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The impact of Greenfield FDI on Economic Growth and Environmental Performance in African Countries

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ABSTRACT

This paper explores the dynamics of greenfield Foreign Direct Investment (FDI) in Africa, focusing on its potential to drive sustainable economic growth and enhance environmental performance. While greenfield FDI offers significant opportunities for job creation and infrastructure development, it also poses challenges related to environmental degradation. Utilizing unbalanced panel data from 43 African countries between 2003 and 2023, the study employs fixed and random effects models to explore the impact of greenfield FDI on GDP growth and Carbon dioxide (CO_2) emissions across various sectors. The findings revealed that while greenfield FDI inflows generally correlate with increased economic growth, their relationship with CO_2 is complex, with significant variations across sectors. Notably, greenfield FDI in manufacturing demonstrates a potential for emissions reduction, whereas the services sector raises environmental concerns. The study provides critical insights for policymakers in African countries.

أثر الاستثمار الأجنبي المباشر على النمو الاقتصادي والأداء البيئي في الدول الأفريقية

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الكلمات المفتاحية:
الاستثمار الأجنبي المباشر في المشاريع الجديدة.
انبعاثات ثاني أكسيد الكربون.
الصناعات الاستخراجية.
قطاع الخدمات.

الملخص

تسعى هذه الورقة البحثية الى استكشاف ديناميكيات الاستثمار الأجنبي المباشر في أفريقيا، مع التركيز على قدرتها على دفع عجلة النمو الاقتصادي المستدام وتعزيز الأداء البيئي. فبينما توفر هذه الاستثمارات فرصًا كبيرة لخلق فرص العمل وتطوير البنية التحتية، فإنها تطرح أيضًا تحديات تتعلق بالتدهور البيئي، لا سيما في الصناعات الاستخراجية. لذا، تركزت هذه الدراسة على 43 دولة افريقية خلال الفترة من 2003 إلى 2023، واعتمدت على نماذج البانل الخاصة بالآثار الثابتة والعشوائية لتحليل أثر الاستثمار الأجنبي المباشر على نمو الناتج المحلي الإجمالي وانبعاثات ثاني أكسيد الكربون في بعض القطاعات الاقتصادية. أظهرت النتائج أن الاستثمار الأجنبي المباشر يؤدي الى زيادة النمو الاقتصادي، بينما اتسم أثرها على انبعاثات ثاني أكسيد الكربون بالتعقيد، مع وجود تباينات كبيرة بين المناطق والقطاعات. ومن الجدير بالذكر أن الاستثمارات في قطاع التصنيع تُظهر إمكانية خفض الانبعاثات، بينما يثير قطاع الخدمات مخاوف بيئية عالية. وتقدم الورقة توصيات مهمة لصانعي القرار في الدول الافريقية.

1.Introduction

Greenfield FDI refers to the investments which made by a foreign company to establish new operations or subsidiaries in a host country, effectively building from scratch. Although Greenfield FDI typically entails greater risks, it can generate greater long-term benefits, such as significant contributions to local economies through job creation and

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economic growth Lakemann et al (2025). For example, it accounts for more than 80% of total FDI projects in most countries in the Middle East and North Africa (MENA) and have created more than 50,000 jobs to date in Algeria, Egypt, Morocco, Saudi Arabia, Tunisia and the United Arab Emirates. On average, these investments accounted for 4.86% of the MENA region's GDP between 2003 and 2012. The Gulf Cooperation Council (GCC) countries are a major source of these greenfield FDI in neighbouring MENA countries and contribute significantly to intra-OIC relations Caccia, ed al, (2018). Furthermore, greenfield FDI projects usually result in higher levels of knowledge transfer and local capacity building, in addition to the enhancement of competition in local markets [1]. Hence, it offers opportunities for technology transfer and can stimulate the development of local supply chains, improving the overall economic outlook of host countries [2].

Greenfield FDI inflows target several sectors, namely: manufacturing, services, extractive industry, and agriculture, forestry and fishing. More specifically, in the extractive sector, Greenfield FDI is frequently utilized to establish new companies in the regions with untapped mineral resources or where local entities lack the capital for extensive exploration [3]. Meanwhile, the manufacturing and services sectors represent a crucial frontier for economic diversification. Within the aforementioned sectors, renewable energy projects, particularly solar and wind, have seen an increase in greenfield investments (Rashed, et al, 2021). For example, Africa has seen a dramatic rise renewable energy investment, reflecting a growing demand for clean energy solutions. These projects not only contribute to energy security, but also align with global sustainability goals (Alex-Oke, et al, 2025). Concurrently, greenfield FDI in Africa's extractive industries, such as mining, oil and gas extraction continues to be substantial (Hansen, 2014). While these investments offer significant economic opportunities, they often introduce complex environmental and social challenges, as pointed out by (Aneto, 2025). Investments in these areas can lead to increased local production capacities and reduced reliance on resource extraction, fostering more balanced and sustainable economic growth, positioning Africa for long-term prosperity beyond its natural resources. The relationship between extractive industries, manufacturing, services, and agriculture, forestry and fishing and sustainable development is complex and requires careful management to minimise negative impacts on local communities and ecosystems (Calderón et al, 2004; [4].

The objectives of this paper are threefold. The first is to explore the Impact of Greenfield FDI on economic growth. The second is to investigate the relationship between greenfield FDI and CO_2 Emissions, and the third is to identify sectoral dynamics by examining the unique impacts of greenfield FDI across key sectors, namely: extractive industries, manufacturing, services and agriculture, forestry and fishing. This paper contributes to several strands of the literature. Empirically, it provides empirical evidence of the relationship between greenfield FDI and economic growth, along with its environmental implications, contributing to the existing literature on greenfield FDI in Africa. With regard to sectoral analysis, this study provides a disaggregated view of greenfield FDI impacts. This approach allows for the identification of specific sectors that align with sustainability goals, providing policymakers with nuanced and actionable recommendations. Finally, regarding the policy recommendations, the findings offer actionable insights for improving investment climates and fostering responsible investment practices, promoting both economic resilience and environmental stewardship.

In line with the African agenda 2063 and the 17 sustainable development goals, it is critical that investment mechanisms address the overall challenge of ensuring that greenfield FDI drives a new green economy. By fostering collaboration in these critical areas, the potential of greenfield FDI can be harnessed to contribute significantly to sustainable development, benefiting both host countries and the broader global community. According to the United Nations Conference on Trade and Development (UNCTAD 2021), the African continent has seen a significant increase in greenfield investments in recent years, with a 39% increase in the number of announced projects, reaching 766 in 2022. These projects, which involve the creation of new activities from scratch, offer the opportunity to develop modern and sustainable infrastructure, thus responding to a growing demand for renewable energy and environmentally friendly services. However, this number of greenfield FDI announced projects presents both opportunities and challenges for sustainable economic growth and environmental performance (Aneto, 2025). While greenfield FDI can drive job creation and infrastructure development, it also carries risks of environmental degradation and social inequities, particularly within extractive industries. This complexity underscores the critical importance of the current study. By providing a comprehensive analysis of sectoral dynamics, this research offers essential empirical evidence required to navigate the greenfield FDI landscape, ensuring that investments not only spur economic growth but also align with Africa's long-term sustainability and environmental goals related to the 2063 agenda.

In addition to the introduction section above, this paper organized as follows: section 2 bases the theoretical foundation of the subject. Section 3 reviews the relevant literature. Section 4 present the methodology. Section 5 report and discusses the results, while section 6 draws the conclusion offers policy implications.

2.Theoretical Foundation

The theories in the framework greenfield FDI can be divided into two theories, namely, the pollution haven hypothesis and the Pollution Halo hypothesises, each of which is discussed below.

2.1. The Pollution Haven Hypothesis.

This theory posits that multinational corporations (MNCs) from developed countries may prefer locations with less stringent environmental regulations to reduce production costs. This may result in the transfer of harmful practices to host countries, contributing to environmental pollution (Aguilera-Caracuel et al. 2012). The continent is currently facing multifaceted environmental challenges exacerbated by rapid capital flows and human activities, including increased dependence on fossil fuels, urbanization, and economic growth (Lieder and Rashid 2016). In recent decades, climate change has emerged as a critical threat, affecting food security, economic stability, and overall human well-being (McMichael 2013). According to the International Energy Agency, Africa's primary energy supply has undergone significant changes, with a notable dependence on fossil fuels, which has implications for CO_2 emissions and overall environmental health. Rising fossil fuel consumption has led to increased emissions, contributing to poor air quality and health problems across the continent. The World Health Organization has reported that air pollution is a leading cause of respiratory diseases and premature deaths in many African countries.

2.2. The Pollution Halo Hypothesises.

Pollution Halo hypothesises argued that strong environmental laws in a host nation can lead international companies to adopt advanced technology, resulting in environmental improvements and sustainability. This occurs because companies engaging in greenfield FDI in environmentally stringent regions are compelled to adopt the most advanced, cleaner production technologies and management practices. The best example for the latter is renewable energy production, carbon, storage and utilizing and waste recycling. The hypothesis argues that these sophisticated technologies and practices, once implemented, can diffuse to local industries, effectively raising the overall environmental performance and contributing to long-term environmental improvements and sustainability within the host country. Generally, European region has more stringent regulation with regard to environment in comparison to African countries [5].

3.Literature Review

This section reviews previous literature in the impact of greenfield FDI on economic growth and environment degradation. For coherence, the literature review is divided into two segments. These are the greenfield FDI and economic growth nexus and the relationship between greenfield FDI and environment. The following sections reflects on each nexus by elaborating on existing relevant evidence.

3.1. Greenfield FDI and Economic Growth

There have been many studies that explore the nexus between greenfield FDI and economic growth. For example, [4] used a sample of 14 Eastern Africa countries to examine the impact of foreign direct investment on economic growth over the period from 1980 to 2013. Results confirmed a positive impact from the side of foreign direct

investment on economic growth. In Pakistan [6] found a positive impact of greenfield FDI on economic development during the period from 1990 to 2018. Furthermore, greenfield FDI facilitate the entry of productive foreign firms, leading to higher productivity gains. In support of this, Wang and Wong (2009) found that greenfield investments significantly boost economic growth in both developed and developing countries. Research by Liu and Zou (2008) indicates that greenfield FDI positively impact the innovation of domestic firms through both intra- and inter-industry R&D activities. More recently, Harms and Méon (2018) highlighted that these investments improve overall productivity by expanding the host country's capital stock. Conversely, there are a few studies documented a positive impact from the side of greenfield FDI on economic growth. For example, [7] examined the impact of greenfield FDI on sustainable economic growth and poverty reduction in 46 African countries during the periods from 2003 to 2020. Utilizing the fixed and random effect methods, finding revealed that greenfield FDI not only insignificant in terms of its relationship to economic growth but also promotes poverty reduction. In the same vein, Calderón et al. (2004) did not find a significant link, while Eren and Zhuang (2015) suggested that greenfield FDI might initially hamper growth and only stimulate it when the host country's absorptive capacity reaches a certain threshold. This indicates that the benefits of greenfield investments depend on the local context and institutional frameworks. Furthermore, some researches highlighted a potential negative impact from greenfield FDI, such as the crowding-out effect of domestic investment. In this regard, [8] [9] noted that greenfield FDI could displace local firms, as foreign firms often outperform their domestic counterparts in competing for market share. Balsvik and Haller (2010) also reported that increased competition in product and labour markets could exacerbate this displacement effect. In support of this view, [10] documented significant displacement effects in their analysis of 100 developing countries between 2003 and 2011. More recently, Chen et al. (2017) suggested that market-seeking new firms could displace domestic competitors, further complicating the relationship between foreign investment and local economic growth.

3.2. Greenfield FDI and Environment.

There are several studies that explore the nexus between greenfield FDI and environment. For example, [11], explored the effect of greenfield FDI on environmental quality in 34 less-developed countries from 2003 to 2021. Their findings uncovered that greenfield FDI helped to improve environmental quality. [12] tested both, the pollution Haven and the pollution Halo hypothesis, in addition to Environmental Kuznets Curve (EKC) in Indonesia during the period from 1976 to 2018. Results found strong evidence of the pollution Halo hypothesis and the EKC. This means that greenfield FDI impacts positively the environmental quality in Indonesia. However, at the beginning of this greenfield FDI, its impact on the environmental is negative, but after a certain threshold this impact becomes positive. In a comparison study, [13] compare the impact of greenfield FDI on environment in two different types of FDI, namely mergers and acquisitions (M&A) and greenfield FDI in a sample consist of 91 countries of 2005– 2020. Findings revealed that M&A is less harmful to the environment of host countries than greenfield FDI. In addition, greenfield FDI is found to be more harmful to the environment in emerging markets and developing countries than FDI from developed countries.

In conclusion, while greenfield FDI has the potential to boost economic growth and might enhance environmental quality, its effects are multifaceted and no decisive conclusion is reached. In addition, many studies look at total greenfield FDI, few disaggregate Greenfield FDI by sector in Africa, all of this indicate that this subject warrant further studies, particularly in African continental.

4.The African Context of Greenfield FDI

Africa is experiencing a significant influx of greenfield FDI, which presents both opportunities for economic growth and challenges related to environmental sustainability, particularly in sectors like services sector, where the sub energy and supply segments accounts for more than 50% of this sector in 2023.

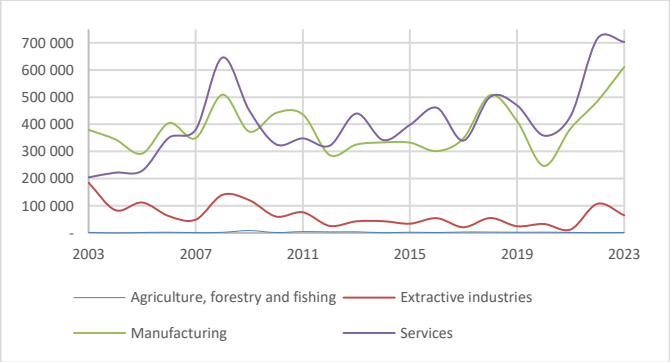

Fig. 1: Value of announced greenfield FDI projects, by sector/industry, 2003–2023 in millions of dollars

It can be seen from the chart that greenfield FDI flows into Africa have gained momentum, reflecting the continent's growing attractiveness as an investment destination. For example, in 2023, Africa attracted approximately 1309 billion $ in greenfield FDI, a significant increase compared to 2021. The chart illustrates the value of greenfield FDI projects, segmented into four sectors: services, extractive industries, manufacturing, and agriculture, forestry and fishing, from 2003 to 2023.

The value of greenfield FDI projects in the services and manufacturing sectors shows a fluctuating trend, with notable peaks in certain years, in particular around 2020 to 2023.Generally, these sectors exhibit a gradual upward trend, indicating a slow but steady increase in investments over the years. This suggests a growing recognition of the importance of manufacturing for economic diversification in Africa. This indicates periods of heightened investment interest, possibly linked to changes in global commodity prices or economic conditions in Africa. Conversely, the value of greenfield FDI projects in the extractive industries shows a fluctuating trend, with notable peaks in certain years, in particular around 2008 and 2022, but this sector showed a gradual downward trend, indicating a slow but steady decrease in investments over the years. Finally, the agriculture, forestry and fishing sector represent the lowest value of greenfield FDI projects during the entire period of the study.

In conclusion, service sector, which renewable energy projects is one of its subcategories, dominated the greenfield FDI landscape and it since around 2015 onwards, this sector started to grow considerably. This significant increase in the renewable energy projects in 2021 suggests a strong push towards renewable energy initiatives and infrastructure projects, possibly influenced by global shifts towards green energy and sustainability goals. Data for 2023 indicates a continuation of this trend, indicating continued investment interest in energy solutions.

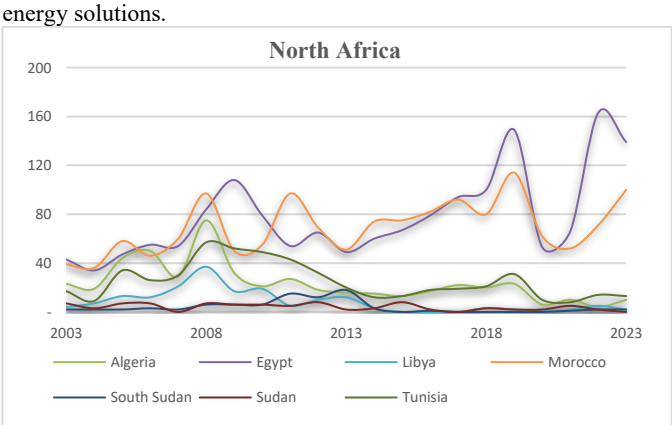

Fig. 2: Number of announced greenfield FDI projects, by destination, 2003–2023 in millions of dollars

The chart 2 above presents the number of new greenfield FDI projects announced in North African countries (Algeria, Egypt, Libya, Morocco, South Sudan, Sudan and Tunisia) between 2003 and 2023. These data provide insights into regional investment trends and the relative attractiveness of these countries to foreign investors.

The chart indicates fluctuations in the number of new FDI projects announced over the years, with notable spikes in certain years, particularly in 2022. Some specific years show significant increases in project announcements, which may be correlated with political

stability, economic reforms or global investment trends.

Overall Egypt exhibits the highest number of announced projects, especially in more recent years, indicating its attractiveness as a key destination for FDI in North Africa. Morocco: shows a steady upward trend, particularly notable in recent years, suggesting growing investor confidence and economic diversification efforts. Algeria: fluctuates significantly, with some spikes but generally lower than Egypt and Morocco, indicating potential challenges in attracting consistent FDI. affecting the number of announced projects. Sudan and South Sudan: appear to have the lowest numbers over the entire period, reflecting challenges such as economic instability and less favourable investment climates. Tunisia shows moderate levels of investment, with some fluctuations, indicating a mixed investment environment. Variations in the number of projects may indicate different levels of economic stability, regulatory frameworks and infrastructure development in these countries. Libya experiences volatility, likely due to ongoing political instability.

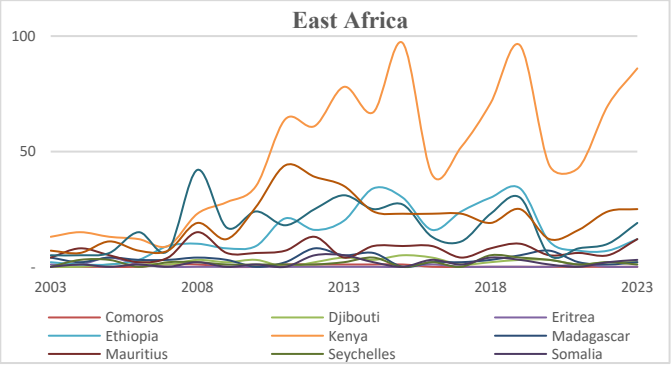

Fig. 3: Number of announced greenfield FDI projects, by destination, 2003–2023 in millions of dollars

The chart 3 above shows the number of greenfield FDI projects announced in East African countries, including Comoros, Ethiopia, Mauritius, Djibouti, Kenya, Seychelles, Eritrea, Madagascar and Somalia, between 2003 and 2023. This data provides insight into investment trends across the period through the region and highlights the attractiveness of individual countries to foreign investors.

The chart shows notable fluctuations in the number of announced greenfield FDI projects over the years. Broadly, a general upward trend is seen in since 2008 to 2019, but this trend loses the momentum in recent years (2020 and 2023), reflecting the challenges of maintaining that interest of greenfield FDI. Kenya consistently leads in terms of the number of announced projects, indicating its status as a leading investment destination in East Africa.

Djibouti and Ethiopia show significant numbers of projects, particularly in the middle and late years, reflecting foreign interest in natural resources and development projects. Comoros shows a hamble and steady number of greenfield FDI during the period of study. The rest of East African countries, namely: Seychelles, Eritrea, Madagascar and Somalia have the lowest number of greenfield FDI projects, indicating the difficulty of attracting theses kind of greenfield FDI. The chart highlights a competitive environment in which Kenya remains dominant, while other countries such as Seychelles, Eritrea, Madagascar and Somalia have experienced such difficulties in greenfield FDI attraction, suggest that factors such as political stability, economic policies, business environment and resource availability significantly influence investment decisions.

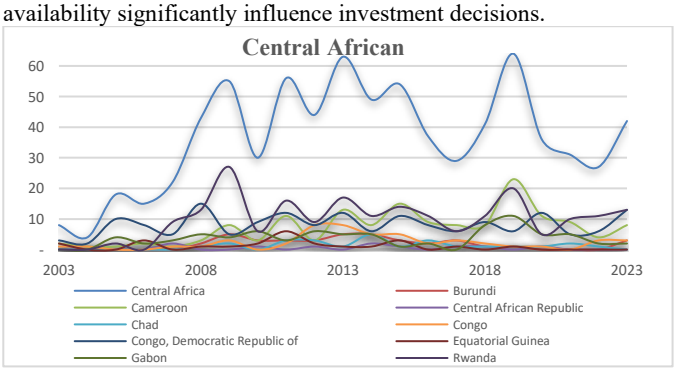

Fig. 4: Number of announced greenfield FDI projects, by destination, 2003–2023 in millions of dollars

The chart 4 illustrates the number of greenfield FDI projects announced in Central African countries, including Burundi, Cameroon, Congo, Democratic Republic of the Congo (DRC), Central African Republic, Equatorial Guinea, Chad, Gabon, Rwanda and Sao Tome and Principe, between 2003 and 2023. These data help to understand investment trends and the relative attractiveness of these countries to foreign investors.

The chart shows considerable fluctuations in the number of announced projects over several years, indicating inconsistent investment patterns in the region. Some years, in particular around 2011 and 2018, show notable spikes in project announcements, suggesting periods of heightened investor interest or favourable economic conditions.

Cameroon, overall, leads the number of announced projects, indicating its relative attractiveness as an investment destination in Central Africa. The DRC shows significant variations in the number of projects, reflecting its resource wealth but also ongoing challenges related to political stability and infrastructure. Rwanda shows a steady increase in the number of projects, suggesting a growing reputation as a favourable environment for investment due to reforms and stability. Equatorial and Guinea show moderate levels of investment, driven primarily by their oil and gas sectors, although showing variability over the years. Burundi shows consistently low levels of announced projects; likely reflecting challenges related to political instability and economic conditions that deter foreign investment.

The distribution of projects highlights a competitive environment, with Cameroon and the Democratic Republic of the Congo as key players, while smaller nations struggle to attract substantial foreign direct investment. Variations in investment levels across countries suggest different regulatory frameworks, economic policies and infrastructure readiness.

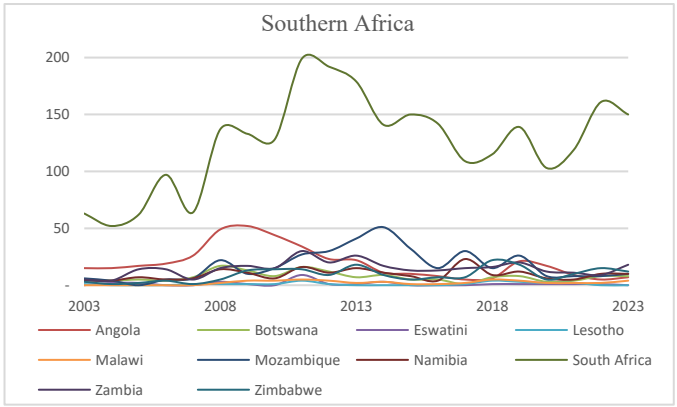

Fig. 5: Number of announced greenfield FDI projects, by destination, 2003–2023 in millions of dollars

The chart 5 illustrates the number of greenfield FDI projects announced in Southern African countries, including Angola, Botswana, Eswatini, Lesotho, Malawi, Mozambique, Namibia, South Africa, Zambia and Zimbabwe, between 2003 and 2023. These data highlight regional investment trends and the relative attractiveness of these countries to foreign investors.

The chart shows significant fluctuations in the number of announced projects over the years, with notable peaks in 2011 and 2012. An upward trend is observed in recent years (2022 and 2023), suggesting renewed interest and investment in the region.

South Africa consistently records the highest number of announced projects, indicating its status as a key investment destination in Southern Africa. Angola and Mozambique initially showed high numbers of projects, reflecting foreign interest in natural resources, but have experienced fluctuations in recent years. Zambia shows a notable increase in recent years, indicating possible improvements in attracting foreign investment. Zimbabwe historically has a lower number of projects, with a gradual improvement in recent years, suggesting a possible change in investor confidence. Botswana, Eswatini, Lesotho, Malawi and Namibia show, in general, lower and more variable levels of investment, indicating that there is difficulty in attracting significant FDI compared to larger economies.

The chart highlights the competitive landscape, dominated mainly by South Africa, while other countries such as Angola and Mozambique face challenges. Variations in investment levels across the region reflect different economic conditions, political stability.

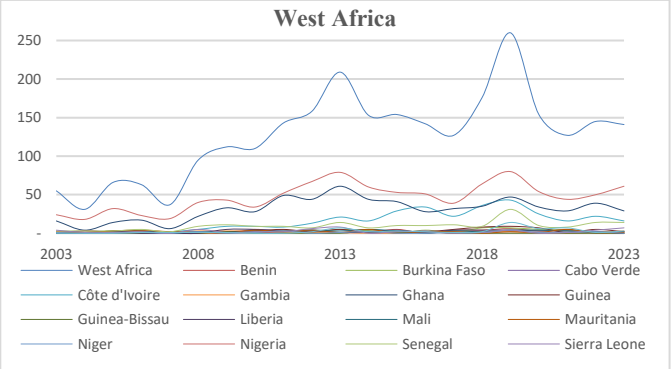

Fig. 6: Number of announced greenfield FDI projects, by destination, 2003–2023 in millions of dollars

The chart 6 illustrates the number of greenfield FDI projects announced in West African countries, including Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal and Sierra Leone, from 2003 to 2023. This data provides insight into investment trends across the region and highlights the relative attractiveness of these countries to foreign investors.

The chart indicates a general upward trend in the number of announced projects, particularly notable from 2015 onwards, suggesting growing interest in West Africa as an investment destination. The years 2019 and 2022 show significant spikes in project announcements, reflecting increased investor interest during those periods. Nigeria consistently shows the highest number of announced projects, reinforcing its position as a leading investment destination in West Africa, driven by its large market size and resource richness. Ghana and Côte d'Ivoire also show a solid number of projects, indicating their attractiveness due to political stability and economic growth. Mali and Niger show lower levels of investment, reflecting potential challenges such as political instability or less developed infrastructure. Benin, Burkina Faso and Senegal show moderate levels of investment, with some fluctuations, suggesting varying degrees of investor confidence and economic conditions. Gambia, Guinea and Liberia show relatively low levels of announced projects, likely due to ongoing economic or political challenges. The distribution of projects highlights a competitive landscape, with Nigeria, Ghana and Côte d'Ivoire emerging as key players in attracting greenfield FDI. Variations in investment levels across countries suggest different regulatory environments, economic policies and infrastructure readiness.

Overall, North Africa shows fluctuating trends with notable spikes, particularly in Egypt and Morocco, indicating strong investor interest. The region shows resilience in attracting greenfield FDI, with Egypt emerging as a key player. East Africa shows a generally upward trend in project announcements, especially in Kenya and Ethiopia. Recent years indicate growing investor confidence, particularly after the pandemic. Central Africa is characterized by significant fluctuations and lower overall investment compared to other regions. Cameroon and the Democratic Republic of Congo dominate, but challenges such as political instability hamper consistent growth.

Southern Africa leads in greenfield FDI, but the region has faced volatility in the number of projects. Zambia shows a recent upward trend, while countries such as Zimbabwe are gradually improving their investment climates. Leading countries in North Africa: Egypt and Morocco lead in attracting FDI. In East Africa, Kenya is the dominant player, with Ethiopia gaining ground. In Central Africa, Cameroon and the Democratic Republic of the Congo are significant contributors, although investment levels are generally lower. In Southern Africa, South Africa is the clear leader, followed by Angola and Mozambique. In contrast, in North Africa, Algeria shows lower investment levels than Egypt and Morocco. In East Africa, Somalia and Eritrea struggle to attract FDI. In Central Africa, Burundi and the Central African Republic have consistently low numbers of projects, while in Southern Africa, countries such as Lesotho shows lower investment levels.

Each region in Africa shows unique investment trends and challenges in attracting greenfield FDI projects in new areas. North and East Africa show stronger overall trends and more consistent growth in recent years, while Central Africa faces significant obstacles affecting greenfield FDI levels. Southern Africa's investment landscape is dominated by South Africa, with other countries gradually improving. In Africa, a significant share of greenfield FDI projects in new areas is directed to the resource sector, particularly extractive industries. These investments typically do not result in substantial job creation or technology transfer (Asiedu, 2006).

5. Data and Econometric Methodology

5.1. Data

1. Greenfield FDI inflow data was sourced from the UNCTAD database, while CO_2 emissions and GDP growth data were obtained from the World Bank. The study covers the period from 2003 to 2023, selected based on data availability. The sample of the study consisted of all African countries. Finally, empirical analysis will be implemented with the software packages of Stata 17.0.

5.2. Econometric Methodology

2. The prime objective of this empirical study is to investigated the impact of greenfield FDI inflows on CO_2 and GDP in African countries. To achieve this goal, unbalanced panel data techniques were utilised. The main reason for applying this methodology is that it permits controlling for heterogeneity issues, working with a sample consist of a shorter time series and more observations (Baltagi, 2008). Notably, the data of this study is taken from a short time series because it covers the period from 2003 to 2023 cross 43 African countries. It is therefore, some econometric techniques such as cointegration estimations and causality tests would not be suitable in this analysis. In addition, the panel 'African countries' are heterogeneous in terms of some economic policies, traditions, and culture. Thus, panel data has the advantage of controlling for these unobserved effects (or heterogeneity) for each country, which is going to be captured by αi in the models. In this regard, the FE and RE models are used to eliminate the problem of an unobserved country-specific effect. The FE model treats αi as a country-specific intercept that remains fixed over time (αi = α) and can be associated with independent variables. Conversely, the RE model considers country characteristics as a random variable that is uncorrelated with explanatory repressors (Cameron and Trivedi, 2009). To determine the appropriate estimator between FE and RE models, the Hausman specification test is employed (Hausman, 1978). Accordingly, the following panel data regression model is established:

$$LGDPG_{it} = \alpha_0 + \alpha_1 \text{ Lgfdi value}_{it} + \alpha_2 \text{ Lgfdi dealse}_{it} + \rho_t + \varepsilon_{it} \quad (1)$$

$$LCO_{2it} = \alpha_0 + \alpha_1 \, Lgfdi\ value_{it} + \alpha_2 \, Lgfdi\ deals_{it} + \rho_t + \varepsilon_{it} \quad (2)$$

$$LCO_{2it} = \alpha_0 + \alpha_1 \text{ Lagri}_{it} + \alpha_2 \text{ Lextra}_{it} + \alpha_3 \text{ Lmanuf}_{it} + \alpha_4 \text{ Lserv}_{it} + \rho_t + \varepsilon_{it} \quad (3)$$

Where i represents the country, and t represents the year. Where $RGDP$ in equation 1 is the dependent variable, which is the growth rate of GDP. Lgfdi value and Lgfdi deals are the main explanatory variables of interest which are the greenfield DFI measured by value and deals of projects. γi is the country-specific error component, and ρ_t is time-fixed effects, and εit is the error term.

In equation 2, (LCO_{2it}) is the dependent variable, which is the CO_2 emission. Lgfdi value and Lgfdi deals are the main explanatory variables of interest which are the greenfield DFI measured by value and deals of projects. γi is the country-specific error component, and ρ_t is time-fixed effects, and εit is the error term.

In equation 3, (LCO_{2it}) is the dependent variable, which is the CO_2 emission. Lagri is Agriculture, forestry and fishing sector, Lextra is Extractive industries, Lmanuf is Manufacturing, and Lserv is Services, are the main explanatory variables of interest which are the greenfield DFI measured by Value of announced greenfield FDI projects, by sector/industry. γi is the country-specific error component, and ρ_t is time-fixed effects, and εit is the error term.

Before conducting any empirical analysis, it is essential to assess the stationarity of the variables. Stationarity ensures that the statistical properties of a time series remain constant over time, which is a

prerequisite for the validity of many analytical tools and statistical tests. The main purpose of the stationarity analysis is to avoid the issue of spurious regression. This study applies Fisher test for the panel unit root tests and the results are presented in Table 1.

Table 1 illustrates that all series used in this study are stationary at the level. Thus, Fisher unit root test rejects the null hypothesis; namely, a unit root exists against the alternative that there is no unit root.

Table 1: Panel Unit root tests.

Variables	Fisher Chi-square	Description
LCO_2	132.7404 (0.0000)	No Unit root
LGDPG	354.3260 (0.0000)	No Unit root
Lgfdi value	233.5040 (0.0000)	No Unit root
Lgfdi dealse	281.4519 (0.0000)	No Unit root

Author's elaboration.

6. Results and Discussion

Tables 2, 3 and 4 presents the results of fixed effect model concerning the impact of greenfield FDI on economic growth and CO_2 emission, in addition to the impact of Greenfield FDI by sector on CO_2.

With regard to the table 1, it can be seen that the positive coefficients for greenfield FDI values across all regions suggest that higher green FDI values are associated with increased GDP. This result is in line with [4] who found a positive impact from the side of foreign direct investment on economic growth in a sample consist of 14 Eastern Africa countries. However, this results chondritic with [7] who utilized the fixed and random effect models and found that greenfield FDI did not have impact on economic growth in 46 African countries.

In terms of regions, North Africa shows the strongest positive impact (0.870), indicating that higher values of greenfield FDI significantly contribute to economic growth. Southern Africa has the lowest coefficient (0.00809), indicating minimal impact, suggesting that greenfield FDI value is not effectively driving GDP growth in this region. Concerning the result of the impact of the number of greenfield FDI deals on GDP growth, the value of coefficient is very close to zero (0.00707) suggesting a weak impact from the side of the number of greenfield FDI deals on economic growth. More specifically, the negative significant coefficient for the number of greenfield FDI deals in North Africa (-2.730***) suggests a counterintuitive relationship, where greener FDI deals may not positively impact GDP. This could indicate inefficiencies in how these investments are managed or integrated into the economy. Other regions, particularly West Africa (0.251**), show a positive relationship between the number of greenfield FDI deals and GDP, suggesting that these deals are more effective in driving economic growth in those areas. Central Africa also shows a positive impact (0.195), indicating potential for growth through green FDI deals. In North Africa, the strong positive impact of greenfield FDI value contrasted with the negative impact of the number of greenfield FDI deals indicates a possible need for improved management and strategic investment in green projects. In Central Africa, the positive coefficient for the number of greenfield FDI deals suggests that while the region is not heavily impacted by greenfield FDI value, the deals made are beneficial for GDP growth. In East and Southern Africa, both regions show modest positive impacts from green FDI value, though Southern Africa's minimal effect suggests challenges in leveraging green investments effectively. In West Africa, displays a promising relationship with both green FDI value and deals, indicating that this region may be effectively harnessing green investments for growth.

As for table 3, which shows the result related to the impact of Greenfield FDI on CO_2 emission. It is clear that the overall coefficient for Lgfdi deals (-0.00612) is not statistically significant, suggesting that the number of greenfield FDI deals does not have a clear impact on CO_2 emissions across all regions. Generally, this outcome is congruent with [11] who found that greenfield FDI improved environmental quality. Regionally, Central Africa shows a significant negative relationship (-0.0367*), indicating that while the total number of greenfield FDI deals may not be impactful elsewhere, in Central Africa, greener FDI deals are associated with lower emissions. The other regions do not show significant results, suggesting that the effectiveness of greenfield FDI deals in reducing emissions may be limited or inconsistent.

In North Africa, the lack of significance in both variables suggests that greenfield FDI may not be effectively translating into reduced emissions or that the investments are not aligned with sustainability goals. In Central Africa, the significant coefficients in both greenfield FDI value and deals indicate a more favourable environment for green FDI to contribute to emissions reduction, suggesting effective management of investments. In East Africa, shows no significant results for both variables, indicating potential challenges in integrating green FDI into sustainable practices. In Southern Africa, the positive coefficient for greenfield FDI value suggests minimal impact on emissions, while greenfield FDI deals show no significant effect, indicating a need for more effective policies or practices. In West Africa, the significant negative impact of greenfield FDI value indicates that green FDI is likely beneficial in reducing emissions, but the lack of significance for greenfield FDI deals suggests that the number of deals alone does not guarantee emission reductions.

The analysis illustrates that greenfield FDI values generally have a negative relationship with CO_2 emissions, particularly in Central and West Africa, indicating effective use of these investments for environmental benefits. However, the relationship with greenfield FDI deals is less clear, with significant effects only noted in Central Africa. This suggests that while increasing the value of green FDI can contribute to emissions reduction, the sheer number of deals may not be sufficient and alignment with sustainability objectives.

Last, table 4 depicts the results concerning the impact of Greenfield FDI by sector on CO_2. Notably, the coefficient value of Agriculture, forestry, and fishing is 0.0263 indicates that a slight increase in CO_2 emissions associated with investment in this sector; however, it is not statistically significant, suggesting weak or unclear relationship.

The coefficient of Extractive Industries (Lextra) is 0.00480, suggesting that an increase in green FDI in the extractive industries is associated with an increase in CO_2 emissions. However, since the coefficient is close to zero, the impact appears minimal. This indicates that green FDI in extractive industries may not be effectively reducing emissions, aligning with concerns about the environmental impacts of fossil fuel extraction. The coefficient of Manufacturing (Lmanuf) is -0.0153 suggests that an increase in green FDI in the manufacturing sector is associated with a slight decrease in CO_2 emissions. This implies that investments in this sector may effectively contribute to emissions reduction. The coefficient value of Services sector (Lserv) is significant and positive (0.0803***) indicating that green FDI in the services sector is strongly associated with increased CO_2 emissions. This suggests that investments in services may not be aligned with sustainability goals, potentially indicating higher energy consumption or less efficient practices in this sector.

In conclusion, this chapter explore the impact of greenfield FDI on GDP and CO_2 emission across African regions. First, the results show varying impacts of greenfield FDI values and deals on GDP across different African regions. North Africa demonstrated the highest positive impact from greenfield FDI values, while West Africa exhibited a significant positive relationship with the number of greenfield FDI deals. Central Africa showed potential benefits from both greenfield FDI values and deals, indicating effective integration of these investments into economic growth. Second, the results concerning the impact of greenfield FDI on CO_2 emissions indicate that higher values of greenfield FDI generally correlate with reduced CO_2 emissions, particularly in Central and West Africa. However, the relationship with the number of greenfield FDI deals was less consistent, with only Central Africa showing a significant negative relationship, suggesting that more deals contribute to lower emissions. North Africa exhibited a weak or negligible relationship between greenfield FDI and emissions, highlighting potential inefficiencies in investment management. Last, the sectoral analysis revealed that the investments in the manufacturing sector are associated with a slight decrease in CO_2 emissions, indicating effective sustainability practices. Conversely, the services sector exhibited a significant positive relationship with increased emissions, raising concerns about the sustainability of investments in that area. The extractive industries showed a minimal impact on emissions, suggesting challenges in aligning greenfield FDI with environmental goals.

Table 2: Greenfield FDI and economic growth (fixed Effect- robust

VARIABLES	(all) gdpg	(North Africa) gdpg	(Central Africa) gdpg	(East Africa) gdpg	(Southern Africa) gdpg	(West Africa) gdpg
Lgfdi value	0.222	0.870	0.189	0.0818	0.00809	0.0844
	(0.148)	(0.804)	(0.259)	(0.207)	(0.279)	(0.183)
Lgfdi deals	0.00707	-2.730***	0.195	0.145	0.236	0.251**
	(0.120)	(0.858)	(0.252)	(0.167)	(0.261)	(0.119)
Constant	4.480***	12.39**	3.788**	5.080***	4.508***	3.941***
	(0.849)	(5.243)	(1.525)	(1.208)	(1.561)	(1.008)
Hausman test	(0.000) ***	-	-	-	-	-
Observations	888	132	127	168	168	294
Number of countries	43	7	7	8	8	14

***p < 0.01, **p < 0.05, *p < 0.1 indicate significance at 1%, 5% and 10% respectively

Table 3: Greenfield FDI and CO_2 emission (fixed Effect- robust)

VARIABLES	(all) lco2	(North Africa) lco2	(Central Africa) lco2	(East Africa) lco2	(Southern Africa) lco2	(West Africa) lco2
Lgfdi value	-0.0349***	-0.0210	-0.0465**	-0.0340	0.00719	-0.0498**
	(0.0106)	(0.0174)	(0.0219)	(0.0282)	(0.0264)	(0.0212)
Lgfdi deals	-0.00612	-0.0295	-0.0367*	0.00350	-0.0336	0.0104
	(0.00854)	(0.0179)	(0.0213)	(0.0227)	(0.0247)	(0.0138)
Constant	15.70***	17.56***	15.13***	15.16***	16.06***	15.14***
	(0.0602)	(0.105)	(0.129)	(0.165)	(0.148)	(0.117)
Observations	902	146	127	168	168	294
Number of countries	43	7	7	8	8	14

***p < 0.01, **p < 0.05, *p < 0.1 indicate significance at 1%, 5% and 10% respectively

Table 4: Greenfield FDI by sector and CO_2 emission (fixed Effect- robust)

VARIABLES	(1) lco2	(2) lco2	(3) lco2	(4) lco2	(5) lco2
Lagri	0.0263				0.00370
	(0.0251)				(0.0202)
Lextra		-0.000563			0.00480
		(0.0258)			(0.0193)
Lmanuf			0.00592		-0.0153
			(0.0257)		(0.0202)
Lserv				0.0802***	0.0835***
				(0.0180)	(0.0208)
Constant	24.19***	24.25***	24.23***	24.07***	24.08***
	(0.0577)	(0.0594)	(0.0593)	(0.0416)	(0.0794)
Observations	21	21	21	21	21

* Lagri = Agriculture, forestry and fishing, Lextra = Extractive industries, Lmanuf =Manufacturing, Lserv = Services
***p < 0.01, **p < 0.05, *p < 0.1 indicate significance at 1%, 5% and 10% respectively.

7. Conclusion

The prime objective of this study is to explore the impact of greenfield FDI inflows on economic growth and CO_2 emission in African countries. To achieve this goal, an unbalanced panel data fixed effects model was utilized covering the period from 2003 to 2023. The findings of this study underscore the complex relationship between greenfield FDI, economic growth, and environmental sustainability across African regions and sectors. First, different sectors respond uniquely to greenfield FDI. While manufacturing shows promise in reducing emissions, the services sector raises concerns about sustainability. Tailored strategies for each sector are essential to maximize the benefits of green investments. Second, the effectiveness of greenfield FDI in driving economic growth and reducing emissions varies significantly across regions. Central and West Africa demonstrate more favourable conditions for integrating greenfield FDI into sustainable practices, while North Africa may require policy reforms to enhance the efficacy of such investments.

Policymakers must prioritize strategic management and policy frameworks that align greenfield FDI with the African Union's Agenda 2063. Crucially, African nations should adopt a collective approach to policy formulation to secure the inflow of environmentally sustainable greenfield FDI. Without such integration, the potential benefits of greenfield FDI may not be fully realized, particularly in regions and sectors where the relationship with emissions is weak or inconsistent. Furthermore, policymakers should foster a supportive environment for the services sector by promoting best practices to address current challenges. This strategy includes implementing stricter environmental regulations, incentivizing sustainable operations, and facilitating knowledge transfer. Finally, further research at the sectoral and regional levels is warranted to comprehensively analyse the impact of greenfield FDI on economic growth and environmental sustainability across African countries.

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