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# Insurance and Sustainable Structural Transformation: Does Renewable Energy Matter?

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## Abstract

The existing body of research examining the interplay between finance and development predominantly concentrates on the banking sector and capital markets, often overlooking the significant potential of the insurance sector. To address this gap, this paper investigates the impact of the insurance sector on sustainable structural transformation, specifically emphasizing the mediating role of renewable energy adoption. Employing panel data from 40 African countries spanning the period 2000-2019 and utilizing panel corrected standard error (PCSE) and feasible generalized least squares (FGLS) estimation techniques, the findings indicate a positive and statistically significant relationship between insurance sector development and sustainable structural transformation. Further, the disaggregation of insurance into life and non-life insurance reveals that both sub-sectors contribute positively, with non-life insurance exhibiting a more substantial effect. Crucially, the analysis establishes renewable energy as a key transmission mechanism through which the insurance sector influences sustainable structural transformation. These results suggest that policymakers should strategically leverage the savings generated by the insurance sector to foster and fund initiatives that promote a transition towards sustainable development pathways.

## Keywords

Insurance Sector, Sustainable Structural Transformation, Renewable Energy

## 1. Introduction

The prevailing global paradigm of sustainable development is widely considered a crucial framework for addressing the multifaceted challenges confronting both developed and developing nations. A defining characteristic of many southern countries is their constrained access to the financial resources necessary to fuel their development ambitions. The adoption of renewable energy stands as a key objective within the Sustainable Development Goals (SDG 7), and the pivotal role of energy efficiency in combating climate change was underscored at COP 21.

Despite concerted global efforts to accelerate the growth of renewable energy, a significant impediment remains: the challenge of securing adequate financing (IEA, 2021). Compounding this issue is the often-low return on investment associated with clean energy projects (Taghizadeh-Hesary & Yoshino, 2020). Indeed, research by Del Gaudio et al. (2022) suggests that green loans can potentially reduce bank profitability and elevate default risk. However, contrasting findings from Zyadin et al. (2014) highlight the substantial commercial potential inherent in renewable energies, thus advocating for increased investment. Despite this potential, recent data from the International Energy Agency (IEA, 2021) indicate that renewable energy sources still constitute less than 30% of global energy production. Overall, Alharbi et al. (2023) emphasize the compelling role of renewable energy as a solution to climate change.

The expansion of renewable energy necessitates the integration of innovative technologies. Existing literature has established the significant role of the financial sector in fostering innovation (Cornaggia et al., 2015; Hsu et al., 2014). Capital mobilized by the insurance sector can contribute to advancements in renewable energy technologies through several mechanisms. Firstly, an efficient financial sector can lower the financing costs associated with new technologies through effective resource allocation. Secondly, the insurance sector can facilitate the diversification of investor risks, enabling companies to leverage external funds to mitigate the inherent risks of innovation (Cornaggia et al., 2015). Finally, the increasing urgency of climate action is driving investors towards greater social responsibility, prioritizing sustainable investments (Krueger et al., 2020).

Prior scholarly work indicates that shifting economies away from basic farming and raw material exploitation toward industrial and service-based frameworks is crucial for boosting economic expansion and increasing output potential (Mora & Olabisi, 2023; Page, 2015). Specifically, factory-based production provides benefits like increased wealth, cost efficiencies through large-scale operations, and advancements in technology, making it a favored pathway for improving how efficiently things are made (Page, 2015). Additionally, factory output creates substantial indirect positive impacts on the service industry through interconnected activities, encouraging external benefits in technological advancement, workforce skill improvement, and knowledge acquisition, all essential for bettering overall competitive standing (Page, 2015). The core of reshaping industrial structures involves moving production resources from less efficient to more efficient and resource-conscious areas, driven by the best possible distribution and organization of these resources across different economic activities (Lin & Zhou, 2021). Nevertheless, conventional factory-led output can severely harm the environment.

In response, some African nations, such as South Africa, have implemented carbon taxes to incentivize companies to adopt greener inputs, such as renewable energy, which possesses the potential to significantly reduce greenhouse gas (GHG) emissions. The South African government has adopted various supply-side interventions as instruments of green industrial policy. For instance, a carbon tax was introduced in 2019 at a rate of R120 per ton of carbon dioxide equivalent ($tCO_2e$), subsequently increasing to R190 per $tCO_2e$ from January 1, 2022 (National Treasury, 2024). The National Treasury aims for a carbon tax of US$30 per $tCO_2e$ by 2030, which remains below the International Monetary Fund's target of US$50 per $tCO_2e$ for emerging markets (SARB, 2023; Gaspar & Parry, 2021). Notably, South Africa's carbon tax covers a substantial portion (80%) of the country's emissions. In contrast to carbon-emitting energy sources, clean power from sunlight, wind, and water produces electricity without direct greenhouse gas emissions during its use. The widespread integration of sustainable technologies is fueling the expansion of environmentally sound manufacturing industries. Similarly, monetary progress can act as a driver in converting conventional industrial setups into advanced, intelligent industries, fostering industrial modernization as a means to stimulate economic advancement (Nian & Dong, 2022).

Numerous investigations have underscored the influence of financial progress on economic restructuring. Research conducted by Xue et al. (2024) suggests that the evolution of digital finance facilitates the updating of industrial frameworks. Likewise, Dong et al. (2024) highlight the role of financial technology in reshaping economic structures. Wang et al. (2023) emphasize the significant part played by environmentally conscious finance in enabling economic transformation, and Yang et al. (2023) establish a connection between financial development and the sophisticated evolution of the manufacturing sector. Nevertheless, existing research appears to have largely ignored the insurance industry when examining the link between financial growth and economic restructuring.

The African insurance industry is expanding rapidly, with increased participation from corporations, individuals, and governing bodies across life, non-life, and reinsurance markets. In 2019, insurance premiums in Africa were valued at USD 68.15 billion. The largest markets are concentrated in South Africa, Kenya, Egypt, Nigeria, Algeria, Angola, and Tunisia, collectively representing 83% of all African premiums in 2019. Data from the Federation of African National Insurance Companies (FANAF, 2023) indicates that the African insurance market accounted for only about 1% of total global premiums in 2022, compared to 43% in the Americas, 28% in Asia, and 27% in Europe. Despite often being less prominent within broader financial service sectors in Africa, the long-term growth and financial capacity of the insurance industry could arguably be vital for overall economic expansion and, particularly, economic restructuring.

This study makes three main contributions. Firstly, it seeks to fill the existing void in the analysis of the relationship between the financial sector and economic restructuring by specifically analyzing the role of the insurance industry. The insurance sector offers essential safeguards against capital investments and credit, and by extending investment timelines, it can increase the readiness of banks and investors to assume risks. It serves as a catalyst for economic and structural diversification by redirecting financial resources from less productive sectors to more productive activities and by increasing access to financing. Consequently, enhancing the efficiency of financial resource allocation is crucial for driving broader economic efficiency and economic restructuring (Beck et al., 2012). Secondly, this study utilizes a contemporary and comprehensive measure for sustainable economic restructuring, the "Sustainable and Inclusive Structural Transformation Index", developed by Lin et al. (2019). Finally, this research aims to elucidate the function of renewable energy in the relationship between insurance and sustainable economic restructuring, a dimension largely overlooked in prior research. The mobilization of funds from the insurance sector could significantly contribute to the advancement of renewable energy technologies, ultimately facilitating the substitution of fossil fuels in companies' production processes and promoting sustainable economic restructuring.

The subsequent sections of this paper are structured as follows: Section 2 provides a succinct overview of the relevant scholarly work, Section 3 details the methodological framework, Section 4 presents the empirical findings, and Section 5 concludes with a discussion of the results and their implications for policy.

## 2. Literature Review

This section is structured into two sub-sections: the theoretical foundation (2.1) and empirical evidence (2.2).

### 2.1. Theoretical Literature

Economic restructuring involves a fluid redistribution of productive endeavors, generally moving from farming to factory production and subsequently to service industries, marked by related changes in the proportional contribution of each sector to total production, job creation, and spending patterns (Pineli et al., 2021; Tyler et al., 2017). Monetary progress is broadly acknowledged as a vital element in facilitating this evolutionary change (Levine, 1997). Based on the principles of financial deregulation, eliminating restrictions on monetary systems is believed to encourage effectiveness and economic expansion (Naceur, 2016). Such deregulation can stimulate increased rivalry, greater novelty in financial instruments, and improved availability of funding, all of which can substantially aid economic restructuring. The conceptual links between monetary progress and economic restructuring are complex and have been investigated from various theoretical standpoints.

#### 2.1.1. Role of Financial Development in Facilitating Structural Transformation

A well-developed financial system acts as a catalyst for structural transformation by optimizing resource allocation, encouraging capital accumulation, and driving technological innovation. Efficient financial markets direct funds towards their most productive applications, empowering firms to invest in advanced technologies and scale their operations (Levine, 1997). This function is especially critical for the expansion of the manufacturing and service sectors, which generally demand more substantial capital investments compared to agriculture.

#### 2.1.2. Resource Allocation and Investment

An advanced financial system underpins structural transformation by enabling the efficient allocation of capital across diverse economic sectors (Levine, 1997). Financial institutions, encompassing banks and capital markets, play a pivotal role in information gathering, project evaluation, and the channeling of funds towards the most promising investment opportunities. This process is fundamental to structural change, facilitating the movement of resources from lower-productivity agricultural activities towards higher-productivity industrial and service sectors (Bustos et al., 2020). Furthermore, financial development fosters capital accumulation, a prerequisite for funding investments in nascent industries and advanced technologies (Levine, 1997). The expansion of credit markets empowers firms to secure loans for investment purposes, while the growth of equity markets provides avenues for raising capital through the issuance of shares.

#### 2.1.3. Innovation and Technological Adoption

In developing economies, firms frequently encounter financial limitations that hinder their capacity to invest in research and development (R&D) and implement new technologies. A robust financial system can alleviate these constraints by offering firms access to the necessary funding for innovation (Pradhan et al., 2016). Supporting this, Liu and Liu (2021) demonstrated that financial development contributes to a reduction in carbon emission intensity through the promotion of technological innovation.

The body of theoretical literature robustly supports the premise that financial development is instrumental in facilitating structural transformation. By optimizing resource allocation, encouraging capital accumulation, fostering innovation, and effectively managing risk, well-functioning financial systems empower economies to transition from agrarian-based structures towards industrial and service-oriented models.

### 2.2. Empirical Literature

The empirical literature on the relationship between financial development and structural transformation is organized around two key aspects: the direct and indirect effects.

#### 2.2.1. Direct Effect

Investigations centered on the Sub-Saharan African region (SSA) have explored how monetary progress influences economic restructuring, frequently within the context of integrated financial systems. These analyses commonly suggest that monetary progress encourages economic shifts by increasing the worth added by both factory production and farming. Nevertheless, its effect on the service industry might be less pronounced, and the noticed outcomes may be more interconnected than separate (Alagidede et al., 2020). As an example, Ustarz and Fanta (2021) discovered a beneficial effect of monetary progress on service and farming industries in SSA, but pointed out that a certain level of monetary progress is needed to positively affect the factory sector. Likewise, Lo and Ramde (2019) determined that monetary progress supports long-run economic restructuring within the Franc Zone.

Looking beyond Africa, research in other areas provides pertinent understandings. Li et al. (2021a) studied the interaction between ecological rules and monetary progress on environmentally friendly overall production efficiency in China's Yangtze River Delta (YRD) area. Yang et al. (2023) examined data from 283 Chinese urban centers to evaluate how monetary progress affects carbon releases, while taking into account the improvement of industrial frameworks. Their results indicate a distinct positive impact of monetary progress on both carbon releases and the advancement of industrial frameworks. While a straightforward connection between monetary progress and economic restructuring is often seen, an indirect connection influenced by elements like the uptake of sustainable energy sources merits further investigation.

#### 2.2.2. Indirect Effect

The exploration of the indirect relationship between financial development and structural transformation is organized into two key areas. The first (point 1)) examines the established links between financial development and renewable energy adoption, while the second (point 2)) presents evidence on the nexus between renewable energy and structural transformation.

1) *Financial development and renewable energy*

Heightened worldwide worry about climatic shifts and the pressing need for enduring power options has placed the connection between monetary progress and sustainable energy at the forefront of both scholarly inquiry and governmental policy creation. A growing collection of academic work points to a favorable link between monetary progress and the embrace of sustainable energy.

Monetary progress can spur the utilization of sustainable energy by easing the acquisition of funds for relevant undertakings (Qamruzzaman, 2024). Monetary organizations are increasingly presenting varied financial tools, including loans and equities, specifically crafted to bolster the implementation of sustainable energy technologies. This ease of funding is especially vital for high-cost sustainable energy ventures like extensive solar and wind power plants. Furthermore, monetary progress can lessen the perceived hazards tied to sustainable energy investments, thereby making them more appealing to investors (Taghizadeh-Hesary & Yoshino, 2020). Effective monetary systems can also steer resources toward exploration and innovation, encouraging technological leaps and lowering the costs of sustainable energy technologies. Such novelty is crucial for enhancing the competitive advantage of sustainable energy sources compared to traditional fossil fuels. Moreover, monetary progress can boost the effectiveness of sustainable energy markets by offering transparent price indicators, decreasing transaction expenses, and fostering vigorous competition (Sun et al., 2023).

Beyond funding ventures, monetary progress can also encourage the uptake of sustainable energy by individual consumers and businesses. Access to borrowing and other monetary services empowers households and firms to invest in sustainable energy systems, such as solar panels and energy-efficient appliances. Moreover, monetary progress underpins the expansion of sustainable energy industries by supplying essential working capital, trade financing, and other vital monetary services. A broad investigation encompassing 103 economies revealed a notable beneficial effect of monetary progress, particularly via banking institutions, on sustainable energy consumption (Sun et al., 2023). Further analysis underscored the impact of market depth, accessibility, and efficiency in both stock and bond markets on sustainable energy consumption (Sun et al., 2023).

The idea of ecological finance, encompassing monetary investments with clear environmental advantages, is increasingly recognized as a key driver for the sustainable energy sector. Ecological bonds, ecological loans, and other specialized ecological financial products serve to channel capital toward sustainable energy projects and promote wider ecological advancement objectives (Subramaniam & Loganathan, 2024), who also found that ecological finance propels sustainable energy growth in Singapore. In a related vein, Ye et al. (2022) scrutinized the influence of diverse aspects of monetary progress, including credit, equities, and securities, alongside corporate social responsibility (CSR) reporting, on sustainable energy investment in a developing economy, finding that CSR efforts positively shape sustainable energy adoption. Similarly, Iqbal and Fikri (2024) emphasize the capacity of Islamic finance, guided by Sharia principles, to fund sustainable energy projects across 30 nations with a presence of Islamic banks, suggesting that Sharia-compliant investors can play a significant role in financing clean technologies and promoting ecological advancement.

2) *Renewable energy and sustainable structural transformation*

Worldwide energy systems are undergoing a deep change, spurred by increasing worries about climatic shifts, the crucial need for secure energy supplies, and the pursuit of lasting economic progress (Yang et al., 2024). This shift involves a basic move away from fossil-based power towards sustainable energy forms, such as sunlight, wind, water power, and plant-based fuels, with major effects across different parts of the economy (Li et al., 2021b). This analysis of existing research explores the varied effects of adopting sustainable energy on economic reshaping, covering changes in productive activities, the makeup of industries, technological progress, and societal betterment. Economic reshaping is defined as a basic change in how an economy is structured, typically involving moving resources from traditional areas like farming to manufacturing and service provision (Wei et al., 2022).

The growth and implementation of sustainable energy technologies act as a trigger for expansion in various economic sectors, including factory output, building, and services. For example, making key parts for sustainable energy systems, like solar panels and wind generators, creates new industries and job opportunities. Similarly, the building and setting up of sustainable energy plants greatly add to economic growth. Furthermore, the ongoing upkeep and running of these plants require specialized services, further boosting the service sector (Liu et al., 2019), who showed that sustainable energy better encourages the improvement of China's industrial structure compared to coal-based energy. According to Maria et al. (2023), a basic economic reshaping is vital to stop the rise in global temperatures and advance lasting progress through a move to a low-carbon system. Overall, current research suggests that sustainable energy plays a key part in driving economic reshaping and creating a more lasting and fair future. By embracing sustainable energy and pushing technological innovation, nations can achieve their climate goals and ease economic restructuring (Shan et al., 2021). Despite these significant advantages, the move to sustainable energy also brings considerable challenges, notably including financial obstacles.

This review points out three main gaps in the current research. Firstly, the established link between monetary progress and economic reshaping has largely ignored the possible role of the insurance industry in easing financial hurdles faced by businesses. Secondly, earlier studies on economic reshaping have not yet used the more complete and lasting measures now available for this factor. However, Lin et al. (2019) developed the "Sustainable and Inclusive Structural Transformation Index", which evaluates a nation's economic performance by considering environmental sustainability and social inclusion alongside economic reshaping. Finally, the research examining the connection between monetary progress and economic reshaping has not adequately highlighted the mediating role of sustainable energy. Yet, the growth of the sustainable energy sector significantly affects economic progress, particularly through intermediate industries such as electrical machinery production, transportation, warehousing, and various service industries. These identified gaps form the basic starting point for this study, leading to the development of the following hypotheses:

$H_1$: *The insurance sector promotes sustainable structural transformation*.

$H_2$: *Renewable energy is a channel through which the insurance sector fosters the structural transformation*.

## 3. Data and Methodology

### 3.1. Data

This study employs panel data covering 40 African countries over the period spanning 2000 to 2019. Data pertaining to insurance activities were sourced from the Global Financial Development database. Macroeconomic variables were collected from the World Development Indicators. The sustainable structural transformation indicator (ISST) was obtained from the research of Lin et al. (2019). The selection of the study period and countries was determined by data availability. A comprehensive description of the data is presented in **Table 1** and **Table 2**, and the specific list of countries included in the analysis is provided in **Table A1** in the **Appendix**. **Table 1** provides a summary of the model variables using key indicators. As illustrated in this table, the distribution of total insurance activity across the African countries in our sample exhibits considerable heterogeneity.

$\left(\text{Variation coefficient} = \frac{\text{Standard deviation}}{\text{Mean}} = \frac{2.339}{1.459} = 1.60 > 0.33\right)$. **Table 2** presents the results of the correlation analysis. As shown in this table, a positive relationship exists between total insurance activity (TINS), life insurance (LINS), and non-life insurance (NLINS) and sustainable structural transformation. This positive association is further substantiated by the graphical representation in **Figure 1**. The implication of this finding is that countries with more developed insurance markets tend to accumulate sufficient resources to facilitate their transition towards sustainable structural transformation.

**Table 1.** Descriptive statistics.

| | N | Mean | SD | Median | Min | Max |
|---|---|---|---|---|---|---|
| ISST | 800 | 0.478 | 0.049 | 0.488 | 0.335 | 0.575 |
| TINS | 800 | 1.459 | 2.339 | 0.707 | 0.002 | 17.023 |
| LINS | 800 | 0.781 | 1.962 | 0.143 | 0 | 15.381 |
| NLINS | 800 | 0.698 | 0.522 | 0.537 | 0.002 | 2.914 |
| Renewable | 800 | 62.273 | 29.375 | 75.55 | 0.1 | 98.3 |
| Domcred | 800 | 23.276 | 25.228 | 14.419 | 0.002 | 142.422 |
| Debtstocks | 772 | 50.272 | 42.418 | 37.651 | 2.551 | 366.033 |
| Mineralrents | 800 | 1.243 | 2.826 | 0.059 | 0 | 24.834 |

Source: Authors.

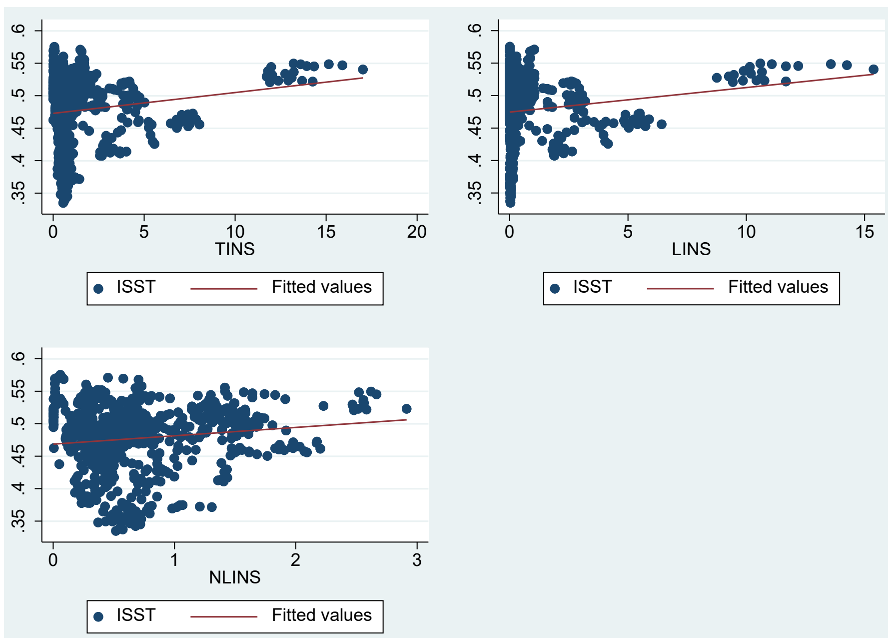


**Figure 1.** Insurance and sustainable structural transformation. Source: Authors.

Table 2. Correlation matrix.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| (1) ISST | 1.000 | | | | | |
| (2) TINS | 0.185 | 1.000 | | | | |
| (3) Renewable | −0.019 | −0.449 | 1.000 | | | |
| (4) Domcred | 0.156 | 0.784 | −0.674 | 1.000 | | |
| (5) Debtstocks | 0.134 | −0.086 | 0.122 | −0.046 | 1.000 | |
| (6) Mineralrents | 0.183 | −0.064 | 0.004 | −0.009 | −0.049 | 1.000 |

Source: Authors.

The dependent variable in this study is sustainable structural transformation, which we measure using the sustainable and inclusive structural transformation index (ISST) developed by Lin et al. (2019). This index assesses the degree to which a country has cultivated a modern economy grounded in industry or services while simultaneously safeguarding the environment and promoting gender inclusivity. A key distinction of the SIST is its methodology, which, in line with New Structural Economics, accounts for variations in development levels across countries. The index evaluates a nation's performance relative to its available resources, employing multiple imputation techniques to address data limitations. This allows for comparative analysis across a broad spectrum of indicators for nearly 200 countries over a 25-year period. The ISST comprises several indicators categorized into three principal components: structural transformation, environmental sustainability, and social inclusiveness. Each indicator is transformed using a conditional cumulative density function to ensure equitable comparisons between countries at comparable stages of development.

Our primary independent variable of interest is insurance. For our baseline analyses, we utilize total insurance penetration as our measure. To ensure the robustness of our findings, we further differentiate between life and non-life insurance penetration. Insurance penetration is defined as the ratio of total insurance premium volume to GDP, serving as an indicator of the significance of insurance activity relative to the overall size of the economy. This measure is widely adopted in the existing literature (Arena, 2008; Bayar et al., 2021; Horvey et al., 2023).

The control variables included in our analysis are selected based on established literature concerning the determinants of structural transformation. Specifically, we incorporate the following variables: mineral resources (measured as the ratio of total mineral resource rents to GDP), external debt (captured by the percentage of external debt stock in GDP), domestic credit (measured as domestic credit extended by banks to the private sector as a percentage of GDP), and renewable energy (measured as the percentage of renewable energy consumption in total final energy consumption). Prior research on structural transformation has identified several key determinants. For instance, Huang et al. (2023) found a positive correlation between resource rents and structural transformation in developing countries. Similarly, Fogang and Tchitchoua (2020) demonstrated a non-linear relationship between external debt and structural transformation. Regarding renewable energy, Tian et al. (2024) established its role in promoting sustainable development. Finally, Kromtit (2022) showed a positive association between financial development and structural transformation.

### 3.2. Estimation Strategy

The objective of this paper is to study the effect of insurance sector on the sustainable structural transformation in Africa. Our model specification is based on the study conducted by Tong et al. (2020). The econometric specification of our model is structured as follows:

$$\begin{aligned}\text{ISST}_{it} = {} & \gamma_0 + \gamma_1 \text{Tins}_{it} + \gamma_2 \text{Renew}_{it} + \gamma_3 \text{Domcred}_{it} + \gamma_4 \text{Debt}_{it} \\ & + \gamma_5 \text{Mineral}_{it} + u_i + v_t + e_{it}\end{aligned} \tag{1}$$

where $u_i$ is the unobserved country-specific effect, $v_t$ is the time-specific effect and $e_{it}$ is the error term. INS, Renew, Domcred, Debt, and Mineral respectively represent the insurance activity, renewable energy, domestic credit, external debt, and mineral resources. Given that Insurance activities might influence the sustainable structural transformation through renewable energy, we defined the interaction variable between insurance and renewable energy (Tins × Renewable). This variable is included in Equation (1) to form Equation (2).

$$\begin{aligned}\text{ISST}_{it} = {} & \gamma_0 + \gamma_1 \text{Tins}_{it} + \gamma_2 \text{Renew}_{it} + \gamma_3 \text{Domcred}_{it} + \gamma_4 \text{Debt}_{it} + \gamma_5 \text{Mineral}_{it} \\ & + \gamma_6 \left(\text{Tins} * \text{Renewable}\right)_{it} + u_t + v_t + e_{it}\end{aligned} \tag{2}$$

Since our sample includes a larger N (40) compared to T (20), the automatic choice for robustness is the Panel Corrected Standard Error (PCSE). The PCSE models are both heteroskedastic and simultaneously correlated across panels, with or without autocorrelation. However, since the empirical literature has found the two estimators to be mostly identical with common attributes, except when the number of time periods is twice the number of cross sections (Reed & Ye, 2011), we also present the results of the FGLS method as an alternative measure to check the robustness of our findings. For a popular Prais-Winsten estimation with the panel corrected standard error (PCSE), suggested by Beck and Katz (1995), has been performed to offer efficiency and consistency. Nevertheless, a related technique that would also achieve the same goal of overcoming group heteroskedasticity, time-invariant cross-sectional dependence, as well as serial correlations is the feasible generalized least squares (FGLS) estimator previously proposed by Parks (1967). In fact, Monte Carlo simulations revealed that the FGLS and PCSE estimators are robust to three econometric problems: autocorrelation, heteroskedasticity, and panel correlation (Bai et al., 2021). However, as reported by Reed and Ye (2011), the FGLS estimator has been found to significantly underestimate standard errors in finite samples and cannot be used when the number of cross sections (N) is greater than the number of periods (T). In such circumstances, Beck and Katz (1995) proposed the PCSE estimator, which is a modification of the full GLS-Parks estimator that preserves the Prais-Winsten weighting of the observations for autocorrelation, but uses a sandwich estimator to incorporate the cross-sectional dependence when calculating the standard errors.

## 4. Results

This section is organized into three key parts. The first presents the main findings and their interpretation. The second explores the results while considering potential heterogeneity across the sample. Finally, the third part examines the role of renewable energy as a mediating factor in the relationship between insurance activities and sustainable structural transformation.

### 4.1. Main Results

**Table 3** presents the results of the panel corrected standard error (PCSE) estimation, illustrating the effect of insurance activities on sustainable structural transformation. The findings in this table indicate that total insurance positively influences sustainable structural transformation in African countries (Columns 1 and 4). Decomposing total insurance into its life and non-life components confirms this initial result, with non-life insurance exhibiting a more substantial impact (Columns 2 - 3, 5 - 6). This outcome aligns with the premise that financial development fosters capital accumulation, which is crucial for funding investments in emerging industries and technologies (Levine, 1997). The expansion of credit markets enables firms to access borrowing for investment purposes. Indeed, the finance industry plays a significant role in long-term growth by influencing savings rates, investment decisions, and technological innovations (Levine, 2005). Consequently, improved resource allocation can spur innovation and facilitate the transition of economies from agriculture to industry and services, while simultaneously reducing carbon emission intensity through technological advancements (Liu & Liu, 2021). This result is consistent with the findings of Lo and Ramde (2019), who observed that financial development promotes long-run structural transformation in the Franc Zone, and the work of Jiang et al. (2020), which established a positive contribution of financial development to industrial structure upgrading in China.

Regarding renewable energy, the results indicate a positive and significant effect on sustainable structural transformation (Columns 4 - 6). The development of renewable energy can stimulate growth across various sectors, including manufacturing and services. For example, renewable energy technologies such as wind turbines and solar panels lead to the creation of new industries and employment opportunities, ultimately contributing to economic growth. As noted by Liu et al. (2019), renewable energy is more effective in promoting the upgrading of China's industrial structure than coal energy. Furthermore, Shan et al. (2021) demonstrated that by adopting renewable energy and fostering innovation, countries can achieve their climate goals and promote economic restructuring. The relatively modest effect of renewable energy on sustainable structural transformation in our African sample might reflect the current limited allocation of significant budgets towards clean energy development in these countries. Nevertheless, the positive relationship observed between these two variables should inform policymakers about the potential positive impacts of prioritizing clean energy development. Similarly, external debt also shows a positive influence on sustainable structural transformation. The relatively low impact of foreign debt presented in **Table 3** could be attributed to the possibility that African countries' debt is not primarily directed towards promoting technological innovation, and even less so towards combating climate change.

**Table 3.** Effect of insurance on sustainable structural transformation (PCSE).

| Variables | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| | ISST | ISST | ISST | ISST | ISST | ISST |
| TINS | 0.00321*** | | | 0.00426*** | | |
| | (0.000290) | | | (0.000561) | | |
| NLINS | | 0.0129*** | | | 0.0163*** | |
| | | (0.00196) | | | (0.00529) | |
| LINS | | | 0.00378*** | | | 0.00420*** |
| | | | (0.000356) | | | (0.000590) |
| Renewable | | | | 0.000176*** | 0.000217*** | 0.000176*** |
| | | | | (2.17e−05) | (2.12e−05) | (2.35e−05) |
| Domcred | | | | 0.000174*** | 0.000249*** | 0.000237*** |
| | | | | (5.18e−05) | (9.31e−05) | (5.05e−05) |
| Debtstocks | | | | 0.000175*** | 0.000158*** | 0.000175*** |
| | | | | (4.10e−05) | (4.22e−05) | (4.10e−05) |
| Mineralrents | | | | 0.00347*** | 0.00372*** | 0.00335*** |
| | | | | (0.000418) | (0.000497) | (0.000403) |
| Constant | 0.473*** | 0.469*** | 0.475*** | 0.445*** | 0.436*** | 0.447*** |
| | (0.000539) | (0.00139) | (0.000439) | (0.00301) | (0.00306) | (0.00323) |
| Obs | 800 | 800 | 800 | 772 | 772 | 772 |
| R-squared | 0.023 | 0.019 | 0.023 | 0.104 | 0.101 | 0.102 |
| Number of I | 40 | 40 | 40 | 39 | 39 | 39 |
| Prob (Chi$^2$) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Source: Authors. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Concerning mineral resources, their positive and significant impact on sustainable structural transformation can be explained by the fact that their exploitation can provide raw materials for the industrial sector. Moreover, the export of certain mineral resources generates foreign currency for exporting countries, which can be utilized to finance the transition from agriculture to industry and services. This finding contradicts the resource curse hypothesis identified by Nkemgha et al. (2022), who argued that natural resources constitute a hindrance to African industrialization. Similar results were obtained using feasible generalized least squares (FGLS) and pooled ordinary least squares (OLS) estimations, as detailed in **Table 4**.

**Table 4.** Effect of insurance on sustainable structural transformation (FGLS and pooled OLS).

| Variables | FGLS | FGLS | FGLS | Pooled OLS | Pooled OLS | Pooled OLS |
|---|---|---|---|---|---|---|
| | ISST | ISST | ISST | ISST | ISST | ISST |
| TINS | 0.00426*** | | | 0.00426*** | | |
| | (0.00126) | | | (0.000761) | | |
| NLINS | | 0.0163*** | | | 0.0163* | |
| | | (0.00555) | | | (0.00796) | |
| LINS | | | 0.00420*** | | | 0.00420*** |
| | | | (0.00138) | | | (0.00111) |
| Renewable | 0.000176** | 0.000217*** | 0.000176** | 0.000176*** | 0.000217*** | 0.000176*** |
| | (7.87e−05) | (7.75e−05) | (7.91e−05) | (3.07e−05) | (2.17e−05) | (3.63e−05) |
| Domcred | 0.000174 | 0.000249* | 0.000237* | 0.000174*** | 0.000249 | 0.000237*** |
| | (0.000135) | (0.000128) | (0.000129) | (6.01e−05) | (0.000168) | (7.27e−05) |
| Debtstocks | 0.000175*** | 0.000158*** | 0.000175*** | 0.000175*** | 0.000158** | 0.000175*** |
| | (3.99e−05) | (3.98e−05) | (4.01e−05) | (5.46e−05) | (5.66e−05) | (5.38e−05) |
| Mineralrents | 0.00347*** | 0.00372*** | 0.00335*** | 0.00347*** | 0.00372*** | 0.00335*** |
| | (0.000585) | (0.000603) | (0.000583) | (0.000511) | (0.000515) | (0.000491) |
| Constant | 0.445*** | 0.436*** | 0.447*** | 0.445*** | 0.436*** | 0.447*** |
| | (0.00687) | (0.00700) | (0.00702) | (0.00248) | (0.00347) | (0.00299) |
| Observations | 772 | 772 | 772 | 772 | 772 | 772 |
| R-squared | | | | 0.104 | 0.101 | 0.102 |
| Number of I | 39 | 39 | 39 | 39 | 39 | 39 |
| Prob ($Chi^2$) | 0.00 | 0.00 | 0.00 | | | |
| Prob (F-stat) | | | | 0.00 | 0.00 | 0.00 |

Source: Authors. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

## 4.2. Accounting for Heterogeneity

South Africa holds a dominant position in the African insurance market, accounting for approximately 68.2% of the continent's total insurance premiums. Given this significant share, it is pertinent to highlight the distinction between the results obtained from the full sample and those derived from a sample excluding South Africa. **Table 5** presents the analysis of the effect of insurance on sustainable structural transformation for the sample excluding South Africa. The findings indicate that both total insurance and non-life insurance exert a positive influence on sustainable structural transformation in this subsample. However, life insurance shows an insignificant effect. This outcome can be attributed to the composition of South Africa's insurance market, where non-life insurance constitutes roughly 80% of the total premiums, while life insurance accounts for only 20%. These statistics suggest that while the non-life insurance market is largely driven by South Africa, the life insurance market has a more distributed presence across other African countries.

Table 5. Regression without South Africa.

| Variables | 1 | 2 | 3 |
|---|---|---|---|
| | ISST | ISST | ISST |
| TINS | 0.00417** | | |
| | (0.00174) | | |
| NLINS | | 0.0170*** | |
| | | (0.00506) | |
| LINS | | | 0.00276 |
| | | | (0.00231) |
| RENEWABLE | 0.000168*** | 0.000156*** | 0.000166*** |
| | (2.63e−05) | (2.65e−05) | (2.61e−05) |
| Domcred | 0.000149** | 2.61e−05 | 0.000236*** |
| | (5.82e−05) | (8.41e−05) | (5.24e−05) |
| Debtstocks | 0.000177*** | 0.000170*** | 0.000176*** |
| | (4.12e−05) | (4.21e−05) | (4.06e−05) |
| Mineralrents | 0.00348*** | 0.00376*** | 0.00333*** |
| | (0.000395) | (0.000507) | (0.000383) |
| Constant | 0.446*** | 0.443*** | 0.448*** |
| | (0.00319) | (0.00376) | (0.00307) |
| Observations | 752 | 752 | 752 |
| R-squared | 0.073 | 0.079 | 0.069 |
| Number of I | 38 | 38 | 38 |
| Prob ($Chi^2$) | 0 | 0 | 0 |

Source: Authors. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

### 4.3. Role of Renewable Energy in the Insurance-Sustainable Structural Transformation Nexus

Table 6 demonstrates an indirect relationship between the insurance sector and sustainable structural transformation, mediated by renewable energy. This finding establishes renewable energy as a key transmission mechanism through which the insurance sector fosters sustainable structural transformation in Africa. This result can be explained by the potential of savings generated by the insurance sector to facilitate loans and investments in the development of renewable energy technologies. Such access to finance is particularly crucial for capital-intensive renewable energy projects like solar and wind farms. Furthermore, financial development can mitigate the risks associated with renewable energy investments, thereby enhancing their appeal to investors (Taghizadeh-Hesary & Yoshino, 2020). Consequently, advancements in renewable energy technologies are expected to stimulate growth across various sectors, including manufacturing, construction, and services. For example, the production of solar panels, wind turbines, and other renewable energy systems creates new industries and employment opportunities. As highlighted by Liu et al. (2019), renewable energy more effectively promotes the upgrading of the industrial structure in China compared to coal energy.

**Table 6.** The role of renewable energy in the relationship between insurance and sustainable structural transformation.

| Variables | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| | ISST | ISST | ISST | ISST | ISST | ISST |
| TINS | 0.00321*** | 0.00382*** | 0.00176*** | 0.00352*** | 0.00426*** | 0.00172** |
| | (0.000290) | (0.000314) | (0.000638) | (0.000599) | (0.000561) | (0.000792) |
| Renewable | | 0.000104*** | 0.000208*** | 0.000186*** | 0.000176*** | 0.000131*** |
| | | (1.51e−05) | (2.66e−05) | (2.25e−05) | (2.17e−05) | (2.19e−05) |
| Domcred | | | 0.000309*** | 0.000229*** | 0.000174*** | 0.000278*** |
| | | | (7.03e−05) | (5.55e−05) | (5.18e−05) | (5.85e−05) |
| Debtstocks | | | | 0.000160*** | 0.000175*** | 0.000173*** |
| | | | | (4.76e−05) | (4.10e−05) | (4.20e−05) |
| Mineralrents | | | | | 0.00347*** | 0.00359*** |
| | | | | | (0.000418) | (0.000428) |
| TINS × Renewable | | | | | | 0.000120*** |
| | | | | | | (3.57e−05) |
| Constant | 0.473*** | 0.465*** | 0.455*** | 0.449*** | 0.445*** | 0.443*** |
| | (0.000539) | (0.00127) | (0.00254) | (0.00304) | (0.00301) | (0.00321) |
| Observations | 800 | 800 | 800 | 772 | 772 | 772 |
| R-squared | 0.023 | 0.026 | 0.032 | 0.063 | 0.104 | 0.110 |
| Number of I | 40 | 40 | 40 | 39 | 39 | 39 |
| Prob ($Chi^2$) | 0 | 0 | 0 | 0 | 0 | 0 |

Source: Authors. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

## 5. Conclusion

Africa's green transition represents a significant challenge for the continent. However, the delayed industrialization process could offer African nations a unique opportunity to "leapfrog" traditional development pathways and directly pursue sustainable structural transformation. Guided by this perspective, this study aimed to investigate the impact of the insurance sector on sustainable structural transformation, with a particular focus on the mediating role of renewable energy. Employing panel corrected standard error (PCSE) and feasible generalized least squares (FGLS) methods on a sample of 40 African countries spanning the period 2000-2019, our findings establish that the insurance sector indeed promotes sustainable structural transformation. Furthermore, the disaggregation of insurance into life and non-life categories reinforces this conclusion, with non-life insurance exhibiting a more pronounced effect. Crucially, our results also reveal that renewable energy serves as a key transmission mechanism through which the insurance sector fosters sustainable structural transformation. Consequently, policymakers should strategically leverage the savings generated by the insurance sector to implement programs that steer the continent towards sustainable development. Moreover, African governments should actively promote the development and adoption of green solutions by alleviating financial constraints on environmentally friendly technologies and projects through incentives such as green subsidies for technology development and adoption. The limitation of this study is that the estimation technique does not account for endogeneity.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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## Appendix

**Table A1.** List of countries.

| | | | | |
|---|---|---|---|---|
| Algeria | Central Africa Republic | Gambia | Mauritania | Senegal |
| Angola | Chad | Ghana | Mauritius | Sierra Leone |
| Benin | Democratic Republic of the Congo | Guinea | Morocco | South Africa |
| Botswana | Congo | Kenya | Mozambique | Tanzania |
| Burkina Faso | Cote d'Ivoire | Lesotho | Namibia | Togo |
| Burundi | Egypt | Madagascar | Niger | Tunisia |
| Cabo Verde | Ethiopia | Malawi | Nigeria | Uganda |
| Cameroon | Gabon | Mali | Rwanda | Zambia |