# Mining Governance and Human Development in the Democratic Republic of the Congo

Lonzo Lubu Gastonfils[1]

[1] PhD Candidate in Economics Sciences, Faculty of Economics and Management, Cheik Anta Diop University, Congo

Correspondence: Lonzo Lubu Gastonfils, PhD Candidate in Economics Sciences, Faculty of Economics and Management, University of Kinshasa, Congo DR.

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**Abstract**

The objective of the present study is to assess the impact of mining governance on human development in the DRC. The econometric approach used is based on estimates of simultaneous equations using the GMM, 3SLS and SURE methods. The results show that employment, education and per capita GDP are all negatively affected by mining governance. Both exchange rates and inflation are positively affected by the price of copper and mining. The volatility of exchange rates is detrimental. The study results in the recommendation to strengthen governance of mineral resources in order to maintain human and sustainable growth.

**Keywords:** Mining governance, human development, simultaneous equations, DRC

## 1. Introduction

Many research studies have demonstrated a strong correlation between dependence on or abundance of natural mineral resources and less democratic regimes. These factors have an adverse effect on the general well-being of the population, leading ultimately to poverty. In particular, mining governance and corruption are linked. This is due to the ease with which political elites can monopolize and control profits from mineral resources (Boix et al., 2003).

As a result, there are fewer incentives to maintain accountability to the community and transparency. Brunnschweiler et al. (2008) speculate that the relationship between resource reliance and corruption might just be the result of corrupt nations having ineffective industrial sectors.

Given their essential significance in modern life, mining activities, deposits, and metallic elements are critical for social and economic advancement. However, because mineral reserves are finite, maintaining natural resources needs their logical and optimal use in addition to taking the environment, economics, and social equality into balanced consideration (Chattopadhyay, 2013).

Mineral goods are indeed indispensable to modern economies and civilizations. Many basic demands would be very difficult to meet without them. But the demands of society go beyond the mineral sector just satisfying the market. Along with helping to expand national economies, it also anticipates that the production, use, and recycling of minerals would create jobs directly and indirectly and advance society by facilitating access to wholesome food, high-quality healthcare, and high-quality education. If this is not the case, society will criticize the industry for failing to live up to its expectations and will close its doors more and more.

Dependency on mineral resources negatively affects the standard of local governance and the general well-being of the populace because mining activities encourage corruption at the local level. Nevertheless, there are ways to limit this phenomenon. For instance, mechanisms could be established that require mining companies to invest in local public goods like law enforcement, which could lower production and transaction costs (Esteves, 2008). In this way, mining companies could “replace” existing, subpar local institutions, which would lessen corruption and improve local governance (Knusten, 2016).

Additionally, the money made from these profitable activities is used for favoritism and illegal transactions. Resource-rich countries are always characterized by politically divided or opportunistic governments that manipulate the

economy to extract rents (Auty, 2001).

In public administration, dishonesty has an impact at nearly all levels. Countries that mismanage their natural resources often find themselves in this predicament, which hinders their ability to develop. Thorough investigation has shown these properties of natural resources. Studies have, in fact, verified the theory that property value is explained by the caliber of governance.

As evidenced by the institutional quality index, countries with strong institutions are not affected by the resource curse, claims Van Der Ploeg (2011). The United States, Canada, Australia, Norway, New Zealand, and Botswana are among the nations that fall under this category. However, the Dutch illness syndrome is more likely to occur in nations with weak institutions or inadequate governance.

This profile suits most resource-rich African countries, except for Botswana. It is important to notice that in nations that call themselves democratic, the people in parliamentary democracies gain more from the earnings of natural resources than in presidential ones. In the second kind of regime, resources are solely set aside for a small group of close aides to the president and a few political elites chosen on the basis of clientelism, according to Andersen & Aslaksen (2008).

According to other studies, corruption among public servants and political leaders is fostered by the wealth of the natural world (Ades & Di Tella, 1999). Essentially, these nations' corruption is fueled and sustained by the quantity and finding of fresh deposits or new methods of exploitation.

According to Sachs and Warner (1995), the lack of natural resources causes poverty and long-term unemployment that are inherited by future generations. It is true that the extraction of mineral resources raises the worth of the money. The traded products industry's ability to compete is hampered by the currency's increase in value. Workers in industries that produce marketable items subsequently become jobless. They want to get into the manufacturing of non-tradable items. The national economy as a whole experiences widespread unemployment as a result of this dispersion.

On a generational level, the curse of natural wealth also shows up. Natural capital is used as security by governments to take out large loans on international markets due to the availability of natural resources, claims Van Der Ploeg (2011). Unfortunately, the payback terms for these debts span several decades, meaning that they are a burden—a detrimental legacy—that is transferred to the next generation. Many times, these debts were accrued for pointless activities like ostentatious spending. These debts are known as "deferred debts" because of the lengthy repayment term.

According to the International Debt Observatory (OID), "in over half of indebted countries, debt service represents an amount greater than the education budget and greater than the health budget in 75% of these countries." Future generations may find it more difficult to succeed as a result, since they will have to prioritize paying off large generational debts that they are not responsible for. Debt thus limits flexibility and impedes future generations' chances for progress in resource-rich nations.

According to economists who have researched the resource curse, economic development and natural resource economics are intimately related.

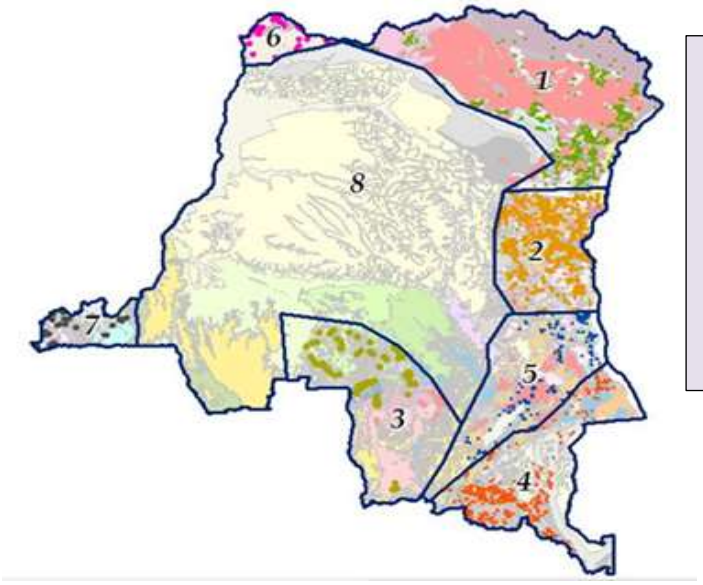
Drawing on the findings of Acemoglu, Reed & Robinson (2014) and Nunn & Wantchekon (2011), we investigate the curse of mining resources in the DRC with an emphasis on the local consequences of mining management.

### *1.1 Summary of the Mining Industry in the DRC*

The DRC is widely recognized for its abundant mineral resources, comprising more than 1,100 distinct varieties. The nation's provinces take great pride in their mineral riches. This section highlights the various minerals contained in the subsurface of the DRC. There's also a focus on the operators' diversity, complexity, and governance within the sector. These natural resources' vastness, their distinctive uses, and the variety of mining companies make it difficult to implement fiscal policy in the sector.

#### 1.1.1 Mineral Resources' Potential

This study uses copper, cobalt, zinc, and gold as examples of mineral resources from the DRC. Throughout the nation, these resources are dispersed among several sectors. The mineral concentration by metallogenic province and sector is depicted on the maps below.

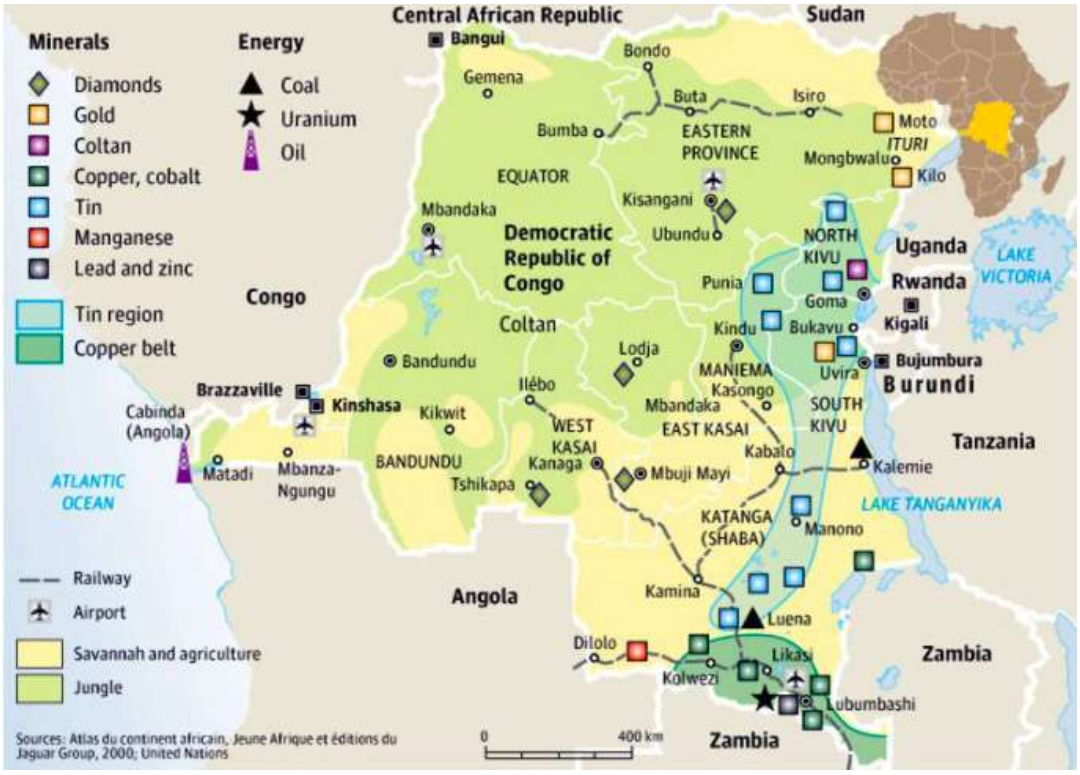



1. Haut-Congo Block: Gold, Iron
2. Karagwe-Ankole Belt: Gold, 3T (Tin, Coltan, Tungsten)
3. Kasai Block: Diamond, Nickel, Chrome
4. Copper Belt (Katanga): Copper, Cobalt
5. Kibarian Belt: Tin, 3T, Gold
6. UBANGI Block: Gold, Diamond, Tin, Monazite

Source: DRC, Ministry of Mines, 2020

Figure 1. Metallogenic Provinces and Distinctive Mineral Substances

By examining the above map, it is evident that every part of the country is rich in a variety of minerals, justifying the nickname of the DRC as a "geological scandal."

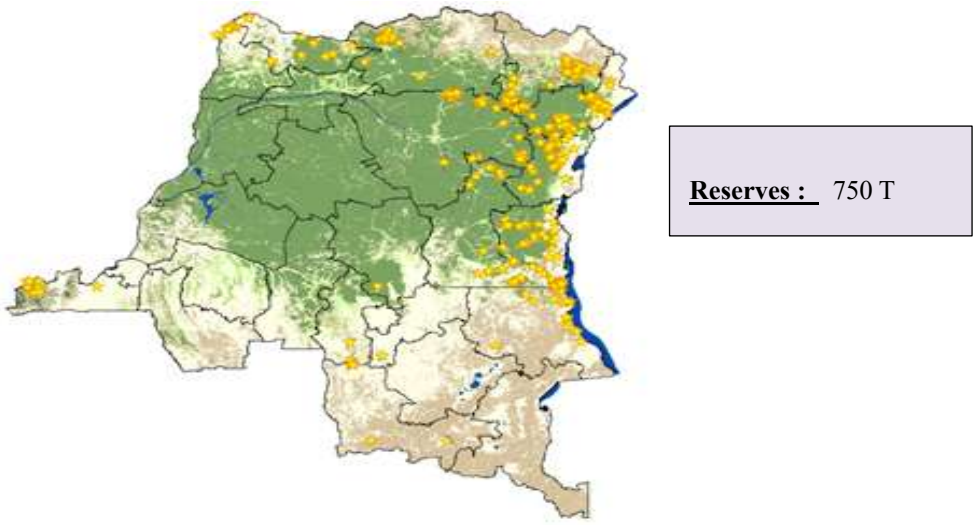



**Source:** Jeune Afrique, Jaguar Group and UN, 2000

Figure 2. Copper-Cobalt-Zinc Supply Chain

The reserves in the copper-cobalt-zinc sector are estimated at 75 million tonnes of copper, 6 million tonnes of cobalt, and 7 million tonnes of zinc in the DRC (DRC). These reserves are located in the former Katanga province, as well as in Kasaï-Oriental, Central Congo, and Equateur provinces.

The company Gécamines, either independently or in collaboration with other companies, extracts copper, cobalt, and zinc in the former Katanga region. In 2020, the DRC's production reached 1,600,000 tonnes of copper and 100,000 tonnes of cobalt.




Source: DRC, Ministry of Mines, 2020

Figure 3. Gold Supply Chain

The DRC is home to 10% of the world's total known gold deposits. Presently, the provinces of Maniema, Eastern Province, former Katanga province, Kongo Central, North Kivu, South Kivu, and Equateur are home to an estimated 750 tons of gold reserves.

Formerly known as the Sokimo, was the only company that mined these reserves. AngloGold Ashanti and Randgold Resources, two of Sokimo's partner firms, underuse the mines in Mongwalu, Kanga, and the adjacent areas. Sokimo's exploration programs are presently being carried out by its other partners.

The DRC is home to several mineral resources, such as diamond, iron-manganese, 3T, aluminum, nickel, platinum, rare earths, uranium, and lithium, in addition to the supply networks described above.

*1.2 Reasons Why Mining Resources Hinder Human Development*

The following can be used to summarize the arguments made for why the exploitation of mineral resources impedes economic and human development: (i) the ongoing decline in relative resource prices (Prebisch, 1950); (ii) notable price fluctuations (Hausmann & Rigobon, 2003); (iv) disapproval of infrastructure and education supply (Isham et al., 2005); (iii) incentives to prioritize rent-seeking over productive activity (Aunty, 2001); and indirect negative impacts that have a deleterious impact on institutional structures and governance. Humphreys et al., 2007; Ross, [2001, 2012] state that "political wealth" is the combination (hard power) of a number of natural and mineral resources that influence a number of factors, including corruption, governance quality, conflicts, and democracy.

*1.3 Empirical Evidence of Mining Governance and Human Development in the DRC*

The DRC has enormous mineral reserves and wealth. Both copper and cobalt are produced there in greater quantities than any other country in the world. Also, the DRC is home to significant reserves of 3T minerals (tin, tantalum, and tungsten), gold, diamonds, zinc-lead, uranium, iron, and manganese. Industrial sector growth has been rapid during the last 20 years. It now contributes more than 20% of the country's GDP and generates close to one-third of governmental revenue. Mining income, encompassing both industrial and artisanal mining, accounts for more than one-third of government revenue. The economy is thought to be heavily dependent on mining.

Even though the DRC is home to significant international mining companies, not many projects have been constructed there. Small and medium-sized enterprises struggle with a shortage of skilled labor and restricted access to international

markets. Thousands of people work simultaneously in dangerous manual labor settings without formal contracts or permissions. Harvesting raw resources involves simple methods, often involving only the hands. Still, a lot of households depend on the income these artisanal activities generate.

Still, the DRC has abundant natural resources that have drawn large exploration and production expenditures recently. However, the severely poor people does not benefit from these large investments; as a result, there is a highly troubling scenario where they lack access to decent healthcare, education, and employment possibilities.

Cooperation is hampered in the mining industry today by the major companies' distrust of one another. To satisfy the demands and expectations of the principal players, more openness in the management of the mining industry and participation from all stakeholders are important. The country's natural resources must be fully utilized by the populace, which means the mining industry needs to provide strong job possibilities. The mining industry's needs must be accommodated by the economy. In order to make artisanal mining operations' working conditions more acceptable, it is also imperative that they be improved.

The state coffers have benefited greatly from the increasing mineral exports, which have brought in much-needed cash to support national output and human capital. Over 50% of the government's resources are derived from mining earnings.

Ultimately, the region now has optimism for a sustained economic trajectory as the extractive industry's prominence as a significant source of income has grown. Despite the fact that the steep drop in commodity prices has lowered expectations and slowed down resource development and investment, commodities are still likely to account for a sizable portion of exports and government revenue (IMF, 2019).

If the growth of natural resources in resource-rich countries in the region has aided in their economic development, the question is whether this has resulted in higher earnings and a notable decrease in poverty. Have there been noteworthy advancements in, say, health and education, outside from the financial front?

Once per capita income impacts are taken into account, resource-rich nations (Angola, Gabon, Mozambique, Nigeria) have much lower non-monetary measures of well-being (Figure 1.1). This demonstrates how many undeveloped natural resources there are. Living in a resource-rich nation has a cost: life expectancy is 4.5 years shorter, literacy rates are 3.1 points lower, and the rate of malnutrition among family children is 2.1 among kids and 3.7 among women. There is a lot of violence and no responsibility or engagement.

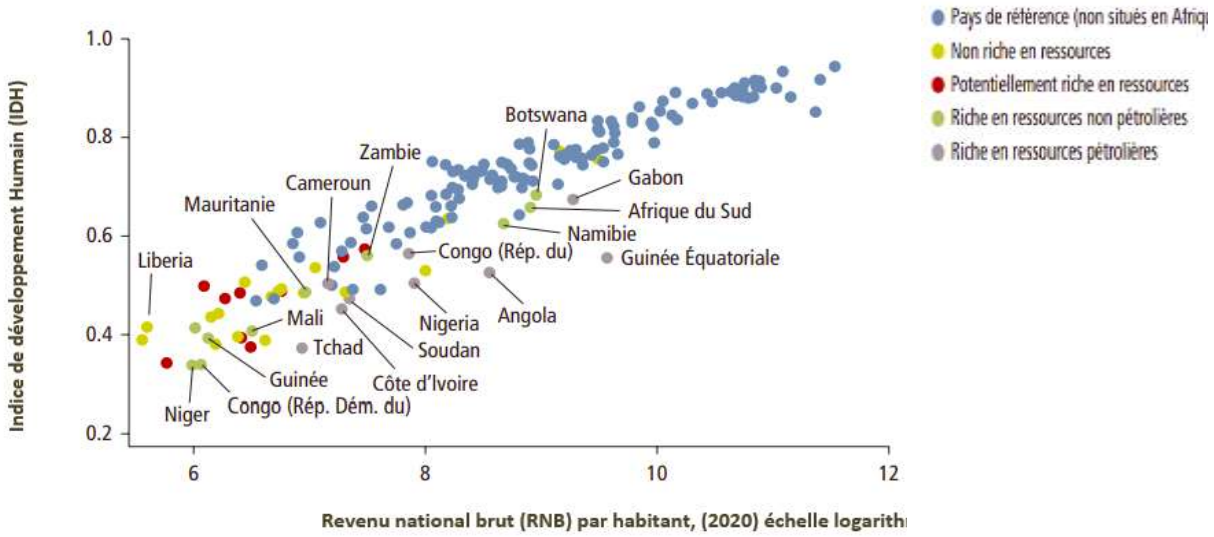



Figure 4. Evolution of HDI and GNI per capita in Africa

Sources: Human Development Report 2020 and World Development Indicators.

*Note.* HDI values range between a minimum of 0 and a maximum of 1.

The challenges of the mining and minerals industry are the most complex and they generate a great deal of mistrust among the local population who live with it on a daily basis. In many cases, their "social right" to settle is called into question, despite the contributions they could make: (i) Countries rely on mineral exploitation to support their economic growth. (ii) To make up for the dangers and effects they endure and to better their circumstances after the conclusion of the project, local communities expect the industry to produce jobs, build infrastructure, and produce other benefits. (iii) Workers anticipate greater work-related health and safety, an enhanced standard of living in the community, and equitable treatment upon termination of employment. (iv) Even in cases when governments fail to do so, citizens and human rights activists insist that businesses uphold and respect fundamental rights. (v) Environmental organizations expect much better performance and want the industry to withdraw from environmentally and culturally sensitive areas. (vi) Investors demand increasing profits and are highly concerned about the industry's financial results. (vii) Consumers want to buy safe products that have been manufactured in an environmentally and socially responsible manner. Companies must achieve much more, sometimes with limited resources.

*1.4 Human Development and HDI Ranking of the DRC*

The procedure of giving people more options so they may make better decisions, live longer and healthier lives, have access to education and a reasonable quality of living, and actively engage in their communities is referred to as development. The fact that human progress cannot be boiled down to economic expansion alone must be emphasized. The UNDP really promotes this idea through its yearly report, but it transcends the confines of economic theory and takes into account the interplay between social policy and governance.

As per the UNDP, it is widely acknowledged that in order to remove obstacles that hinder numerous players from taking advantage of their primary development prospects, public policies must be refocused to encourage pertinent modifications that aim to fortify the institutional and economic milieu. In this sense, Human Progress aims to update the conventional understanding of economic progress by emphasizing the human being at the center of development issues and increasing investments in the one capital—human capital—that adds value to all other forms of capital (UNDP/Gabon, 2006).

With a Human Development Index of 0.480 in 2019, the DRC was placed in the "low human development" category, ranking 175th out of 189 countries and territories. Guinea-Bissau is ranked next to Liberia.

Between 1990 and 2019, the DRC's HDI increased by 30.1%, from 0.369 to 0.480. Table 1.1 shows the progress of each HDI indicator for the country. The average number of years of schooling increased by 4.5 years, the predicted number of years of schooling increased by 3 years, and the life expectancy at birth increased by 11.6 years throughout this period.

However, between 1990 and 2019, the GNI per person decreased by more than 37.3%. Figure 1. (UNDP/DRC, 2020) illustrates the respective contributions of each component to the HDI of the DRC from 1990.

Table 1. Based on reliable statistics, the DRC's HDI has evolved

| | **Life expectancy at birth** | **Expected years of schooling** | **Average years of schooling** | **GNI per capita (2017 PPP dollars)** | **HDI value** |
|---|---|---|---|---|---|
| 1990 | 49.0 | 6.8 | 2.3 | 1,695 | 0.369 |
| 1995 | 49.1 | 6.6 | 2.9 | 911 | 0.347 |
| 2000 | 50.0 | 7.0 | 3.3 | 740 | 0.349 |
| 2005 | 53.7 | 7.5 | 4.3 | 749 | 0.381 |
| 2010 | 56.9 | 9.2 | 5.9 | 830 | 0.435 |
| 2015 | 59.3 | 9.6 | 6.4 | 980 | 0.464 |
| 2016 | 59.7 | 9.6 | 6.6 | 1,039 | 0.471 |
| 2017 | 60.0 | 9.7 | 6.8 | 1,030 | 0.475 |
| 2018 | 60.4 | 9.7 | 6.8 | 1,056 | 0.478 |
| 2019 | 60.7 | 9.7 | 6.8 | 1,063 | 0.480 |

Source: Author, based on data from www.countryeconomy.com/hdi

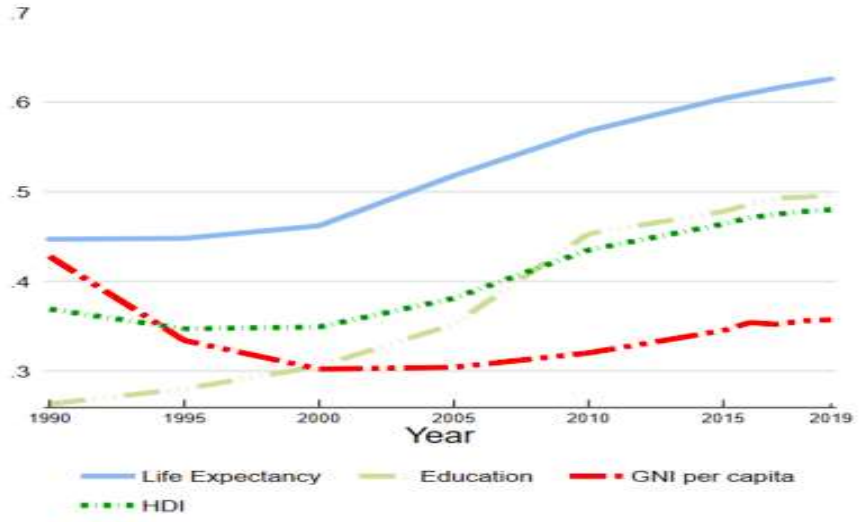



Figure 5. The DRC's HDI's component evolution from 1990 to 2019

Source: Author, based on data from Table 1.

The Human Progress Index (HDI), which gauges advancement in humankind, is an essential tool for comparing two or more nations. Using Tanzania (United Republic of), Botswana, and the DRC as examples, we can see that their HDI increased between 1990 and 2019 (Figure 5).

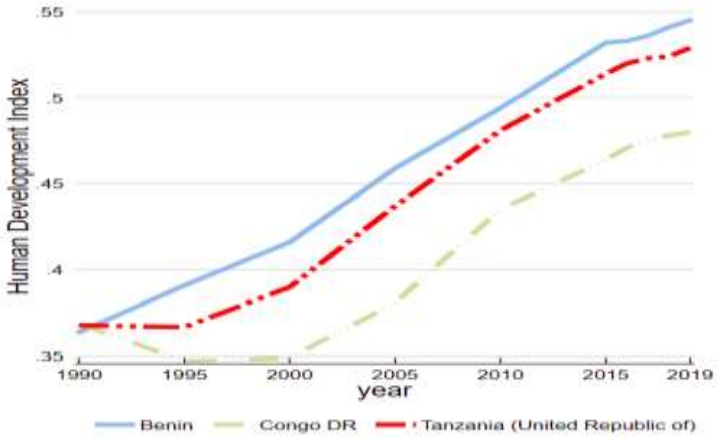



Figure 6. From 1990 to 2019, the DRC, Tanzania (United Republic of), and Benin's Human Development Index (HDI) evolved

Source: Author, based on data from Table 1.

With an HDI of 0.480 in 2019, the DRC lagged behind both the average for Sub-Saharan Africa (0.547) and the average for countries classified as having low human development (0.513). Ethiopia and Nigeria, whose HDIs rank 173rd and 161st among Sub-Saharan African countries, respectively, are compared to the results of the DRC in Table 2.

Table 2. The DRC's HDI and its component metrics for 2019 in comparison to a few chosen nations and categories.

| | HDI value; | Ranking according HDI; | Life to expectancy birth; | Expected years at of schooling; | Average years of schooling; | GNI per capita (2017 PPP dollars). |
|---|---|---|---|---|---|---|
| DRC; | 0.480 | 175 | 60.7 | 9.7 | 6.8 | 1,063 |
| Ethiopia; | 0.485 | 173 | 66.6 | 8.8 | 2.9 | 2,207 |
| Botswana; | 0.735 | 100 | 69.6 | 12.5 | 8.9 | 15.570 |
| Nigeria; | 0.539 | 161 | 54.7 | 10.0 | 6.7 | 4,910 |
| Sub-Saharan Africa; | 0.547 | — | 61.5 | 10.1 | 5.8 | 3,686 |
| Low HDI. | 0.513 | — | 61.4 | 9.4 | 4.9 | 2,745 |

Source: Author, based on data from UNDP, WDI (https://fe.countryeconomy.com)

## 2. Literature Review

In many African countries, the economy is still primarily driven by raw minerals. Although they are meant to be a blessing, they usually end up being a source of instability and a curse (the Dutch disease) because African states—all but Botswana—are ill-equipped to handle the rents from their natural resources. Greater macroeconomic instability and slower post-war growth have been observed in countries that have implemented disastrous macroeconomic policies, such as excessive inflation, significant budget deficits, and misaligned exchange rates (Acemoglu et al., 2003).

Researchers contend that countries with poor macroeconomic policies also have poor "institutions," such as political elites and politicians being unchecked, investor property rights being poorly protected, political instability being severe, and widespread corruption.

Scholars like Acemoglu et al. (2003) and Aizenman & Pinto (2005) have provided copious evidence indicating that nations endowed with natural resources need "strong institutions" in order to effectively oversee the advantages of these resources. By doing this, they can break free from the resource curse and reduce the long-term oscillations caused by ineffective benefit management. A strict constitution that limits the power of politicians and elites, a set of social arrangements that include the rule of law, the strict enforcement of property rights, mechanisms for mediating social

conflicts, and relatively wide access to education are among the institutions that are suggested. Oil-exporting developing nations have built up reserves and stability to guard against changes in oil prices. The purpose of stability funds is to provide both financial stability and expenditure transparency. Funds for saves are intended to create wealth for future generations by converting a limited income stream into a continuous income flow (Fasano-Filho, 2000; Heilbrunn, 2002).

Actually, there are a few things that need to happen in order for natural resources to stimulate economic development. Strong institutions are necessary to provide macroeconomic stability, according to Acemoglu et al. (2003). Institutions are limitations placed by people to control their relationships, according to North (1994). In his research on growth factors, Acemoglu (2008) centers his findings around institutions. "The rules, regulations, laws, and policies that influence economic incentives for investment in technologies, physical and human capital," is how he characterizes them. Funds for saves are intended to create wealth for future generations by converting a limited income stream into a continuous income flow (Fasano-Filho, 2000; Heilbrunn, 2002).

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In actuality, a few things must take place before natural resources may promote economic growth. Acemoglu et al. (2003) assert that strong institutions are required to provide macroeconomic stability. According to North, institutions are constraints that people impose on themselves in order to manage their relationships (1994). Institutions are the focal point of Acemoglu's (2008) growth factor research. "The rules, regulations, laws, and policies that influence economic incentives for investment in technologies, physical and human capital," according to his definition." Governments must prove before they can use resources that they can avoid the resource curse. This can only be done if leaders are sufficiently rewarded, which includes through participatory political processes and capable, transparent internal control systems. Mailey (2015) suggests a tripartite reform strategy to bolster responsibility for safeguarding Africa's natural resources, guaranteeing that these wealth benefit the people who possess them.

With the aforementioned things in mind, it is reasonable that the goal of this review is to answer the following query: "How does mining governance affect human development indicators in the DRC?"

## 3. The Study's Methodology

The presentation and explanation of the model selection, the pre-econometric estimation study technique, and the interpretation of the findings will be the main topics of this section.

### *3.1 The Simultaneous Equations Model's Presentation*

Haavelmo (1943) first proposed simultaneous equations models as a way to give a statistical framework for analyzing a theoretical model that has a system of interdependent equations. These models are frequently employed in macroeconomics, where the model's equations characterize a nation's economy and, more precisely, the connections among macroeconomic variables (SEM variables).

There are two categories of variables that they differentiate between: predefined variables, whose values are set outside the model, and endogenous variables, whose values are established inside the model. Two types of predefined variables are distinguished: current and lag exogenous variables and lag endogenous variables. G structural equations linking g endogenous variables to k preset variables make up the overall system:

$$\begin{aligned} b_{11}y_{1t} + b_{12}y_{2t} + \cdots + b_{1g}y_{gt} + c_{11}x_{1t} + c_{12}x_{2t} + \cdots + c_{1k}x_{kt} &= \varepsilon_{1t} \\ b_{21}y_{1t} + b_{22}y_{2t} + \cdots + b_{2g}y_{gt} + c_{21}x_{1t} + c_{22}x_{2t} + \cdots + c_{2k}x_{kt} &= \varepsilon_{2t} \\ \vdots & \\ b_{g1}y_{1t} + b_{g2}y_{2t} + \cdots + b_{gg}y_{gt} + c_{g1}x_{1t} + c_{g2}x_{2t} + \cdots + c_{gk}x_{kt} &= \varepsilon_{gt} \end{aligned}$$

As a matrix:

$$\underset{(g,g)}{B}\ \underset{(g,1)}{Y} + \underset{(g,k)}{C}\ \underset{(k,1)}{X} = \underset{(g,1)}{\varepsilon} \tag{1}$$

The variable that depends on the other is the one with a coefficient of 1, as is evident in all equations. Some coefficients are obviously absent. An equation is an identity if all of its terms have coefficients of 1 and there isn't a single random term. In this case, no coefficient needs to be calculated.

By expressing $Y$ in terms of $X$, we can convert from the structural form to the reduced form if the matrix $B$ is regular. This can be done as follows:

$$Y=-B^{-1}CX+B^{-1}\,\varepsilon \tag{2}$$

And we can apply OLS (Ordinary Least Squares). Indeed, the errors $B^{-1}\,\varepsilon$ are independent of $X$.

*3.2 Model Details*

To evaluate how mining governance affects human development in a nation rich in natural resources, we have created a simultaneous equations model. Research on the GDP per capita equation (equation 1) by Lederman and Maloney (2007), Mankiw et al. (1992), and Diandy (2020); the education equation (equation 2) by OECD (2005), Bilek (2007), and Bolito (2010); the equation of healthcare expenditure determinants by OECD (2000) and Mahieu (2002), which uses a macroeconomic approach to measure the impact of institutional structures and technological advancements (equation 3); research by Kalaitzidakis and Kalyvitis (2004), Estache (2007), for the equation of public investment as an endogenous variable (equation 4);

The institutional framework equation (equation 5) was studied by Mehlum et al. (2006), Brunnschweiler (2008), Bulte et al. (2007), Bhattacharyya and Hodler (2010), Bruckner et al. (2012), Mabali (2016), Marshall and Jaggers (2002); the employment equation (equation 6) was studied by Blanchard and Wolfers (2000), Nunziata et al. (2005).

The first set of simultaneous equations looks like this:

$$RNBT_t = \alpha_1 + \alpha_2 RNBT_{t-1} + \alpha_3 EDUC_t + \alpha_4 SANTE_t + \alpha_5 UN_t + \alpha_6 INFRA_{t-1} + \alpha_7 RM_t + \alpha_8 GOV_t + \sum_{k=2}^{k} \alpha_9 X_{,t} + \varepsilon_{1t} \tag{1}$$

$$EDUC_t = \beta_1 + \beta_2 \Delta RNBT_t + \beta_3 INFRA_{t-1} + \beta_4 RM_t + \beta_5 GOV_t + \sum_{k=2}^{k} \beta_6 X_{,t} + \varepsilon_{2t} \tag{2}$$

$$SANTE_t = \vartheta_1 + \vartheta_2 RNBT_{t-1} + \vartheta_3 INFRA_{t-1} + \vartheta_4 RM_t + \vartheta_5 GOV_t + \sum_{k=2}^{k} \vartheta_6 X_{,t} + \varepsilon_{3t} \tag{3}$$

$$GOV_t = \gamma_1 + \gamma_2 GOV_{t-1} + \gamma_3 RM_{t-1} + \sum_{k=2}^{k} \gamma_5 X_{,t} + \varepsilon_{4t} \tag{4}$$

$$INFRA_t = \delta_1 + \delta_2 INFRA_{t-1} + \delta_3 RM_{t-1} + \delta_4 GOV_t + \delta_5 OUV_t + \sum_{k=2}^{k} \delta_6 X_{,t} + \varepsilon_{5t} \tag{5}$$

$$UN_t = \sigma_1 + \sigma_2 UN_{t-1} + \sigma_3 RNBT_t + \sigma_4 RM_t + \sigma_5 GOV_t + \sum_{k=2}^{k} \sigma_6 X_{,t} + \varepsilon_{6t} \tag{6}$$

The first equation (1) estimating the role of mining governance on human development ($RNBT_t$) is explained by its lagged value ($RNBT_{t-1}$), followed by human capital in education ($EDUC_t$) and health ($SANTE_t$), employment ($UN_t$), economic performance of infrastructure ($INFRA_{t-1}$), mining rent resources ($RM_t$), reforms of governance institutions ($GOV_t$) (mining, petroleum, forestry governance, corruption, political stability), and a vector of control macroeconomic variables ($X_{,t}$).

As for equation (2), the function of human capital, measured by the overall enrollment rate ($EDUC_t$), is explained by the growth of per capita output ($\Delta RNBT_t$) and the economic performance of public facilities ($INFRA_{t-1}$), as well as resources from mining operations ($RM_{t-1}$), reforms of governance institutions ($GOV_t$) (including mining, petroleum, forestry governance, corruption, and political stability), and a vector of control macroeconomic variables ($X_{,t}$).

In equation (3), the explanation of healthcare supply measured by public healthcare expenditure ($SANTE_t$) is presented in the context of an economy characterized by abundant natural resources, gross national income per capita ($RNBT_t$), mining rent resources ($RM_t$), reforms of governance institutions $GOV_t$ (forestry, mining, petroleum governance, political stability, corruption), and a vector of control macroeconomic variables ($X$(,t)).

Using equation (4), the quality of institutions is measured by $GOV_t$. This quality is explained by the inertia of institutional quality, modeled by the lagged variable $GOV_{t-1}$, lagged mining rent ($RM_{t-1}$), reforms of governance institutions $GOV_t$ such as mining, petroleum, forestry governance, corruption, and political stability, as well as a vector of control macroeconomic variables ($X_{,t}$).

In equation (5), financing and provision of infrastructure ($INFRA_t$) primarily remain the responsibility of the public sector. In this framework, facilities are defined by the inventory of facilities in satisfactory condition ($INFRA_{t-1}$) financial support from mining rent ($RM_{t-1}$), trade volume measured by the sum of imports and exports as a proportion of GDP ($X$(,t)) changes in governance institutions (mining, petroleum, forestry governance, anti-corruption efforts, political stability), and a set of control macroeconomic variables ($X$(,t)).

Using equation (6), the unemployment rate $UN_t$ is influenced by several factors, including its lagged value $UN_{t-1}$,

gross national product per capita ($RNBT_t$), income from mining operations ($RM_{t-1}$), relationships with government institutions (mining, petroleum, forestry governance, corruption, political stability), and macroeconomic events (money supply, labor demand, fluctuations in terms of trade, overall factor productivity).

**4. Presentation, Interpretation, and Discussion of Results**

The Central Bank of the Congo (BCC), the World Development Indicators (WDI, 2019) database, the World Government Indicators (WGI, 2019), and Penn World (PWT10.0) Bank provided the data utilized for this estimation. The reports span the years 1980–2019.

Table 2 displays the findings from estimations carried out with a variety of techniques, including Ordinary Least Squares (OLS), the Generalized Method of Moments in a Two-Step System (GMM), Three-Stage Least Squares (3SLS), and Zellner's seemingly unrelated regressions (SURE), which have proven to be robust against heteroscedasticity of all kinds (Asiedu and Lien, 2011).

The tests that were performed to verify the validity of the instruments used have yielded significant results overall. Specifically, the results of the Hansen overidentification test and the second-order autocorrelation test do not rule out the hypotheses of instrument validity and no autocorrelation, respectively.

Six equations were used in this investigation, which ran from 1980 to 2019, and were found using the resilient Zellner approach (SURE). Consequently, a number of observations on these findings are possible.

Table 3. Results of the estimation of equation qlngdpcap (equation 1, SURE)

| qlndpcap | lndgcap(-1) | lnductbs | lnstante | lnu | lninfra | lnrentim | igov1 | igov2 | igov3 | instopol | ouv | lntxchr | lnipc | lndevf | lnvagr | cons |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | -0.1804 | 12.6438 | 0.9520 | -0.0399 | 0.0041 | -0.0089 | '0.0831 | 0.0801 | -0.0208 | -0.0007 | 2.2968 | -0.0774 | 0.0042 | -0.0295 | 0.1285 | 3.4326 |
| | (-3.90)*** | (25.50)*** | (-4.72)*** | (-8.06)*** | (7.81)*** | (-10.34)*** | (13.94)*** | (9.68)*** | (-2.16)*** | (-1.47)* | (8.59)*** | (-41.53)*** | (1.22) | (-10.73)*** | (20.50)*** | (5.97)*** |
| $R^2$=98.09 | | RMSE=0.0009 | | | Chi2=547580.03 | | | | | Seuil de Signification | | | | | | |
| Obs=18 | | Parametres=15 | | | P_Chi2=0.0000 | | | | | ***: 1% | **:5% | *:10% | | | | |

Source: Author's estimation.

The econometric estimations of the simultaneous equations model lead to different conclusions. Equation (1) shows that mining governance (igovmin) has a positive coefficient and is statistically significant at 1%, regarding per capita income measured by the logarithm of real income per capita (lngdpcap). Such a result aligns with the findings of Alesina et al. (1996) and Siermann (1998). A 1% increase in administrative policy would lead to a 0.14% decrease in real GDP per capita. In terms of policy implications, this suggests that improving governance in the mining sector in the DRC can foster favorable economic conditions for economic growth and the well-being of the population.

The coefficient of the variable representing the percentage of students enrolled in secondary education (lneductbs) is also positive and significant at 1%, according to the estimation results. This means that improving the quality of education plays a crucial role in the development of individuals in the DRC. This finding is consistent with Couttenier's (2012) conclusions.

Life expectancy at birth (Insante), which measures people's health, has a negative impact on per capita income. The absence of a national legal framework for universal healthcare coverage and the lack of healthcare infrastructure and facilities hinder human development in the DRC.

An increase in the number of unemployed individuals (lnu) also leads to a 0.03% decrease in per capita GDP growth. Similarly, a 1% decrease in mining profits results in a 0.0068% decrease in per capita GDP. In the DRC, the National Social Security Institute represents the main cause of unemployment.

Political stability is negatively affected by population unemployment. Urban residents have the opportunity to gather, defend positions, and fuel tensions.

According to the obtained results, lagged real GDP per capita ($lndgdpcap_{t-1}$), human capital in the health sector ($lnsante_t$), unemployment rate ($un_t$), mining rent ($lnrentmin_t$), corruption index (igov3), political stability index ( 〖instabpol〗 _t), real exchange rate ($txchr_t$), and financial development ($lndevf_t$) have a negative and significant influence on the growth of real GDP per capita in the DRC. On the other hand, human capital in the education sector ($lneductbs_t$), economic infrastructure efficiency ($lninfra_t$), public management index ($igov_t$), natural resource

governance index ( 〖igov2〗 _t), economic openness ($X_t$), consumer price index ($lnipc_t$), and agricultural value added (lnvagt) have a positive impact on real GDP per capita in the DRC. In other words, they contribute to improving human development and the well-being of the Congolese population.

If there is a 1% variation in real GDP in period n-1 (lndgpc(-1)), it leads to a 0.18 increase in national wealth at time t. Thus, economic growth is sustained in the short term.

However, it is important to note that the growth in the DRC has been positive over the past decade, surpassing the Sub-Saharan Africa average, with a rate of 6% compared to 4% (IMF, 2018). However, it should be emphasized that the outcomes of this growth are not distributed fairly. This growth only benefits a small minority, and it is worth noting that this economic growth is not inclusive as it does not contribute significantly to per capita GDP increase. The mining sector, with high capital intensity and low labor utilization, is the driving force behind this growth.

It is also important to note that if GDP increases by 1%, the unemployment rate decreases by 0.24%. Economic growth, therefore, contributes to reducing unemployment in the DRC.

Table 4. Results of the estimation of equation qlneductbs (equation 2, SURE)

| qlneductbs | lngdprcap | lninfra | lnrentmin | igov1 | igov2 | igov3 | instpol | lnvagr | cons |
|---|---|---|---|---|---|---|---|---|---|
| | -0.0004 | 0.0019 | 0.0053 | -0.0506 | -0.0226 | 0.0875 | 0.0041 | -0.0324 | 0.5207 |
| | (-0.02) | (1.64)* | (3.60)*** | (-5.63)*** | (-1.17)* | (4.06)*** | (2.79)** | (-2.81)** | (9.77)*** |
| $R^2$=98.09 | | RMSE=0.0028554 | | | Chi2=946.79 | | Seuil de Signification | | |
| obs=18 | | Parametres=8 | | | P_Chi2=0.0000 | | ***:1% | **:5% | *:10% |

Source: Author's estimation.

From the results of equation (2) of the model, it appears that the variables included in the model have a significant impact on human capital in the DRC, with the exception of two variables: real per capita income (lngdpcap) and natural resource governance ($igov2_t$), which do not have a significant effect on human capital in the DRC. However, the variable measuring performance in the model, economic infrastructure efficiency ($lninfra_t$), shows a significant impact at the 10% threshold.

Mining rent ($lnrentmin_t$), corruption rate (igov3), and political stability level ($instabpol_t$) have a beneficial impact on human capital in the DRC. However, public management index ($igov1_t$) and net agricultural production ($lnvagr_t$) have a negative influence on human capital in the DRC.

On the other hand, a 1% increase in current mining rent ($lnrentmin_t$) leads to a 0.05% increase in intellectual capital. As mineral resources contribute to investments in healthcare and education infrastructure in the DRC, which is a growing trend, it is evident that mining rents have a positive effect on intellectual capital. This result confirms the findings of Kabwe (2014) and Bulte et al. (2005).

Similarly, a 1% increase in corruption rate ($igov3_t$) results in a 0.09% improvement in human capital. It is understandable that corruption rate has a positive influence on human capital, as access to quality and healthy education reassures the population about the future and promotes literacy.

Furthermore, a 1% variation in political stability index ($instabpol_t$) leads to a 0.004% increase in human capital. This finding confirms the studies conducted by Esfahani et al. (2003) and Zergawu et al. (2020), which emphasized the importance of considering institutional quality when assessing the influence of human capital on economic growth.

On the other hand, a 1% variation in agricultural value added ($lnvagr_t$) results in a 0.03% reduction in human capital in the education sector.

Table 5. Results of the estimation of equation qsant (equation 3, SURE)

| qsant | lngdpcap | lninfra | lnrentmin | igov1 | igov2 | igov3 | instpol | lnvagr | _cons |
|---|---|---|---|---|---|---|---|---|---|
| | -0.0004 | 0.0040 | 0.0178 | -0.1197 | -0.0851 | 0.2239 | 0.0112 | -0.0760 | 4.1405 |
| | (-0.08) | (1.54)* | (4.38)*** | (-4.84)*** | (-1.59)* | (3.78)*** | (2.79)** | (-2.40)** | (28.28)*** |
| R2=98.09 | | RMSE=0.0078393 | | | Chi2=930.14 | | Seuil de Signification | | |
| Obs=18 | | Parametres=8 | | | P_Chi2=0.0000 | | ***:1% | **:5% | *:10% |

Source: Author's estimation.

Equation (3) shows that all of the model's variables have a significant impact on health and human capital in the DRC, with the exception of two variables that have no significant effect on either: natural resource governance index (igov2 t) and real per capita income (lngdpcap). Nonetheless, a substantial coefficient is observed at the 10% threshold for the economic infrastructure efficiency variable (lninfra t).

The DRC's human development is positively impacted by the mining rent (lnrentmin t), political stability index (instabpol t), and corruption index (igov3t). Conversely, the DRC's human development is negatively impacted by the public governance index (igov1t) and agricultural value added (lnvagr t).

On the other hand, a 1% change in mining rent (lnrentmin t) results in a 0.004% increase in human capital with regard to health. This conclusion supports the ideas of Kabwe F. (2014) and Bulte et al. (2005) that mining rent has a beneficial impact on human capital since expenditures in the DRC (healthcare infrastructure, education) are financed by mining resources, which are one of the contributing elements to growth.

In a similar vein, a 1% rise in the rate of corruption (igov3t) leads to a 0.22% improvement in human capital concerning health. Given that access to good healthcare and education reassures people about their future and fosters literacy, it makes sense that a lower rate of corruption would have a favorable impact on human capital.

Moreover, a 0.004% gain in human capital results from a 1% shift in the political stability index (instabpolt). This conclusion highlights the significance of taking institutional quality into account when studying the influence of human capital on economic growth, supporting earlier studies by Esfahani et al. (2003) and Zergawu et al. (2020).

Conversely, a 1% fluctuation in agricultural value added (lnvagrt) causes a 0.03% reduction in human capital in the education industry.

Table 6. Results of the estimation of equation qinfra (equation 4, SURE)

| qinfra | lninfra | lninvest | lnrentmin | igov2 | igov3 | instpol | ouv | lntxchr | _lnvagr | cons |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0.3035 | 3.6515 | 0.1171 | -0.8421 | 0.6337 | -0.5097 | 92.2857 | 0.1608 | 3.8239 | -42.7156 |
| | (2.64)** | (3.74)* * | (-0.40)*** | (-0.31) | (0.33)* | (-2.16)*** | (1.75)* | (0.50) | (2.02)** | (-3.96)*** |
| $R^2$=90.23 | | RMSE=0.4521681 | | Chi2=192.47 | | | | Seuil de Signification | | |
| obs=18 | | Parametres=9 | | P_Chi2=0.0000 | | | | ***:1% | **:5% | *:10% |

Source: Author's estimation.

After analyzing equation (4), the infrastructure of the DRC is determined by the following factors: government investments (lninvestt), political stability index (instabpolt), level of existing infrastructure (lninfrat), and economic growth in the agricultural sector (lnvagrt).

The amount of infrastructure that is currently in place therefore benefits the infrastructure as a whole. Infrastructure in the DRC improves by 0.3% for every 1% change in infrastructure quantity. Said another way, resources that are already available influence those that will be available later.

Nonetheless, public infrastructure in the DRC is negatively impacted by the political stability index. As a result, infrastructure deteriorates for every 1% change in the political stability index. This finding partially supports earlier research on the topic carried out in the DRC (DRC), which pointed out the detrimental effects of political instability on infrastructure (Lonzo et al., 2023; Esfahani et al., 2003; Zergawu et al., 2020).

Infrastructure in the DRC benefits ultimately from agricultural value addition. Infrastructure increases by 3.8% for every 1% change in agricultural value added. This outcome is consistent with Diandy's research (2020).

Table 7. Results of the estimation of equation qgov (equation 5, SURE)

| qgov | igov1 | lninvest | lnrentmin | igov2 | igov3 | instpol | lnvagr | _cons |
|---|---|---|---|---|---|---|---|---|
| | 0.0135 | -0.0157 | 0.0049 | -0.1198 | 0.7552 | 0.2490 | 0.0155 | 0.3373 |
| | (0.69) | (-2.19)* * | (-0.51) | (-1.41) | (9.72)* * | (25.88)*** | (0.20) | (1.01) |
| $R^2$=98.56 | | RMSE=0.0189145 | | Chi2=1337.67 | | Seuil de Signification | | |
| obs=7 | | Parametres=18 | | P_Chi2=0.0000 | | ***:1% | **:5% | *:10% |

Source: Author's estimation.

The results of equation (5) make it evident that the political stability index (instabpolt), the corruption index (igov3t), and the economic performance variable of infrastructure (lninfrat) all have an impact on the quality of institutions. The quality of institutions in the DRC is actually negatively impacted by the economic performance of infrastructure, although the political stability index (instabpolt) and corruption index (igov3 t) positively affect institutional quality in the country.

According to equation (5)'s results, the political stability index (instabpolt), the corruption index (igov3 t), and the infrastructure's economic performance variable (lninfrat) all have a significant impact on the quality of institutions. While the political stability index (instabpolt) and corruption index (igov3) have a favorable influence on institutional quality in the DRC, the economic performance of infrastructure has a negative impact on it.

As a result, there is a 0.02% drop in institutional quality for every 1% decline in infrastructure's economic performance. This contradictory outcome might be explained by the interplay of several institutional factors, such as the notable prevalence of corruption in the transportation industry, which raises costs for goods and causes large delays in delivery times. These outcomes are consistent with what Diandy (2021) found.

Additionally, there is a positive correlation between institutional quality and a 1% fluctuation in the corruption index of roughly 0.75%. Finally, there is a positive correlation between total political stability and institutional quality of about 0.24%. These outcomes are consistent with predictions.

Table 8. Results of the estimation of equation qU (equation 6, SURE)

| qu | lnu(-1) | lnrentmin | lninvest | igov2 | igov3 | instpol | ouv | lntxchr | lnvagr | _cons |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0.4376 | 0.0205 | 0.4786 | 0.0821 | -0.4953 | 0.0111 | -0.5922 | -0.0618 | 0.9923 | -2.7162 |
| | (3.95)** | (0.64) | (3.93)*** | (0.25) | (-2.22)** | (0.41) | (-0.10) | (-1.72) | (4.10)*** | (-2.16)** |
| $R^2$=83.65 | | RMSE=0.0504362 | | Chi2=103.74 | | | | Seuil de Signification | | |
| obs=18 | | Parametres=9 | | P_Chi2=0.0000 | | | | ***:1% | **:5% | *:10% |

Source: Author's estimation.

Based on the model's equation (6) results, the following factors can be considered as determinants of the unemployment rate in the DRC: the previous rate (lnut-1), the corruption index (igov3t), government investments (lninvest), and the growth of value added in the agricultural sector (lnvagrt).

Moreover, there is no doubt that a 1% increase in the unemployment stock has a favorable 0.45% impact on future unemployment. Stated differently, the current unemployment rate influences the rate that exists tomorrow.

The rate of unemployment has decreased as a result of government investments. In other words, the unemployment rate rises by 0.47% for every 1% increase in government spending. According to Gavin (1993), this results from public investments in wealthy countries lacking economic rationale, which often leads to low employment returns. Conversely, there is a 0.49% decrease in the unemployment rate for every 1% change in the corruption index.

Due to agriculture's economic sway, the unemployment rate is negative (a 1% rise in agricultural spending results in a

0.99% increase in the unemployment rate). The results of the study need to be clarified because they disagree with popular belief.

To begin with, the great majority of people (more than 60%) live in rural areas and work in agriculture. The transition from traditional to mechanized agriculture has resulted in "technological" unemployment, as machines replace human labor and force farmers to lose their jobs. An excellent illustration of this is the Bukanga Lonzo project, which generated a substantial amount of capital (about $300 million USD) for automated and intensive agriculture but was unable to provide the thousands of employment that were projected.

Due to inadequate agricultural access roads that make it easier to evacuate agricultural products and the dearth of agro-processing businesses, subsistence agriculture—which is characterized by underemployment—is the only kind of agriculture that can grow.

Finally, the 1954 surplus labor hypothesis developed by Arthur Lewis is fully embraced by conventional political economy. According to this theory, agricultural labor is the main force behind economic growth. Over time, the relationship between profit to land rent and salaries influences capital accumulation. An increase in this fraction leads to rapid accumulation and urban expansion.

Lewis asserts that revenue is increased by investing in dynamic agriculture. In this analysis, two economic variables that constitute the fundamental components of developing economies are examined: the traditional subsistence farming sector, which now has a significant cooperative labor structure in the field of income generating. In the agricultural sector, worker departure does not result in a decrease in production since marginal productivity does not exist. Employment can rise as a result of population growth, agricultural technological developments, and property rights protection.

Similar to the English agricultural revolution of the mid-1800s, the latter needs to be liberated in order to lay the foundation for industrialization (Berthelier et al., 2005). Growth and jobs are created as a result of this transition from agricultural to industry.

Structural elements that influence demand are critical to the growth of agriculture. cheaper production costs brought on by increased agricultural productivity translate into cheaper prices for agricultural products. According to Engel's law, the food industry benefits from an increase in agricultural output because food commodities have an inflation rate between one and one.

The increase in the balance of agricultural demand, which is oriented toward industrial commodities, somewhat counteracts the decrease in farm prices. While food prices decline in reaction to rising income levels, those for industrial goods and services climb. This leads to a shift in labor from farm to industry, which results in poor quality work.

The DRC's agricultural transition is challenging due to the absence of an agro-processing industry. The agriculture industry has significantly reduced its economic contribution to both the North and the South during the last 200 years. Agriculture currently accounts for 23% of GDP in low-income nations, 10% in middle-income nations, and 2% in high-income nations. In low-income countries, farmers and laborers make up no more than 30% of the population. Their transfer of ownership (along with labor and capital) to the company and then to the tertiary sector has resulted in an efficient burden cycle and a decrease in the unemployment rate.

## 5. Conclusion & Recommendation

The impact of mining governance on human development in the DRC is examined at the conclusion of this essay, with particular attention paid to indicators like infrastructure, employment, health, and education.

The Mining Governance Index, which is based on NRGI and is produced by PCA analysis of many governance indicators taken from the CPIA database in accordance with the NRGI methodology, was given in its entirety.

Based on estimates of simultaneous equation econometric models, this paper examines and assesses this influence from 1980 to 2019 utilizing methods like OLS, GMM, 3SLS, and Zellner's SURE.

Econometric regression results have demonstrated that mining governance affects GDP per capita in an indirect manner. Human development metrics including work, infrastructure, health, and education are all impacted by this.

The findings indicate that GDP per capita, employment, and education are all negatively impacted by mining governance. It has a favorable impact on currency rates and inflation. Additionally, estimates show that price volatility is favorably influenced by mining production, copper prices, and oil prices. The fluctuation of exchange rates has a detrimental effect.

These results highlight how crucial it is to enhance mining governance in order to maximize the advantages from mineral resources and promote sustainable growth. Institutions must be strengthened in order to improve socioeconomic results from the nation's rich mineral resources. This demonstrates how governance changes could maximize the benefits from its strategic mineral wealth.

This research supports the notion that inadequate mining governance impedes human development in the DRC, with a focus on public infrastructure, employment, health, and education. Thus, actions must be made to raise the standard of institutions generally and the mining industry in particular. The following is how the primary takeaway from this article might be expressed: Reducing corruption is important for managing natural resources in many ways, particularly for state-owned and private mining firms. This emphasizes the need to improve public management and corruption control.

The study's conclusions have led to the following seven recommendations have been developed with the goal of enhancing mining governance and human development in the DRC:

i. Reinforce the laws and rules that control the mining industry, emphasizing openness in the issuance of mining licenses and the handling of mining profits. This will support the battle against corruption;

ii. Make mining corporations contribute more to community-driven local development initiatives (roads, schools, health facilities, etc.) in order to enhance people's quality of life; Establish a sovereign wealth fund utilizing a portion of mining profits, with investments focused on infrastructure improvement and industries that generate employment, like agriculture;

iii. Strengthen the capacities of mining and environmental administrations to better monitor mining activities and assess their social and environmental impacts;

iv. Enhance data collection and dissemination on the mining industry to enable more stringent governance of mining and its impact on development;

v. v. Diversify the economy by bolstering SMEs and the agricultural sector to lessen over-reliance on mineral resources and generate employment outside of mining;

Fortify the educational system to foster the technical and managerial competencies required for better mining sector management and the emergence of a more diversified economy.

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