspired by Easterly and Levine (1997). The analysis of these variables is taken into account through the ethnic fragmentation, linguistic fragmentation and religious fragmentation from Alesina et al. (2003). We also add in the analysis the geographic characteristics since they are considered to be the cause of the underperformance of former colonies (Keneck and Nvuh, 2021; Bloom et al., 1998). Indeed, geographic location has important effects on income levels through its effects on transportation costs, illness burdens, and agricultural productivity. There is a disjuncture between these regions and many areas of high population density and rapid population growth. This is particularly true for populations that are far from the coast and navigable rivers and thus face high transportation costs for trade, as well as populations in tropical regions with a high disease burden. We measure geographic characteristics by distance to the equator (latitude) from La Porta et al. (1999).

Table 3 presents the results of these estimates. Columns from 1 to 4 present the results by adding ethnic, language, religion and distance to equator respectively. The analyses show that, although they affect educational inequality differently, all these factors do not call into question the robustness of our main results. Indeed, socio-cultural variables tend to increase educational inequality, while distance from the equator is insignificant. However, the estimates are consistent with the fact that political concentration worsens the effect of natural resources on educational inequality.

*Table 3 : Sensitivity test using cultural and geographic variables*

| | Educational inequality | | | |
|---|---|---|---|---|
| | Socio-cultural | | | Geography |
| | (1) | (2) | (3) | (4) |
| **Natural resources** | -0.044*** | -0.030*** | -0.032** | -0.055*** |
| | (0.016) | (0.011) | (0.015) | (0.011) |
| **Political concentration** | -0.017 | 0.318 | 0.032 | -0.158 |
| | (0.214) | (0.218) | (0.205) | (0.227) |
| **NatRes*PoCon** | 0.052*** | 0.032** | 0.043** | 0.071*** |
| | (0.019) | (0.015) | (0.019) | (0.016) |
| **Ethnic** | 0.707*** | | | |

| | | | | |
|---|---|---|---|---|
| | (0.183) | | | |
| **Language** | | 1.201*** | | |
| | | (0.187) | | |
| **Religion** | | | 0.941*** | |
| | | | (0.171) | |
| **Distance to equator** | | | | -0.001 |
| | | | | (0.000) |
| **Constant** | 5.725*** | 5.599*** | 5.016*** | 5.436*** |
| | (0.538) | (0.569) | (0.553) | (0.540) |
| **Observations** | **418** | **372** | **418** | **416** |
| **Country fixed effects** | **Yes** | **Yes** | **Yes** | **Yes** |
| **Time fixed effects** | **Yes** | **Yes** | **Yes** | **Yes** |
| **Control variables** | **Yes** | **Yes** | **Yes** | **Yes** |
| **R-squared** | **0.303** | **0.367** | **0.326** | **0.303** |
| **Hansen** | **0.609** | **0.178** | **0.828** | **0.736** |

*Source: Author's estimate*
*Notes: standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.*

### 4.2. Sensitivity to income level

We test the comparative effects of income levels across countries. Therefore, we analyze the effect of political concentration on the natural resources and education inequality nexus across income levels. Our sample includes 58 observations from low-income countries and 153 from middle-income countries. The results are summarized in Table 4. The coefficient associated with the interaction between political concentration and natural resources remains positive and statistically significant in both samples. However, the effect is stronger in low-income countries than in middle-income countries. Specifically, in low-income countries the coefficient is 0.636 and significant at the 1% level; while in middle-income countries the coefficient is 0.045 with a significance of 10%. It can therefore be concluded that the effect of political concentration in the extent to which natural resources affect educational inequality is influenced by the income level of the countries. When the level of income is low, natural resource rents are subject to more conflict; this may thus accentuate the effect of political concentration on the effect of natural resource dependence on educational inequality.

*Table 4: Heterogeneity according to income level*

| | **Educational inequality** | |
|---|---|---|
| | **Low income countries** | **Middle income countries** |
| | **(1)** | **(2)** |
| **Natural resources** | -0.372*** | -0.033* |
| | (0.113) | (0.018) |
| **Political concentration** | -5.585*** | -0.218 |
| | (1.529) | (0.269) |
| **NatRes*PoCon** | 0.636*** | 0.045* |
| | (0.137) | (0.024) |
| **Constant** | 22.734*** | 7.393*** |
| | (2.224) | (0.621) |
| **Observations** | **58** | **153** |
| **Country fixed effects** | **Yes** | **Yes** |
| **Time fixed effects** | **Yes** | **Yes** |
| **Control variables** | **Yes** | **Yes** |
| **R-squared** | **0.836** | **0.577** |

| | | |
|---|---|---|
| **Hansen** | **0.366** | **0.317** |

*Source: Author's estimate*
*Notes: standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.*

### 4.3.Sensitivity to regional group affiliation

We estimate our model by splitting the sample according to regions. This analysis is relevant insofar as it allows us to take into account the unobservable heterogeneity linked to regions. We distinguish between developing countries in the regions of Sub-Saharan Africa (SSA), Asia, America, and Middle East and North Africa (MENA). The sample covers 18 observations in the Americas, 49 observations in Asia, 109 observations in Sub-Saharan Africa, and 18 in MENA. In Table 5, the regressions show that the interaction between natural resources and political concentration has a positive and significant effect only in Asia and SSA, unlike in the other regions. This result suggests that it is only in these regions that political concentration deteriorates the effect of natural resources on educational inequality because they present the most politically concentrated governments according to DPI (2020). Therefore, SSA and Asia appear to be more affected by the natural resource curse on educational inequality.

*Table 5: Heterogeneity by region*

| | **Educational inequality** | | | |
|---|---|---|---|---|
| | **America** | **Asia** | **SSA** | **MENA** |
| | **(1)** | **(2)** | **(3)** | **(3)** |
| **Natural resources** | 1.710 | -0.054 | -0.235*** | 0.057 |
| | (1.255) | (0.042) | (0.079) | (0.050) |
| **Political concentration** | 0.925 | -1.684*** | -1.720** | 0.308 |
| | (0.684) | (0.283) | (0.770) | (0.948) |
| **NatRes*PoCon** | -1.980 | 0.089** | 0.273*** | -0.205 |
| | (1.361) | (0.039) | (0.098) | (0.126) |
| **Constant** | 5.792 | 14.090*** | 6.527** | 17.725** |
| | (15.962) | (1.237) | (2.812) | (7.566) |
| **Observations** | **18** | **49** | **109** | **18** |
| **Country fixed effects** | **Yes** | **Yes** | **Yes** | **Yes** |
| **Time fixed effects** | **Yes** | **Yes** | **Yes** | **Yes** |
| **Control variables** | **Yes** | **Yes** | **Yes** | **Yes** |
| **R-squared** | **0.846** | **0.881** | **0.420** | **0.986** |
| **Hansen** | **0.075** | **0.498** | **0.114** | **0.115** |

*Source: Author's estimate*
*Notes: standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.*

### 4.4.Take into account democracy

Several studies show that the effects of natural resources in an economy are conditioned by the quality of the institutions that prevail, making it possible to determine whether natural resources are a blessing or a curse (Njangang et al., 2022; Belarbi et al., 2021). Countries with institutions that promote state responsibility and competence will benefit from natural resources. Conversely, countries lacking such institutions may suffer from the resource curse (Robinson et al., 2006). The aim of this subsection is to examine whether political concentration alters the effect of natural resources on educational inequality differently depending on whether the country is democratic or not. Indeed, the redistributive effect of natural resource rents can be influenced on the one hand by the government's ability to involve a country's citizens in the selection of their government, as well as freedom of expression, freedom of association and freedom of the media. On the other hand, this effect may be conditioned by the level of accountability of elected representatives to the electorate. In this way, a country's level of political concentration may depend on its level of democracy.

We distinguish the sample into two groups: countries with relatively high levels of democracy and countries with lower levels. The estimation results are shown in Table 6. Column 1 shows the results for countries with a lower level of democracy, while column 2 shows the estimates for countries with a higher level of democracy. The coefficients associated with the interaction between political concentration and natural resources remain positive and significant. However, the coefficient is lower in the sample of countries with higher levels of democracy (0.080) than in those with lower levels (0.126). Specifically, the results show that, in general, political concentration worsens the effect of natural resources on educational inequality. But the magnitude of this effect is weaker in highly democratic countries. Our results are consistent with those of Dauvin and Guerreiro (2017), according to whom when institutions reach their best level, the resource curse disappears and can be transformed into a blessing.

*Table 6: Results with democracy*

| | **Educational inequality** | |
|---|---|---|
| | **(1)** | **(2)** |
| **Natural resources** | -0.074** | -0.076*** |
| | (0.031) | (0.014) |
| **Political concentration** | 0.802 | -0.879*** |
| | (0.532) | (0.224) |
| **Natural resources*Political concentration** | 0.126*** | 0.080*** |
| | (0.044) | (0.018) |
| **Constant** | 6.062** | 6.612*** |
| | (2.438) | (0.585) |
| **Observations** | 104 | 300 |
| **R-squared** | 0.514 | 0.380 |
| **Hansen** | 0.505 | 0.203 |
| **Control variables** | Yes | Yes |
| **Country fixed effect** | Yes | Yes |
| **Time fixed effects** | Yes | Yes |

*Source: Author's estimate*

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

## 5. Robustness tests

Three robustness tests are conducted in this study. In the first test, we use an alternative measure of natural resource. The second test involves changing the estimation technique and the third test is related to the non-parametric approach.

### 5.1. Alternative measure of natural resource

To test the sensitivity of our results, we consider each type of natural resource. Literature has established that the effect of natural resources seems to be conditioned by the type of natural resources (Papyrakis, 2017). Indeed, some resources may likely reduce educational inequality while others may instead increase. As a result, revenues from these types of natural resources do not necessarily guarantee a reduction of educational inequality. This article therefore considers oil rent, forestry rent, mineral rent, gas rent, and coal rent. Table 7 highlights the effect of political concentration in the relationship between natural resources and educational inequality by resource type.

*Table 7: Effect of political concentration on the relationship between different resources and educational inequality*

| | Educational inequality | | | | |
|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** |
| **Political concentration** | 0.025 | 0.291 | 0.604 | 0.759** | 0.520*** |
| | (0.234) | (0.265) | (0.408) | (0.315) | (0.187) |
| **Minerals** | -0.141*** | | | | |
| | (0.041) | | | | |
| **Minerals*Political concentration** | 0.238*** | | | | |
| | (0.056) | | | | |
| **Oil** | | -0.085*** | | | |
| | | (0.018) | | | |
| **Oil* Political concentration** | | 0.112*** | | | |
| | | (0.028) | | | |
| **Forest** | | | -0.063 | | |
| | | | (0.049) | | |
| **Forest* Political concentration** | | | 0.036 | | |
| | | | (0.065) | | |
| **Coal** | | | | 0.123 | |
| | | | | (0.168) | |
| **Coal *Political concentration** | | | | 0.019 | |
| | | | | (0.183) | |
| **Gas** | | | | | 1.078*** |
| | | | | | (0.347) |
| **Gas* Political concentration** | | | | | -0.866** |
| | | | | | (0.340) |
| **Constant** | 5.068*** | 5.401*** | 4.321*** | 3.652*** | 5.389*** |
| | (0.844) | (0.794) | (1.041) | (1.130) | (0.501) |
| **Observations** | 242 | 241 | 169 | 166 | 419 |
| **Control variables** | Yes | Yes | Yes | Yes | Yes |
| **Country fixed effects** | Yes | Yes | Yes | Yes | Yes |
| **Time fixed effects** | Yes | Yes | Yes | Yes | Yes |
| **R-squared** | 0.313 | 0.266 | 0.221 | 0.238 | 0.287 |
| **Hansen** | 0.233 | 0.240 | 0.246 | 0.366 | 0.242 |

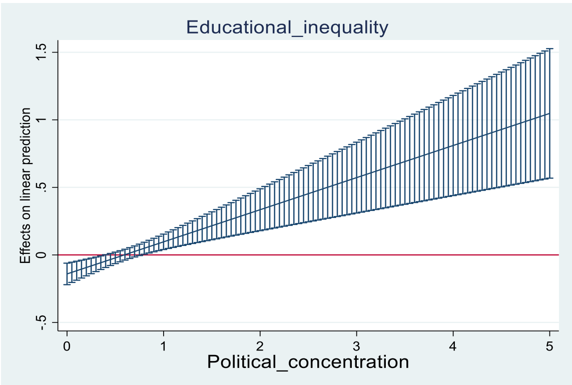
*Source: Author's estimate*
*Notes: standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.*

Columns (1) through (5) summarize the results when we consider minerals, oil, forest, coal, and gas respectively. The variables *Oil*Political concentration*, *Forest*Political concentration, Coal*Political concentration, Gas*Political concentration* and *Minerals*Political concentration* represente respectively the interactions between oil and political concentration, forest and political concentration, coal and political concentration, gas and political concentration, minerals and political concentration. We find that the effect of the interaction is different for each type of natural resource. More specifically, Table 6 highlights three main findings. First, political concentration degrades the effect of natural resources on education inequality by 0.141 % and 0.085 % for minerals and oil, respectively. Second, political concentration does not affect the rent effect of oil and coal. Third, however, political concentration allows the gas rent to reduce educational inequality. This can be explained by the fact that minerals and oil are point resources; while gas is diffuse resources. And according to Le Billon (2001), dependence on point resources is the only one to affect economic performances. This result is confirmed by the analysis of marginal effects in figure 3.

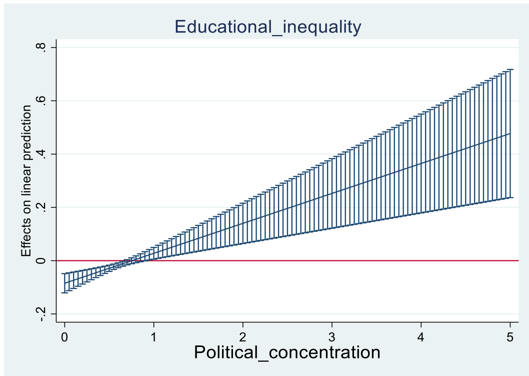
Figure 3 indicates the evolution of the effect of different resources on educational inequality by level of political concentration. Two lessons can be highlighted from the Figure. First, it shows that the higher the level of political concentration, the more mineral and oil resources tend to increase education inequality over the period studied. Second, gas revenues reduce education inequality with political concentration. These findings can be justified by the fact that fossil fuels account for the largest share of consumption in the world. In addition, these types of resources are the most important natural resources in DCs and therefore offer the most important revenues. The importance of these revenues leads them to be subject to political considerations and interests. Thus, the more lucrative a resource is, the more it interests the political class, so that in the event of a concentration of power, the purpose of these revenues will only serve the interests of the power in place.

*Figure 3: Marginal effects in DCs by type of natural resource*

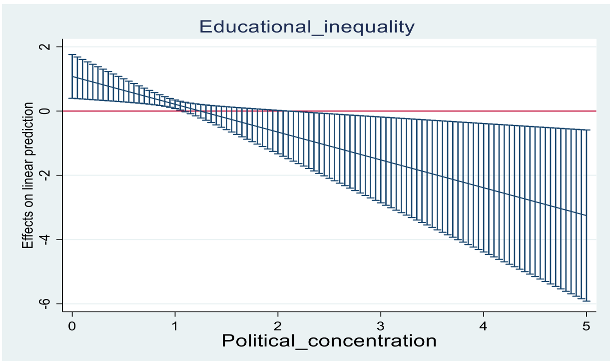
1.Minerals




2.Oil




3.Gas




*Source: Author's construction*

## 5.2.Endogeneity control: external instrumentation and system GMM

The issue of endogeneity is fundamental to understanding how political concentration affects the effect of natural resources on educational inequality. In previous estimations, we used the IV-2SLS technique, with an internal instrumentation of using lags and differences of the suspected endogenous variables. However, this approach may be limited due to the difficulty in finding the right instrument that retains the right properties, i.e., weakly correlated with the error term and strongly correlated with the endogenous variable. For this reason, we follow the approach of Song (2020) and remove the control variables from the model. To take account of heterogeneity, we maintain only country fixed effects and time fixed effects. This makes it easier to find an external instrument. Suspecting the endogeneity of natural resources, the literature offers us several instruments, namely debt (McGuirk, 2013). Indeed, the volume of debt can explain the intensity and effectiveness of redistributive policies and is an important indicator of natural resource rents, which seem to be abnormally higher in indebted countries.

Moreover, assuming the existence of a memory effect of educational inequalities and suspecting the permanence of heteroscedasticity of unknown origin, the estimators obtained by IV-2SLS may be inefficient. For these reasons, Baum et al. (2003) recommend using the GMM estimator, introduced by Hansen (1982) and popularized by Arellano and Bover (1995) and Blundell and Bond (1998), with additional conditions for its robustness systematized by Roodman (2009).

We use these two approaches to better control for endogeneity bias. The results by IV-2SLS with external instruments are summarized in the table 8; while results with GMMs are reported in table 9. They provide overall validation of the effect of political concentration in the relationship between natural resources and educational inequality. Political concentration allows natural resources to aggravate the educational inequality in developing countries. Also, as postulated, the memory effect is significant in all specifications, with educational inequality being significantly self-explanatory with respect to its own past values.

*Table 8: External instrumentation*

| | **Educational inequality** |
|---|---|
| **Natural resources** | -0.047** |
| | (0.021) |
| **Political concentration** | -1.210* |
| | (0.696) |
| **Natural resources*Political concentration** | 0.071*** |
| | (0.026) |
| **Constant** | -1.039 |
| | (0.662) |
| **Observations** | 936 |
| **Control variables** | No |
| **Countries fixed effects** | Yes |
| **Times fixed effects** | Yes |
| **R-squared** | 0.937 |
| **Hansen** | 0.287 |

*Source: Author's estimate*
*Notes: standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.*

*Table 9: System-GMM estimates*

| | **Educational inequality** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
| **L.Educational inequality** | 1.010*** | 0.987*** | 0.997*** | 0.996*** | 0.985*** | 0.933*** | 0.974*** |
| | (0.020) | (0.004) | (0.005) | (0.008) | (0.018) | (0.034) | (0.036) |
| **Natural resources** | -0.057*** | -0.019** | -0.010** | -0.020** | -0.163* | -0.178*** | -0.069* |
| | (0.013) | (0.009) | (0.004) | (0.009) | (0.084) | (0.063) | (0.038) |
| **Political concentration** | -0.692*** | -0.124 | -0.087*** | -0.131** | -0.691** | -1.201*** | -0.475 |
| | (0.123) | (0.080) | (0.031) | (0.058) | (0.292) | (0.421) | (0.295) |

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| **Natural resources*Political concentration** | 0.048*** | 0.018* | 0.016*** | 0.030*** | 0.174** | 0.193*** | 0.073* |
| | (0.011) | (0.010) | (0.005) | (0.010) | (0.082) | (0.062) | (0.039) |
| **Expenditure** | | 0.003*** | 0.001 | 0.001 | -0.003 | -0.010 | -0.000 |
| | | (0.001) | (0.001) | (0.001) | (0.003) | (0.007) | (0.007) |
| **Inflation** | | | -0.007*** | -0.011*** | -0.008** | -0.011*** | 0.003 |
| | | | (0.001) | (0.002) | (0.003) | (0.004) | (0.003) |
| **Foreign direct investment** | | | | -0.006 | -0.005 | -0.007 | -0.001 |
| | | | | (0.004) | (0.005) | (0.013) | (0.002) |
| **Fertility rate** | | | | | 0.059*** | 0.052** | 0.024 |
| | | | | | (0.019) | (0.024) | (0.020) |
| **Urbanisation** | | | | | | -0.064* | -0.011 |
| | | | | | | (0.034) | (0.038) |
| **Economic growth** | | | | | | | -0.032*** |
| | | | | | | | (0.009) |
| **Constant** | 0.716*** | 0.030 | 0.048 | 0.109** | 0.596* | 2.329** | 0.615 |
| | (0.129) | (0.072) | (0.037) | (0.043) | (0.309) | (1.093) | (0.991) |
| **Observations** | 355 | 135 | 170 | 170 | 169 | 170 | 130 |
| **Number of countries** | 24 | 20 | 19 | 19 | 19 | 19 | 19 |
| **AR(1)** | 0.0100 | 0.0760 | 0.0688 | 0.0694 | 0.0790 | 0.0700 | 0.0928 |
| **AR(2)** | 0.283 | 0.372 | 0.291 | 0.348 | 0.290 | 0.396 | 0.314 |
| **Hansen** | 0.748 | 0.926 | 0.969 | 0.926 | 0.935 | 0.966 | 0.993 |

*Source: Author's estimate*

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

### 5.3.A non-parametric approach

According to Liu et al. (2022) and Lachebeb et al. (2021), the effect of natural resources and institutions on economic performance is not always monotonous. So, to capture the dimensional effect of political concentration on the natural resources-educational inequality nexus, it is possible to use a non-parametric approach. Thus, this study performs a quantile regression analysis (QR).

The double least squares approach focuses on the average effect on educational inequality, but the relevance of our results may be questioned because the effect of our interest variables may vary across different intervals of educational inequality. Thus, quantile regressions derived from the work of Koenker and Bassett (1978) provide an answer to this shortcoming. Indeed, it is an estimation technique that allows us to take into account the effect of one variable on another at different points of its distribution. This method seems to be superior to the parametric approach because the estimate of the mean effect may sometimes be biased in the case where censored data exist.

The QR method provides a richer characterization of the data and considers the impact of a covariance on the entire distribution of the dependent variable, not just its conditional mean. Thus, by considering the effect of one variable on all points in the distribution of another variable, this technique determines dimensional effects based on the strength of the relationship (Mignamissi and Mouhamed, 2022; Xu 2019; Dufrenot et al., 2010). Low (high) quantiles representing low (high) strength. The quantile estimator is obtained by resolving the following optimization problem:

$$\min_{\beta \in R^K} \left[ \sum_{i \in \{i: y_i \geq x' \beta\}} \theta \left| y_i - x_i' \beta \right| + \sum_{i \in \{i: y_i \prec x' \beta\}} (1-\theta) \left| y_i - x_i' \beta \right| \right] \qquad (2)$$

for the $\theta th$ quantile ($0 < \theta < 1$)

$Yi$ is the education inequality index of country $i$. $\beta$ is the vector of parameters to be estimated and $xi$ is a $K$- 1 vector of explanatory variables.

Table 10 presents the effect of political concentration on the relationship between natural resources and the different intervals of educational inequality. Column 1 represents the baseline analysis with IV-2SLS; while columns 2-6 present estimates for the $10^{th}$, $25^{th}$, $50^{th}$, $75^{th}$ and $95^{th}$ quantile using quantile regression. The results show that the positive effect of political concentration in the relationship between natural resources and educational inequality varies along the distribution of educational inequality. More precisely, the effect is statically significant and valid only from the 50th quantiles. Moreover, when the QR is evaluated at the median effect of educational inequality, political concentration has no impact on the extent to which natural resources affect educational inequality. However, for quantiles above the 50th, the effect tends to be positive and significant. Thus, countries that are not heavily dependent on natural resources and in which power is less concentrated have better management systems than countries that are heavily dependent on natural resources and where political power is highly concentrated. High natural resource rents thus attract more covetousness and conflict within the political class, so that political concentration alters its effectiveness in reducing inequality. Moreover, this result implies that, in line with Avom et al. (2022), the natural resource curse only operates in cases where the quality of institutions is poor (high political concentration).

*Table 10: Estimate with quantile regression analysis*

| | Educational inequality | | | | | |
|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
| | **IV-2SLS** | **Q(10)** | **Q(25)** | **Q(50)** | **Q(75)** | **Q(95)** |
| **Natural resources** | -0.042*** | -0.038 | -0.040** | -0.036* | -0.058** | -0.042*** |
| | (0.016) | (0.023) | (0.020) | (0.021) | (0.025) | (0.016) |
| **Political concentration** | 0.005 | -0.404 | -0.376 | 0.048 | -0.068 | -0.502** |
| | (0.215) | (0.328) | (0.279) | (0.296) | (0.350) | (0.227) |
| **Natural resources *Political concentration** | 0.053*** | 0.042 | 0.059** | 0.048* | 0.065** | 0.057*** |
| | (0.020) | (0.027) | (0.023) | (0.024) | (0.029) | (0.019) |
| **Constant** | 5.432*** | 4.064*** | 2.720*** | 5.917*** | 6.730*** | 5.381*** |
| | (0.538) | (0.848) | (0.722) | (0.766) | (0.903) | (0.585) |
| **Observations** | 418 | 452 | 452 | 452 | 452 | 452 |
| **Control variables** | Yes | Yes | Yes | Yes | Yes | Yes |
| **R-squared/Pseudo R-squared** | 0.283 | 0.106 | 0.058 | 0.161 | 0.224 | 0.174 |

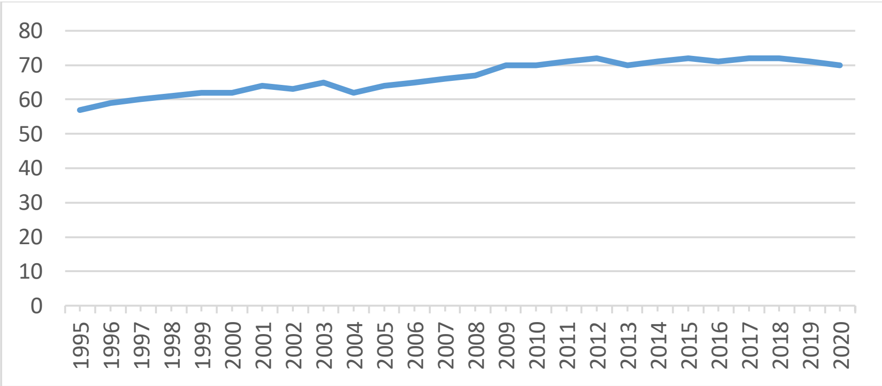
*Source: Author's estimate*
*Notes: standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.*

## 6. Conclusion

This paper investigated the role of political concentration in the relationship between natural resources and educational inequality in developing countries. To this end, we apply the two-stage least squares method on a panel data from 81 developing countries over the period 1995-2019. Results indicate that political concentration worses the effect of natural resources on educational inequality. These results call for policy recommendations. In particular, the existence of the conditional effect of natural resources through political concentration casts doubt on the effectiveness of redistributive policies aimed at ensuring the blessing of natural resources. As power is concentrated in the hands of a group of people, the pursuit of self-interest leads to a bias in the targeting of policies that do not benefit the entire population. Our results call for mechanisms within developing countries to improve the institutional environment, including the distribution of political power. These mechanisms could include better decentralization of powers, with a view to ensuring better management of natural resource rents.

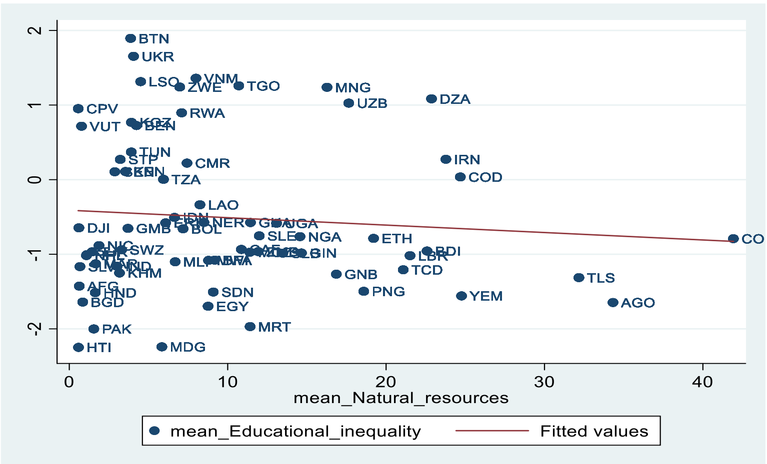
## Annexes

Figure A.1: Political concentration in DCs between 1995 and 2019




*Source: Author's construction*

Figure A.2: Natural resources and educational inequality in DCs




*Source: Author's construction*

Table A.1: List of countries

| |
|---|
| Afghanistan – Algeria – Angola – Bangladesh – Belize – Benin – Bhutan – Bolivia – Burkina Faso – Burundi – Cape Verde – Cambodia – Cameroon – Central African Republic – Chad – Democratic Republic of Congo – Republic of Congo – Côte d'Ivoire – Djibouti – Egypt – El Salvador – Eritrea – Ethiopia – Eswatini – Gambia – Ghana – Guinea – Guinea Bissau – Haiti – Honduras – India – Indonesia – Iran – Kenya – Korea Kiribati – Korea – Kyrgyzstan – Lao PDR – Lesotho – Liberia – Madagascar – Malawi – Mali – Mauritania – Micronesia – Mongolia – Morocco – Mozambique – Myanmar – Nepal – Nicaragua – Niger – Nigeria – Pakistan – Papua New Guinea – Philippines - Rwanda – Samoa – Sao Tome – Senegal – Sierra Leone Solomon Islands – Somalia – South Sudan – Sri Lanka – Sudan – Syrian Arab Republic – Tanzania – Tajikistan – Timor-Leste – Togo – Tunisia – Uganda – Ukraine – Uzbekistan – Vanuatu – Vietnam – West Bank of Gaza – Zambia – Zimbabwe – Yemen |

Table A.2: Variable description and source

| Variables | Descriptions | Sources |
|---|---|---|
| Educational inequality | The inverse of education equality index. It varies between 0 and 4. | Vdem (2020) |
| Natural resources | Total natural resource rents as a percentage of GDP. | WDI (2020) |

| | | |
|---|---|---|
| Political concentration | The Herfindhal index of government and takes into account the seat shares of all political parties in the government of a country. | DPI (2020) |
| Oil | Oil rent as a percentage of GDP. | WDI (2020) |
| Forest | Forest rent as a percentage of GDP. | WDI (2020) |
| Coal | Coal rent as a percentage of GDP. | WDI (2020) |
| Gas | Gas rent as a percentage of GDP. | WDI (2020) |
| Mineral | Mineral rent as a percentage of GDP. | WDI (2020) |
| Public expenditures | Public spending on education as a percentage of GDP. | WDI (2020) |
| Inflation | Current annual rate of inflation. | WDI (2020) |
| Foreign direct investment | Net inflows as a percentage of GDP. | WDI (2020) |
| Fertility rate | Number of births per woman. | WDI (2020) |
| Urbanization | Share of the urban population in the total population. | WDI (2020) |
| Economic growth | GDP growth. | WDI (2020) |
| Ethnic | Probability that two people taken at random do not belong to the same ethnic group (ethnic fragmentation) | Alesina et al. (2003) |
| Language | Probability that two randomly selected people do not speak the same language (language fragmentation) | Alesina et al. (2003) |
| Religion | Probability that two people taken are not from the same Frag_Religion (religion fragmentation) | Alesina et al. (2003) |
| Distance to equator | Distance to the equator. | La Porta et al. (1999) |

Table A.3: correlation matrix

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Educational inequality | 1.000 | | | | | | | | | | | | | | | | | |
| Natural resources | -0.061* | 1.000 | | | | | | | | | | | | | | | | |
| Political concentration | -0.042 | -0.017 | 1.000 | | | | | | | | | | | | | | | |
| Oil | -0.083* | 0.751* | 0.052* | 1.000 | | | | | | | | | | | | | | |
| Forest | -0.074* | 0.386* | 0.004 | -0.169* | 1.000 | | | | | | | | | | | | | |
| Coal | 0.191* | 0.116* | 0.033 | -0.036 | -0.077* | 1.000 | | | | | | | | | | | | |
| Gas | 0.069* | 0.331* | -0.141* | 0.146* | -0.106* | 0.001 | 1.000 | | | | | | | | | | | |
| Mineral | 0.051* | 0.245* | -0.072* | -0.062* | 0.018 | 0.309* | 0.014 | 1.000 | | | | | | | | | | |
| P. expenditures | -0.280* | -0.120* | -0.101* | -0.200* | 0.184* | -0.183* | -0.183* | -0.008 | 1.000 | | | | | | | | | |
| Inflation | -0.048 | 0.155* | 0.030 | 0.171* | 0.034 | -0.005 | -0.009 | -0.017 | -0.058 | 1.000 | | | | | | | | |
| Foreign direct investment | 0.006 | 0.123* | 0.102* | 0.003 | 0.105* | 0.203* | -0.019 | 0.169* | -0.062 | 0.012 | 1.000 | | | | | | | |
| Fertility rate | -0.347* | 0.302* | -0.002 | 0.079* | 0.528* | -0.167* | -0.139* | -0.022 | 0.456* | 0.089* | 0.013 | 1.000 | | | | | | |
| Urbanization | -0.123* | 0.133* | -0.039 | 0.187* | -0.097* | 0.061* | 0.080* | 0.030 | -0.132* | 0.032 | -0.098* | -0.164* | 1.000 | | | | | |
| Economic growth | 0.033 | 0.029 | 0.006 | 0.014 | -0.025 | 0.054* | 0.020 | 0.075* | -0.002 | 0.040 | 0.079* | 0.028 | 0.087* | 1.000 | | | | |
| Ethnic | -0.119* | 0.215* | 0.027 | 0.139* | 0.183* | -0.066* | -0.067* | 0.023 | 0.127* | 0.051* | 0.084* | 0.454* | 0.088* | 0.013 | 1.000 | | | |
| Language | 0.089* | 0.091* | -0.092* | -0.024 | 0.209* | -0.034 | -0.095* | 0.015 | 0.106* | 0.042 | 0.031 | 0.305* | 0.078* | 0.053* | 0.700* | 1.000 | | |
| Religion | 0.094* | 0.099* | 0.046 | -0.044 | 0.334* | -0.084* | -0.168* | -0.093* | 0.025 | 0.049* | 0.001 | 0.225* | -0.197* | -0.066* | 0.169* | 0.335* | 1.000 | |
| Distance to the equator | -0.134* | 0.207* | -0.137* | 0.287* | -0.238* | 0.207* | 0.176* | 0.142* | -0.229* | 0.051* | -0.056* | -0.063* | 0.577* | 0.070* | 0.297* | 0.223* | -0.203* | 1.000 |

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