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**Economic policies and natural resources in the context of energy transition**

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# General Introduction

# General Introduction

Since the beginning of the 21st century, awareness of the devastating effects of climate change has grown rapidly, triggering a shift in global economic and geopolitical priorities. A certain scientific consensus, most notably through successive reports of the Intergovernmental Panel on Climate Change (IPCC), has consistently warned of the urgent need for an energy transition aimed at drastically reducing greenhouse gas (GHG) emissions. In response, several major international initiatives have been launched. The 2015 Paris Agreement, signed by 196 countries, marked a turning point by committing the global community to limiting the rise in average global temperature to well below 2°C above pre-industrial levels, while striving to cap it at 1.5°C. Achieving this requires a swift transformation of energy production and consumption systems, moving away from fossil fuels (coal, oil, gas) toward renewable energy sources (solar, wind, hydro) and low-carbon technologies (electric vehicles, batteries, hydrogen). However, these technologies demand massive quantities of strategic minerals, often referred to as critical or energy transition metals, including cobalt, lithium, nickel, copper, and rare earth. This growing dependency has sparked a new geopolitical era for natural resources, characterized by securitization strategies and intensified global competition for access to these minerals.

### Human Influence on Global Warming : Evidence and Trends

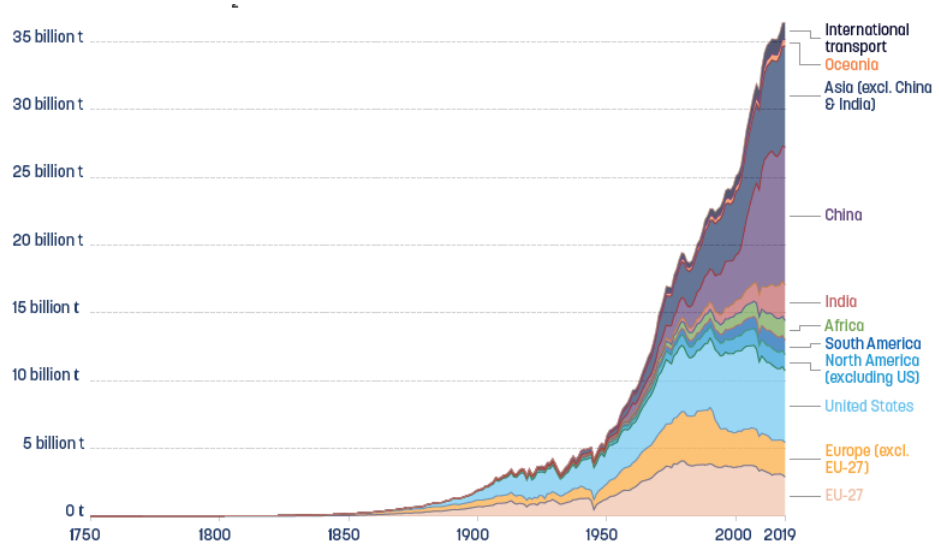
Scientific consensus confirms that human activities have unquestionably contributed to the warming of the Earth's atmosphere, oceans, and land masses (Calvin et al., 2023). Estimates suggest that anthropogenic actions have led to approximately 1.0°C of warming above pre-industrial levels, with projections indicating that this could rise to 1.5°C sometime between 2030 and 2052 if current trends persist (IPCC, 2022). Although natural climatic variations have occurred throughout Earth's history such as alternating ice ages and interglacial periods over the last 800,000 years, the current trend of rapid warming stands out. This modern surge in global temperatures, beginning in the 19th century, is directly linked to human-induced factors like fossil fuel combustion and widespread deforestation. Unlike previous natural

cycles, this human-driven warming is unfolding at a much faster pace and presents a severe risk to both human societies and ecosystems (NASA, 2024). This acceleration in global temperature is primarily caused by increased greenhouse gas (GHG) concentrations in the atmosphere. From 2021 to 2022, global GHG emissions climbed by 1.2%, reaching an unprecedented 57.4 gigatons of $CO_2$ equivalent (Figure 1). $CO_2$ emissions from burning fossil fuels and industrial activity account for about two-thirds of this total (United Nations Environment Programme, 2023). Despite significant advances in renewable energy, especially solar, many countries continue to invest heavily in fossil fuel development. Alarmingly, existing national plans indicate a trajectory toward doubling fossil fuel production by 2030, in direct contradiction with the targets of the Paris Agreement. Emissions disparities are also stark across and within nations. The wealthiest 10% of the global population, primarily located in developed countries, are responsible for roughly 48% of total consumption-based emissions, while the bottom half of the population contributes only 12%. Similarly, historical emissions show a clear imbalance. Nearly 80% of cumulative $CO_2$ emissions from fossil fuels and land-use changes originate from G20 countries, led by China, the United States, and the European Union. In contrast, the least developed nations are responsible for just 4% of these historical emissions (Figure 2). The impacts of climate change are already visible across the globe. Rising global temperatures have intensified the frequency and severity of heatwaves in many regions. This warming has also disrupted the planet's water cycle, resulting in more frequent heavy rainfall events globally, while increasing the risk of prolonged droughts in other areas due to altered weather patterns. Climate change has brought about extensive damage to natural ecosystems and human communities alike. The consequences disproportionately affect the most vulnerable populations, those who have contributed the least to the problem (IPCC, 2022). Between 3.3 and 3.6 billion people currently live in environments highly exposed to climate risks. Increasingly frequent extreme events have led to heightened food insecurity and reduced access to clean water. Particularly at risk are Indigenous Peoples, smallholder farmers, and low-income communities. During the period 2010–2020, the death toll from climate-related disasters such as floods, droughts, and storms was 15 times higher in the most at-risk regions compared to low-risk areas (FAO, 2021). Economic disruptions are also being felt across critical sectors including agriculture, forestry, fisheries, energy, and tourism. These climate impacts are compounding existing inequalities, with the poorest and most marginalized communities facing the brunt of the consequences.

## Climate agreements

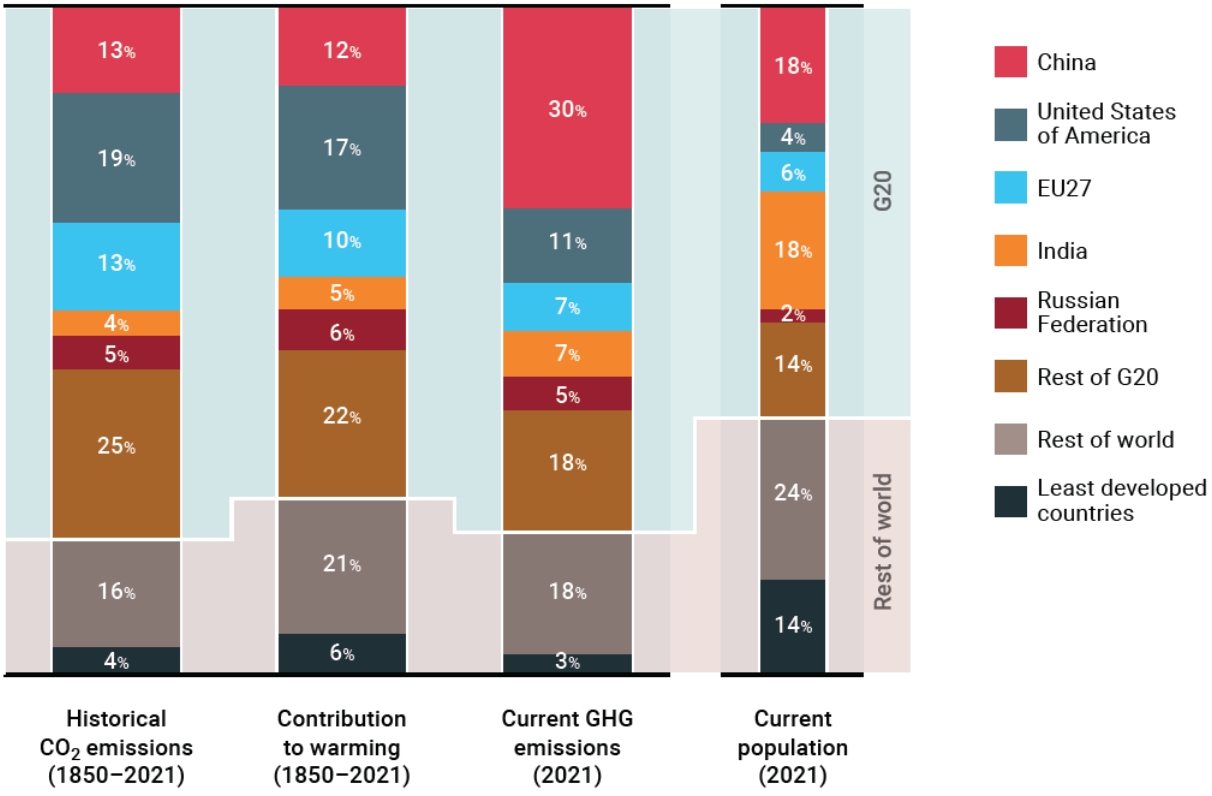
Over the last several decades, global efforts to combat climate change have gained considerable momentum through a series of landmark international agreements and collaborative initiatives. These frameworks have aimed not only to reduce greenhouse gas (GHG) emissions, but also to safeguard fragile ecosystems and reinforce international solidarity in addressing the climate crisis. Table 1 offers a summary of some

Figure 1: Evolution of GHGs




Annual Total CO2 Emissions by World Region. Source: World Bank (2021)

Figure 2: Current and historic contributions to climate change




Source: United Nations Environment Programme (2023)

of the most influential accords and mechanisms that have shaped the evolution of global climate governance. Collectively, these developments reflect an increasing awareness of the urgency of coordinated and sustained climate action at the international level. Among these milestones, the Paris Agreement has emerged as a transformative moment in climate diplomacy. By committing countries to limit the rise in global average temperatures to well below 2°C, and ideally to 1.5°C above pre-industrial levels, it established an ambitious framework for collective climate ambition. In addition to its temperature targets, the Paris Agreement laid a foundational pathway toward the decarbonization of the global economy. This transition, which entails reducing dependency on fossil fuels and scaling up clean energy systems, is central to achieving the Agreement's long-term objectives. The following section examines the broader implications of decarbonization, including the rising global demand for renewable energy. These elements are not only crucial for energy security and sustainable development, but also for ensuring compliance with the Paris climate commitments and avoiding the most dangerous impacts of global warming.

Table 1: Main agreements and initiatives

| Agreement or initiative | Year | Purpose |
|---|---|---|
| Montreal Protocol | 1987 | To stop the production of substances that damage the ozone layer |
| IPCC | 1988 | Provides scientific assessments of climate change, informing policymakers and the public. |
| UNFCCC | 1992 | Established an annual forum (COP) for international discussions aimed at stabilizing the concentration of greenhouse gases in the atmosphere. |
| Kyoto Protocol | 2005 | First legally binding climate treaty. It required developed countries to reduce emissions by an average of 5 percent below 1990 levels, and established a system to monitor countries' progress. |
| Paris Agreement | 2015 | Governments set targets, with the goals of preventing the global average temperature from rising 2°C above preindustrial levels and pursuing efforts to keep it below 1.5°C |
| Glasgow Pact (COP26) | 2021 | Strengthened the Paris Agreement by urging countries to accelerate efforts to phase out coal, reduce methane emissions, and increase finance for developing countries. |
| Sharm el-Sheikh Plan (COP27) | 2022 | Established a loss and damage fund to help vulnerable countries cope with climate change impacts |

Source : Maizland (2023)

## Decarbonization and energy demand

The Paris Agreement sets a global objective of limiting global warming to well below 2°C, ideally to 1.5°C. Achieving this requires a fundamental transformation of the global energy system. Figure 3 presents several emission scenarios aligned with different temperature targets, from 1.5°C to over 4°C. These trajec-

tories involve a steep reduction in greenhouse gas (GHG) emissions, with $CO_2$ reaching net-zero around mid-century and declining into negative territory thereafter (IPCC, 2022). This transformation depends heavily on the large-scale deployment of clean energy technologies. Electricity demand is expected to increase nearly fourfold by 2050, rising from approximately 28,000 TWh in 2022 to 110,000 TWh, with wind and solar supplying more than 75% of the total (ETC, 2023). Such growth necessitates major investments in grid infrastructure and the decarbonization of transport systems. Crucially, this transition will require vast quantities of energy transition metals (ETMs) such as lithium, cobalt, and nickel, which are essential to technologies like solar panels, wind turbines, and electric vehicle batteries, as shown in Table 2.

According to ETC (2023), the energy sector could consume an estimated 6.5 billion tonnes of materials between 2022 and 2050, primarily steel, copper, and aluminum. While base metals dominate by volume, critical minerals such as lithium, though used in smaller quantities, remain indispensable, requiring approximately 20 million tonnes during this period. Although known terrestrial reserves may suffice globally, demand surges could strain supply chains without improvements in recycling, substitution, or extraction efficiency. For example, reserves may need to expand by 30% for copper, 70% for nickel, and 90% for silver to meet projected needs by 2050 (ETC, 2023). Current and planned mining capacity falls short of anticipated demand : only about 50% of future lithium and cobalt needs, and 80% of copper, are covered for 2030 targets (IEA, 2021). Bridging these gaps will require new investments in exploration and mining, particularly in underdeveloped regions with untapped resource potential. Developing and emerging economies are therefore central to securing future supply chains.

However, as highlighted by Bank (2017*a*), reliable data on the geographic distribution and commercial viability of mineral reserves in these countries remain limited. Moreover, while high-income countries currently dominate production for several ETMs, many of the largest reserves such as those for lithium, cobalt, and rare earth elements are concentrated in less industrialized contexts. This imbalance creates both opportunities and challenges in aligning mineral development with sustainability, governance, and equitable growth. Table 2 summarizes key materials used in low-carbon technologies. Depending on the scenario, demand for some of these minerals particularly those used in battery production could increase by 150% to over 1,000% (Bank, 2017*a*).

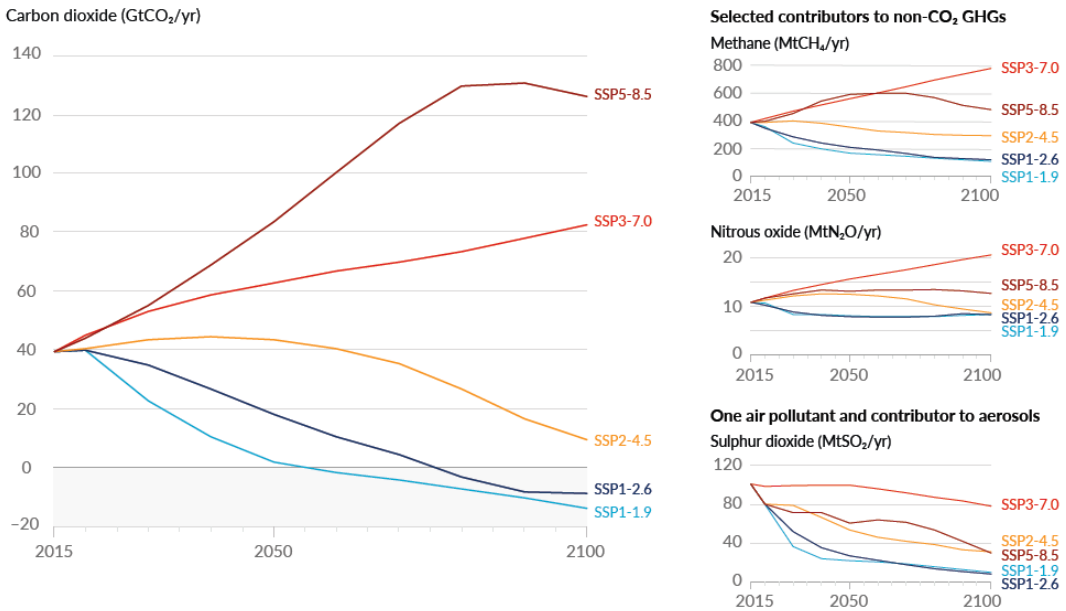
## Critical Raw Materials and Rare Earths : New Strategic Resources for the Global Energy Transition

The global energy transition is reshaping the landscape of natural resource economics. While tradi-

Table 2: Key materials for selected green technologies

| | Wind | Solar | Batteries |
|---|---|---|---|
| Aluminum | X | X | X |
| Chromium | X | | |
| Cobalt | | | X |
| Copper | X | X | |
| Rare earth | | X | |
| Iron | X | X | |
| Lead | X | X | X |
| Lithium | | | X |
| Manganese | X | | X |
| Nickel | X | X | X |
| Silver | | X | |
| Steel | X | | X |
| Zinc | X | X | |

Figure 3: Future annual GHGs emissions




The five scenarios are SSP1-1.9 (target 1.4°C), SSP1-2.6 (1.8°C), SSP2-4.5 (2.7°C), SSP3-7.0 (3.6°C) and SSP5-8.5 (4.4°C). Source: World Bank (2021)

tional resources such as oil, coal, and natural gas have long underpinned industrial development, the shift toward low-carbon technologies has brought a new category of resources to the forefront : critical raw materials (CRMs) and rare earth elements (REEs).

According to the European Commission (2023), critical raw materials are those that are economically and strategically important for the economy, but whose supply is exposed to high risks of disruption Grohol and Veeh (2023). These minerals including lithium, cobalt, nickel, and rare earths, are essential inputs for renewable energy infrastructure, electric mobility, and digital technologies. They are also essential for modern technologies such as batteries, wind turbines, semiconductors, and electric vehicles. Among them, rare earth elements, a group of 17 metallic elements including neodymium, dysprosium, and terbium, are indispensable for the production of permanent magnets and high-performance components used in renewable energy systems and electronics. Unlike traditional energy resources, critical minerals are not primarily used for energy production but rather for the manufacture of energy technologies. Their production and processing require different types of infrastructure, often less extensive in physical scale but more demanding in technological sophistication and environmental control. Furthermore, extraction and refining are highly concentrated in a few countries, generating new forms of dependency and geopolitical risk.

On the demand side, the rapid expansion of electric vehicles, batteries, and renewable energy systems has triggered a structural increase in the need for these materials, raising concerns about supply security and market volatility. Understanding the dynamics of production, transformation, consumption, and stockpiling of critical minerals has therefore become central to economic policy debates. Comparing these new resources with traditional ones helps illuminate the distinct challenges and opportunities of the energy transition, from investment patterns to governance and conflict risks in resource-rich countries.

### African countries , climate change and Energy transition Mineral (ETMs)

While Critical Raw Materials (CRMs) encompass a broader set of resources identified as economically vital but supply-constrained, Energy Transition Minerals (ETMs) refer specifically to minerals essential for clean energy technologies. Many ETMs, such as lithium, cobalt, and rare earth elements, are therefore also classified as CRMs by the European Commission and the IEA, reflecting their dual importance for both energy systems and strategic resilience. African countries are at the center of a complex intersection between the imperatives of climate change mitigation and the geopolitical realities of the energy transition. The continent is endowed with vast reserves of energy transition minerals (ETMs) such as cobalt in the Democratic Republic of Congo, lithium in Zimbabwe and Mali, copper in Zambia and the DRC,

and rare earth elements in countries like South Africa and Madagascar. These minerals are indispensable components of green technologies including electric vehicle batteries, solar photovoltaic cells, wind turbines, and grid storage systems which are critical for decarbonizing the global economy. This growing demand offers African economies a unique opportunity to reposition themselves in the global value chains of the 21st century. Revenues from ETMs have the potential to catalyze industrialization, create jobs, and finance climate adaptation efforts. However, realizing these benefits is far from guaranteed. Many resource-rich African countries face serious structural challenges, including weak governance, limited infrastructure, environmental degradation, and socio-political instability. The mining sector in particular is often marked by opaque contracts, limited local beneficiation, and a history of exploitative practices that have left communities impoverished and ecosystems damaged. Moreover, climate change itself poses a direct threat to African development and complicates the governance of extractive industries. Rising temperatures, erratic rainfall, and the increasing frequency of extreme weather events undermine agricultural productivity, exacerbate water scarcity, and heighten the risk of displacement and conflict all of which put additional pressure on governments and local populations. In mining regions, these dynamics can intensify competition over land and water, fuel grievances, and deepen inequalities.

To navigate this delicate balance, African countries and the international community must adopt a holistic and forward-looking approach. This includes strengthening institutional capacity, enforcing environmental and social safeguards, promoting local processing and value addition, and ensuring that mineral wealth contributes to broader development goals. Equally important is the need to embed climate resilience into national mining strategies, integrate local communities into decision-making processes, and ensure transparency and equity in benefit sharing. Ultimately, if managed responsibly, Africa's ETM endowments can serve as a lever not only for global decarbonization, but also for advancing a just and inclusive energy transition that supports the continent's own long-term development, stability, and climate resilience.

# The resource curse and development

### Natural Resources and Economic Growth

The relationship between natural resource abundance and economic growth has long intrigued economists and policy-makers alike. In theory, natural resources should serve as a catalyst for development, providing states with the revenues needed to invest in infrastructure, education, and health care. However, empirical evidence especially in the African context tells a more complex story. The paradox of plenty, also known as the "resource curse", suggests that countries rich in natural resources often experience slower economic growth compared to those with fewer natural endowments Sachs and Warner (2001). This paradox is particularly pronounced in Sub-Saharan Africa, where many resource-rich countries have struggled to transform resource wealth into broad-based and sustainable economic development. From Nigeria's oil sector to the Democratic Republic of Congo's mineral wealth, the continent provides numerous examples where resource abundance has failed to translate into meaningful improvements in living standards. This observation has led to a growing scholarly interest in understanding the underlying mechanisms that connect resource wealth to growth outcomes in Africa.

### Dutch Disease and Economic Structure

One of the most widely cited economic mechanisms through which natural resources can harm growth is the Dutch Disease. This phenomenon occurs when a boom in the resource sector leads to an appreciation of the real exchange rate, making other tradable sectors particularly agriculture and manufacturing less competitive. As a result, economies become overly dependent on volatile commodity exports and fail to diversify. In Africa, several countries have witnessed this dynamic firsthand. For example, in Angola and Nigeria, booming oil exports have been accompanied by the stagnation or even collapse of the agricultural and industrial sectors. This lack of diversification increases vulnerability to external shocks, particularly fluctuations in global commodity prices, and hampers long-term development prospects. Moreover, the enclave nature of many extractive industries in Africa limits their integration into the broader economy. Capital intensive and often controlled by foreign firms, these industries generate limited employment and weak linkages with local businesses, further diminishing their developmental impact.

### Volatility and Macroeconomic Instability

Natural resource revenues are notoriously volatile, subject to unpredictable swings in global commodity prices. This volatility poses significant challenges for macroeconomic management, especially in low-income African countries with limited institutional capacity. Sudden drops in prices can lead to severe fiscal crises, while windfall revenues are often poorly managed due to weak public financial systems. In

countries such as Zambia, Ghana, and Chad, boom-and-bust cycles in copper, gold, and oil revenues have resulted in repeated budget shortfalls, inflationary pressures, and rising debt levels. The inability to smooth expenditure over time, due to either weak institutions or political constraints, has undermined fiscal discipline and macroeconomic stability. These dynamics also reduce the effectiveness of public investment and limit the potential for sustained growth.

**Institutional Quality and Governance**

Natural resource abundance also has profound implications for institutional development, particularly in African countries with fragile governance structures. A growing body of literature underscores the adverse effects of resource wealth on the quality of governance and democratic accountability. Ross (2001) identifies three mechanisms by which resource rents may weaken democratic institutions. First, the "rentier effect" suggests that governments reliant on resource revenues face less pressure to tax citizens, which in turn weakens the social contract and reduces incentives for transparency and accountability. Second, the "repression effect" implies that resource wealth enables regimes to finance coercive apparatuses, often used to suppress dissent and entrench power. Third, the "modernization effect" argues that economies dependent on resource exports may under-invest in education and human capital, slowing the emergence of a middle class that typically supports democratic institutions. In many African countries, these dynamics are evident. For instance, in Chad, Equatorial Guinea, and Sudan, resource wealth has coincided with the persistence of authoritarian rule, the erosion of institutional checks and balances, and the marginalization of civil society. Additionally, the concentration of resource rents in the hands of political elites has contributed to patronage networks, clientelism, and widespread corruption. Empirical studies have further shown that weak legal frameworks and limited transparency around resource contracts and revenue management are associated with higher corruption levels in resource-rich African states ( Leite and Weidmann (1999); Knutsen et al. (2016)). This governance deficit not only distorts public spending but also undermines the legitimacy of state institutions and weakens prospects for inclusive development.

**Conflict and Political Instability**

Another critical dimension of the resource curse in Africa is the increased likelihood of violent conflict and political instability. A substantial body of empirical research has shown that the presence of valuable natural resources particularly when they are easily lootable, such as alluvial diamonds, gold, or cobalt can fuel civil wars and prolong existing conflicts (Collier and Hoeffler (2005); Berman et al. (2017)). These resources provide both the motive and the means for armed groups to contest control over territory, while also weakening state authority in peripheral regions. In countries like the Democratic Republic of Congo, South Sudan, and the Central African Republic, resource-rich zones have become epicenters of armed

conflict, often involving both domestic actors and transnational networks. The competition over access to resource rents fosters fragmentation, undermines national cohesion, and distorts incentives for peaceful governance. Moreover, the presence of extractive industries in conflict-prone areas often exacerbates grievances related to land rights, environmental degradation, and exclusion from benefits, further fueling instability. These dynamics not only have devastating human consequences but also impose massive economic costs by disrupting production, deterring investment, and destroying public infrastructure. In fragile African states, the risk of conflict linked to natural resources thus represents a major obstacle to long-term development.

**Inequality and Regional Disparities**

Resource-driven growth in Africa has often failed to translate into broad-based improvements in welfare, leading instead to rising inequality and regional disparities. The extractive nature of many industries characterized by capital intensity and spatial concentration means that the benefits of resource exploitation are frequently captured by a narrow elite or confined to specific regions. This is particularly evident in countries such as Angola, Nigeria, and Mozambique, where coastal cities or regions close to oil and gas infrastructure have experienced rapid growth, while inland or rural areas remain underdeveloped and marginalized. The concentration of revenues in central governments also tends to crowd out local development priorities, especially in the absence of effective fiscal decentralization mechanisms. In the absence of strong redistributive policies and inclusive institutions, resource wealth may exacerbate horizontal inequalities across ethnic, geographic, or social lines. Such inequalities not only threaten social cohesion but can also reinforce political instability and undermine the legitimacy of the state.

**Environmental Degradation and the Sustainability Challenge**

Finally, the exploitation of natural resources in Africa raises profound environmental and intergenerational concerns. Mining, oil extraction, and deforestation have contributed to widespread ecological degradation, including land contamination, water pollution, deforestation, and loss of biodiversity. These environmental impacts are often borne disproportionately by vulnerable communities, particularly Indigenous populations and smallholder farmers, who depend directly on natural ecosystems for their livelihoods. In many African countries, weak environmental regulations and limited enforcement capacity allow extractive activities to proceed with little regard for sustainability. The short-term focus on maximizing rents frequently comes at the expense of long-term ecological resilience. Moreover, the climate crisis introduces an additional layer of complexity, as fossil fuel–dependent economies must now grapple with the transition to low-carbon development paths. As the global economy moves toward renewable energy and green technologies, resource-rich African countries face both risks and opportunities. The demand

for critical minerals such as cobalt, lithium, and rare earth elements could provide new growth prospects, but only if managed responsibly and equitably. Without careful planning, the continent may once again find itself locked into a path of extractive dependency, environmental harm, and missed opportunities for structural transformation.

**Between Geopolitics and Sustainability : China's Energy Strategy in Africa**

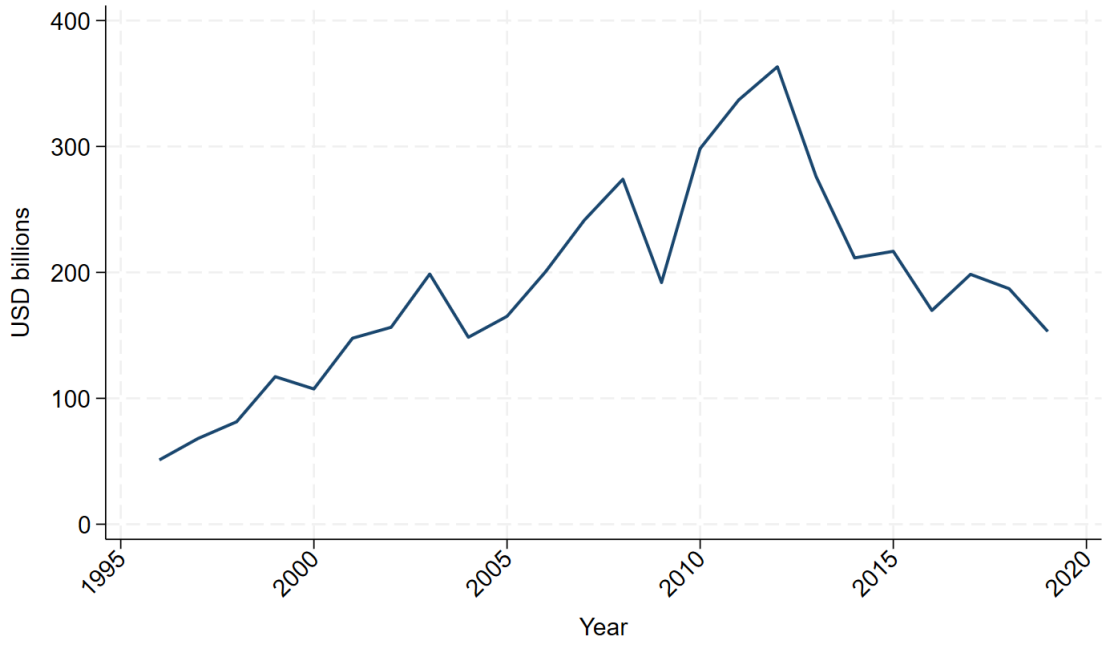
Since the early 2000s, China has emerged as a major player in Africa's energy transition, leveraging massive investments in energy infrastructure and in the extraction of critical natural resources. According to the Overseas Development Institute (ODI, 2022), between 2010 and 2021 Chinese financial institutions lent an average of USD 18 billion annually to energy-related projects worldwide, with one-third of that amount directed toward African countries primarily through engineering, procurement, and construction (EPC) contracts without direct equity stakes Kiryakova et al. (2025). Over the same period, China has become the world's leading investor in renewable energy and a dominant exporter of photovoltaic technologies, wind turbines, and lithium-ion batteries strategic assets for African nations seeking to achieve energy independence. In this evolving landscape, China has positioned itself as a central actor in the extraction, processing, and trade of critical minerals : through the Belt and Road Initiative (BRI) and partnerships with African governments, it has secured control over key mining assets and value chains, particularly in cobalt, copper, and lithium. This strategy is especially visible in mineral-rich countries such as the Democratic Republic of Congo (DRC), which holds over 50% of the world's cobalt reserves, with an estimated 80% of cobalt exports controlled by Chinese enterprises like Sinohydro under "resources-for-infrastructure" agreements such as the Sicomines project that exchange mining concessions for large infrastructure projects. Similar investments in lithium extraction in Zimbabwe and Mali further illustrate China's deliberate effort to align foreign policy with long-term resource security objectives. While this expanding presence has improved access to clean and sustainable energy in several African countries supported by scholarly evidence of statistically significant correlations between Chinese investments and energy access, it has also raised concerns regarding asymmetric dependencies, governance standards, environmental impacts, and broader issues of sovereignty and local sustainability.

**Statistics on Chinese Foreign Direct Investment (FDI) in Africa**

Sectorally, the evidence shows a pronounced rise in Chinese FDI to Africa from the late 1990s up to a 2013-2014 peak , followed by a normalization through 2020, consistent with global commodity and financing cycles (Figure 4 and 5). The statistical evidence shows a strong sectoral concentration of Chinese FDI in Africa, with a clear dominance of transport and energy-related investments. Transport alone accounts for the largest share, followed by energy and real estate (Figures 6 and 7). At the subsector

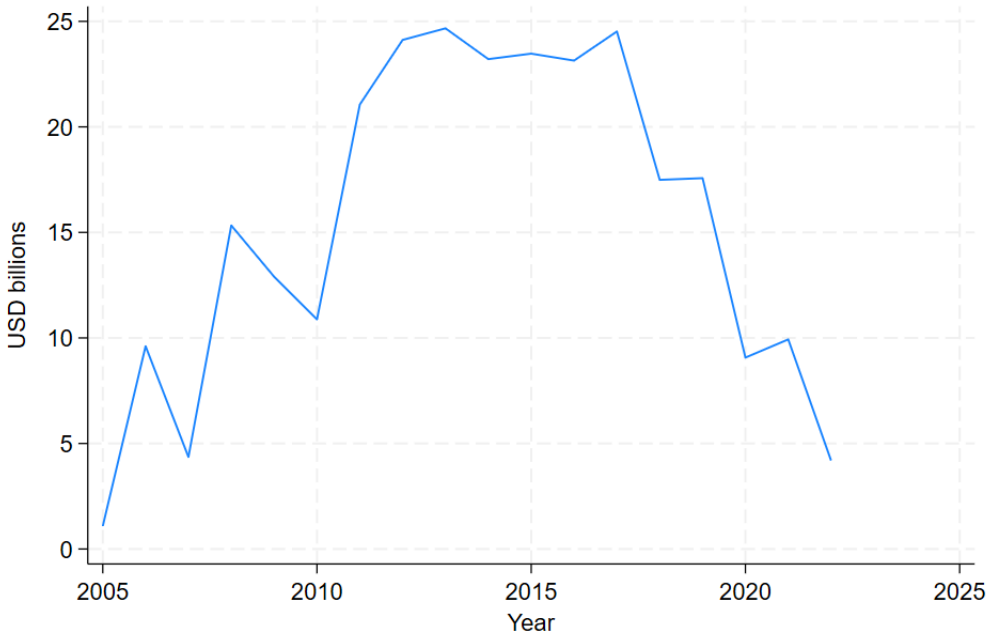
level, investments are heavily oriented toward rail, automotive, hydropower, and construction, while oil represents a comparatively smaller share. Metals such as copper remain marginal in comparison to energy and infrastructure-related investments. Overall, the pattern suggests a strategic focus on large-scale infrastructure and energy systems, consistent with efforts to support connectivity, industrialization, and access to key resources. Geographically, flows are highly concentrated : the DRC dominates (in line with copper–cobalt endowments), followed by major recipients such as South Africa, Nigeria, Mozambique, Namibia, Zambia, Zimbabwe, and Egypt, while many countries receive comparatively modest amounts (Figure 2.A.2). Taken together, the statistical analysis depict a cyclical yet strategically targeted FDI profile tilted toward hydrocarbons and core transition relevant metals with a strong geographic concentration, all of which is consistent with a geo-economic strategy focused on securing critical resources and upstream access to mineral value chains.

Figure 4: Trends in China Foreign Direct Investment (FDI) in Africa (1996-2019)



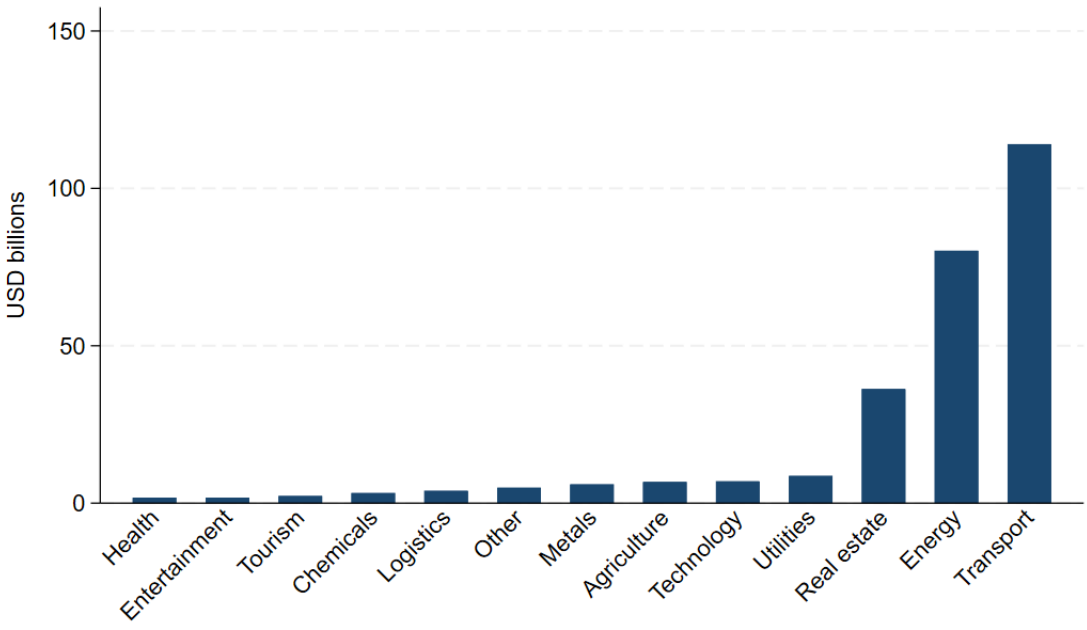

Author calculation Source : Data steming from Chinese Ministry of Commerce (MOFCOM)

Figure 5: Trends in Chinese firms Investment in Africa over years (2005-2022)



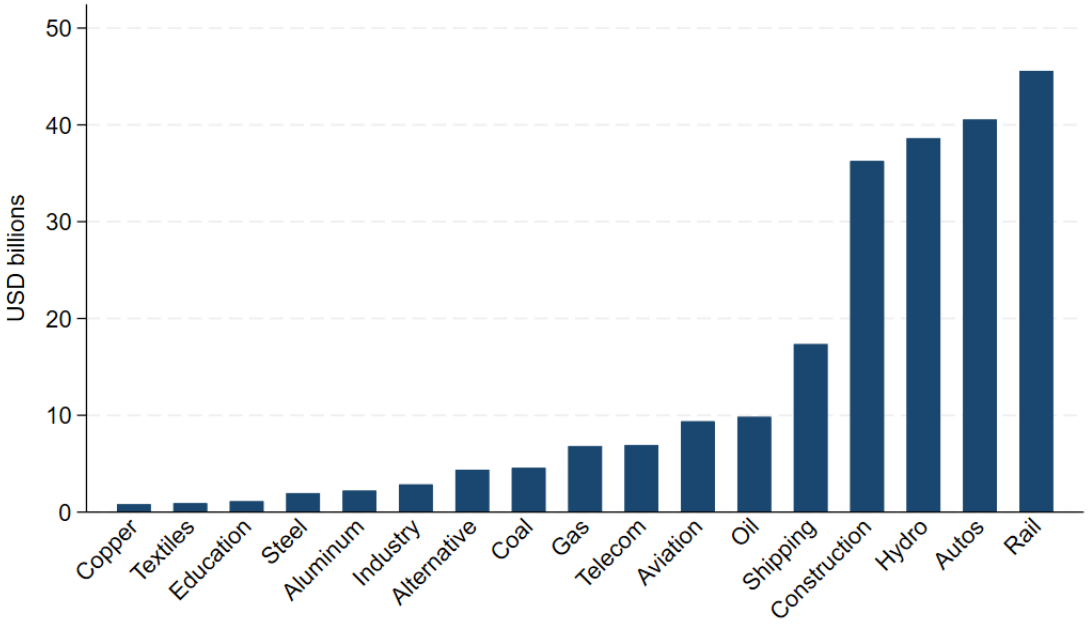

Author calculation Source : Data steming from from American Enterprise Institute : China Global Investment Tracker

Figure 6: Trends in Chinese firms Investment in Africa by sectors : Construction (2005-2022)




Author calculation Source : Data steming from from American Enterprise Institute : China Global Investment Tracker

Figure 7: Trends in Chinese firms Investment in Africa by subsector (2005-2022) : Construction

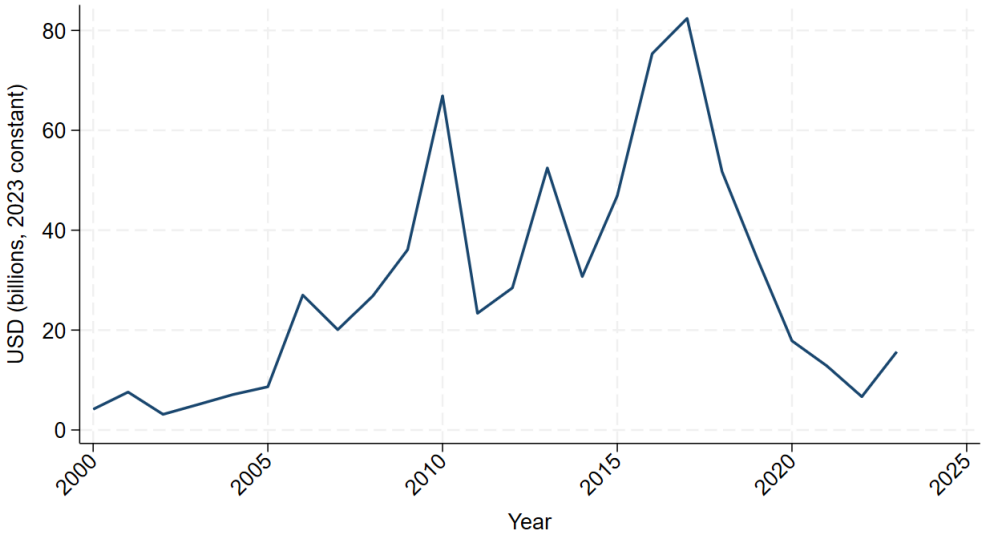



Author calculation Source : Data steming from from American Enterprise Institute : China Global Investment Tracker

**Statistics on Chinese Development finance in Africa**

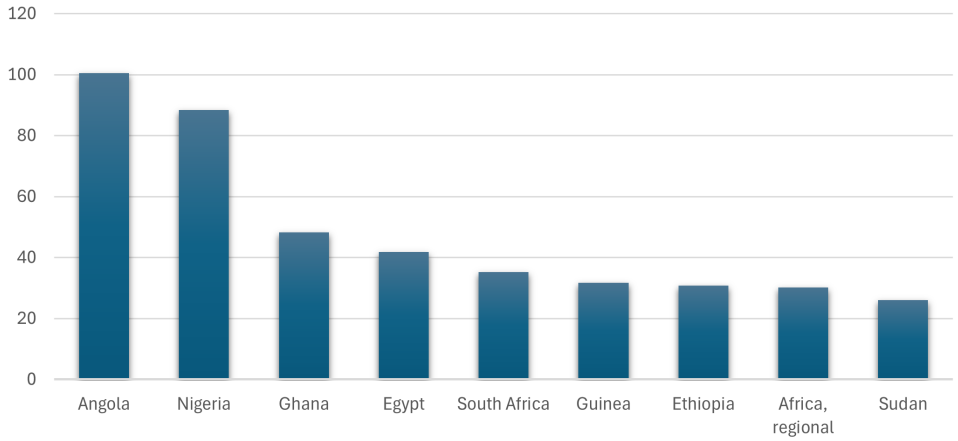
The statistics on Chinese development finance in Africa reveal a trajectory that broadly mirrors, but is more volatile than, Chinese FDI : a steady rise from the early 2000s, a surge between 2009 and 2016 with peaks above USD •70–80•billion in constant 2023 dollars and a sharp contraction after 2017, consistent with Beijing's tightening of external lending conditions, rising domestic financial constraints, and a re-calibration of Belt and Road financing (Figure 8). Geographically, Chinese development finance is even more concentrated than FDI, with Angola and Nigeria absorbing the largest shares (reflecting oil-backed credit lines and mega-projects), followed by Ghana, Egypt, South Africa, Guinea and Ethiopia, while most other countries receive comparatively modest amounts (Figure 9). Sectorally, the portfolio is dominated by transport and storage, industry/mining/construction, and energy, which together account for the majority of commitments; social sectors (water, sanitation, agriculture, social infrastructure) remain relatively marginal (Figure 10). Taken together, these patterns depict Chinese development finance as a counterpart and complement to Chinese FDI : large-scale, infrastructure-centred, highly concentrated, and strategically aligned with the logistics, industrial capacity, and energy systems necessary to secure and transport natural resources particularly relevant in the context of mineral-intensive global energy transitions.

Figure 8: Trends in China Development finance by country in Africa over years (2000-2024)



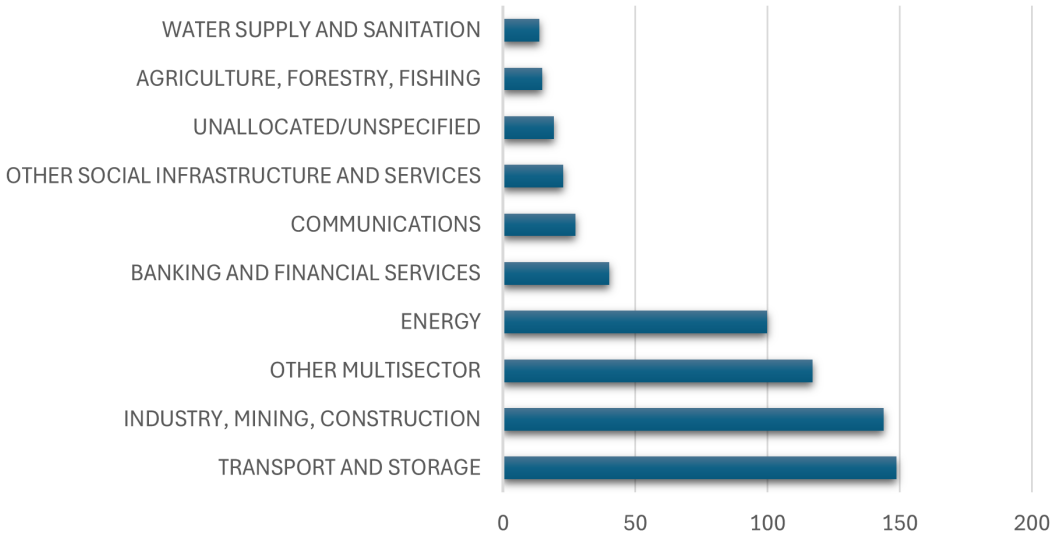

Author calculation using AidData Source : Tierney et al. (2011)

Figure 9: Trends in China Development finance by country in Africa (Amount > 25 billions)




Author calculation using AidData Source: Tierney et al. (2011)

Figure 10: Trends in China Development finance by sectors in Africa

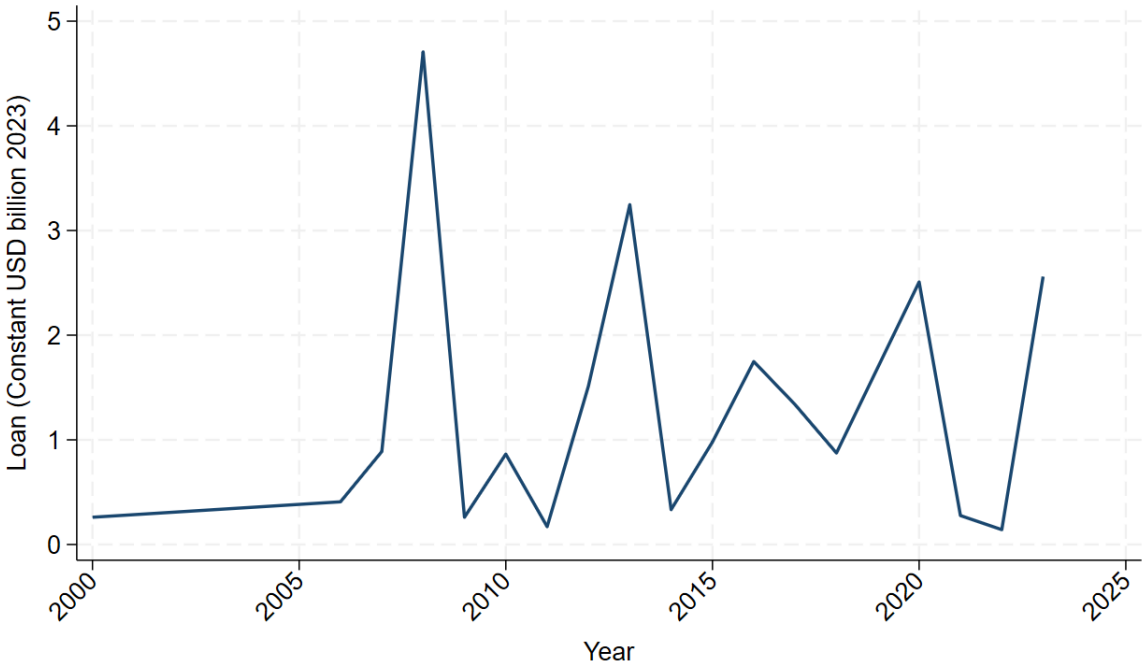



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**Statistics on Chinese Financing for Transition Minerals in Africa**

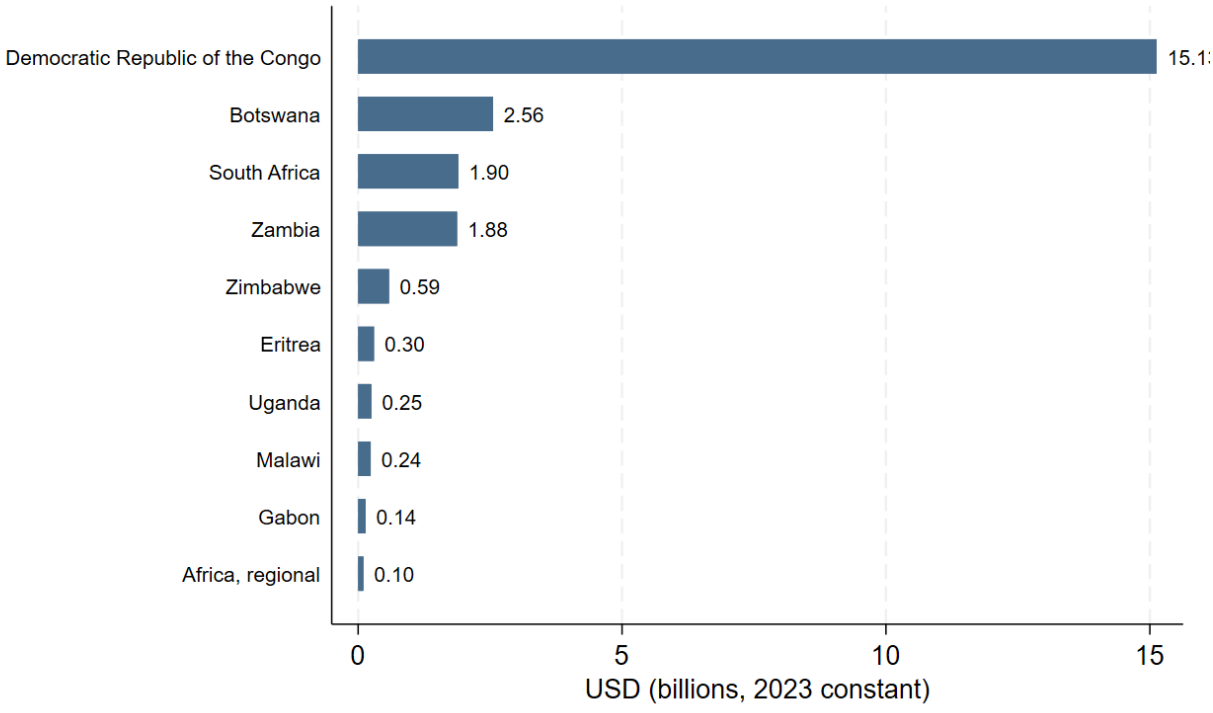
Figure 11 show that Chinese financing for transition minerals in Africa has followed a highly irregular, deal–driven trajectory since the mid–2000s, with sharp spikes (around 2009, 2014, 2021 and 2024) separated by years of very limited activity. By mineral category, financing is overwhelmingly concentrated in the cobalt–copper value chain : the combined *Cobalt/Copper* category (about 15.1 billion USD, constant 2023 prices) far exceeds all others, followed by *Copper* alone (about 4.62 billion USD). Much smaller amounts are directed toward *Chromium*, *Manganese*, *Niobium/Tantalum*, *rare earths*, and *Lithium*, reflecting a structure closely aligned with metals critical to battery components, wiring, electric motors and grid infrastructure (Figure 13). Geographically, Chinese financing is strongly concentrated : the Democratic Republic of the Congo dominates (about 15.1 billion USD), followed by a second tier of recipients such as Botswana (2.56 billion USD), South Africa (1.90 billion USD), Zambia (1.88 billion USD) and Zimbabwe (0.59 billion USD), with a long tail including Eritrea, Uganda, Malawi, Gabon and regional facilities ( Figure 12). Overall, the temporal volatility, mineral composition and geographic concentration point to a targeted Chinese strategy aimed at securing upstream access to copper–cobalt systems (and, to a lesser extent, other transition minerals) through intermittent large scale transactions in a limited number of resource-rich African countries.

Figure 11: Chinese Financing for Transition Minerals in Africa over years (2000-2024)



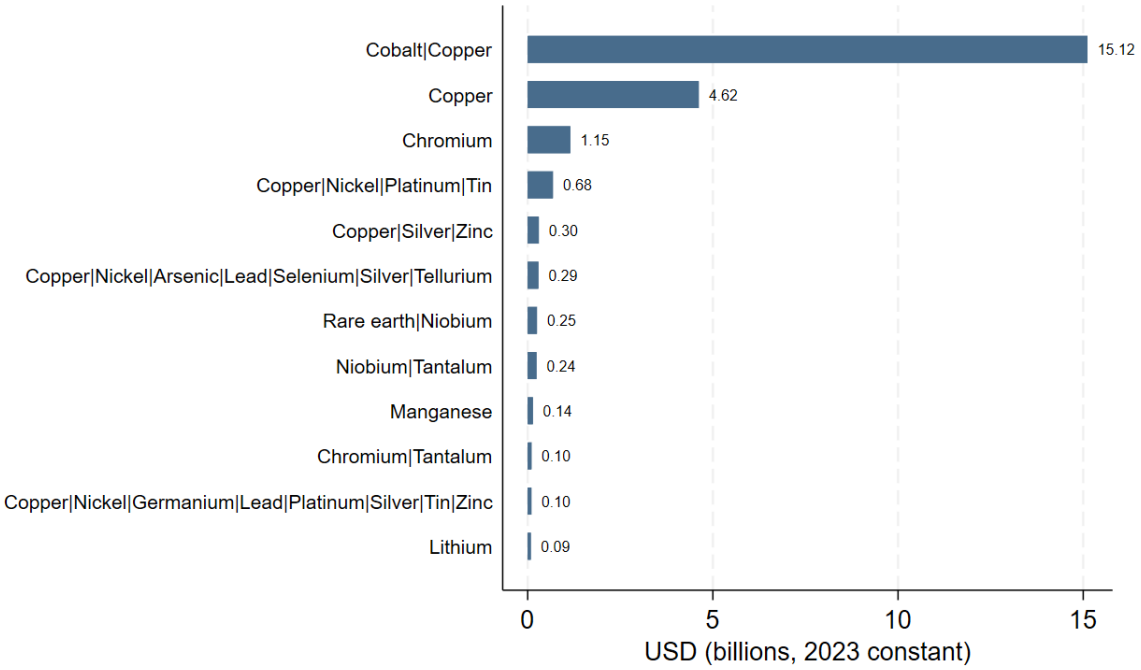

Author calculation using AidData. Source: Tierney et al. (2011)

Figure 12: Chinese Financing for Transition Minerals in Africa by country (2000-2024)




Author calculation using AidData Source: Tierney et al. (2011)

Figure 13: Chinese Financing for Transition Minerals in Africa by minerals (2000-2024)




Author calculation using AidData Source : Tierney et al. (2011)

### Rethinking the Resource Curse in the Context of the Green Transition

Natural resource abundance has not always been a blessing for resource-rich countries. Rather, it has often been associated with perverse dynamics known as the "resource curse". Popularized by Sachs et al. (1995), this theory posits that natural wealth tends to hinder economic growth, foster corruption, weaken institutions, and fuel conflict. Several mechanisms underlie this theory : the “Dutch Disease”, in which resource-driven capital inflows cause currency appreciation and harm the manufacturing sector, commodity price volatility, which leads to chronic macroeconomic instability, the institutional trap, where resource rents breed corruption and undermine democratic governance, and finally, violent conflicts over resource control, especially in fragile states. Today, in the context of the green energy transition, these risks may resurface in new forms. The surging demand for strategic minerals highly concentrated in just a few regions, risks exacerbating internal and external tensions, fuelling economic predation, and reviving neo-colonial dynamics.

### Africa : Navigating potential and policy realities

Africa holds a central place in this new resource geopolitics. The continent is home to 70% of the world’s cobalt reserves (critical for electric batteries), 50% of platinum group metals, and significant deposits of lithium, copper, manganese, graphite, and rare earths. Countries such as the Democratic Republic of

Congo (DRC), Zambia, Zimbabwe, Mali, and Ghana are now central to global supply strategies. Yet Africa's recent history shows that natural wealth has not always translated into prosperity. Resource extraction has often come at the cost of severe human rights abuses, widespread environmental degradation, and prolonged armed conflict, as illustrated by the coltan wars in the DRC. Today, the acceleration of the global energy transition threatens to reproduce, under new guises, the same extractive and exploitative mechanisms witnessed during colonial and Cold War periods.

### The New Critical Minerals Race

In this geopolitical reshuffling, major powers are racing to secure access to critical minerals. China has gained a decisive edge by heavily investing in the extraction and refining of many of these metals. Its Belt and Road Initiative (BRI) now includes mining projects across Southern, Central, and Eastern Africa. The United States has responded with initiatives like the "Mineral Security Partnership" to diversify supply chains. The European Union has launched its Critical Raw Materials Act to reduce dependence on China. Meanwhile, India, Russia, and Japan are also seeking to secure strategic supplies from Africa. This competition intensifies the risks of new forms of dependency, exploitation, and "economic recolonization", through conditional aid, direct investments, and unbalanced strategic partnership , all at the expense of African sovereignty.

### A Strategic Choice for Africa : Choose to engage

Africa now stands at a crossroads, will it once again be subjected to resource exploitation with little developmental return ? Or can it transform its natural wealth into a driver of structural transformation, anchored in sovereign, sustainable, and inclusive economic policies ? The continent has key assets to build upon : a growing awareness of the need to control resource value chains (e.g., local cobalt processing initiatives in the DRC), strengthened bargaining power due to rising global demand and diversified partners, a young and educated population, and promising regional dynamics such as the African Continental Free Trade Area (AfCFTA). However, seizing this opportunity will require moving beyond rent-seeking and short-term thinking. It will necessitate massive investment in infrastructure, governance, transparency, and technological innovation.

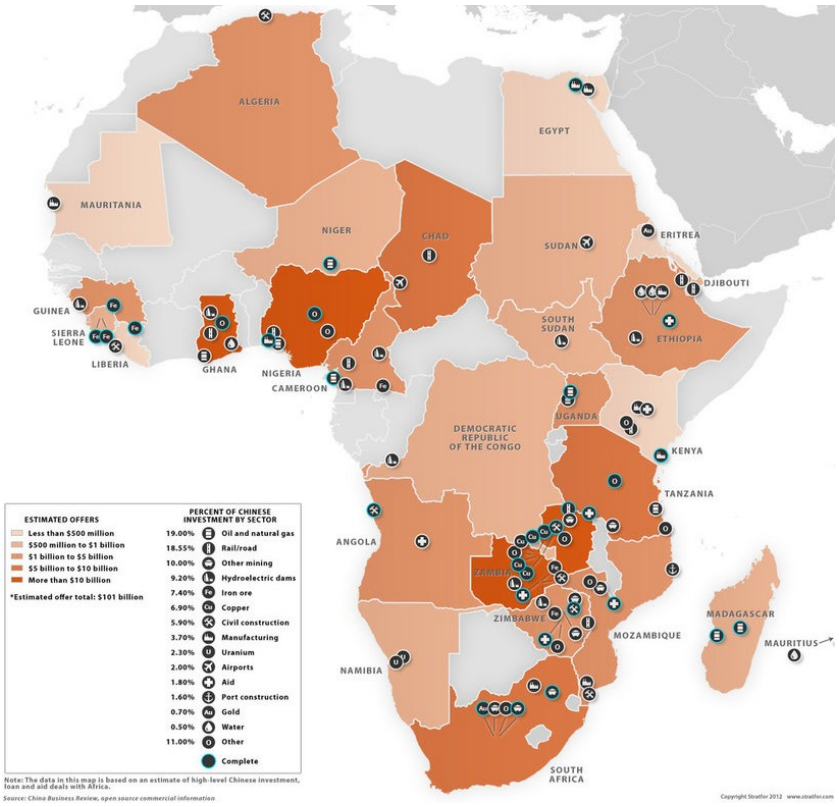
## Thesis Objectives

This thesis seeks to examine the economic and geopolitical dynamics shaping Africa's natural resources within the broader context of the global energy transition, with particular attention to the role played by China. It is organised around four interconnected research axes that together aim to illuminate how external actors influence resource governance on the continent. First, the study investigates whether the presence of oil, gas, and mineral endowments increases the attractiveness of African countries for Chinese Official Development Assistance (ODA), thereby assessing the extent to which natural resource wealth determines aid allocation patterns. Second, it analyses whether similar resource-seeking incentives structure Chinese Foreign Direct Investment (FDI) flows, exploring the degree to which Chinese corporate engagement mirrors or diverges from the strategic logic observed in development assistance. Third, the thesis evaluates the risk of conflict linked to cobalt production in the Democratic Republic of Congo, questioning how the rapidly rising global demand for electric-vehicle batteries may heighten instability in cobalt-rich regions and reshape local socio-political dynamics. Finally, the fourth chapter moves beyond rhetoric by examining whether China is genuinely 'going green' in Africa. In this final chapter, we assess whether Chinese FDI is effectively driving sustainable investment across the continent.

In sum, this thesis analyses the economic and geopolitical dynamics surrounding Africa's natural resources in the context of the global energy transition, with a particular focus on China's strategies and their implications for African development. It explores how natural resources influence the allocation of Chinese development aid and foreign direct investment, and how these flows interact with the political economy of African resource governance. The research also investigates how the surge in demand for critical minerals, particularly cobalt in the DRC, affects the risk of conflict. And finally, this thesis assess whether Chinese FDI is effectively driving sustainable investment across the continent. By combining disaggregated analyses of aid and investment flows with spatial and econometric methods, this study seeks to capture the multiple channels through which the global energy transition reshapes Africa's integration into the world economy.

Ultimately, the thesis aims to contribute to ongoing debates on the political economy of the green transition in developing contexts. It questions whether Africa can leverage the global demand for its critical minerals to foster structural transformation and industrialisation, or whether it risks entering a new cycle of dependency, one that reproduces, under a "green" narrative, the same extractive logic that has long constrained its development trajectory. Through these analyses, the thesis aims to contribute to critical

Figure 14: China investments in Africa since 2010

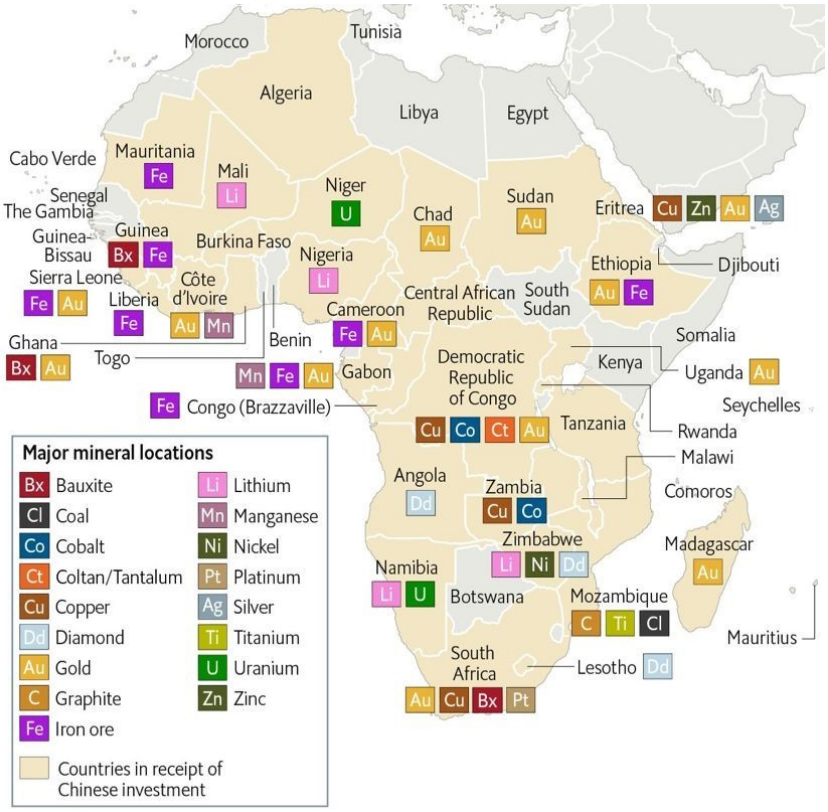



Source : China Business Review

debates on : Africa's capacity to harness its resource wealth for sustainable development; emerging forms of economic dependency in the age of decarbonization; the global strategies of major powers amidst shifting economic balances.

The thesis adopts an analytical framework to examine the economic policies of major actors, with a particular focus on China, through the lens of development aid, foreign direct investment, and their political, economic, and environmental consequences. By shedding light on the attractiveness of natural resources, the potential for conflict, and the possible "greenness" of energy transition investments, this research contributes to rethinking the conditions for a sustainable, and inclusive development path for Africa.

Figure 15: China investments in Africa during 2021




Source : Economist Intelligence Unit (EIU)

## Research contributions

This dissertation contributes to the understanding of how the global energy transition is reshaping the economic and geopolitical landscape of resource-rich African countries, provides new empirical evidence on four fronts. First, it shows that development aid particularly from emerging donors such as China is increasingly channelled toward resource-rich countries, which also tend to possess critical minerals like cobalt, reflecting a strategic alignment with energy transition priorities. Second, it shows that Chinese foreign direct investment is shifting away from oil and becoming increasingly oriented toward countries well endowed in natural resources especially metals, relevant to the energy transition, indicating a strategic realignment with important consequences for African industrial policy and infrastructure development. Third, focusing on the Democratic Republic of Congo, the research develops a localized early-warning model linking cobalt mining to rising risks of fragility and conflict. In particular, the predictive model shows an overall increase in conflict risk in the region, driven by the growing strategic importance of cobalt, underlining the need for improved governance and local development in mining areas. Finally, the fourth chapter shifts the focus from volumes of aid and investment to questions of quality and development outcomes, it assesses whether Chinese FDI projects contribute to sustainable development in host African countries. The findings show that Chinese FDI plays a meaningful and positive role in promoting sustainable development across the continent. While concerns persist regarding environmental standards and investment quality, the empirical evidence indicates that Chinese engagement is increasingly aligned with both development and environmental objectives.

By combining geospatial analysis, econometric modeling, and policy evaluation, the dissertation offers evidence-based insights that are highly relevant for international development institutions seeking to foster sustainable, inclusive, and conflict-sensitive growth in the context of the global shift to clean energy.

## Chapter 1 : Natural resources and China's foreign assistance in Africa : a two-sided story ?

This chapter investigates whether aid flows, particularly from emerging donors like China are increasingly aligned with the strategic resource interests driven by the green transition. Using both country-level and disagregated /geocoded project data from Africa, the findings suggest that countries rich in natural resources with reserves of critical minerals (e.g., cobalt) receive significantly more Chinese aid. These patterns raise important questions about donor coordination, transparency, and the alignment of aid with long-term development outcomes.

## Chapter 2 : Chinese FDI in Africa, natural resources and the energy transition challenges

This chapter examines the sectoral drivers of Chinese foreign direct investment (FDI) in Africa, with a focus on extractive industries. It finds that while FDI is increasingly oriented toward minerals (minerals essential to the energy transition, such as copper and cobalt), oil has lost its attractiveness possibly due to price volatility and climate-related risks. The analysis offers key insights into how the global shift to clean energy is transforming investment priorities.

## Chapter 3 : We can't ignore the elephant in the room : Cobalt, Conflicts, and energy transition in DRC

Focusing on the Democratic Republic of Congo (DRC), this chapter evaluates whether rising demand for cobalt could exacerbate fragility and conflict. While historical data show a weaker correlation between cobalt and conflict compared to gold, the chapter develops an early-warning econometric model that predicts an increase of the risks of instability tied to cobalt mining and regulatory vacuums. The findings support the case for strengthened governance, due diligence, and local development in mining zones.

## Chapter 4 : Greening or Greenwashing : Is China Going Green in Africa ?

This final chapter, using a panel dataset and a set of econometrics technics, assesses whether Chinese FDI projects contribute to sustainable development in host African countries. The findings suggest that Chinese FDI plays a meaningful and positive role in promoting sustainable development in Africa. While concerns remain regarding environmental standards and investment quality, the empirical evidence indicates that Chinese engagement increasingly supports sustainable development objectives.

# Chapter 1

# Chapter 1

# Chapter 1 - Natural resources and China's foreign assistance in Africa: a two-sided story ?

Co-written with Camélia Turcu

## 1.1 Introduction

Foreign aid is a key vector to finance development strategies in emerging and developing countries(Reilly, 2013; Isaksson and Kotsadam, 2018; Pérez Niño and Le Billon, 2014; Brant, 2013). Given the existing development gaps between the so-called Southern and Northern countries, the latter have come together in a development assistance committee (DAC) under the aegis of the OECD. They have developed aid systems aimed at supporting the least developed economies on their development paths[1], based on specific criteria. This aid, which is most often anchored to well-defined projects, is oriented to all the sectors that drive development in the recipient countries.

The leadership of OECD countries in the field of official development assistance (ODA) is challenged by the emergence of new actors in the South. Among them, China, despite its status as an emerging country, has become a key provider of foreign aid to the African continent (Gelpern et al., 2023) and the largest bilateral creditor of Sub-Saharan countries (Bertrand and Zoghely, 2021). Unlike traditional North-South aid, Chinese foreign assistance[2] is usually described as a mutually beneficial partnership between emerging-developing countries and is associated to the South-South cooperation (Turcu and Zhang, 2024). The emergence of China as a key provider of development assistance has raised considerable interest in the factors that shape its aid allocation decisions. More broadly, this is related to general questions such as : do donor countries allocate their aid on humanitarian or development criteria only ? are there other specific interests that could be pursued ? Numerous studies (Alesina and Dollar, 2000; Dreher et al., 2011; Berthelemy, 2006; Fuchs and Richert, 2018) suggest that aid allocation decisions may be influenced by a range of political, economic, and social interests.

These questions have become particularly relevant in the context of the global energy transition. As demand for strategic natural resources increases, and as many of these resources are concentrated in developing and emerging countries, access to them has become an important economic and geopolitical issue. Against this background, this chapter examines whether China increasingly allocates aid to resource-rich countries, especially those holding strategic minerals for the energy transition. For this purpose, we rely on two distinct datasets. The first is a relatively aggregated dataset covering a large set of African economies, over the period 2000–2016. The second is a more disaggregated dataset spanning

[1]Since 1972, OECD DAC has defined ODA for its 24 members as « Those flows to countries and territories on the DAC list of ODA recipients and to multilateral institutions » which are : i. provided by official agencies, including state and local governments, or by their executive agencies; and ii. each transaction of which : a) is administered with the promotion of the economic development and welfare of developing countries as its main objective; and b) is concessional and conveys a grant element of at least 25 percent (calculated at a rate of discount of 10 percent).

[2]The Chinese development aid can take several forms (i.e. complete projects, goods and materials, technical cooperation and human resources development cooperation, medical teams and volunteers, emergency humanitarian aid, debt relief, construction of infrastructure and implementation of production projects).

1999–2013 (Dreher et al., 2019) allowing an analysis at both the Chinese aid project level and the recipient economies' subnational level. This is possible as aid projects are georeferenced to African first-order administrative regions (ADM1) (i.e. the spatial scale is based on African administrative regions (ADM1)). Both datasets were analyzed using different econometric techniques, including Least Squares Dummy Variables (LSDV) and Poisson Pseudo-Maximum Likelihood (PPML) approaches. Our results, obtained at national and subnational levels, suggest that natural resource endowment is as a key determinant in China's aid allocation decisions. Nevertheless, China also appears responsive to the needs of recipient countries in areas such as education and public debt sustainability.

The rest of the chapter is structured as follows. The next section will be devoted to the literature review. Section 3 will describe the different datasets and the empirical methodology used in our study. In Section 4 we will check the robustness of our results. Section 5 concludes.

## 1.2 Literature Review

The literature on the determinants of development aid is extensive[3]. Many studies have focused on the factors that may influence the aid decisions of donor countries and the characteristics of recipient countries. In the case of emerging donors, in particular, the motivations behind foreign aid allocation, have attracted a lot of attention in the recent decade. A key question is whether such aid is driven by humanitarian and development concerns or if it primarily serves the strategic interests of donor countries. Moreover the question of whether this aid allocation patterns differ from those of traditional OECD-DAC donors is also raised. It is often shown that, while emerging donors emphasize the principles of South-South cooperation, mutual benefit, and non-interference, their aid allocation decisions are also influenced by political and economic interests (Dreher et al., 2011). For example, research on India shows that its development aid is shaped by geographic proximity, regional security concerns, and diplomatic relations (Fuchs et al., 2014), whereas studies on Brazil highlight the importance of foreign policy objectives and South-South partnerships, particularly in Latin America (Cabral and Weinstock, 2010; Milani et al., 2017). Similarly, the literature on Arab donors finds that political alliances and cultural ties play a key role in aid allocation (Neumayer, 2003). Among emerging donors, however, China has attracted a lot of the attention because of the scale of its development aid.

A body of the literature indicates that political considerations significantly influence China's aid distribution. For instance, Dreher et al. (2019) examine whether Chinese aid is politically motivated by

[3] See Carter (2017) for further details on the literature review on China's aid

analyzing the birthplaces of 117 African political leaders and mapping these against over 1,600 Chinese-funded development projects between 2000 and 2012. They find that regions corresponding to leaders' birthplaces receive significantly more aid during their tenure, suggesting political favoritism in allocation. Similarly, Dreher and Fuchs (2011) assess China's aid allocation from 1956 to 2012, focusing on project, food, and medical aid. While confirming that political factors are indeed a key determinant, they also find that China does not differ significantly from traditional donors in this respect. Notably, contrary to widespread assumptions, their results show no strong correlation between Chinese aid and recipient countries' natural resource wealth or democratic status. Complementing this perspective, Dreher et al. (2018) emphasize the importance of disaggregating China's financial flows into official development assistance (ODA) and more commercially-oriented funding. Using a compiled dataset of Chinese official commitments to Africa (2000–2013), they show that ODA tends to align with foreign policy interests, while non-concessional funding is better explained by economic motives. This distinction is essential for understanding the growing complexity of Chinese foreign aid. In a comparative context, Furuoka (2017) evaluate both Chinese and Japanese foreign aid allocation using panel regressions. They conclude that donor self-interest dominates both countries' aid strategies, although Japan appears more responsive to recipient needs and governance quality. This distinction suggests heterogeneity in donor behavior, even among East Asian donors.

Other donor nations in East Asia also exhibit strategic considerations in aid distribution. Kim and Oh (2012), focusing on South Korea's development aid over 23 years and across 154 countries, demonstrate that aid is disproportionately directed toward wealthier and faster-growing economies. The authors interpret this pattern as evidence of South Korea pursuing economic self-interest under the guise of development cooperation. Interestingly, they note a duality in aid behavior: Korea's aid is more humanitarian toward low-income countries but more strategic for high-income recipients. Likewise, Japan's aid allocation reveals a similar dual pattern. Cooray and Shahiduzzaman (2004) find that Japan's ODA from 1981 to 2001 is significantly influenced by GDP per capita, trade relationships, demographic size, and democratic governance. While developmental objectives remain relevant, Japan increasingly directs aid toward countries with which it has important trade relations.

Overall, these studies highlight the multifaceted nature of foreign aid. Across traditional and emerging donors, aid allocation seems often shaped by a certain combination of strategic, political, and economic considerations rather than by sole development objectives. Against this background, we investigate the possible impact of natural resources, in the recent energy transition's context, on China's development aid allocation in Africa. We also compare China's strategy with that of other donors (i.e. Japan).

## 1.3 Methodology and Data

This section highlights the data and empirical strategy used to analyze the role of natural resources in China's development aid allocation to African countries. The analysis is conducted at two different levels. First, we perform a country-level analysis covering 49 African countries over the period 2000–2016. Second, we conduct a project-level and subnational analysis based on Chinese aid projects located in 49 African countries between 1999 and 2013. For the latter analysis, we follow Dreher et al. (2019), and use georeferenced information on Chinese aid projects and their locations within administrative regions in Africa. The unit of analysis is the first-order administrative region (ADM1), corresponding to provinces, states, or governorates. Information on these administrative units and their boundaries is obtained from the Global Administrative Areas Database (GADM), as illustrated in Figure 1.1. The sample includes 709 ADM1 regions within the 49 African countries covered by the study.

### 1.3.1 Empirical strategy

In order to assess whether natural resources play a key role in China's development assistance to African countries, as previously mentioned, we have conducted two types of analysis : one at the country level (national scale) and another one at a more dissagregated (by considering Chinese aid projects and their location within countries) level. The national scale analysis is translated by equation 1.1, where $ChineseAid_{it}$, our dependent variable, represents the amount of China's development projects aggregated for each host country and year, $Natural\ Resources_{it}$ the natural resource rents of each host country at time $t$ as a percentage of their GDP and $X_{it}$ a set of control variables (GDP per capita, demography, debt service (% of Gross National Income (GNI)), trade openness, education level, life expectancy and a dummy which takes the value 1 if there is a resource discovery in the host country at time $t$ and 0 otherwise).

The project-level and subnational analysis is captured by equation 1.2, where $ChineseAid_{rt}$ is our explained variable. It represents the amount of each of China's 1650 development projects geocoded at administrative region level ($r$). This variable is assumed to be a function of $Mines_{rt}$ (defined as the number of mine installations available in each administrative region $r$ for all mineral resources), $Oilgas_{rt}$ (which is a dummy which takes a value of 1 if parts of an oil or gas field are within the boundaries of an administrative region $r$) and $X_{rt}$ (that captures a set of control variables at regional level, such as: night lights, population, capital region, area (in squared km), existence of a port and the road density). Both equations have been estimated by Ordinary Least Square (OLS)[4] and Least Square Dummy Variable (LSDV). In the following, we will further insist on the LSDV approach as it better controls for individual

[4]The OLS estimates they are available upon request.

heterogeneity and is consistent under fixed effects assumptions. Our specifications take the following form, in the Least Square Dummy Variable (LSDV) approach :

$$ChineseAid_{it} = \beta_1 \, Resource \; Rents_{it} + \beta_2 \, X_{it} + \mu_i + \lambda_t +_{i \; t} \tag{1.1}$$

where $\mu_i$ are country fixed effects and $\lambda_t$ are year fixed effects.

$$ChineseAid_{rt} = \gamma_1 Mines_{rt} + \gamma_2 Oilgas_{rt} + \gamma_3 X_{rt} + \mu_i + \lambda_t +_{r \; t} \tag{1.2}$$

where $\mu_r$ are region fixed effects and $\lambda_t$ are year fixed effects.

While OLS and LSDV provide useful benchmark estimates, we also employ another estimator, namely the Poisson Pseudo Maximum Likelihood (PPML). The PPML is particularly well suited to our data as the dependent variable contains a certain number of zero observations and may be affected by heteroskedasticity. As shown by Silva and Tenreyro (2006), PPML produces consistent estimates in the presence of heteroskedasticity and generally performs better than conventional log-linear OLS and Tobit specifications.

$$ChineseAid_{it} = \exp\left(\delta_1 Resource \; Rents_{it} + \delta_2 X_{it} + \mu_i + \lambda_t\right) * \eta_{it} \tag{1.3}$$

$$ChineseAid_{rt} = \exp\left({}_1 Mines_{rt} +_2 Oilgas_{rt} +_3 X_{rt} + \mu_r + \lambda_t\right) * \eta_{rt} \tag{1.4}$$

### 1.3.2 Data

Various data sources are used to conduct our study at the national and regional levels. In the national scale analysis, AidData is used to capture data on the amount of development projects financed by China in African countries over a 17 year period (2000 to 2016). The data is then aggregated by country and by year and included in our *ChineseAid* variable at national level. All other variables come from the World Bank WDI database. Our variable measuring the natural resource wealth of the recipient country is the total natural *Resources rents* expressed as a percentage of GDP. This variable has been further decomposed by type of resource (*Mineral*, *Oil* and *Natural gas*) to allow a more detailed analysis. The variable *Population* is the logarithm of the total population in each country $i$ at time $t$, *GDP per head* the logarithm of per capita GDP. The *debt* variable translates the debt service of each country expressed in percentage of Gross National Income (GNI). *Trade openness* is the sum of exports and imports of goods and services measured as a share of Gross Domestic Product. The *education* variable captures the level of tertiary education. *Life expectancy* is the average time men and women in each country $i$ are expected to live at birth. The *Resources discoveries* variable is a dummy taking a value of 1 if there is a

resource discovery in the country at time $t$ and 0 otherwise. These data were collected from the Minex database.

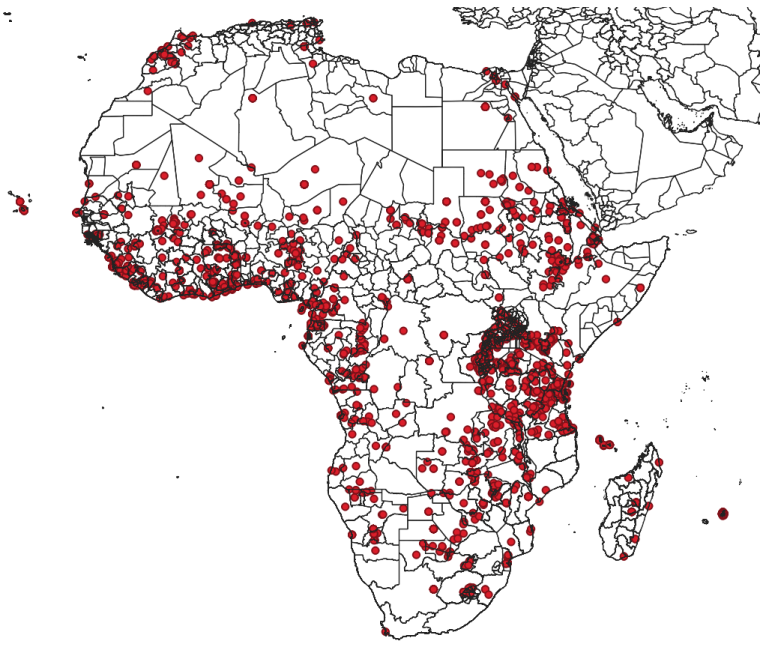
In the dissagregated analysis conducted at regional level in Africa to take account of the location of each specific Chinese aid project, we use data stemming from Dreher et al. (2019)[5]. Our *ChineseAid* variableat regional level is constructed using data on the 1650 Chinese development projects geocoded across 2969 physical locations in Africa from 1999 to 2013 at administrative regional level (ADM1). *Night light intensity* is a variable defining the night time light intensity at regional level from the National Oceanic and Atmospheric Administration (NOAA, 2014). This variable was preferred over GDP per capita as a proxy of the level of development of each administrative region due to its high granularity and availability. Indeed, income data at the regional level is difficult to obtain, especially in African countries. *Area*, expressed in squared kilometers, is the regional area directly calculated from the shapefile of subnational boundaries. Our *population* variable represents an estimate of the population at regional level based on high-resolution data on the spatial distribution of the world population in 2000 by the Center for International Earth Science Information Network (CIESIN). *Road density* is computed as the total length of road per km$^2$ at regional level using geographic data from CIESIN (2013). *Capital region* is a dummy which takes a value of 1 if the capital city is located in the administrative region. *Port* is also a binary variable that is equal to 1 if a port is located in region $r$ at time $t$ and 0 otherwise, in line with Dreher et al. (2019) and World Port Index data(National Geospatial-Intelligence Agency, 2011) To test the hypothesis that Chinese aid might be motivated by access to natural resources, a variable called $Mines$ is used : it is defined as the logarithm of the sum of mining facilities in each subnational region $r$ according to the mineral resource data system United States Geological Survey (USGS, 2005).

The new georeferenced data on China's foreign aid activities have been obtained by building on the Strange et al. (2017) and Dreher et al. (2019) dataset, which provide project-level information on Chinese government-funded activities in African countries (see Strange et al. (2014) for methodological details). These data on Chinese official funding were assembled using AidData's Tracking Underreported Financial Flows (TUFF) method. In total, they cover 1650 projects committed in 49 African countries, representing approximately $83.3 billion in official funding over the period 1999-2013[6]. Figure 1.1 plots the geographical distribution of Chinese aid projects in Africa at the ADM1 level.

[5]We are sincerely grateful to Axel Dreher for sharing his data with us.

[6]See: Hendrix and Noland (2014), Dreher and Fuchs (2015), Hernandez (2017), Li (2017), Eichenauer et al. (2018); In order to bring the data to the sub-national level, the project-level data have been geo-referenced from AidData's Chinese Official Finance to Africa dataset version 1.1 using the method described in Strandow et al. (2011). This method is based on a double-blind system, in which two coders use a defined hierarchy of geographic terms and independently assign uniform latitude and longitude coordinates, data accuracy information and standardised names to projects.

Figure 1.1: China's aid projects in Africa geocoded at ADM1 level



Source: Own elaboration using data taken from Strange et al. (2014) - https://www.aiddata.org/datasets

## 1.4 Results

### 1.4.1 Country level analysis: baseline results

In order to address our research question at the country level, we estimate equations 1.1 and 1.3 using the LSDV and PPML estimation techniques. They are robust estimation approaches as they not only overcome the endogeneity problems (LSDV) but also solve the problems of heteroskedasticity and zero observations in the data (PPML). Table 1.1 and table 1.2 show the results obtained from estimating equation 1.1 using alternative specifications of natural resource wealth. While table 1.1 relies on an aggregate measure of resource rents, table 1.2 distinguishes between three categories of resource rents: this is done in order to examine whether different types of resources exert heterogeneous effects on Chinese aid allocation. Our results underline some interesting facts related to Chinese aid, especially in the current context of energy transition in recent years, which has triggered a race for critical metals.

More specifically, our findings suggest that the variables that positively impact Chinese aid are GDP per head and debt service (in percentage of GNI). This means that the higher the GDP per head, the higher the Chinese aid these countries benefit of, which is not necessarily in line with the development perspective of foreign aid. Furthermore, Chinese aid seems to be more concentrated in countries that are more indebted. The level of education (i.e. tertiary education) and life expectancy are negatively

correlated with Chinese foreign aid. This implies that countries with higher levels of educational attainment and longer life expectancy tend to receive lower amounts of Chinese aid. Since both these variables are commonly used as indicators of a country's level of development, these results suggest that Chinese aid seems to be targeted, at least in this dimension, toward countries with lower levels of socio-economic development.

Our measure of natural resource wealth, represented by the annual natural resource rents of the countries in our sample, when taken at an aggregate level, is not significant. We therefore decomposed it by resource type: the results show that only mineral and oil resources play a key role in explaining China's foreign assistance. The positive correlation between aid and oil revenues can be explained by China's new status as one of world's leading economic powers. Faced with huge energy resources needs for its development, it might want to diversify its imports to stabilize its supplies and reduce its dependency on the Middle East. For example, a new strategic partnership with many oil-producing African countries such as Algeria, Sudan, Cameroon, Nigeria, Gabon, Congo and Angola, has been launched within the 3rd China-Africa summit, since 2006. Finally Mineral rents[7] are positively associated with Chinese aid flows. Although this result does not establish a causal relationship, it is consistent with Guillon and Mathonnat (2020), who show that Chinese aid allocated to economic infrastructure and production sectors is positively associated with recipients' natural-resource endowments. More broadly, the result suggests that China's aid allocation may be driven, at least partially, by economic and strategic interests related to access to natural resources. However, it contrasts with the findings of Dreher and Fuchs (2015), who report no robust relationship between aggregate natural resource endowments and Chinese aid allocation, or with Dreher et al. (2018), who argue that economic interests are more strongly reflected in less concessional forms of Chinese state financing than in ODA-like aid. These differences may indicate that the effect of resources depends on the type of resource considered. In this respect, we suggest that certain categories of resources, rather than resource abundance in general, may play a role in shaping Chinese aid allocation decisions.

### 1.4.2 Country level analysis: an extension on the crowding-in or crowding-out effect of Chinese Aid

We further investigate whether aid provided by other leading donor nations can be associated to a crowding-in or crowding-out effect on China's aid. To do this, we incorporate aid contributions from USA, Germany and Japan as control variables and re-run our country level specification, by examining

[7]The minerals included in the calculation are tin, gold, silver, lead, zinc, iron, copper, nickel, bauxite and phosphate. Some metals in this list such as lead, zinc, iron, copper, nickel, bauxite and phosphate are energy transition metals and are essential in the energy transition process.

first, natural resource rents as a whole, and then, by considering three distinct categories of resource rents. Our results in Tables 1.3 and 1.4 show no significant effect of United States' and Germany's aid on the Chinese one. However, our analysis indicates a positive association between Chinese aid and aid from Japan: this can be consistent with a crowding-in interpretation, although the results might reflect as well similarities in donor allocation strategies. This finding holds when natural resource rents is included as a total or separated into different resource categories. Hence, Chinese development aid seems linked to the Japanese one: in other words, China grants aid in the same areas as Japan.

### 1.4.3 Country-level analysis: taking account of countries' heterogeneity

As countries are characterized by different structural characteristics, we further take into account cross-countries heterogeneity. Countries are ranked into two categories : rich resource economies and less rich resources countries. The purpose of this ranking is to see whether our results still hold when we take these structural characteristics into account. To do so, we use the method developed by the IMF to classify countries according to their level of natural resource wealth in Lundgren et al. (2013). We consider a country to be resource-rich when its total resource rents as a percentage of GDP, averaged over the study period, exceeded 20% and less resource-rich when its total resource rents as a percentage of GDP, averaged over the study period, was below 20%. The results are presented in Table 1.A.1 and 1.A.2. The results show no significant correlation between Chinese aid and natural resources for our two groups when resource rents are taken as a whole in Table 1.A.1. These results are consistent with those we found in our country-level analysis when resource rents were taken at an aggregate level. When performing this robustness check analysis by distinguishing three types of resource, the results become more interesting. In the group of less resource-rich countries, only mineral resources seem to impact aid, as its coefficient is positive and significant. In the other group of countries, that of resource-rich countries, we note that the types of resources that impact aid are related to oil and mining (as shown in Table 1.A.2). We also highlight the fact that our coefficients are higher in the group of resource-rich countries. These results also support our country-level results that link China's development aid to African countries to access to natural resources.

### 1.4.4 Country-level analysis: robustness check by type of Chinese Aid

We conducted additional estimations by disaggregating Chinese Official Development Assistance (ODA) into two distinct categories: (i) technical and financial assistance, and (ii) debt-related aid. Both fixed effects (LSDV) and Poisson Pseudo Maximum Likelihood (PPML) models were employed to ensure consistency across different estimation techniques. The results obtained for the former aid category are

available in tables 1.A.4 and 1.A.3. They suggest that, for the technical and financial assistance category, natural resource endowments particularly mineral and oil rents are positively correlated with this type of aid. This reinforces the hypothesis that China's assistance strategy is partly driven by economic and strategic interests in resource-rich countries. Other variables such as debt levels, trade, life expectancy, and resource discoveries do not show consistent significant effects. On the other hand, the results available in 1.A.6 and 1.A.5, for debt-related aid, suggest a different allocation logic. Unlike technical and financial assistance, this type of aid is expected to be repaid or managed through debt restructuring. Therefore, countries rich in natural resources who often have alternative financing options through export revenues are less likely to receive debt-related ODA. This is reflected in the negative or insignificant coefficients associated with natural resource variables, contrasting with the positive and significant effects observed in the case of non repayable assistance.

### 1.4.5 Country-level analysis: extension to other donors

We also extended the country-level analysis by adopting an alternative perspective. The aim was to examine whether the overall development aid received by the 49 African countries included in our analysis over the same period is linked to natural resource availability. In other words, we investigate whether China's allocation behavior differs from that of other donors. To this end, we took as dependent variable, alternatively, the total net amount of ODA in constant US$ 2020, the total net ODA and official aid received in current US$. The results confirm the determining role of natural resources in development aid allocation decisions, in general. We notice that mineral resources are the resources that impact development aid when we analyze the total amount of aid received by African countries from all donors. This means that China does not seem to differ substantially from other donors, in general, in terms of its sensitivity to natural resources. These additional findings conducted using net ODA received by African countries from the Development Assistance committee of the OECD (constant 2020 USD), are reported in tables 1.A.9 and 1.A.10. The ones obtained using net ODA and official aid received (current USD), are presented in tables (1.A.11 and 1.A.12. All these results corroborate the findings of our previous analyses.

We further extend the analysis by analyzing for each country of the 49 African countries of our sample, the determinants of the net bilateral aid from three of the largest OECD DAC (the USA, Germany and Japan) over the time period 2000-2021. Hence we run our analysis, using the aid from each of these three countries as dependent variable. The idea is to compare the results with those related to the Chinese aid. The results reported in table 1.A.13, show the key role of natural resources in development aid allocation decisions by USA and Germany. For Japan, we did not find any significant correlation between access to natural resources and development aid.

### 1.4.6 Geographically disaggregated project-level analysis: baseline results

At this disaggregated level, we analyze China's aid allocation at administrative regions level (such as provinces). The economies analyzed in the country-level analysis were therefore subdivided into administrative regions using the GADM[8] map data. The LSDV and PPML (high dimensional fixed effects) approaches with region and country-year fixed effect are used to estimate equations 1.2 and 1.4. The results are presented in table 1.5.

The results indicate that, at this disaggregated level of analysis, most of the significant control variables are positively associated with the allocation of Chinese aid (the only exception is the port-related variable, which has a negative significant relationship with the dependent variable). Overall, the results suggest that Chinese aid projects are more likely to be located in economically active and politically important regions (i.e. capital regions). Capital regions receive significantly more projects. Mining areas strongly attract aid projects, whereas the presence of oil and gas resources does not seem to affect aid project allocation. This also reinforces the idea that different categories of natural resources may have distinct effects on aid allocation decisions. Further, Chinese aid tends to be concentrated also in areas with larger populations, greater road density, larger size (in squared km) and higher levels of economic activity. The presence of ports within a region does not seem a key determinant of Chinese aid, once other factors are controlled for. One possible explanation of this latter result is that port regions already benefit from relatively better infrastructure and economic connectivity, reducing the need for additional aid projects.

Taken together, our findings indicate that the geographical distribution of Chinese aid projects is associated with both the economic characteristics of regions and the presence of mining activities. These results partially confirm the results of our country-level analysis and suggest that access to natural resources can be a key determinant in China's development aid allocation. While the country-level analysis indicates that both mineral rents and oil rents are positively associated with Chinese aid flows, the regional and aid project analysis reveals a more nuanced picture. At this latter level, aid projects are significantly more likely to be located in mining areas, whereas the presence of oil and gas resources does not seem to affect their geographical allocation within recipient countries. One possible explanation is that oil presence influences Chinese aid decisions at the national level rather than the local level. Oil-producing countries may receive more Chinese aid overall due to their strategic importance, but this does not necessarily imply that aid projects are concentrated in oil-producing provinces (besides oil and gas facilities might be located offshore). In contrast, mining activities appear to shape both the overall

[8]GADM is defined as the Database of Global Administrative Areas

allocation of aid across countries and the location of projects within countries. This may be related to the fact that mining operations are often geographically dispersed and require complementary infrastructure investments, making mining regions more likely to attract aid-funded projects.

### 1.4.7 Geographically disaggregated project-level analysis: robustness check by including additional controls

We test the robustness of our baseline results obtained at the geographically disaggregated project-level, by including additional controls. Within this framework, we add further information on the climatic conditions of the regions under consideration (i.e. temperature and precipitations). The data is taken from the World Bank Climate Change Knowledge Portal. The variable $Temperature$ is computed as the mean annual temperature in °C, in region $r$ and year $t$. As for *precipitations*, the index is calculated as the annual average precipitation (mm/year) in region $r$ at time $t$. Further, for each aid project, we identify all mines located within a 1° radius (approximately 110 km) of the Chinese aid project location, at time $t$. This $buffer$ captures the local mining environment surrounding each project.

The results are presented in table 1.6. Our findings indicate that aid projects are more likely to be located in areas with a higher concentration of mines. This suggests that China aid tends to be attracted by regions where mines are important (ex. mining clusters) : this might be due to the fact that these regions are economically strategic, have greater infrastructure needs, or can be associated with stronger development opportunities. Further our results, suggest that aid projects are more likely to be located in areas with higher precipitation and temperatures. On the one hand, this can be explained by the fact that warmer and wetter areas might have a greater agricultural potential and population density, which may increase the demand for development projects and public infrastructure. On the other hand, these regions might face a greater risk of flooding or climate-related vulnerabilities, increasing the need for development assistance.

### 1.4.8 Geographically disaggregated project-level analysis: robustness check by type of Chinese Aid

In order to test the robustness of our results obtained at geographically disaggregated project-level, we also analyzed China's development aid projects to African countries over the period 1999-2013 and kept into the analysis only those projects that meet the criteria characterizing ODA as defined by the OECD. We re-estimate equation 1.2 and 1.4 using the same estimation techniques (LSDV and PPML) with administrative region and country-year fixed effects. The results are almost identical to the analysis carried

out in the geographically disaggregated project-level analysis in the baseline scenario, or the previous one enriched with additional controls. They are reported in table 1.A.7 and table 1.A.8. The control variables explaining the allocation of Chinese aid at dissagregated level are the same and, when significant, are in general positively (except population) correlated with our redefined dependent variable. However, more consistent and significant results are obtained only with the PPML estimations. This is likely due to the nature of our dataset. Our sample is restricted to Chinese aid projects in African countries that meet the OECD definition of ODA. As a consequence, some regions are recorded as receiving no aid, resulting in a large number of zero observations. In this context, simple OLS estimations may be biased, as highlighted by Silva and Tenreyro (2006). The PPML estimator is therefore more appropriate, as it is specifically designed to deal with dependent variables characterized by a high proportion of zeros.

Table 1.1: Country-level analysis using an aggregate measure of resources 1/2

| | (1) LSDV | (2) PPML | (3) LSDV | (4) PPML | (5) LSDV | (6) PPML |
|---|---|---|---|---|---|---|
| Population | 3.425 | 0.194 | 3.583 | 0.204 | 3.570 | 0.203 |
| | (1.49) | (1.52) | (1.59) | (1.63) | (1.57) | (1.62) |
| GDP per head | 4.660*** | 0.271*** | 4.669*** | 0.272*** | 4.669*** | 0.272*** |
| | (4.00) | (4.27) | (4.00) | (4.28) | (4.00) | (4.28) |
| Debt | 0.0542* | 0.00327* | 0.0560* | 0.00338* | 0.0560* | 0.00337* |
| | (1.73) | (1.90) | (1.78) | (1.95) | (1.77) | (1.94) |
| Trade openness | -0.0786 | -0.00315 | -0.118 | -0.00556 | -0.120 | -0.00565 |
| | (-0.48) | (-0.34) | (-0.71) | (-0.59) | (-0.71) | (-0.60) |
| Education | -0.543* | -0.0315* | -0.548* | -0.0319* | -0.546* | -0.0318* |
| | (-1.77) | (-1.85) | (-1.78) | (-1.88) | (-1.77) | (-1.87) |
| Life expectancy | -6.535** | -0.399** | -6.122* | -0.374** | -6.089* | -0.372** |
| | (-2.07) | (-2.25) | (-1.85) | (-2.01) | (-1.82) | (-1.98) |
| Resource rents | | | 0.201 | 0.0123 | 0.203 | 0.0124 |
| | | | (0.69) | (0.76) | (0.69) | (0.76) |
| Resource discoveries | | | | | 0.119 | 0.00486 |
| | | | | | (0.13) | (0.10) |
| $N$ | 442 | 442 | 442 | 442 | 442 | 442 |
| $R^2$ | 0.280 | | 0.280 | | 0.280 | |
| pseudo $R^2$ | | 0.013 | | 0.013 | | 0.013 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.2: Country-level analysis using resource-specific measures 2/2

| | (1) LSDV | (2) PPML | (3) LSDV | (4) PPML | (5) LSDV | (6) PPML |
|---|---|---|---|---|---|---|
| Population | 3.425 | 0.194 | 3.753* | 0.218* | 3.731 | 0.217* |
| | (1.49) | (1.52) | (1.65) | (1.74) | (1.63) | (1.72) |
| GDP per head | 4.660*** | 0.271*** | 4.444*** | 0.260*** | 4.443*** | 0.260*** |
| | (4.00) | (4.27) | (3.78) | (4.07) | (3.77) | (4.07) |
| Debt | 0.0542* | 0.00327* | 0.0612** | 0.00366** | 0.0611* | 0.00366** |
| | (1.73) | (1.90) | (1.97) | (2.15) | (1.96) | (2.15) |
| Trade openness | -0.0786 | -0.00315 | -0.250 | -0.0134 | -0.254 | -0.0135 |
| | (-0.48) | (-0.34) | (-1.49) | (-1.42) | (-1.49) | (-1.42) |
| Education | -0.543* | -0.0315* | -0.405 | -0.0238 | -0.403 | -0.0237 |
| | (-1.77) | (-1.85) | (-1.29) | (-1.37) | (-1.27) | (-1.36) |
| Life expectancy | -6.535** | -0.399** | -5.010 | -0.313* | -4.954 | -0.310 |
| | (-2.07) | (-2.25) | (-1.48) | (-1.66) | (-1.45) | (-1.63) |
| Mineral rents | | | 0.481* | 0.0269* | 0.482* | 0.0269* |
| | | | (1.87) | (1.90) | (1.87) | (1.90) |
| Oil rents | | | 0.445** | 0.0277** | 0.448** | 0.0278** |
| | | | (2.03) | (2.26) | (2.01) | (2.25) |
| Natural gas rents | | | -0.190 | -0.0123 | -0.180 | -0.0119 |
| | | | (-0.34) | (-0.41) | (-0.32) | (-0.39) |
| Resource discoveries | | | | | 0.181 | 0.00740 |
| | | | | | (0.18) | (0.14) |
| $N$ | 442 | 442 | 441 | 441 | 441 | 441 |
| $R^2$ | 0.280 | | 0.290 | | 0.290 | |
| pseudo $R^2$ | | 0.013 | | 0.013 | | 0.013 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.3: Country-level analysis: an extension on crowding in/out effect of Chinese aid in the presence of an aggregate measure of natural resources 1/2

| | (1) LSDV | (2) PPML | (3) LSDV | (4) PPML | (5) LSDV | (6) PPML |
|---|---|---|---|---|---|---|
| Population | 2.274 | 0.127 | 2.492 | 0.140 | 2.473 | 0.139 |
| | (1.00) | (1.02) | (1.11) | (1.14) | (1.09) | (1.12) |
| GDP per head | 4.374*** | 0.253*** | 4.438*** | 0.257*** | 4.439*** | 0.257*** |
| | (3.29) | (3.53) | (3.31) | (3.57) | (3.31) | (3.57) |
| Debt | 0.0536 | 0.00313* | 0.0541 | 0.00316* | 0.0541 | 0.00316* |
| | (1.56) | (1.65) | (1.56) | (1.65) | (1.55) | (1.65) |
| Trade openness | -0.114 | -0.00532 | -0.171 | -0.00882 | -0.172 | -0.00885 |
| | (-0.67) | (-0.55) | (-0.96) | (-0.88) | (-0.96) | (-0.88) |
| Education | -0.549 | -0.0316 | -0.561 | -0.0324* | -0.559 | -0.0323* |
| | (-1.54) | (-1.63) | (-1.56) | (-1.67) | (-1.55) | (-1.66) |
| Life expectancy | -4.400 | -0.281 | -3.762 | -0.242 | -3.744 | -0.241 |
| | (-1.27) | (-1.47) | (-1.04) | (-1.21) | (-1.03) | (-1.20) |
| ODA USA | 0.0408 | 0.00305 | 0.0288 | 0.00234 | 0.0288 | 0.00234 |
| | (0.35) | (0.47) | (0.24) | (0.35) | (0.24) | (0.35) |
| ODA Germany | 0.0438 | 0.00240 | 0.0316 | 0.00168 | 0.0326 | 0.00173 |
| | (0.34) | (0.34) | (0.25) | (0.24) | (0.26) | (0.25) |
| ODA Japan | 0.175** | 0.0107** | 0.176** | 0.0107** | 0.177** | 0.0107** |
| | (2.17) | (2.39) | (2.19) | (2.40) | (2.18) | (2.40) |
| Resource rents | | | 0.283 | 0.0172 | 0.281 | 0.0171 |
| | | | (0.82) | (0.91) | (0.81) | (0.90) |
| Resource discoveries | | | | | 0.118 | 0.00532 |
| | | | | | (0.13) | (0.12) |
| $N$ | 410 | 410 | 410 | 410 | 410 | 410 |
| $R^2$ | 0.285 | | 0.286 | | 0.286 | |
| pseudo $R^2$ | | 0.014 | | 0.014 | | 0.014 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.4: Country-level analysis: an extension on crowding in/out effect of Chinese aid in the presence of resource-specific measures 2/2

| | (1) LSDV | (2) PPML | (3) LSDV | (4) PPML | (5) LSDV | (6) PPML |
|---|---|---|---|---|---|---|
| Population | 2.274 | 0.127 | 2.754 | 0.160 | 2.754 | 0.161 |
| | (1.00) | (1.02) | (1.26) | (1.34) | (1.24) | (1.33) |
| GDP per head | 4.374*** | 0.253*** | 4.255*** | 0.246*** | 4.255*** | 0.246*** |
| | (3.29) | (3.53) | (3.23) | (3.49) | (3.23) | (3.49) |
| Debt | 0.0536 | 0.00313* | 0.0602* | 0.00349* | 0.0602* | 0.00349* |
| | (1.56) | (1.65) | (1.74) | (1.84) | (1.74) | (1.84) |
| Trade openness | -0.114 | -0.00532 | -0.345* | -0.0191* | -0.345* | -0.0191* |
| | (-0.67) | (-0.55) | (-1.91) | (-1.90) | (-1.90) | (-1.90) |
| Education | -0.549 | -0.0316 | -0.397 | -0.0227 | -0.397 | -0.0227 |
| | (-1.54) | (-1.63) | (-1.09) | (-1.15) | (-1.08) | (-1.15) |
| Life expectancy | -4.400 | -0.281 | -2.327 | -0.161 | -2.328 | -0.161 |
| | (-1.27) | (-1.47) | (-0.64) | (-0.81) | (-0.64) | (-0.81) |
| ODA USA | 0.0408 | 0.00305 | 0.0206 | 0.00181 | 0.0206 | 0.00181 |
| | (0.35) | (0.47) | (0.18) | (0.29) | (0.18) | (0.29) |
| ODA Germany | 0.0438 | 0.00240 | 0.00498 | 0.000205 | 0.00496 | 0.000187 |
| | (0.34) | (0.34) | (0.04) | (0.03) | (0.04) | (0.03) |
| ODA Japan | 0.175** | 0.0107** | 0.176** | 0.0106** | 0.176** | 0.0106** |
| | (2.17) | (2.39) | (2.12) | (2.33) | (2.12) | (2.32) |
| Mineral rents | | | 0.794** | 0.0445*** | 0.794** | 0.0445*** |
| | | | (2.55) | (2.61) | (2.56) | (2.63) |
| Oil rents | | | 0.462** | 0.0288** | 0.462** | 0.0289** |
| | | | (2.06) | (2.34) | (2.06) | (2.34) |
| Natural gas rents | | | -0.310 | -0.0191 | -0.310 | -0.0192 |
| | | | (-0.46) | (-0.54) | (-0.46) | (-0.54) |
| Resource discoveries | | | | | -0.00307 | -0.00186 |
| | | | | | (-0.00) | (-0.04) |
| $N$ | 410 | 410 | 409 | 409 | 409 | 409 |
| $R^2$ | 0.285 | | 0.302 | | 0.302 | |
| pseudo $R^2$ | | 0.014 | | 0.015 | | 0.015 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.5: Geographically disaggregated project-level analysis: baseline results

| | (1) LSDV | (2) PPML | (3) LSDV | (4) PPML | (5) LSDV | (6) PPML | (7) LSDV | (8) PPML |
|---|---|---|---|---|---|---|---|---|
| Mines | 0.279*** | 0.520*** | 0.185*** | 0.468*** | 0.204*** | 0.440*** | 0.214*** | 0.481*** |
| | (0.064) | (0.165) | (0.064) | (0.165) | (0.064) | (0.167) | (0.064) | (0.165) |
| Night light | 0.192*** | 0.106 | 0.407*** | 0.214 | 0.457*** | 0.285* | 0.448*** | 0.253 |
| | (0.036) | (0.072) | (0.048) | (0.140) | (0.048) | (0.160) | (0.048) | (0.165) |
| Population | 0.158*** | 0.489*** | 0.032 | 0.391** | 0.021 | 0.384** | 0.016 | 0.353* |
| | (0.055) | (0.137) | (0.055) | (0.181) | (0.055) | (0.186) | (0.055) | (0.183) |
| Capital region | 3.218*** | 0.913*** | 3.096*** | 0.878** | 3.040*** | 0.794** | 2.970*** | 0.799** |
| | (0.271) | (0.353) | (0.270) | (0.352) | (0.269) | (0.375) | (0.271) | (0.377) |
| Oil & gas | -0.012 | 0.294 | -0.183 | 0.222 | -0.042 | 0.295 | -0.078 | 0.145 |
| | (0.110) | (0.255) | (0.117) | (0.283) | (0.118) | (0.298) | (0.119) | (0.280) |
| Area | | | 0.333*** | 0.173 | 0.325*** | 0.233 | 0.337*** | 0.220 |
| | | | (0.048) | (0.187) | (0.048) | (0.197) | (0.049) | (0.202) |
| Port | | | | | -0.704*** | -0.337 | -0.689*** | -0.357 |
| | | | | | (0.127) | (0.381) | (0.127) | (0.391) |
| Road density | | | | | | | 1.519** | 3.451*** |
| | | | | | | | (0.744) | (1.111) |
| $N$ | 11550 | 10260 | 11550 | 10260 | 11550 | 10260 | 11550 | 10260 |
| $R^2$ | 0.167 | | 0.169 | | 0.172 | | 0.172 | |
| pseudo $R^2$ | | 0.377 | | 0.377 | | 0.378 | | 0.384 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.6: Geographically disaggregated project-level analysis: including additional controls

| | (1) PPML | (2) PPML | (3) PPML | (4) PPML | (5) PPML | (6) PPML | (7) PPML | (8) PPML | (9) PPML | (10) PPML |
|---|---|---|---|---|---|---|---|---|---|---|
| Mines | 0.0788** | 0.201*** | 0.106*** | 0.121*** | 0.121*** | 0.0338 | 0.0299 | 0.0464 | 0.0569 | 0.0622 |
| | (2.42) | (5.26) | (2.74) | (2.99) | (3.00) | (0.76) | (0.67) | (1.04) | (1.25) | (1.37) |
| Buffer | 0.000806*** | 0.000883*** | 0.000834*** | 0.000777*** | 0.000777*** | 0.000793*** | 0.000799*** | 0.000805*** | 0.000652*** | 0.000645*** |
| | (10.74) | (11.46) | (10.79) | (10.10) | (10.11) | (10.35) | (10.42) | (10.47) | (7.63) | (7.49) |
| Night light | | 0.318*** | 0.318*** | 0.160*** | 0.161*** | 0.317*** | 0.329*** | 0.313*** | 0.272*** | 0.273*** |
| | | (19.92) | (19.91) | (6.77) | (6.68) | (7.94) | (8.03) | (7.55) | (5.80) | (5.79) |
| Population | | | 0.340*** | 0.303*** | 0.303*** | 0.185*** | 0.186*** | 0.184*** | 0.145*** | 0.155*** |
| | | | (8.52) | (7.80) | (7.84) | (4.37) | (4.38) | (4.29) | (3.28) | (3.49) |
| Capital region | | | | 1.017*** | 1.014*** | 0.961*** | 0.950*** | 0.929*** | 1.011*** | 1.003*** |
| | | | | (8.75) | (8.74) | (8.30) | (8.19) | (7.98) | (8.16) | (8.14) |
| Oil & gas | | | | | -0.0239 | -0.0953 | -0.0606 | -0.103 | -0.260** | -0.252** |
| | | | | | (-0.18) | (-0.73) | (-0.45) | (-0.78) | (-2.02) | (-1.97) |
| Area | | | | | | 0.259*** | 0.266*** | 0.259*** | 0.307*** | 0.281*** |
| | | | | | | (4.89) | (4.97) | (4.84) | (4.73) | (4.28) |
| Port | | | | | | | -0.116 | -0.104 | -0.0491 | -0.0974 |
| | | | | | | | (-1.14) | (-1.01) | (-0.47) | (-0.89) |
| Road density | | | | | | | | 0.923*** | 0.805** | 0.816** |
| | | | | | | | | (2.81) | (2.47) | (2.42) |
| Precipitation | | | | | | | | | 0.814*** | 0.705** |
| | | | | | | | | | (2.60) | (2.23) |
| Temperature | | | | | | | | | | 0.248** |
| | | | | | | | | | | (2.03) |
| $N$ | 4357 | 4357 | 4357 | 4357 | 4357 | 4357 | 4357 | 4357 | 3299 | 3284 |
| pseudo $R^2$ | 0.329 | 0.430 | 0.446 | 0.463 | 0.463 | 0.467 | 0.468 | 0.470 | 0.442 | 0.443 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

## 1.5 Conclusion

In the context of the energy transition and the increasing strategic importance of critical minerals, we investigate the determinants of Chinese aid allocation in Africa. Specifically, we test whether recipient countries' natural resource endowments constitute a key factor in shaping the allocation of Chinese aid in the African economies.

To conduct our analysis, we use two sets of data: a more aggregated one, available at country level for the period 2000-2021, and a geo-referenced dataset of officially funded Chinese development aid projects in Africa during the period 1999-2013. We conducted thus both a country-level and a geographically disagregated project level analysis. The results of both studies are convergent. They point to a strategic component in the allocation of Chinese development aid to African countries. Natural resource endowments, when considered at a more disaggregated level, are consistently associated with higher levels of aid, suggesting that access to resources plays an important role in aid allocation decisions. However, aid is also directed toward countries with weaker educational outcomes and higher debt burdens, indicating that recipient needs remain an important consideration.

Several avenues for future research can be considered. First, a more detailed analysis could be conducted for specific critical mineral in order to determine the role of each of these resources in China's international aid strategy. As the energy transition shifts demand from fossil fuels toward minerals, understanding whether the strategic importance of individual minerals is associated with different patterns of aid allocation could be a nice avenue for future research. Second, future work could investigate whether the relationship between natural resource endowments and Chinese aid has evolved over time, particularly following the acceleration of the global energy transition and the growing demand for critical minerals. Finally, while this chapter documents a strong association between natural resource endowments and aid allocation, further research could be developed to better identify the mechanisms underlying this relationship (for example, whether Chinese aid facilitates access to mining projects through complementary investments in transport, energy, or other infrastructure)

## 1.6 Appendix

### 1.6.1 Tables

Table 1.A.1: Country-level analysis: taking account of countries' heterogeneity while using resource rents at aggregated level 1/2

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Resources rents superior to 20% of GDP** | | | | | | **Resources rents inferior to 20% of GDP** | | | | | |
| | LSDV | PPML | LSDV | PPML | LSDV | PPML | LSDV | PPML | LSDV | PPML | LSDV | PPML |
| Population | -1.660 | -0.0992 | -1.382 | -0.0824 | -1.382 | -0.0824 | 4.442** | 0.249** | 4.541** | 0.255** | 4.530** | 0.255** |
| | (-0.22) | (-0.24) | (-0.15) | (-0.16) | (-0.15) | (-0.16) | (2.19) | (2.22) | (2.26) | (2.31) | (2.23) | (2.28) |
| GDP per head | -3.469 | -0.207 | -3.517 | -0.209 | -3.517 | -0.209 | 5.525*** | 0.317*** | 5.568*** | 0.320*** | 5.571*** | 0.320*** |
| | (-0.78) | (-0.86) | (-0.76) | (-0.84) | (-0.76) | (-0.84) | (4.92) | (5.11) | (4.94) | (5.16) | (4.94) | (5.17) |
| Debt | -0.0581 | -0.00338 | -0.0595 | -0.00346 | -0.0595 | -0.00346 | 0.0612* | 0.00366** | 0.0641* | 0.00384** | 0.0641* | 0.00384** |
| | (-0.54) | (-0.56) | (-0.56) | (-0.59) | (-0.56) | (-0.59) | (1.84) | (2.02) | (1.90) | (2.09) | (1.90) | (2.09) |
| Trade openness | 0.452 | 0.0285 | 0.433 | 0.0273 | 0.433 | 0.0273 | -0.127 | -0.00647 | -0.162 | -0.00874 | -0.165 | -0.00889 |
| | (1.22) | (1.38) | (1.00) | (1.16) | (1.00) | (1.16) | (-0.69) | (-0.63) | (-0.86) | (-0.84) | (-0.86) | (-0.84) |
| Education | 1.196 | 0.0728 | 1.215 | 0.0740 | 1.215 | 0.0740 | -0.886*** | -0.0499*** | -0.909*** | -0.0514*** | -0.906*** | -0.0512*** |
| | (1.21) | (1.34) | (1.14) | (1.27) | (1.14) | (1.27) | (-2.73) | (-2.79) | (-2.81) | (-2.88) | (-2.77) | (-2.85) |
| Life expectancy | -5.260 | -0.343 | -5.510 | -0.358 | -5.510 | -0.358 | -6.736** | -0.401** | -6.291** | -0.374** | -6.261** | -0.372** |
| | (-0.34) | (-0.40) | (-0.33) | (-0.40) | (-0.33) | (-0.40) | (-2.32) | (-2.45) | (-2.08) | (-2.20) | (-2.04) | (-2.16) |
| Resource rents | | | 0.0718 | 0.00429 | 0.0718 | 0.00429 | | | 0.229 | 0.0143 | 0.231 | 0.0144 |
| | | | (0.08) | (0.09) | (0.08) | (0.09) | | | (0.79) | (0.89) | (0.79) | (0.89) |
| Resource discoveries | | | | | 0 | 0 | | | | | 0.0957 | 0.00496 |
| | | | | | (.) | (.) | | | | | (0.13) | (0.12) |
| $N$ | 64 | 64 | 64 | 64 | 64 | 64 | 406 | 406 | 406 | 406 | 406 | 406 |
| $R^2$ | 0.412 | | 0.412 | | 0.412 | | 0.272 | | 0.273 | | 0.273 | |
| pseudo $R^2$ | | 0.016 | | 0.016 | | 0.016 | | 0.013 | | 0.013 | | 0.013 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.A.2: Country-level analysis: taking account of countries' heterogeneity while using specific measures of resources rents 2/2

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Resources rents superior to 20% of GDP** | | | | | | **Resources rents inferior to 20% of GDP** | | | | | |
| | LSDV | PPML | LSDV | PPML | LSDV | PPML | LSDV | PPML | LSDV | PPML | LSDV | PPML |
| Population | -1.660 | -0.0992 | 4.390 | 0.274 | 4.390 | 0.274 | 4.442** | 0.249** | 4.678** | 0.266** | 4.670** | 0.265** |
| | (-0.22) | (-0.24) | (0.52) | (0.61) | (0.52) | (0.61) | (2.19) | (2.22) | (2.32) | (2.40) | (2.30) | (2.38) |
| GDP per head | -3.469 | -0.207 | -3.857 | -0.227 | -3.857 | -0.227 | 5.525*** | 0.317*** | 5.450*** | 0.312*** | 5.450*** | 0.312*** |
| | (-0.78) | (-0.86) | (-0.92) | (-1.04) | (-0.92) | (-1.04) | (4.92) | (5.11) | (4.70) | (4.92) | (4.70) | (4.92) |
| Debt | -0.0581 | -0.00338 | -0.153 | -0.00904 | -0.153 | -0.00904 | 0.0612* | 0.00366** | 0.0689** | 0.00412** | 0.0689** | 0.00412** |
| | (-0.54) | (-0.56) | (-1.47) | (-1.62) | (-1.47) | (-1.62) | (1.84) | (2.02) | (2.04) | (2.25) | (2.04) | (2.25) |
| Trade openness | 0.452 | 0.0285 | -0.332 | -0.0202 | -0.332 | -0.0202 | -0.127 | -0.00647 | -0.249 | -0.0139 | -0.251 | -0.0140 |
| | (1.22) | (1.38) | (-0.67) | (-0.76) | (-0.67) | (-0.76) | (-0.69) | (-0.63) | (-1.31) | (-1.32) | (-1.30) | (-1.31) |
| Education | 1.196 | 0.0728 | 1.637* | 0.0980* | 1.637* | 0.0980* | -0.886*** | -0.0499*** | -0.769** | -0.0431** | -0.768** | -0.0431** |
| | (1.21) | (1.34) | (1.72) | (1.95) | (1.72) | (1.95) | (-2.73) | (-2.79) | (-2.32) | (-2.37) | (-2.29) | (-2.34) |
| Life expectancy | -5.260 | -0.343 | -9.517 | -0.582 | -9.517 | -0.582 | -6.736** | -0.401** | -5.828* | -0.348* | -5.806* | -0.347* |
| | (-0.34) | (-0.40) | (-0.54) | (-0.63) | (-0.54) | (-0.63) | (-2.32) | (-2.45) | (-1.81) | (-1.94) | (-1.77) | (-1.90) |
| Mineral rents | | | 0.987* | 0.0568** | 0.987* | 0.0568** | | | 0.454 | 0.0268 | 0.454 | 0.0268 |
| | | | (1.75) | (1.99) | (1.75) | (1.99) | | | (1.51) | (1.63) | (1.50) | (1.63) |
| Oil rents | | | 1.252* | 0.0792** | 1.252* | 0.0792** | | | 0.447* | 0.0259* | 0.447* | 0.0259* |
| | | | (1.88) | (2.26) | (1.88) | (2.26) | | | (1.69) | (1.79) | (1.69) | (1.79) |
| Natural gas rents | | | 1.205 | 0.0662 | 1.205 | 0.0662 | | | -0.517 | -0.0293 | -0.512 | -0.0291 |
| | | | (0.92) | (1.02) | (0.92) | (1.02) | | | (-0.83) | (-0.85) | (-0.81) | (-0.85) |
| Resources discoveries | | | | | 0 | 0 | | | | | 0.0623 | 0.00263 |
| | | | | | (.) | (.) | | | | | (0.08) | (0.06) |
| $N$ | 64 | 64 | 63 | 63 | 63 | 63 | 406 | 406 | 406 | 406 | 406 | 406 |
| $R^2$ | 0.412 | | 0.478 | | 0.478 | | 0.272 | | 0.282 | | 0.283 | |
| pseudo $R^2$ | | 0.016 | | 0.019 | | 0.019 | | 0.013 | | 0.014 | | 0.014 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.A.3: Country-level analysis : robustness with Chinese ODA related to technical and financial assistance while using an aggregate measure of resource rents 1/2

| | (1) LSDV | (2) PPML | (3) LSDV | (4) PPML | (5) LSDV | (6) PPML |
|---|---|---|---|---|---|---|
| Population | 2.431 | 0.133 | 3.006 | 0.168 | 2.985 | 0.167 |
| | (1.01) | (1.01) | (1.28) | (1.30) | (1.26) | (1.29) |
| GDP per head | 4.586*** | 0.266*** | 4.791*** | 0.279*** | 4.793*** | 0.279*** |
| | (3.79) | (4.04) | (3.93) | (4.22) | (3.93) | (4.22) |
| Debt | 0.0442 | 0.00270 | 0.0455 | 0.00276 | 0.0454 | 0.00276 |
| | (1.41) | (1.56) | (1.44) | (1.59) | (1.43) | (1.59) |
| Trade openness | 0.0514 | 0.00506 | -0.0437 | -0.000666 | -0.0474 | -0.000844 |
| | (0.29) | (0.50) | (-0.23) | (-0.06) | (-0.25) | (-0.08) |
| Education | -0.699** | -0.0402** | -0.729** | -0.0422** | -0.726** | -0.0421** |
| | (-2.24) | (-2.35) | (-2.33) | (-2.47) | (-2.31) | (-2.45) |
| Life expectancy | -3.969 | -0.255 | -3.440 | -0.223 | -3.389 | -0.221 |
| | (-1.07) | (-1.25) | (-0.91) | (-1.07) | (-0.88) | (-1.05) |
| Resource rents | | | 0.450 | 0.0274 | 0.453 | 0.0275 |
| | | | (1.34) | (1.47) | (1.34) | (1.47) |
| Resource discoveries | | | | | 0.188 | 0.00851 |
| | | | | | (0.24) | (0.21) |
| $N$ | 398 | 397 | 398 | 397 | 398 | 397 |
| $R^2$ | 0.300 | | 0.303 | | 0.303 | |
| pseudo $R^2$ | | 0.016 | | 0.016 | | 0.016 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.A.4: Country-level analysis : robustness with Chinese ODA related to technical and financial assistance while using specific measures of resource rents 2/2

| | (1) LSDV | (2) PPML | (3) LSDV | (4) PPML | (5) LSDV | (6) PPML |
|---|---|---|---|---|---|---|
| Population | 2.431 | 0.133 | 3.065 | 0.179 | 3.046 | 0.178 |
| | (1.01) | (1.01) | (1.30) | (1.38) | (1.29) | (1.37) |
| GDP per head | 4.586*** | 0.266*** | 4.605*** | 0.267*** | 4.606*** | 0.267*** |
| | (3.79) | (4.04) | (3.89) | (4.18) | (3.89) | (4.18) |
| Debt | 0.0442 | 0.00270 | 0.0505 | 0.00305* | 0.0505 | 0.00305* |
| | (1.41) | (1.56) | (1.63) | (1.80) | (1.62) | (1.79) |
| Trade openness | 0.0514 | 0.00506 | -0.167 | -0.00813 | -0.171 | -0.00828 |
| | (0.29) | (0.50) | (-0.89) | (-0.78) | (-0.91) | (-0.79) |
| Education | -0.699** | -0.0402** | -0.553* | -0.0317* | -0.550* | -0.0316* |
| | (-2.24) | (-2.35) | (-1.75) | (-1.84) | (-1.73) | (-1.82) |
| Life expectancy | -3.969 | -0.255 | -2.739 | -0.190 | -2.691 | -0.187 |
| | (-1.07) | (-1.25) | (-0.72) | (-0.91) | (-0.70) | (-0.90) |
| Mineral rents | | | 0.829** | 0.0465** | 0.829** | 0.0466** |
| | | | (2.46) | (2.51) | (2.46) | (2.52) |
| Oil rents | | | 0.395* | 0.0257** | 0.396* | 0.0258** |
| | | | (1.72) | (2.01) | (1.71) | (2.01) |
| Natural gas rents | | | -0.324 | -0.0213 | -0.314 | -0.0208 |
| | | | (-0.56) | (-0.69) | (-0.54) | (-0.68) |
| Resource discoveries | | | | | 0.177 | 0.00719 |
| | | | | | (0.21) | (0.16) |
| $N$ | 398 | 397 | 397 | 396 | 397 | 396 |
| $R^2$ | 0.300 | | 0.316 | | 0.316 | |
| pseudo $R^2$ | | 0.016 | | 0.017 | | 0.017 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.A.5: Country-level analysis: robustness with Chinese debt-related ODA while using an aggregate measure of resource rents 1/2

| | (1) LSDV | (2) PPML | (3) LSDV | (4) PPML | (5) LSDV | (6) PPML |
|---|---|---|---|---|---|---|
| Population | -1.785 | -0.101 | -2.069 | -0.124 | -2.069 | -0.124 |
| | (-0.35) | (-0.46) | (-0.42) | (-0.59) | (-0.42) | (-0.59) |
| GDP per head | 0.164 | 0.0148 | 2.108 | 0.126 | 2.108 | 0.126 |
| | (0.09) | (0.19) | (0.95) | (1.37) | (0.95) | (1.37) |
| Debt | 0.0396 | 0.00236 | -0.0257 | -0.00162 | -0.0257 | -0.00162 |
| | (0.34) | (0.46) | (-0.21) | (-0.30) | (-0.21) | (-0.30) |
| Trade openness | 0.456 | 0.0261* | 0.544* | 0.0320** | 0.544* | 0.0320** |
| | (1.46) | (1.92) | (1.77) | (2.43) | (1.77) | (2.43) |
| Education | -0.119 | -0.00784 | -0.382 | -0.0219 | -0.382 | -0.0219 |
| | (-0.16) | (-0.24) | (-0.55) | (-0.75) | (-0.55) | (-0.75) |
| Life expectancy | -5.988 | -0.351* | -8.421* | -0.498*** | -8.421* | -0.498*** |
| | (-1.38) | (-1.85) | (-1.95) | (-2.65) | (-1.95) | (-2.65) |
| Resource rents | | | -0.677 | -0.0403** | -0.677 | -0.0403** |
| | | | (-1.50) | (-2.04) | (-1.50) | (-2.04) |
| Resource discoveries | | | | | 0 | 0 |
| | | | | | (.) | (.) |
| $N$ | 71 | 58 | 71 | 58 | 71 | 58 |
| $R^2$ | 0.649 | | 0.672 | | 0.672 | |
| pseudo $R^2$ | | 0.007 | | 0.007 | | 0.007 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.A.6: Country-level analysis: robustness with Chinese debt-related ODA while using specific measures of resource rents 2/2

| | (1) LSDV | (2) PPML | (3) LSDV | (4) PPML | (5) LSDV | (6) PPML |
|---|---|---|---|---|---|---|
| Population | -1.785 | -0.101 | -1.839 | -0.121 | -1.839 | -0.121 |
| | (-0.35) | (-0.46) | (-0.46) | (-0.73) | (-0.46) | (-0.73) |
| GDP per head | 0.164 | 0.0148 | 2.119 | 0.126 | 2.119 | 0.126 |
| | (0.09) | (0.19) | (1.06) | (1.54) | (1.06) | (1.54) |
| Debt | 0.0396 | 0.00236 | 0.164 | 0.00938** | 0.164 | 0.00938** |
| | (0.34) | (0.46) | (1.47) | (1.99) | (1.47) | (1.99) |
| Trade openness | 0.456 | 0.0261* | 1.022** | 0.0600*** | 1.022** | 0.0600*** |
| | (1.46) | (1.92) | (2.25) | (3.11) | (2.25) | (3.11) |
| Education | -0.119 | -0.00784 | -0.334 | -0.0177 | -0.334 | -0.0177 |
| | (-0.16) | (-0.24) | (-0.52) | (-0.66) | (-0.52) | (-0.66) |
| Life expectancy | -5.988 | -0.351* | -13.62** | -0.792*** | -13.62** | -0.792*** |
| | (-1.38) | (-1.85) | (-2.38) | (-3.25) | (-2.38) | (-3.25) |
| Mineral rents | | | -0.422 | -0.0256* | -0.422 | -0.0256* |
| | | | (-1.29) | (-1.82) | (-1.29) | (-1.82) |
| Oil rents | | | -2.253 | -0.132** | -2.253 | -0.132** |
| | | | (-1.60) | (-2.15) | (-1.60) | (-2.15) |
| Natural gas rents | | | -2.009 | -0.118* | -2.009 | -0.118* |
| | | | (-1.32) | (-1.82) | (-1.32) | (-1.82) |
| Resource discoveries | | | | | 0 | 0 |
| | | | | | (.) | (.) |
| $N$ | 71 | 58 | 71 | 58 | 71 | 58 |
| $R^2$ | 0.649 | | 0.712 | | 0.712 | |
| pseudo $R^2$ | | 0.007 | | 0.008 | | 0.008 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.A.7: Geographically disaggregated project-level analysis: robustness check of the baseline scenario using only China's ODA as defined by the OECD

| | (1) LSDV | (2) PPML | (3) LSDV | (4) PPML | (5) LSDV | (6) PPML | (7) LSDV | (8) PPML |
|---|---|---|---|---|---|---|---|---|
| Mines | 0.027 | 0.214*** | -0.043 | 0.167** | -0.025 | 0.132** | -0.017 | 0.164** |
| | (0.046) | (0.056) | (0.047) | (0.065) | (0.047) | (0.062) | (0.046) | (0.064) |
| Night light | 0.197*** | 0.226*** | 0.356*** | 0.301*** | 0.403*** | 0.322*** | 0.395*** | 0.296*** |
| | (0.029) | (0.031) | (0.040) | (0.054) | (0.041) | (0.059) | (0.041) | (0.060) |
| Population | -0.024 | 0.129*** | -0.117*** | 0.060 | -0.126*** | 0.118* | -0.131*** | 0.132* |
| | (0.042) | (0.048) | (0.042) | (0.064) | (0.043) | (0.069) | (0.043) | (0.069) |
| Capital region | 2.492*** | 0.988*** | 2.401*** | 0.945*** | 2.349*** | 1.103*** | 2.295*** | 1.061*** |
| | (0.224) | (0.163) | (0.223) | (0.167) | (0.223) | (0.190) | (0.223) | (0.191) |
| Oil & gas | -0.034 | -0.165 | -0.160** | -0.219 | -0.030 | 0.129 | -0.058 | 0.074 |
| | (0.064) | (0.203) | (0.069) | (0.209) | (0.069) | (0.218) | (0.071) | (0.217) |
| Area | | | 0.246*** | 0.128* | 0.239*** | 0.125 | 0.248*** | 0.099 |
| | | | (0.039) | (0.075) | (0.039) | (0.081) | (0.040) | (0.082) |
| Port | | | | | -0.655*** | -1.126*** | -0.643*** | -1.133*** |
| | | | | | (0.095) | (0.189) | (0.095) | (0.190) |
| Road density | | | | | | | 1.191* | 1.202** |
| | | | | | | | (0.653) | (0.578) |
| $N$ | 11550 | 9540 | 11550 | 9540 | 11550 | 9540 | 11550 | 9540 |
| $R^2$ | 0.161 | | 0.164 | | 0.168 | | 0.168 | |
| pseudo $R^2$ | | 0.286 | | 0.287 | | 0.301 | | 0.303 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.A.8: Geographically disaggregated project-level analysis: robustness check using only China's ODA as defined by the OECD and additional controls

| | (1) PPML | (2) PPML | (3) PPML | (4) PPML | (5) PPML | (6) PPML | (7) PPML | (8) PPML | (9) PPML | (10) PPML |
|---|---|---|---|---|---|---|---|---|---|---|
| Mines | -0.0556 | 0.120** | 0.0546 | 0.106* | 0.107* | 0.0505 | 0.0314 | 0.0430 | 0.0624 | 0.0665 |
| | (-1.27) | (2.13) | (0.94) | (1.69) | (1.71) | (0.75) | (0.49) | (0.67) | (0.97) | (1.04) |
| Buffer | 0.000678*** | 0.000770*** | 0.000732*** | 0.000667*** | 0.000668*** | 0.000675*** | 0.000708*** | 0.000707*** | 0.000486*** | 0.000479*** |
| | (7.18) | (7.64) | (7.18) | (6.51) | (6.51) | (6.65) | (6.91) | (6.88) | (4.28) | (4.19) |
| Night Light | | 0.381*** | 0.378*** | 0.189*** | 0.187*** | 0.287*** | 0.307*** | 0.293*** | 0.211*** | 0.213*** |
| | | (18.62) | (18.53) | (5.96) | (5.76) | (5.51) | (5.67) | (5.30) | (3.42) | (3.38) |
| Population | | | 0.274*** | 0.232*** | 0.231*** | 0.148*** | 0.166*** | 0.172*** | 0.160*** | 0.179*** |
| | | | (5.46) | (4.75) | (4.73) | (2.68) | (2.93) | (3.04) | (2.64) | (2.93) |
| Capital region | | | | 1.220*** | 1.230*** | 1.191*** | 1.217*** | 1.191*** | 1.268*** | 1.252*** |
| | | | | (7.71) | (7.59) | (7.39) | (7.58) | (7.33) | (7.12) | (7.10) |
| Oil & gas | | | | | 0.0797 | 0.0140 | 0.153 | 0.127 | -0.0143 | -0.0300 |
| | | | | | (0.43) | (0.07) | (0.79) | (0.65) | (-0.08) | (-0.16) |
| Area | | | | | | 0.173** | 0.178** | 0.166** | 0.145 | 0.105 |
| | | | | | | (2.39) | (2.39) | (2.21) | (1.55) | (1.14) |
| Port | | | | | | | -0.410** | -0.407** | -0.292* | -0.355** |
| | | | | | | | (-2.54) | (-2.51) | (-1.79) | (-2.14) |
| Road density | | | | | | | | 0.617 | 0.674 | 0.636 |
| | | | | | | | | (1.45) | (1.58) | (1.45) |
| Precipitation | | | | | | | | | 0.461 | 0.317 |
| | | | | | | | | | (1.09) | (0.75) |
| Temperature | | | | | | | | | | 0.440*** |
| | | | | | | | | | | (2.93) |
| $N$ | 3328 | 3328 | 3328 | 3328 | 3328 | 3328 | 3328 | 3328 | 2496 | 2484 |
| pseudo $R^2$ | 0.308 | 0.449 | 0.459 | 0.481 | 0.481 | 0.483 | 0.486 | 0.487 | 0.465 | 0.469 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.A.9: Country-level analysis: robustness with the net ODA received (constant US$ 2020) and aggregate resource rents 1/2

| | (1) LSDV | (2) PPML | (3) LSDV | (4) PPML | (5) LSDV | (6) PPML |
|---|---|---|---|---|---|---|
| Population | -1.000** | -0.0538*** | -0.853** | -0.0464** | -0.847** | -0.0461** |
| | (-2.33) | (-2.62) | (-2.13) | (-2.42) | (-2.08) | (-2.38) |
| GDP per head | -0.00609 | -0.00237 | 0.0213 | -0.000801 | 0.0208 | -0.000837 |
| | (-0.02) | (-0.18) | (0.08) | (-0.06) | (0.07) | (-0.06) |
| Debt | 0.0146 | 0.000813 | 0.0157 | 0.000869 | 0.0157 | 0.000872 |
| | (1.13) | (1.25) | (1.21) | (1.33) | (1.21) | (1.33) |
| Trade openness | 0.142*** | 0.00741*** | 0.111*** | 0.00589*** | 0.112*** | 0.00596*** |
| | (3.52) | (3.80) | (2.76) | (3.02) | (2.79) | (3.05) |
| Education | 0.0276 | 0.00182 | 0.0193 | 0.00135 | 0.0182 | 0.00129 |
| | (0.29) | (0.41) | (0.21) | (0.30) | (0.19) | (0.29) |
| Life expectancy | 2.163*** | 0.110*** | 2.416*** | 0.123*** | 2.401*** | 0.122*** |
| | (3.47) | (3.68) | (3.71) | (3.91) | (3.65) | (3.84) |
| Resource rents | | | 0.159* | 0.00776** | 0.158* | 0.00771** |
| | | | (1.95) | (2.02) | (1.93) | (1.99) |
| Resource discoveries | | | | | -0.0672 | -0.00348 |
| | | | | | (-0.33) | (-0.38) |
| $N$ | 510 | 509 | 510 | 509 | 510 | 509 |
| $R^2$ | 0.875 | | 0.877 | | 0.877 | |
| pseudo $R^2$ | | 0.011 | | 0.011 | | 0.011 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.A.10: Country-level analysis: robustness with the net ODA received (constant 2020 US$ ) and specific measures of resource rents 2/2

| | (1) LSDV | (2) PPML | (3) LSDV | (4) PPML | (5) LSDV | (6) PPML |
|---|---|---|---|---|---|---|
| Population | -1.000** | -0.0538*** | -1.018** | -0.0545*** | -1.010** | -0.0540*** |
| | (-2.33) | (-2.62) | (-2.51) | (-2.81) | (-2.46) | (-2.76) |
| GDP per head | -0.00609 | -0.00237 | -0.0406 | -0.00392 | -0.0408 | -0.00393 |
| | (-0.02) | (-0.18) | (-0.14) | (-0.29) | (-0.14) | (-0.29) |
| Debt | 0.0146 | 0.000813 | 0.0165 | 0.000911 | 0.0165 | 0.000915 |
| | (1.13) | (1.25) | (1.23) | (1.35) | (1.23) | (1.35) |
| Trade openness | 0.142*** | 0.00741*** | 0.126*** | 0.00665*** | 0.127*** | 0.00673*** |
| | (3.52) | (3.80) | (2.91) | (3.18) | (2.92) | (3.20) |
| Education | 0.0276 | 0.00182 | 0.0397 | 0.00240 | 0.0385 | 0.00234 |
| | (0.29) | (0.41) | (0.42) | (0.53) | (0.40) | (0.52) |
| Life expectancy | 2.163*** | 0.110*** | 2.365*** | 0.119*** | 2.344*** | 0.118*** |
| | (3.47) | (3.68) | (3.48) | (3.64) | (3.40) | (3.55) |
| Mineral rents | | | 0.139** | 0.00675** | 0.140** | 0.00676** |
| | | | (2.20) | (2.24) | (2.20) | (2.24) |
| Oil rents | | | -0.00445 | -0.000260 | -0.00534 | -0.000308 |
| | | | (-0.07) | (-0.08) | (-0.08) | (-0.10) |
| Natural gas rents | | | 0.0176 | 0.000305 | 0.0136 | 0.0000887 |
| | | | (0.09) | (0.04) | (0.07) | (0.01) |
| Resource discoveries | | | | | -0.0850 | -0.00444 |
| | | | | | (-0.44) | (-0.52) |
| $N$ | 510 | 509 | 509 | 508 | 509 | 508 |
| $R^2$ | 0.875 | | 0.876 | | 0.876 | |
| pseudo $R^2$ | | 0.011 | | 0.011 | | 0.011 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.A.11: Country level analysis:robustness with the net ODA and official aid (current US$) and aggregate resource rents 1/2

| | (1) LSDV | (2) PPML | (3) LSDV | (4) PPML | (5) LSDV | (6) PPML |
|---|---|---|---|---|---|---|
| Population | -1.372*** | -0.0751*** | -1.127** | -0.0628*** | -1.110** | -0.0619*** |
| | (-2.61) | (-2.98) | (-2.43) | (-2.81) | (-2.35) | (-2.73) |
| GDP per head | -0.193 | -0.0131 | -0.147 | -0.0104 | -0.149 | -0.0105 |
| | (-0.62) | (-0.88) | (-0.49) | (-0.74) | (-0.50) | (-0.75) |
| Debt | 0.0149 | 0.000856 | 0.0168 | 0.000950 | 0.0169 | 0.000957 |
| | (1.17) | (1.32) | (1.30) | (1.44) | (1.30) | (1.45) |
| Trade openness | 0.259*** | 0.0136*** | 0.207*** | 0.0110*** | 0.210*** | 0.0112*** |
| | (6.00) | (6.46) | (4.92) | (5.34) | (4.93) | (5.35) |
| Education | 0.115 | 0.00650 | 0.101 | 0.00570 | 0.0984 | 0.00555 |
| | (1.12) | (1.31) | (1.00) | (1.16) | (0.96) | (1.13) |
| Life expectancy | 2.371*** | 0.122*** | 2.796*** | 0.142*** | 2.757*** | 0.140*** |
| | (3.28) | (3.48) | (3.55) | (3.74) | (3.44) | (3.62) |
| Resource rents | | | 0.266** | 0.0130*** | 0.264** | 0.0129*** |
| | | | (2.58) | (2.66) | (2.52) | (2.60) |
| Resource discoveries | | | | | -0.173 | -0.00892 |
| | | | | | (-0.75) | (-0.86) |
| $N$ | 510 | 509 | 510 | 509 | 510 | 509 |
| $R^2$ | 0.863 | | 0.867 | | 0.867 | |
| pseudo $R^2$ | | 0.012 | | 0.012 | | 0.012 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.A.12: Country-level analysis: robustness with net official development assistance and official aid received (current US$) and specific measures of resource rents 2/2

| | (1) LSDV | (2) PPML | (3) LSDV | (4) PPML | (5) LSDV | (6) PPML |
|---|---|---|---|---|---|---|
| Population | -1.372*** | -0.0751*** | -1.364*** | -0.0741*** | -1.347*** | -0.0731*** |
| | (-2.61) | (-2.98) | (-2.91) | (-3.29) | (-2.83) | (-3.20) |
| GDP per head | -0.193 | -0.0131 | -0.257 | -0.0160 | -0.258 | -0.0160 |
| | (-0.62) | (-0.88) | (-0.81) | (-1.06) | (-0.81) | (-1.07) |
| Debt | 0.0149 | 0.000856 | 0.0176 | 0.000995 | 0.0178 | 0.00100 |
| | (1.17) | (1.32) | (1.33) | (1.48) | (1.33) | (1.48) |
| Trade openness | 0.259*** | 0.0136*** | 0.224*** | 0.0119*** | 0.227*** | 0.0121*** |
| | (6.00) | (6.46) | (5.01) | (5.45) | (5.00) | (5.43) |
| Education | 0.115 | 0.00650 | 0.124 | 0.00688 | 0.122 | 0.00675 |
| | (1.12) | (1.31) | (1.23) | (1.41) | (1.19) | (1.38) |
| Life expectancy | 2.371*** | 0.122*** | 2.793*** | 0.142*** | 2.749*** | 0.139*** |
| | (3.28) | (3.48) | (3.38) | (3.52) | (3.24) | (3.37) |
| Mineral rents | | | 0.214*** | 0.0103*** | 0.214*** | 0.0103*** |
| | | | (3.09) | (3.14) | (3.09) | (3.14) |
| Oil rents | | | 0.0175 | 0.000849 | 0.0156 | 0.000748 |
| | | | (0.22) | (0.22) | (0.19) | (0.19) |
| Natural gas rents | | | 0.179 | 0.00764 | 0.170 | 0.00717 |
| | | | (0.73) | (0.67) | (0.68) | (0.61) |
| Resource discoveries | | | | | -0.182 | -0.00950 |
| | | | | | (-0.82) | (-0.95) |
| $N$ | 510 | 509 | 509 | 508 | 509 | 508 |
| $R^2$ | 0.863 | | 0.866 | | 0.866 | |
| pseudo $R^2$ | | 0.012 | | 0.012 | | 0.012 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.A.13: Country-level analysis: robustness with the total net bilateral aid flows from 3 of the largest DAC donors

| | **USA** | | **GERMANY** | | **JAPAN** | |
|---|---|---|---|---|---|---|
| | LSDV | PPML | LSDV | PPML | LSDV | PPML |
| Population | -0.918 | -0.0598 | 2.602*** | 0.159*** | -0.00914 | -0.00883 |
| | (-1.24) | (-1.46) | (3.76) | (3.90) | (-0.01) | (-0.13) |
| GDP per head | -0.115 | -0.0155 | 0.965** | 0.0576** | -0.815 | -0.0569 |
| | (-0.17) | (-0.43) | (2.14) | (2.20) | (-1.24) | (-1.45) |
| Debt | -0.0191 | -0.00120 | -0.0846*** | -0.00607*** | -0.0298* | -0.00196* |
| | (-1.13) | (-1.07) | (-4.68) | (-4.88) | (-1.70) | (-1.70) |
| Trade openness | 0.223** | 0.0143*** | -0.0103 | -0.00108 | 0.380** | 0.0250*** |
| | (2.38) | (2.64) | (-0.13) | (-0.24) | (2.48) | (2.64) |
| Education | 0.304* | 0.0197** | -0.479*** | -0.0293*** | -0.241 | -0.0150 |
| | (1.87) | (2.19) | (-3.72) | (-3.86) | (-1.08) | (-1.13) |
| Life expectancy | 4.275*** | 0.224*** | -2.651* | -0.165* | 2.914 | 0.179 |
| | (3.50) | (3.31) | (-1.80) | (-1.88) | (1.41) | (1.44) |
| Resources rents | 0.310** | 0.0172** | 0.431*** | 0.0255*** | -0.0794 | -0.00623 |
| | (2.03) | (2.03) | (2.95) | (3.10) | (-0.43) | (-0.58) |
| Resources discoveries | 0.0487 | 0.00124 | -0.424** | -0.0240** | -0.374 | -0.0230 |
| | (0.22) | (0.11) | (-2.18) | (-2.24) | (-1.36) | (-1.53) |
| $N$ | 486 | 486 | 489 | 489 | 478 | 478 |
| $R^2$ | 0.885 | | 0.822 | | 0.710 | |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 1.A.14: Summary statistics - Country-level Analysis

| | **Count** | **Mean** | **Sd** | **Min** | **Max** |
|---|---|---|---|---|---|
| ChineseAid | 758 | 16.99378 | 2.052801 | 7.352071 | 23.79368 |
| Population | 862 | 15.90973 | 1.500357 | 11.30382 | 19.04104 |
| GDP per head | 827 | 7.19451 | 1.000162 | 5.555394 | 9.70739 |
| Debt | 764 | 2.862992 | 4.620305 | 0.0006069 | 59.67141 |
| Trade openness | 843 | 5.703213 | 2.195536 | -1.224186 | 10.7945 |
| Mineral rents | 836 | 0.4036466 | 0.6791519 | 0 | 3.264333 |
| Oil rents | 830 | 0.7769611 | 1.279483 | 0 | 4.215275 |
| Natural gas rents | 827 | 0.1458587 | 0.3611353 | 0 | 1.905914 |
| Life expectancy | 867 | 4.057938 | 0.1356369 | 3.674806 | 4.334647 |
| Resources discoveries | 867 | 0.0069204 | 0.0829485 | 0 | 1 |
| Education | 531 | 1.816303 | 1.061418 | -1.311484 | 4.1026 |
| Resource rents | 830 | 2.171923 | 0.973735 | 0.0011706 | 4.232912 |
| *N* | 867 | | | | |

Table 1.A.15: Summary statistics - Geographical dissaggregated project level analysis

| | **Count** | **Mean** | **Sd** | **Min** | **Max** |
|---|---|---|---|---|---|
| China's aid total flows | 10,436 | 5,866,522 | 79,700,000 | 0 | 5,210,000,000 |
| China's aid ODA flows | 10,494 | 1,418,255 | 26,600,000 | 0 | 1,510,000,000 |
| Night light intensity | 10,635 | 1.96 | 5.99 | 0 | 48.20 |
| Population | 10,635 | 1,091,995 | 1,736,613 | 6,046.85 | 21,900,000 |
| Capital region (dummy) | 10,635 | 0.0663 | 0.249 | 0 | 1 |
| Mines | 10,635 | 3.58 | 12.58 | 0 | 139 |
| Oil & gas (dummy) | 10,635 | 0.1735 | 0.379 | 0 | 1 |
| Area (km²) | 10,635 | 41,106.88 | 81,046.73 | 41.56 | 626,800 |
| Port (dummy) | 10,635 | 0.186 | 0.389 | 0 | 1 |
| Road density (km/km²) | 10,635 | 0.0919 | 0.146 | 0 | 1.874 |
| Temperature (°C) | 8,915 | 23.58 | 4.06 | 9.12 | 31.3 |
| Precipitation (mm) | 8,960 | 3,929.77 | 2,334.15 | 1 | 7,891 |
| Buffer (km) | 11,678 | 331.66 | 401.31 | 1 | 1,216 |
| *N* | 10,635 | | | | |

Table 1.A.16: Countries included in the sample for national level analysis

| | |
|---|---|
| Algeria | Madagascar |
| Angola | Mali |
| Burundi | Mozambique |
| Benin | Mauritania |
| Central African Republic | Mauritius |
| Cote d'Ivoire | Malawi |
| Cameroon | Namibia |
| Congo, Dem Rep | Niger |
| Congo, Rep | Nigeria |
| Comoros | Rwanda |
| Cabo Verde | Sudan |
| Djibouti | Senegal |
| Egypt, Arab Rep | Sierra Leone |
| Eritrea | Somalia |
| Ethiopia | South Sudan |
| Gabon | Seychelles |
| Ghana | Chad |
| Guinea | Togo |
| Gambia, The | Tunisia |
| Guinea-Bissau | Tanzania |
| Equatorial Guinea | Uganda |
| Kenya | South Africa |
| Libya | Zambia |
| Lesotho | Zimbabwe |
| Morocco | |

Table 1.A.17: Countries included in the sample for the geographical dissaggregated product level analysis

| | |
|---|---|
| Algeria | Madagascar |
| Angola | Mali |
| Burundi | Mozambique |
| Benin | Mauritania |
| Central African Republic | Mauritius |
| Côte d'Ivoire | Malawi |
| Cameroon | Namibia |
| Congo, Dem. Rep. | Niger |
| Congo, Rep. | Nigeria |
| Comoros | Rwanda |
| Cabo Verde | Sudan |
| Djibouti | Senegal |
| Egypt, Arab Rep. | Sierra Leone |
| Eritrea | Somalia |
| Ethiopia | South Sudan |
| Gabon | Seychelles |
| Ghana | Chad |
| Guinea | Togo |
| Gambia, The | Tunisia |
| Guinea-Bissau | Tanzania |
| Equatorial Guinea | Uganda |
| Kenya | South Africa |
| Libya | Zambia |
| Lesotho | Zimbabwe |
| Morocco | – |

Table 1.A.18: Cross-correlation table - variables included in the country-level analysis

| Variables | ChineseAid | Population | GDP per head | Debt | Trade | LE | Education | MR | OR | NGR | RD | RR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ChineseAid | 1.000 | | | | | | | | | | | |
| Population | 0.003 | 1.000 | | | | | | | | | | |
| GDP per head | 0.026 | -0.326 | 1.000 | | | | | | | | | |
| Debt | -0.004 | -0.133 | 0.295 | 1.000 | | | | | | | | |
| Trade opnness | 0.109 | 0.518 | 0.334 | 0.067 | 1.000 | | | | | | | |
| LE | 0.127 | -0.118 | 0.499 | 0.133 | 0.303 | 1.000 | | | | | | |
| Education | 0.097 | 0.061 | 0.720 | 0.242 | 0.537 | 0.680 | 1.000 | | | | | |
| MR | 0.047 | 0.156 | -0.085 | -0.098 | 0.255 | 0.017 | 0.129 | 1.000 | | | | |
| OR | -0.067 | 0.162 | 0.450 | 0.092 | 0.439 | 0.138 | 0.288 | -0.193 | 1.000 | | | |
| NGR | -0.022 | 0.192 | 0.345 | 0.042 | 0.360 | 0.224 | 0.313 | -0.174 | 0.528 | 1.000 | | |
| RD | -0.012 | 0.085 | 0.042 | -0.011 | 0.130 | 0.052 | 0.078 | 0.010 | 0.032 | 0.010 | 1.000 | |
| RR | -0.077 | 0.393 | -0.196 | -0.108 | 0.321 | -0.258 | -0.131 | 0.153 | 0.617 | 0.330 | -0.011 | 1.000 |

LE = Life Expectancy MR = Mineral Rents OR = Oil Rents NGR = Natural Gas Rents RD = Resources discoveries RR = Resources Rents

# Chapter 2

# Chapter 2

# Chinese FDI in Africa, natural resources and the energy transition challenges

Co-written with Camélia Turcu

## 2.1 Introduction

Foreign direct investment (FDI) has become a key channel through which emerging and developing economies integrate into global economy, with significant implications for structural transformation, resource allocation, and environmental outcomes. In parallel, the global energy transition has sharply increased demand for critical minerals such as cobalt, lithium, copper, and rare earth elements, reshaping patterns of international investment and geopolitical competition ((International Energy Agency, 2021); (World Bank, 2020)). These non-renewable mineral resources, necessary for energy transition, play a key role in the economies of more than 80 countries: together, these countries account for a quarter of global GDP, half of the world's population, and nearly 70 % of people in extreme poverty (Bank, 2017*b*). Within this context, the energy transition could represent an opportunity for these economies, as it could trigger significant inflows of foreign investment to these countries rich in strategically important metals. It is estimated that the producers of these metals, in the respective countries, could alone generate revenues similar to those of the oil sector over the next 20 years (Pescatori et al., 2021). This perspective highlights the central role of African countries which hold one-third of the world's mineral reserves needed for the energy transition (ECA, 2024). The continent accounts for 90% of platinum reserves, 80% of coltan, 60% of cobalt, 70% of tantalum, as well as 46% of diamond reserves and 40% of gold reserves (Hruby, 2024). Hence, due to its substantial endowments of energy-transition minerals and its growing strategic importance in global supply chains, Africa plays a central role in the geopolitical economy of the energy transition..

In recent decades, China has emerged as one of the largest outward investors at the world level, having an expanding presence in Africa. Chinese outward FDI seem driven by a combination of resource-related interests, structural change, and the internationalization of Chinese firms (Brautigam, 2009); (Chen and Lin, 2018). Recent studies highlight a diversification of motives behind the Chinese outward FDI, including manufacturing relocation, infrastructure development, and participation in emerging value chains (Kaplinsky and Morris, 2009); (Dollar, 2016). However, despite this growing body of literature, there is a still room to investigate on how the energy transition specifically shapes Chinese investment patterns across African countries and sectors. Existing empirical evidence on FDI in Africa has largely focused on aggregate flows and traditional determinants such as market size, institutional quality, natural resource abundance, and macroeconomic stability (Asiedu, 2006) ; (Busse and Hefeker, 2007). Yet the increasing importance of critical minerals for energy transition needs raises new questions about whether these structural determinants are being reshaped by the global transition to a low-carbon economy. In particular, the extent to which Chinese FDI responds to energy-transition-related resource endowments

deserves further attention.

Against this background, our work contributes to the literature and investigates the determinants of Chinese FDI in Africa through the lens of the energy transition. To do so, we employ a multi-step empirical approach at country-level using macroeconomic data and at a geographically disaggregated level, using firm level information. Specifically, we use Panel Corrected Standard Errors (PCSE) to address cross-sectional dependence across panels. Second, we complement this analysis with cross-variable specifications incorporating conflicts, as well as a gravity model, to validate our baseline results. Finally, we employ the Feasible Generalized Least Squares (FGLS) estimator to account for heteroskedasticity and potential serial correlation in the error term. We also conduct the analysis at a more disaggregated level using firm-level data. Hence, using different techniques, we aim to produce robust estimates on the link between natural resources in Africa and Chinese Foreign Direct Investment. A sample of 30 African countries over the period 2000 to 2018 is used. Our results suggest that the impact of natural resources on FDI attractiveness is not uniform across resource types. Mineral resources and natural gas were found to be key determinants of FDI while oil resources have a negative impact on Chinese FDI flows to Africa. These results might reflect a certain engagement of the Chinese economy in the energy transition process: this requires specific mineral resources and is associated with a decline in oil consumption.This research analyzes thus the main determinants of Chinese FDI in Africa, while paying a particular attention to the potential links to the resource needs of the energy transition. We explicitly distinguish between country-level determinants such as mineral endowments, institutional quality, infrastructure, and market potential and firm level characteristics. By combining these two levels of analysis, we aim to provide a more comprehensive understanding of the drivers of Chinese investment decisions in African economies.

The rest of the chapter is structured as follows. The next section presents the literature review. Section 3 describes some stylized facts, Section 4 outlines the methodology and data used, Section 5 presents the empirical results, and Section 6 reports the robustness checks. Finally, Section 7 concludes.

## 2.2 Literature Review

The literature on the relationship between natural resources and foreign direct investment (FDI) is extensive, and the evidence varies according to both the type of FDI considered and the countries under analysis.[1] Early empirical research on the determinants of Chinese outward foreign direct investment

[1]Early empirical research on the determinants of Chinese outward investment relied mainly on descriptive evidence (e.g., Deng, 2004; Wong and Chan, 2003), company case studies (e.g., (Liu and Li, 2002) ; (Warner et al., 2013); (Zhang

(OFDI) generally did not account for cross-country heterogeneity or distinguish among different types of FDI. Within this literature, natural resources have often been associated with lower FDI inflows, even after controlling for institutional quality and other conventional determinants of investment (Asiedu, 2013; Hayat, 2018). Moreover, the presence of abundant natural resources appears to weaken the positive contribution of FDI to economic growth.

The determinants of FDI also differ systematically across host countries. Saini and Singhania (2018) show that, in developed economies, FDI is primarily driven by policy-related factors such as economic growth, trade openness, and institutional quality, whereas in developing economies it responds more strongly to economic fundamentals, including gross fixed capital formation, trade openness, and production efficiency. These differences suggest that the relationship between natural resources and FDI cannot be treated as homogeneous across countries. Several studies further distinguish between resource-seeking and non-resource-seeking investment. Poelhekke and van der Ploeg (2010) show that resource-related FDI is predominantly vertical, whereas non-resource FDI is mainly associated with export-fragmentation strategies.

Evidence for Africa points to an important interaction between natural resources, institutions, and FDI. Resource revenues influence FDI inflows (Bokpin et al., 2015), while the effect of democracy depends on the importance of natural resources in the host economy. Using a broad cross-country sample, Asiedu and Lien (2011) show that democratization promotes FDI only when the share of minerals and oil in total exports remains below a critical threshold. Likewise, Asiedu (2013) conclude that the adverse relationship between natural resources and FDI persists even after controlling for several dimensions of institutional quality.

The literature on Chinese OFDI also emphasizes the importance of institutional conditions. Shan et al. (2018) report that political stability and regulatory quality are negatively associated with Chinese investment in Africa, whereas voice and accountability has a positive effect, while the rule of law and control of corruption are not statistically significant. Similarly, Kolstad and Wiig (2012) show that natural resources and institutions jointly shape Chinese investment decisions. Chinese firms are more likely to invest in resource-rich countries when institutional quality is weak, a result that is consistent with the earlier findings of Kolstad and Wiig (2011), who argue that such investments may reinforce existing institutional weaknesses in resource-rich economies.

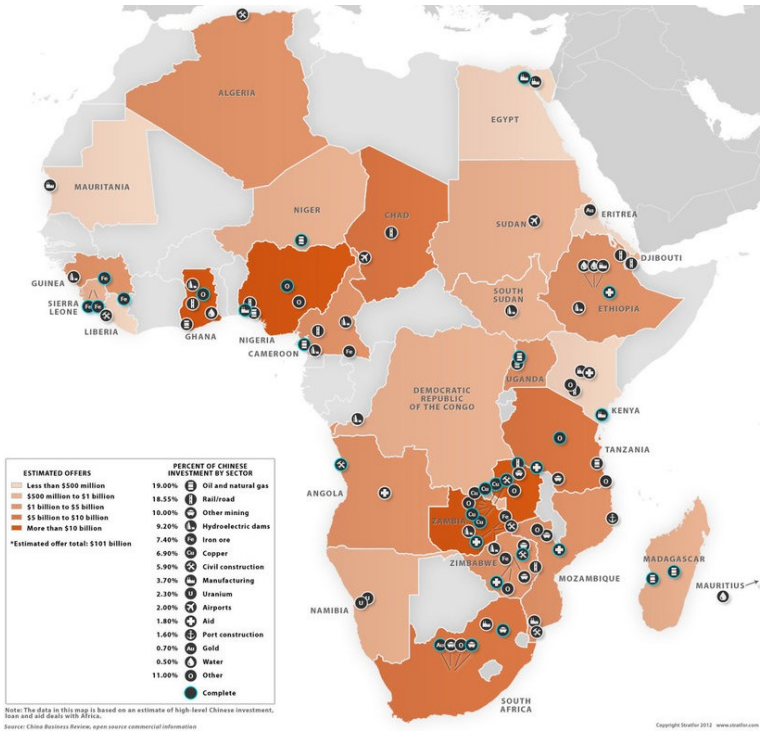
More recent studies confirm the importance of natural resources in explaining the destination of Chi-

and Filippov, 2009)), studies of specific host countries (e.g., (Schüler-Zhou and Schüller, 2009) ; (Pietrobelli et al., 2011); (Voss et al., 2010); (Liu and Tian, 2008), and analyses of particular industries (e.g., (Amighini and Franco, 2011).

nese outward FDI. Tuman and Shirali (2017) find that Chinese investment is attracted by host countries endowed with oil, ores, and metals, while also responding to trade linkages and relatively low income levels. Examining the post-2008 period, Feng et al. (2022) show that Chinese multinationals have become increasingly resource-seeking, whereas the level of financial development in the host economy has become less important. At the sectoral level, Amighini et al. (2013) confirm the market-seeking motive for Chinese OFDI but find only limited evidence supporting resource-seeking behavior. Other studies identify exchange rates, market potential, and trade openness as important determinants of Chinese OFDI, whereas infrastructure quality has a negative association with investment flows (Liu et al., 2018). For countries participating in the Belt and Road Initiative, however, Chinese investment appears less responsive to exchange rate volatility, labor costs, technology, political conditions, and natural resources than in other destinations. Instead, imports of oil, minerals, and agricultural products, together with political instability, are found to stimulate Chinese investment (Gold, 2022).

Despite this extensive literature, little attention has been paid to the implications of the global energy transition for the geography of Chinese FDI. Existing studies generally treat natural resources as a homogeneous category and do not distinguish between different types of resources, namely those critical for low-carbon technologies and the others. This distinction has become increasingly important as the energy transition has reshaped global demand for critical minerals. Our paper addresses this gap by examining whether Chinese FDI in Africa responds differently to resources associated with the energy transition than to conventional ones. In doing so, we aim to provide new evidence on how the changing composition of global mineral demand affects the location of Chinese investment in Africa.

Figure 2.1: China investments in Africa since 2010




Source : China Business Review

## 2.3 Methodology and Data

### 2.3.1 Methodology

This section highlights the empirical strategy used to determine the determinants of Chinese FDI outflows in the energy transition's context. Following Cheng and Ma (2010) and Kolstad and Wiig (2012), our specification is written as follows 2.1 :

$$FDI_{ijt} = \beta_1 \, Natural \; Resources_{jt} + \beta_2 \, GDP_{jt} + \beta_3 \, Openess_{jt} + \beta_5 \, X_{jt} + e_{it} \qquad (2.1)$$

Where $j$ is the individual African country, $t$ the time and $i$ represents China. Our dependent variable $FDI_{it}$ is the natural log of Chinese total outward FDI flows in country $j$. $Natural \; Resources_{jt}$ which are the total natural resource rents of the host country $j$ are used as a proxy to measure its natural resource wealth. We also used it at a disaggregated level to run a more in-depth analysis and to investigate which type of resource can attract Chinese FDI. It was thus decomposed by types of resources: Mineral resource rents, Oil rents and Natural gas rents. The other explanatory variables included in the model are described below and are chosen following the existing literature

(). $GDP_{jt}$ is the per capita GDP and is used as a proxy for the market size. $Trade_{jt}$ represents the openness of the host country (i.e the ratio between the sum of its exports and imports on the GDP). $X_{jt}$ which is a set of variable representing the control variables. These control variables are related to: inflation (i.e. the consumers price index evolution of the host country), quality of institutions (i.e. governement stability, corruption or law and order) and infrastructure (i.e. the mobile cellular subscriptions per 100 people). This latter variable has been used as proxy of the level of development in terms of infrastructure of the host country. $e_{it}$ is the error term of our model.

We begin by estimating Equation 2.1 using a country fixed-effects panel estimator. Preliminary tests indicate the presence of heteroskedasticity and serial correlation in the error term. To account for this, we estimate the model using Panel-Corrected Standard Errors (PCSE). The PCSE estimator accounts for panel heteroskedasticity and contemporaneous cross correlation accorss countries, providing more reliable standard errors and statistical inference while leaving the coefficient estimates unchanged compared to the fixed-effects estimates. As an additional robustness check, we re-estimate the model using Feasible Generalized Least Squares (FGLS), which allows for panel-specific AR(1) autocorrelation, cross-sectional correlation, and heteroskedasticity across panels. We report results from all three estimators to check the robustness of our findings.

### 2.3.2 Data

Data from several sources were used to verify whether there is a link between Chinese FDI in African countries and the natural resources endowment of these (Table 2.A.1). Two data sets on Chinese FDI were used. The first set is taken from the statistical bulletin of China's outward-forward direct investment - Chinese Ministry of Commerce (MOFCOM) and the second from the American Enterprise Institute (AEI-China global investment tracker). The data from MOFCOM provides information on China's total outward FDI flows for 30 African countries (Table 2.A.2)[2] over the period from 2000 to 2018, and the data from AEI provides specific details on the investment projects conducted by Chinese firms in African countries from 2005 to 2022 (Table 2.A.5).

*Resource rents* are used as a proxy of natural resource wealth of countries. This variable comes from the World Bank's WDI database and is expressed as a percentage of GDP. It includes oil, natural gas and mineral rents. The latter is particularly relevant for the energy transition dimension of our study since the minerals included in are, for the most part, essential to the energy transition (ex. tin, gold, lead,

[2]Due to a lack of data, not all African countries were included in our analysis.

zinc, iron, copper, nickel, silver, bauxite, and phosphate).

Several controls are used in our study. *Trade openness* is the sum of exports and imports of goods and services measured as a share of GDP. The quality of an economy's infrastructure is an important dimension in investment decisions for both domestic and foreign investors. The quality of the host country $infrastructure$ is measured using an indicator often used in the literature, namely the number of mobile cell phone subscriptions (per 100 people). The $inflation$ variable, which is a proxy for the macroeconomic stability of recipient countries, is measured by the consumer price index. All these variables come from the World Development Indicator (WDI) database of the World Bank. We also control for the quality of host countries' institutions via different institutional quality variables (*government stability*, *corruption*, *law and order*[3] coming from the ICRG database.

## 2.4 Results and robustness checks

### 2.4.1 Macroeconomic analysis: baseline results

OOur country fixed-effects estimates show that the relationship between natural resources and Chinese FDI differs across resource types. When total natural resource rents are included in the regression, the coefficient is not statistically significant. However, disaggregating total natural resource rents into mineral, oil, and natural gas rents shows substantial differences. Chinese FDI is positively associated with natural gas and mineral resources, whereas oil resources are negatively associated with Chinese investment. These findings are consistent with the current context of the energy transition, in which China, like other major economies, is progressively shifting toward lower-carbon technologies. The positive association between mineral resources and Chinese FDI may reflect the growing demand for the minerals required to produce green technologies. At the same time, although China remains one of the world's largest oil producers, its transition toward cleaner technologies seems gradual and requires reliable energy sources to sustain economic growth. In this context, natural gas may represent a transitional energy source, as it can substitute for oil while generating approximately 40 to 50% fewer emissions (Gould and McGlade, 2017). Finally, our results also indicate that trade openness and macroeconomic stability are important determinants of Chinese FDI in Africa.

[3]Government stability measures both the government's ability to implement its declared policies and its capacity to remain in office. Corruption captures the extent of corruption within the political system. Law and order is a composite indicator comprising two dimensions: the Law component measures the strength and impartiality of the legal system, while the Order component assesses the extent to which the population complies with the law. These variables are obtained from the International Country Risk Guide (ICRG) database.

### 2.4.2 Macroeconomic analysis : robustness with correction of potential cross-section dependance & heteroscedasticity

One potential issue when analyzing panel data is the presence of high correlations among the explanatory variables, which may lead to multicollinearity. As a first assessment, we examine the correlation matrix to identify possible pairwise correlations among the regressors. Table 2.A.3 shows that the pairwise correlations between the explanatory variables are all below 0.8, suggesting that multicollinearity is unlikely to be a major concern. We then perform the Pesaran cross-sectional dependence test (Table 2.A.4), which rejects the null hypothesis of cross-sectional independence, indicating the presence of cross-sectional dependence in the data. To account for this issue, as well as potential heteroskedasticity and serial correlation, we estimate our model using the Panel-Corrected Standard Errors (PCSE) estimator developed by Beck and Katz (1995). The PCSE estimator accounts for contemporaneous correlation across panels and deviations from spherical errors, thereby providing more reliable standard errors and statistical inference. It is particularly well suited to panels with a relatively small time dimension and corrects for finite-sample bias while allowing for heteroskedasticity and correlation within panels (Cameron and Trivedi, 2005). The PCSE estimator has been widely used in the empirical literature[4] and has been shown to provide robust inference under these conditions.

The results show no significant relationship when total natural resource rents are considered. In other words, total natural resource rents mask important differences across resource types. However, disaggregating natural resource rents by resource type shows important differences. Mineral resources and natural gas remain positively associated with FDI, whereas oil is negatively associated with FDI in Africa. Trade openness is the only variable that remains positive and highly significant throughout all specifications. The estimated coefficient is stable, suggesting that countries that are more integrated into international trade tend to attract larger inflows of Chinese FDI. This finding is consistent with the view that openness facilitates market access and reduces transaction costs for foreign investors. Among the macroeconomic controls, inflation enters positively and is statistically significant. Although this result may seem counterintuitive, it may reflect periods of rapid economic expansion or macroeconomic adjustments (i.e. it may reflect commodity-driven economic expansions, resource booms) rather than macroeconomic instability per se. Further, infrastructure displays a weak positive effect only in the baseline specification, but loses statistical significance once additional institutional controls are included, suggesting that its explanatory power is limited after accounting for other country characteristics. Institutional variables, including government stability and corruption, are generally not significantly associated with

[4]See Halvorsen (2012), Herrerías Talamantes et al. (2013), Hecock and Jepsen (2013), and Elheddad (2018).

Chinese FDI. By contrast, law and order becomes positive and weakly significant in the most comprehensive specification, suggesting that a stronger legal environment may contribute to attracting Chinese investment, although the evidence remains limited.

Table 2.1: Macroeconomic analysis: OLS estimates using aggregate natural resource rents 1/2

| | (1) FDI | (2) FDI | (3) FDI | (4) FDI | (5) FDI |
|---|---|---|---|---|---|
| Resource rents | 0.0255 | -0.00420 | -0.00903 | -0.0119 | -0.0193 |
| | (0.60) | (-0.09) | (-0.20) | (-0.26) | (-0.42) |
| GDP per head | 0.436 | -0.943 | -0.687 | -1.383 | -0.994 |
| | (0.25) | (-0.47) | (-0.33) | (-0.65) | (-0.47) |
| Trade openness | 2.907*** | 2.583*** | 2.546*** | 2.511*** | 2.612*** |
| | (5.23) | (4.52) | (4.43) | (4.37) | (4.53) |
| Infrastructure | 0.284* | 0.198 | 0.231 | 0.265 | 0.230 |
| | (1.91) | (1.13) | (1.26) | (1.43) | (1.24) |
| Inflation | | 0.510** | 0.514** | 0.457* | 0.440* |
| | | (2.07) | (2.09) | (1.83) | (1.76) |
| Government Stability | | | 0.105 | 0.0624 | 0.0243 |
| | | | (0.61) | (0.36) | (0.14) |
| Corruption | | | | 0.595 | 0.584 |
| | | | | (1.42) | (1.40) |
| Law and Order | | | | | 1.307* |
| | | | | | (1.69) |
| $N$ | 512 | 461 | 461 | 461 | 461 |
| $R^2$ | 0.085 | 0.060 | 0.061 | 0.066 | 0.072 |
| Fixed effect | Yes | Yes | Yes | Yes | Yes |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 2.2: Macroeconomic analysis: OLS estimates with disaggregated resource rents 2/2

| | (1) FDI | (2) FDI | (3) FDI | (4) FDI | (5) FDI |
|---|---|---|---|---|---|
| Oil rents | -0.0979** | -0.117** | -0.130*** | -0.133*** | -0.151*** |
| | (-2.21) | (-2.47) | (-2.69) | (-2.75) | (-3.12) |
| Natural gas rents | 4.524*** | 5.004*** | 5.060*** | 5.040*** | 5.128*** |
| | (9.47) | (7.37) | (7.45) | (7.42) | (7.59) |
| Mineral rents | 0.249** | 0.254** | 0.240** | 0.234** | 0.245** |
| | (2.44) | (2.34) | (2.20) | (2.14) | (2.25) |
| GDP per head | -2.683* | -2.549 | -2.033 | -2.641 | -2.069 |
| | (-1.70) | (-1.35) | (-1.05) | (-1.34) | (-1.05) |
| Trade openness | 2.826*** | 2.699*** | 2.635*** | 2.607*** | 2.775*** |
| | (5.54) | (5.00) | (4.86) | (4.81) | (5.12) |
| Infrastructure | 0.229* | 0.139 | 0.205 | 0.236 | 0.180 |
| | (1.65) | (0.84) | (1.18) | (1.36) | (1.03) |
| Inflation | | 0.580** | 0.588** | 0.536** | 0.510** |
| | | (2.52) | (2.56) | (2.30) | (2.20) |
| Government Stability | | | 0.212 | 0.174 | 0.125 |
| | | | (1.30) | (1.06) | (0.76) |
| Corruption | | | | 0.532 | 0.516 |
| | | | | (1.36) | (1.33) |
| Law and Order | | | | | 1.885*** |
| | | | | | (2.59) |
| $N$ | 512 | 461 | 461 | 461 | 461 |
| $R^2$ | 0.240 | 0.182 | 0.185 | 0.189 | 0.202 |
| Fixed effect | Yes | Yes | Yes | Yes | Yes |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 2.3: Macroeconomic analysis: PCSE estimates with aggregate resource rents 1/2

| | (1) FDI | (2) FDI | (3) FDI | (4) FDI | (5) FDI |
|---|---|---|---|---|---|
| Resource rents | -0.0456 | -0.0529 | -0.0586 | -0.0608 | -0.0610 |
| | (-0.80) | (-0.90) | (-1.00) | (-1.04) | (-1.04) |
| GDP per head | -3.276* | -3.590** | -2.731 | -2.956 | -2.636 |
| | (-1.91) | (-2.01) | (-1.45) | (-1.57) | (-1.33) |
| Trade openness | 3.352*** | 3.051*** | 3.010*** | 3.047*** | 3.087*** |
| | (4.94) | (4.70) | (4.63) | (4.63) | (4.58) |
| Infrastructure | 0.305** | 0.226 | 0.262* | 0.269* | 0.254 |
| | (2.07) | (1.42) | (1.69) | (1.72) | (1.58) |
| Inflation | | 0.259 | 0.260 | 0.260 | 0.269* |
| | | (1.64) | (1.63) | (1.62) | (1.68) |
| Government Stability | | | 0.227* | 0.200 | 0.177 |
| | | | (1.94) | (1.61) | (1.39) |
| Corruption | | | | 0.328 | 0.318 |
| | | | | (1.03) | (1.00) |
| Law and Order | | | | | 0.418 |
| | | | | | (1.08) |
| $N$ | 512 | 461 | 461 | 461 | 461 |
| $R^2$ | 0.231 | 0.258 | 0.263 | 0.268 | 0.269 |
| Fixed effect | Yes | Yes | Yes | Yes | Yes |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 2.4: Macroeconomic analysis: PCSE estimates with disaggregated resource rents 2/2

| | (1) FDI | (2) FDI | (3) FDI | (4) FDI | (5) FDI |
|---|---|---|---|---|---|
| Oil rents | -0.137** | -0.157** | -0.168** | -0.168** | -0.170** |
| | (-2.04) | (-2.22) | (-2.32) | (-2.35) | (-2.36) |
| Natural gas rents | 2.081** | 2.077* | 2.158* | 2.139* | 2.207** |
| | (2.21) | (1.87) | (1.94) | (1.92) | (1.98) |
| Mineral rents | 0.237*** | 0.238*** | 0.227** | 0.225** | 0.233** |
| | (2.76) | (2.70) | (2.54) | (2.48) | (2.55) |
| GDP per head | -3.652** | -3.778** | -2.868 | -3.048 | -2.469 |
| | (-2.13) | (-2.03) | (-1.46) | (-1.53) | (-1.17) |
| Trade openness | 3.207*** | 2.953*** | 2.870*** | 2.904*** | 2.935*** |
| | (5.24) | (4.99) | (4.86) | (4.84) | (4.83) |
| Infrastructure | 0.153 | 0.0841 | 0.134 | 0.138 | 0.109 |
| | (1.09) | (0.55) | (0.90) | (0.93) | (0.71) |
| Inflation | | 0.304* | 0.300* | 0.302* | 0.302* |
| | | (1.94) | (1.90) | (1.90) | (1.91) |
| Government Stability | | | 0.248** | 0.231* | 0.208 |
| | | | (2.07) | (1.82) | (1.61) |
| Corruption | | | | 0.277 | 0.268 |
| | | | | (0.89) | (0.85) |
| Law and Order | | | | | 0.618 |
| | | | | | (1.48) |
| $N$ | 512 | 461 | 461 | 461 | 461 |
| $R^2$ | 0.306 | 0.319 | 0.321 | 0.319 | 0.320 |
| Fixed effect | Yes | Yes | Yes | Yes | Yes |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

### 2.4.3 Macroeconomic analysis : robustness using a temporal perspective

We conducted a further analysis to examine whether Chinese FDI in Africa became more closely associated with natural resources in the recent period, in the context of the energy transition. To this end, we split our sample into two sub-periods: 2000–2009 and 2010–2018. The structural break around 2009 coincides with major developments in global climate governance, particularly the Copenhagen COP15 (2009), which marked a turning point in international efforts to promote low-carbon technologies. During the following decade, the growing deployment of renewable energy technologies substantially increased the strategic importance of critical minerals such as cobalt, copper, and other transition-related resources. This evolving context may have strengthened China's incentives to secure access to these resources through increased investment in Africa. This period also coincides with a broader shift in international environmental priorities. Following the adoption of the Millennium Development Goals in 2000, environmental sustainability gained increasing prominence in the international development agenda. At the same time, the global financial crisis contributed to a decline in investment by several Western countries, whereas Chinese investment in Africa continued to expand. As illustrated in Figure 2.A.1, the decline in U.S. FDI and the rapid increase in Chinese FDI occurred around 2010, providing additional motivation for distinguishing between the two sub-periods.

Our results suggest a before and after effect around 2009 and thus a structural break in the relationship between natural resource endowments and Chinese FDI. In the period 2000–2009, we find no statistically significant association between Chinese FDI and oil or mineral resources, whereas natural gas is positively and significantly correlated with Chinese investment inflows. By contrast, over the period 2010–2019, when environmental considerations became more prominent in policy design, the pattern of resource-seeking appears to have shifted. Chinese FDI is positively and significantly associated with both mineral and natural gas endowments, consistent with their relevance for energy transition-related needs. In addition, oil resources are negatively and significantly correlated with Chinese FDI, suggesting a reorientation of investment away from carbon-intensive resources in response to evolving energy and environmental policy priorities.

Table 2.5: Macroeconomic analysis: robustness using disagregated resource rents and the subsample 2000–2009

| | (1) FDI | (2) FDI | (3) FDI | (4) FDI | (5) FDI | (6) FDI | (7) FDI | (8) FDI | (9) FDI | (10) FDI |
|---|---|---|---|---|---|---|---|---|---|---|
| Oil rents | -0.162 | -0.159 | -0.159 | -0.159 | -0.168 | | | | | |
| | (-1.44) | (-1.49) | (-1.48) | (-1.49) | (-1.54) | | | | | |
| Natural gas rents | 0.592 | 2.869*** | 2.869*** | 2.870*** | 2.833*** | | | | | |
| | (0.84) | (2.87) | (2.86) | (2.81) | (2.88) | | | | | |
| Mineral rents | 0.0961 | 0.119 | 0.120 | 0.122 | 0.120 | | | | | |
| | (1.16) | (1.22) | (1.22) | (1.22) | (1.21) | | | | | |
| GDP per head | -4.629** | -9.026*** | -9.048*** | -9.086*** | -8.821** | -3.542** | -7.086** | -7.093** | -7.008** | -6.693** |
| | (-2.03) | (-2.61) | (-2.61) | (-2.60) | (-2.52) | (-2.03) | (-2.26) | (-2.26) | (-2.26) | (-2.12) |
| Trade openness | 3.810*** | 3.459** | 3.463** | 3.484** | 3.510** | 4.356*** | 3.739** | 3.731** | 3.611** | 3.683** |
| | (3.17) | (2.37) | (2.34) | (2.31) | (2.33) | (3.13) | (2.38) | (2.36) | (2.25) | (2.29) |
| Infrastructure | 0.259** | 0.451*** | 0.452*** | 0.453*** | 0.437*** | 0.276** | 0.420*** | 0.418*** | 0.416*** | 0.402*** |
| | (2.37) | (3.05) | (3.04) | (3.03) | (2.94) | (2.54) | (3.00) | (2.97) | (3.00) | (2.90) |
| Inflation | | 0.381** | 0.381** | 0.374* | 0.385** | | 0.377** | 0.377** | 0.388** | 0.395** |
| | | (1.98) | (1.98) | (1.95) | (1.99) | | (2.00) | (2.01) | (2.06) | (2.10) |
| Government Stability | | | 0.00261 | 0.00287 | -0.0144 | | | -0.0209 | -0.0523 | -0.0680 |
| | | | (0.02) | (0.02) | (-0.08) | | | (-0.13) | (-0.30) | (-0.39) |
| Corruption | | | | -0.0161 | 0.0456 | | | | 0.221 | 0.283 |
| | | | | (-0.05) | (0.15) | | | | (0.74) | (0.91) |
| Law and Order | | | | | 0.508 | | | | | 0.453 |
| | | | | | (1.10) | | | | | (1.00) |
| Resource rents | | | | | | -0.108 | -0.108 | -0.107 | -0.109 | -0.114 |
| | | | | | | (-1.20) | (-1.13) | (-1.13) | (-1.14) | (-1.17) |
| $N$ | 263 | 223 | 223 | 223 | 223 | 263 | 223 | 223 | 223 | 223 |
| $R^2$ | 0.353 | 0.351 | 0.352 | 0.352 | 0.361 | 0.305 | 0.294 | 0.294 | 0.294 | 0.302 |
| Fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 2.6: Macroeconomic analysis: robustness using disaggregated resource rents and the subsample 2010–2018

| | (1) FDI | (2) FDI | (3) FDI | (4) FDI | (5) FDI | (6) FDI | (7) FDI | (8) FDI | (9) FDI | (10) FDI |
|---|---|---|---|---|---|---|---|---|---|---|
| Oil rents | -0.187*** | -0.265*** | -0.302*** | -0.320*** | -0.318*** | | | | | |
| | (-2.77) | (-3.87) | (-4.07) | (-4.45) | (-4.44) | | | | | |
| Natural gas rents | 2.841* | 3.128* | 3.381* | 3.476** | 3.457** | | | | | |
| | (1.68) | (1.90) | (1.96) | (2.01) | (1.99) | | | | | |
| Mineral rents | 0.513** | 0.533** | 0.521** | 0.541** | 0.551** | | | | | |
| | (2.34) | (2.23) | (2.25) | (2.31) | (2.33) | | | | | |
| GDP per head | 7.882 | 8.608 | 9.433 | 8.725 | 8.711 | 3.929 | 4.304 | 4.287 | 4.154 | 4.156 |
| | (1.14) | (1.20) | (1.32) | (1.19) | (1.20) | (0.59) | (0.62) | (0.62) | (0.58) | (0.58) |
| Trade openness | 1.972*** | 2.171*** | 2.120*** | 2.136*** | 2.118*** | 1.947*** | 1.914*** | 1.895*** | 1.906*** | 1.893*** |
| | (3.58) | (4.09) | (3.98) | (3.97) | (3.94) | (2.99) | (3.12) | (3.08) | (3.05) | (3.01) |
| Infrastructure | -3.596 | -3.957* | -3.332 | -3.009 | -3.011 | -4.157* | -4.265* | -3.794 | -3.739 | -3.751 |
| | (-1.59) | (-1.69) | (-1.38) | (-1.19) | (-1.19) | (-1.83) | (-1.80) | (-1.54) | (-1.45) | (-1.45) |
| Inflation | | -0.315 | -0.216 | -0.262 | -0.268 | | -0.168 | -0.0891 | -0.0908 | -0.0902 |
| | | (-0.75) | (-0.52) | (-0.62) | (-0.63) | | (-0.33) | (-0.18) | (-0.18) | (-0.18) |
| Government Stability | | | 0.509* | 0.466* | 0.474* | | | 0.303 | 0.292 | 0.294 |
| | | | (1.81) | (1.66) | (1.69) | | | (1.03) | (0.99) | (1.00) |
| Corruption | | | | 1.084 | 1.123 | | | | 0.199 | 0.225 |
| | | | | (1.42) | (1.46) | | | | (0.26) | (0.29) |
| Law and Order | | | | | -1.112 | | | | | -0.570 |
| | | | | | (-0.72) | | | | | (-0.41) |
| Resource rents | | | | | | -0.0896 | -0.135** | -0.152** | -0.155** | -0.153** |
| | | | | | | (-1.53) | (-1.99) | (-2.10) | (-2.17) | (-2.13) |
| $N$ | 223 | 212 | 212 | 212 | 212 | 223 | 212 | 212 | 212 | 212 |
| $R^2$ | 0.706 | 0.726 | 0.732 | 0.733 | 0.732 | 0.650 | 0.661 | 0.663 | 0.664 | 0.664 |
| Fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

### 2.4.4 Macroeconomic analysis: robustness including conflict-related variables

We extend our baseline scenario to include conflict related variables. We do so as the relationship between natural resources and conflict has been extensively studied in the empirical literature (Girard et al., 2022), where natural resources are often identified as a potential source of conflict. A large literature documents that natural resources are systematically linked to conflicts, particularly in Sub-Saharan Africa, where oil, diamonds, and mineral resources have been shown to increase both the likelihood and duration of conflicts (Collier and Hoeffler (2005), Ross (2001), Lujala et al. (2005), Fearon and Laitin (2003)).

To conduct our analysis, we interact our resource rents variables with indicators of conflicts. The latter are assessed under different angles: internal and external conflicts, religious tensions, ethnic tensions [5]. This allows us to investigate whether Chinese FDI continues to target resource-rich locations even in the presence of conflicts. We estimate the augmented specification using the PCSE estimator. The results (Table 2.7) are consistent with the baseline findings. The interaction between total natural resource rents and conflict is negative and significant only for external conflict, while it is positive and significant for ethnic tensions. These results are available upon request. If we consider resource rents at a more disaggregated level, our results are as follows: oil rents interacted with external conflict and natural gas rents interacted with ethnic tensions are negatively and significantly correlated with Chinese FDI. By contrast, mineral rents interacted with internal conflict and natural gas rents interacted with religious tensions are positively and significantly associated with Chinese FDI.

These results are partly in line with Driffield et al. (2013) or Abdelzaher and Ramadan (2023). The former examines, for example, the determinants of a firm's strategy to invest in a conflict location. Their results suggest that firms from countries with relative weak institutions are more likely to invest in conflict locations.

### 2.4.5 Macroeconomic analysis : robustness with an alternative econometric approach

We complement our baseline specification by estimating a FDI gravity model, as a robustness check (cf. Equation 2.2. Following the literature on bilateral trade and investment flows, the gravity framework enables us to account for the bilateral nature of FDI by controlling for factors such as market size,

[5] Data on internal and external conflicts, religious and ethnic tensions is taken from ICRG. ...

geographical distance, and historical or cultural links between countries.[6]

$$Ln\ FDI_{ijt} = \alpha\ ln\ GDP_{it} + \lambda\ ln\ GDP_{jt} + \sigma ln\ X_{ijt} + \lambda\ ln\ D_{ij} + \epsilon_i \tag{2.2}$$

where $FDI_{ij}$ represents the bilateral flows from $i$ to $j$; $GDP_i$ the Gross Domestic Product of the origin country ; $GDP_j$ the Gross Domestic Product of the destination country and $D_{ij}$ the distance between country $i$ and country $j$. $X_{ij}$ is a set of control variable which include: inflation rate, total natural resource rents, oil rents, mineral rents, natural gas rents, trade openness, infrastructure, government stability. The data on the gravity variables used in this analysis come from the CEPII database.

Equation 2.2 is estimated using the Panel-Corrected Standard Errors (PCSE) estimator (our dependent variable is continuous and contains few zeros). The results continue to indicate that only mineral resources are positively and significantly associated with Chinese FDI. Among the control variables, trade openness and the GDP per capita of the origin country are also positively and significantly correlated with Chinese FDI. In the same vein, we re-estimate the gravity model using the Feasible Generalized Least Squares (FGLS) estimator. The results remain qualitatively unchanged, confirming that mineral resources are a key determinant of China's foreign investment decisions.

[6]See Talamo (2007), Kahouli and Maktouf (2015) ; Falk (2016), Zwinkels and Beugelsdijk (2010), Fratianni et al. (2011) Morley et al. (2014) or Peter and Brakman (2010).

Table 2.7: Macroeconomic analysis with interaction terms: disaggregated resource rents and conflicts

| | FDI | FDI | FDI |
|---|---|---|---|
| Oil rents | 0.369 | -0.035 | -0.030 |
| | (1.25) | (-0.79) | (-0.72) |
| Gas rents | 1.189 | 1.376 | -1.457 |
| | (1.39) | (1.63) | (-0.30) |
| Mineral rents | 0.196** | -0.642 | 0.203*** |
| | (2.56) | (-0.63) | (2.66) |
| GDP per head | -0.639 | -0.586 | -0.241 |
| | (-1.62) | (-1.42) | (-0.64) |
| Trade openness | 2.249*** | 2.210*** | 2.113*** |
| | (4.33) | (4.26) | (4.37) |
| Infrastructure | -0.163 | -0.080 | -0.169 |
| | (-1.02) | (-0.53) | (-1.09) |
| Inflation | 0.450*** | 0.346** | 0.395*** |
| | (3.23) | (2.39) | (2.76) |
| Gov. Stability | 0.252* | 0.321** | 0.299** |
| | (1.82) | (2.36) | (2.27) |
| Corruption | -0.293 | -0.293 | -0.299 |
| | (-0.85) | (-0.87) | (-0.87) |
| Law | -0.081 | -0.168 | -0.093 |
| | (-0.33) | (-0.66) | (-0.43) |
| Internal conflict | -0.035 | -0.169 | 0.190 |
| | (-0.21) | (-0.85) | (1.23) |
| External conflict | -0.052 | -0.511* | -0.766*** |
| | (-0.18) | (-1.72) | (-2.60) |
| Religious tensions | -0.093 | 0.191 | -0.187 |
| | (-0.42) | (0.85) | (-0.83) |
| Ethnic tensions | 0.428 | 0.822** | 0.633* |
| | (1.15) | (1.98) | (1.86) |
| Oil × Internal conflict | 0.023 | | |
| | (0.68) | | |
| Oil × External conflict | -0.074* | | |
| | (-1.95) | | |
| Oil × Religious tensions | 0.012 | | |
| | (0.28) | | |
| Oil × Ethnic tensions | 0.030 | | |
| | (0.60) | | |
| Mineral × Internal conflict | | 0.115** | |
| | | (2.04) | |
| Mineral × External conflict | | 0.076 | |
| | | (0.49) | |
| Mineral × Religious tensions | | -0.146 | |
| | | (-1.05) | |
| Mineral × Ethnic tensions | | -0.075 | |
| | | (-1.03) | |
| Gas × Internal conflict | | | -0.494 |
| | | | (-1.50) |
| Gas × External conflict | | | 0.617 |
| | | | (1.45) |
| Gas × Religious tensions | | | 1.513*** |
| | | | (3.68) |
| Gas × Ethnic tensions | | | -1.335** |
| | | | (-2.36) |
| $N$ | 461 | 461 | 461 |
| $R^2$ | 0.255 | 0.226 | 0.301 |

$t$-statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 2.8: Macroeconomie analysis: a gravity approach using PCSE and FGLS

| | (PCSE) FDI | (FGLS) FDI | (PCSE) FDI | (FGLS) FDI |
|---|---|---|---|---|
| Resource rents | | | 0.0515* | -0.0193 |
| | | | (1.88) | (-1.42) |
| Oil rents | -0.0215 | -0.0303 | | |
| | (-0.57) | (-1.62) | | |
| Natural gas rents | 1.522 | -0.0479 | | |
| | (1.54) | (-0.34) | | |
| Mineral rents | 0.194* | 0.183** | | |
| | (1.79) | (2.10) | | |
| Trade openness | 1.861*** | 0.536** | 1.927*** | 0.591** |
| | (4.00) | (2.26) | (3.85) | (2.49) |
| GDP per head of destination | -0.369 | -0.0463 | -0.563* | -0.320 |
| | (-1.10) | (-0.17) | (-1.73) | (-1.42) |
| GDP per head of origin | 37.39** | 8.934 | 43.92*** | 8.226 |
| | (2.24) | (0.82) | (2.62) | (0.77) |
| Inflation | 0.364** | -0.0426 | 0.405** | -0.0421 |
| | (2.16) | (-0.61) | (2.40) | (-0.61) |
| Infrastructure | -0.153 | -0.184 | -0.158 | -0.134 |
| | (-0.62) | (-1.20) | (-0.64) | (-0.91) |
| Distance most populated cities | -0.00156* | -0.00168*** | -0.00123 | -0.00181*** |
| | (-1.80) | (-4.24) | (-1.56) | (-5.00) |
| Government Stability | 0.327** | 0.0984 | 0.302** | 0.102 |
| | (2.20) | (1.56) | (2.02) | (1.63) |
| $N$ | 374 | 374 | 374 | 374 |
| $R^2$ | 0.216 | | 0.187 | |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

### 2.4.6 Macroeconomic analysis: robustness with an alternative methodology

To test the robustness of our results in the presence of heteroskedasticity and cross-sectional dependence, we estimate a Feasible Generalized Least Squares (FGLS) model. This approach allows for AR(1) autocorrelation within panels, as well as heteroskedasticity and cross-sectional correlation across panels.

The results, obtained with country fixed effects to account for time-invariant cross-country heterogeneity, indicate no statistically significant effect when total natural resource rents are considered. However, when disaggregating resources, mineral resources remain the only category that consistently attracts Chinese FDI in Africa.

Table 2.9: Macroeconomuc analysis: robustness with a FGLS approach and aggregated resources rents 1/2

| | (1) FDI | (2) FDI | (3) FDI | (4) FDI | (5) FDI |
|---|---|---|---|---|---|
| Resource rents | -0.00113 | 0.00290 | 0.00110 | 0.00214 | 0.0144 |
| | (-0.08) | (0.17) | (0.07) | (0.13) | (0.87) |
| GDP per head | -0.983*** | -0.900*** | -0.818*** | -0.831*** | -0.646*** |
| | (-5.46) | (-5.03) | (-4.63) | (-4.58) | (-3.24) |
| Trade openness | 1.461*** | 1.363*** | 1.339*** | 1.303*** | 0.993*** |
| | (5.92) | (4.56) | (5.00) | (4.71) | (3.35) |
| Infrastructure | 0.0936 | 0.0305 | 0.102 | 0.0986 | 0.0840 |
| | (1.49) | (0.41) | (1.45) | (1.38) | (1.24) |
| Inflation | | 0.170*** | 0.149** | 0.150** | 0.187*** |
| | | (2.65) | (2.26) | (2.27) | (2.82) |
| Government Stability | | | 0.172*** | 0.162*** | 0.0976 |
| | | | (2.87) | (2.61) | (1.52) |
| Corruption | | | | 0.0818 | -0.0292 |
| | | | | (0.51) | (-0.18) |
| Law and Order | | | | | 0.352*** |
| | | | | | (3.35) |
| *N* | 512 | 461 | 461 | 461 | 461 |

*t* statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 2.10: Macroeconomic analysis: robustness with FGLS approach and resource rents at disagregated level 2/2

| | (1) FDI | (2) FDI | (3) FDI | (4) FDI | (5) FDI |
|---|---|---|---|---|---|
| Oil rents | -0.0210 | -0.0411 | -0.0274 | -0.0307 | -0.0259 |
| | (-0.82) | (-1.50) | (-1.01) | (-1.13) | (-0.96) |
| Natural gas rents | 0.0852 | 0.146 | 0.162 | 0.161 | 0.113 |
| | (0.32) | (0.49) | (0.56) | (0.56) | (0.39) |
| Mineral rents | 0.103* | 0.186*** | 0.172*** | 0.168*** | 0.149*** |
| | (1.81) | (3.80) | (3.16) | (3.01) | (2.71) |
| GDP per head | -0.820*** | -0.711*** | -0.607*** | -0.600*** | -0.446** |
| | (-4.31) | (-4.19) | (-3.77) | (-3.44) | (-2.36) |
| Trade openness | 1.162*** | 1.090*** | 0.983*** | 1.022*** | 0.718** |
| | (3.76) | (3.36) | (3.06) | (3.17) | (2.08) |
| Infrastructure | 0.0317 | -0.0574 | -0.00614 | 0.000866 | -0.00832 |
| | (0.39) | (-0.70) | (-0.07) | (0.01) | (-0.09) |
| Inflation | | 0.197*** | 0.172** | 0.174** | 0.209*** |
| | | (2.90) | (2.43) | (2.47) | (2.93) |
| Government Stability | | | 0.188*** | 0.186*** | 0.114 |
| | | | (2.94) | (2.75) | (1.62) |
| Corruption | | | | -0.0406 | -0.145 |
| | | | | (-0.24) | (-0.83) |
| Law and Order | | | | | 0.343*** |
| | | | | | (3.23) |
| *N* | 512 | 461 | 461 | 461 | 461 |

*t* statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

## 2.5 Further analysis at firm-level

### 2.5.1 Data and stylized fact

In addition to the macroeconomic and country related analysis, we performed a firm-level study to evaluate the correlation between China's foreign direct investment (FDI) and natural resources in Africa in the current context of energy transition. For this purpose, we used company data sourced from the American Enterprise Institute (AEI) - China Global Investment Tracker, which encompasses investment information on 1,930 Chinese enterprises worldwide spanning the years 2005 to 2022. The sectoral distribution of Chinese investment worldwide (Figure 2.4) is concentrated in the oil sector, followed by copper and other metals, including cobalt and molybdenum. Nonetheless, for the purposes of our investigation, we kept solely those investments registered within Africa. The firm level data show that the investments of Chinese firms in Africa are made mainly in 3 sectors : energy, transport and metals (Figure 2.3 and Figure 2.4) unlike the rest of the world (Figure 2.2). The Democratic Republic of the Congo (DRC) is the largest recipient of Chinese investment at firm level, which might be related to its substantial copper and cobalt endowments (Figure 2.A.2).

### 2.5.2 Methodology and results

We conduct a firm-level analysis using the China Global Investment Tracker database provided by the American Enterprise Institute (AEI). This dataset contains information on the investment activities of 59 Chinese firms/consortia in Africa (Table 2.A.6), including sectoral allocation, sub-sector classification, investment amounts, and destination countries (see Figures 2.3 and 2.4). Unfortunately additional information on these companies are not available. The distribution of firm-level investments is highly concentrated, with a small number of large state-owned enterprises accounting for a large share of observations (approx 20%) : CNPC (China National Petroleum Corporation), Sinopec (China Petroleum and Chemical), and CNMC (China Nonferrous Metal Mining). This is true also in terms of investments where top 5 investors account for approx 30% of overall Chinese investment in Africa. We also note that project counts do not follow a monotonic upward trend. Instead, investment occurred in waves, with relatively active periods in 2011–2013 and 2021, separated by years of lower activity. As for investment value, it seems considerably more volatile than project numbers. For example, while 2013 recorded only nine projects, it accounted for approximately 13.2 billion dollars more than double the investment observed in most other years. Conversely, 2021 registered the highest number of projects but less than half the investment value of 2013.

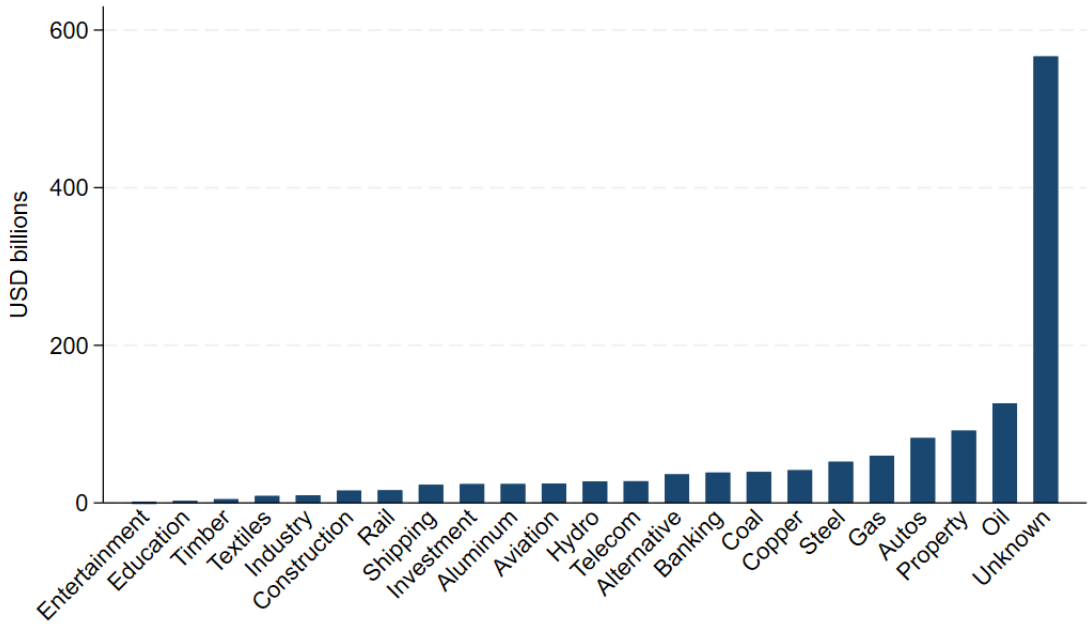
Further, we continue the analysis and use a simple OLS specification with firm fixed effects and a sample of 101 observations, to examine heterogeneity in Chinese investment amounts across sectors, over the period 2005-2022. Given the limited availability of firm-level data, a parsimonious specification described in Equation 2.3 is estimated:

$$Inv_{ijt} = \beta_1 Oil_{jt} + \beta_2 Metals_{jt} + \beta_3 Gas_{jt} + \beta_4 Hydro_{jt} + \beta_5 Coal_{jt} + e_{it} \tag{2.3}$$

The dependent variable, $Inv$, measures the investment amount of Chinese firms in country $j$ at time $t$, expressed in billions of dollars. The explanatory variables are sectoral indicator variables taking the value of one if an investment is made in the corresponding sector, and zero otherwise. For example, *Oil* takes the value of one if the investment is in the oil sector, and zero otherwise. $Metals$, $Gas$, $Hydro$, and $Coal$ are constructed in the same way.

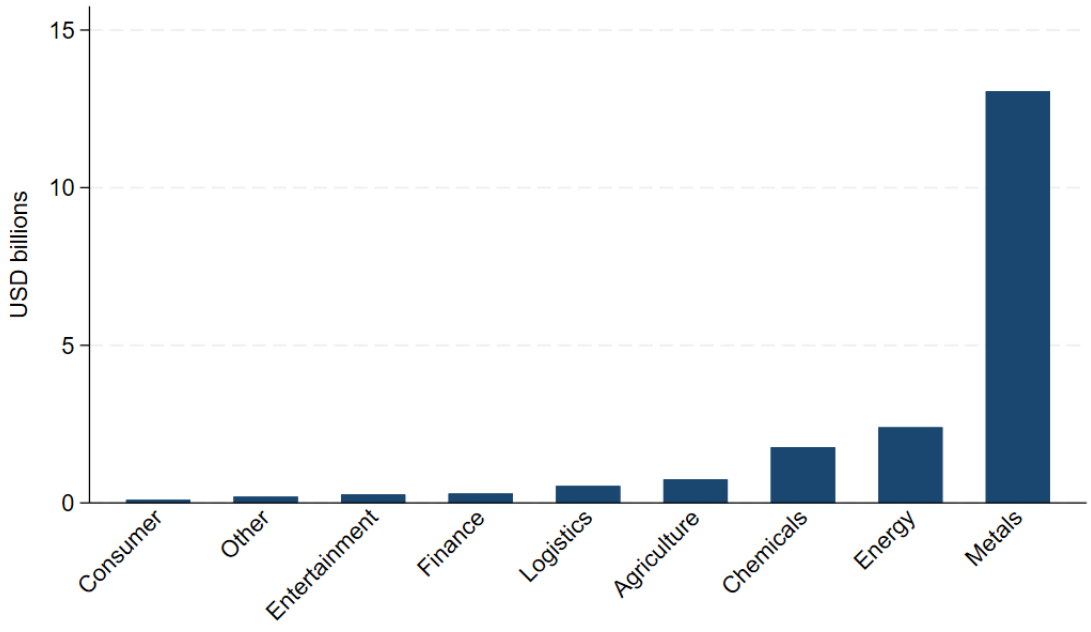
The sector indicators capture differences in average investment size across resource types rather than causal determinants of investment decisions. The results (Table 2.11) are consistent with the macroeconomic level evidence presented in previous sections. Further, we also introduce macroeconomic determinants in relation to Chinese firms investment flows. The results are described in Table 2.12. In this latter table, we notice that metals and gas remain significant and positive, while hydro and coal lose significance. As for oil, if we compare the robustness check results with the baseline ones, we observe an increase in the oil coefficient after the introduction of country controls. This suggests that oil-rich countries might exhibit systematic macroeconomic and structural characteristics that are negatively correlated with Chinese FDI. Once these factors are accounted for in in Table 2.12, the positive association between oil endowments and investment becomes stronger, indicating that the baseline specification might have underestimated the oil-related behavior of Chinese FDI.

Figure 2.2: Chinese firms investment in the world by sub-sector, over 2005-2022



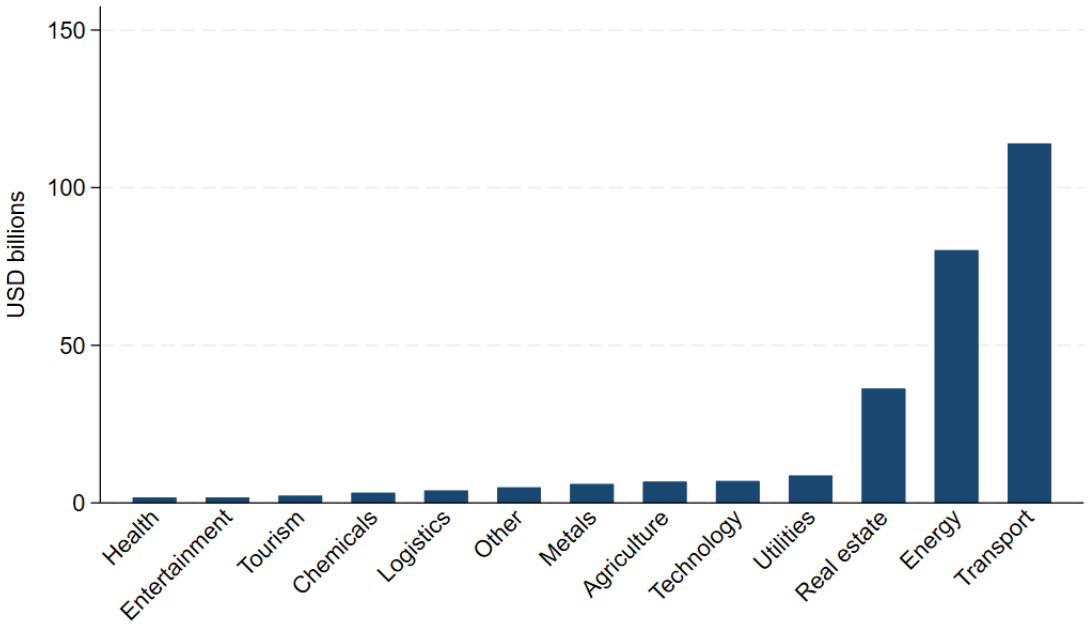

Authors' elaboration. Data source: American Enterprise Institute: China Global Investment Tracker

Figure 2.3: Chinese firms investment in Africa by sectors, over 2005-2022 (1/2)




Authors' elaboration. Data source: American Enterprise Institute : China Global Investment Tracker

Figure 2.4: Chinese firms investment in Africa by sectors, over 2005-2022 (2/2)




Authors' elaboration. Data source: American Enterprise Institute : China Global Investment Tracker

Table 2.11: Firm level analysis: baseline scenario

| | (1) FDI | (2) FDI | (3) FDI | (4) FDI | (5) FDI | (6) FDI |
|---|---|---|---|---|---|---|
| Oil | -1.720 | | -1.720** | -0.166 | -0.0871 | -0.0813 |
| | (-1.33) | | (-2.14) | (-0.22) | (-0.12) | (-0.11) |
| Metals | | 4.608*** | 4.608*** | 5.221*** | 5.602*** | 5.630*** |
| | | (8.12) | (8.44) | (11.05) | (11.92) | (8.67) |
| Gas | | | | 4.291*** | 4.510*** | 4.526*** |
| | | | | (4.54) | (5.03) | (4.81) |
| Hydro | | | | | 3.668** | 3.636** |
| | | | | | (2.51) | (2.32) |
| Coal | | | | | | -0.0605 |
| | | | | | | (-0.06) |
| $N$ | 101 | 101 | 101 | 101 | 101 | 101 |
| $R^2$ | 0.952 | 0.980 | 0.982 | 0.988 | 0.990 | 0.990 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 2.12: Chinese firms' investment in Africa and country characteristics

| | (1) FDI | (2) FDI | (3) FDI | (4) FDI | (5) FDI |
|---|---|---|---|---|---|
| Oil | 1.873*** | 1.921*** | 1.997*** | 2.223*** | 2.209*** |
| | (3.36) | (3.43) | (3.41) | (3.60) | (3.53) |
| Metals | 0.740* | 0.771* | 0.845* | 0.985* | 0.969* |
| | (1.88) | (1.95) | (1.92) | (1.99) | (1.92) |
| Gas | 1.445** | 1.029 | 1.167 | 1.225 | 1.215 |
| | (2.23) | (1.47) | (1.60) | (1.47) | (1.45) |
| Hydro | 0.156 | 0.199 | 0.561 | 0.844 | 0.857 |
| | (0.24) | (0.30) | (0.69) | (1.01) | (1.01) |
| Coal | -0.144 | -0.147 | 0.0191 | -0.0106 | 0.0131 |
| | (-0.34) | (-0.35) | (0.04) | (-0.02) | (0.03) |
| Trade openness | | 0.00500 | 0.00469 | 0.00563 | 0.00553 |
| | | (0.75) | (0.66) | (0.79) | (0.77) |
| Inflation | | | -0.00525 | -0.00471 | -0.00479 |
| | | | (-0.54) | (-0.49) | (-0.50) |
| Infrastructure | | | | 0.00787** | 0.00891 |
| | | | | (2.15) | (1.54) |
| GDP per head | | | | | -0.0000319 |
| | | | | | (-0.23) |
| $N$ | 101 | 96 | 84 | 82 | 82 |
| $R^2$ | 0.432 | 0.438 | 0.480 | 0.519 | 0.520 |
| Fixed effect | Yes | Yes | Yes | Yes | Yes |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| | lconflicts | lconflicts | lconflicts | lconflicts | lconflicts | lconflicts | lconflicts |
| mine_all_ln | 0.420* | 0.229 | 0.246 | 0.336 | 0.509* | 0.564* | 0.581 |
| | (0.228) | (0.233) | (0.264) | (0.221) | (0.291) | (0.329) | (0.387) |
| pop2000_ln | | 1.898* | 1.757 | 0.571 | 0.908 | 2.299 | 2.290 |
| | | (1.068) | (1.316) | (1.246) | (1.383) | (2.015) | (2.331) |
| light2000_ln | | | -0.0380 | -0.312 | -0.726 | -0.995 | -1.013 |
| | | | (0.213) | (0.271) | (0.517) | (0.635) | (0.754) |
| logForestloss | | | | -0.309 | -0.142 | -0.0229 | -0.0110 |
| | | | | (0.272) | (0.294) | (0.304) | (0.308) |
| areakm_ln | | | | | -0.855 | -1.361 | -1.403 |
| | | | | | (0.809) | (1.001) | (1.169) |
| port_dummy | | | | | | 1.710 | 1.725 |
| | | | | | | (1.655) | (1.946) |
| variationtemp | | | | | | | 0.0926 |
| | | | | | | | (0.695) |
| Constant | 1.200*** | -27.98* | -25.95 | -4.468 | -3.182 | -21.40 | -21.01 |
| | (0.447) | (16.43) | (19.92) | (20.34) | (21.92) | (29.54) | (33.85) |
| Observations | 74 | 74 | 74 | 60 | 60 | 60 | 60 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| | lconflicts | lconflicts | lconflicts | lconflicts | lconflicts | lconflicts | lconflicts |
| mine_all_ln | 0.157 | 0.0451 | 0.0525 | 0.116 | 0.135 | 0.140 | 0.140 |
| | (0.107) | (0.0819) | (0.0747) | (0.110) | (0.164) | (0.170) | (0.169) |
| pop2000_ln | | 1.450*** | 1.372*** | 0.349 | 0.406 | 0.752 | 0.769 |
| | | (0.227) | (0.270) | (0.587) | (0.552) | (0.622) | (0.627) |
| light2000_ln | | | -0.0299 | -0.209** | -0.250 | -0.261 | -0.260 |
| | | | (0.0484) | (0.101) | (0.204) | (0.222) | (0.222) |
| logForestloss | | | | -0.192 | -0.157 | -0.0937 | -0.0883 |
| | | | | (0.156) | (0.159) | (0.163) | (0.157) |
| areakm_ln | | | | | -0.102 | -0.176 | -0.183 |
| | | | | | (0.397) | (0.441) | (0.429) |
| port_dummy | | | | | | 0.474 | 0.479 |
| | | | | | | (0.354) | (0.352) |
| variationtemp | | | | | | | -0.0656 |
| | | | | | | | (0.248) |
| Constant | 0.486* | -22.04*** | -20.93*** | -3.174 | -3.447 | -8.828 | -9.075 |
| | (0.289) | (3.532) | (4.188) | (10.50) | (10.18) | (10.74) | (10.89) |
| Observations | 74 | 74 | 74 | 60 | 60 | 60 | 60 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

## 2.6 Conclusion

This paper examines whether Chinese foreign direct investment (FDI) in Africa has responded to the changing demand for natural resources associated with the energy transition. Using Chinese Ministry of Commerce data (2000–2018) and the China Global Investment Tracker (2005–2022), we find that Chinese FDI is positively associated with mineral and natural gas endowments, while oil resources are negatively associated with investment. These patterns are robust across the two datasets.

The results are consistent with a shift in China's overseas investment toward resources that are increasingly important for the deployment of low-carbon technologies. The positive link with mineral resources reflects the growing importance of critical inputs for the energy transition, whereas the positive association with natural gas is consistent with its role as a transition fuel. The negative association with oil suggests that China's outward investment has evolved alongside changes in its domestic energy and environmental policies. At the same time, the positive effects of trade openness and macroeconomic stability indicate that conventional investment determinants continue to shape Chinese FDI in Africa.

These findings contribute to the literature on the determinants of Chinese FDI by highlighting the role of the energy transition in shaping international investment patterns. They also suggest that the growing demand for critical minerals may reinforce the strategic importance of resource-rich African economies. An important avenue for future research is to examine whether this reallocation of investment generates broader economic and environmental benefits for host countries, particularly through technology transfer, industrial development, and the governance of extractive industries.

# 2.7 Appendix

## 2.7.1 Tables

Table 2.A.1: Summary statistics - Macroeconomic analysis

| | Count | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| Resource rents | 570 | 11.028 | 9.019 | 0.193 | 55.875 |
| Oil rents | 570 | 3.830 | 9.087 | 0.000 | 55.407 |
| Natural gas rents | 570 | 0.252 | 0.749 | 0.000 | 4.382 |
| GDP per head | 570 | 7.138 | 0.887 | 5.555 | 8.973 |
| Trade openness | 521 | 4.069 | 0.512 | 0.259 | 5.027 |
| Inflation | 513 | 1.651 | 1.128 | -3.305 | 5.784 |
| Infrastructure | 560 | 3.012 | 1.849 | -4.012 | 5.099 |
| Government Stability | 570 | 8.316 | 1.507 | 4.458 | 11.583 |
| Internal Conflict | 570 | 8.375 | 1.421 | 2.958 | 12.000 |
| External Conflict | 570 | 9.768 | 1.306 | 3.958 | 12.000 |
| Corruption | 570 | 2.036 | 0.741 | 0.000 | 4.000 |
| Religious Tensions | 570 | 4.016 | 1.376 | 0.000 | 6.000 |
| Ethnic Tensions | 570 | 3.285 | 1.008 | 0.000 | 5.000 |
| *N* | 570 | | | | |

Table 2.A.2: Countries included in the sample for the macroeconomic level analysis

| | |
|---|---|
| Algeria | Mozambique |
| Angola | Malawi |
| Botswana | Namibia |
| Côte d'Ivoire | Niger |
| Cameroon | Nigeria |
| Ethiopia | Sudan |
| Gabon | Senegal |
| Ghana | Sierra Leone |
| Guinea | Togo |
| Guinea-Bissau | Tunisia |
| Kenya | Tanzania |
| Liberia | Uganda |
| Morocco | South Africa |
| Madagascar | Zambia |
| Mali | Zimbabwe |

Table 2.A.3: Correlation Matrix of Macroeconomic variables

| Variables | Resource rents | Oil rents | Natural gas rents | Mineral rents | GDP per head | Trade | Inflation | Infrastructure | FDI | Government Stability | Corruption |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Resource rents | 1.000 | | | | | | | | | | |
| Oil rents | 0.780 | 1.000 | | | | | | | | | |
| Natural gas rents | 0.255 | 0.303 | 1.000 | | | | | | | | |
| Mineral rents | 0.059 | -0.207 | -0.165 | 1.000 | | | | | | | |
| GDP per head | 0.053 | 0.452 | 0.150 | -0.054 | 1.000 | | | | | | |
| Trade openness | 0.178 | 0.156 | 0.101 | 0.172 | 0.202 | 1.000 | | | | | |
| Inflation | 0.202 | 0.093 | -0.045 | 0.051 | -0.091 | -0.080 | 1.000 | | | | |
| Infrastructure | -0.098 | 0.032 | 0.088 | 0.192 | 0.437 | 0.127 | -0.135 | 1.000 | | | |
| FDI | 0.168 | -0.070 | 0.108 | 0.181 | -0.142 | 0.209 | 0.112 | 0.051 | 1.000 | | |
| Government Stability | 0.007 | 0.114 | 0.003 | -0.103 | 0.070 | 0.183 | -0.060 | -0.363 | 0.042 | 1.000 | |
| Corruption | -0.215 | -0.202 | -0.086 | 0.104 | 0.100 | 0.287 | 0.027 | 0.037 | 0.085 | 0.252 | 1.000 |

Table 2.A.4: CD Pesaran Test

| Variable | CD-test | p-value | Average Joint T | Mean $\rho$ | Mean $\lvert\rho\rvert$ |
|---|---|---|---|---|---|
| FDI | 3.844 | 0.000 | 19.00 | 0.04 | 0.27 |
| Inflation | 6.376 | 0.000 | 15.51 | 0.08 | 0.29 |
| Infrastructure | 86.401 | 0.000 | 18.34 | 0.97 | 0.97 |
| Government Stability | 48.998 | 0.000 | 19.00 | 0.54 | 0.55 |
| Internal Conflict | 11.694 | 0.000 | 19.00 | 0.13 | 0.35 |
| External Conflict | 10.652 | 0.000 | 19.00 | 0.12 | 0.45 |
| Corruption | 4.719 | 0.000 | 19.00 | 0.05 | 0.40 |
| Law and Order | 2.171 | 0.030 | 19.00 | 0.02 | 0.23 |
| Ethnic Conflict | 2.673 | 0.008 | 19.00 | 0.03 | 0.24 |
| Resource Rents | 18.111 | 0.000 | 19.00 | 0.20 | 0.33 |
| Oil Rents | 6.900 | 0.000 | 19.00 | 0.08 | 0.13 |
| Natural Gas Rents | 6.803 | 0.000 | 19.00 | 0.07 | 0.09 |
| Mineral Rents | 27.075 | 0.000 | 19.00 | 0.30 | 0.33 |

Table 2.A.5: Summary Statistics

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Inv (billions USD) | 101 | 708.614 | 881.833 | 100 | 4990 |
| Log Inv | 101 | 6.0160 | 1.0064 | 4.6052 | 8.5152 |
| Metals | 101 | 0.6337 | 0.4842 | 0 | 1 |
| Oil | 101 | 0.3663 | 0.4842 | 0 | 1 |
| Hydro | 101 | 0.0297 | 0.1706 | 0 | 1 |
| Coal | 101 | 0.0792 | 0.2714 | 0 | 1 |
| Gas | 101 | 0.0495 | 0.2180 | 0 | 1 |

Table 2.A.6: List of Chinese companies involved in overseas projects (101 observations)

| Obs | Company |
|---|---|
| 1 | China Petroleum and Chemical (Sinopec) |
| 2 | China Nonferrous Metal Mining |
| 3 | China National Off-shore Oil (CNOOC) |
| 4 | Sinosteel |
| 5 | China International Trust and Investment (CITIC), Aluminum Corporation of China (Chinalco) |
| 6 | China National Petroleum Corp. (CNPC) |
| 7 | Ex-Im Bank |
| 8 | Sinosteel |
| 9 | China National Petroleum Corp. (CNPC) |
| 10 | Shenzhen Energy, China Development Bank |
| 11 | MCC, Sinohydro |
| 12 | China Railway Engineering |
| 13 | China National Nuclear |
| 14 | Wuhan Iron and Steel, China Development Bank |
| 15 | China Nonferrous Metal Mining |
| 16 | China National Petroleum Corp. (CNPC) |
| 17 | China National Petroleum Corp. (CNPC) |
| 18 | China National Petroleum Corp. (CNPC) |
| 19 | Jinchuan Group, China Development Bank |
| 20 | Bosai Minerals |
| 21 | China Railway Construction |
| 22 | Anhui Foreign Economic Construction |
| 23 | China Minmetals |
| 24 | CITIC, China Development Bank, Long March Capital |
| 25 | Sinosteel |
| 26 | China Petroleum and Chemical (Sinopec) |
| 27 | China National Petroleum Corp. (CNPC) |
| 28 | Shandong Iron |
| 29 | China National Petroleum Corp. (CNPC) |

*Continued on next page*

| Obs | Company |
|---|---|
| 30 | Gold One |
| 31 | Jinchuan Group |
| 32 | China National Machinery Industry (Sinomach) |
| 33 | China Nonferrous Metal Mining |
| 34 | Hebei Steel, General Development, Tewoo |
| 35 | Beijing Jingmei |
| 36 | Aluminum Corporation of China (Chinalco) |
| 37 | China Petroleum and Chemical (Sinopec) |
| 38 | China Power Investment |
| 39 | China Copper Mines |
| 40 | Aluminum Corporation of China (Chinalco) |
| 41 | Anhui Foreign Economic Construction |
| 42 | China National Petroleum Corp. (CNPC) |
| 43 | China National Off-shore Oil (CNOOC) |
| 44 | Kingho Energy |
| 45 | Yunnan Copper-led consortium |
| 46 | Anhui Foreign Economic Construction |
| 47 | China Petroleum and Chemical (Sinopec) |
| 48 | China Petroleum and Chemical (Sinopec) |
| 49 | China General Nuclear Power |
| 50 | Zhenfa New Energy Science |
| 51 | China Nonferrous Metal Mining |
| 52 | Solargiga |
| 53 | China Energy Engineering |
| 54 | Hebei Zhongbo Platinum |
| 55 | Hongqiao |
| 56 | China National Nuclear |
| 57 | Guodian |
| 58 | Qingdao Hengshun |
| 59 | Shenzhen Energy, China Development Bank |
| 60 | Zhejiang Huayou Cobalt |

*Continued on next page*

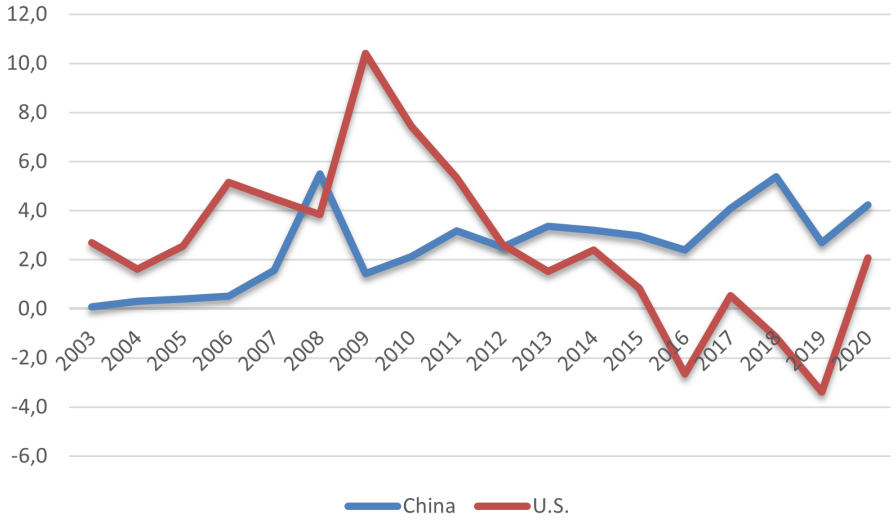
| Obs | Company |
|---|---|
| 61 | Zijin Mining |
| 62 | PowerChina, China Railway Construction |
| 63 | Shandong Iron |
| 64 | Jiangxi International Cooperation Corp |
| 65 | China Molybdenum |
| 66 | CEFC China Energy |
| 67 | China Molybdenum |
| 68 | China Nonferrous Metal Mining |
| 69 | Tidfore Heavy Equipment |
| 70 | Shenyang Lan Sa |
| 71 | Aluminum Corporation of China (Chinalco) |
| 72 | Aluminum Corporation of China (Chinalco) |
| 73 | Sinosteel |
| 74 | Hanrui Cobalt, Qingyuan Keweike Mineral |
| 75 | China Poly |
| 76 | China Petroleum and Chemical (Sinopec) |
| 77 | China Petroleum and Chemical (Sinopec) |
| 78 | Zhejiang Huayou Cobalt |
| 79 | Tebian Electric Apparatus (TBEA) |
| 80 | China National Nuclear |
| 81 | Tebian Electric Apparatus (TBEA) |
| 82 | China Energy Engineering, PowerChina, Sinopec |
| 83 | Power Construction Corp. (PowerChina) |
| 84 | China Molybdenum, Contemporary Amperex |
| 85 | China Nonferrous Metal Mining |
| 86 | China Molybdenum |
| 87 | Zijin Mining |
| 88 | Three Gorges |
| 89 | Jiangxi Ganfeng |
| 90 | Tsingshan Holding |
| 91 | Zhejiang Huayou Cobalt |

*Continued on next page*

| Obs | Company |
|---|---|
| 92 | China National Off-shore Oil (CNOOC) |
| 93 | Zijin Mining |
| 94 | Chengtun Mining |
| 95 | Contemporary Amperex Tech |
| 96 | Chifeng Jilong |
| 97 | Zhejiang Huayou Cobalt |
| 98 | China Petroleum and Chemical (Sinopec) |
| 99 | China Nonferrous Metal Mining |
| 100 | China Nonferrous Metal Mining |
| 101 | China Minmetals |

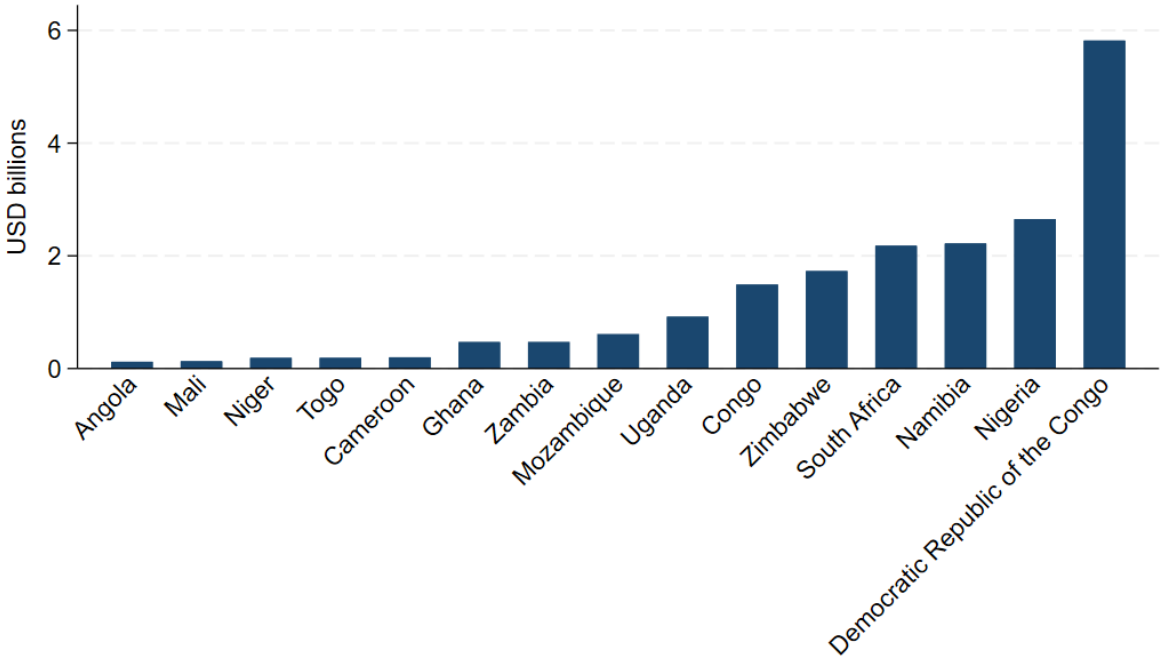
### 2.7.2 Figures

Figure 2.A.1: Chinese FDI net flow vs. US FDI net flow to Africa (in billion USD)




Source : Authors' elaboration. Data source: China Africa Research Initiative

Figure 2.A.2: China investments in Africa by country




Source: Own elaboration. Data source: American Enterprise Institute - China Global Investment Tracker

# Chapter 3

## Chapter 3

# We can't ignore the elephant in the room : cobalt, conflicts, and energy transition in DRC

## 3.1 Introduction

The rapid acceleration of climate change and the global energy transition have brought critical natural resources, particularly cobalt[1], to the forefront of geopolitical and economic debates ( Herrington (2021); Hund et al. (2020)). Criticality is an approach based on the evaluation of risks associated with the production, utilization or end-of-life management of a raw material ( Graedel and Nuss (2014)). A raw material is considered critical when it is used in industrial sectors, difficult to substitute in the short term, has many industrial applications, has a high economic value and its reserves and production are geographically concentrated. Cobalt has a high level of geological criticality, which must be taken into account. The primary risk associated with cobalt is geopolitical, due to potential supply issues, as mining production is concentrated in the Democratic Republic of Congo (DRC), a country with a historically highly unstable political environment. This rising demand can spark significant tensions in this country which supplies over 70% of the world's cobalt(World Bank (2021) ; Buchholz and Brandenburg (2018)).

While the literature on resource-related conflicts is extensive, it has primarily focused on oil, diamonds, and gold, documenting their socio-economic and environmental consequences through quantitative analyses (Ross, 2004). By contrast, relatively little attention has been paid to conflicts associated with critical minerals required for the energy transition, such as cobalt. The few existing studies tend to be qualitative in nature, lacking a robust quantitative framework to assess the conflict dynamics linked to these critical resources necessary for the energy transition. Our hypothesis is that cobalt mining activities in the Democratic Republic of Congo (DRC) might exacerbate conflict dynamics, with both artisanal and industrial mining contributing to regional instability. We argue that the presence of cobalt mining might increase the likelihood of conflict (due to competition over resource rents, weak governance, and illicit activities).

The resource curse (Brunnschweiler and Bulte (2008), Collier and Hoeffler (2004)) provides a theoretical framework, suggesting that natural resource dependence in fragile governance contexts heightens conflict risks. This can be due to economic incentives for armed groups to control valuable mining sites, governance weaknesses that allow disputes over mining rights to escalate, local grievances stemming from environmental degradation and displacement, and the financing of armed groups through illicit mining activities. Additionally, the geopolitical significance of cobalt, crucial for the global energy transition, may intensify local tensions. Within this framework, putting a particular focus on Dube and Vargas

[1]Cobalt is a key component in the production of lithium-ion batteries, which are essential for green technologies, including electric vehicles (EVs) and renewable energy storage systems (Matthews (2020)).It is present in the magnets of wind turbines, but also and especially in the cathodes of lithium-ion batteries and nickel metal.

(2013) hypothesis could provide additional explanations. This hypothesis, known as Vargas' hypothesis, suggests that artisanal mining, being labor-intensive, provides alternative livelihoods that reduce the opportunity cost of joining armed groups, thereby lowering conflict risk. In contrast, industrial mining is capital-intensive, generates fewer local jobs, and concentrates rents, which can push marginalized populations toward armed groups, increasing the likelihood of conflict.

Within this framework, our study aims to deepen the understanding of how resources fuel conflict in resource-rich but fragile states like the DRC. We do so by employing a quantitative approach that leverages probabilistic models to evaluate the impact of cobalt extraction on conflict dynamics in the Democratic Republic of Congo. Historically, this region has been marred by violent conflict, massive population displacement, and millions of deaths (Stearns (2012)). Moreover, cobalt mining in the DRC is largely dominated by foreign corporations, particularly Chinese companies, which control approximately 80% of global production (Mancheri et al. (2019); Gulley (2023)). As the race for technological supremacy intensifies, especially among major powers like China, the U.S., and the European Union, geopolitical competition over access to cobalt could exacerbate existing conflicts or even spark new ones, as countries and corporations seek to secure their long-term supply chains. The research questions guiding this chapter are : Do mining activities fuel conflicts in the Democratic Republic of Congo (DRC) ? How does cobalt production specifically influence conflict dynamics ? Can we validate Vargas'[2] hypothesis in this context ?

These questions are important because the existing literature on resource-related conflicts predominantly focuses on traditional strategic minerals like oil, gas, or even gold, while cobalt remains underexplored despite its rising significance in the global energy transition. Cobalt's distinct characteristics, including its critical role in battery technology and the dual nature of its extraction (both artisanal and industrial), pose unique risks for conflict and geopolitical tension. The resource's demand is expected to surge as part of the transition toward low-carbon economies, raising concerns about the implications for local communities in cobalt-rich regions. Our study stands out by taking a comprehensive approach to analyze conflict dynamics at the provincial level across the entire DRC, rather than limiting the focus to areas with known industrial cobalt mining. This approach allows us to consider the potential impact of artisanal mining activities, which may not be officially recorded but could still influence regional conflict patterns. The use of panel data methods enables us to control for fixed effects across provinces, providing a more accurate representation of the relationship between mining and conflicts while addressing

[2]The Vargas Hypothesis suggests that artisanal mining, being labor-intensive, provides alternative livelihoods that reduce the opportunity cost of joining armed groups, thereby lowering conflict risk. In contrast, industrial mining is capital-intensive, generates fewer local jobs, and concentrates rents, which can push marginalized populations toward armed groups, increasing the likelihood of conflict

potential endogeneity issues. By testing Vargas' hypothesis in this context (Dube and Vargas (2013)), we aim to understand whether the violence linked to mining spreads in a manner consistent with economic incentives or whether other factors, such as governance quality, local grievances, or illicit activities, are more relevant drivers. The analysis incorporates key conflict determinants identified in the literature, such as climatic conditions and natural resource availability, to develop predictive models that assess the likelihood of conflict escalation in the DRC. The results shows that conflict in the DRC is driven by the combined effects of valuable mineral resources (especially cobalt and gold), environmental stressors and socio-economic pressures. Mining activities intensify violence through competition for deposits, financing of armed groups and severe ecological impacts. Rainfall variability, deforestation and pollution further exacerbate resource scarcity and local grievances, while population density and the presence of oil and gas heighten tensions. Taken together, these factors reveal a multidimensional conflict system in which natural resources, environmental degradation and governance weaknesses interact, underscoring the need for integrated strategies combining responsible resource management, community empowerment and stronger international due diligence mechanisms. By situating our findings within the broader context of the global energy transition, this study highlights how resource competition driven by green technology development may influence the trajectory of violence in resource-rich, conflict-prone regions. Our contribution lies not only in addressing a gap concerning cobalt-related conflicts but also in refining our understanding of the mechanisms linking resource extraction to violence, thus providing insights that could inform policy responses in high-risk areas.

## 3.2 Literature Review

Natural resource conflicts have been extensively studied in the literature for a while , even if the mechanisms linking natural resources and conflict remain poorly understood, and scholars disagree on both the scale and direction of this relationship. Variations in empirical findings are often driven by the type of resource being examined, as resources differ greatly in terms of their origin (renewable vs. non-renewable), their importance to human life (ranging from essential needs like water to luxury items like diamonds), their market value, and the degree to which they can be easily exploited or lootable. A common assumption is that scarcity of renewable resources and abundance of non-renewable ones both increase the likelihood of violence (Koubi et al. (2014)). However, recent empirical and qualitative studies challenge this distinction, suggesting that the abundance of renewable resources can also heighten the risk of conflict ( Brown (2010), 2010; Hendrix and Salehyan (2012); Theisen (2012)). Furthermore, these differences in results cannot be solely attributed to resource type. These conflicts can arise for various

reasons, including unequal access to resources, competition over their use, environmental degradation,and climate change. Unequal access to natural resources is frequently identified as a major cause of conflict. Marginalized groups and impoverished communities often have limited access to these resources, which can lead to conflicts with other groups over control or use (Adano et al. (2012)). Additionally, competition for resource use can exacerbate tensions. Conflicts can emerge between different economic sectors, such as agriculture, fishing, and mining, as they compete for land, water, and mineral resources (Conca and Dabelko (2002)). Environmental degradation is another significant source of conflict. Water and air pollution, deforestation, and soil erosion can negatively impact local communities that depend on these resources for their livelihoods. In such cases, conflicts may arise as these communities seek to protect their environment and secure access to vital resources ( Chapin et al. (2005)). Moreover, climate change has increasingly been recognized as a potential driver of conflict. The effects of climate change, including droughts, floods, and storms, can disrupt natural resources and local livelihoods, leading to competition and conflict over resource access (Nordås et al. (2015)). While the literature on resource-based conflicts is extensive, relatively few studies have specifically focused on mineral's and no one on the impact of strategic minerals like cobalt on conflict dynamic. For example, Berman et al. (2017) combines georeferenced data on the extraction of 14 minerals without taking into account the strategic metals needed for the energy transition. The minerals he used in his analysis are : Bauxite (aluminum), Coal, Copper, Diamond, Gold,Iron, Lead, Nickel, Platinum, Phosphate, Silver, Tantalum (Coltan), Tin, and Zinc. These minerals are present in 92 variations in global mineral prices, the results show that rising mineral prices significantly increase local conflict. The commodity super-cycle may explain up toone-fourth of the average violence level in African countries during the period. The study also shows that armed groups' control of mining areas can escalate conflicts from local to global levels and examines the role of corporate practices and transparency initiatives in mitigating these effects. Unlike gold and diamonds, which are largely consumed for luxury goods and investment purposes, cobalt is essential for technological and energy-related advances, making it a strategic resource that could intensify existing conflicts or spark new ones. Conflicts in the Democratic Republic of Congo (DRC) stem from a range of economic, environmental, and social factors. As the second-largest country in the world, the DRC wealth in minerals has historically fueled environmental degradation and violent conflict, exacerbating its ongoing humanitarian crisis since the country is rich in natural resources, including timber, oil, gas, gold, and diamonds, as well as critical minerals like cobalt and copper that are essential for the global energy transition.

## 3.3 Background and stylized facts

### 3.3.1 Country Context: The Democratic Republic of the Congo

The Democratic Republic of Congo (DRC), is one of Africa's most resource-rich countries, with vast reserves of minerals and natural resources. The country is globally renowned for its mining industry, particularly for the extraction of copper, cobalt, niobium, tin, silver, diamonds, tantalum (coltan), manganese, uranium, and coal. Despite this wealth, the DRC, home to some of the world's most biodiverse ecosystems, faces significant development challenges. With approximately 3.5 million metric tons of cobalt reserves (Figure 3.A.2 and Figure 3.A.4), the DRC plays a key role in the global shift toward electrification and decarbonization, as minerals like cobalt and copper are essential components of electric vehicle batteries, solar panels, and wind turbines. While this natural wealth positions the country to attract foreign investment, generate revenue, and create jobs, large-scale resource extraction comes with severe consequences, such as ecosystem destruction and pollution. Additionally, poor governance in the extractive industries exacerbates existing social and economic inequalities. The DRC has experienced repeated cycles of violence over the past decades, with natural resources playing a significant role in fueling these conflicts (Figure 3.2). Reports from the United Nations Group of Experts highlight how the mining sector substantially finances armed groups in the country. The extraction of these resources also places immense pressure on the biodiversity of the DRC, leading to extensive environmental damage. Poaching, pollution, deforestation, and soil erosion are all direct consequences of resource exploitation, seriously threatening the unique ecosystems of the country. As the world's largest producer of cobalt, the largest mines in the Democratic Republic of the Congo are located in the southern Katanga province, producing millions of tons of copper and cobalt ore annually. Additionally, the DRC is Africa's leading producer of copper, holding 80% of the world's coltan reserves and nearly 30% percent of global diamond reserves. The DRC is estimated to have approximately 24 trillion worth of untapped mineral deposits, solidifying its status as a mineral rich nation (Jansson (2011)).

The Democratic Republic of Congo (DRC) shares borders with nine other countries, including Uganda, Rwanda, Burundi, Tanzania, Zambia, Angola, the Republic of Congo, and the Central African Republic (Figure 3.1). The country is the second-largest country in Africa by area, with a total area of 2,344,858 $km^2$, divided into 11 provinces from 1966 to 2015 and 26 provinces since 2015, and the fourth-largest population in the African continent, with an estimated population of over 100 million people. Based on the available data, we have kept the administrative division of 1966 - 2015 with the 11 regions. The climate of the DRC is mainly tropical, with high temperatures and significant humidity (Figure 3.A.3). The

country is also rich in natural resources, including minerals such as copper, cobalt, and diamonds. Since its independence in 1960, the DRC has faced numerous challenges, including armed conflicts, economic crises, and disease outbreaks such as HIV/AIDS and Ebola. However, the country has also experienced periods of stability and development, and has a rich cultural and historical heritage

### 3.3.2 Stylized facts

Conflict in the Democratic Republic of Congo (DRC) was caused by a combination of factors, including access to natural resources, ethnic and political competition, and regional instability. One of the main factors was access to natural resources, particularly minerals such as coltan, gold and diamonds, which are used in electronics and other high-tech industries around the world. Armed groups used these resources to finance their war, controlling the mines and selling them on international markets. Ethnic and political competition was also an important factor, particularly between the Hutu and Tutsi ethnic groups. Tensions were exacerbated by the 1994 Rwandan genocide, when Hutu extremists killed approximately 800,000 Tutsis and moderate Hutus in Rwanda. Many Hutu refugees fled to Congo, creating a humanitarian crisis that contributed to instability in the region. Finally, regional instability was another important factor. Several neighbouring countries, including Uganda and Rwanda, supported armed groups in the conflict to protect their interests and expand their influence in the region. In sum, the war in the DRC was caused by a complex combination of factors, including access to natural resources, ethnic and political competition and regional instability, all of which contributed to the escalation of the conflict. The Mutanda mine is an open pit copper and cobalt mine owned by Glencore, a major Anglo-Swiss commodity trading, brokering and mining company, located in the province of Katanga, in the southeastern part of the Democratic Republic of the Congo, and is the largest cobalt mine in the world. The importance of cobalt in the energy transition and the resulting surge in demand and prices in global markets could lead to a repeat of historic events ?

## 3.4 Methodology and Data

### 3.4.1 Methodology

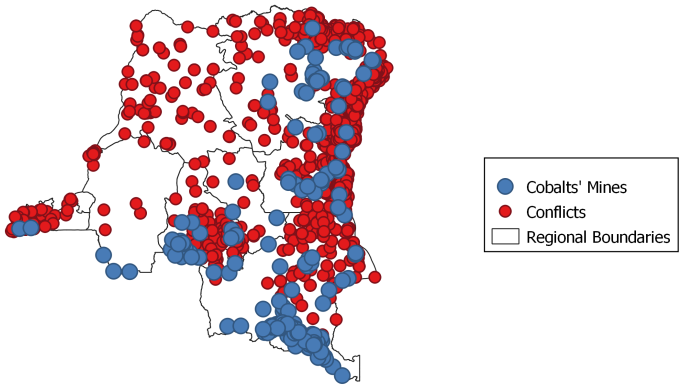
This section highlights the empirical strategy adopted to determine the determinants of conflicts in DRC. Previous studies investigating the impact of climate change on conflict have primarily utilized panel data models, as opposed to cross-sectional models, due to their superior advantages Miguel et al. (2004) ;

Figure 3.1: Geospatial depiction of the study region within Africa's continental boundaries




Source : Author's elaboration Data source: Global Administrative Area Database (GADM)

Figure 3.2: Spatial distribution of conflicts and cobalt mine in the DRC




Source : Author's elaboration Data source: Global Administrative Area Database (GADM) , S&P Global Market Intelligence (cobalt mines) and ACLED (conflicts)

Raleigh and Kniveton (2012) ; Hsiang and Burke (2014) ; Buhaug et al. (2014); Von Uexkull (2014) ; Burke et al. (2015). Panel data models are advantageous as they consider both the temporal and individual dimensions, which is not possible in cross-sectional models. Hence, we can formulate the model as follows :

$$Conflicts_{it} = \beta_1 Cobalt_{it} + \beta_2 Precipitation_{it} + \beta_2 Temperature_{it} + \beta_3 \triangle X_{it} +_i + \varphi_t + e_{it} \tag{3.1}$$

Where $i$ represents each region according to the administrative division of DRC from 1963 to 2015 and t the time. This gives us a total of 11 regions (table 3.A.4) over a period of 31 years (1990 to 2021). Conflict is a binary variable equal to 1 if at least one conflict event is recorded in a region in a given year and 0 otherwise. The variable Mines is defined as the logarithm of the total number of mining facilities located in each subnational region, using data from the United States Geological Survey's Mineral Resources Data System (USGS, 2005). Population is measured using regional population estimates derived from the high-resolution spatial population dataset developed by the Center for International Earth Science Information Network (CIESIN). Area, measured in square kilometers, is computed directly from the shapefiles of subnational administrative boundaries. Additional control variables include oil and gas activity, forest loss, precipitation, and temperature, which respectively capture the presnece of oil or gas in the region, annual forest cover loss, annual rainfall, and average annual temperature over the study period. We also include temperature variation and precipitation variation, defined as the difference between the average temperature and precipitation observed in year t and those observed in year $t-1$, in order to capture short-term climatic shocks. The empirical specification is estimated using a conditional fixed-effects logit model, which controls for unobserved time-invariant regional characteristics while accounting for the binary nature of the dependent variable

### 3.4.2 Data

In order to analyze the determinants of conflicts in the Democratic Republic of Congo (DRC) and to investigate whether cobalt mining is or can be a contributing factor, we utilized a combination of multiple datasets. We first used in our main analysis data steming from Dreher et al. (2019) to make a global

analysis, restricting information to the Democratic Republic of Congo. This dataset contain for each region, the number of mines, the population, the surface area, precipitation, temperature and whether there is a port or oil&gas deposits in the region from 1999 to 2013.

The conflict data comprises approximately 5,500 conflicts occurring over a period of 33 years (1989-2021) and was sourced from ACLED. This dataset provides details on conflict locations, actors involved, number of fatalities, the type of violence, starting and ending date. We then constructed for the further analysis a panel dataset grouping the conflict data by the 11 regions of the DRC that were part of the administrative division from 1963 to 2015, and associated each region with cobalt production, climate data (Figure 3.A.3) such as average temperature and precipitation (provided by the World Bank) and deforestation data (provided by the Forest Global Watch) for each year which represents tree cover loss in hectares at the national level, between 2001 and 2020, classified by percentage of cover. Our variable of interest in the further analysis is our annual cobalt production in each region instead of mines in the main analysis .

## 3.5 Results

In order to determine the variables that positively influence conflict in the Democratic Republic of Congo, we first ran a logistic regression with the first data set from Dreher et al. (2019) to which we added climatic variables, where our conflict variable takes the value 1 if in this region and during the year in question there was a conflict. The results of the logistic regression (table 3.1 and table 3.2) show several significant relationships between the variables studied and the probability of conflict in the Democratic Republic of Congo (DRC). The Mines variable has a positive and significant coefficient in the majority of models, indicating that mining activity is strongly associated with an increase in the probability of conflict. This link can be explained by several factors : competition for resources, where mining intensifies the control struggle for natural resources leading to conflicts between different factions; environmental impact, as mining causes environmental damage affecting local livelihoods such as agriculture, creating social tensions; and the war economy, where mining resources finance armed groups, prolonging and intensifying conflicts. The coefficients for population density are very high and significant in all models, indicating a strong association between population density and conflict. This can be attributed to increased competition for scarce resources in densely populated areas, such as land, water, and food; exacerbated social and economic tensions in contexts of poverty and underdevelopment; and a broader recruitment base for armed groups in densely populated areas. The coefficients for Oil & Gas are also positive and significant,

indicating that the presence of these resources increases the likelihood of conflict. This phenomenon can be attributed to the covetousness and control of oil and gas resources as major economic assets, and the creation of significant economic rents attracting armed groups seeking to appropriate these revenues. Coefficients for precipitation are positive and significant, as higher rainfall is associated with increased conflict due to access and logistics challenges, where high rainfall makes access to mining areas more difficult, increasing competition and tensions for resource control, and agricultural impact, where rainfall affects agricultural production, exacerbating social tensions if crops are destroyed or flooding disrupts livelihoods. The coefficients for the variable "Port dummy" are significant and positive in all models, indicating a strong association between the presence of a port and the probability of conflict. The presence of a port increases the probability of conflict in the region, as ports are strategic transport points for exports and imports, including precious natural resources such as cobalt and oil. Control of these points can be a source of conflict between different armed groups or political factions seeking to monopolize revenues and power. In summary, our first analysis of the results indicates that conflict in the DRC is strongly influenced by mining activity, population density and the presence of oil and gas resources. Rainfall also plays a role, albeit a secondary one, by increasing logistical challenges and social tensions. Policies aimed at reducing conflict should therefore focus on managing natural resources and reducing demographic tensions, while taking environmental impacts into account.

Table 3.1: Logistic regression with Oil-Gas

| | (1) Conflicts | (2) Conflicts | (3) Conflicts | (4) Conflicts | (5) Conflicts | (6) Conflicts | (7) Conflicts | (8) Conflicts | (9) Conflicts |
|---|---|---|---|---|---|---|---|---|---|
| Mines | 0.494*** | 0.286* | 0.292* | 0.214 | 0.687*** | 0.587** | 0.738** | 0.905** | 0.908** |
| | (3.19) | (1.74) | (1.75) | (1.28) | (2.87) | (2.17) | (2.25) | (2.55) | (2.55) |
| Population | | 2.205*** | 2.045** | 4.001*** | 5.721*** | 5.675*** | 8.224*** | 9.059*** | 9.071*** |
| | | (3.01) | (2.46) | (3.33) | (3.83) | (3.78) | (4.06) | (4.14) | (4.14) |
| Area (in km) | | | 0.0709 | 0.0434 | -0.112 | -0.0715 | -0.352 | -0.453 | -0.450 |
| | | | (0.40) | (0.24) | (-0.55) | (-0.34) | (-1.30) | (-1.58) | (-1.56) |
| Oil & gas | | | | 2.205*** | 4.528*** | 4.432*** | 5.843*** | 6.586*** | 6.604*** |
| | | | | (2.64) | (3.56) | (3.50) | (3.53) | (3.62) | (3.62) |
| Precipitation | | | | | 0.0357*** | 0.0397*** | 0.0462*** | 0.0454*** | 0.0462*** |
| | | | | | (2.77) | (2.81) | (2.75) | (2.71) | (2.63) |
| Annual average mean temperature | | | | | | -0.0137 | -0.00456 | 0.0124 | 0.0118 |
| | | | | | | (-0.76) | (-0.20) | (0.49) | (0.46) |
| Forest loss | | | | | | | 0.00194 | 0.000698 | 0.000642 |
| | | | | | | | (0.19) | (0.07) | (0.06) |
| $\triangle$ *Temperature* | | | | | | | | -0.0217 | -0.0214 |
| | | | | | | | | (-1.44) | (-1.41) |
| $\triangle$ *Precipitation* | | | | | | | | | -0.00121 |
| | | | | | | | | | (-0.15) |
| Constant | -0.398 | -34.31*** | -32.69*** | -62.79*** | -90.52*** | -89.70*** | -127.3*** | -139.5*** | -139.6*** |
| | (-1.62) | (-3.04) | (-2.74) | (-3.53) | (-4.02) | (-3.97) | (-4.16) | (-4.22) | (-4.22) |
| $N$ | 135 | 135 | 135 | 135 | 135 | 135 | 117 | 117 | 117 |
| pseudo $R^2$ | 0.067 | 0.121 | 0.122 | 0.161 | 0.209 | 0.212 | 0.271 | 0.284 | 0.284 |

$t$ statistics in parentheses
* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 3.2: Logistic regression with Port dummy

| | (1) Conflicts | (2) Conflicts | (3) Conflicts | (4) Conflicts | (5) Conflicts | (6) Conflicts | (7) Conflicts | (8) Conflicts | (9) Conflicts |
|---|---|---|---|---|---|---|---|---|---|
| Mines | 0.494*** | 0.286 | 0.292 | 0.214 | 0.687*** | 0.587** | 0.738** | 0.905** | 0.908** |
| | (2.76) | (1.54) | (1.51) | (1.13) | (2.92) | (2.15) | (1.96) | (2.01) | (2.02) |
| Population | | 2.205*** | 2.045** | 4.001*** | 5.721*** | 5.675*** | 8.224*** | 9.059*** | 9.071*** |
| | | (2.95) | (2.43) | (3.38) | (3.07) | (3.11) | (2.77) | (2.60) | (2.61) |
| Area (in km) | | | 0.0709 | 0.0434 | -0.112 | -0.0715 | -0.352 | -0.453 | -0.450 |
| | | | (0.40) | (0.24) | (-0.56) | (-0.34) | (-1.20) | (-1.35) | (-1.33) |
| Port dummy | | | | 2.205** | 4.528*** | 4.432*** | 5.843** | 6.586** | 6.604** |
| | | | | (2.54) | (2.94) | (2.90) | (2.45) | (2.33) | (2.34) |
| Precipitation | | | | | 0.0357*** | 0.0397*** | 0.0462*** | 0.0454*** | 0.0462*** |
| | | | | | (2.86) | (3.22) | (2.98) | (2.96) | (2.86) |
| Annual average mean temperature | | | | | | -0.0137 | -0.00456 | 0.0124 | 0.0118 |
| | | | | | | (-0.92) | (-0.22) | (0.46) | (0.43) |
| Forest loss | | | | | | | 0.00194 | 0.000698 | 0.000642 |
| | | | | | | | (0.20) | (0.07) | (0.07) |
| $\triangle$ *Temperature* | | | | | | | | -0.0217 | -0.0214 |
| | | | | | | | | (-1.41) | (-1.38) |
| $\triangle$ *Precipitation* | | | | | | | | | -0.00121 |
| | | | | | | | | | (-0.17) |
| Constant | -0.398 | -34.31*** | -32.69*** | -62.79*** | -90.52*** | -89.70*** | -127.3*** | -139.5*** | -139.6*** |
| | (-1.58) | (-2.98) | (-2.70) | (-3.60) | (-3.21) | (-3.25) | (-2.81) | (-2.63) | (-2.64) |
| $N$ | 135 | 135 | 135 | 135 | 135 | 135 | 117 | 117 | 117 |
| pseudo $R^2$ | 0.067 | 0.121 | 0.122 | 0.161 | 0.209 | 0.212 | 0.271 | 0.284 | 0.284 |

$t$ statistics in parentheses
* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

## 3.6 Further analysis

### 3.6.1 Methodology and data

To assess the contribution of cobalt production to conflict dynamics in the Democratic Republic of Congo (DRC), we specify the following empirical equation 3.2 :

$$Nb\,Conflicts_{it} = \beta_1\,Cobalt_{it} + \beta_2\,Precipitation_{it} + \beta_2\,Temperature_{it} + \beta_3 \triangle X_{it} + {}_i + \varphi_t + e_{it} \tag{3.2}$$

Where i denotes a region according to the administrative division of the Democratic Republic of Congo (DRC), and t denotes time. The sample consists of 11 regions observed annually over the period 1990–2021. The dependent variable, Conflict, measures the number of conflict events recorded in region i during year t. The main explanatory variable of interest is Cobalt Production, defined as the annual regional production of cobalt. Control variables include Forest Loss, which captures annual forest cover loss in each region, Temperature, measured as the annual average mean temperature, and Precipita-

tion, measured as annual rainfall. To account for short-term climatic shocks, we also include Temperature Variation and Precipitation Variation, defined as the difference between the annual average temperature and precipitation in year t and their respective values in year $t-1$. Given the count nature of the dependent variable, the model controls for unobserved regional heterogeneity through regional fixed effects. These fixed effects capture time-invariant characteristics of regions that may influence the incidence of conflicts. Standard errors are clustered at the regional level to account for potential serial correlation within regions over time.

Our dataset combines information from several sources. Data on conflict events are obtained from the Armed Conflict Location  Event Data Project (ACLED). Unlike previous analysis that rely on a binary indicator of conflict occurrence, we use the number of conflict events recorded in a given region and year as our dependent variable. Data on cobalt and gold production are drawn from the S&P Global Market Intelligence (Gold and cobalt mines) , which provides detailed information on mining production at the regional level. Climate variables are sourced from the World Bank Climate Change Knowledge Portal (CCKP) and include annual average temperature and annual precipitation. We also compute temperature variation and precipitation variation, defined as the difference between the values observed in year t and those observed in year $t-1$ , in order to capture short-term climatic shocks. Finally, data on forest loss are obtained from the Global Forest Change database and measure annual forest cover loss at the regional level.

### 3.6.2 Results

In order to assess the determinants of conflict in the Democratic Republic of Congo in previous years, we used our self-constructed database, this time with a larger time dimension, from 1990 to 2021, but with few variables. We used OLS and PPML regression methods to estimate our model. Silva and Tenreyro (2006) shows that PPML outperfoms simple OLS with Tobit approaches with heteroskedasticity and many zero observations in the data. The findings indicate for our PPML estimation technics that climatic factors such as precipitation and forest loss, rather than cobalt mining, are the primary drivers of conflict in the DRC (table 3.3 and table 3.4). Precipitation can impact conflict in a variety of ways, some examples include competition for resources and forced migration. Indeed precipitation can affect the availability of water, which is a critical resource for agricultural and other activities Hendrix and Glaser (2007). During prolonged drought, conflicts can erupt between communities seeking access to limited water sources.

Regarding extreme rainfall events, such as floods, can destroy homes and infrastructure, as well as crops, forcing local people to migrate to other areas. This forced migration can lead to tensions between local communities and newcomers, all of whom seek access to limited resources. Concerning the impact on the economy , rainfall can impact agriculture and other economic sectors. For example, prolonged drought can reduce agricultural yields, which can lead to higher food prices and increased poverty. This in turn can lead to increased crime and conflict. About the perception of injustice, rainfall can also affect perceptions of injustice. For example, if some communities have access to high quality water sources, while others have to make do with contaminated or limited water sources, this can be perceived as unfair and lead to conflict. It is important to note that rainfall is not the only cause of conflict, but it can contribute to exacerbating tensions and creating conditions for conflict.

Loss of forest cover in the DRC can exacerbate conflict in a number of ways. Deforestation leads to a reduction in available natural resources, intensifying competition between local communities, ethnic groups and companies for access to remaining land and resources. It also causes the displacement of forest-dependent local populations, leading to tensions with established communities and land disputes. Deforestation disrupts the ecological balance, increasing flooding and reducing agricultural yields, exacerbating social and economic tensions. In addition, natural resources are often linked to armed conflict, with armed groups illegally exploiting forests to finance their activities, leading to violent conflicts over control of forest areas. Finally, deforestation affects the livelihoods of local populations, increasing poverty and social tensions. In short, the loss of forest cover in the DRC can exacerbate conflict by fuelling competition for resources, provoking displacement, upsetting the ecological balance, fuelling armed conflict and affecting the livelihoods of local populations.

These results are in perfect agreement with the real situation in sofar as cobalt has acquired a great notoriety only very recently and also in Katanga and Kasai Oriental, copper and cobalt mining is largely industrial, while in the two Kivus and in Ituri, the mines are organized on an artisanal basis.

Table 3.3: OLS and region fixed effects for cobalt production

| | (1) Nb Conflicts | (2) Nb Conflicts | (3) Nb Conflicts | (4) Nb Conflicts | (5) Nb Conflicts | (6) Nb Conflicts |
|---|---|---|---|---|---|---|
| Cobalt production | -0.276 | -0.273 | -0.257 | -0.0998 | 0.132 | 0.176 |
| | (-0.16) | (-0.16) | (-0.09) | (-0.03) | (0.04) | (0.06) |
| Precipitation | | 9.392 | 42.86 | 44.47 | 52.09 | 120.1** |
| | | (1.03) | (1.30) | (1.35) | (1.56) | (2.50) |
| Forest loss | | | 12.24*** | 12.34*** | 10.95** | 10.65** |
| | | | (2.72) | (2.75) | (2.40) | (2.35) |
| Annual Average Mean Temperature | | | | -18.85 | -32.00** | -32.09** |
| | | | | (-1.40) | (-2.00) | (-2.02) |
| $\triangle$ *Temperature* | | | | | 24.41 | 25.33 |
| | | | | | (1.50) | (1.56) |
| $\triangle$ *Precipitation* | | | | | | -0.0444* |
| | | | | | | (-1.96) |
| Constant | 16.40*** | -52.30 | -449.9* | -8.551 | 270.3 | -220.2 |
| | (6.39) | (-0.78) | (-1.88) | (-0.02) | (0.62) | (-0.44) |
| $N$ | 331 | 331 | 220 | 220 | 220 | 220 |
| $R^2$ | 0.000 | 0.003 | 0.048 | 0.057 | 0.067 | 0.085 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 3.4: PPML and region fixed effects for cobalt production

| | (1) Nb Conflicts | (2) Nb Conflicts | (3) Nb Conflicts | (4) Nb Conflicts | (5) Nb Conflicts | (6) Nb Conflicts |
|---|---|---|---|---|---|---|
| Cobalt production | -0.0315 | -0.0314 | -0.0284 | -0.0361 | -0.0356 | -0.0347 |
| | (-0.90) | (-0.89) | (-0.58) | (-0.70) | (-0.67) | (-0.65) |
| Precipitation | | 0.233*** | 2.672** | 2.712** | 2.708** | 8.254*** |
| | | (2.69) | (2.09) | (2.00) | (2.00) | (3.28) |
| Forest loss | | | 1.019*** | 1.248*** | 1.223*** | 1.257*** |
| | | | (4.00) | (3.85) | (3.28) | (3.61) |
| Annual Average Mean Temperature | | | | 0.731 | 0.651 | 0.770 |
| | | | | (1.14) | (0.92) | (1.12) |
| $\triangle$ *Temperature* | | | | | 0.171 | 0.317 |
| | | | | | (0.20) | (0.36) |
| $\triangle$ *Precipitation* | | | | | | -0.00350*** |
| | | | | | | (-2.70) |
| Constant | 3.595*** | 1.899*** | -28.58*** | -48.49** | -46.32** | -89.65*** |
| | (24.90) | (2.93) | (-2.73) | (-2.42) | (-2.01) | (-3.56) |
| $N$ | 331 | 331 | 220 | 220 | 220 | 220 |
| pseudo $R^2$ | 0.453 | 0.456 | 0.631 | 0.638 | 0.638 | 0.674 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 3.5: Logistic regression

| | (1) Conflicts | (2) Conflicts | (3) Conflicts |
|---|---|---|---|
| Cobalt production | 0.0501 | 0.0478 | 0.0198 |
| | (0.76) | (0.72) | (0.28) |
| Gold production | 1.454*** | 1.416*** | 1.279*** |
| | (11.57) | (10.80) | (9.75) |
| Precipitation | -1.795 | -1.889 | -3.125** |
| | (-1.50) | (-1.58) | (-2.12) |
| Forest loss | 0.115 | 0.127 | 0.155 |
| | (0.98) | (1.07) | (1.27) |
| $\triangle$ *Temperature* | | -0.859 | -0.852 |
| | | (-1.21) | (-1.20) |
| $\triangle$ *Precipitation* | | | 0.00144 |
| | | | (1.50) |
| Constant | 11.84 | 12.39 | 21.08** |
| | (1.41) | (1.48) | (2.05) |
| $N$ | 220 | 220 | 220 |
| pseudo $R^2$ | 0.023 | 0.028 | 0.036 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Even if cobalt production in the DRC does not significantly influence conflicts, other minerals might. Coltan, cassiterite, and gold have been identified as coveted minerals. According to Jacquemot* (2009), over the past fifteen years, a militarized and illicit extractive economy has taken root in the region, with its dynamics increasingly shaped by the exploitation and commercialization of three strategic minerals: coltan, cassiterite (tin oxide ore), and gold. Cobalt, rubies, semi-precious stones, tropical wood, meat, tea, quinine, and papain are considered ancillary resources. This leads us to establish the link between these coveted minerals and the conflicts during our period of study. To this end, we estimated our model by adding new control variables on gold production per year and per region, based on Jacquemot* (2009). The results obtained through Ordinary Least Squares (OLS) and Poisson Pseudo Maximum Likelihood (PPML) methods are consistent with those obtained previously. These results suggest that rainfall and loss of forest cover are significant factors that increase the likelihood of conflict in the DRC, while temperature variations show no significant relationship (table 3.A.1 and table 3.A.2). Stable rainfall also appears to play a role in reducing conflict.

The results indicate that environmental factors, such as rainfall and forest cover loss, have a more substantial impact on conflict than mineral production. This highlights the importance of addressing environmental degradation and its socio-economic impacts as part of conflict mitigation strategies. Our findings suggest that efforts to stabilize rainfall patterns and preserve forest cover could contribute to reducing conflict in the DRC.

Unfortunately, due to data limitations, we cannot verify the impact of other conflict minerals, such as diamonds, coltan, cassiterite (tin oxide ore), rubies, semi-precious stones, tropical woods, meat, tea, quinine, and papain, on the conflict in the Democratic Republic of Congo. Further research is necessary to fully understand the complex interactions between these resources and the persistent conflicts in the region. This underscores the importance of comprehensive data collection and analysis to better inform policies and interventions aimed at mitigating resource-related conflicts in the DRC. Expanding data availability on these ancillary resources could provide deeper insights into the dynamics of resource-driven conflicts and help tailor more effective conflict prevention and resolution strategies. We have verified the robustness of our results by running a logistic regression on the database we have constructed. This will enable us to determine which variables increase the probability of conflict in the Democratic Republic of Congo. The results (table 3.5) show that gold production is the variable that increases the likelihood of conflict in the DRC's regions. The regression analysis reveals a differentiated impact of natural resources on conflict dynamics. Cobalt production shows no significant effect, suggesting that, despite global demand, it has not yet emerged as a direct driver of past conflicts. By contrast, gold production consistently appears as a strong predictor of violence, confirming its role in financing armed groups and sustaining instability. These results are in line with the current situation in the DRC. It is widely acknowledged that rebel groups are more heavily engaged in artisanal gold mining Girard et al. (2022) than in cobalt extraction, largely because cobalt exploitation poses greater technical and logistical challenges : Vargas' hypothesis seems therefore verified.

The results of the analyses show several significant relationships between the variables studied and the probability of conflict in the DRC. Cobalt and gold production, taken individually, do not appear to have a significant effect on the probability of conflict. On the other hand, higher levels of rainfall and increased loss of forest cover are strongly associated with increased conflict. This may be explained by the fact that higher rainfall and deforestation exacerbate competition for natural resources and disrupt agricultural activities, thus creating social tensions. Although mean annual temperature does not have a significant direct effect on conflict.

The interaction between cobalt production and rainfall variations suggests that these regions may be more susceptible to tensions (table 3.6. Indeed The risks associated with rainfall and cobalt production in the DRC are significant, particularly as regards arsenic pollution. Rainfall in the DRC exacerbates the dispersion of pollutants, particularly arsenic, from cobalt mining. This pollution affects soil, water and local ecosystems, posing serious risks to human health, such as cancers and neurological disorders, as well as devastating environmental impacts on biodiversity. Contamination of agricultural land also com-

promises the food security of local communities. Rigorous mine waste management and environmental protection measures are therefore essential to minimize these risks.

Table 3.6: PPML and region fixed effects

| | (1) Conflicts events | (2) Conflicts events | (3) Conflicts events |
|---|---|---|---|
| Cobalt Production | 0.0262 | -0.0401 | -0.0360 |
| | (0.22) | (-0.79) | (-0.71) |
| Gold production | -0.0382 | 0.0217 | -0.0218 |
| | (-0.72) | (0.54) | (-0.60) |
| Precipitation | 2.721** | 2.676** | 2.704** |
| | (2.00) | (1.97) | (1.99) |
| Forest loss | 1.256*** | 1.265*** | 1.253*** |
| | (3.81) | (3.86) | (3.81) |
| Annual Average Mean Temperature | 0.736 | 0.764 | 0.746 |
| | (1.15) | (1.19) | (1.13) |
| Cobalt * Forest loss | -8.62e-08 | | |
| | (-0.61) | | |
| Cobalt * $\triangle$ *Precipitation* | | 0.000795* | |
| | | (1.74) | |
| Cobalt * $\triangle$ *Temperature* | | | -0.0304 |
| | | | (-0.44) |
| Constant | -48.77** | -49.21** | -48.82** |
| | (-2.42) | (-2.46) | (-2.40) |
| $N$ | 220 | 220 | 220 |
| pseudo $R^2$ | 0.638 | 0.639 | 0.638 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

## 3.7 Projection of Conflict Patterns in Cobalt Supply Chains

The analysis combines classical statistical methods and machine learning techniques to investigate the link between resource production and conflict probability in the context of the energy transition. Logistic regression results, based on fitted values, indicate that the probability of conflict is an increasing function of cobalt production (Figure 3.3 and Figure 3.A.5) and a decreasing function of gold production (Figure 3.4). The positive relationship with cobalt can be explained by its strategic role in green technologies, such as electric vehicle batteries and energy storage systems, which stimulates intensive mining and potentially heightens local tensions. In contrast, the negative relationship with gold production may reflect resource depletion or a declining economic interest in gold, which is less central to the current energy transition.

To reinforce these findings, we applied a Random Forest classifier, a non-parametric ensemble learning method that aggregates decision trees to improve predictive accuracy and capture nonlinear interactions. The model achieved an AUC of 0.81, (Figure 3.A.6) confirming its strong ability to discriminate between conflict-prone and non-conflict areas. This performance not only validates the statistical results obtained through logistic regression but also demonstrates the robustness of machine learning techniques

for analyzing complex socio-environmental dynamics.

Taken together, these results highlight that the increasing reliance on cobalt as a critical raw material in the energy transition is associated with heightened risks of conflict. These findings underline the importance of integrating conflict sensitivity into resource governance strategies to ensure that the transition towards renewable energy is both sustainable and socially responsible.

## 3.8 Analysis with Split data

The results indicate a significant shift in the relationship between cobalt production and conflict events in the Democratic Republic of Congo (DRC) before and after 2006. Prior to 2006, increased cobalt production was associated with a reduction in conflict events, suggesting a stabilizing effect. This effect can be linked to the relatively lesser importance of cobalt during that period, making it a less coveted resource. However, as cobalt production expanded substantially in the following years, this relationship changed, showing a weak positive association with conflict. The increase in cobalt's importance and market demand likely made it a more coveted resource, contributing to increased conflict events. This shift underscores the evolving dynamics in the mining sector and highlights the need for adaptive and responsive policies to manage resource production and mitigate conflict effectively.

Table 3.7: PPML and region fixed effects

| | Conflicts events Before 2006 | Conflicts events After 2006 |
|---|---|---|
| Cobalt production | -0.167*** | 0.0477* |
| | (-3.89) | (1.66) |
| Constant | 2.447*** | 4.274*** |
| | (15.49) | (28.66) |
| $N$ | 176 | 144 |
| pseudo $R^2$ | 0.340 | 0.605 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

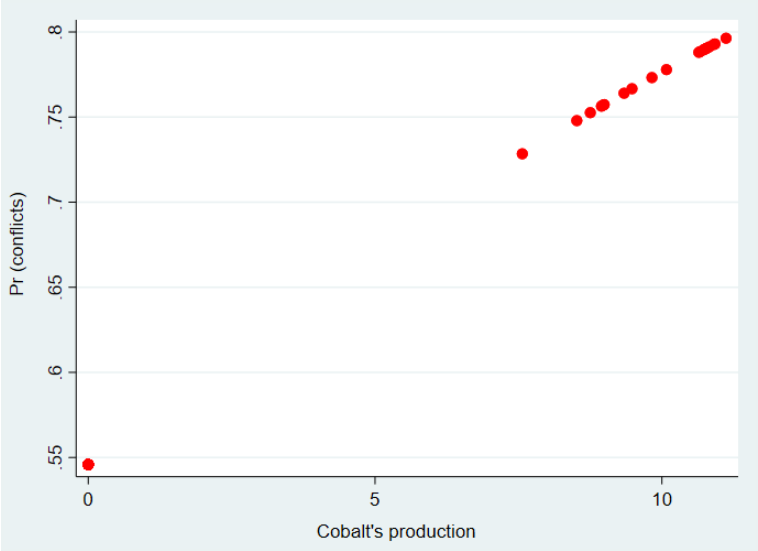
Table 3.8: PPML and region fixed effects

| | Conflicts events Year < or = 2006 | Conflicts events Year > 2006 |
|---|---|---|
| Cobalt production | -0.158*** | 0.0477* |
| | (-4.11) | (1.66) |
| Constant | 2.465*** | 4.274*** |
| | (16.53) | (28.66) |
| $N$ | 187 | 144 |
| pseudo $R^2$ | 0.356 | 0.605 |

$t$ statistics in parentheses

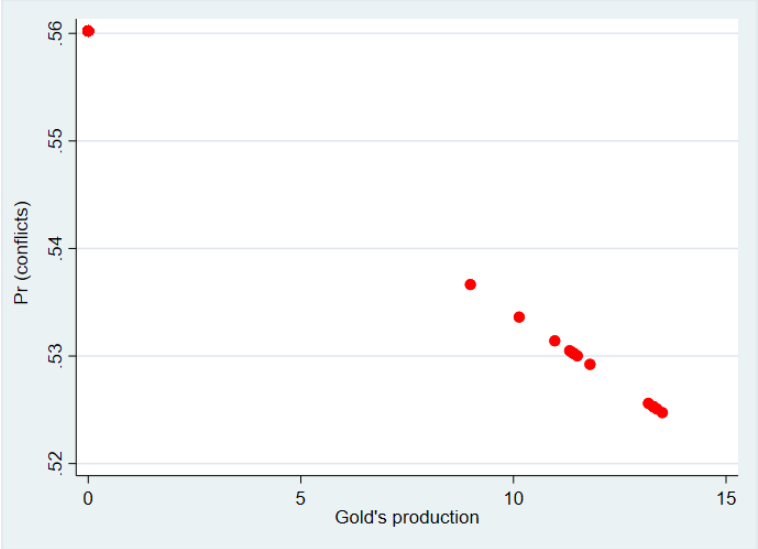
* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Figure 3.3: Prediction of the probability of conflicts associated with cobalt production.




Source : Author's elaboration

Figure 3.4: Prediction of the probability of conflicts associated with gold production.




Source : Author's elaboration

## 3.9 Conclusion and policy implication

This study examines the determinants of conflict in the Democratic Republic of the Congo, with particular attention to the roles of natural resources and environmental and economic conditions. The results indicate that mining activity, especially cobalt and gold extraction, is positively associated with conflict, consistent with the view that resource abundance can intensify competition over rents and generate conflicts. Population density, oil and gas resources, rainfall, deforestation, and proximity to ports also emerge as significant correlates of conflict, suggesting that both resource endowments and environmental conditions shape the spatial distribution of violence.

The findings highlight the importance of environmental change as an additional channel through which conflict may arise. Deforestation and climatic variability are associated with greater conflict risk, potentially through their effects on livelihoods, land use, and resource scarcity. These results highlight the interconnected nature of economic activity, environmental degradation, and conflict dynamics in resource-rich contexts. At the same time, the estimated relationships should be interpreted as associations rather than definitive causal effects, given the complexity of conflict processes and the possibility of remaining unobserved confounding factors.

From a policy perspective, the results suggest that reducing conflict requires an integrated approach combining improved natural resource governance, environmental protection, and stronger local institutions. Policies that promote transparency in mineral supply chains, strengthen environmental regulation, and ensure that resource revenues benefit local communities may help reduce incentives for violence. Expanding due diligence requirements to cover critical minerals such as cobalt could further enhance responsible sourcing practices and reduce the financing of armed groups through mineral extraction.

Although our empirical analysis establishes a relationship between cobalt production and conflict intensity in the Democratic Republic of Congo (DRC), it does not directly test the mechanisms through which this relationship operates. Future research could further investigate the mechanisms linking resource extraction, environmental change, and conflict, with particular attention to local institutional capacity, the role of global mineral supply chains, and the heterogeneous effects of different mineral resources. Such work would contribute to a better understanding of the conditions under which natural resource development can support economic development without increasing the risk of conflict and help identify more effective policy interventions.

The discussion of these potential channels suggests several policy areas that could be explored in future research. Government regulations aimed at improving transparency in mineral supply chains, interna-

tional initiatives promoting responsible mining practices, and sustainable development programs may contribute to mitigating conflict risks associated with cobalt production. Likewise, future studies could investigate whether fluctuations in global cobalt prices, local socioeconomic conditions, or the presence of armed groups mediate the relationship between cobalt extraction and violence.

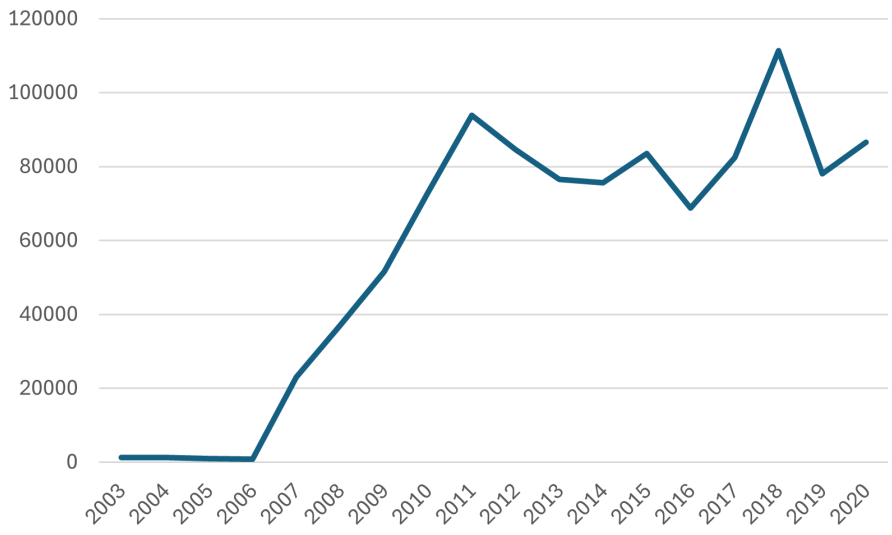
Environmental concerns also deserve further attention. In particular, future research could examine the extent to which pollution associated with cobalt extraction, including arsenic contamination, affects local livelihoods and indirectly contributes to social tensions. Understanding these environmental dimensions would help provide a more comprehensive assessment of the broader impacts of cobalt mining in the DRC.

Hence, further work is needed to identify and test the mechanisms through which natural resource extraction affects conflict, in order to improve our understanding of the processes underlying these relationships.

## 3.10 Appendix

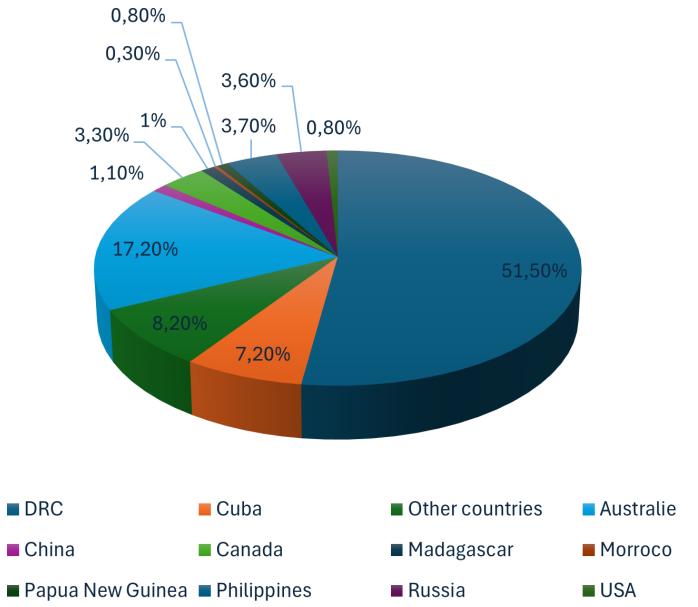
### 3.10.1 Figure

Figure 3.A.1: Annual cobalt production in the DRC (tonnes)




Source: Author's elaboration Data source: Ministry of Mines of the DRC

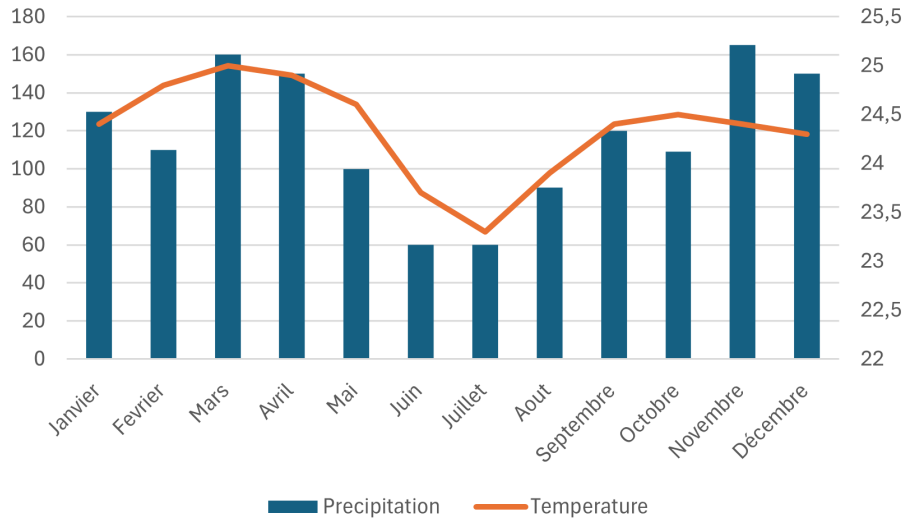
Figure 3.A.2: Global cobalt reserves by country (share in %)




Source : Author's elaboration Data source: Natural resources canada [a]

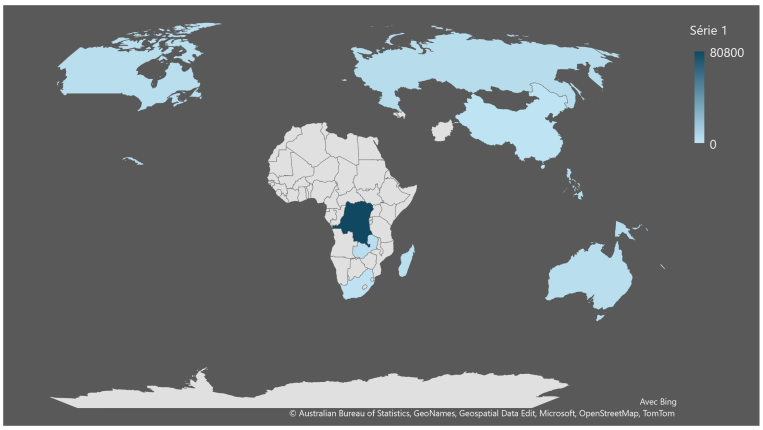
[a]https://natural-resources.canada.ca/minerals-mining/mining-data-statistics-analysis/minerals-metals-facts/cobalt-facts

Figure 3.A.3: Climatology of Mean-Temperature and Precipitation in DRC from 1991-2020




Source : Author's elaboration Data source: World Bank Climate Change Knowledge Portal

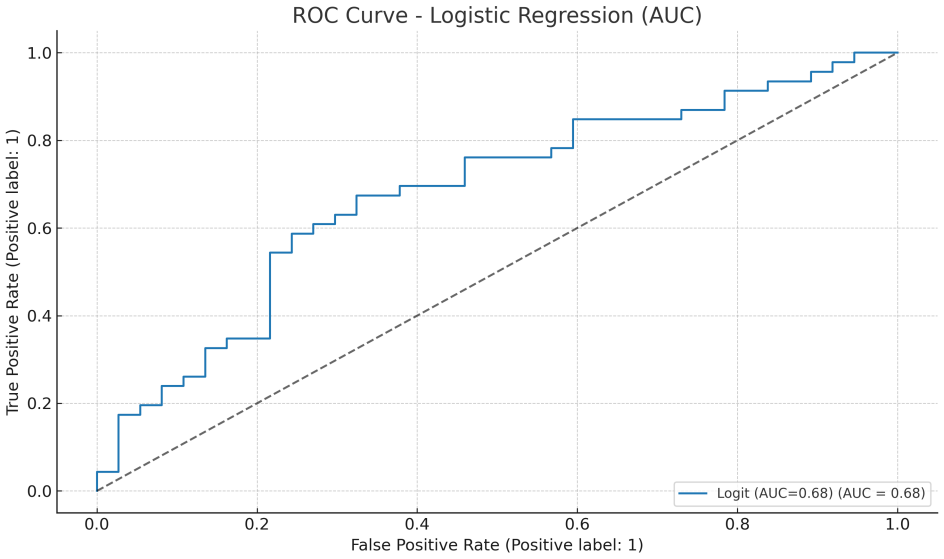
Figure 3.A.4: Map of major cobalt's producers in the world in 2020




Source : Author's elaboration Data source: Natural resources canada [a]

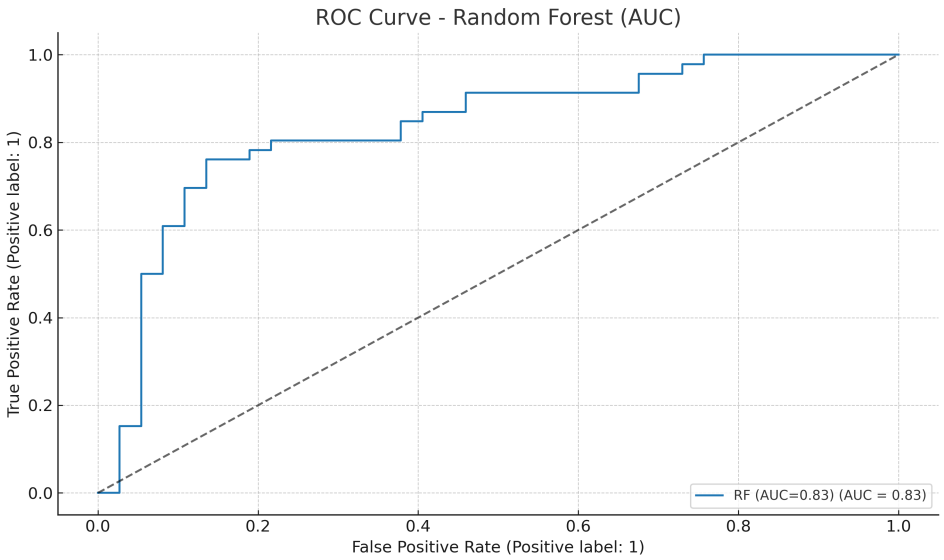
[a]https://natural-resources.canada.ca/minerals-mining/mining-data-statistics-analysis/minerals-metals-facts/cobalt-facts

Figure 3.A.5: Prediction using machine learning techniques : Logistic Regression




Author's elaboration

Figure 3.A.6: Prediction using machine learning techniques : Random Forest




Author's elaboration

### 3.10.2 Table

Table 3.A.1: OLS and region fixed effects for Gold production

| | (1) Conflicts events | (2) Conflicts events | (3) Conflicts events | (4) Conflicts events | (5) Conflicts events | (6) Conflicts events |
|---|---|---|---|---|---|---|
| Gold production | -0.183 | -0.169 | 0.361 | 0.486 | 1.562 | 1.456 |
| | (-0.16) | (-0.15) | (0.08) | (0.10) | (0.32) | (0.30) |
| Precipitation | | 9.379 | 42.85 | 44.47 | 52.29 | 120.2** |
| | | (1.03) | (1.30) | (1.35) | (1.57) | (2.50) |
| Forest loss | | | 12.27*** | 12.38*** | 10.99** | 10.69** |
| | | | (2.73) | (2.76) | (2.41) | (2.36) |
| Annual Average Mean Temperature | | | | -18.89 | -32.46** | -32.50** |
| | | | | (-1.41) | (-2.02) | (-2.04) |
| $\triangle$ *Temperature* | | | | | 25.15 | 26.00 |
| | | | | | (1.53) | (1.59) |
| $\triangle$ *Precipitation* | | | | | | -0.0443* |
| | | | | | | (-1.95) |
| Constant | 16.34*** | -52.27 | -450.4* | -7.981 | 279.4 | -211.1 |
| | (6.68) | (-0.78) | (-1.88) | (-0.02) | (0.64) | (-0.42) |
| $N$ | 331 | 331 | 220 | 220 | 220 | 220 |
| $R^2$ | 0.000 | 0.003 | 0.048 | 0.057 | 0.068 | 0.085 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 3.A.2: PPML and region fixed effects for Gold production

| | (1) Conflicts events | (2) Conflicts events | (3) Conflicts events | (4) Conflicts events | (5) Conflicts events | (6) Conflicts events |
|---|---|---|---|---|---|---|
| Gold production | -0.0445** | -0.0447** | -0.0250 | -0.0108 | -0.00419 | 0.000730 |
| | (-2.28) | (-2.29) | (-0.77) | (-0.30) | (-0.09) | (0.01) |
| Precipitation | | 0.234*** | 2.673** | 2.715** | 2.710** | 8.259*** |
| | | (2.69) | (2.09) | (2.00) | (2.00) | (3.28) |
| Forest loss | | | 1.020*** | 1.247*** | 1.222*** | 1.256*** |
| | | | (4.00) | (3.84) | (3.28) | (3.61) |
| Annual Average Mean Temperature | | | | 0.726 | 0.646 | 0.764 |
| | | | | (1.14) | (0.92) | (1.12) |
| $\triangle$ *Temperature* | | | | | 0.173 | 0.319 |
| | | | | | (0.20) | (0.37) |
| $\triangle$ *Precipitation* | | | | | | -0.00350*** |
| | | | | | | (-2.70) |
| Constant | 3.592*** | 1.895*** | -28.61*** | -48.40** | -46.21** | -89.54*** |
| | (24.89) | (2.92) | (-2.74) | (-2.42) | (-2.01) | (-3.56) |
| $N$ | 331 | 331 | 220 | 220 | 220 | 220 |
| pseudo $R^2$ | 0.454 | 0.457 | 0.631 | 0.638 | 0.638 | 0.674 |

$t$ statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 3.A.3: List of provinces in the Democratic Republic of Congo since 2015

| **Provinces** |
|---|
| Bas-Uélé |
| Haut-Uélé |
| Ituri |
| Tshopo |
| Bas-Congo (Kongo-Central) |
| Kwango |
| Kwilu |
| Mai-Ndombe |
| Kinshasa |
| Kasaï |
| Kasaï-Central |
| Kasaï-Oriental |
| Lomami |
| Sankuru |
| Haut-Lomami |
| Lualaba |
| Haut-Katanga |
| Nord-Kivu |
| Sud-Kivu |
| Maniema |
| Tanganyika |
| Mongala |
| Nord-Ubangi |
| Sud-Ubangi |
| Équateur |
| Tshuapa |

Table 3.A.4: List of former provinces of the Democratic Republic of Congo from 1966 to 2015, used for the study

| **Provinces** | **Code ISO** |
|---|---|
| Bandundu | CD-BN |
| Bas-Congo | CD-BC |
| Équateur | CD-EQ |
| Kasaï-Occidental | CD-KW |
| Kasaï-Oriental | CD-KE |
| Katanga | CD-KA |
| Kinshasa | CD-KN |
| Maniema | CD-MA |
| Nord-Kivu | CD-NK |
| Orientale | CD-OR |
| Sud-Kivu | CD-SK |

Table 3.A.5: Descriptive statistics of our database combined with Axel Dreher's database

| **Variable** | **N** | **Mean** | **Sd** | **Min** | **Max** |
|---|---|---|---|---|---|
| Conflicts events | 135 | 41.56168 | 0 | 0 | 424 |
| Conflicts | 135 | 0.5481481 | 0.4995299 | 0 | 1 |
| Mines | 135 | 12.33333 | 28.08436 | 0 | 91 |
| Population | 135 | 5639678 | 1659014 | 3122871 | 8950579 |
| Area (in km) | 135 | 260384.2 | 170600.1 | 11051.63 | 505005.9 |
| Port dummy | 135 | 0.1111111 | 0.3154401 | 0 | 1 |
| Oil & Gas | 135 | 0.1111111 | 0.3154401 | 0 | 1 |
| Forest loss | 117 | 642950.1 | 574186.5 | 5194 | 2695198 |
| N | 135 | | | | |

Table 3.A.6: Descriptive statistics of the self-constructed database

| **Variable** | **N** | **Mean** | **Sd** | **Min** | **Max** |
|---|---|---|---|---|---|
| Conflicts events | 331 | 16.24773 | 48.53901 | 0 | 459 |
| Conflicts | 331 | 0.5589124 | 0.4972689 | 0 | 1 |
| Précipitation | 331 | 1925.571 | 7857.757 | 960.99 | 144411.2 |
| Annual Average Mean Temperature | 331 | 24.07205 | 1.374943 | 21.15 | 25.83 |
| Cobalt production | 331 | 1684.251 | 8509.776 | 0 | 67448 |
| Gold production | 331 | 11350.59 | 76715.55 | 0 | 730000 |
| Forest Loss | 220 | 559276.8 | 568905.3 | 5194 | 2695198 |
| $\triangle$ *Temperature* | 331 | -0.0038066 | 0.2197326 | -1.02 | 0.73 |
| $\triangle$ *Precipitation* | 331 | 422.5465 | 7852.901 | -901.9 | 142829.5 |
| Region id | 331 | 6.126888 | 3.184561 | 1 | 11 |
| N | 331 | | | | |

Table 3.A.7: Correlation matrix of the self-constructed database

| | Conflicts events | Conflicts | Précipitation | AAMT | Cobalt production | Gold production | Forest loss |
|---|---|---|---|---|---|---|---|
| Conflicts events | 1.0000 | | | | | | |
| Conflicts | 0.2978* | 1.0000 | | | | | |
| Precipitation | 0.0351 | 0.0453 | 1.0000 | | | | |
| Annual Average Mean Temperature | -0.3101* | -0.3103* | -0.0957 | 1.0000 | | | |
| Cobalt production | -0.0302 | 0.0651 | -0.0176 | -0.1464* | 1.0000 | | |
| Gold production | -0.0464 | -0.1201* | -0.0092 | 0.0756 | -0.0291 | 1.0000 | |
| Forest loss | 0.0472 | 0.0587 | 0.3436* | 0.3336* | 0.0526 | -0.0280 | 1.0000 |

Table 3.A.8: Correlation matrix of our database combined with Axel Dreher's database

| | Conflicts events | Conflicts | Mines | Population | Area (in km) | Port dummy | Forest loss | Oil&gas |
|---|---|---|---|---|---|---|---|---|
| Conflicts events | 1.0000 | | | | | | | |
| Conflicts | 0.3276 | 1.0000 | | | | | | |
| Mines | 0.0027 | 0.1632 | 1.0000 | | | | | |
| Population | 0.4271 | 0.4607 | 0.2839 | 1.0000 | | | | |
| Area (in km) | 0.1220 | 0.2911 | 0.4733 | 0.5843 | 1.0000 | | | |
| Port dummy | -0.0991 | -0.0907 | -0.1432 | -0.5384 | -0.4283 | 1.0000 | | |
| Forest loss | -0.1200 | -0.0056 | -0.0000 | 0.0403 | 0.5402 | -0.2481 | 1.0000 | |
| Oil&gas | -0.0991 | -0.0907 | -0.1432 | -0.5384 | -0.4283 | 1.0000 | -0.2481 | 1.0000 |

# Chapter 4

# Chapter 4

# Greening or greenwashing : Is China going green in Africa ?

Co-written with Asbath Alassani

## 4.1 Introduction

In recent years, the sustainable development agenda has emerged as a strategic policy for African economies. Although the sustainable development agenda is designed to balance economic growth, social equity and environmental sustainability, the various recent crises are challenging durability and jeopardizing the achievement of sustainable development. To finance development, African countries often resort to attracting foreign investment. Foreign Direct investment (FDI) can therefore be considered as an important and strategic source for achieving development and responding to the needs of populations. The economic literature has largely shown the impact of FDI on the economy. Globally, FDI can facilitate technology spillovers (Liu, 2008; Bwalya, 2006), contributes to human capital formation (Noorbakhsh et al., 2001), facilitates integration into international trade (Aizenman and Noy, 2006), helps create a more competitive business climate, improves business development, and can improve environmental and social conditions in the host country (Hansen and Rand, 2006; Li and Liu, 2005; Opoku et al., 2021) (e.g. by transferring "cleaner" technologies and by encouraging companies to have more socially responsible policies). Overall, this can promote economic growth and poverty reduction, and there considered to be in line with sustainable policies.

As the above literature points out, attracting FDI can positively affect sustainable development. However, foreign direct investments are not without negative externalities on environmental sustainability, and more broadly on climate change. Looking at the ecological dimension, FDI can have both favourable and adverse effects on the environment. Mahmood et al. (2020) investigated the role of FDI and concluded that FDI accelerates environmental degradation. Narula (2012); Aust et al. (2020) emphasize in their studies that FDI can have a positive influence on greenhouse gas emissions. Overall, it is important to note that differences in regulatory frameworks, environmental standards, and labor requirements across countries of origin of FDI may lead to heterogeneity in the environmental and social performance of foreign-invested projects in host countries.

China has been a significant contributor of foreign direct investment (FDI) in Africa (Togbetse and Turcu (2023*a*)). In 2009, it overtook the United States and France to become the continent's largest trading partner (Shinn and Eisenman (2012) and Figure 2.A.1). As FDI plays a crucial role in promoting sustainable development, it is imperative that such investments align with global efforts to address climate change and attain sustainable development goals. However, the environmental and social implications of Chinese investment in Africa remain the subject of considerable debate. While foreign direct investment (FDI) can contribute to economic development through capital inflows, technology transfer, and employment creation, it may also generate environmental and social challenges depending on the characteristics of the investment, the sector involved, and the host country's institutional context. The mixed evidence reported in the literature likely reflects differences in study contexts, data, empirical methodologies, and the indicators used to measure environmental and social outcomes.

This study looks at the impact of Chinese investment on sustainable development in Africa by measuring sustainable development through the ecological efficiency of human development, an index created by (Hickel, 2020) as a proxy for sustainable development. We provide a first step towards understanding the effects of Chinese investment on sustainable development in Africa and highlight the need for further research in this area. In this line, we aim to answer the following questions: How does Chinese FDI affect sustainable development in Africa ? Does institutional quality and regulatory quality play a role in determining the effect of Chinese FDI on sustainable development in Africa ? Is the impact of Chinese FDI on sustainable development in Africa dependent on the presence of natural resource wealth ? By answering these questions, this study aims to provide insights into the factors that influence the impact of Chinese FDI on sustainable development in Africa, and to inform policy decisions that promote responsible investment practices.

To estimate the relationship between foreign direct investments and sustainable devel-

opment, we employ a multi-step econometric approach. Specifically, we use firstly the Driscoll and Kraay estimator to address cross-sectional dependence between panels. Secondly, the fixed-effects Tobit model to account for the limited range of the dependent variable. And finally, the Generalized Method of Moments (GMM) system and instrumental variables technics to control for unobserved heterogeneity and simultaneity bias. A sample of 45 African countries over the period 1996 to 2019 was used. Our results indicate that Chinese FDI might have a positive effect on sustainable development in Africa.

The following section presents the literature review. Section 3 presents some stylised facts. Further, Section 4 describes the methodology and data, while Section 5 presents the empirical results. Section 6 analyses the robustness of our results. Finally, Section 7 concludes and presents the main policy recommendations.

## 4.2 Literature Review

Foreign direct investment and its relationship with sustainable development have been the subject of growing scholarly attention, even though the mechanisms linking FDI inflows to economic, social, and environmental outcomes remain only partially understood. Evidence on the relationship remains mixed, with estimates differing in both sign and magnitude across studies. This heterogeneity largely reflects differences in measures of sustainable development, the sectoral composition of FDI inflows, and the institutional and environmental regulatory frameworks of host countries.

On the one hand, it is considered that FDI can contribute positively to host-country development by providing capital, technology, and managerial know-how, thus facilitating progress towards the Sustainable Development Goals (SDGs) (Fang (2021); Aust et al. (2020)). On the other hand, the literature highlights potential negative effects, such as environmental degradation or unequal regional benefits (Ayamba et al. (2020); Kardos (2014)). Empirical research on the role of China is rather scarce, despite the country's

emergence over the past decade as one of Africa's largest providers of both development aid and FDI (Togbetse and Turcu (2023*a*) ;Togbetse and Turcu (2023*b*)). Fang (2021) applies a panel data random effects model and an ordered probit framework to assess China's FDI impact on SDGs across Africa, grouping them into social, economic, and environmental dimensions. The results suggest that Chinese FDI contributes positively to SDG achievement overall. Similarly, Gohou and Soumaré (2012) find a strong and significant relationship between FDI inflows per capita and the Human Development Index (HDI) in Africa, although with marked regional disparities: the relationship is positive and significant in Central and East Africa, non-significant in Northern and Southern Africa, and ambiguous in West Africa.

The relationship between FDI and environmental sustainability is less clear-cut. For example, in the case of European countries, it was suggested that environmental performance can be both a determinant and an outcome of FDI flows, with "green FDI" showing the potential to enhance sustainability outcomes (Kardos, 2014). In China, Ayamba et al. (2020) show that, in the long run, FDI has a negligible impact on environmental quality but helps bridge gaps in physical capital, while confirming the "pollution halo" hypothesis. They also observe that environmental pollutants such as sulfur dioxide, smoke, and dust deter FDI inflows in the short term, though this effect weakens with the adoption of advanced technologies. Beyond host-country case studies, Sauvant and Mann (2019) review 150 instruments, including treaties, standards, and codes to identify common and emerging sustainability principles in FDI governance, covering economic, social, environmental, and governance dimensions. Their findings underline a convergence of expectations among governments, intergovernmental organizations, and multinational enterprises (MNEs) regarding FDI's role in promoting sustainable development. Focusing on Africa, Aust et al. (2020) analyze 44 countries and find that FDI positively influences SDG performance in areas such as basic infrastructure, clean water, sanitation, and renewable energy, while its effect on climate action (SDG13) is negative. This duality reflects the broader debate in the literature: while FDI can act as a catalyst for economic and social progress, it

may simultaneously generate environmental risks if not guided by stringent sustainability policies. As such, the consensus that emerges is not that FDI is inherently beneficial or harmful, but that its contribution to sustainable development depends critically on host-country governance, sectoral allocation, and the integration of environmental safeguards into investment frameworks.

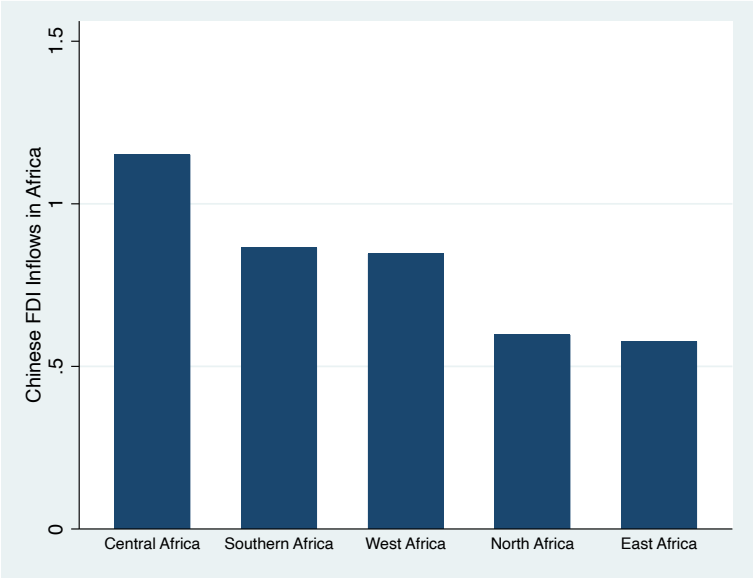
## 4.3 Stylized facts

In this section, we present some stylized facts that characterize the sustainable development index and FDI flows from China to Africa between 1996 and 2019. Figure 4.1 shows the distribution at the regional level in terms of Chinese FDI flows. We observe that Central Africa is the region that receives the most FDI from China. And East Africa is the region receiving the lowest amont of flows. Figure 4.2 illustrates the evolution of Chinese FDI inflows to Africa between 2000 and 2024. Overall, Chinese FDI inflows show a fluctuating trend, with a period of strong growth during the early 2010s followed by a marked decline in recent years. After relatively low inflows in the mid-2000s, FDI increased significantly, reaching around USD 20–25 billion between 2011 and 2017. However, from 2018 onward, FDI inflows experienced a sharp downturn, falling from above USD 20 billion to below USD 10 billion by 2020. This decline may be associated with global economic uncertainty, reduced commodity investment, and the impacts of the COVID-19 pandemic. Although there was a slight recovery around 2021, inflows declined again afterward, reaching approximately USD 4 billion in 2023–2024. Overall, the trend suggests that while Africa has attracted substantial foreign investment over the past two decades, FDI inflows remain volatile and sensitive to global economic conditions.

As for Figure 4.3, it shows a positive and growing relationship between Chinese FDI and sustainable development in Africa. This seems consistent with the theoretical hypothesis of beneficial effects associated with FDI. However, this figure plots a trend line, a correlation. Further investigations, at the econometric level are needed to further explore the

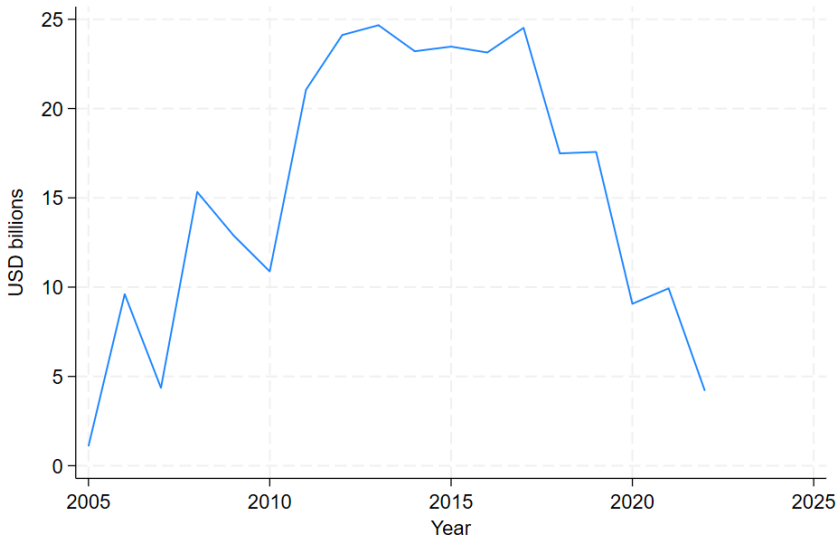
impact of Chinese FDI flows.

Figure 4.1: Chinese FDI inflows across Africa



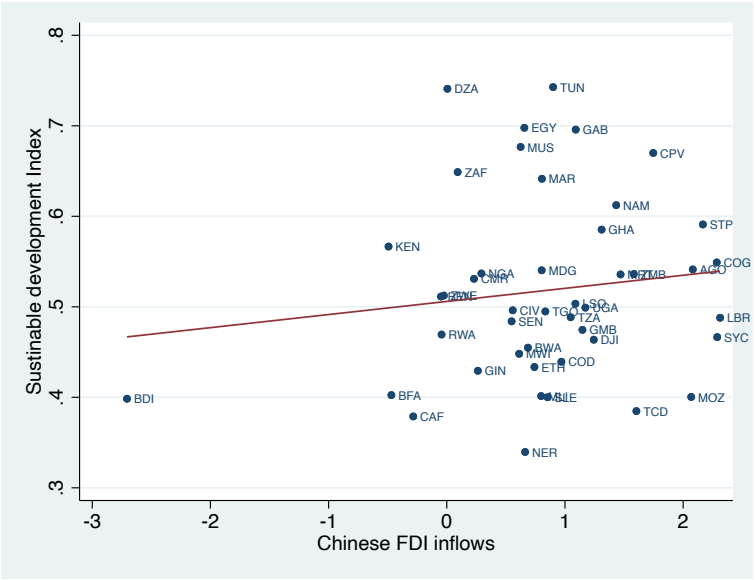

Source : Authors' elaboration Data source: Chinese Ministry of Commerce (MOFCOM)

Figure 4.2: FDI inflows in Africa (2000-2024)




Source : Author's elaboration Data source: American Enterprise Institute: China Global Investment Tracker

Figure 4.3: Relation between Chinese FDI and Sustainable development Index




Source : Authors' elaboration Data source: Chinese Ministry of Commerce (MOFCOM) and Sustainable Development Index (Hickel)

## 4.4 Data and Methodology

### 4.4.1 Data

Data are collected for 45 African countries between the 1996 to 2019 period. The data sources include : the World Development Indicators (WDI) of the World Bank, the World Governance Indicators (WGI) of the World Bank, Hickel (2020), for the Sustainable Development Index (SDI) and its associated ecological and social components. The choice of this sample of countries is dictated by the availability of data on both dependant and various independent variables.

The dependent variable of our study is the Sustainable Development Index (SDI), introduced by Hickel (2020). By quantifying the efficiency of nations in achieving human development while considering their ecological impact, the SDI provides valuable insights into the sustainability of economic growth. The SDI is calculated as the ratio of two components: the Human Development Index (HDI) and the Ecological Impact Index (EII).

The HDI considers three critical dimensions of human development: life expectancy, education, and a modified income index. The EII assesses the extent to which a nation's material footprint and consumption-based CO2 emissions exceed its per capita share of planetary boundaries. These two components together create a comprehensive measure of sustainable development that takes into account both human well-being and environmental sustainability. The calculation of the SDI, HDI, and EII are presented in Equations (1), (2), and (3) respectively.

$$SDI(i,t) = \frac{Human\ development\ index_{i,t}}{Ecological\ impact\ index_{i,t}} \tag{4.1}$$

The development index follows the base formula of the Human Development Index (HDI), with a sufficiency threshold on income. The formula and its components can be described as follows:

$$Human\ development\ index_{i,t} = \sqrt[3]{Life\ expectancy_{i,t} \times Education_{i,t} \times Income_{i,t}} \tag{4.2}$$

$$Ecological\ impact\ index = \frac{e^{AO} - e^{1}}{e^{4} - e^{1}} \tag{4.3}$$

Where AO is the average overshoot, which is the ratio of the material footprint and each of their emission values to their respective per capita planetary boundaries[1].

In recent years, the SDI has emerged as a key empirical tool in the literature, with a growing number of studies employing it to examine patterns and determinants of sustainable development across countries (Nchofoung and Asongu, 2022; Destek et al., 2022).[2]

Our variable of interest is Foreign direct investisment of China to Africa. The data has been collected from the Statistical bulletin of China's outward forward direct investment on the website of the Chinese Ministry of Commerce (MOFCOM).

Further, different control variables are used in our work. Hence, we include a set of

[1] see (Hickel, 2020) for more details

[2] `https://www.sustainabledevelopmentindex.org/methods`

standard macroeconomic and structural control variables commonly used in the empirical development literature. First, log GDP per capita controls for differences in income levels across countries. Higher-income economies tend to exhibit stronger institutional capacity, more diversified productive structures, and greater absorptive capacity for foreign investment, all of which can independently influence the Sustainable Development Index. Second, we include trade openness, which captures the degree of integration into global markets. More open economies generally attract larger volumes of foreign capital, benefit from faster technological diffusion, and are subject to external competitive pressures that may affect both FDI dynamics and sustainable development outcomes.Third, population growth is added to account for demographic dynamics. Rapid population expansion increases demand for public services, infrastructure, and employment creation, potentially shaping development trajectories independently of Chinese FDI inflows. Finally, the agricultural share of GDP is used as a proxy for structural transformation. Countries with a large agricultural sector are typically less industrialized and may exhibit lower levels of digitalization and institutional capacity, which can influence their ability to attract and productively absorb foreign investment. Together, these controls ensure that the estimated coefficient associated with Chinese FDI reflects its specific contribution to sustainable development performance rather than capturing broader macroeconomic or structural characteristics.

### 4.4.2 Methodology

To investigate the impact of Chinese foreign direct (FDI) investment on sustainable development in Africa, this study adopts a panel data econometric approach. This framework allows us to control for both time-specific effects and unobserved country-specific heterogeneity that could bias the estimated relationship. Given potential econometric challenges such as heterogeneity, endogeneity, and persistence in sustainable development, we employ several complementary estimation techniques, including Ordinary Least Squares (OLS), Fixed Effects (FE), Random Effects (RE), Driscoll-Kraay standard errors, fractional logit

and Tobit models, as well as Instrumental Variables (IV) and Generalized Method of Moments (GMM) estimators. Given the complexity of the relationship under investigation, relying on a single estimation technique could lead to biased or incomplete conclusions. Sustainable development is influenced by numerous economic, social, and institutional factors, some of which are difficult to observe or quantify. Moreover, Chinese FDI may be endogenous to development outcomes, as more sustainable countries could simultaneously be more attractive to foreign investors. In addition, African countries are exposed to common external shocks, such as fluctuations in commodity prices, global economic crises, and climate-related events, which may create cross-sectional dependence

The baseline empirical model is specified as follows:

$$SDI_{it} = \alpha + \beta_1 CFDI_{it} + \beta_2 GDPpc_{it} + \beta_3 Trade_{it} + \beta_4 Popg_{it} + \beta_5 Agric_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.4)$$

where:

- $SDI_{it}$: Sustainable Development Index for country $i$ at time $t$
- $CFDI_{it}$: Chinese foreign direct investment inflows
- $GDPpc_{it}$: GDP per capita (log)
- $Trade_{it}$: Trade openness (% of GDP)
- $Popg_{it}$: Population growth rate
- $Agric_{it}$: Agricultural value added (% of GDP)
- $\mu_i$: Country-specific effects
- $\lambda_t$: Time effects
- $\varepsilon_{it}$: Error term

To control for unobserved heterogeneity, both Fixed Effects (FE) and Random Effects (RE) models are estimated. The FE model captures all time-invariant country-specific

characteristics, while the RE model assumes that unobserved heterogeneity is uncorrelated with the explanatory variables. A Hausman test is used to determine the most appropriate specification.

Given the presence of common shocks affecting African countries, such as global economic fluctuations or commodity price changes, cross-sectional dependence may arise. To account for this issue, we use Driscoll-Kraay standard errors, which are robust to heteroskedasticity, serial correlation, and cross-sectional dependence. Since the SDI is bounded between 0 and 1, we estimate nonlinear models to ensure robustness. A fractional logit model is specified as:

$$E(SDI_{it}|X_{it}) = G(\alpha + \beta X_{it}) \tag{4.5}$$

where $G(.)$ is the logistic cumulative distribution function.

We further continue with a Tobit specification that is defined as:

$$SDI^*_{it} = \alpha + \beta X_{it} + \varepsilon_{it} \tag{4.6}$$

$$SDI_{it} = \begin{cases} 0 & \text{if } SDI^*_{it} \leq 0 \\ SDI^*_{it} & \text{if } 0 < SDI^*_{it} < 1 \\ 1 & \text{if } SDI^*_{it} \geq 1 \end{cases} \tag{4.7}$$

To address potential endogeneity issues such as reverse causality and omitted variable bias, we employ an instrumental variables (IV) approach. This method allows us to isolate the causal effect of Chinese FDI on sustainable development. To capture persistence in sustainable development, we start by estimating a dynamic panel model:

$$SDI_{it} = \alpha + \gamma SDI_{it-1} + \beta_1 CFDI_{it} + \beta X_{it} + \mu_i + \varepsilon_{it} \tag{4.8}$$

The inclusion of the lagged dependent variable might introduce endogeneity, which is addressed using the Generalized Method of Moments (GMM) estimator. The empirical

strategy combines then multiple estimation methods to ensure robustness. The empirical strategy addresses observed and unobserved heterogeneity, cross-sectional dependence, and endogeneity, thereby aiming to yield consistent estimates of the impact of Chinese FDI on sustainable development in Africa.

## 4.5 Empirical results

### 4.5.1 Baseline Regression Results (OLS)

Table 4.1 reports the results from the baseline Ordinary Least Squares (OLS) estimation. The findings indicate that Chinese foreign direct investment (CFDI) exhibits a positive but statistically insignificant coefficient. This result suggests that, in a naïve specification that does not account for country-specific heterogeneity, the impact of Chinese FDI on sustainable development remains inconclusive. The lack of statistical significance may be explained by structural differences across African countries, such as institutional quality, initial development levels, and policy environments, which simultaneously influence both Chinese investment flows and sustainable development outcomes. In contrast, GDP per capita has a positive and highly significant coefficient, indicating that higher income levels are associated with improved sustainable development performance. This finding is in line with the existing literature, which emphasizes that economic development facilitates investment in infrastructure, education, and environmentally sustainable technologies. Trade openness exhibits a positive but statistically insignificant coefficient, suggesting that greater integration into global markets does not automatically translate into improvements in sustainable development outcomes in African countries. This may reflect the continued reliance of many African economies on primary commodity exports, which may not necessarily promote sustainable development. Population growth appears to be statistically insignificant, suggesting that demographic expansion alone does not determine sustainable development outcomes. Instead, its impact likely depends on complementary factors such as employment creation, urbanization, and human capital

development. Finally, the agricultural share of GDP shows a positive and significant coefficient, suggesting that agriculture may contribute positively to sustainable development in certain African economies, particularly through food security and sustainable agricultural practices. However, these results should be interpreted cautiously, as the OLS model does not account for unobserved country-specific heterogeneity.

### 4.5.2 Fixed Effects Models

We estimate both fixed-effects (FR) and random-effects (RE) models. The Hausman test favors the fixed-effects specification, whose results will be further presented (4.A.6). We recall that the fixed effects model controls for time-invariant country-specific characteristics. The fixed-effects results show that Chinese FDI has a positive and statistically significant effect on sustainable development (Table 4.1), highlighting the importance of controlling for unobserved country-specific heterogeneity. GDP per capita remains positive and highly significant, while trade openness and the agricultural share become statistically insignificant. Population growth is positive and significant, suggesting that demographic factors contribute to sustainable development. Estimation using High-Dimensional Fixed Effects (HDFE) yields nearly identical results (Table 4.1), confirming the robustness of the findings.

### 4.5.3 Accounting for Cross-Sectional Dependence: the Driscoll–Kraay Estimator

The Pesaran cross-sectional dependence test indicates strong dependence across African countries (table 4.A.4). This result suggests that common shocks, such as global economic fluctuations, commodity price changes, or regional policy developments, simultaneously affect multiple countries. This finding implies that conventional panel estimation techniques may produce biased standard errors. Therefore, the use of Driscoll-Kraay standard errors could be appropriate to account for cross-sectional dependence and obtain

robust inference. The results obtained using Driscoll-Kraay standard errors confirm the robustness of the baseline findings (table 4.1). Chinese FDI exhibits a positive and statistically significant coefficient, suggesting that Chinese investment contributes positively to sustainable development in Africa. This positive effect may be attributed to China's investment in infrastructure development, including roads, ports, and energy projects, which enhance productivity and facilitate access to essential services (Figure 4.2 and 4.A.1). Such investments are likely to promote both economic and social dimensions of sustainable development. GDP per capita remains positive and statistically significant, reinforcing the importance of income growth in improving sustainable development outcomes. Trade openness also becomes significant, suggesting that international trade may facilitate the diffusion of environmentally friendly technologies. Population growth also becomes statistically significant, indicating that demographic dynamics may contribute to sustainable development when accompanied by adequate infrastructure and economic opportunities. These findings confirm the robustness of the positive impact of Chinese FDI.

Table 4.1: Main Regression Results

| | (1) OLS | (2) FE | (3) Driskoll Krayy | (4) HDFE |
|---|---|---|---|---|
| Chinese FDI | 0.000939 | 0.000760** | 0.000760** | 0.000760** |
| | (0.00105) | (0.000369) | (0.000329) | (0.000369) |
| GDP per head | 0.109*** | 0.0563** | 0.0563*** | 0.0563** |
| | (0.00527) | (0.0226) | (0.00815) | (0.0226) |
| Trade openness | -0.00996 | 0.0176 | 0.0176*** | 0.0176 |
| | (0.00771) | (0.0116) | (0.00499) | (0.0116) |
| Population Growth | -0.00278 | 0.0263* | 0.0263*** | 0.0263* |
| | (0.00499) | (0.0141) | (0.00620) | (0.0141) |
| Agriculture Value Added | 0.0290*** | 0.0129 | 0.0129*** | 0.0129 |
| | (0.00614) | (0.0145) | (0.00411) | (0.0145) |
| Constant | -0.298*** | -0.0729 | -0.0729 | -0.0120 |
| | (0.0628) | (0.147) | (0.0688) | (0.146) |
| Observations | 930 | 930 | 930 | 930 |

Standard errors in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

## 4.6 Robustness Check

### 4.6.1 Fractional Logit Model

Given that the sustainable development index is bounded between 0 and 1, a fractional logit model was estimated. The results show that Chinese FDI has a positive and marginally significant effect on sustainable development (table 4.2). This findings suggest that Chinese investments might contribute to gradual improvements in sustainable development performance. GDP per capita remains positive and statistically significant, confirming its central role in sustainable development. Population growth becomes marginally significant, indicating that demographic expansion may support sustainable development when combined with appropriate investments. These results further confirm the robustness of the baseline findings.

### 4.6.2 Tobit Model

A Tobit model was estimated to account for the bounded nature of the dependent variable. The results indicate that Chinese FDI is positively linked to sustainable development, which is consistent with previous estimations. GDP per capita remains highly significant, confirming that economic development plays a central role in improving sustainable development outcomes (table 4.2). Trade openness also becomes positive, suggesting that economic integration supports sustainable development. These findings provide additional evidence supporting the robustness of the positive impact of Chinese FDI.

### 4.6.3 Instrumental Variables Estimation

To address potential endogeneity, we employ an instrumental variables (IV) approach. The IV estimates continue to show a positive and statistically significant effect of Chinese FDI on sustainable development (Table 4.3). The similarity between the IV and baseline estimates suggests that the main findings are robust to potential reverse causality, thereby

Table 4.2: Robustness Checks 1/2

| | (1) Fractional Logit | (2) Tobit |
|---|---|---|
| Chinese FDI | 0.00269* | 0.000733* |
| | (0.00150) | (0.000434) |
| GDP per head | 0.240*** | 0.0640*** |
| | (0.0913) | (0.00704) |
| Trade openness (% GDP) | 0.0708 | 0.0169*** |
| | (0.0456) | (0.00491) |
| Population Growth | 0.111* | 0.0260*** |
| | (0.0597) | (0.00263) |
| Agriculture Value Added (% GDP) | 0.0624 | 0.0119** |
| | (0.0587) | (0.00489) |
| Constant | -1.652** | -0.123** |
| | (0.675) | (0.0568) |
| sigma_u | | 0.0791*** |
| | | (0.00886) |
| sigma_e | | 0.0261*** |
| | | (0.000621) |
| Observations | 930 | 930 |

Standard errors in parentheses.
Year FE included; Country FE included (Fractional Logit).
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

lending potential support to a causal interpretation of the relationship.

### 4.6.4 Dynamic Panel Model (GMM)

A dynamic panel model using the Generalized Method of Moments (GMM) was estimated to capture the persistence of sustainable development. The results indicate that Chinese FDI has a positive and statistically significant effect on sustainable development.The lagged dependent variable is also positive and significant, indicating strong persistence in sustainable development outcomes (table 4.3). This suggests that improvements in sustainable development tend to be sustained over time. These results indicate that the impact of Chinese FDI operates through long-term development mechanisms, including infrastructure investment, technology transfer, and institutional development. Overall, the GMM results confirm that Chinese FDI might positively contributes to sustainable development in Africa.

Table 4.3: Robustness Checks 2/2

| | (1) IV-2SLS | (2) System GMM |
|---|---|---|
| Chinese FDI | 0.00826* | 0.000329** |
| | (0.00482) | (0.000155) |
| GDP per head | 0.112*** | -0.0268*** |
| | (0.0163) | (0.00767) |
| Trade openness (% GDP) | 0.0141 | 0.00278 |
| | (0.0199) | (0.00370) |
| Population Growth | -0.0141 | 0.00511 |
| | (0.0197) | (0.00328) |
| Agriculture Value Added (% GDP) | 0.0401 | -0.00649** |
| | (0.0252) | (0.00314) |
| L.SD_Index | | 1.217*** |
| | | (0.0786) |
| Constant | -0.446** | 0.0720** |
| | (0.203) | (0.0322) |
| Observations | 752 | 892 |

Standard errors in parentheses.
System GMM: two-step robust estimator; year FE included; SE clustered at country level.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

## 4.7 Conclusion

This study set out to examine whether Chinese foreign direct investment (FDI) contributes to sustainable development in Africa, addressing the broader question of whether China is "going green" in its engagement with the continent. Using the Sustainable Development Index (SDI) as a comprehensive measure capturing both development and environmental sustainability, the analysis provides new empirical evidence on the nature and impact of Chinese investment.

The empirical results consistently indicate that Chinese FDI has a positive effect on sustainable development in Africa. While the baseline OLS regression produced statistically insignificant results, more robust econometric approaches, including fixed effects, Driscoll-Kraay estimators, fractional logit, Tobit models, instrumental variables, and dynamic panel GMM, confirm the initial results. These findings suggest that once country-specific

heterogeneity, cross-sectional dependence, and potential endogeneity issues are properly addressed, the positive link between Chinese FDI and sustainable development indicator is still present. Chinese investments might support sustainable development primarily through infrastructure development, industrial expansion, and improvements in productive capacity or by supporting investments in renewable energy, improvements in energy efficiency, and the diffusion of cleaner technologies. Additionally, increased trade openness shown to be significant in several specifications may facilitate the transfer of environmentally friendly technologies and sustainable production practices across African economies. These possible channels indicate that Chinese FDI may contribute to sustainable development. The results also highlight the importance of control variables in shaping sustainable development outcomes. GDP per capita consistently emerges as a strong and significant determinant of SDI, confirming that higher income levels enable investments in infrastructure, education, and environmental protection. Population growth also shows a positive effect in several specifications, suggesting that demographic expansion can support development when accompanied by adequate infrastructure and economic opportunities. Similarly, the agricultural share of GDP shows mixed but occasionally positive effects, indicating that sustainable agricultural practices may contribute to food security and inclusive development. Importantly, the dynamic panel results indicate strong persistence in sustainable development outcomes, suggesting that possible improvements generated by Chinese FDI might operate through long-term development mechanisms.

Overall, the results suggest that Chinese FDI is positively associated with sustainable development in Africa, and this relationship remains robust across a range of specifications. While the findings do not rule out concerns regarding environmental standards or investment quality, they are consistent with the view that Chinese investment can contribute to sustainable development. Future research could examine sectoral heterogeneity, alternative measures of environmental performance, and country-specific institutional factors to better identify the channels through which Chinese FDI influences sustainable development outcomes in African economies.

## 4.8 Appendix

### 4.8.1 Tables

Table 4.A.1: Summary Statistics

| Variable | Obs | Mean | Std. Dev. | Variance | Min | Max |
|---|---|---|---|---|---|---|
| SD_Index | 1043 | 0.5185 | 0.1126 | 0.0127 | 0.2630 | 0.7920 |
| Chinese FDI | 1080 | 2.7146 | 2.5664 | 6.5863 | -7.3962 | 9.1712 |
| GDP per head | 1054 | 7.1163 | 0.9568 | 0.9155 | 5.4700 | 9.7404 |
| Trade Openness | 961 | 4.1609 | 0.4493 | 0.2019 | 3.0783 | 5.8551 |
| Population Growth | 1071 | 0.7719 | 0.5838 | 0.3409 | -4.5789 | 2.0941 |
| Agriculture Value Added (% GDP) | 1080 | 2.7263 | 0.9096 | 0.8274 | -0.0044 | 4.3700 |

Table 4.A.2: Correlation Matrix

| Variable | Corr. (rho) | p-value | Obs |
|---|---|---|---|
| Chinese FDI | 0.0996 | 0.0013 | 1043 |
| GDP per head | 0.6965 | $6.4 \times 10^{-149}$ | 1020 |
| Trade openness (% GDP) | 0.3172 | $2.84 \times 10^{-23}$ | 934 |
| Population Growth | -0.2897 | $1.90 \times 10^{-21}$ | 1034 |
| Agriculture Value Added (% GDP) | -0.4447 | $8.50 \times 10^{-52}$ | 1043 |

Table 4.A.3: Pairwise Correlation Matrix

| Variable | SD_Index | Chinese FDI | GDP per head | Trade openness (% GDP) | Population Growth | Agriculture Value Added (% GDP) |
|---|---|---|---|---|---|---|
| SD_Index | 1.0000 | 0.0996 | 0.6965 | 0.3172 | -0.2897 | -0.4447 |
| Chinese FDI | 0.0996 | 1.0000 | 0.1237 | -0.0626 | 0.0365 | -0.0325 |
| GDP per head | 0.6965 | 0.1237 | 1.0000 | 0.5573 | -0.4279 | -0.8299 |
| Trade openness (% GDP) | 0.3172 | -0.0626 | 0.5573 | 1.0000 | -0.3490 | -0.6280 |
| Population Growth | -0.2897 | 0.0365 | -0.4279 | -0.3490 | 1.0000 | 0.4294 |
| Agriculture Value Added (% GDP) | -0.4447 | -0.0325 | -0.8299 | -0.6280 | 0.4294 | 1.0000 |

Table 4.A.4: Cross-Sectional Dependence Test (Pesaran CD)

| Test | Statistic | p-value | Additional Info |
|---|---|---|---|
| Pesaran CD (abs) | 54.919 | 0.0000 | Avg. abs. corr = 0.698 |

Table 4.A.5: Variance Inflation Factors (VIF)

| Variable | VIF | 1/VIF |
|---|---|---|
| Agriculture Value Added (% GDP) | 3.85 | 0.2599 |
| GDP per head | 3.48 | 0.2876 |
| Trade openness | 1.66 | 0.6007 |
| Population Growth | 1.27 | 0.7870 |
| Chinese FDI | 1.04 | 0.9661 |
| Mean VIF | 2.26 | |

Table 4.A.6: Hausman Specification Test

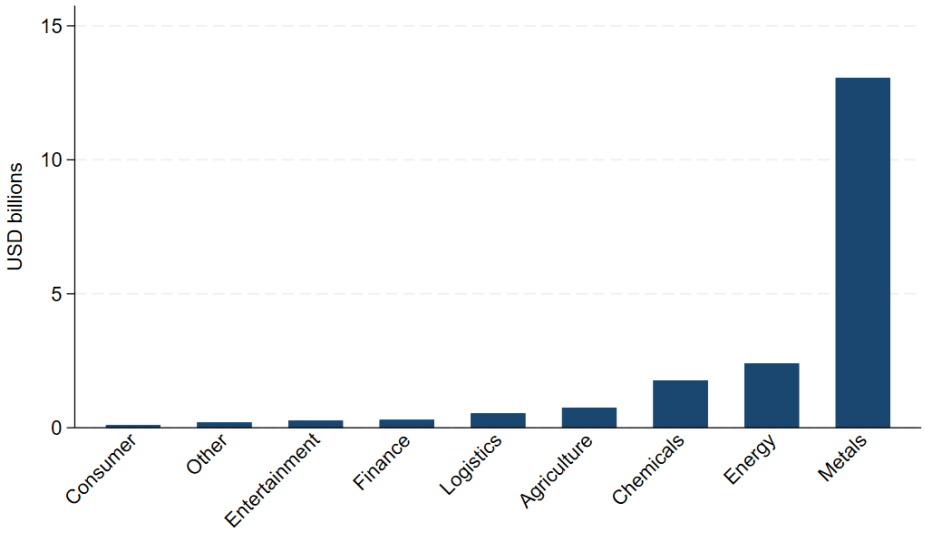
| Variable | Fixed Effects (FE) | Random Effects (RE) | Difference (FE-RE) |
|---|---|---|---|
| Chinese FDI | -0.0001180 | -0.0001099 | -0.0000081 |
| GDP per head | 0.1879968 | 0.1626413 | 0.0253555 |
| Trade Openess | 0.0282579 | 0.0257738 | 0.0024841 |
| Population Growth | 0.0314788 | 0.0316824 | -0.0002036 |
| Agriculture Value Added (% GDP) | -0.0267699 | -0.0154381 | -0.0113318 |

$$\chi^2(5) = 87.56$$

$$p\text{-value} = 0.0000$$

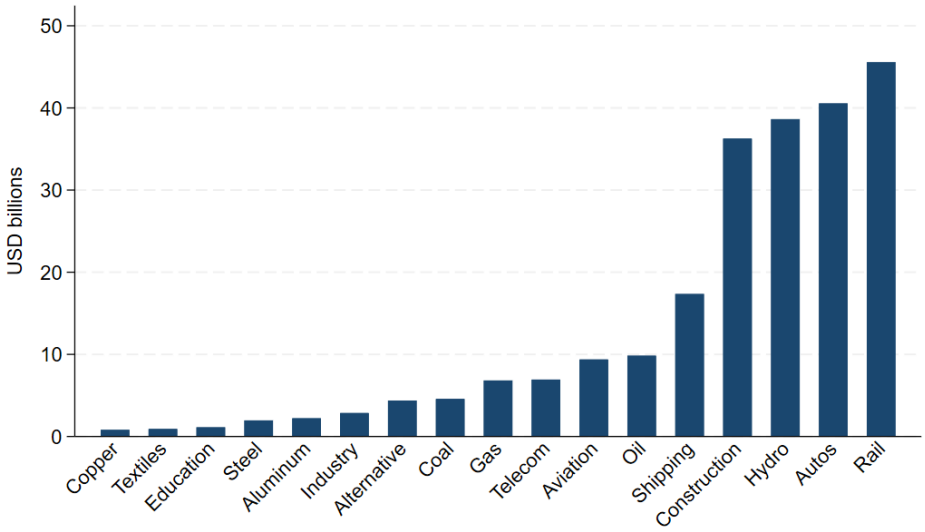
### 4.8.2 Figures

Figure 4.A.1: Chinese Investment by sectors across Africa (2000-2024)



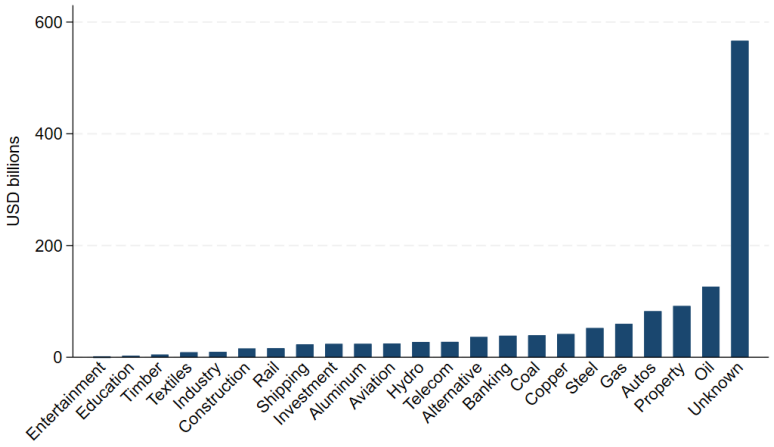

Source : Author calculation using Data steming from from American Enterprise Institute : China Global Investment Tracker

Figure 4.A.2: Chinese Investment by subsectors across Africa (2000-2024)



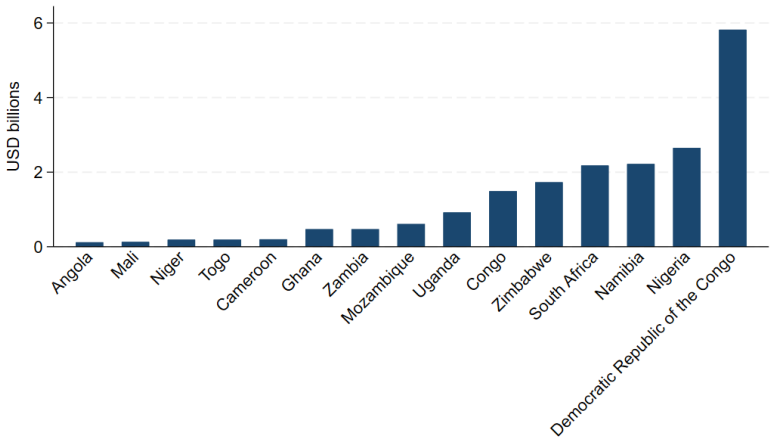

Source : Author calculation using Data steming from from American Enterprise Institute : China Global Investment Tracker

Figure 4.A.3: Chinese Investment by subsectors across Africa (2000-2024)




Source : Author calculation using Data steming from from American Enterprise Institute : China Global Investment Tracker

Figure 4.A.4: Chinese Investment by country across African countries (2000-2024)




Source : Author calculation using Data steming from from American Enterprise Institute : China Global Investment Tracker

# General Conclusion

# General conclusion

The twin challenges of sustainable development and climate change have become defining issues for the 21st century, particularly for low and middle-income countries. As the global community accelerates efforts to limit global warming and reduce carbon emissions, the demand for critical raw materials such as cobalt, copper, and rare earth elements has intensified. These minerals are essential for the deployment of green technologies. While this shift presents new economic opportunities for resource-rich countries, especially in Africa, it also brings significant risks. In particular, it revives longstanding concerns around the management of resource wealth, institutional fragility, and environmental degradation. Sub-Saharan Africa holds vast reserves of the minerals that are vital to the global energy transition. The Democratic Republic of Congo alone supplies over 70% of the world's cobalt, a mineral considered indispensable for lithium-ion batteries. However, despite this natural wealth, many African countries have struggled to translate resource abundance into broad-based and inclusive development. A large body of literature on the so-called "resource curse" suggests that natural resources, instead of fueling prosperity, often exacerbate inequality, foster corruption, weaken institutions, and in some cases, provoke violent conflict. These challenges are especially acute in contexts characterized by weak governance, limited state capacity, and geopolitical competition over access to strategic materials.

At the same time, the role of emerging powers particularly China has fundamentally reshaped the landscape of international development and investment in Africa. Since the

early 2000s, China has become a major player in Africa's extractive and infrastructure sectors, often combining aid, loans, and commercial interests through integrated packages. In mineral-rich countries, these engagements often take the form of "resources-for-infrastructure" deals, which blur the boundaries between development cooperation and economic diplomacy. While such arrangements can contribute to much-needed infrastructure, they also raise concerns about transparency, debt sustainability, and political leverage. This thesis contributes to the literature on the political economy of natural resources by examining how the global energy transition is transforming aid flows, foreign investment, and conflict dynamics in resource-rich African countries. It focuses on the intersection between natural resource governance, sustainable development, and geopolitical competition, with a particular emphasis on China's growing influence. The research draws on both macro-level datasets and subnational geospatial data to provide a multi-scalar empirical analysis of these issues.

Chapter 1 investigates whether Chinese development aid in Africa is increasingly directed toward countries rich in natural resource. Using both country-level statistics and geocoded project data, the analysis reveals a significant positive relationship between the presence of natural resources or energy transition minerals and the volume of Chinese aid, particularly in infrastructure and energy-related sectors. This suggests that resource endowments may be shaping donor behavior in ways that have long-term implications for African development trajectories.

Chapter 2 explores a possible sector reorientation of Chinese foreign direct investment (FDI) in Africa in response to global decarbonization efforts. While China was previously a dominant investor in oil and gas, the data now show a pivot toward minerals (like copper and cobalt). This shift could translate both environmental pressures and industrial policy priorities in China and raises questions about how African economies can leverage this transformation.

Chapter 3 focuses on the Democratic Republic of Congo and examines whether rising global demand for cobalt increases the risk of conflict at the local level. Through an econometrics and machine learning model based on geospatial data, the results indicates a rise in conflict risk linked to cobalt production due to the increasing strategic relevance of this mineral in the global energy transition. The findings underscore the importance of regulatory reform, local governance strengthening, and responsible sourcing frameworks.

The fourth chapter, using a panel dataset and several econometrics, assesses whether Chinese-financed investments contribute to sustainable development in host African countries. The results are mixed but overall could suggest a certain positive link between Chinese investments and sustainable development indicators in Africa. The chapter highlights the importance of strengthening institutions while aligning foreign investment with SDG priorities.

In sum, this thesis provides new insights into the risks and opportunities that the energy transition presents for Africa. While the demand for strategic minerals offers a chance to reconfigure Africa's role in the global economy, it also intensifies existing vulnerabilities tied to governance, inequality, and conflict.

While this thesis offers several contributions to the understanding of critical minerals, external engagement, and resource governance in Africa, it also opens promising avenues for future research. *First*, the empirical analyses rely on datasets whose temporal and spatial coverage varies across African countries. This diversity highlights the need for continued efforts to expand and harmonize data collection on critical mineral production, Chinese development finance, and state-owned enterprise activities. Future research could build on this work by integrating newly available datasets or contributing to ongoing data improvement initiatives. In addition, more systematic and transparent datasets on critical minerals, energy-related investments, and contract-level information are needed to better understand how the global energy transition reshapes development finance. Further

work could also leverage machine-learning techniques, satellite imagery, and remote sensing to track informal mining activity, land degradation, and infrastructure deployment across time and space. *Second*, the combination of macro-level indicators and geocoded information used in this thesis underscores the potential of multi-scalar approaches. Further studies could refine these measures, such as artisanal mining intensity, institutional quality, or subnational conflict dynamics, to enhance the precision and granularity of empirical analyses. More granular political economy studies, particularly at the community and mining-site levels, could also shed light on how local institutions, customary authorities, and social norms mediate the risks and opportunities associated with the growing global demand for critical minerals. *Third*, although the identification strategies employed here shed light on important mechanisms, future work could explore complementary methods capable of capturing the complexity of geopolitical bargaining, informal arrangements, and elite dynamics that shape resource governance, particularly in fragile contexts. *Fourth*, this thesis focuses primarily on China as an external actor. Expanding the analytical lens to include other emerging powers, such as India, Turkey, or Gulf countries, as well as Western donors, private investors, and regional development banks, would provide a richer comparative perspective. This would help assess whether these actors' engagements are complementary, competitive, or substitutive.

Finally, extending the analysis to environmental and social dimensions would be essential to evaluate whether the current "green rush" reproduces past extraction patterns or contributes to more sustainable and inclusive development trajectories. In sum, while this thesis sheds light on the links between the energy transition, natural resources, and external engagement in Africa, much remains to be explored regarding the long-term developmental, environmental, and geopolitical implications of the continent's growing centrality in the context of the energy transition.

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# Résumé français

# Résumé français

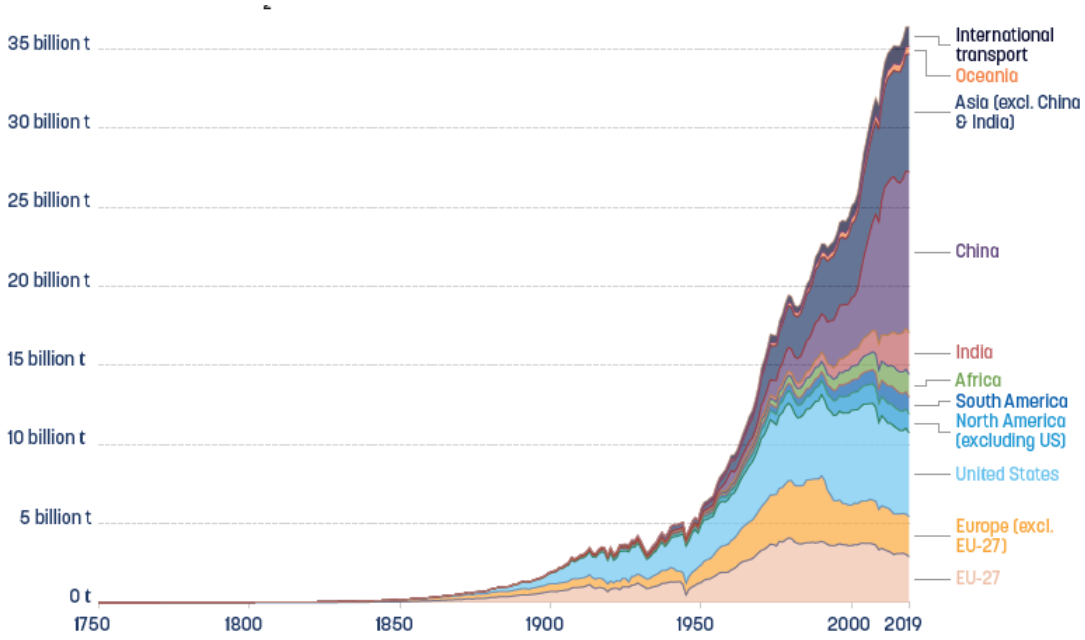
Depuis le début du XXI siècle, la prise de conscience des effets dévastateurs du changement climatique a fortement progressé, entraînant un profond repositionnement des priorités économiques et géopolitiques mondiales. Le consensus scientifique, notamment à travers les rapports successifs du Groupe d'experts intergouvernemental sur l'évolution du climat (GIEC), n'a cessé d'alerter sur l'urgence d'opérer une transition énergétique visant à réduire drastiquement les émissions de gaz à effet de serre (GES). En réponse, plusieurs initiatives internationales majeures ont été lancées. L'Accord de Paris de 2015, signé par 196 parties, a marqué un tournant en engageant la communauté mondiale à limiter la hausse de la température moyenne globale à bien en dessous de 2°C par rapport aux niveaux préindustriels, tout en s'efforçant de la contenir à 1,5°C. Atteindre cet objectif nécessite une transformation rapide des systèmes de production et de consommation d'énergie, en s'éloignant des combustibles fossiles (charbon, pétrole, gaz) au profit des sources d'énergie renouvelables (solaire, éolien, hydroélectricité) et des technologies bas carbone (véhicules électriques, batteries, hydrogène). Cependant, ces technologies exigent des quantités massives de minéraux stratégiques, souvent désignés sous le nom de métaux critiques ou métaux de la transition énergétique, parmi lesquels le cobalt, le lithium, le nickel, le cuivre et les terres rares. Cette dépendance croissante a inauguré une nouvelle ère géopolitique des ressources naturelles, caractérisée par des tensions accrues, des stratégies de sécurisation et une intensification de la compétition mondiale pour l'accès à ces minéraux.

## Influence humaine sur le réchauffement climatique : preuves et tendances

Le consensus scientifique confirme que les activités humaines ont indéniablement contribué au réchauffement de l'atmosphère terrestre, des océans et des masses continentales (Calvin et al., 2023). Les estimations suggèrent que les actions anthropiques ont entraîné environ 1,0°C de réchauffement par rapport aux niveaux préindustriels, et les projections indiquent que ce chiffre pourrait atteindre 1,5°C entre 2030 et 2052 si les tendances actuelles se poursuivent (IPCC, 2022). Bien que des variations climatiques naturelles aient eu lieu tout au long de l'histoire de la Terre, telles que l'alternance des périodes glaciaires et interglaciaires au cours des 800000 dernières années, la tendance actuelle de réchauffement rapide se distingue nettement. Cette hausse moderne des températures mondiales, débutant au XIX siècle, est directement liée à des facteurs d'origine humaine comme la combustion de combustibles fossiles et la déforestation massive. Contrairement aux cycles naturels précédents, ce réchauffement d'origine anthropique se déroule à un rythme beaucoup plus rapide et présente un risque grave pour les sociétés humaines et les écosystèmes (NASA, 2024). Cette accélération de la température mondiale est principalement causée par l'augmentation des concentrations de gaz à effet de serre (GES) dans l'atmosphère. De 2021 à 2022, les émissions mondiales de GES ont augmenté de 1,2%, atteignant un niveau inédit de 57,4 gigatonnes d'équivalent $CO_2$ (Figure 1). Les émissions de $CO_2$ provenant de la combustion des combustibles fossiles et des activités industrielles représentent environ les deux tiers de ce total (United Nations Environment Programme, 2023). Malgré des avancées significatives dans les énergies renouvelables, en particulier le solaire, de nombreux pays continuent d'investir massivement dans le développement des combustibles fossiles. De manière alarmante, les plans nationaux actuels indiquent une trajectoire menant à un doublement de la production de combustibles fossiles d'ici 2030, en contradiction directe avec les objectifs de l'Accord de Paris. Les disparités en matière d'émissions sont également marquées entre les pays et au sein de ceux-ci. Les 10% les plus riches de la population mondiale, principalement situés dans les pays développés, sont responsables d'environ 48% des émissions totales liées à la consommation, tandis que la moitié la plus pauvre de la population ne contribue qu'à hauteur de 12%. De la même manière, les émissions historiques montrent un déséquilibre clair. Près de 80% des émissions cumulées de $CO_2$ issues des combustibles fossiles et des changements d'usage des terres proviennent des pays du G20, menés par la Chine, les États-Unis et l'Union européenne. À l'inverse, les pays les moins développés ne sont responsables que de 4% de ces émissions historiques (Figure 2). Les impacts du changement climatique sont déjà visibles à travers le monde. La hausse des températures mondiales a intensifié la fréquence et la sévérité des vagues de chaleur dans de nombreuses régions. Ce réchauffement a également perturbé le cycle de l'eau de la planète, entraînant des épisodes plus fréquents de fortes précipitations à l'échelle mondiale, tout en augmentant le risque de sécheresses prolongées dans d'autres zones en raison de schémas météo-

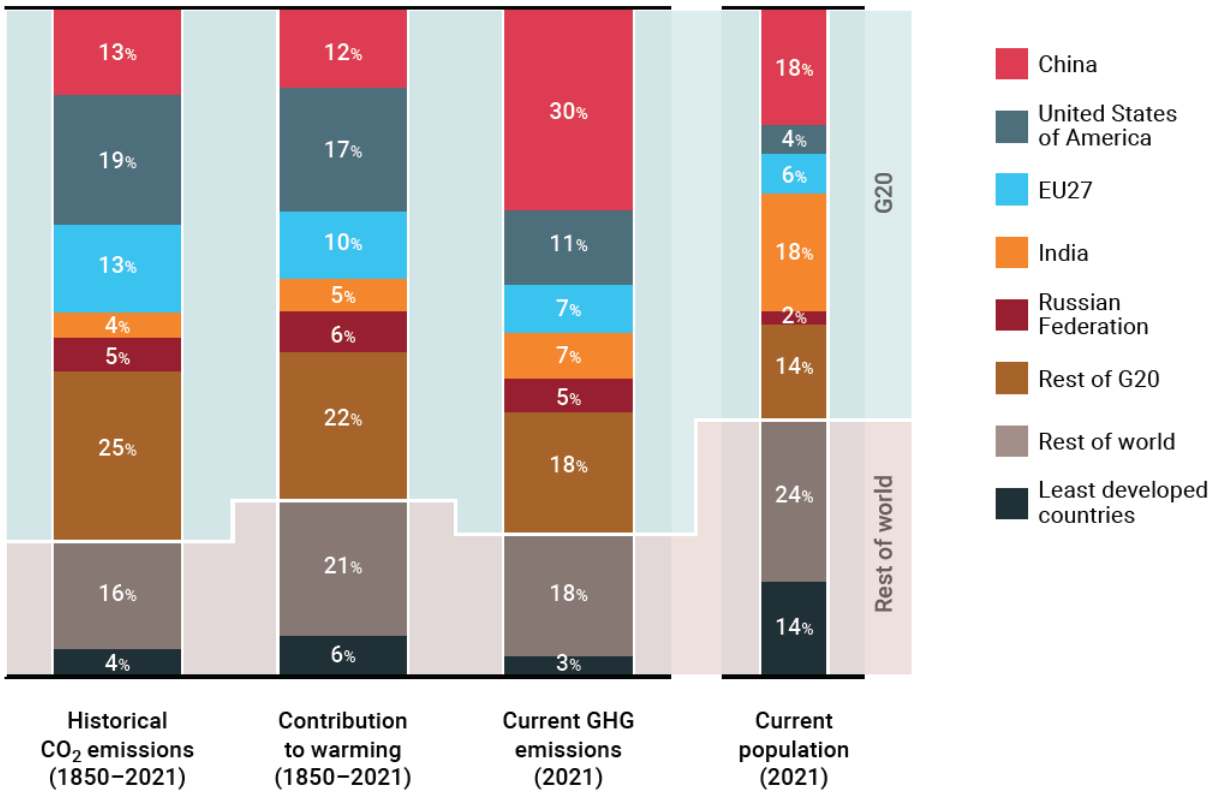
rologiques modifiés. Le changement climatique a provoqué des dommages considérables aux écosystèmes naturels et aux communautés humaines. Les conséquences touchent de manière disproportionnée les populations les plus vulnérables, celles qui ont le moins contribué au problème (IPCC, 2022). Entre 3,3 et 3,6 milliards de personnes vivent actuellement dans des environnements fortement exposés aux risques climatiques. Les événements extrêmes de plus en plus fréquents ont conduit à une insécurité alimentaire accrue et à un accès réduit à l'eau potable. Les peuples autochtones, les petits exploitants agricoles et les communautés à faible revenu sont particulièrement exposés. Durant la période 2010–2020, le nombre de décès dus à des catastrophes liées au climat comme les inondations, les sécheresses et les tempêtes a été 15 fois plus élevé dans les régions les plus à risque par rapport aux zones moins exposées (FAO, 2021). Des perturbations économiques se font également sentir dans des secteurs essentiels tels que l'agriculture, la foresterie, la pêche, l'énergie et le tourisme. Ces impacts climatiques aggravent les inégalités existantes, les communautés les plus pauvres et marginalisées subissant le poids des conséquences.

FIGURE 1 : Evolution of GHGs




Annual Total CO2 Emissions by World Region. Source : World Bank (2021)

FIGURE 2 : Contributions actuelles et historiques au changement climatique




Source : United Nations Environment Programme (2023)

## Accords internationaux sur le climat

Au cours des dernières décennies, les efforts mondiaux visant à lutter contre le changement climatique ont gagné une dynamique considérable grâce à une série d'accords internationaux majeurs et d'initiatives de collaboration. Ces cadres ont eu pour objectif non seulement de réduire les émissions de gaz à effet de serre (GES), mais aussi de protéger les écosystèmes fragiles et de renforcer la solidarité internationale face à la crise climatique. Le tableau 1 présente un résumé de certains des accords et mécanismes les plus influents ayant façonné l'évolution de la gouvernance climatique mondiale. Pris collectivement, ces développements témoignent d'une prise de conscience croissante de l'urgence d'une action climatique coordonnée et soutenue au niveau international. Parmi ces moments déterminants, l'Accord de Paris s'est imposé comme une étape transformative dans la diplomatie climatique. En engageant les pays à limiter la hausse des températures moyennes mondiales à bien en dessous de 2°C, et idéalement à 1,5°C par rapport aux niveaux préindustriels, il a établi un cadre ambitieux pour l'action climatique collective. En plus de ses objectifs de température, l'Accord de Paris a tracé une voie structurante vers

la décarbonation de l'économie mondiale. Cette transition, qui implique une réduction de la dépendance aux combustibles fossiles et une montée en puissance des systèmes énergétiques propres, est centrale pour atteindre les objectifs de long terme de l'Accord. La section suivante examine les implications plus larges de la décarbonation, notamment la hausse de la demande mondiale en énergie renouvelable. Ces éléments sont essentiels non seulement pour la sécurité énergétique et le développement durable, mais également pour garantir le respect des engagements climatiques de Paris et éviter les impacts les plus dangereux du réchauffement climatique.

Table 1 : Principaux accords et initiatives

| Accord ou initiative | Year | Objectif |
|---|---|---|
| Protocole de Montréal | 1987 | Viser à arrêter la production de substances qui endommagent la couche d'ozone |
| GIEC (IPCC) | 1988 | Fournir des évaluations scientifiques sur le changement climatique, afin d'informer les décideurs politiques et le public. |
| CCNUCC (UNFCCC) | 1992 | Établir un forum annuel (COP) pour les discussions internationales visant à stabiliser la concentration de gaz à effet de serre dans l'atmosphère. |
| Protocole de Kyoto | 2005 | Premier traité climatique juridiquement contraignant. Il exigeait des pays développés qu'ils réduisent leurs émissions de 5 % en moyenne par rapport aux niveaux de 1990, et instaurait un système de suivi des progrès des pays. |
| Accord de Paris | 2015 | Fixer des objectifs visant à empêcher la température moyenne mondiale d'augmenter de plus de 2°C par rapport aux niveaux préindustriels, tout en poursuivant les efforts pour la limiter à 1,5°C. |
| Pacte de Glasgow (COP26) | 2021 | Renforcer l'Accord de Paris en exhortant les pays à accélérer les efforts pour éliminer progressivement le charbon, réduire les émissions de méthane et accroître le financement destiné aux pays en développement. |
| Plan de Charm el-Cheikh (COP27) | 2022 | Établir un fonds « pertes et dommages » destiné à aider les pays vulnérables à faire face aux impacts du changement climatique. |

Source : Maizland (2023)

## Décarbonation et demande énergétique

L'Accord de Paris fixe un objectif mondial consistant à limiter le réchauffement climatique à bien en dessous de 2°C, idéalement à 1,5°C. Atteindre cet objectif nécessite une transformation fondamentale du système énergétique mondial. La figure 3 présente plusieurs scénarios d'émissions alignés sur différents objectifs de température, allant de 1,5°C à plus de 4°C. Ces trajectoires impliquent une forte réduction des émissions de gaz à effet de serre (GES), avec des émissions de $CO_2$ atteignant la neutralité carbone

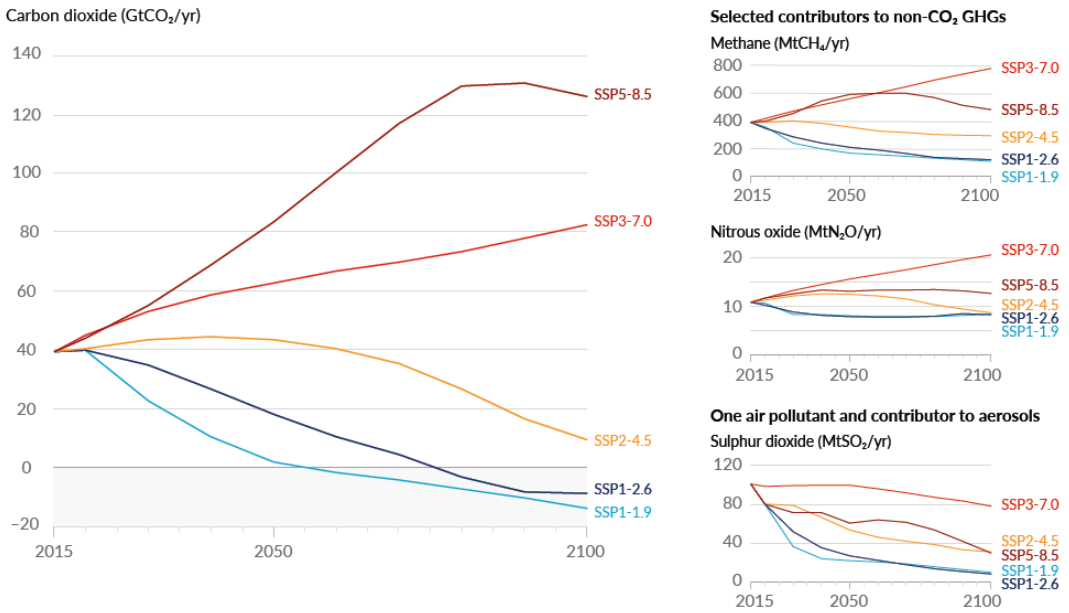
autour du milieu du siècle, puis devenant négatives par la suite (IPCC, 2022). Cette transformation dépend largement du déploiement à grande échelle des technologies d'énergie propre. La demande en électricité devrait presque quadrupler d'ici 2050, passant d'environ 28000 TWh en 2022 à 110000 TWh, l'éolien et le solaire fournissant plus de 75% du total (ETC, 2023). Une telle croissance nécessite des investissements majeurs dans les infrastructures de réseau et la décarbonation des systèmes de transport. De manière cruciale, cette transition exigera d'immenses quantités de métaux de la transition énergétique (ETMs), tels que le lithium, le cobalt et le nickel, essentiels aux technologies comme les panneaux solaires, les éoliennes et les batteries des véhicules électriques, comme le montre le tableau 2. Selon ETC (2023), le secteur de l'énergie pourrait consommer environ 6,5 milliards de tonnes de matériaux entre 2022 et 2050, principalement de l'acier, du cuivre et de l'aluminium. Bien que les métaux de base dominent en volume, les minéraux critiques comme le lithium, bien que utilisés en plus faible quantité, restent indispensables, avec environ 20 millions de tonnes nécessaires sur cette période. Bien que les réserves terrestres connues puissent suffire à l'échelle mondiale, la hausse de la demande pourrait mettre les chaînes d'approvisionnement sous pression sans améliorations en matière de recyclage, de substitution ou d'efficacité d'extraction. Par exemple, les réserves pourraient devoir augmenter de 30% pour le cuivre, 70% pour le nickel et 90% pour l'argent afin de répondre aux besoins prévus pour 2050 (ETC, 2023). La capacité minière actuelle et prévue est insuffisante pour répondre à la demande anticipée : seule environ 50% des futures exigences en lithium et cobalt, et 80% pour le cuivre, sont couvertes pour les objectifs de 2030 (IEA, 2021). Combler ces écarts nécessitera de nouveaux investissements dans l'exploration et l'exploitation minière, en particulier dans les régions sous-développées disposant d'un potentiel encore inexploité. Les économies en développement et émergentes sont donc centrales pour sécuriser les futures chaînes d'approvisionnement.

Cependant, comme le souligne Bank (2017*a*), les données fiables sur la distribution géographique et la viabilité commerciale des réserves minérales dans ces pays restent limitées. De plus, bien que les pays à revenu élevé dominent actuellement la production de plusieurs ETMs, une grande partie des plus importantes réserves comme celles du lithium, du cobalt et des terres rares est concentrée dans des contextes moins industrialisés. Ce déséquilibre crée à la fois des opportunités et des défis pour aligner le développement minier sur la durabilité, la gouvernance et une croissance équitable. Le tableau 2 résume les matériaux clés utilisés dans les technologies bas carbone. Selon les scénarios, la demande pour certains de ces minéraux en particulier ceux utilisés dans la production de batteries pourrait augmenter de 150% à plus de 1000% (Bank, 2017*a*).

TABLE 2 : Matériaux clés pour certaines technologies vertes

| | Éolien | Solaire | Batteries |
|---|---|---|---|
| Aluminium | X | X | X |
| Chrome | X | | |
| Cobalt | | | X |
| Cuivre | X | X | |
| Terres rares | | X | |
| Fer | X | X | |
| Plomb | X | X | X |
| Lithium | | | X |
| Manganèse | X | | X |
| Nickel | X | X | X |
| Argent | | X | |
| Acier | X | | X |
| Zinc | X | X | |

FIGURE 3 : Émissions annuelles futures de gaz à effet de serre




The five scenarios are SSP1-1.9 (target 1.4°C), SSP1-2.6 (1.8°C), SSP2-4.5 (2.7°C), SSP3-7.0 (3.6°C) and SSP5-8.5 (4.4°C). Source : World Bank (2021)

## Matières premières critiques et terres rares : nouvelles ressources stratégiques pour la transition énergétique mondiale

La transition énergétique mondiale redessine le paysage de l'économie des ressources naturelles. Alors que les ressources traditionnelles telles que le pétrole, le charbon et le gaz naturel ont longtemps soutenu le développement industriel, le passage aux technologies bas carbone a mis en avant une nouvelle catégorie de ressources : les matières premières critiques (CRM) et les terres rares (REEs). Selon la Commission européenne (2023), les matières premières critiques sont celles qui sont économiquement et stratégiquement importantes pour l'économie, mais dont l'approvisionnement est exposé à des risques élevés de perturbation Grohol et Veeh (2023). Ces minéraux notamment le lithium, le cobalt, le nickel et les terres rares constituent des intrants essentiels pour les infrastructures d'énergie renouvelable, la mobilité électrique et les technologies numériques. Ils sont également indispensables aux technologies modernes telles que les batteries, les éoliennes, les semi-conducteurs et les véhicules électriques. Parmi eux, les terres rares, un groupe de 17 éléments métalliques comprenant le néodyme, le dysprosium et le terbium, sont incontournables pour la production d'aimants permanents et de composants haute performance utilisés dans les systèmes d'énergie renouvelable et l'électronique. Contrairement aux ressources énergétiques traditionnelles, les minéraux critiques ne sont pas utilisés principalement pour la production d'énergie, mais plutôt pour la fabrication des technologies énergétiques. Leur extraction et leur transformation nécessitent des infrastructures différentes, souvent moins étendues en termes d'échelle physique mais beaucoup plus exigeantes en sophistication technologique et en contrôle environnemental. De plus, l'extraction et le raffinage sont fortement concentrés dans quelques pays, générant de nouvelles formes de dépendance et de risque géopolitique. Du côté de la demande, l'expansion rapide des véhicules électriques, des batteries et des systèmes d'énergie renouvelable a déclenché une hausse structurelle des besoins pour ces matériaux, suscitant des inquiétudes quant à la sécurité d'approvisionnement et à la volatilité des marchés. Comprendre les dynamiques de production, de transformation, de consommation et de constitution de stocks des minéraux critiques est ainsi devenu central dans les débats de politique économique. Comparer ces nouvelles ressources aux ressources traditionnelles permet de mettre en lumière les défis et les opportunités distincts de la transition énergétique, allant des modèles d'investissement aux questions de gouvernance et de risques de conflits dans les pays riches en ressources.

## Pays africains, changement climatique et minéraux de la transition énergétique (ETMs)

Les matières premières critiques (CRMs) regroupent un ensemble plus large de ressources identifiées comme économiquement vitales mais soumises à des contraintes d'approvisionnement, tandis que les

minéraux de la transition énergétique (ETMs) désignent spécifiquement les minéraux essentiels aux technologies d'énergie propre. De nombreux ETMs, tels que le lithium, le cobalt et les terres rares, sont donc également classés parmi les CRMs par la Commission européenne et l'AIE, reflétant leur double importance pour les systèmes énergétiques et la résilience stratégique. Les pays africains se situent au cœur d'une intersection complexe entre les impératifs de l'atténuation du changement climatique et les réalités géopolitiques de la transition énergétique. Le continent est doté d'importantes réserves de minéraux de la transition énergétique (ETMs) : cobalt en République démocratique du Congo, lithium au Zimbabwe et au Mali, cuivre en Zambie et en RDC, ainsi que terres rares dans des pays comme l'Afrique du Sud et Madagascar. Ces minéraux constituent des composants indispensables des technologies vertes, batteries de véhicules électriques, cellules photovoltaïques, éoliennes, systèmes de stockage qui sont essentielles à la décarbonation de l'économie mondiale. Cette demande croissante offre aux économies africaines une opportunité unique de se repositionner dans les chaînes de valeur mondiales du XXI siècle. Les revenus tirés des ETMs pourraient catalyser l'industrialisation, créer des emplois et financer les efforts d'adaptation au climat. Toutefois, la concrétisation de ces bénéfices est loin d'être garantie. De nombreux pays africains riches en ressources sont confrontés à de sérieux défis structurels : gouvernance faible, infrastructures limitées, dégradation environnementale et instabilité sociopolitique. Le secteur minier, en particulier, est souvent marqué par des contrats opaques, une faible transformation locale, et un passé de pratiques extractives qui ont appauvri les communautés et dégradé les écosystèmes. De plus, le changement climatique représente lui-même une menace directe pour le développement africain et complique la gouvernance des industries extractives. La hausse des températures, l'irrégularité des précipitations et l'augmentation de la fréquence des événements météorologiques extrêmes réduisent la productivité agricole, aggravent la rareté de l'eau et augmentent les risques de déplacement et de conflits, autant de phénomènes qui exercent une pression supplémentaire sur les gouvernements et les populations locales. Dans les régions minières, ces dynamiques peuvent intensifier la concurrence pour les terres et l'eau, alimenter les frustrations et accentuer les inégalités.

Pour naviguer cet équilibre délicat, les pays africains et la communauté internationale doivent adopter une approche holistique et prospective. Cela implique de renforcer les capacités institutionnelles, de faire respecter les garanties environnementales et sociales, de promouvoir la transformation locale et la création de valeur, et de veiller à ce que la richesse minérale contribue réellement aux objectifs plus larges de développement. Tout aussi important est le besoin d'intégrer la résilience climatique dans les stratégies minières nationales, d'associer les communautés locales aux processus décisionnels, et d'assurer transparence et équité dans le partage des bénéfices. En définitive, si elles sont gérées de manière responsable, les ressources africaines en ETMs peuvent constituer un levier non seulement pour la décar-

bonation mondiale, mais aussi pour promouvoir une transition énergétique juste et inclusive, soutenant le développement à long terme du continent, sa stabilité et sa résilience face au climat.

## La malédiction des ressources et le développement

**Ressources naturelles et croissance économique**

La relation entre l'abondance de ressources naturelles et la croissance économique intrigue depuis longtemps les économistes et les décideurs politiques. En théorie, les ressources naturelles devraient servir de catalyseur au développement, en fournissant aux États les revenus nécessaires pour investir dans les infrastructures, l'éducation et les soins de santé. Cependant, les preuves empiriques en particulier dans le contexte africain révèlent une réalité plus complexe. Le paradoxe de l'abondance, également appelé « **malédiction des ressources** », suggère que les pays riches en ressources naturelles connaissent souvent une croissance économique plus lente que ceux disposant de dotations plus limitées Sachs et Warner (2001). Ce paradoxe est particulièrement marqué en Afrique subsaharienne, où de nombreux pays riches en ressources ont peiné à transformer cette richesse en un développement économique durable et largement partagé. Du secteur pétrolier du Nigeria aux richesses minérales de la République démocratique du Congo, le continent offre de nombreux exemples où l'abondance de ressources n'a pas conduit à une amélioration significative du niveau de vie. Cette observation a suscité un intérêt croissant parmi les chercheurs pour comprendre les mécanismes sous-jacents qui relient la richesse en ressources aux performances économiques en Afrique.

**Maladie hollandaise et structure économique**

L'un des mécanismes économiques les plus souvent cités pour expliquer comment les ressources naturelles peuvent nuire à la croissance est la maladie hollandaise. Ce phénomène se produit lorsqu'un boom dans le secteur des ressources entraîne une appréciation du taux de change réel, rendant les autres secteurs échangeables en particulier l'agriculture et l'industrie manufacturière moins compétitifs. Par conséquent, les économies deviennent excessivement dépendantes des exportations de matières premières, souvent volatiles, et échouent à se diversifier. En Afrique, plusieurs pays ont observé cette dynamique de près. Par exemple, en Angola et au Nigeria, l'essor des exportations pétrolières s'est accompagné de la stagnation, voire de l'effondrement, des secteurs agricole et industriel. Ce manque de diversification accroît la vulnérabilité aux chocs externes, notamment aux fluctuations des prix mondiaux des matières premières, et compromet les perspectives de développement à long terme. De plus, la nature d'enclave de nombreuses industries extractives en Afrique limite leur intégration dans l'économie nationale. Intensives en capital et souvent contrôlées par des entreprises étrangères, ces industries génèrent un emploi limité et entretiennent

de faibles liens avec les entreprises locales, réduisant encore davantage leur impact sur le développement.

**Volatilité et instabilité macroéconomique**

Les revenus tirés des ressources naturelles sont notoirement volatils, soumis à des variations imprévisibles des prix mondiaux des matières premières. Cette volatilité constitue un défi majeur pour la gestion macroéconomique, en particulier dans les pays africains à faible revenu disposant de capacités institutionnelles limitées. Des baisses soudaines des prix peuvent entraîner de graves crises budgétaires, tandis que les recettes exceptionnelles sont souvent mal gérées en raison de systèmes de finances publiques peu performants. Dans des pays comme la Zambie, le Ghana et le Tchad, les cycles d'expansion et de récession liés aux recettes du cuivre, de l'or et du pétrole ont provoqué des déficits budgétaires répétés, des pressions inflationnistes et une augmentation des niveaux d'endettement. L'incapacité à lisser les dépenses dans le temps en raison d'institutions faibles ou de contraintes politiques a sapé la discipline budgétaire et la stabilité macroéconomique. Ces dynamiques réduisent également l'efficacité de l'investissement public et limitent le potentiel de croissance durable.

**Qualité institutionnelle et gouvernance**

L'abondance de ressources naturelles a également des implications profondes pour le développement institutionnel, en particulier dans les pays africains où les structures de gouvernance sont fragiles. Une littérature croissante met en évidence les effets négatifs de la richesse en ressources sur la qualité de la gouvernance et la responsabilité démocratique. Ross (2001) identifie trois mécanismes par lesquels les rentes des ressources peuvent affaiblir les institutions démocratiques. Premièrement, l'effet rentier suggère que les gouvernements dépendant des revenus tirés des ressources sont soumis à une pression moindre pour taxer les citoyens, ce qui affaiblit le contrat social et réduit les incitations à la transparence et à la reddition de comptes. Deuxièmement, l'effet de répression implique que la richesse en ressources permet aux régimes de financer des appareils coercitifs, souvent utilisés pour réprimer la contestation et consolider le pouvoir. Troisièmement, l'effet de modernisation avance que les économies dépendantes des exportations de ressources ont tendance à sous-investir dans l'éducation et le capital humain, ralentissant l'émergence d'une classe moyenne qui soutient habituellement les institutions démocratiques. Dans de nombreux pays africains, ces dynamiques sont clairement observables. Par exemple, au Tchad, en Guinée équatoriale et au Soudan, la richesse en ressources a coïncidé avec la persistance de régimes autoritaires, l'érosion des mécanismes institutionnels de contrôle et la marginalisation de la société civile. De plus, la concentration des rentes dans les mains des élites politiques a favorisé l'émergence de réseaux de patronage, de clientélisme et une corruption généralisée. Les études empiriques montrent également que des cadres juridiques faibles et une transparence limitée concernant les contrats et la gestion des revenus

issus des ressources sont associés à des niveaux plus élevés de corruption dans les États africains riches en ressources (Leite et Weidmann (1999) ; Knutsen et al. (2016)). Ce déficit de gouvernance fausse non seulement les dépenses publiques, mais il sape aussi la légitimité des institutions étatiques et compromet les perspectives de développement inclusif.

**Conflits et instabilité politique**

Une autre dimension essentielle de la malédiction des ressources en Afrique est la probabilité accrue de conflits violents et d'instabilité politique. Un important corpus de recherches empiriques montre que la présence de ressources naturelles de grande valeur en particulier lorsqu'elles sont facilement exploitables, comme les diamants alluvionnaires, l'or ou le cobalt peut alimenter les guerres civiles et prolonger les conflits existants (Collier et Hoeffler (2005) ; Berman et al. (2017)). Ces ressources offrent à la fois le motif et les moyens aux groupes armés pour contester le contrôle de territoires, tout en affaiblissant l'autorité de l'État dans les régions périphériques. Dans des pays comme la République démocratique du Congo, le Soudan du Sud et la République centrafricaine, les zones riches en ressources sont devenues des épicentres de conflits armés, impliquant souvent à la fois des acteurs nationaux et des réseaux transnationaux. La compétition pour l'accès aux rentes minérales favorise la fragmentation, sape la cohésion nationale et crée des incitations perverses à l'encontre d'une gouvernance pacifique. Par ailleurs, la présence d'industries extractives dans des zones sujettes aux conflits exacerbe souvent les griefs liés aux droits fonciers, à la dégradation environnementale et à l'exclusion des retombées économiques, alimentant ainsi davantage l'instabilité. Ces dynamiques ont non seulement des conséquences humaines dévastatrices, mais elles imposent également des coûts économiques considérables en perturbant la production, en décourageant l'investissement et en détruisant les infrastructures publiques. Dans les États africains fragiles, le risque de conflit lié aux ressources naturelles constitue ainsi un obstacle majeur au développement à long terme

**Inégalités et disparités régionales**

La croissance tirée par les ressources en Afrique n'a que rarement conduit à une amélioration généralisée du bien-être ; elle a au contraire souvent entraîné une augmentation des inégalités et des disparités régionales. La nature extractive de nombreuses industries caractérisées par une forte intensité capitalistique et une concentration spatiale fait que les bénéfices de l'exploitation des ressources sont fréquemment captés par une élite restreinte ou confinés à des zones géographiques spécifiques. Ce phénomène est particulièrement visible dans des pays comme l'Angola, le Nigeria ou le Mozambique, où les villes côtières ou les régions proches des infrastructures pétrolières et gazières ont connu une croissance rapide, tandis que les zones intérieures ou rurales restent sous-développées et marginalisées. La concentration des revenus entre les mains des gouvernements centraux a également tendance à évincer les priorités de dé-

veloppement locales, en particulier en l'absence de mécanismes efficaces de décentralisation fiscale. Sans politiques redistributives solides et sans institutions inclusives, la richesse tirée des ressources naturelles peut exacerber les inégalités horizontales qu'elles soient ethniques, géographiques ou sociales. Ces inégalités menacent non seulement la cohésion sociale, mais peuvent aussi renforcer l'instabilité politique et miner la légitimité de l'État.

**Dégradation environnementale et enjeu de durabilité**

Enfin, l'exploitation des ressources naturelles en Afrique soulève des préoccupations environnementales et intergénérationnelles majeures. L'exploitation minière, l'extraction pétrolière et la déforestation ont contribué à une dégradation écologique généralisée, incluant la contamination des sols, la pollution de l'eau, la déforestation et la perte de biodiversité. Ces impacts environnementaux sont souvent supportés de manière disproportionnée par les communautés vulnérables, en particulier les populations autochtones et les petits exploitants agricoles, qui dépendent directement des écosystèmes naturels pour leurs moyens de subsistance. Dans de nombreux pays africains, la faiblesse des réglementations environnementales et le manque de capacité à les faire respecter permettent aux activités extractives de se poursuivre avec peu de considération pour la durabilité. L'accent mis sur la maximisation des rentes à court terme se fait fréquemment au détriment de la résilience écologique à long terme. De plus, la crise climatique ajoute une couche supplémentaire de complexité, car les économies dépendantes des combustibles fossiles doivent désormais s'engager sur des trajectoires de développement bas carbone. À mesure que l'économie mondiale se tourne vers les énergies renouvelables et les technologies vertes, les pays africains riches en ressources font face à la fois à des risques et à des opportunités. La demande croissante de minéraux critiques tels que le cobalt, le lithium et les terres rares pourrait offrir de nouvelles perspectives de croissance, mais seulement si ces ressources sont gérées de manière responsable et équitable. Sans une planification rigoureuse, le continent pourrait à nouveau se retrouver piégé dans une trajectoire de dépendance extractive, de dommages environnementaux et d'occasions manquées de transformation structurelle.

**Entre géopolitique et durabilité : la stratégie énergétique de la Chine en Afrique**

Depuis le début des années 2000, la Chine s'est imposée comme un acteur majeur de la transition énergétique en Afrique, en s'appuyant sur des investissements massifs dans les infrastructures énergétiques et dans l'extraction de ressources naturelles critiques. Selon l'Overseas Development Institute (ODI, 2022), entre 2010 et 2021, les institutions financières chinoises ont prêté en moyenne 18 milliards de dollars par an à des projets liés à l'énergie dans le monde, dont un tiers destiné aux pays africains, principalement via des contrats d'ingénierie, d'approvisionnement et de construction (EPC), sans prise de participation

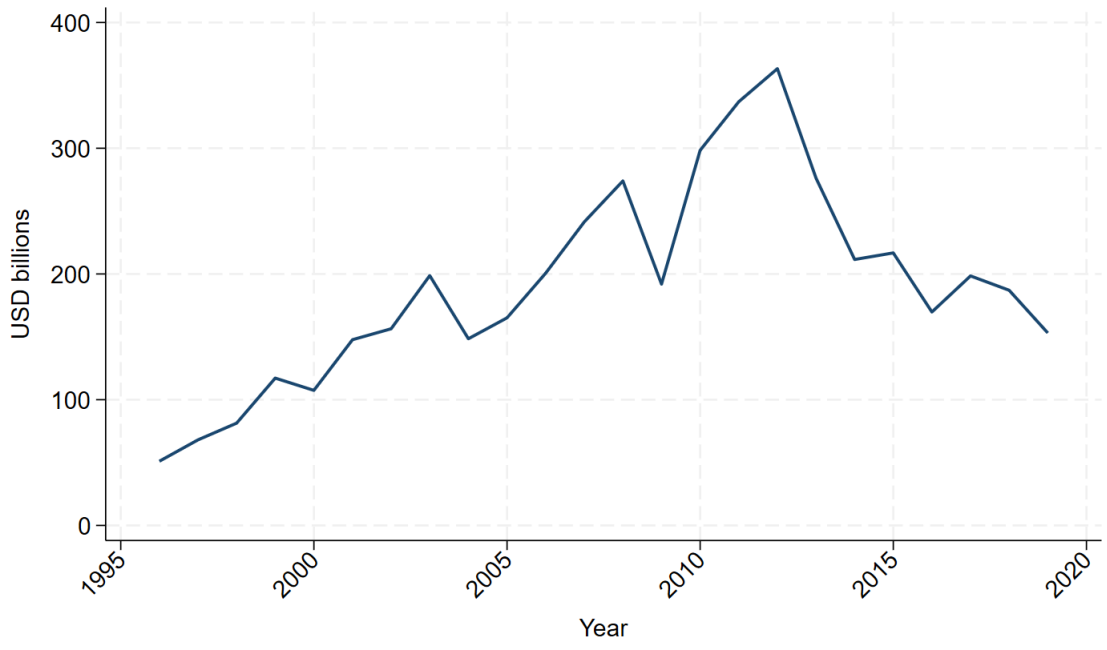
directe Kiryakova et al. (2025). Durant la même période, la Chine est devenue le premier investisseur mondial dans les énergies renouvelables ainsi qu'un exportateur dominant de technologies photovoltaïques, d'éoliennes et de batteries lithium-ion, des actifs stratégiques pour les pays africains cherchant à renforcer leur indépendance énergétique. Dans ce paysage en mutation, la Chine s'est positionnée comme un acteur central dans l'extraction, la transformation et le commerce des minéraux critiques : grâce à l'Initiative « Belt and Road » (BRI) et à des partenariats avec les gouvernements africains, elle a sécurisé le contrôle d'actifs miniers et de chaînes de valeur stratégiques, en particulier dans le cobalt, le cuivre et le lithium. Cette stratégie est particulièrement visible dans des pays riches en ressources comme la République démocratique du Congo (RDC), qui détient plus de 50% des réserves mondiales de cobalt, avec environ 80% des exportations contrôlées par des entreprises chinoises telles que Sinohydro dans le cadre d'accords « ressources contre infrastructures », comme le projet Sicomines, qui échange des concessions minières contre de vastes projets d'infrastructures. Des investissements similaires dans l'extraction du lithium au Zimbabwe et au Mali illustrent également l'effort délibéré de la Chine pour aligner sa politique étrangère sur des objectifs de sécurité en ressources à long terme. Bien que cette présence croissante ait amélioré l'accès à une énergie propre et durable pour plusieurs pays africains, ce qu'attestent des travaux académiques mettant en évidence des corrélations statistiquement significatives entre investissements chinois et accès à l'énergie elle suscite aussi des inquiétudes quant à des dépendances asymétriques, aux normes de gouvernance, aux impacts environnementaux et à des enjeux plus larges de souveraineté et de durabilité locale.

## 4.9 Statistiques sur les investissements directs étrangers (IDE) chinois en Afrique

Les données statistiques montrent une hausse marquée des investissements directs étrangers (IDE) chinois en Afrique depuis la fin des années 1990, culminant en 2013-2014, puis se normalisant jusqu'en 2020, une évolution cohérente avec les cycles mondiaux des matières premières et du financement (Figure4). Les données statistiques mettent en évidence une forte concentration sectorielle des investissements directs étrangers (IDE) chinois en Afrique, avec une nette prédominance des investissements dans les transports et l'énergie. Le secteur des transports représente à lui seul la plus grande part, suivi par l'énergie et l'immobilier (Figure6 et 7). Au niveau des sous-secteurs, les investissements sont fortement orientés vers le rail, l'automobile, l'hydroélectricité et la construction, tandis que le pétrole occupe une place relativement plus modeste. Les métaux, tels que le cuivre, restent marginaux en comparaison des investissements liés à l'énergie et aux infrastructures. Dans l'ensemble, cette configuration suggère une orientation stratégique

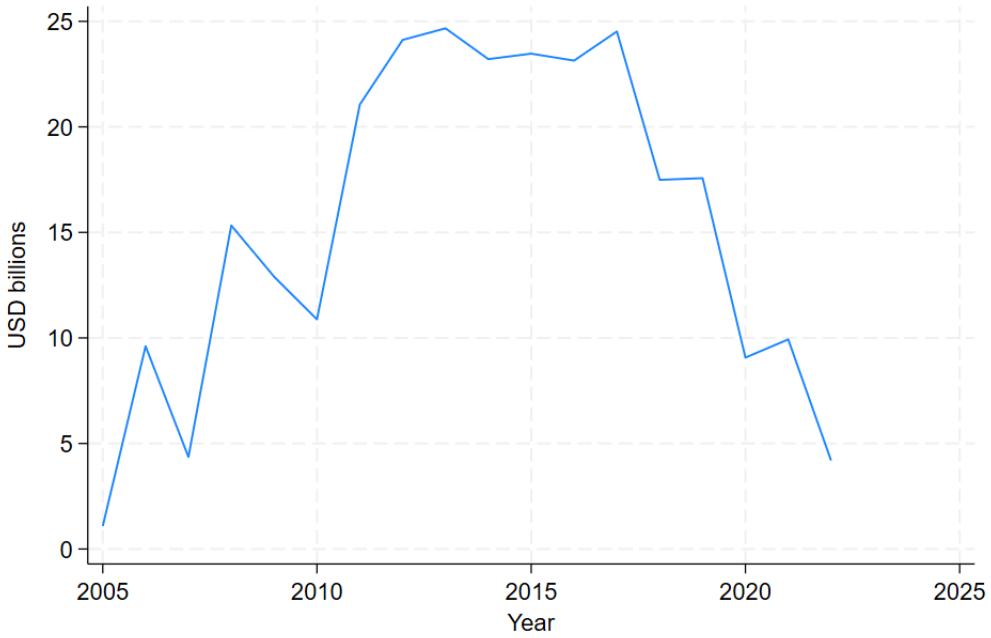
vers les infrastructures à grande échelle et les systèmes énergétiques, en cohérence avec les objectifs de renforcement de la connectivité, d'industrialisation et d'accès aux ressources clés . Géographiquement, les flux sont fortement concentrés : la RDC domine (en raison de ses dotations en cuivre et cobalt), suivie de grands récipiendaires tels que l'Afrique du Sud, le Nigeria, le Mozambique, la Namibie, la Zambie, le Zimbabwe et l'Égypte, tandis que de nombreux pays ne reçoivent que des volumes modestes (Figure2.A.2). Dans l'ensemble, l'analyse statistique met en évidence un profil d'IDE cyclique mais stratégiquement ciblé, orienté vers les hydrocarbures et les métaux essentiels à la transition énergétique, avec une forte concentration géographique, un modèle cohérent avec une stratégie géo-économique centrée sur la sécurisation des ressources critiques et l'accès en amont aux chaînes de valeur des minerais.

FIGURE 4 : Evolution des investissements directs étrangers (IDE) de la Chine en Afrique (1996-2019)



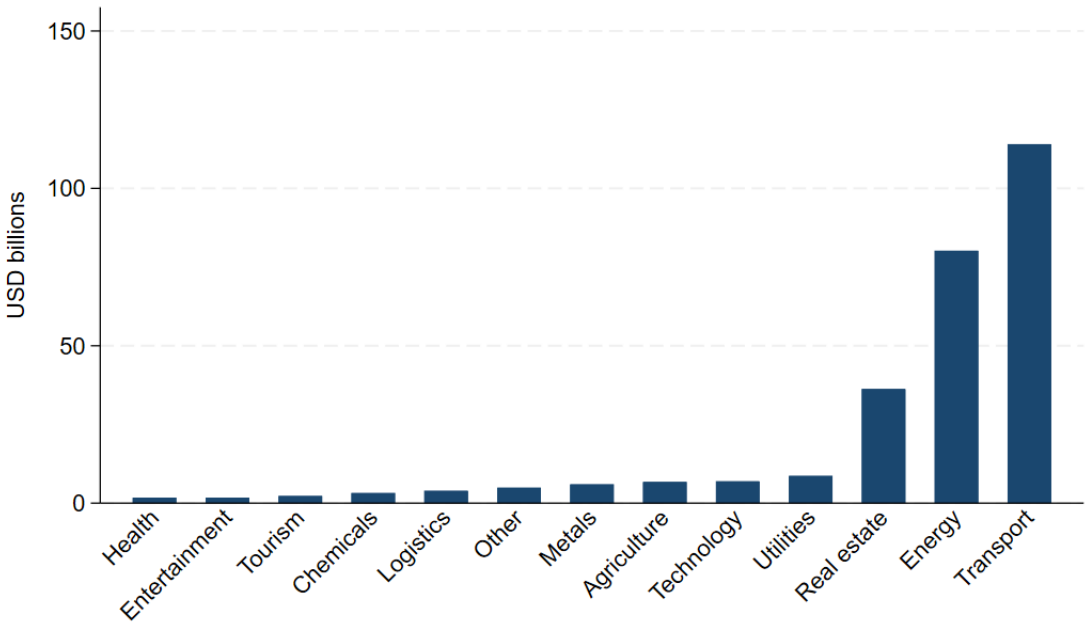

Élaboration de l'auteur Source : Données issues du ministère chinois du Commerce (MOFCOM)

FIGURE 5 : Evolution des investissements directs étrangers (IDE) de la Chine en Afrique (2005-2022)



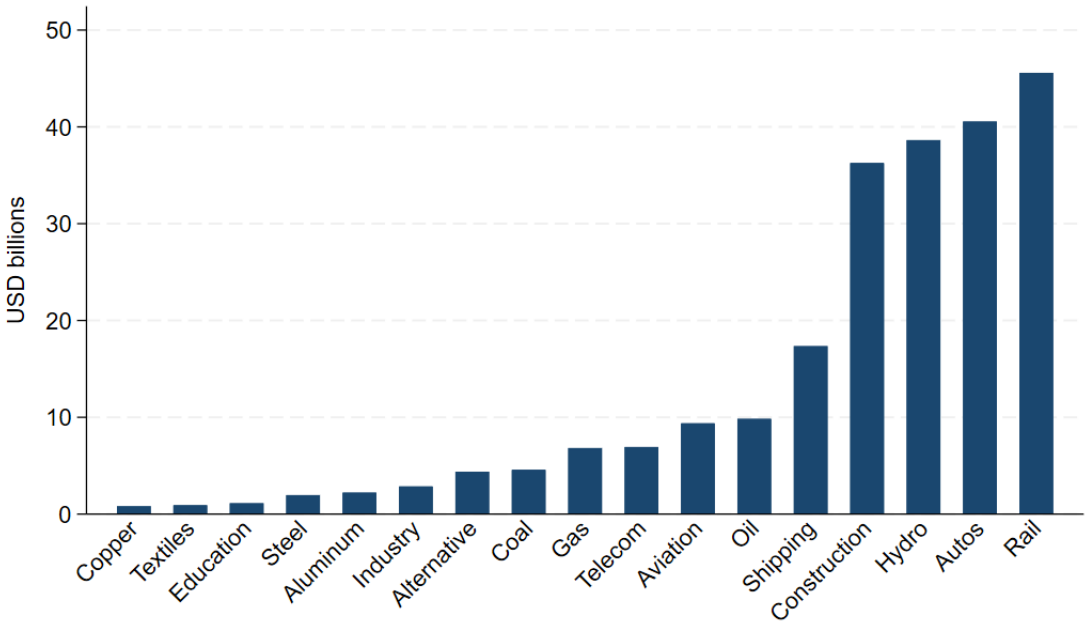

Élaboration de l'auteur Source : Données provenant de l'American Enterprise Institute : China Global Investment Tracker

FIGURE 6 : Part des IDE chinois en Afrique par secteur (2005-2022)




Élaboration de l'auteur Source : Données provenant de l'American Enterprise Institute : China Global Investment Tracker

FIGURE 7 : Part des IDE chinois en Afrique par sous-secteurs (2005-2022)



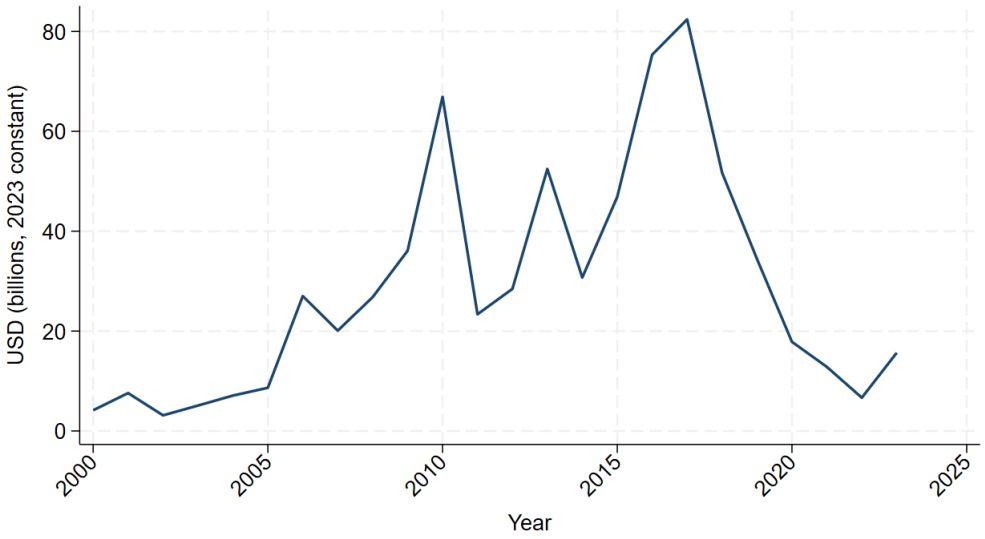

Élaboration de l'auteur Source : Données provenant de l'American Enterprise Institute : China Global Investment Tracker

## 4.10 Statistiques sur le financement du développement Afrique par la Chine

Les statistiques sur le financement du développement en Afrique par la Chine révèlent une trajectoire qui, globalement, reflète celle des IDE chinois, mais avec une volatilité plus marquée : une progression régulière depuis le début des années 2000, une forte hausse entre 2009 et 2016 avec des pics dépassant 70 à 80 milliards USD (en dollars constants de 2023), puis une contraction prononcée après 2017, en cohérence avec le durcissement par Pékin des conditions de prêt externes, l'accroissement des contraintes financières internes et la reconfiguration du financement de l'Initiative "Belt and Road" (Figure 8). Sur le plan géographique, le financement du développement chinois est encore plus concentré que les IDE : l'Angola et le Nigeria absorbent les parts les plus importantes (reflétant des lignes de crédit garanties par le pétrole et des méga-projets), suivis par le Ghana, l'Égypte, l'Afrique du Sud, la Guinée et l'Éthiopie, tandis que la plupart des autres pays ne reçoivent que des montants relativement modestes (Figure 9). Sur le plan sectoriel, le portefeuille est dominé par les secteurs des transports et de la logistique, de l'industrie/mines/construction et de l'énergie, qui représentent à eux seuls la majorité des engagements ; les secteurs sociaux (eau, assainissement, agriculture, infrastructures sociales) restent relativement mar-

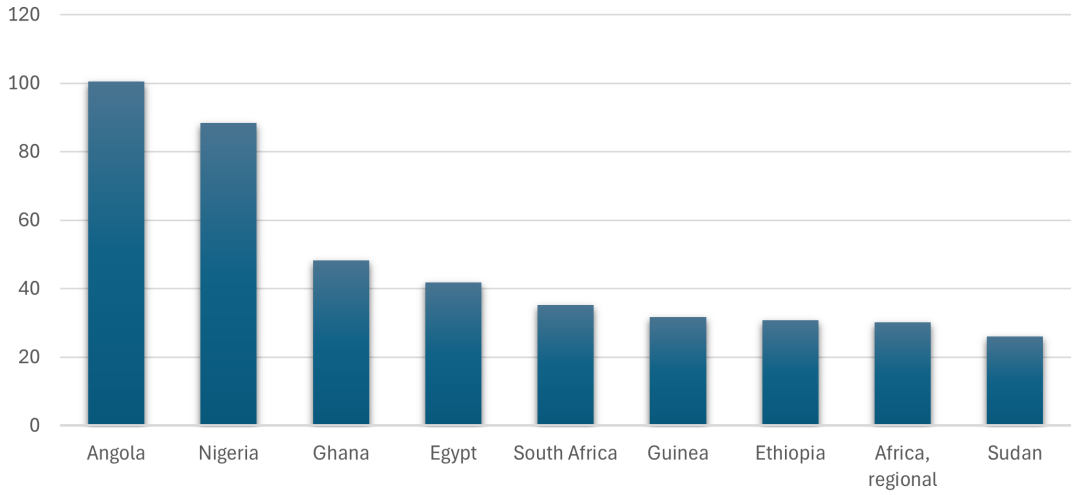
ginaux (Figure 10). Pris ensemble, ces schémas montrent que le financement chinois du développement constitue à la fois un pendant et un complément aux IDE chinois : de grande échelle, centré sur les infrastructures, fortement concentré et stratégiquement aligné sur les besoins en logistique, en capacités industrielles et en systèmes énergétiques nécessaires pour sécuriser et transporter les ressources naturelles, un élément particulièrement pertinent dans le contexte des transitions énergétiques mondiales, fortement dépendantes des minéraux.

FIGURE 8 : Évolution des financements du développement chinois par pays en Afrique au fil des années (2000-2024)



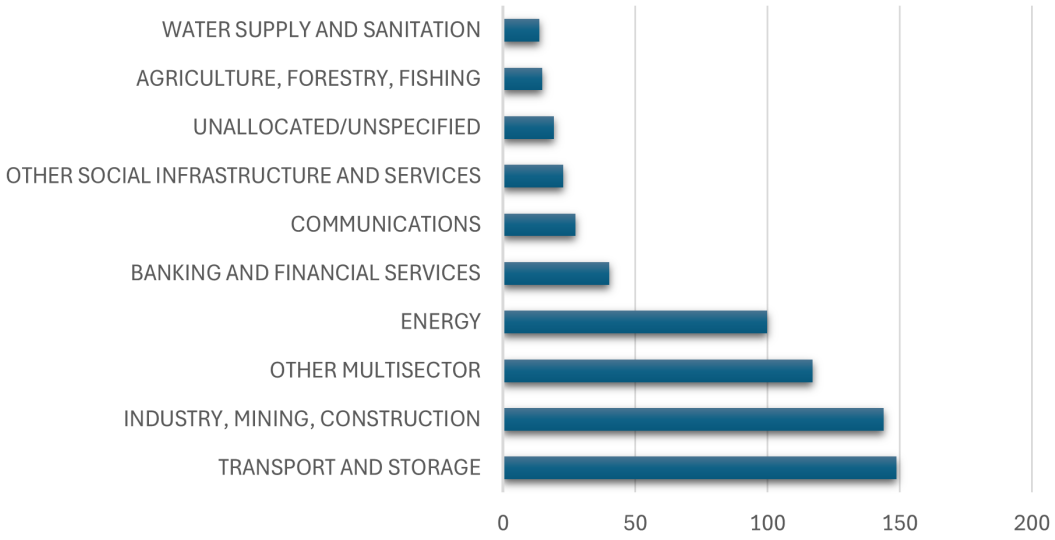

Calcul de l'auteur à partir des données d'AidData Source : Tierney et al. (2011)

FIGURE 9 : Part des financements chinois du développement en Afrique par pays(2000-2024)




Calcul de l'auteur à partir des données d'AidData Source : Tierney et al. (2011)

FIGURE 10 : Part des financements chinois du développement en Afrique par secteur (2000-2024)



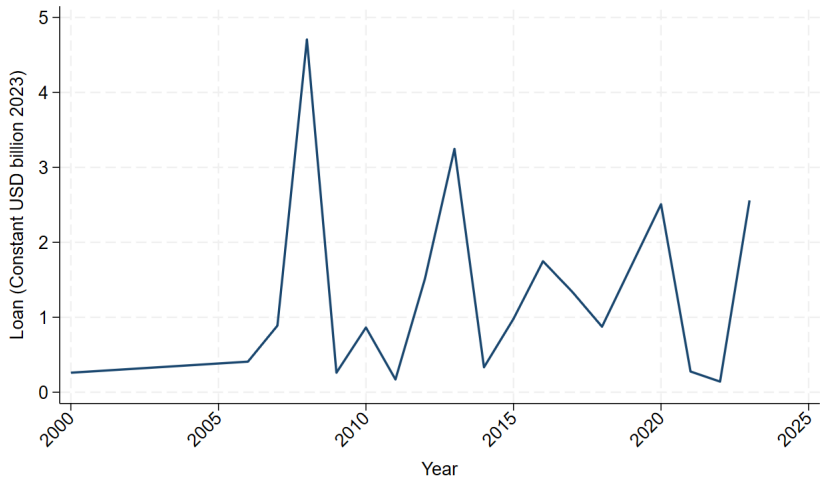

Calcul de l'auteur à partir des données d'AidData Source : Tierney et al. (2011)

## 4.11 Statistiques sur le financement chinois des minéraux de la transition énergétique en Afrique

La figure 11 montre que le financement chinois destiné aux minéraux de la transition énergétique en Afrique suit, depuis le milieu des années 2000, une trajectoire fortement irrégulière et dominée par des opérations ponctuelles, marquée par des pics prononcés (autour de 2009, 2014, 2021 et 2024) séparés par des années d'activité très limitée.Par catégorie de minéraux, le financement est largement concentré dans la chaîne de valeur cobalt–cuivre : la catégorie combinée *Cobalt/Copper* (environ 15,1milliards USD, en prix constants de 2023) dépasse de loin toutes les autres, suivie du *Copper* seul (environ 4,62milliards USD). Des montants nettement plus faibles sont dirigés vers le *Chrome*, le *Manganèse*, le *Niobium/Tantale*, les *terres rares* et le *Lithium*, reflétant une structure étroitement alignée avec les métaux critiques pour les composants de batteries, les câblages, les moteurs électriques et les infrastructures de réseaux (Figure 13). Géographiquement, le financement chinois est fortement concentré : la République démocratique du Congo domine (environ 15,1 milliards USD), suivie d'un deuxième groupe de pays récipiendaires tels que le Botswana (2,5 milliards USD), l'Afrique du Sud (1,90 milliard USD), la Zambie (1,88 milliard USD) et le Zimbabwe (0,59 milliard USD), avec une longue traîne incluant l'Érythrée, l'Ouganda, le Malawi, le Gabon ainsi que des mécanismes régionaux (Figure 12). Dans l'ensemble, la volatilité temporelle, la composition minérale et la concentration géographique mettent en évidence une stratégie chinoise ciblée visant à sécuriser l'accès en amont aux systèmes cuivre–cobalt (et, dans une moindre mesure, à d'autres

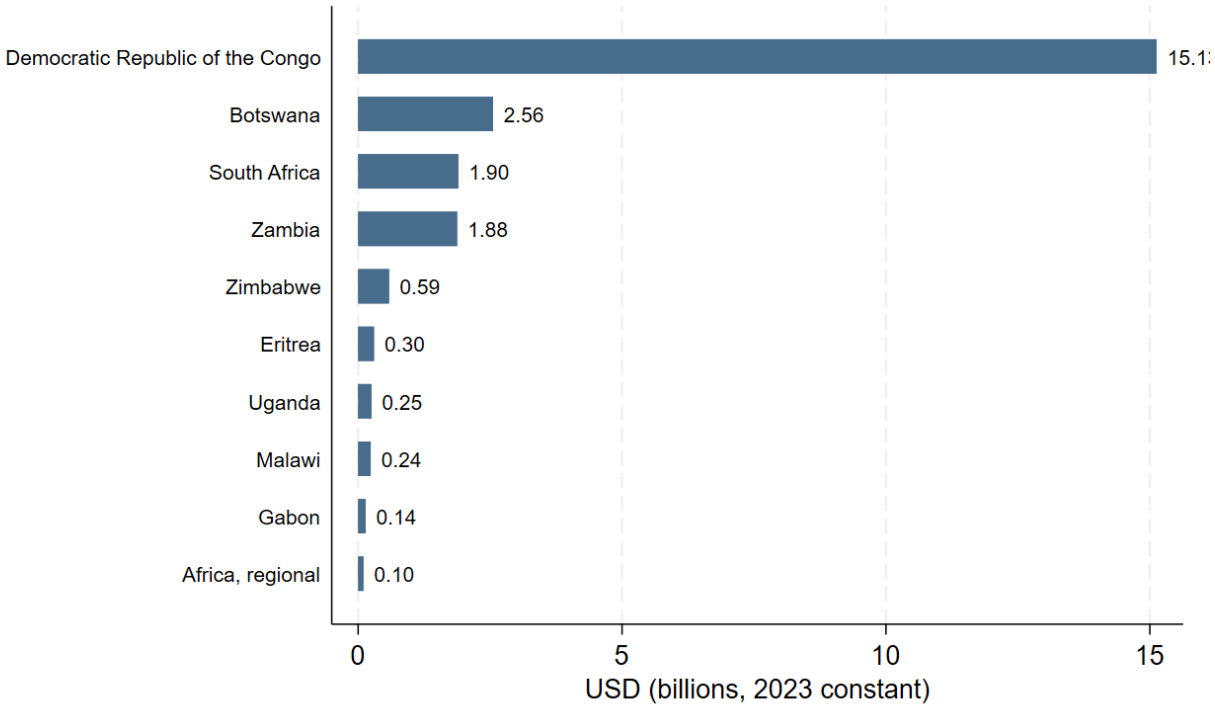
minéraux de la transition) au moyen de transactions intermittentes de grande ampleur dans un nombre limité de pays africains riches en ressources.

FIGURE 11 : Évolution des financements chinois des minerais de transition en Afrique (2000-2024)



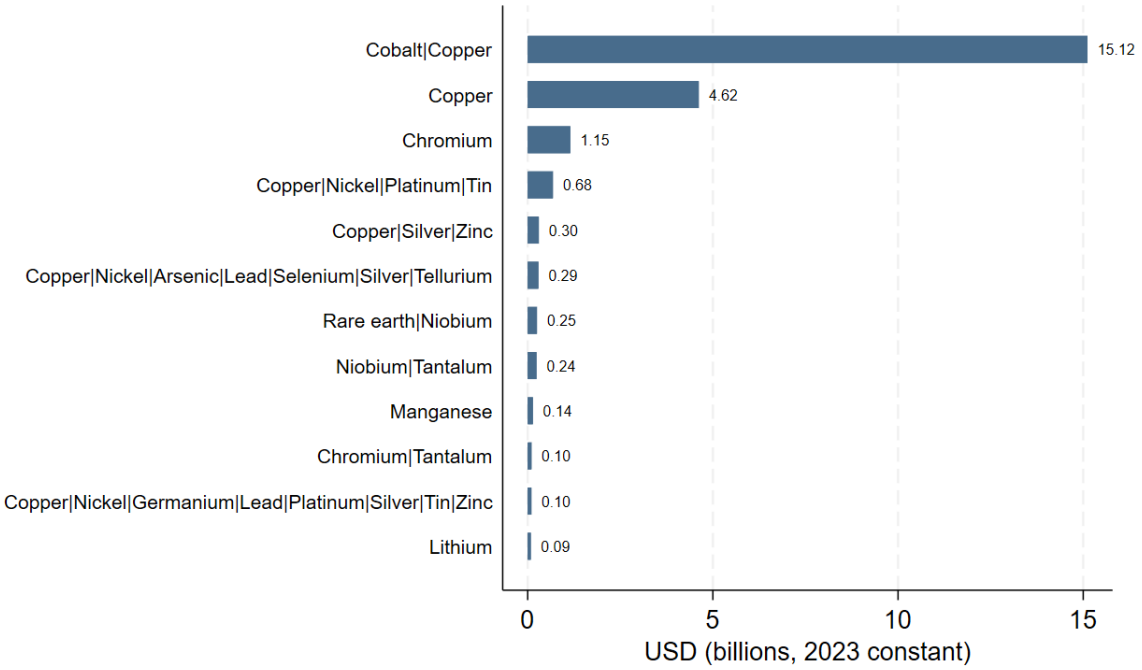

Calcul de l'auteur à partir des données d'AidData Source : Tierney et al. (2011)

FIGURE 12 : Évolution des financements chinois des minerais de transition par pays en Afrique (2000-2024)




Calcul de l'auteur à partir des données d'AidData Source : Tierney et al. (2011)

FIGURE 13 : Financements chinois des minerais de transition en Afrique par type de minerai (2000-2024)




Calcul de l'auteur à partir des données d'AidData Source : Tierney et al. (2011)

## Repenser la malédiction des ressources dans le contexte de la transition verte

L'abondance de ressources naturelles n'a pas toujours été une bénédiction pour les pays riches en ressources. Au contraire, elle a souvent été associée à des dynamiques perverses connues sous le nom de « malédiction des ressources ». Popularisée par Sachs et al. (1995), cette théorie postule que la richesse naturelle tend à freiner la croissance économique, à favoriser la corruption, à affaiblir les institutions et à alimenter les conflits. Plusieurs mécanismes sous-tendent cette théorie : la « maladie hollandaise », dans laquelle les afflux de capitaux liés aux ressources provoquent une appréciation de la monnaie et nuisent au secteur manufacturier ; la volatilité des prix des matières premières, qui entraîne une instabilité macroéconomique chronique ; le piège institutionnel, où les rentes issues des ressources nourrissent la corruption et affaiblissent la gouvernance démocratique ; et enfin, les conflits violents pour le contrôle des ressources, particulièrement dans les États fragiles. Aujourd'hui, dans le contexte de la transition énergétique verte, ces risques pourraient réapparaître sous de nouvelles formes. La demande croissante de minéraux stratégiques fortement concentrés dans quelques régions risque d'exacerber les tensions internes et externes, d'alimenter des logiques de prédation économique et de raviver des dynamiques néocoloniales.

## Afrique : naviguer entre potentiel et réalités politiques

L'Afrique occupe une place centrale dans cette nouvelle géopolitique des ressources. Le continent abrite 70% des réserves mondiales de cobalt (crucial pour les batteries électriques), 50% des métaux du groupe du platine, ainsi que d'importants gisements de lithium, de cuivre, de manganèse, de graphite et de terres rares. Des pays comme la République démocratique du Congo (RDC), la Zambie, le Zimbabwe, le Mali ou le Ghana sont désormais au cœur des stratégies mondiales d'approvisionnement. Pourtant, l'histoire récente de l'Afrique montre que la richesse naturelle ne s'est pas toujours traduite par la prospérité. L'extraction des ressources s'est souvent accompagnée de graves violations des droits humains, d'une dégradation environnementale massive et de conflits armés prolongés, comme l'ont illustré les « guerres du coltan » en RDC. Aujourd'hui, l'accélération de la transition énergétique mondiale menace de reproduire, sous de nouvelles formes, les mêmes mécanismes extractifs et exploiteurs observés durant les périodes coloniale et de la Guerre froide.

## La nouvelle course aux minéraux critiques

Dans ce reconfigurage géopolitique, les grandes puissances s'engagent dans une véritable course pour sécuriser l'accès aux minéraux critiques. La Chine a pris une longueur d'avance en investissant massivement dans l'extraction et le raffinage de nombreux de ces métaux. Son Initiative « Belt and Road » (BRI) inclut désormais des projets miniers en Afrique australe, centrale et orientale. Les États-Unis ont répliqué avec des initiatives telles que le « Mineral Security Partnership » pour diversifier leurs chaînes d'approvisionnement. L'Union européenne a lancé son Critical Raw Materials Act afin de réduire sa dépendance vis-à-vis de la Chine. Parallèlement, l'Inde, la Russie et le Japon cherchent eux aussi à sécuriser des approvisionnements stratégiques en Afrique. Cette compétition intensifie les risques de nouvelles formes de dépendance, d'exploitation et de « recolonisation économique », via une aide conditionnelle, des investissements directs et des partenariats stratégiques déséquilibrés souvent au détriment de la souveraineté africaine.

## Un choix stratégique pour l'Afrique : choisir d'agir

L'Afrique se trouve désormais à la croisée des chemins : sera-t-elle une fois de plus soumise à l'exploitation de ses ressources avec peu de retombées pour son développement ? Ou pourra-t-elle transformer sa richesse naturelle en moteur de transformation structurelle, fondée sur des politiques économiques souveraines, durables et inclusives ? Le continent possède des atouts majeurs : une prise de conscience croissante de la nécessité de contrôler les chaînes de valeur (ex. : initiatives locales de traitement du cobalt en RDC) ;un pouvoir de négociation renforcé par la hausse de la demande mondiale et la diversification des partenaires ; une population jeune et éduquée ; des dynamiques régionales prometteuses, comme la

Zone de libre-échange continentale africaine (ZLECAf / AfCFTA). Cependant, saisir cette opportunité exigera de dépasser les logiques de rente et la vision à court terme. Cela nécessitera des investissements massifs dans les infrastructures, la gouvernance, la transparence et l'innovation technologique.

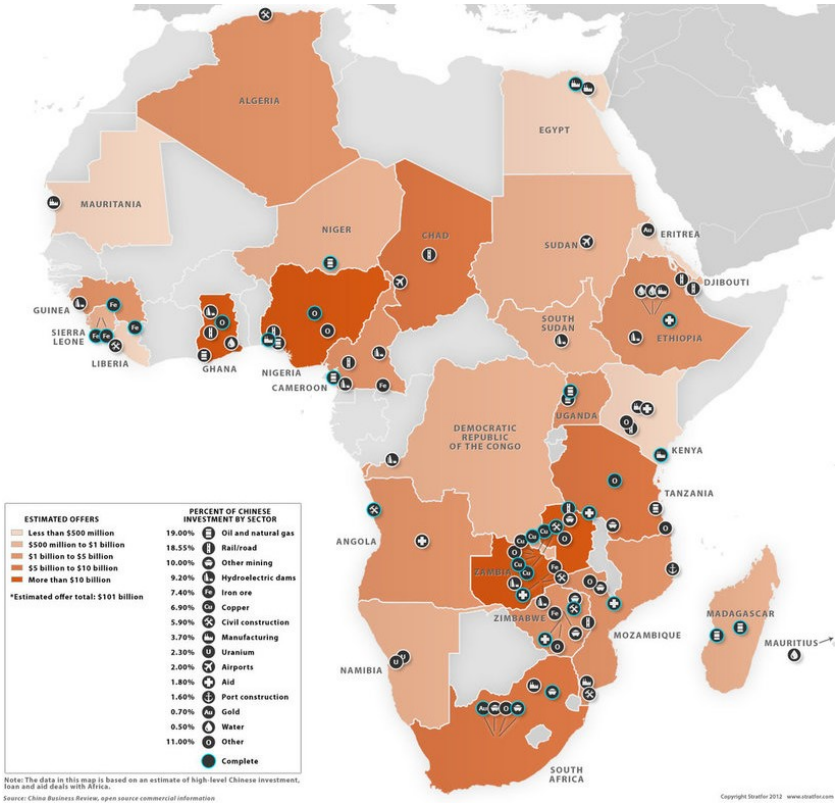
## Objectifs de la thèse

Cette thèse analyse la manière dont la transition énergétique mondiale reconfigure les dynamiques économiques et géopolitiques en Afrique, avec un accent particulier sur les stratégies chinoises et leurs implications pour les pays riches en ressources naturelles. Elle s'appuie sur quatre axes de recherche complémentaires permettant d'appréhender les interactions entre ressources, finance extérieure, gouvernance et risques socio-politiques.

Le premier volet examine dans quelle mesure la présence de ressources pétrolières, gazières ou minérales influence l'allocation de l'Aide publique au développement (APD) chinoise. En mobilisant des données macro et micro issues de projets géolocalisés, il montre que les pays disposant de ressources naturelles y compris les minéraux critiques , notamment le cobalt reçoivent davantage d'aide chinoise, en particulier pour les infrastructures et le secteur énergétique. Le deuxième axe analyse les moteurs sectoriels des investissements directs étrangers (IDE) chinois. Les résultats indiquent que, dans un contexte de transition énergétique, les IDE se réorientent progressivement du pétrole vers les minerais. Cette évolution redéfinit les priorités d'investissement et soulève des enjeux importants pour la politique industrielle et la planification des infrastructures en Afrique. Le troisième volet évalue le risque de conflit lié à la production de cobalt en République démocratique du Congo, en s'interrogeant sur la manière dont la hausse rapide de la demande mondiale de batteries pour véhicules électriques pourrait accroître l'instabilité dans les régions riches en cobalt et remodeler les dynamiques sociopolitiques locales. Enfin, le quatrième chapitre déplace l'analyse du volume des flux financiers vers leur qualité et leurs effets. À partir d'un panel de données et de méthodes économétriques avancées, il évalue la contribution des IDE de la Chine au développement durable dans les pays africains. Enfin, le quatrième chapitre dépasse la simple rhétorique en examinant si la Chine adopte réellement une démarche "verte" en Afrique. Dans ce dernier chapitre, nous évaluons si les investissements directs chinois à l'étranger contribuent effectivement à promouvoir des investissements durables sur l'ensemble du continent. Dans leur ensemble, ces quatre volets offrent une lecture intégrée des liens entre transition énergétique mondiale, stratégies chinoises et gouvernance des ressources africaines. En combinant méthodes spatiales, économétriques et analyses sectorielles, la thèse met en lumière les opportunités et les risques associés à la montée en puissance des minéraux de la transition énergétique,

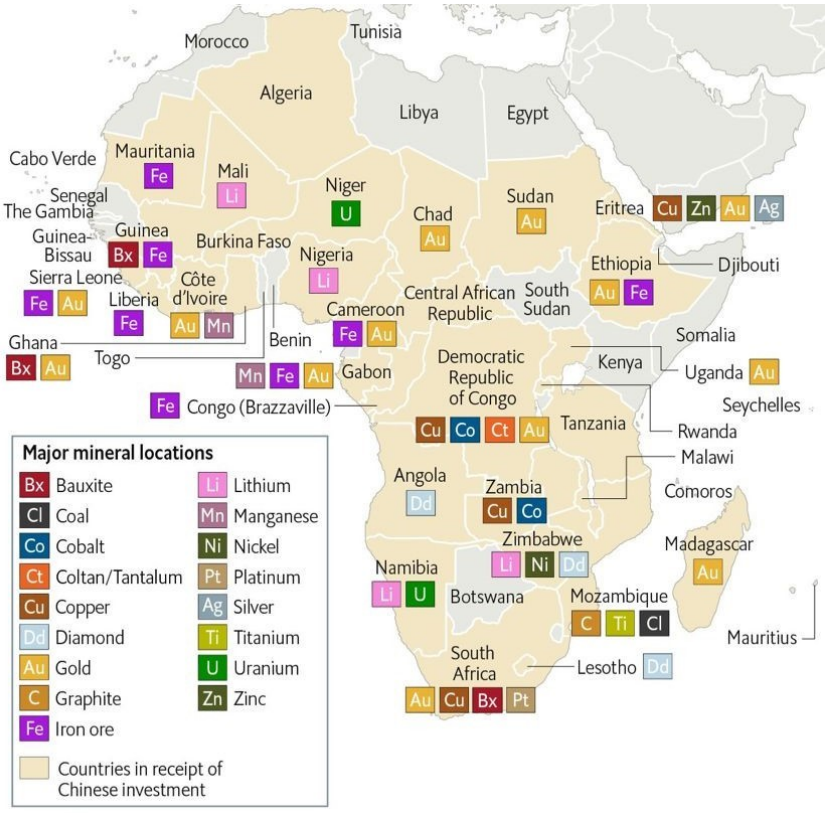
et interroge les conditions dans lesquelles l'Afrique pourrait transformer sa richesse naturelle en levier de développement structurel plutôt qu'en source renouvelée de dépendance.

FIGURE 14 : Les investissements de la Chine en Afrique depuis 2010




Source : China Business Review

FIGURE 15 : Investissements chinois en Afrique en 2021




Source : Economist Intelligence Unit (EIU)

## Contributions de la thèse

Cette thèse contribue à une meilleure compréhension de la manière dont la transition énergétique mondiale reconfigure les paysages économiques et géopolitiques des pays africains riches en ressources, en apportant des preuves empiriques nouvelles sur quatre fronts. Premièrement, elle montre que l'aide au développement, en particulier celle provenant de nouveaux bailleurs comme la Chine, est de plus en plus orientée vers les pays disposant de minéraux critiques tels que le cobalt, traduisant un alignement stratégique avec les priorités de la transition verte. Deuxièmement, elle démontre que les investissements directs chinois se détournent progressivement du pétrole au profit de minéraux liés à la transition énergétique tels que le cuivre et le cobalt, ce qui a des implications majeures pour les politiques industrielles africaines et la planification des infrastructures. Troisièmement, en se concentrant sur la République démocratique du Congo, la thèse développe un modèle prédictif qui démontre que la hausse rapide de la demande mondiale de batteries pour véhicules électriques pourrait accroître l'instabilité dans les régions riches en cobalt et remodeler les dynamiques sociopolitiques. En combinant analyse géospatiale, modélisation économétrique

et évaluation des politiques publiques, la thèse propose des éclairages fondés sur des données, particulièrement utiles pour les institutions internationales de développement cherchant à promouvoir une croissance durable, inclusive et sensible aux conflits dans un contexte de transition vers des énergies propres.

## Chapter 1 : Ressources naturelles et aide étrangère chinoise en Afrique : une dynamique à double face ?

Ce chapitre examine si les flux d'aide, en particulier en provenance de bailleurs émergents comme la Chine, sont de plus en plus alignés sur les intérêts stratégiques liés aux ressources, dans un contexte de transition énergétique verte. En mobilisant des données macro (niveau pays) et micro (projets géolocalisés) pour l'Afrique, les résultats montrent que les pays disposant de réserves de minéraux critiques (comme le cobalt) reçoivent significativement plus d'aide chinoise, notamment pour les projets d'infrastructures et d'énergie. Ces tendances posent des questions importantes sur la coordination des bailleurs, la transparence, et l'alignement de l'aide sur les objectifs de développement à long terme.

## Chapter 2 : : IDE chinois en Afrique, ressources naturelles et défis de la transition énergétique

Ce chapitre analyse les déterminants sectoriels des investissements directs étrangers (IDE) chinois en Afrique, avec un accent particulier sur les industries extractives. Il montre que, tandis que les IDE se réorientent progressivement vers les minéraux essentiels à la transition énergétique comme le cuivre et le cobalt, le pétrole perd de son attractivité en raison de sa volatilité et des risques liés au climat. Cette analyse offre des éclairages clés sur la manière dont la transition vers les énergies propres transforme les priorités d'investissement, avec des implications directes pour la politique industrielle africaine et la planification infrastructurelle.

## Chapter 3 : : Ne pas ignorer l'éléphant dans la pièce : cobalt, conflits et transition énergétique en RDC

Ce chapitre, centré sur la République démocratique du Congo, évalue dans quelle mesure la demande croissante de cobalt essentiel pour les batteries et les technologies des véhicules électriques pourrait accroître la fragilité et le risque de conflit. Bien que les données historiques montrent une corrélation plus faible entre cobalt et conflit qu'entre or et conflit, le chapitre développe un modèle économétrique d'alerte précoce qui grâce à un modèle prédictif utilisant des données géospatiales, montre une hausse du risque de conflits associée à l'intensification de la production de cobalt et à l'importance stratégique accrue de ce minerai dans la transition énergétique. Les résultats soulignent l'importance de renforcer les institutions locales, la régulation minière et les mécanismes de diligence raisonnable. Les résultats renforcent la nécessité de renforcer la gouvernance, le devoir de diligence et le développement local dans les zones minières des thèmes cruciaux pour les programmes FCV et de gouvernance de la Banque mondiale.

## Chapter 4 : : La Chine devient-elle « verte » en Afrique ?

Ce dernier chapitre déplace l'analyse des volumes d'aide et d'investissement vers la qualité et les résultats. En s'appuyant sur un jeu de données de panel et un ensemble de techniques économétriques avancées, il évalue dans quelle mesure les projets d'IDE chinois contribuent au développement durable dans les pays africains hôtes. Les résultats suggèrent que les IDE chinois jouent un rôle significatif et positif dans la promotion du développement durable en Afrique. Si certaines préoccupations persistent concernant les normes environnementales et la qualité des investissements, les preuves empiriques indiquent que l'engagement chinois soutient de plus en plus à la fois les objectifs de développement et les objectifs environnementaux.

# Conclusion Générale

Les défis jumeaux du développement durable et du changement climatique sont devenus des enjeux structurants du XXI siècle, en particulier pour les pays à revenu faible et intermédiaire. Alors que la communauté internationale accélère ses efforts pour limiter le réchauffement climatique et réduire les émissions de carbone, la demande en matières premières critiques telles que le cobalt, le cuivre et les terres rares s'est fortement intensifiée. Ces minerais sont indispensables au déploiement des technologies vertes, notamment les véhicules électriques, les éoliennes et les panneaux solaires. Si cette transition ouvre de nouvelles opportunités économiques pour les pays riches en ressources, en particulier en Afrique, elle s'accompagne également de risques importants. Elle ravive notamment des préoccupations anciennes liées à la gestion de la rente des ressources, à la fragilité institutionnelle et à la dégradation environnementale. L'Afrique subsaharienne dispose de vastes réserves de minerais essentiels à la transition énergétique mondiale. La République démocratique du Congo, à elle seule, fournit plus de 70% du cobalt mondial, un minerai considéré comme indispensable à la fabrication des batteries lithium-ion. Pourtant, malgré cette richesse naturelle, de nombreux pays africains peinent à transformer l'abondance des ressources en un développement inclusif et durable. Une littérature abondante sur la "malédiction des ressources" suggère que les ressources naturelles, loin de favoriser la prospérité, tendent souvent à exacerber les inégalités, à alimenter la corruption, à affaiblir les institutions et, dans certains cas, à provoquer des conflits violents. Ces défis sont particulièrement aigus dans des contextes marqués par une gouvernance faible, des capacités étatiques limitées et une concurrence géopolitique accrue pour l'accès aux matériaux stratégiques. Parallèlement, le rôle des puissances émergentes, en particulier celui de la Chine, a profondément transformé le paysage du développement et de l'investissement international en Afrique. Depuis le début des années 2000, la Chine est devenue un acteur majeur des secteurs extractif et infrastructurel africains, combinant souvent aide, prêts et intérêts commerciaux au sein de dispositifs intégrés. Dans les pays riches en minerais, ces engagements prennent fréquemment la forme d'accords dits de "ressources contre infrastructures", qui brouillent la frontière entre coopération au développement et diplomatie économique. Si ces arrangements peuvent contribuer à combler des déficits infrastructurels importants, ils soulèvent

également des inquiétudes en matière de transparence, de soutenabilité de la dette et de levier politique. Cette thèse contribue à la littérature sur l'économie politique des ressources naturelles en analysant la manière dont la transition énergétique mondiale transforme les flux d'aide, les investissements étrangers et les dynamiques de conflit dans les pays africains riches en ressources. Elle se situe à l'intersection de la gouvernance des ressources naturelles, du développement durable et de la concurrence géopolitique, avec un accent particulier sur l'influence croissante de la Chine. L'analyse mobilise à la fois des bases de données macroéconomiques et des données géospatiales infranationales afin de proposer une approche empirique et multi-scalaire. Le chapitre 1 examine si l'aide chinoise au développement en Afrique est de plus en plus orientée vers les pays dotés de ressources naturelles, en particulier ceux disposant de minerais critiques. À partir de statistiques au niveau national et de données de projets géolocalisées, l'analyse met en évidence une relation positive significative entre la présence de ressources naturelles ou de minerais liés à la transition énergétique et le volume de l'aide chinoise, notamment dans les secteurs des infrastructures et de l'énergie. Ces résultats suggèrent que les dotations en ressources influencent le comportement des bailleurs, avec des implications de long terme pour les trajectoires de développement africaines. Le chapitre 2 analyse la réorientation sectorielle des investissements directs étrangers (IDE) chinois en Afrique dans le contexte de la décarbonation mondiale. Alors que la Chine était auparavant un investisseur dominant dans le pétrole et le gaz, les données révèlent désormais un recentrage vers des minerais non fossiles tels que le cuivre et le cobalt. Cette évolution reflète à la fois des contraintes environnementales et des priorités de politique industrielle en Chine, et soulève la question de la capacité des économies africaines à tirer parti de cette transformation pour promouvoir la diversification et le changement structurel. Le chapitre 3 se concentre sur la République démocratique du Congo et analyse si l'augmentation de la demande mondiale de cobalt accroît le risque de conflit au niveau local. À l'aide d'un modèle économétrique d'alerte précoce fondé sur des données géospatiales, l'étude identifie des zones à haut risque où se combinent exploitation artisanale, faiblesse institutionnelle et chocs de prix internationaux, créant ainsi des conditions propices à une instabilité accrue. Les résultats soulignent l'importance des réformes réglementaires, du renforcement de la gouvernance locale et des cadres d'approvisionnement responsable. Le quatrième et dernier chapitre déplace l'analyse des volumes d'aide et d'investissement vers la qualité et les résultats. En mobilisant un jeu de données de panel et plusieurs techniques économétriques, il évalue dans quelle mesure les projets d'infrastructures financés par la Chine contribuent au développement durable dans les pays africains bénéficiaires. Les résultats sont contrastés : si l'accès à l'électricité et aux infrastructures routières s'améliore dans les zones concernées, les garanties environnementales et l'inclusion sociale restent souvent insuffisantes ou inégales. Le chapitre met en évidence l'importance de la standardisation des critères ESG, du renforcement institutionnel et de l'alignement des investissements étrangers sur les priorités des Objectifs de développement durable, domaines dans lesquels l'expertise et le leadership de la

Banque mondiale sont essentiels. En résumé, cette thèse apporte de nouveaux éclairages sur les risques et les opportunités que la transition énergétique fait peser sur l'Afrique. Si la demande en minerais stratégiques offre une opportunité de reconfigurer la place du continent dans l'économie mondiale, elle accentue également des vulnérabilités existantes liées à la gouvernance, aux inégalités et aux conflits. Relever ces défis exige plus qu'une simple extraction des ressources : cela requiert des stratégies de développement délibérées, inclusives et tournées vers l'avenir, capables d'aligner la richesse naturelle sur des objectifs sociétaux de long terme. Malgré les contributions de cette thèse, plusieurs limites doivent être reconnues. Premièrement, les analyses empiriques reposent sur des bases de données dont la couverture temporelle et spatiale demeure inégale selon les pays africains. Les données sur la production de minerais critiques, l'aide chinoise et les investissements en particulier ceux impliquant des entreprises publiques sont souvent fragmentées, incomplètes ou marquées par une opacité stratégique. Les résultats doivent donc être interprétés avec prudence lorsqu'il s'agit de généraliser à des contextes où les lacunes de données restent importantes. Deuxièmement, bien que la thèse mobilise à la fois des indicateurs macroéconomiques et des données géolocalisées, des erreurs de mesure potentielles concernant l'intensité de l'exploitation artisanale, la qualité institutionnelle ou les événements conflictuels infranationaux peuvent affecter la précision des estimations. Troisièmement, les stratégies d'identification causale adoptées ne permettent pas de saisir pleinement la complexité des processus de négociation géopolitique, des arrangements informels et des dynamiques élitaires qui façonnent la gouvernance des ressources, en particulier dans les États fragiles. En outre, la thèse se concentre principalement sur la Chine en tant qu'acteur externe, alors que d'autres puissances émergentes — notamment l'Inde, la Turquie et les pays du Golfe — jouent un rôle croissant dans les secteurs extractifs et infrastructurels africains, sans être couvertes par cette étude. Ces limites ouvrent plusieurs pistes de recherche futures. Il apparaît d'abord nécessaire de disposer de bases de données plus systématiques et transparentes sur les minerais critiques, les investissements liés à l'énergie et les contrats, afin d'approfondir la compréhension des transformations induites par la transition énergétique mondiale sur le financement du développement. Des travaux futurs pourraient mobiliser des techniques d'apprentissage automatique, l'imagerie satellitaire et la télédétection pour mieux suivre l'exploitation minière informelle, la dégradation des terres et le déploiement des infrastructures dans le temps et l'espace. Ensuite, des recherches supplémentaires devraient analyser les interactions entre plusieurs acteurs externes Chine, bailleurs occidentaux, investisseurs privés et banques de développement régionales afin d'évaluer si leurs engagements sont complémentaires, concurrentiels ou substituables. Enfin, l'élargissement de l'analyse aux dimensions environnementales et sociales permettrait de déterminer si la "ruée verte" actuelle reproduit les schémas extractifs passés ou favorise des trajectoires plus durables et inclusives. Des études d'économie politique plus fines, notamment au niveau des communautés et des sites miniers, pourraient également éclairer la manière dont les institutions locales, les autorités coutumières et

les normes sociales modèrent les risques et les opportunités associés à la demande mondiale de minerais critiques. En définitive, si cette thèse met en lumière des mécanismes clés reliant transition énergétique, gouvernance des ressources naturelles et engagements externes en Afrique, de nombreuses questions demeurent quant aux implications à long terme développementales, environnementales et géopolitiques de la centralité croissante du continent dans la quête mondiale de minerais stratégiques.

Koami TOGBETSE

**Politiques économiques et ressources naturelles dans le contexte de la transition énergétique**

Résumé :

Cette thèse s'inscrit dans l'économie politique des ressources naturelles en Afrique, dans le contexte de la transition énergétique mondiale. Elle analyse comment la demande croissante en minerais stratégiques (cobalt, cuivre, gaz naturel, etc.) recompose les dynamiques d'aide internationale, d'investissement étranger, de fragilité et de développement durable dans les pays riches en ressources. À travers quatre chapitres empiriques, elle mobilise des données macroéconomiques, géolocalisées et géospatiales afin d'éclairer les implications économiques, environnementales et institutionnelles de cette transformation. Le premier chapitre examine l'évolution des flux d'aide au développement notamment en provenance de la Chine à destination des pays africains riches en ressources naturelles, et donc détenteurs de minerais critiques nécessaires à la transition énergétique. En combinant données macro-pays et projets géolocalisés, les résultats montrent que ces pays reçoivent significativement plus d'aide, en particulier dans les secteurs des infrastructures et de l'énergie, ce qui soulève des défis de coordination entre bailleurs, de transparence et d'alignement avec les objectifs de développement à long terme. Le deuxième chapitre étudie les déterminants sectoriels de l'investissement direct étranger (IDE) chinois en Afrique, en mettant l'accent sur les industries extractives. Il met en évidence une réorientation progressive des IDE vers les métaux, le gaz et l'hydroélectricité, au détriment du pétrole, devenu moins attractif en raison de sa volatilité et des risques climatiques. Ces évolutions ont des implications directes pour les politiques industrielles, la planification des infrastructures et la diversification économique. Le troisième chapitre porte sur la République démocratique du Congo et évalue dans quelle mesure l'augmentation de la demande mondiale en cobalt accroît les risques de conflit au niveau local. Grâce à un modèle prédictif utilisant des données géospatiales, l'analyse montre une hausse du risque de conflits associée à l'intensification de la production de cobalt et à l'importance stratégique accrue de ce minerai dans la transition énergétique. Les résultats soulignent l'importance de renforcer les institutions locales, la régulation minière et les mécanismes de diligence raisonnable. Enfin, le quatrième chapitre évalue la contribution des IDE chinois au développement durable en Afrique. En mobilisant un ensemble d'indicateurs économiques, sociaux et environnementaux, les résultats montrent que ces investissements peuvent soutenir le développement durable lorsqu'ils financent des infrastructures de réseau (transport, électricité), améliorent l'accès à l'énergie y compris à des sources plus propres et génèrent des effets d'entraînement locaux (emplois, services, diversification). Toutefois, cet impact positif dépend fortement de la qualité institutionnelle, du respect de normes environnementales effectives et de l'existence de mécanismes de redevabilité capables d'encadrer les investissements et d'en répartir équitablement les retombées.

Mots clés : Transition énergétique, Ressources naturelles, Investissement direct étranger, Aide au développement, Gouvernance, RDC, Conflits, Cobalt, Chine–Afrique, Développement durable.

**Economic policies and natural resources in the context of the energy transition**

Abstract : This dissertation is situated within the political economy of natural resources in Africa, against the backdrop of the global energy transition. It examines how the rising demand for strategic minerals such as cobalt, copper, and natural gas is reshaping international aid dynamics, foreign investment patterns, fragility, and sustainable development prospects in resource-rich countries.Through four empirical chapters, it mobilizes macroeconomic, geolocated, and geospatial datasets to shed light on the economic, environmental, and institutional implications of these transformations. The first chapter analyses the evolution of development aid flows, particularly from China towards African countries endowed with natural resources, and therefore possessing critical minerals essential for the energy transition. Combining cross-country indicators with geocoded project data, the results show that these countries receive significantly more aid, especially in infrastructure and energy sectors. This raises important challenges related to donor coordination, transparency, and alignment with long-term development objectives. The second chapter investigates the sectoral determinants of Chinese foreign direct investment (FDI) in Africa, with a focus on extractive industries. It highlights a gradual reorientation of Chinese FDI towards metals, natural gas, and hydropower, and away from oil, which has become less attractive due to price volatility and climate-related risks. These trends have direct implications for industrial policy, infrastructure planning, and economic diversification strategies across the continent. The third chapter focuses on the Democratic Republic of Congo and evaluates whether the surge in global demand for cobalt increases local conflict risks. Using a geospatially informed predictive model, the analysis indicates a rise in conflict risk linked to cobalt production and to the increasing strategic relevance of this mineral in the global energy transition. The findings underscore the need to strengthen local governance, regulatory oversight, and responsible sourcing mechanisms. Finally, the fourth chapter assesses the contribution of Chinese FDI to sustainable development in Africa. Drawing on a range of economic, social, and environmental indicators, the results suggest that these investments can support sustainable development when they finance network infrastructure (transport, electricity), improve access to energy including cleaner segments and generate local spillovers (employment, services, diversification). However, the magnitude of these positive effects remains contingent upon institutional quality, effective environmental standards, and accountability mechanisms capable of regulating investments and distributing their benefits more equitably.

Keywords : Energy transition, Natural resources, Foreign direct investment, Development aid, Governance, DRC, Conflicts, Cobalt, China–Africa, Sustainable development.

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