

Volume 24  
Number 2  
Summer 2026

ISSN 1854-6935

*Managing  
Global  
Transitions*

EDITOR IN CHIEF  
Jana Hojnik

*International  
Research  
Journal*



# *Managing Global Transitions*

## *International Research Journal*

VOLUME 24 · NUMBER 2 · SUMMER 2026 · ISSN 1854-6935

- 171 SIFIDE's Double Impact in Portugal: Boosting R&D and Optimizing Taxes  
*Pedro Feliciano, Cristina Sá, and José Luís Martins*
- 203 Scaling Up the Clean Energy Transition in Turkey: The Role of Financial Development, Green Technologies, and Economic Complexity  
*Foday Joof and Mehdi Seraj*
- 227 The Effect of Corruption on the Nexus Between Public Health Expenditure and Economic Growth in Sub-Saharan Africa  
*Omobola H. Arowolo and Sunday O. Adewara*
- 255 Migration and Human Capital Development in Africa: The Brain Drain to Brain Gain Philosophy  
*Uche Abamba Osakede, Joel Tobiloba Adeyemo, Opeyemi Eunice Olagunju, Olayinka Omolara Adenikinju, Johnson Olaosebikan, Akanni Olayinka Lawanson, and Olanrewaju Olaniyan*
- 281 Education and Youth Unemployment in South Africa after COVID-19: Evidence from the General Household Survey (GHS)  
*Lana Erasmus, Clement Moyo, and Andrew Phiri*
- 305 Abstracts in Slovene



# *SIFIDE's Double Impact in Portugal: Boosting R&D and Optimizing Taxes*

Pedro Feliciano  
Polytechnic University  
of Leiria, Portugal  
2210523@my.ipleiria.pt

José Luís Martins  
Polytechnic University  
of Leiria, Portugal  
jose.martins@ipleiria.pt

Cristina Sá  
CARME, Polytechnic University  
of Leiria, Portugal  
cristina.sa@ipleiria.pt

Economic growth is closely linked to innovation, with R&D playing a key role in generating new knowledge, products, and processes. In Portugal, public policies support R&D through financial incentives and tax benefits. This article examines the relationship between economic growth and R&D investment from both macroeconomic and microeconomic perspectives, focusing on national outcomes and firm-level performance, emphasizing the role of tax incentives in private R&D. Using a linear regression model, we find that innovation-intensive firms investing in R&D exhibit higher levels of tax planning, partly reflecting the direct effect of R&D tax incentives (SIFIDE), and potentially linked to more accurate tax management practices. Our findings align with international evidence while addressing a gap in the Portuguese context. The findings provide insights for policymakers and business leaders, emphasizing the need to monitor private R&D investments supported by SIFIDE and assess their real economic impact, given the scheme's substantial fiscal cost.

*Keywords:* economic growth, tax planning, R&D, tax benefits, SIFIDE

*JEL Classifications:* M48; O38

Received 2025/10/25 · Revised 2026/01/08 · Accepted 2026/01/20

Published online 2026/06/30 © Author



<https://doi.org/10.26493/1854-6935.24.171-201>

## **Introduction**

Innovation is now, more than ever, a critical driver of economic growth for countries and companies. It is a keystone for transitioning a developing country into a developed one, as this process relies not only on the ability to attract investment but also on the capacity to acquire and utilize both cutting-edge and existing technologies (Dhar et al. 2023).

Innovation bridges market demands with scientific and technological advancements, adapting and transforming processes and products to align with market needs. Furthermore, it enhances productivity, providing companies with a competitive advantage over their rivals, which translates into higher profit margins, increased market share, and greater overall financial performance (Caron 2006).

One of the key drivers of technical progress – and consequently innovation and productivity growth in both nations and companies – is investment in Research and Development (R&D). A strong correlation is expected between innovation investments and economic growth over the medium to long term. Economic agents with robust innovation strategies, such as advanced training in science and engineering, investments in R&D, and technological development, tend to achieve higher levels of economic growth and prosperity. Consequently, the efforts of organizations in R&D are widely regarded as critical contributions to innovation, which, in turn, is recognized as a pillar of economic development (Lichtenberg 1992; Guellec and van Pottelsberghe de la Potterie 2001).

Given the importance of R&D investments in fostering innovation and economic growth, analysing the policies and incentives available in Portugal to encourage such activities is crucial. In Portugal, public policy efforts to promote R&D activities primarily rely on financial and tax benefits.

Financial incentives are tools designed to support business development, primarily by assisting companies in executing their investments. Organizations like IAPMEI (Agency for Competitiveness and Innovation) play a strategic public role in supporting small and medium-sized enterprises (SME) in sectors such as industry, commerce, services, and construction to access financial incentives. IAPMEI promotes business growth through various initiatives aimed at fostering expansion and internationalization.

In Portugal, a significant portion of financial incentives stems from European Union funding programmes, such as Portugal 2030. These programmes define the policy framework for economic, social, and territorial development within a given period. They include several systems of incentives designed to stimulate national economic growth and development. For example, the ‘Business Competitiveness Incentive System’, particularly its ‘Productive Innovation’ component, aims to encourage innovative business investments. This programme promotes changes in Portugal’s economic specialization profile and enhances its external

competitiveness through diversification, differentiation, and innovation. Eligible expenditures include those made by SMEs to develop innovative, digital, and sustainable production capabilities (Presidência do Conselho de Ministros 2023).

Tax benefits, on the other hand, promote productive investments by offering tax savings linked to such expenditures. The most relevant tax benefits for supporting and promoting investment are outlined in the Investment Tax Code (ITC, Portuguese acronym: CFI). Among these, the Corporate R&D Tax Incentive System (SIFIDE – Sistema de Incentivos Fiscais à Investigação e Desenvolvimento Empresarial) stands out as a benefit exclusively targeting R&D activities. Over the years, this benefit has become increasingly vital in supporting R&D investments. SIFIDE is currently the most widely used tax benefit under the ITC, enabling companies in Portugal to deduct €407 million from their assessed corporate tax income in 2021, representing 56.74% of the total deductions that year.

In addition to the importance of innovation investments, effective tax planning is crucial in today's global economic landscape. Optimized tax planning plays a significant role in economic growth, allowing companies to improve profitability through mechanisms such as tax benefits. Thus, tax planning has become an increasingly critical variable for organizational leaders (Fernandes 2013). Tax planning is defined as the structuring of a taxpayer's actions in compliance with tax laws, aiming to minimize, defer, or eliminate tax liabilities (Silva 2008). It is a form of tax management and savings where taxpayers use their knowledge about legal rules to implement the most favourable solutions (Santos 2010).

Within this context, the study contributes to the existing literature by providing new empirical evidence on the relationship between R&D investment and corporate tax planning in a national context. While prior research has extensively examined the links between R&D, innovation, and economic growth, as well as the role of fiscal incentives in stimulating R&D activities, empirical analyses directly connecting R&D investment to corporate tax planning remain limited, particularly at the firm level and within specific institutional frameworks.

The originality of this paper lies in three main aspects. First, it focuses on the Portuguese context, where the SIFIDE represents one of the most generous and widely used R&D tax incentive schemes among OECD countries, but remains relatively underexplored in empirical research. Second, the study uses SIFIDE-approved amounts as a direct and objec-

tive proxy for R&D investment, relying on accounting data rather than indirect innovation indicators such as patents. Third, by combining data from the Portuguese Tax Authority and the Iberian Balance Sheet Analysis System (SABI) database and by analysing a large and balanced sample of beneficiary and non-beneficiary firms, this research offers robust evidence on how R&D-related tax incentives influence effective tax rates and corporate tax planning behaviour.

By addressing these gaps, this study provides a comprehensive analysis of the interplay between economic growth, innovation, R&D activities, and public support mechanisms, contributing to the literature on innovation economics and fiscal policy while offering relevant insights for both corporate decision-makers and public authorities.

The paper is organized as follows. Section 2 offers a literature review by exploring theories and empirical evidence on how R&D investments stimulate economic growth, foster technological innovation, and enhance the competitiveness of nations and companies. Section 2 also characterizes tax benefits for R&D investments, with a particular emphasis on SIFIDE. This includes tracing the historical evolution of SIFIDE, evaluating its impact on innovation, and analysing the dynamics between public and private sectors. Additionally, it offers insights into optimizing fiscal policies to maximize corporate innovation potential and, in turn, drive economic growth. Section 3 deals with methodology applied in this research. Section 4 shows the influence of R&D activities on corporate tax planning practices by analysing the results of the linear regression model developed. Section 5 concludes.

## Literature Review

### ECONOMIC GROWTH AND INVESTMENT IN R&D

In today's highly competitive and globalized markets, innovation has become a crucial factor for businesses' survival (Pereira 2020). The market is characterized by constant change, making it increasingly essential for companies to stand out. They can achieve this by diversifying their products and services compared to competitors and by enhancing their performance to maximize revenues and minimize costs. In this context, modern economic theory has placed growing emphasis on issues related to knowledge and technological innovation, particularly highlighting the critical role of investment in R&D activities (Kučera and Fiľa 2022).

Economic growth can be defined as an increase in the quantity and quality of goods and services produced by a society over time. The most significant quantitative change occurs when production moves from zero to one, meaning the creation of a new product (Roser 2021).

Two main models of economic growth dominate the literature. The exogenous growth model, representing first-generation growth theories, held dominance for many years. In this model, technology is not an explanatory factor; instead, labour and capital are considered the primary drivers of economic growth. Innovation is viewed as an unintended byproduct of the accumulation of production factors, such as learning through experience or study (Romer 1986; Lucas 1988).

In contrast, the endogenous growth model emerged as a second-generation economic growth theory, positioning knowledge as the central driver of economic growth. It argues that R&D efforts are essential for innovation activities, which increase productivity and ultimately drive economic growth. Unlike the exogenous model, the endogenous approach emphasizes intentional decisions by economic agents aiming for returns on investment. This perspective underscores the direct dependence of technological and human capital intensity on R&D activities, training incentives, and other strategic investments (Romer 1990; Jones 1995).

A prevailing consensus holds that technological progress and innovation are fundamental to economic growth. Guei and Choga (2022) demonstrate that innovation plays a significant role in promoting economic upgrading and long-term growth through global value chains. Their analysis shows that R&D investment increases value creation and productivity, especially when developing countries engage in trade with advanced economies. The study shows that promoting innovation is essential for sustainable economic growth. Innovation, particularly through artificial intelligence (AI) adoption, supports economic growth by enhancing productivity and strengthening competitiveness. As shown by Costa et al. (2025), the dissemination of AI across firms stimulates innovation, efficiency, and creativity – core drivers of sustainable development. Their findings emphasize that innovation capacity is a strategic determinant of both business performance and national economic growth.

This relationship has been extensively studied, with numerous investigations confirming the connection. The evidence can be examined from two perspectives: macroeconomic (national economies, including Portugal) and microeconomic (businesses).

*Evidence from European Countries and Portugal*

Recent studies underscore the role of R&D investment as a key driver of economic growth across nations, particularly in emerging economies. Tung and Hoang (2024) emphasize that in these contexts, R&D spending has direct and indirect positive effects on economic growth. It helps nations escape the ‘middle-income trap’ and transition to more advanced economies. Investments in physical capital and education complement R&D activities, further powering growth. These findings highlight the strategic importance of increasing R&D investments to achieve sustainable national development.

Ulku (2004) examined the relation between economic growth, measured by GDP per capita, R&D investment, and innovation (using patents as a proxy). Analysing data from 20 OECD member countries and 10 non-members, the study confirmed that innovation positively influences economic growth. It also demonstrated that R&D investment plays a central role in driving innovation levels, regardless of whether a country is an OECD member.

Maradana et al. (2017) analysed the relation between innovation and per capita economic growth across 19 European countries between 1989 and 2014. They utilized five innovation indicators: patent registrations (by residents and non-residents), R&D expenditure, high-tech exports, scientific publications, and the number of R&D researchers. Their findings identified bidirectional relationships between these indicators, suggesting that innovation drives economic growth, while economic growth can also stimulate innovation. However, their study highlights the need for government intervention to align innovation policies with national development goals.

Kučera and Fiľa (2022) explored the relationship between R&D expenditure, innovation, and economic growth within EU countries. Their study relied on three key indicators: the Summary Innovation Index (SII) to measure innovation levels, R&D spending as a percentage of GDP, and economic growth measured by GDP per capita. They concluded that R&D spending and innovation are crucial determinants of economic growth. Over the long term, sustaining competitiveness requires substantial investment in R&D-driven innovation.

Global projections for 2024 anticipate that R&D funding will reach \$2.53 trillion, an 8.3% increase from 2022. This growth reflects a rising R&D-to-GDP ratio in various economies, signalling that technological in-

novation remains the centre of economic policy and sustainable growth. Industrialized nations, such as the United States – where the industrial sector accounts for 75% of R&D investments – serve as prime examples of how fostering innovation can catalyse macroeconomic growth.

From a Portuguese perspective, several studies have explored the link between R&D investment and economic growth, both at the macroeconomic level and within the corporate context. The 'OECD Review of Higher Education, Research and Innovation: Portugal' examined how R&D incentive policies, such as the SIFIDE programme, have fostered innovation and competitiveness (Organisation for Economic Co-operation and Development (OECD) 2019). It concluded that promoting R&D is vital for enhancing productivity and sustaining long-term growth in Portugal.

Rosário and Costa (2018) investigated how technological innovation indicators impacted national economic growth between 2000 and 2013. Using GDP and real GDP growth rates to measure economic performance, they found that technological innovation significantly contributed to economic growth, surpassing the impact of research in other areas such as social sciences. Additionally, they highlighted that higher percentages of engineers among researchers and a focus on applied research were particularly effective in driving GDP growth.

### *Evidence from Businesses*

R&D investment has increasingly become a critical success factor for businesses, enabling them to gain competitive advantages through differentiation strategies and the creation of new and improved products and services (Chan et al. 1990; Doukas and Switzer 1992).

Jiménez-Jiménez and Sanz-Valle (2011) examined the relationship between innovation and the performance of approximately 1,600 Spanish companies (55% manufacturing; 45% services). They found a positive correlation between innovation and overall performance. Factors such as company size and industry – particularly within manufacturing – positively influenced this relationship.

Gök and Peker (2017) examined how innovation impacts firms across two dimensions: financial performance and market performance. Drawing on existing literature, the authors identified three categories of studies addressing the relationship between innovation and firm performance. The first category focuses on the interaction between innovation and a

firm's strategic orientations, such as market strategy, learning strategy, and overall performance. These studies primarily emphasize the relationship between innovation and firm performance (e.g. Han et al. 1998). The second category encompasses research investigating the link between firm performance and various innovation domains, including administrative innovation, production processes, technological advancements, and more (e.g. Subramanian and Nilakanta 1996; Damanpour et al. 1989). The third category includes studies that explore the connection between innovation and firms' market value, often measured through stock prices. This line of research focuses on the impact of product innovation on a firm's profitability indicators.

The study targets the largest manufacturing and service firms in Turkey's industrial sector in 2015, spanning various market segments, including marketing, accounting, procurement, sales, and manufacturing. The findings demonstrate that innovation has a positive overall impact on firm performance. However, a more nuanced analysis reveals that while the effect on financial performance is negative, it is offset by a positive impact on market performance. This highlights the critical role of the market in translating firms' innovation efforts into financial gains over the medium to long term. Innovation is an inherently costly activity that exposes firms to greater market risk, often resulting in short-term negative impacts on financial performance. Nevertheless, innovation serves as a key driver of firm performance and should occupy a central role in a firm's market strategy.

The level of innovation is a critical factor in a highly competitive global economy characterized by increasingly globalized companies, offering a clear perspective on the opportunities the future may hold (Rajapathirana and Hui 2018).

The literature provides various definitions of the concept of innovation. According to the OECD and Eurostat, the *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data* defines innovation as: 'the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations' (Organisation for Economic Co-operation and Development (OECD) and Eurostat 2005, 46).

This definition encompasses all scientific, technological, organizational, financial, and commercial stages necessary to develop new products and processes that are commercially viable. In this context, the Oslo

Manual identifies four distinct types of innovation: product innovation, process innovation, marketing innovation, and organizational innovation. Product innovation refers to the 'introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses' (OECD and Eurostat 2005, 48). Process innovation focuses on the 'implementation of a new or significantly improved production or delivery method' (p. 49). Marketing innovation involves the 'implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing' (p. 49). Finally, organizational innovation is defined as the 'the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations' (p. 51).

Innovation is therefore expected to positively impact firm performance and drive economic growth. From a business perspective, innovation creates competitive advantages, boosts productivity, and enables the development of new and improved products and services. This underscores the necessity for firms to innovate to ensure competitiveness and technological progress, leading to sustainable economic growth.

At the macroeconomic level, economic growth is closely linked to firm-level performance. When firms invest in R&D and engage in innovation, they contribute to increased national productivity and, consequently, to the country's economic growth. Hence, implementing public policies that support the creation of resources necessary for firms to invest in innovation is of critical importance.

Additionally, the interaction between public policies and private initiatives is a key determinant of successful R&D investment. Well-designed government policies – such as those that promote fiscal incentives, foster collaborations with academic institutions, and encourage the development of innovation networks – are essential for establishing a robust innovation ecosystem.

#### INCENTIVES FOR R&D ACTIVITIES

##### *The Importance of Tax Incentives and R&D Activities*

According to the Frascati Manual, R&D activities are critical drivers of innovation, which in turn fosters wealth creation. These activities encompass systematic creative work aimed at expanding knowledge, including human, cultural, and societal understanding, and applying this knowledge to create or significantly improve applications (Organisation

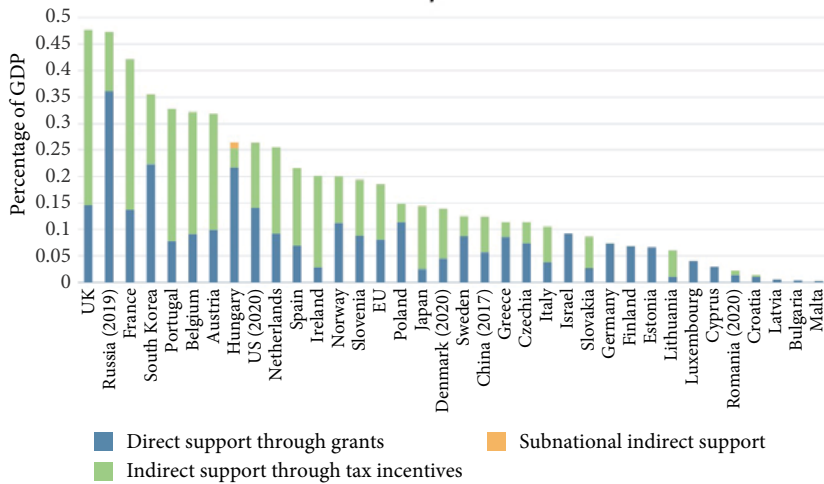


FIGURE 1 Direct Government Funding and Tax Support for Business R&D, 2021 or Latest Year Available (adapted from European Commission (2024, 68))

for Economic Co-operation and Development 2015). Investing in R&D promotes the pursuit of new knowledge, which directly influences innovation (Carvalho 2006). Innovation serves as a key differentiator for businesses, enabling them to achieve sustainable competitive advantages (Porter 1985). In this context, countries have developed economic measures and policies to attract and encourage investments in R&D. These measures primarily include tax incentives and financial support.

Figure 1 illustrates how countries structure their R&D support policies, highlighting the predominance of tax benefits, which constitute the largest share of resources allocated to R&D promotion. Over the last decade, the number of companies benefitting from such tax incentives has significantly increased, underscoring their growing importance in fostering R&D activities (Organisation for Economic Co-operation and Development 2024). Tax relief and fiscal support targeted at R&D investments are effective mechanisms for encouraging corporate R&D initiatives (Appelt et al. 2016; Hall 2019; Hall and Van Reenen 2000).

In Portugal, tax benefits play a significant role in supporting private investments, including R&D activities. As shown in figure 1, approximately 0.33% of the national GDP is allocated to R&D promotion policies, with 76% of this amount directed to tax benefits.

Government concerns about economic growth and the business environment have led to the creation of tax benefits for corporate investments (Peixoto 2016).

The OECD's 'Corporate Tax Statistics' report (Organisation for Economic Co-operation and Development 2024) indicates that in 2023, Portugal, Poland, and France had the lowest capital costs for R&D, reflecting robust tax-based incentives in these jurisdictions to boost R&D investments.

From a corporate perspective, tax benefits create fiscal savings associated with R&D investments. Faria (1995) defines tax benefits as measures designed to reduce or eliminate the tax burden that would otherwise be imposed on specific taxpayers, groups, or activities. These benefits, codified in article 2 of the Portuguese Tax Benefits Statute (TBS, Portuguese acronym: EBF), allow companies to reduce their tax expenses through deductions, exemptions, and rate reductions. They serve as instruments for achieving state objectives related to economic growth, technological innovation, modernization, support for underdeveloped regions, and social goals.

Most of these benefits apply to direct taxes, specifically personal income tax (PIT, Portuguese acronym: IRS) and corporate income tax (CIT, Portuguese acronym: IRC). Additionally, tax benefits are categorized by function (Employment creation; Industry; Investment; Savings; Tourism, among others), with nine targeted specifically at promoting R&D (Oliveira et al. 2019). Among the various tax benefits for R&D promotion, the Portuguese tax system includes specific measures like the Corporate R&D Tax Incentive System (SIFIDE).

Tax benefits serve as a critical tool enabling companies to optimize their fiscal planning. When such benefits are specifically tied to R&D activities, it raises an important question: are companies investing heavily in R&D also engaging in higher levels of fiscal planning?

The Portuguese Investment Tax Code (ITC), introduced by Decree-Law n.º 249/09 of September 23 (Decreto-Lei n.º 249/2009, de 23 de setembro), aims to reflect a new competitive philosophy in the Portuguese economy, promoting national economic growth and strengthening the business sector. Revised by Decree-Law n.º 162/14 of October 31 (Decreto-Lei n.º 162/2014, de 31 de outubro), the ITC aligns with European legislative standards and enhances tax benefits for investment. Among its provisions, the ITC includes a specific tax benefit exclusively dedicated to R&D activities. This benefit will be explored in the following section to assess its role in fostering investment and promoting R&D activities in Portugal.

### *The Corporate R&D Tax Incentive System (SIFIDE)*

The Corporate R&D Tax Incentive System (SIFIDE) is a fiscal benefit designed to enhance business competitiveness by supporting R&D efforts. It allows companies to deduct a percentage of eligible R&D expenses from assessed corporate income tax in an economic period.

Initially introduced in Portugal in 1997 (Decree-Law n.º 292/97 of October 22 (Decreto-Lei n.º 292/97, de 22 de outubro)), SIFIDE was suspended in 2004 and 2005, and reintroduced from 2006 to 2010. In 2011, it was replaced by SIFIDE II, which is in effect from 2011 to 2025.

The preamble of Decree-Law n.º 292/97 states that the productivity and competitiveness of companies significantly depend on their capacity for innovation, which in turn largely relies on the outcomes of scientific research and experimental development (R&D). In Portugal, the business sector's contribution to overall R&D efforts has been notably low, requiring efforts to support and stimulate such activities. This need is amplified by Portugal's position as one of the few OECD countries lacking a fiscal incentive framework for business-driven R&D, which places the country at a disadvantage in attracting qualified investments, especially compared to neighbouring Spain. Recognizing this context, the government aims to address the current state of R&D activities in businesses by employing a well-established short-term instrument with potential for immediate results: fiscal incentives.

According to Oliveira et al. (2019), the extra fiscal objectives of SIFIDE include fostering innovation and competitiveness in companies through increased R&D investment, boosting the number of qualified personnel within businesses, and contributing to the national goal of achieving 2% of GDP in private R&D investment by 2030.

Article 37 of the ITC outlines eligible expenses under the R&D tax incentive scheme, provided they qualify as research and development activities. These include, for example, acquisition of tangible fixed assets, excluding buildings and land, provided they are newly created or acquired and proportionally allocated to R&D activities; personnel expenses for staff with minimum educational qualifications and directly involved in R&D tasks; expenses for executives and managers involved in overseeing R&D institutions; operating expenses up to 55% of personnel costs directly associated with R&D, covering salaries and remuneration; contracted R&D activities conducted by public entities, entities with public utility status, or those with certified R&D expertise; equity participation in R&D institutions or contributions to public or private

investment funds that invest primarily in R&D-focused companies, including the commercialization of R&D results, with certification from the National Innovation Agency; and patent registration and maintenance costs, among others.

Certain restrictions apply: some enhanced incentives apply specifically to micro, small, and medium enterprises (SME) and expenses are eligible only if pre-approved by the National Innovation Agency. To qualify for the incentive, entities must obtain certification of competence to carry out R&D in specific areas. This certification, stipulated under article 37-A of the ITC, remains valid for 12 fiscal years, after which the National Innovation Agency reviews its validity.

Corporate income taxpayers can deduct a percentage of R&D expenditures incurred between 1 January 2014 and 31 December 2025. Each year's deduction is calculated by applying a 32.5% rate to total R&D costs and an additional 50% rate to any increase in R&D spending compared with the average of the previous two years, up to a maximum of €1.5 million. SMEs that have not completed two fiscal years and have not benefitted from the incremental rate are eligible for a 15% enhancement to the base rate.

If expenses cannot be deducted due to insufficient tax liability, they may be carried forward and deducted over the next 12 fiscal years.

To better understand the impact of the SIFIDE incentive, consider the following example:

- Year 0: Company X incurs €100,000 in R&D expenses. Since the average R&D spending for the previous two years is €0, the incremental expenditure is €100,000. Assuming compliance with the CFI requirements, Company X can benefit from a SIFIDE allocation of €32,500 (base rate) plus €50,000 (incremental rate).
- Year 1: Company X spends the same amount (€100,000) on R&D. However, the average spending for the previous two years is now €50,000. The incremental expenditure is therefore reduced to €50,000. Consequently, Company X can receive €32,500 (base rate) and €25,000 (incremental rate).

This example demonstrates that the company can recover between 32.5% and 82.5% of its R&D investment through SIFIDE.

Following the legal framework overview, it is pertinent to analyse the historical development of SIFIDE, particularly since 2006. As illustrated in figure 2, the number of applications has shown a consistently positive trend over the years.

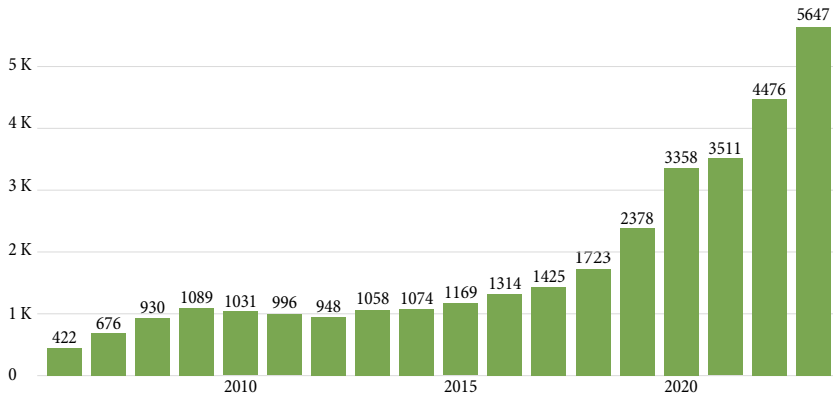


FIGURE 2 SIFIDE Applications Over Time (based on data from Agência Nacional de Inovação (<https://ani.pt/sifide-sistema-de-incentivos-fiscais-a-ied-empresarial/>))

Over the 2006–2023 period, 33,245 applications were filed to SIFIDE tax benefit, of which 25,492 were approved. Aggregate R&D expenditure associated with approved projects totaled €10.1 billion, while the corresponding amount of tax credits granted reached €5.1 billion. In total, 7,971 firms benefited from the program. The mean approval rate was 69.8%, and the average effective support rate was 50.8%.

There has been a consistent growth trend in R&D investment over the years. This indicates the increasing engagement of private entities in R&D activities, supported by public incentives like SIFIDE.

Additionally, data from the Survey of National Scientific and Technological Potential (Direção-Geral de Estatísticas da Educação e Ciência 2023) further reinforces this trend. In 2022, the business sector accounted for 62% of the national R&D expenditure, amounting to over €2.5 billion. Among the 200 top-spending companies in R&D, 80 were classified as SMEs (40% of the total), underscoring the crucial role of R&D in driving both large-scale enterprises and smaller firms.

### TAX PLANNING

In the global economic landscape, optimized tax management enables companies to enhance their profitability by leveraging fiscal benefits. As a result, tax planning has become an increasingly critical factor for organizational leaders (Fernandes 2013).

According to Silva (2008), tax planning involves the arrangement of a taxpayer's actions in compliance with tax laws to achieve non-payment, lower payment, or deferred payment of taxes. It always presupposes ad-

herence to the law, thereby distinguishing it from tax evasion, which entails fraudulent practices to avoid tax obligations. This process relies on the taxpayer's legal knowledge to identify solutions that are most favourable to them.

Tax planning can be categorized into legitimate and illegitimate practices. Illegitimate tax planning involves activities that contravene legal principles or tax regulations, resulting in improper reductions in tax obligations (Sanches 2006). This includes practices such as tax avoidance or evasion, which rely on actions beyond or against the law. These are often premeditated and involve activities not foreseen by legal statutes. Legitimate tax planning, on the other hand, refers to the lawful reduction of tax burdens by opting for choices permitted within the legal framework (Sanches 2006). This approach can serve as a strategic management tool, reducing fiscal burdens and potentially contributing to value creation within companies.

Tax planning mechanisms can lead to fiscal savings through strategies such as Tax Exemptions and Exclusions. Exemptions occur when laws explicitly relieve entities or individuals from paying taxes, either partially or entirely, as an incentive to achieve economic or social objectives. Exclusions refer to non-taxable scenarios where tax liability does not arise, differing from exemptions in that the underlying taxable event does not occur. Fiscal alternatives involve selecting the most tax-favourable option among legally provided choices. Tax benefits represent relief measures granted by the state. These benefits may be structural or temporary and include categories such as investment in R&D, corporate capitalization, savings, real estate, and social programmes.

Empirical studies on tax planning used several proxies to measure this variable. Two of the most common are the Book-Tax Difference (BTD) and Effective Tax Rate (ETR). Book-Tax Difference (BTD) measures discrepancies between accounting and fiscal frameworks, reflecting strategies like tax benefits (Hanlon 2005). Positive BTD values indicate lower taxable income than accounting income, correlating with lower ETRs, while negative BTD values result in higher ETR (Jackson 2015).

Effective Tax Rate is a widely recognized measure of fiscal planning, defined as tax expense divided by pre-tax income (Rego 2003). It provides aggregated insights into corporate tax burdens, highlighting managerial efficiency in reducing payable taxes (Dyreg et al. 2008). Variants like Cash ETR utilize cash flow data, representing actual taxes paid relative to pre-tax earnings (Dyreg et al. 2008).

#### R&D INVESTMENT AND TAX PLANNING

International studies have examined the interplay between R&D and tax planning. Gao et al. (2016) investigated the impact of innovation and R&D investments on corporate tax avoidance in a sample of U.S.-based firms from 1987 to 2010. Metrics such as Cash Effective Tax Rate (CASH\_ETR), BTD, and ETR adjusted for deferred taxes were employed to measure tax avoidance, while R&D investment was assessed through the number of patents registered by each company. Control variables included return on equity, leverage, firm size, the value of intangible and tangible assets, and foreign income. The study concluded that R&D investments are associated with lower tax burdens, suggesting a link between innovation and tax avoidance strategies.

Pfeiffer and Spengel (2017) explored the role of fiscal incentives for R&D in the tax planning strategies of multinational corporations across 32 countries. Using OECD data from 1995 and 2012, the authors conducted linear regression analyses incorporating country-level control variables such as GDP per capita, population size, and average R&D expenditures. Effective Tax Rate was used to measure tax planning, with comparisons made between ETR values with and without R&D fiscal incentives. The number of patents was used as a proxy for R&D activities. Their findings indicated that R&D tax incentives significantly reduced the ETR of companies.

Cheng et al. (2021) studied the impact of innovation on corporate tax planning and economic performance, focusing on U.S. firms from 1987 to 2012. Tax planning, the dependent variable, was measured using CASH\_ETR, while innovation, the independent variable, was assessed through the number of patents registered annually and their citation frequency in subsequent years. A linear regression model was employed, incorporating control variables such as return on assets, liquidity, return on equity, leverage, the value of intangible assets, depreciation and amortization, foreign income, and firm market value. The study concluded that firms with higher patent counts, resulting from R&D investments, engage in more sophisticated tax planning. This effect is driven by two mechanisms: income shifting derived from patent revenues and the use of government-granted R&D tax incentives, which offer credits and deductions.

Bayraktar and Tütüncü (2022) examined the relationship between tax planning and R&D expenditures. Using indicators such as CASH\_ETR and ETR to measure tax planning, the study analysed a sample of

564 firms between 2008 and 2019. Control variables included return on assets, leverage, firm size, capital intensity, and inventory intensity. The authors found that firms increase R&D expenditures to reduce their tax liabilities, leveraging fiscal incentives associated with these expenses.

Further studies have focused on the Portuguese context. Santos (2021) analysed the SIFIDE tax benefit, investigating its practical impact on Portuguese businesses and proposing improvements. A literature review and qualitative analysis, based on questionnaires administered to SIFIDE beneficiaries and non-beneficiaries, revealed that only a limited number of companies utilize SIFIDE, and most beneficiaries use it only once. Ferreira (2017) similarly evaluated the SIFIDE programme, focusing on its practical implementation and proposing measures to make it more appealing and functional for Portuguese firms. These measures included allowing tax credits to offset other taxes beyond corporate income tax, enabling early receipt of credits, permitting the use of credits as collateral for financing, and implementing early approval mechanisms for projects.

Grave (2023) analysed the impact of SIFIDE on the R&D performance of Portuguese companies between 2018 and 2020. The sample was divided into beneficiary and non-beneficiary firms. Using linear regression models, the study assessed SIFIDE's contribution to increased R&D investment, innovation, competitiveness, and innovation quality. R&D investment was measured through the natural logarithm of R&D expenditures, while innovation and competitiveness were evaluated using dummy variables based on the introduction of new or improved products, services, and processes. Innovation quality was measured by the revenue generated from new or improved products introduced during the study period. The findings indicated that SIFIDE significantly increases R&D investment, but its impact on innovation quality and competitiveness remains statistically insignificant.

Abrunhosa (2021) investigated the use of corporate income tax benefits as tax planning tools by Portuguese publicly traded companies between 2017 and 2019. Using quantitative methods, the study analysed financial data related to several tax benefits. The findings revealed substantial tax savings for firms using these benefits, with SIFIDE being the most widely adopted.

These studies collectively underscore the limited focus on the impact of R&D investments on corporate tax planning levels in the Portuguese

context. While Abrunhosa (2021) addresses tax savings, the scope is restricted to firms listed on Euronext Lisbon. Therefore, this research aims to contribute to the literature by analysing the understudied relationship between R&D investment and tax planning in the Portuguese corporate environment.

### **Methodology**

The research methodology adopted in this study involves a mixed-methods approach combining both qualitative and quantitative components. In the qualitative component, the literature review examines the concepts of SIFIDE, innovation, economic growth, and R&D activities, analysing their relationships through various empirical studies. In the quantitative study, the goal is to analyse the impact of R&D activities on corporate tax planning through the development of a multiple linear regression model.

*HYPOTHESIS* The level of corporate tax planning is positively influenced by investment in R&D activities.

### **SAMPLE DEFINITION**

The information sources utilized consist of secondary data of a documentary nature, including financial and related information for companies within the sample. All necessary data for generating the model variables were obtained from the Tax Authority database and the SABI database.

Through the Portuguese Tax Authority available data, we obtained a total of 50,737 observations from companies that received SIFIDE allocations between 2020 and 2022, as well as companies without any tax benefits deductible from their corporate tax in those years. After gathering the necessary data from the SABI database for calculating each variable, 20,553 observations were excluded due to missing information. Among the 30,184 remaining observations, we further excluded those with negative ETR values and outliers, yielding a total of 12,333 observations, of which 1,992 had a positive SIFIDE value. To achieve a more balanced sample, we randomly selected 1,992 observations with zero benefit deductions. After removing observations with negative R&D values, the final sample included 3,965 observations.

#### VARIABLE DEFINITION

The variables are as follows:

1. **Dependent Variable: Tax Planning (TP)** – The dependent variable considered is operationalized through the Effective Tax Rate (ETR), calculated as follows:  $ETR = \text{Income Tax} / \text{Profit Before Taxes}$ .
2. **Independent Variable: R&D Investment (R&D)** – The R&D variable is operationalized as the amount approved for SIFIDE, corresponding to the allocation approved by ANI for each year in the study.
3. **Control Variables** – Based on the literature, five control variables are included: company size (SIZE), leverage (LEV), return on assets (ROA), capital intensity (CAPITALINT), and inventory intensity (INVENTINT).
  - **Company Size (SIZE):** Measured as the natural logarithm of total assets. The impact of this variable on tax planning is non-linear, with some authors reporting a positive relationship (Kraft 2014; Noor et al. 2010) and others reporting a negative one (Stamatopoulos et al. 2016).
  - **Leverage (LEV):** Calculated as the ratio of total liabilities to equity. Studies on this indicator's influence on tax planning show mixed results, with some reporting that higher leverage correlates with a higher ETR (Fernández-Rodríguez and Martínez-Arias 2014), while others find a negative relationship (Nomura 2017).
  - **Return on Assets (ROA):** Calculated as the ratio of net income to total assets, reflecting a company's efficiency in converting asset investments into earnings. Some studies report a positive relationship between ROA and ETR (Salaudeen and Eze 2018), while others report a negative relationship (Pratama 2017).
  - **Capital Intensity (CAPITALINT):** Relates the amount invested in fixed assets to total assets. Studies generally show a negative relationship between this indicator and ETR (Nugrahadi and Rinaldi 2021).
  - **Inventory Intensity (INVENTINT):** Relates inventory investment to total assets. Studies on the effect of this indicator on ETR are inconclusive. While Costa et al. (2012) report a positive relationship, Andreas and Savitri (2017) conclude that higher inventory investment negatively affects ETR.

### LINEAR REGRESSION MODEL

To test the influence of R&D investment on tax planning, we develop a multiple linear regression model as follows:

$$TP_i = \beta_0 + \beta_1 R\&D_i + \beta_2 SIZE_i + \beta_3 LEV_i + \beta_4 ROA_i + \beta_5 CAPITALINT_i + \beta_6 INVENTINT_i + \varepsilon_i, \quad (1)$$

where  $TP_i$ : tax planning of company  $i$ ;  $\beta_0$ : Intercept;  $\beta_j$  ( $j = 1, \dots, 6$ ): partial slopes, representing the change in tax planning level for each unit change in the independent variables;  $R\&D_i$ : R&D investment of company  $i$ ;  $SIZE_i$ : company size of company  $i$ ;  $LEV_i$ : leverage of company  $i$ ;  $ROA_i$ : return on assets of company  $i$ ;  $CAPITALINT_i$ : capital intensity of company  $i$ ;  $INVENTINT_i$ : inventory intensity of company  $i$ ;  $\varepsilon_i$ : model error.

### Results

The 3,965 observations in the sample are divided into two groups: one with 1,973 observations that received SIFIDE allocations during the period under study, and the other consisting of the remaining 1,992 observations from companies without SIFIDE allocations. This study assumes that companies without any SIFIDE allocation did not invest in R&D during the examined periods.

On average, the sample companies with SIFIDE allocations exhibit a lower ETR (9.88%) than those without any fiscal benefit deductions (ETR = 16.66%). This potentially indicates that companies investing in R&D engage in more tax planning. Notably, the average ETR (13.29%) is considerably below Portugal's nominal tax rate of 21%. This discrepancy may be due to other tax-saving instruments not examined in this study, such as the reduced 17% tax rate on the first €50,000 of taxable income for SMEs and Small Mid-Caps. Despite this, the possible effect of R&D investments is clearly visible.

For descriptive statistics, we characterized the sample using dispersion measures (standard deviation), central tendency (mean), and non-central tendency (maximum and minimum), as presented in table 1.

The Pearson Correlation Coefficient measures the strength and direction of the linear association between two variables. To examine the correlations among the variables considered in this study, we present the Pearson correlation coefficients in table 2.

The independent variable, R&D (indicative of R&D investment levels), shows a moderate negative and statistically significant correlation with the

TABLE 1 Descriptive Statistics

	Minimum		Maximum		Mean		Std. Dev.	
	SIFIDE = 0	SIFIDE > 0	SIFIDE = 0	SIFIDE > 0	SIFIDE = 0	SIFIDE > 0	SIFIDE = 0	SIFIDE > 0
ETR	0.000	0.000	0.348	0.350	0.167	0.099	0.078	0.087
R&D	0.000	0.001	0.000	9.341	0.000	3.989	0.000	1.493
SIZE	2.887	3.670	15.358	15.400	7.269	8.562	2.130	1.573
LEV	0.000	0.001	73.519	1.830	0.446	0.443	1.752	0.239
ROA	0.001	0.001	8.170	1.082	0.173	0.142	0.342	0.149
CAPITALINT	0.000	0.000	1.000	0.998	0.321	0.354	0.299	0.247
INVENTINT	0.000	0.000	1.020	0.967	0.133	0.127	0.214	0.164

NOTES SIFIDE = 0 represents the group of companies that has no tax benefit approved for the period under analysis. SIFIDE > 0 represents the group of companies that has tax benefit approved for the period under analysis.

dependent variable, ETR. Other moderate relationships include the positive correlation between R&D and the control variable SIZE, which aligns with the expectation that larger companies have greater capacity for R&D investment.

Analysing table 2 reveals that no strong correlations exist between independent variables that could bias the results obtained.

The multiple linear regression model was estimated using the least squares method and the Enter method for variable selection, given that the objective was to include all variables.

After calculating the model, we assessed whether the independent variable or any control variable could influence the effective tax rate and whether the models fit the data significantly.

TABLE 2 Pearson Correlation Coefficients

	ETR	R&D	SIZE	LEV	ROA	CAPITALINT	INVENTINT
ETR	1.000						
R&D	-0.381**	1.000					
SIZE	-0.011	0.448**	1.000				
LEV	0.019	0.104**	0.194**	1.000			
ROA	-0.170**	0.086**	-0.400**	-0.260**	1.000		
CAPITALINT	-0.154**	0.121**	0.284**	0.019	-0.241**	1.000	
INVENTINT	0.108**	0.127**	0.322**	0.205**	-0.274**	-0.140**	1.000

NOTE \*\* Significant at level 0.05.

Based on the F-test (Coefficient: 164.930;  $p$ -value < 0.01), at least the independent variable or one of the control variables has a significant effect on the variation in the effective tax rate, given that the associated  $p$ -value is less than the significance level of 1%.

Regression coefficients for each independent variable are presented in table 3, along with values and significance levels.

For the sample studied, we validate that R&D investments reduce the effective tax rate, positively impacting companies' tax planning levels. Evidence suggests that R&D investment and the SIFIDE tax benefit contribute significantly to a lower ETR.

Regarding control variables, SIZE, ROA, and CAPITALINT also influence the effective tax rate. Large firms may exhibit a higher ETR due to factors such as increased transparency and control, reduced relative benefit from tax incentives, and limited capacity to leverage exemptions and deductions (Appelt et al. 2020).

The positive impact of asset profitability on tax planning level (ETR negative sign) suggests that companies with greater profitability not only have more resources but also focus on optimizing their tax management to reduce tax burdens. Capital intensity positively impacts tax planning, and since debt does not affect this variable, firms primarily funded through equity appear more likely to engage in tax planning and have fewer opportunities to lower ETR through interest deductions.

Lastly, inventory intensity does not appear to influence tax planning, implying that industry sector may not be a major factor in fiscal management practices.

The coefficient of determination ( $R^2$ ) measures the effect size of independent variables on the dependent variable and the proportion of

TABLE 3 Model Coefficients

	<i>Coefficient</i>	<i>p-value</i>
C	0.111 ***	0.000
R&D	-0.018 ***	0.000
SIZE	0.010 ***	0.000
LEV	0.001	0.477
ROA	-0.020 ***	0.000
CAPITALINT	-0.063 ***	0.000
INVENTINT	-0.009	0.218

NOTE \*\*\* Significant at level 0.001.

total variability explained by the regression model. The adjusted determination coefficient indicates that 19.99% of the total variability in the effective tax rate is explained by the independent variables in the linear regression model.

The empirical results provide clear evidence that investment in R&D activities, measured through SIFIDE-approved amounts, is associated with a statistically significant reduction in the effective tax rate of Portuguese companies. This finding supports Hypothesis and suggests that firms investing in R&D tend to engage in higher levels of tax planning, partly due to the direct effect of fiscal incentives and potentially reflecting more sophisticated tax management practices associated with innovation-intensive firms.

These results are consistent with international evidence showing that R&D activities and innovation are linked to lower corporate tax burdens. Studies such as Gao et al. (2016), Pfeiffer and Spengel (2017), and Cheng et al. (2021) demonstrate that innovation-intensive firms benefit from both explicit R&D tax incentives and enhanced opportunities for tax planning strategies. The present study extends this literature by confirming that similar mechanisms operate within the Portuguese institutional framework, where SIFIDE plays a central role in supporting private R&D investment.

The negative relationship between R&D investment and the ETR can be interpreted through two complementary mechanisms. First, the mechanical effect of the SIFIDE tax credit directly reduces corporate income tax liabilities, leading to lower observed ETRs. Second, firms engaged in R&D activities are more likely to adopt forward-looking and strategic approaches to tax planning, integrating fiscal considerations into their broader innovation and investment decisions. This interpretation aligns with the view that innovative firms tend to develop greater managerial and organizational capacities, including in financial and tax management.

Regarding the control variables, the positive association between firm size and the effective tax rate suggests that larger firms may be subject to greater regulatory and political scrutiny, which can limit their ability to reduce effective tax rates. This interpretation is consistent with the political cost hypothesis, although prior empirical evidence on the relationship between firm size and effective taxation remains mixed. The negative effect of return on assets indicates that more profitable firms place greater emphasis on optimizing their tax position, while the significant impact

of capital intensity reflects the role of investment structure in shaping effective taxation. These findings are broadly in line with previous empirical studies and reinforce the robustness of the estimated model.

Overall, the results highlight the importance of R&D tax incentives not only as tools for promoting innovation but also as key elements influencing corporate tax planning behaviour. In the Portuguese case, SIFIDE emerges as a decisive factor shaping firms' effective tax rates and financial strategies.

### **Conclusion**

Investment in R&D is a cornerstone for economic growth and business success, driving innovation at both macroeconomic and microeconomic levels. Policies such as SIFIDE in Portugal play a critical role by supporting companies in developing new technologies and innovations. At the macroeconomic level, these incentives promote long-term growth, enhance national competitiveness, and drive technological progress. At the microeconomic level, they enable companies to take greater risks, become more competitive, and thrive in an increasingly knowledge-driven global economy.

SIFIDE has proven to be an effective mechanism for stimulating R&D investment in the Portuguese business sector. By providing a deduction in assessed corporate income tax (CIT), it alleviates the financial burden on companies, empowering them to undertake riskier, long-term innovative projects. This is particularly beneficial for small and medium-sized enterprises (SMEs), which often face greater challenges in securing funding for innovation. By lowering the effective cost of R&D, SIFIDE enhances the competitiveness of Portuguese companies, encouraging innovation and investment in activities that generate new products, services, and production processes.

At the macro level, tax benefits like SIFIDE increase total R&D investment in the country, improving aggregate productivity and driving sustainable economic growth. Consistent with studies such as Hall and Van Reenen (2000), tax benefits are shown to positively influence R&D intensity, which is strongly correlated with higher productivity and economic development. At the micro level, companies leveraging these benefits are better positioned to develop new technologies, increase efficiency, and strengthen their market positions. For example, Portugal's technology sector has experienced significant growth, partially due to the strategic use of tax benefits to support technological innovation.

This study reinforces the importance of fostering R&D activities and highlights the role of fiscal incentives such as SIFIDE in shaping corporate tax outcomes. The findings indicate that R&D activities are associated with lower effective tax rates, supporting the view that investment in innovation can enhance corporate tax planning through SIFIDE's mechanism. In addition, firm size, return on assets, and capital intensity significantly influence the effective tax rate, whereas no conclusive evidence is found for the effects of leverage and inventory intensity.

By focusing on the Portuguese context, this study contributes to the literature by providing empirical evidence on the interaction between innovation incentives, corporate taxation, and economic outcomes, offering a basis for future comparative research.

*Implications for Companies:* From a business perspective, the findings indicate that R&D investment supported by fiscal incentives such as SIFIDE should be viewed not only as a driver of innovation but also as a strategic component of corporate tax planning. Companies that integrate innovation, financial management, and tax planning decisions are better positioned to reduce their effective tax burden while simultaneously enhancing long-term competitiveness. This is particularly relevant for small and medium-sized enterprises, for which tax incentives can significantly reduce the cost and risk associated with R&D activities.

*Implications for Policymakers:* For policymakers, the results provide empirical evidence of the effectiveness of SIFIDE in stimulating private R&D investment and influencing corporate tax outcomes. However, the strong fiscal impact of this incentive also highlights the importance of complementing ex ante approval mechanisms with ex post evaluation frameworks. Monitoring the actual outcomes of approved R&D projects – in terms of innovation outputs, productivity gains, and economic impact – may help ensure that public resources are effectively allocated and that tax incentives achieve their intended objectives beyond tax savings alone.

*Implications for Research:* From an academic standpoint, this study contributes to the literature by linking R&D investment and tax planning within a unified empirical framework and by providing evidence from a country-specific institutional setting.

Despite its contributions, the study presents limitations that should be acknowledged. The analysis focuses exclusively on Portugal and the SIFIDE programme, which may limit the generalizability of its findings. The time period examined (2020–2022) coincides with the COVID-19

pandemic, potentially affecting the values of the variables and companies' R&D investment decisions. Furthermore, the tax planning metric, the effective tax rate, includes deferred taxes and other elements, which could influence the results. Finally, the inclusion of companies from diverse sectors may introduce variability in R&D investment behaviour.

Future research could extend this analysis by comparing fiscal incentive regimes across countries to identify international best practices. A longitudinal approach could provide deeper insights into the long-term impacts of fiscal incentives on innovation, business productivity, and sustainable economic growth. By addressing these gaps, future studies can further advance understanding of the complex interplay between R&D investment, fiscal policies, and economic development.

### Acknowledgement

This work was supported by FCT – Fundação para a Ciência e Tecnologia, I.P. by project reference UID/04928/2025 and DOI identifier <https://doi.org/10.54499/UID/04928/2025>.

### Data Availability Statement

The data presented in this study is available on the website of the Portuguese Tax Authority and on the SABI database.

### References

- Abrunhosa, S. da C. 2021. 'Os benefícios fiscais como forma de planeamento fiscal nas empresas cotadas em bolsa.' Master's thesis, Polytechnic Institute of Porto, School of Accounting and Administration.
- Andreas, A., and E. Savitri. 2017. 'Determinants of Effective Tax Rate of the Top 45 Largest Listed Companies of Indonesia.' *International Journal of Management Excellence* 9 (3): 1183–8.
- Appelt, S., M. Bajgar, C. Criscuolo, and F. Galindo-Rueda. 2016. 'R&D Tax Incentives: Evidence on Design, Incidence and Impacts.' OECD Science, Technology and Industry Policy Papers 32, OECD Publishing.
- Appelt, S., M. Bajgar, C. Criscuolo, and F. Galindo-Rueda. 2020. 'The Effects of R&D Tax Incentives and Their Role in the Innovation Policy Mix: Findings from the OECD microBERD Project, 2016–19.' OECD Science, Technology and Industry Policy Papers 92, OECD Publishing.
- Bayraktar, Y., and A. Tütüncü. 2022. 'Does Tax Planning Affect R&D Expenditures? A Study of Borsa Istanbul (BIST) Manufacturing Sector.' *Istanbul Business Research* 51 (2): 563–81.
- Caron, A. 2006. 'Inovação tecnológica e a pequena e média empresa local.' In *O desenvolvimento sustentável em foco: uma construção multidiscipli-*

- plinar, edited by G. B. de Oliveira and J. E. de Souza-Lima. FAE Business School.
- Carvalho, A. 2006. 'Investigação e Desenvolvimento Empresarial: Investir no Futuro.' In *Economia com Compromisso – Ensaio em Memória de José Dias Sena*, edited by M. C. Branco, M. L. S. Carvalho, and M. C. Rego. Universidade de Évora.
- Chan, S. H., J. D. Martin, and J. W. Kensinger. 1990. 'Corporate Research and Development Expenditures and Share Value.' *Journal of Financial Economics* 26 (2): 255–76.
- Cheng, C. S. A., P. Guo, C.-H. Weng, and Q. Wu. 2021. 'Innovation and Corporate Tax Planning: The Distinct Effects of Patents and R&D.' *Contemporary Accounting Research* 38 (1): 621–53.
- Costa, A. G., F. V. Martins, and E. Brandão. 2012. 'Effective Tax Rate in Portugal: Determinants and Financial Reporting Impact.' <http://dx.doi.org/10.2139/ssrn.2180032>.
- Costa, G. G., F. Venier, and R. Pugliese. 2025. 'Unveiling Organizational AI Adoption Patterns in Italian Companies Through the Lens of the Diffusion of Innovations Theory.' *Managing Global Transitions* 23 (1): 79–111.
- Damanpour, F., K. A. Szabat, and W. M. Evan. 1989. 'The Relationship Between Types of Innovation and Organizational Performance.' *Journal of Management Studies* 26 (6): 587–602.
- Decreto-Lei n.º 162/2014, de 31 de outubro. 2014. *Diário da República*. <https://diariodarepublica.pt/dr/detalhe/decreto-lei/162-2014-58683382>.
- Decreto-Lei n.º 249/2009, de 23 de setembro. 2009. *Diário da República*. <https://diariodarepublica.pt/dr/detalhe/decreto-lei/249-2009-490420>.
- Decreto-Lei n.º 292/97, de 22 de outubro. 1997. *Diário da República*. <https://diariodarepublica.pt/dr/detalhe/decreto-lei/292-1997-672448>.
- Dhar, B. K., J. Shaturaev, K. Kurbonov, and R. Nazirjon. 2023. 'The Causal Nexus Between Innovation and Economic Growth: An OECD Study.' *Social Science Quarterly* 104 (4): 395–405.
- Direção-Geral de Estatísticas da Educação e Ciência. 2023. 'Inquérito ao Potencial Científico e Tecnológico Nacional (IPCTN) 2022: Resultados Provisórios.' [https://portugal.gov.pt/api/media/edge/Project/Portal-do-Governo/Portal-do-Governo/gc23/Files/Comunicados/despesa-total-em-2022/despesa\\_total\\_em\\_investigacao\\_desenvolvimento\\_atinge\\_um\\_novo\\_recorde\\_em\\_2022.pdf](https://portugal.gov.pt/api/media/edge/Project/Portal-do-Governo/Portal-do-Governo/gc23/Files/Comunicados/despesa-total-em-2022/despesa_total_em_investigacao_desenvolvimento_atinge_um_novo_recorde_em_2022.pdf).
- Doukas, J., and L. Switzer. 1992. 'The Stock Market's Valuation of R&D Spending and Market Concentration.' *Journal of Economics and Business* 44 (2): 95–114.
- Dyregang, S. D., M. Hanlon, and E. L. Maydew. 2008. 'Long-Run Corporate Tax Avoidance.' *The Accounting Review* 83 (1): 61–82.

- European Commission. 2024. Science, Research and Innovation Performance of the EU 2024: A Competitive Europe for a Sustainable Future. Publications Office of the European Union.
- Faria, M. T. B. V. 1995. *Estatuto dos Benefícios Fiscais: notas explicativas*. Rei dos Livros.
- Fernandes, M. S. 2013. 'Gestão Fiscal e Benefícios Fiscais.' Master's thesis, Polytechnic Institute of Porto.
- Fernández-Rodríguez, E., and A. Martínez-Arias. 2014. 'Determinants of the Effective Tax Rate in the BRIC Countries.' *Emerging Markets Finance and Trade* 50 (3): 214–28.
- Ferreira, L. P. N. S. 2017. 'Portuguese R&D Tax Credit Program, SIFIDE II. How Companies Use It?' Master's thesis, Faculty of Engineering of the University of Porto.
- Gao, L., L. L. Yang, and J. H. Zhang. 2016. 'Corporate Patents, R&D Success, and Tax Avoidance.' *Review of Quantitative Finance and Accounting* 47 (4): 1063–96.
- Gök, O., and S. Peker. 2017. 'Understanding the Links Among Innovation Performance, Market Performance and Financial Performance.' *Review of Managerial Science* 11 (3): 605–31.
- Grave, R. S. V. C. 2023. 'O SIFIDE e a Qualidade de Inovação.' Master's thesis, Faculdade de Economia da Universidade do Porto.
- Guei, K. M., and I. Choga. 2022. 'Global Value Chains and Economic Upgrading in Developing Countries.' *Managing Global Transitions* 20 (1): 59–78.
- Guellec, D., and B. van Pottelsberghe de la Potterie. 2001. 'R&D and Productivity Growth: Panel Data Analysis of 16 OECD Countries.' OECD Science, Technology and Industry Working Papers No. 2001/03, OECD Publishing.
- Hall, B. H. 2019. 'Tax Policy for Innovation.' NBER Working Paper Series No. 25773, National Bureau of Economic Research.
- Hall, B. H., and J. Van Reenen. 2000. 'How Effective are Fiscal Incentives for R&D? A Review of the Evidence.' *Research Policy* 29 (4–5): 449–69.
- Han, J. K., N. Kim, and R. K. Srivastava. 1998. 'Market Orientation and Organizational Performance: Is Innovation a Missing Link?' *The Journal of Marketing* 62 (4): 30–45.
- Hanlon, M. 2005. 'The Persistence and Pricing of Earnings, Accruals, and Cash Flows When Firms Have Large Book-Tax Differences.' *The Accounting Review* 80 (1): 137–66.
- Jackson, M. 2015. 'Book-Tax Differences and Future Earnings Changes.' *Journal of the American Taxation Association* 37 (2): 49–73.
- Jiménez-Jiménez, D., and R. Sanz-Valle. 2011. 'Innovation, Organizational Learning, and Performance.' *Journal of Business Research* 64 (4): 408–17.

- Jones, C. I. 1995. 'R&D-Based Models of Economic Growth.' *Journal of Political Economy* 103 (4): 759–84.
- Kraft, A. 2014. 'What Really Affects German Firms' Effective Tax Rate?' *International Journal of Financial Research* 5 (3): 1–19.
- Kučera, J., and M. Fiľa. 2022. 'R&D expenditure, Innovation Performance & Economic Development of the EU Countries.' *Entrepreneurship and Sustainability Issues* 9 (3): 227–41.
- Lichtenberg, F. R. 1992. 'R&D Investment and International Productivity Differences.' NBER Working Paper Series No. 4161, National Bureau of Economic Research.
- Lucas, R. E. 1988. 'On the Mechanics of Economic Development.' *Journal of Monetary Economics* 22 (1): 3–42.
- Maradana, R. P., R. P. Pradhan, S. Dash, K. Gaurav, M. Jayakumar, and D. Chatterjee. 2017. 'Does Innovation Promote Economic Growth? Evidence from European Countries.' *Journal of Innovation and Entrepreneurship* 6 (1): 1.
- Nomura, H. 2017. 'What Determines Japanese Corporate Effective Tax Rates? Evidence from Firms Listed on the Tokyo Stock Exchange.' Asia-Pacific Economic Association. [https://apeaweb.org/confer/seoul17/papers/Nomura\\_Hiroyasu.pdf](https://apeaweb.org/confer/seoul17/papers/Nomura_Hiroyasu.pdf).
- Noor, R. M., N. S. M. Fadzillah, and N. Mastuki. 2010. 'Corporate Tax Planning: A Study on Corporate Effective Tax Rates of Malaysian Listed Companies.' *International Journal of Trade, Economics and Finance* 1 (2): 189–93.
- Nugrahadhi, E. W., and M. Rinaldi. 2021. 'The Effect of Capital Intensity and Inventory Intensity on Tax Avoidance at Food and Beverage Subsector Companies Listed on the Indonesia Stock Exchange (IDX).' *Advances in Economics, Business and Management Research* 163:221–5.
- Organisation for Economic Co-operation and Development. 2015. *Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development: The Measurement of Scientific, Technological and Innovation Activities*. OECD Publishing.
- Organisation for Economic Co-operation and Development. 2019. *OECD Review of Higher Education, Research and Innovation: Portugal*. OECD Publishing.
- Organisation for Economic Co-operation and Development. 2024. *Corporate Tax Statistics 2024*. OECD Publishing.
- Organisation for Economic Co-operation and Development and Eurostat. 2005. *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*. 3rd ed. OECD Publishing.
- Oliveira, F. G., A. P. Leitão, A. Gonçalves, et al. 2019. *Os benefícios fiscais em Portugal: conceitos, metodologia e prática*. Centro de Estudos Fiscais e Aduaneiros, Autoridade Tributária e Aduaneira.

- Peixoto, M. J. A. 2016. 'Os benefícios fiscais ao investimento em Portugal.' Master's thesis, Instituto Politécnico do Cávado e do Ave.
- Pereira, F. S. 2020. 'O impacto da inovação na performance: O caso das empresas associadas da COTEC.' Master's thesis, Escola Superior de Tecnologia e Gestão, Politécnico de Leiria.
- Pfeiffer, O., and C. Spengel. 2017. 'Tax Incentives for Research and Development and Their Use in Tax Planning.' Discussion Paper No. 17-046, ZEW – Centre for European Economic Research Discussion
- Porter, M. 1985. *The Competitive Advantage: Creating and Sustaining Superior Performance*. Free Press.
- Pratama, A. 2017. 'Company Characteristics, Corporate Governance, and Aggressive Tax Avoidance Practice: A Study of Indonesian Companies.' *Review of Integrative Business and Economics Research* 6 (4): 70–81.
- Presidência do Conselho de Ministros. 2023. *Portaria n.º 103-A/2023 de 12 de abril*. Diário da República, no. 72. <https://diariodarepublica.pt/dr/detalhe/portaria/103-a-2023-211717115>.
- Rajapathirana, R. P. J., and Y. Hui. 2018. 'Relationship Between Innovation Capability, Innovation Type, and Firm Performance.' *Journal of Innovation & Knowledge* 3 (1): 44–55.
- Rego, S. O. 2003. 'Tax-Avoidance Activities of US Multinational Corporations.' *Contemporary Accounting Research* 20 (4): 805–33.
- Romer, P. M. 1986. 'Increasing Returns and Long-Run Growth.' *Journal of Political Economy* 94 (5): 1002–37.
- Romer, P. M. 1990. 'Endogenous Technological Change.' *Journal of Political Economy* 98 (5): 71–102.
- Rosário, C., and A. A. T. D. Costa. 2018. 'Inovação e crescimento económico: Portugal (2000–2013).' *R-LEGO – Revista Lusófona de Economia e Gestão das Organizações* (6):9–25.
- Roser, M. 2021. 'What Is Economic Growth? And Why Is It So Important.' *Our World in Data*, 13 May. <https://ourworldindata.org/what-is-economic-growth>.
- Salaudeen, Y. M., and U. C. Eze. 2018. 'Firm Specific Determinants of Corporate Effective Tax Rate of Listed Firms in Nigeria.' *Journal of Accounting and Taxation* 10 (2): 19–28.
- Sanches, J. L. 2006. *Os limites do planeamento fiscal, substância e forma no direito fiscal português, comunitário e internacional*. Coimbra Editora.
- Santos, A. C. 2010. 'Planeamento fiscal, evasão fiscal, elisão fiscal: o fiscalista no seu labirinto.' *NOMOS: Revista do Curso de Mestrado em Direito da UFC* 30 (2): 227–266.
- Santos, M. E. M. A. 2021. 'SIFIDE II: How Effective Is It at Promoting Innovation?' Master's thesis, Faculdade de Engenharia and Faculdade de Economia, Universidade do Porto.
- Silva, A. F. 2008. 'O Direito dos Contribuintes ao Planeamento Fiscal.' *Revista TOC* 104:42–45.

- Stamatopoulos I., S. Hadjidema, I., and K. Eleftheriou. 2016. 'Explaining Corporate Effective Tax Rates Before and During the Financial Crisis: Evidence from Greece.' MPRA Paper No. 73787, Munich Personal REPEC Archive.
- Subramanian, A., and S. Nilakanta. 1996. 'Organizational Innovativeness: Exploring the Relationship Between Organizational Determinants of Innovation, Types of Innovations, and Measures of Organizational Performance.' *Omega* 24 (6): 631–647.
- Tung, L. T., and L. N. Hoang. 2024. 'Impact of R&D Expenditure on Economic Growth: Evidence from Emerging Economies.' *Journal of Science and Technology Policy Management* 15 (3): 636–654.
- Ulku, H. 2004. 'R&D, Innovation, and Economic Growth: An Empirical Analysis.' IMF Working Paper 185, International Monetary Fund.



# *Scaling Up the Clean Energy Transition in Turkey: The Role of Financial Development, Green Technologies, and Economic Complexity*

Foday Joof  
Bahçeşehir Cyprus University,  
Cyprus  
fjoof@cbg.gm

Mehdi Seraj  
Near East University, Cyprus  
mehdi.seraj@neu.edu.tr

The transition to a low-carbon economy represents a significant challenge and opportunity for Turkey, whose energy mix is 90% fossil fuel. In this context, this research aims to analyse the role of financial development (FD), economic complexity (EC), and environmental technology (PET) on renewable energy consumption (REC) in Turkey over the period from 1980 to 2020. The Fourier Bootstrap ARDL (FBARDL) approach, a new technique that can capture up to five smooth structural breaks and address small sample biases, indicates that a significant ‘green structural lock-in’ exists, where a 1% rise in FD and EC causes a 1.12% and 0.70% decrease in REC, respectively. In other words, Turkey’s financial development and economic complexity are still locked into fossil fuel consumption. In contrast, PET positively influences REC, where a 1% rise in PET causes a 0.12% rise in REC. The Granger causality test further confirms that FD and PET have a one-way causality to REC. The research contributes to the existing literature on the Turkish energy equilibrium, providing a much-needed antidote to the prevailing ‘positive finance’ assumptions in non-OECD economies.

*Keywords:* financial development, renewable energy, environmental technology, Turkey, Fourier Bootstrap ARDL

*JEL Classifications:* C22, G20, Q42, Q43

Received 2025/12/08 · Revised 2026/01/13 · Accepted 2026/02/07

Published online 2026/06/30 © Author



<https://doi.org/10.26493/1854-6935.24.203-225>

## **Introduction**

The international need to reduce global warming has brought about a change in global strategy to include the management associated with a global energy transition. The seventh development goal brings about change to ensure a sustainable future (United Nations 2021), which aims to provide clean, sustainable, and affordable energy to everyone world-

wide. Since climate change progress depends on this goal, a total transition to a zero-emission power source needs to take place in a few decades, as stated by International Renewable Energy Agency (2021).

The implications of this transition are especially complex in the context of the emerging economies. Turkey is an especially interesting case to examine in this regard. It is a rapidly growing country and thus a significant consumer of energy. Its energy usage escalated by a massive 55% between the years 2000 and 2019. Nevertheless, Turkey is also a country that is still substantially locked into carbon-rich energy sources. It has a total energy structure in which fossil fuels comprise a massive 91%. The world is seeing record-high expenditure on renewable energy sources, but Turkey's future in this regard seems to be on the wrong trajectory (International Energy Agency 2021; International Renewable Energy Agency 2021).

The relevance of the study is determined by the identification of the exact drivers and inhibiting factors for reversing the trend. Although current literature tends to study the inhibiting factors separately, this paper will offer a 360-degree view of the intersections of the financial systems, environment innovations, and the complexity of the structure of the economy, which impacts the use of clean sources of energy. This study will have significant value since it will reveal the reasons for the inhibiting effects of the financial sector and the structure of the industry of Turkey on the use of renewable sources of energy.

Many emerging economies, including Turkey, have set their sights on adopting strategic policies to boost sustainable energy growth. These efforts are aimed at achieving the target set during COP26 (26th meeting of the Conference of Parties), which emphasizes the importance of energy transition in mitigating the effects of climate change. Turkey is a rapidly developing country with a growing demand for energy. As the country looks towards a more sustainable energy future, financial development and environmental technologies are crucial factors that can facilitate a transition towards cleaner and renewable energy sources.

As shown in figure 1, the Turkey's renewable energy sources case is demonstrating a rather worrying trend with a downward trajectory, especially in terms of the total final energy consumption structure. From this graphical representation of the data, the core issue with our case study is made clear: the energy structure of the country still strongly depends on fossil fuel sources. This constitutes the empirical foundation for our hypothesis that there is a 'green structural lock-in' in Turkey since its

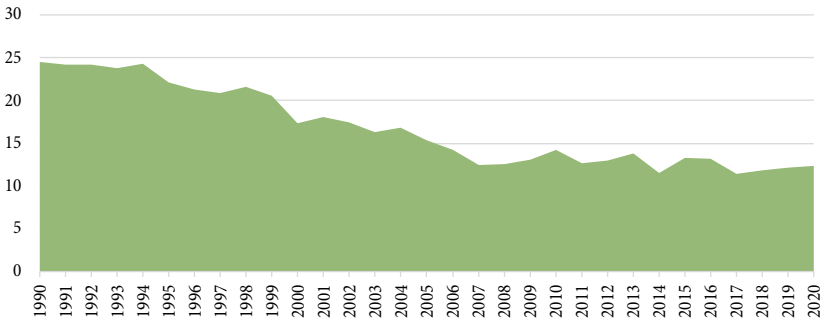


FIGURE 1 Renewable Energy Consumption of Turkey from 1990 to 2020 (based on data from The World Bank (<https://databank.worldbank.org/source/world-development-indicators>))

industrialization and financial growth are still failing to deliver its positive impacts in terms of its energy structure.

Thus, examining factors that trigger the clean energy transition is imperative. However, this transition cannot be achieved in the absence of the financial sector because according to United Nations Environment Programme (2011), to meet the global transition to a low-carbon economy, it has to be funded by the private sector. Similarly, research indicates that finance can facilitate the deployment of renewable energy technologies and accelerate the transition to sustainable energy sources in Turkey (Mukhtarov et al. 2022). Mukhtarov et al. (2022) also found that financial development plays a pivotal part in the adoption of clean energy sources in Turkey. Furthermore, global investment in renewable energy reached a record high of \$305 billion in 2020, representing a 2% increase from the previous year. This increase was attributed to sustainable policies and frameworks, improved technology, decline in financing costs, and an expanding investor base (International Renewable Energy Agency 2021).

On the other hand, environmental technologies, such as energy storage and smart grid systems, are also crucial for the successful integration of renewable energy sources into the energy mix. These technologies help to address the intermittency and variability of renewable energy sources and enable their more efficient use. As highlighted by the International Energy Agency (2021), renewable energy technologies can meet up to 90% of global electricity demand by 2050 with the help of these enabling technologies. Kucukvar et al. (2022) also demonstrated that the adoption of environmental technologies, such as wind and solar energy, can help Turkey reduce its carbon emissions and achieve sustainable energy transition.

The innovative intuition underlying the analysis is rooted in the paradoxical connection between economic sophistication and environmental viability in the emerging world. It is generally assumed in economic theory on the one hand, that the more complex the economic structure, the greater the efficiency of the economy, but on the other hand, this study leads to a hypothesis on a ‘green structural lock-in’ problem in the Turkish case. The implication is, perhaps, the more advanced the economic sophistication, the more the industrial structure is ‘locked in’ on fossil fuel-based industries, while the increased financial sophistication may even support this unsustainable path without proper green institutions. The aim of this analysis is to determine whether this problem functions as a catalyst or a brake for the Turkish transition towards a low-carbon economic system.

Despite these findings, Turkey faces significant challenges in transitioning to sustainable energy sources. These include issues such as energy market liberalization, lack of financing options, and policy and regulatory challenges. Therefore, the authors are motivated to investigate the effect of financial development and environmental technologies on the clean energy transition. In this regard, the authors intend to answer the question, what is the role of financial development and environmental innovations in Turkey’s clean energy transition? The answer to this question can help policymakers and stakeholders make informed decisions about the allocation of resources and the development of sustainable policies and regulations.

This study contributes to the understanding of the energy transition process in Turkey by overcoming some limitations and deficiencies in earlier studies, particularly the one conducted by Mukhtarov et al. (2022), and provides three specific contributions:

- **Measurement Advancement:** In Mukhtarov et al. (2022, 172), ‘total values of stocks traded as a percentage of GDP’ was employed. As a proxy, this has limitations in determining the complex nature of the financial system. Instead, this paper applies an all-inclusive Financial Development Index, which embraces access, depth, and efficiency of both markets and institutions. This provides scope to segment and recognize institutional constraints that are actually obstructing the adoption of clean energy.
- **Theoretical Novelty:** The grouping of financial development, environmental innovations, and economic complexity into one empir-

- ical model can now be clearly justified. This grouping is necessary in order to examine the ‘green structural lock-in’ hypothesis – the innovative hypothesis that the sophistication of industry and the magnitude of finance might paradoxically hinder the growth of renewables if the industry structures lock-in fossil fuel-scarce output.
- **Methodological Rigour:** The methodological novelty introduced in this research is the usage of the Fourier Bootstrap ARDL (FBARDL) method. The proposed Fourier Bootstrap ARDL method surpasses the ARDL or SVAR approaches of previous works. Unlike these previous works that yield biased structures with inconclusive cointegration analyses under small samples, the proposed approach is capable of handling up to five smooth structural break dynamics with robust critical values.

Scientifically, this paper contributes positively to the international discourse on energy transition by exemplifying the ‘green paradox’ found in emerging economies. This paper advances the scientific community beyond the understanding that finance and complexity are universally positive, as it clearly verifies that their effects rely on the structure of industries and the institutions found there. In providing the specific empirical example of Turkey, where the 1% increase in financial development and economic complexity supported the finding that renewable energy demand declines by about 1.12% and 0.70% respectively, this paper offers a necessary antidote to prevailing approaches on energy transition for non-OECD economies.

The structure of the study can be described as follows: Section 2 is a thematic synthesis of the existing literature on financial development, environmental technology, and economic complexity. In turn, Section 3 discusses the Fourier Bootstrap ARDL (FBARDL) approach and sources of the data. Section 4 presents the empirical findings, while Section 5 concludes with summarized policy suggestions.

## **Literature Review**

### **FINANCIAL DEVELOPMENT AND RENEWABLE ENERGY**

The link between financial development (FD) and renewable energy consumption (REC) is two-fold in the global literature. One school of thought argues that financial development encourages renewable energy consumption by reducing costs and mobilizing resources for sustainability, which is observed in high-income countries (Shahbaz et al.

2021), the BRICST region (Zhang and Razzaq 2022), and China (Li et al. 2023). In contrast, some researchers argue that the link between financial development and renewable energy consumption is non-linear/threshold-dependent: in 46 countries in Africa, financial development becomes an incentive only after the attainment of a certain level of institutional depth (Muoneke et al. 2023); in the US and Nigeria, the response of renewable energy demand is only to certain indicators like market access and multidimensional indices (Dimnwobi et al. 2022; Lahiani et al. 2021; Pata et al. 2022).

In terms of Turkey specifically, previous research using Autoregressive Distribute Lagged (ARDL) and Vector Error Correction Model (VECM) techniques indicated that FD and REC have a positive relationship (Mukhtarov et al. 2022). Nevertheless, these studies have been limited by their reliance on narrow measures of financial development, such as stock exchange turnover. In contrast, this research employs a wide-based index to establish the existence of an institutional bottleneck in Turkey. The negative relationship established in this research implies that Turkey's financial development has historically been without ESG-based governance structures and that its growth via exports has been driven by carbon-based industries rather than renewable energy projects (Zhao et al. 2025).

There exists a clear divide in financial development (FD) and renewable energy (REC) literature in general. Some bodies of literature indicate that financial development supports REC development in terms of lowering costs associated with capital. However, other bodies seem to indicate a non-linearity or a financial development with certain thresholds in terms of its effect on RECs. However, a gap exists in literature that focuses on Turkey, as it tends to use a limited stock market measure that is not multi-dimensional, failing to measure institutional efficiency adequately. The gap is filled by this research with a broad-based financial development index.

In summary, although there is a general consensus on the financial development literature supporting the use of renewable energy sources in the reduction of costs, there is a major disagreement on the nature of this dependency between the literature on the topic and the previous findings for the case of emerging countries. Furthermore, there is a crucial research gap, as the majority of the previous findings use a narrow proxy of stock market development instead of indices. This will address this issue, as this research aims to find out the particular institutional

barriers in the case of the country of Turkey that could cause a negatively affecting dependency on the adoption of clean energy.

#### ENVIRONMENTAL TECHNOLOGIES AND RENEWABLE ENERGY

The significance of environmental innovation as a catalyst for the shift towards clean energy sources through efficiency and cost savings has been validated globally. Global evidence indicates that technology patents and R&D investments remain significant factors in determining the energy intensity and demand of various countries, such as the BRICS and G7 countries (Solarin et al. 2022; Peng et al. 2022), Scandinavia, and Indonesia (Serener et al. 2023; Joof et al 2022; Murad et al. 2019; Saudi et al. 2019). Moreover, green technology and AI innovations remain instrumental in determining inequality in emissions and energy security (Bergougui et al. 2025).

In the case of Turkey, while R&D investments in renewable energy have been shown to improve environmental quality, urbanization and fossil fuel-based R&D activities continue to reduce the Load Capacity Factor (Caglar et al. 2024; Yavuz et al. 2024). Despite the global consensus on the positive impacts of eco-innovation on the environment and the shift towards a low-carbon economy, the impacts of PET on Turkey's unique energy equilibrium have remained under-explored until now. This paper fills the gap by identifying PET as the most reliable factor in determining the decarbonization process in Turkey despite the presence of significant hurdles.

What has emerged from the literature is the fact that environmental innovation has a strong positive effect on the promotion of the clean energy transition through efficiency enhancements and a reduction in costs. Though the positive relationship between the two factors is validated in the global context of the G7 and BRICS, the relationship between patent environmental technologies and the special energy structure of Turkey has yet to become fully exposed and assessed. The problem is resolved by isolating the Turkey energy equilibrium effect that supports the fact that environmental technologies are the most dependable factor of decarbonization processes despite the presence of difficulties offered by other factors.

Recent studies on Economic Complexity (EC) indicate paradoxical perspectives: although EC can promote energy efficiency in certain developed countries, it tends to be an impediment in emerging countries with fossil fuel-driven growth in industry. The 'complexity-energy par-

adox' indicated here implies that a country's development level can vary between 'impediment' and 'catalyst' in green transition, being contingent on a certain country's development level that this research aims to shed critical light on in Turkey, currently facing this paradox in industry-environmental relations.

#### ECONOMIC COMPLEXITY AND RENEWABLE ENERGY

Recent studies emphasize the presence of a 'complexity-energy paradox'. In developed OECD countries and the EU, EC is usually positively correlated with environmental sustainability and the reduction of CO<sub>2</sub> emissions through the promotion of energy efficiency (Balsalobre-Lorente et al. 2023; Khezri et al. 2022; Can and Ahmed 2022; Doğan et al. 2020). In contrast, in developing countries such as the BRICS countries or NICS, the presence of high industrial complexity can be considered an impediment to the development of environmental sustainability, given that the complexity in these countries is usually associated with carbon-intensive production (Zeraibi et al. 2023; Li et al. 2025).

This double-edged sword effect is the core of the Turkish case (Balsalobre-Lorente et al. 2022). Turkey's industrial complexity is considered to be highly sophisticated, yet the 'green structural lock-in' is present in the sense that the diversification of industries in the country has not yet taken place in the context of environmental sustainability (Doğan et al. 2021). This study aims to investigate whether the presence of industrial complexity in Turkey acts as a catalyst or an impediment in the development of environmental sustainability.

The literature pertaining to economic complexity has confirmed the presence of a double-edged sword effect. Thus, it can work as an effective force in developed economies regarding efficiency. However, it can become an obstacle in countries with industries that remain highly dependent on carbon-based consumption. This issue presents an important unanswered question related to Turkey's status with regard to the complexity-energy nexus. The question is answered through our research. We seek to examine whether Turkey's industrial complexity is compatible with or obstructs its green energy policies.

Findings from previous studies on Economic Complexity (EC) have shown a grave mismatch, where, on one hand, EC supports efficiency in most OECD countries, while, on the other hand, it frequently proves to be an impediment for emerging economies that rely heavily on carbon-intensive consumption, as industries in these countries are still largely

driven by a carbon-intensive consumption pattern. Such a double-edged sword characteristic points to a pending issue with respect to Turkey's particular positioning in the complexity-energy relationship.

### Methodology

The study examines the effect of financial development, environmental technology, and economic complexity on clean energy in Turkey using the Fourier Bootstrap Autoregressive Distributed Lag (FBARDL) on annual data from 1980–2020. The selected timeframe is based on data availability. However, the transformation of REC and PET into natural logarithms and the use of FD (Financial Development Index) and EC (Economic Complexity) in level form help to facilitate the analysis, and the use of natural logarithms would affect the institutional structure that the indices convey (equation 1):

$$\ln(REC_t) = \beta_0 + \beta_1 FD_t + \beta_2 \ln(PET_t) + \beta_3 EC_t + \nu_t, \quad (1)$$

TABLE 1 Variable Description and Data Sources

Variable	Symbol	Definition / Measurement	Primary Source
Renewable Energy	$REC_t$	Renewable energy consumption as a % of total final energy consumption	World Bank: World Development Indicators (WDI)*
Financial Development	$FD_t$	Financial Development Index (capturing depth, access, and efficiency of institutions and markets)	International Monetary Fund (IMF)**
Environmental Technologies	$PET_t$	Development of environment-related technologies (measured by patent counts)	OECD: Environment Statistics***
Economic Complexity	$EC_t$	Economic Complexity Index (EC) (measuring the knowledge intensity of an economy)	The Atlas of Economic Complexity (Harvard Growth Lab)****

NOTES All variables except for Financial Development ( $FD_t$ ) and Economic Complexity ( $EC_t$ ) are converted into their natural logarithmic forms for the empirical analysis. Also, the data covers the period 1980–2020 based on the maximum available data frequency for all indicators in Turkey.

\* <https://databank.worldbank.org/source/world-development-indicators>

\*\* <https://data.imf.org/?sk=f8032e80-b36c-43b1-ac26-493c5b1cd33b>

\*\*\* <https://www.oecd.org/en/data/indicators/patents-on-environment-technologies.html>

\*\*\*\* <https://atlas.hks.harvard.edu/>

TABLE 2 Descriptive Statistics

	FD	EC	PET	REC
Mean	0.405121	0.339607	7.184839	16.79263
Median	0.429519	0.327068	7.140000	15.33880
Maximum	0.539528	0.787538	11.51000	24.51078
Minimum	0.195825	0.091581	4.170000	11.40300
Std. Dev.	0.103531	0.183092	1.735928	4.589580
Skewness	-0.455815	0.476989	0.357872	0.496280
Kurtosis	2.084302	2.335771	2.737327	1.723335
Jarque-Bera	2.156530	1.745395	0.750830	3.377771
Probability	0.340185	0.417823	0.687004	0.184725

NOTE  $p$ -values for Jarque-Bera indicate that all series are normally distributed at the 5% level.

where  $REC_t$  is renewable energy,  $FD_t$  is financial development,  $PET_t$  is environmental technologies,  $EC_t$  is economic complexity and  $*** v_t$  is the error term. Table 1 indicates the explanation of the variables.

The descriptive statistics (table 2) provides a complete summary of the four economic and environmental variables.

Renewable Energy Consumption (REC) has the highest central tendency measure with a mean of 16.79 and median of 15.34, together with the largest variability measured by the highest standard deviation of 4.59. FD and EC, on the other hand, both have lower means (0.41 and 0.34, respectively) with smaller variability. All the variables' distributions are positively skewed except FD, which is negatively skewed with a skewness measure of  $-0.46$ . The kurtosis measures of the variables all lie below 3, meaning the distributions are platykurtic with less extreme values compared to the normal distribution. Lastly, the outcome of the Jarque-Bera test, as denoted by the low statistics with high probability values (all above 0.05) for all the variables, fails to reject the null hypothesis concerning normality at the conventional significance levels.

#### MODEL ESTIMATION

The choice of the FBARDL model is based on two key factors. The first is the stationarity properties of the variables such as the financial development index, an  $I(0)$  variable, and clean energy which is an  $I(1)$ , indicating mixed order of integration. Thus, the ARDL family models are appropriate. However, due to the limitations (weak power and size

problem) and the inclusiveness of the ARDL bound test (which occurs when the F-statistics fall between the upper and lower bounds), we use the Fourier Bootstrap ARDL which proposes additional F-statistics to resolve the inconclusiveness of the traditional ARDL. Furthermore, the bootstrapping provides robust inference and addresses small sample biases. Secondly, considering the various global events such as the Asia currency crisis in 1997, the 2008 global financial crises, and COVID-19 among others, we hypothesized the presence of structural breaks in the series. Thus, unlike the traditional ARDL, the FBARDL accounts for up to five smooth structural breaks.

Prior to the application of the FBARDL, we applied various preliminary tests. First, the Fourier Augmented Dickey-Fuller (FADF) and Fourier Phillips-Peron (FPP) unit root test which permits smooth structural breaks. The FADF incorporates the Fourier function into the traditional ADF to account for smooth structural breaks (Enders and Lee 2012). The FADF's deterministic form is given in equation (2):

$$a(t) = \alpha_0 + \gamma_1 \sin(2\pi ktT) + \gamma_2 \cos(2\pi ktT) \quad (2)$$

where  $k$  denotes the Fourier form number of frequency; in order to obtain the FADF unit root a deterministic term is added to the ADF process where  $k$  shows the frequency number of Fourier terms. The Fourier ADF unit root test model is obtained by adding the deterministic term to the ADF procedure (Enders and Lee 2012):

$$\Delta y_t = \alpha_1 + \delta t + \beta y_{t-1} + \gamma_1 \sin(2\pi ktT) + \gamma_2 \cos(2\pi ktT) + \sum_{i=1}^p \vartheta_i \Delta y_{t-i} + u_t \quad (3)$$

To maintain clarity on the choice of the Fourier components ( $k$ ) for the data, the data-analytic approach recommended by Enders and Lee (2012) is employed. The results are estimated for a range of  $1 \leq k \leq 5$ . The choice of the optimal  $k$  is made by choosing the particular  $k$  that produces the smallest Residual Sum of Squares (RSS) among the estimated models. An F-test is then conducted to test the significance of the Fourier components, and if significant, the FADF test is said to be more encompassing than the standard unit root tests, ignoring structural breaks.

Moreover, the Akaike Information Criterion (AIC) is selected to determine the lag length in the ARDL process. The AIC choice ascertains that the model

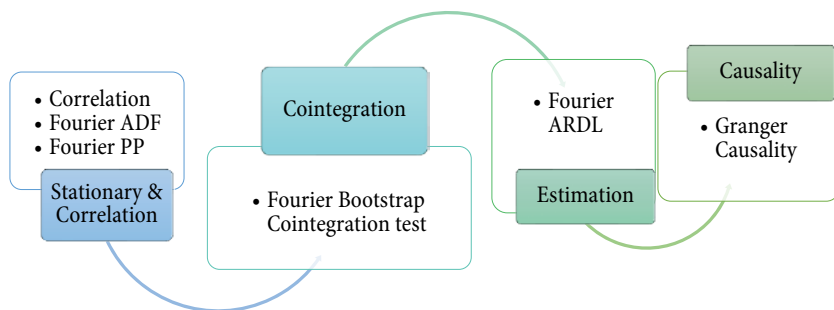


FIGURE 2 Methodological Structure

incorporates adequate lags to remove the serial correlation in the residuals and is parsimonious enough to avoid over-parameterization. Proceeding with this approach, the optimal lag structure was identified, for this analysis, by a configuration of (1, 0, 0, 0), as reflected in the estimation results.

In addition, the Fourier Bootstrap ARDL is applied to assess the cointegration among the variables. The Bootstrap ARDL (BARDL) was proposed by McNown et al. (2018) to resolve the limitations (weak power and size problem) of the traditional ARDL. Based on the ARDL when the F-statistics fall between the upper and lower bounds, the decision on cointegration is inconclusive; however, the BARDL eliminated this constraint by proposing additional F-statistics. The BARDL provides three F-statistics: (i) t-independent is for the lagged independent variable (ii) t-dependent is the lagged value of dependent variable, and (iii) overall F statistics (McNown et al. 2018). However, the BARDL does not account for breaks, thus, Solarin et al. (2022) developed the Fourier BARDL to account for smooth structural breaks as revealed in equation (4):

$$\begin{aligned}
 \Delta REC_t = & \alpha_0 + \sum_{i=1}^{p-1} \alpha_1 \Delta REC_{t-i} + \sum_{i=1}^{q-1} \alpha_2 \Delta FD_{t-i} + \sum_{i=1}^{u-1} \alpha_3 \Delta PET_{t-i} \\
 & + \sum_{i=1}^{u-1} \alpha_4 \Delta EC_{t-i} + \beta_1 REC_{t-1} + \beta_2 FD_{t-1} + \beta_3 LPET_{t-1} \\
 & + \beta_4 EC_{t-1} + \beta_5 \sin\left(\frac{2\pi kt}{T}\right) + \beta_6 \cos\left(\frac{2\pi kt}{T}\right) + v_t.
 \end{aligned} \tag{4}$$

The cointegration among the series is established when all the three F-statistics are higher than the critical values of the bootstrap. Finally, we estimated the long and short run Fourier ARDL model. Figure 2 presents the methodological structure.

## Data and Empirical Results

### CORRELATION TEST

The correlation matrix is presented in table 3. The results suggest the absence of multicollinearity amid the explanatory indicators, hence the coefficients are  $<$  the 0.8 rule of thumb. Moreover, the outcome also revealed that FD has a negative significant association with REC; however, environmental technology was found to improve renewable energy consumption at 1% significance. The level of economic complexity has a negative significant effect on REC.

TABLE 3 Correlation Matrix Analysis

	REC	FD	PET	EC
REC	1	-0.9516***	0.1677***	-0.7760***
FD		1	-0.1847	0.7712***
PET			1	-0.1698
EC				1

NOTE FD is financial development, EC is economic complexity, PET is environmental technologies. \*\*\* signifies 1% significance level.

### FOURIER UNIT ROOT TEST

Table 4 reported the Fourier ADF and PP unit root test; the outcome revealed that financial development, renewable energy and economic complexity contain unit root at level  $I(0)$  but are stationary at first difference  $I(1)$ . However, environmental technology is stationary at  $I(0)$ . This indicates the presence of mixed cointegration between the variables, i.e.  $I(0)$  and  $I(1)$ . The null hypothesis of unit root is rejected when the P value is less than the 5% significance level.

TABLE 4 Fourier Unit Root Test Results

Variables	Fourier-ADF		Fourier-PP		Decision	K	P
	I(0)	I(1)	I(0)	I(1)			
REC	-1.3742	-5.9453***	-2.3915	-7.1873***	I(1)	2	1
FD	-2.0513***	-	-2.6415	-7.8787***	I(0)/ I(1)	1	1
PET	-3.2431***	-	-4.1437***	-	I(0)	5	1
EC	-1.7052	-6.7162***	-1.4606	-4.4544***	I(1)	1	1

NOTE K represents the number of smooth structural breaks; P is the Fourier frequency; \*\*\* shows 1% significance level. The Decision column confirms the mixed integration order of  $I(0)$  and  $I(1)$ .

## FOURIER BOOTSTRAP COINTEGRATION

In table 5 we reported on the Fourier Bootstrap cointegration test. This approach resolves the limitations (weak power and size problem) and the inclusiveness of the ARDL bound test which occurs when the F-statistics fall between the upper and lower bounds, by proposing additional F-statistics, and also accounting for smooth structural breaks. The outcomes suggest the presence of long-run cointegration between the series. The three F-statistics are higher than the bootstrap cointegration critical values at a 5% level of significance.

TABLE 5 Fourier Bootstrap Cointegration Test

Statistics	Critical Values				Decision
	Value	10%	5%	1%	
F-stat.	6.7854**	5.0444	5.9388	9.3348	√
t-dep.	-4.7837**	-3.0813	-3.5611	-4.5345	
F-indep.	3.9707**	2.9707	3.7414	6.0773	

NOTE \*\* denotes 5% significance level.

## DISCUSSION OF FINDINGS AND COMPARATIVE ANALYSIS

Our empirical results strongly support the intuitive ‘green structural trap’. The statistically significant negative impact of both financial development and economic complexity points to the fact that the current growth model of Turkey is still deeply rooted in traditional, energy-intensive sectors. This means that an increase in the volume of finance or complexity of products is not sufficient but rather the direction of those factors towards green innovation is what really matters for the success of the energy transition.

The Fourier ARDL estimations are presented in table 6; the outcome showed an inverse significant lagged error correction term (ECT (-1)), indicates 86% speed of adjustment which the system converges in the long run. The short and long-run estimations revealed that the level of FD in Turkey has a negative effect on REC. The result further indicates that a 1% increase in financial development decreases renewable energy use in Turkey by 0.94% and 1.12% in the short and long run, respectively. The negative impact of financial development (FD) on clean energy in Turkey reveals a specific institutional bottleneck. Unlike developed economies, Turkey’s financial expansion has historically favoured carbon-intensive sectors that serve as the backbone of its export-driven economy. Furthermore, high borrowing costs in the Turkish economy

TABLE 6 Fourier ARDL

Variable	Short run		Long run	
	Coefficient	<i>p</i> -values	Coefficient	<i>p</i> -values
FD	-0.9393	0.0034**	-1.1211	0.0343**
PET	0.1039	0.0000***	0.1211	0.0009***
EC	-0.6034	0.0011***	-0.7047	0.0003***
ECT (-1)			-0.8562	0.0000***
Diagnostics				
Statistics	Coefficients		p-values	
LM serial correlation	1.0612		0.3647	
Breusch-Pagan-Godfrey	1.7881		0.1481	
Normality	0.6868		0.6336	

NOTE The Fourier ARDL (1, 0, 0, 0) was estimated. FD is financial development, EC is economic complexity, PET is environmental technologies. \*\*\*, \*\* signifies 1% and 5% significance level.

make it difficult to fund renewable energy projects, which often require more capital-intensive maintenance than conventional fossil-fuel sources. This negative relationship between financial development and clean energy is contradicted by the study of Mukhtarov et al. (2022), who examine the link between financial development and clean energy in Turkey from 1980–2019 using the ARDL and VECM and found financial development enhances the level of clean energy usage. Likewise, Dimnwobi et al. (2022) in the case of Nigeria, Seraj and Seraj (2025) across 15 of the world's highest carbon-emitting countries and Oben et al. (2025) in the case of Morocco.

These results show that for every 1% economic complexity, there is a resulting 0.70% reduction in overall renewable energy use in the Turkish economy. Turkey's current industrial sophistication is energy-intensive and remains carbon-locked into conventional sources. The country faces a complexity trap where its high industrial complexity is not matched by domestic green tech endowments, forcing a reliance on energy-intensive production and imported renewable technology to meet growth targets. Although most of the literature found that economic complexity promotes clean energy consumption (for instance: Doğan et al. (2020) in OECD countries, Li et al. (2023) in newly industrialized nations (NICs), Ghosh (2025) in G7 nations, Balsalobre-Lorente et al. (2022) in in PIIGS economies, and Wang et al. (2025) in 151 Chinese cities): our findings suggested the reverse in Turkey. The inverse relationship between economic complexity found in our study could be explained by the fact that

Turkey heavily relies on imported renewable energy technologies due to its limited technological capabilities, which makes it more difficult to develop a sustainable domestic renewable energy industry.

On the other hand, environmental technology enhances clean energy usage in Turkey. *Ceteris paribus*, a surge in environmental technology augments the level of renewable energy by 0.10% in the short run and 0.12% in the long run. Turkey has been investing in environmental technologies (wind, solar and geothermal power plants) to improve efficiency and reduce the cost of clean energy. As a result, clean energy has become more competitive and has increased its share in Turkey's energy mix.

To put these results in a better perspective, table 7 compares and contrasts our findings with the existing literature. Our findings clearly diverge from the 'positive-finance' consensus, e.g. Mukhtarov et al. (2022), both statistically, methodologically, and conceptually. Methodologically, by utilizing the FBARDL approach, we account for Turkey's specific structural shifts that traditional models ignore. Conceptually, our findings confirm that Turkish industrial evolution has not yet reached the turning point where sophistication yields environmental efficiency, a dynamic that differentiates Turkey from the established patterns observed in G7 or OECD countries.

Our findings are in support of the following studies: Murad et al. (2019), for the case of Denmark, found that innovation and energy prices are key determinants of energy utilization. Likewise, Saudi et al. (2019) in Indonesia found that innovation is a key indicator of energy intensity. Also, the study of Jin et al. (2018) in China revealed that innovation augments clean energy demand. We also conducted diagnostics such as the Breusch–Pagan–Godfrey LM test of serial correlation, ARCH test for heteroskedasticity and normality, CUSUM and CUSUM of square tests to affirm the stability and reliability of our model. The outcome showed that

TABLE 7 Summary of Comparative Findings

Variable	Our Finding (Turkey)	Previous Literature	Nature of Contrast/Alignment
Financial Development	Negative	Positive (Mukhtarov et al. 2022)	Contrast: Our broad-based index identifies institutional bottlenecks.
Economic Complexity	Negative	Mixed/Positive (Doğan et al. 2020)	Contrast: Suggests industrial 'lock-in' to fossil fuels.
Environmental Technologies	Positive	Positive (Murad et al. 2019)	Consensus: Innovation remains the primary driver of green growth.

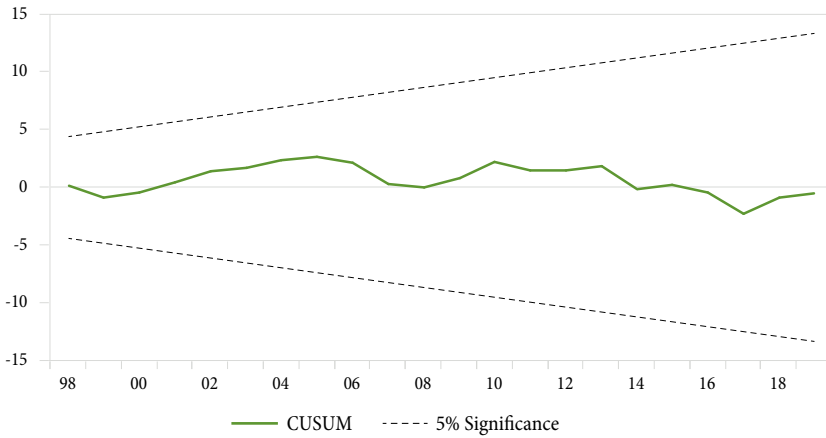


FIGURE 3 CUSUM Stability Test

NOTE The blue line represents the cumulative sum of recursive residuals. The red dashed lines represent the 5% significance boundaries. As the blue line remains within the boundaries, the model is confirmed stable.

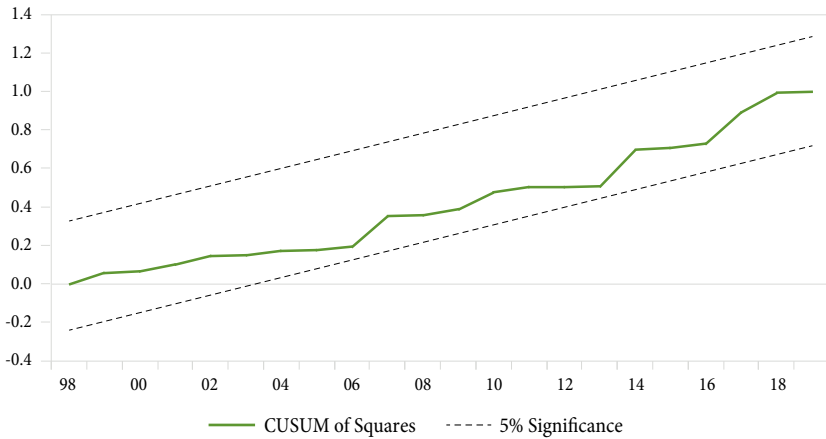


FIGURE 4 CUSUM of Square Test

NOTE The blue line represents the cumulative sum of recursive residuals. The red dashed lines represent the 5% significance boundaries. As the blue line remains within the boundaries, the model is confirmed stable.

the p values are higher than the 5% confidence level, thus indicating that our model is not suffering from serial correlation or heteroskedasticity and the variables are normally distributed. Likewise, the CUSUM and CUSUM of square tests (figs. 3 and 4) also revealed that the model is stable because the red line lay within the 5% confidence levels.

## GRANGER CAUSALITY TEST

Results of the Granger Causality Test, as shown in table 8 below, offer key directional information necessary for interpreting the results of the Fourier ARDL analysis. A one-way causal relationship was determined to exist and run from the financial development variable to the renewable energy consumption variable. This confirms that the negative relationship between FD and REC is not just one-way but that the growth of the financial system of Turkey directly impacts the energy structure, perpetuating the trend of following carbon-emitting industries and not the renewable ones.

A similar process of a one-way reaction from environmental technology to the consumption of renewable energy further accentuates the positive and proactive role of PET as a catalyst for the decarbonized transformation of the Turkish economy. This absence of causality with a zero result from economic complexity and the consumption of renewable energy adds a slight twist of complexity in the context of the ARDL findings. The negative results for EC in the context of the simplified model imply a decoupling of the highly sophisticated industrial process of the country with the green energy vision.

TABLE 8 Causality Test

Null hypothesis	<i>F</i> -statistics	<i>p</i> -value
REC $\leftarrow$ FD	3.5644 0.9273	0.0698** 0.3441
REC $\neq$ PET	0.4221 2.2718	0.5216 0.1356
REC $\leftarrow$ PET	4.0822 0.1627	0.0166** 0.6898

NOTE FD is financial development, EC is economic complexity, PET is environmental technologies. \*\* Signifies 5% significance level.

### Conclusions and Policy Recommendations

This study employs the recently developed Fourier Bootstrap ARDL (FBARDL) model to investigate Turkey's clean energy transition between 1980 and 2020. The results of this study support the existence of a 'green structural trap' phenomenon. Firstly, financial development (FD) has a strong negative impact on REC. A 1% increase in financial development causes a 1.12% decrease in REC. This suggests that Turkey's financial system, with its high interest rates and carbon-locked institutional lending,

is unable to cope with the risks of using renewable energy. Secondly, the 'complexity-energy paradox' is also evident, as Turkey's increasing economic complexity is locked into carbon-intensive technology and hence acts as a barrier to clean energy transition. By contrast, environmental technology (PET) is the main driver of clean energy transition, with a 1% increase in PET increasing REC by 0.12%.

#### **PRACTICAL AND POLICY IMPLICATIONS**

From a policy point of view, the transition is faced with institutional bottlenecks. Turkish policymakers need to adopt directional green finance by creating a Green investment bank to lower interest costs, particularly for renewable SMEs. In addition, R&D tax breaks need to target the automobile and petrochemical industries to separate the sophistication of industry from the consumption of fossil fuels. This is necessary to overcome the complexity trap and ensure that Turkey's growth strategy is consistent with its sustainable energy commitments.

#### **LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH**

Despite the methodological rigour, this study has some limitations. The study is constrained by the availability of data from 1980 to 2020. In addition, although we used a financial development index, our empirical focus is on index-driven growth rather than institutional factors such as regulatory and political stability.

Future research may extend this research by conducting more country-specific analyses on emerging economies to test if the 'green structural trap' is a common feature among non-OECD economies worldwide. Future models may also use the Clean Energy Transition Index or panel data methods to account for regional trends. Analysing the effect of liberalized energy markets and green finance obligations on various sectors may offer more detailed insights into Turkey's journey to a zero-carbon electricity source.

#### **Statements and Declaration:**

Interest: authors have no conflicting interest

Funding: this study did not receive any funding

#### **References**

- Balsalobre-Lorente, D., L. Ibáñez-Luzón, M. Usman, and M. Shahbaz. 2022. 'The Environmental Kuznets Curve, Based on the Economic

- Complexity, and the Pollution Haven Hypothesis in P11GS Countries.' *Renewable Energy* 185:1441–55.
- Balsalobre-Lorente, D., F. Joof, A. Samour, and T. Türsoy. 2023. 'Renewable Energy, Economic Complexity and Biodiversity Risk: New Insights from China.' *Environmental and Sustainability Indicators* 18:100244.
- Bergougui, B., B. Doğan, E. Y. Cobbold, H. Soltani, H. G. H. Sulimany, and E. E. M. Ebrahim. 2025. 'Who Benefits from Green Tech? How Eco-Innovation and Process Eco-Innovation Shape Emissions Inequality Across G7 Economies.' *Sustainable Development* 34 (3): 3699–719.
- Caglar, A. E., N. Gökçe, and D. Balsalobre-Lorente. 2024. 'Towards the Vision of Going Green: The Role of Different Energy Research and Development Investments, Urbanization and Income in Load Capacity Factor.' *Sustainable Energy Technologies and Assessments* 68:103888.
- Can, M., and Z. Ahmed. 2022. 'Towards Sustainable Development in the European Union Countries: Does Economic Complexity Affect Renewable and Non-Renewable Energy Consumption?' *Sustainable Development* 31 (1): 439–51.
- Dimnwobi, S. K., C. V. Madichie, C. Ekesiobi, and S. A. Asongu. 2022. 'Financial Development and Renewable Energy Consumption in Nigeria.' *Renewable Energy* 192:668–77.
- Doğan, E., B. Altinoz, M. Madaleno, and D. Taskin. 2020. 'The Impact of Renewable Energy Consumption to Economic Growth: A Replication and Extension of Inglesi-Lotz (2016).' *Energy Economics* 90:104866.
- Doğan, B., O. M. Driha, D. Balsalobre Lorente, and U. Shahzad. 2021. 'The Mitigating Effects of Economic Complexity and Renewable Energy on Carbon Emissions in Developed Countries.' *Sustainable Development* 29 (1): 1–12.
- Doğan, M., S. Güngör, and S. Gürsoy. 2022. 'The Effect of Exchange Rate Volatility on Bilateral Trade between Turkey and European Union Countries: Asymmetric Analysis with Markov Regime Switching Models.' *Journal of Global Policy and Governance* 11 (2): 3–34.
- Enders, W., and J. Lee. 2012. 'The Flexible Fourier Form and Dickey–Fuller Type Unit Root Tests.' *Economics Letters* 117 (1): 196–9.
- Ghosh, S. 2025. 'Nonlinear Impact of Environmental Pollution on International Tourism, the Role of Institutional Quality, Economic Complexity, Trade, and Exchange Rates: Evidence from G7 and E7 Nations: Evidence from G7 and E7 Nations.' *Environment, Development and Sustainability* 27 (1): 1355–78.
- International Energy Agency. 2021. *World Energy Outlook 2021*. International Energy Agency.
- International Renewable Energy Agency. 2021. *Renewable Power Generation Costs in 2020*. International Renewable Energy Agency.
- Jin, L., K. Duran, and X. Tang. 2018. 'What is the Relationship Between Technological Innovation and Energy Consumption? Empirical Anal-

- ysis Based on Provincial Panel Data from China.' *Sustainability* 10 (1): 145.
- Joof, F., A. Samour, T. Türsoy, and M. Ali. 2022. 'Climate Change, Insurance Market, Renewable Energy, and Biodiversity: Evidence from BRICS Countries.' *Environmental Science and Pollution Research* 30: 28676–689.
- Khezri, M., A. Heshmati, and M. Khodaei. 2022. 'Environmental Implications of Economic Complexity and Its Role in Determining How Renewable Energies Affect CO<sub>2</sub> Emissions.' *Applied Energy* 306, Part B:117948.
- Kucukvar, M., N. C. Onat, A. A. Kutty, et al. 2022. 'Environmental Efficiency of Electric Vehicles in Europe Under Various Electricity Production Mix Scenarios.' *Journal of Cleaner Production* 335:130291.
- Lahiani, A., S. Mefteh-Wali, M. Shahbaz, and X. V. Vo. 2021. 'Does Financial Development Influence Renewable Energy Consumption to Achieve Carbon Neutrality in the USA?' *Energy Policy* 158:112524.
- Li, J., F. Yahya, and M. Waqas. 2025. 'Exploring the Nexus of Globalization and Natural Resource Scarcity in Driving Green Technology Innovation: Insights from Advanced Panel Data Techniques.' *Natural Resources Forum* 49 (2): 1965–95.
- Li, W., N. Cao, and Z. Xiang. 2023. 'Drivers of Renewable Energy Transition: The Role of ICT, Human Development, Financialization, and R&D Investment in China.' *Renewable Energy* 206:441–50.
- McNown, R., C. Y. Sam, and S. K. Goh. 2018. 'Bootstrapping the Autoregressive Distributed Lag Test for Cointegration.' *Applied Economics* 50 (13): 1509–21.
- Mukhtarov, S., S. Yüksel, and H. Dinçer. 2022. 'The Impact of Financial Development on Renewable Energy Consumption: Evidence from Turkey.' *Renewable Energy* 187:169–76.
- Muoneke, O. B., K. I. Okere, and O. P. Egbo. 2023. 'Does Political Conflict Tilt Finance-Renewable Energy Dynamics in Africa? Accounting for the Multi-Dimensional Approach to Financial Development and Threshold Effect of Political Conflict.' *Heliyon* 9 (3): e14155.
- Murad, M. W., M. M. Alam, A. H. M. Noman, and I. Ozturk. 2019. 'Dynamics of Technological Innovation, Energy Consumption, Energy Price and Economic Growth in Denmark.' *Environmental Progress and Sustainable Energy* 38 (1): 22–29.
- Oben, R. J., R. Abubakar, M. Seraj, Ş. Z. Eyüpoğlu, and F. Özdamlı. 2025. 'Financial Development and Climate Change in Morocco: Symmetric and Asymmetric Environmental Effects.' *SN Business & Economics* 5 (12): 205.
- Pata, U. K., V. Yilanci, Q. Zhang, and S. A. R. Shah. 2022. 'Does Financial Development Promote Renewable Energy Consumption in the USA?

- Evidence from the Fourier-Wavelet Quantile Causality Test.' *Renewable Energy* 196:432–443.
- Peng, G., F. Meng, Z. Ahmed, J. Oláh, and E. Harsányi. 2022. 'RETRACTED: A Path Towards Green Revolution: How do Environmental Technologies, Political Risk, and Environmental Taxes Influence Green Energy Consumption?' *Frontiers in Environmental Science* 10:927333.
- Saudi, M. H. M., O. Sinaga, D. Roespinoedji, and E. K. Ghani. 2019. 'The Impact of Technological Innovation on Energy Intensity: Evidence from Indonesia.' *International Journal of Energy Economics and Policy* 9 (3): 11–7.
- Seraj, M., and F. T. Seraj. 2025. 'The Impact of Sustainable Financial Development and Green Energy Transition on Climate Change in the World's Highest Carbon-Emitting Countries.' *Sustainability* 17 (9): 3781.
- Serener, B., D. Kirikkaleli, and K. Addai. 2023. 'Patents on Environmental Technologies, Financial Development, and Environmental Degradation in Sweden: Evidence from Novel Fourier-Based Approaches.' *Sustainability* 15 (1): 302.
- Shahbaz, M., B. A. Topcu, S. S. Sarigül, and X. V. Vo. 2021. 'The Effect of Financial Development on Renewable Energy Demand: The Case of Developing Countries.' *Renewable Energy* 178:1370–80.
- Solarin, S. A., M. O. Bello, and A. K. Tiwari. 2022. 'The Impact of Technological Innovation on Renewable Energy Production: Accounting for the Roles of Economic and Environmental Factors Using a Method of Moments Quantile Regression.' *Heliyon* 8 (7): e09913.
- United Nations. 2021. *The Sustainable Development Goals Report 2021*. United Nations.
- United Nations Environment Programme. 2011. *UNEP Year Book 2011: Emerging Issues in Our Global Environment*. United Nations Environment Programme.
- Wang, J., S. Park, and G. Akar. 2025. 'Is the Environmental Kuznets Curve Still Relevant in the Modern Context? – Insights From Air Pollutants in Chinese Cities.' *Managing Global Transitions* 23 (3): 327–58.
- Yavuz, E., E. Kilic, and A. E. Caglar. 2024. 'A New Hypothesis for the Unemployment-Environment Dilemma: Is the Environmental Phillips Curve Valid in the Framework of Load Capacity Factor in Turkey?' *Environment, Development and Sustainability* 26 (11): 29475–92.
- Zeraibi, A., A. Jahanger, T. S. Adebayo, M. Ramzan, and Y. Yu. 2023. 'Greenfield Investments, Economic Complexity, and Financial Inclusion-Environmental Quality Nexus in BRICS Countries: Does Renewable Energy Transition Matter?' *Gondwana Research* 117:139–54.
- Zhang, R. J., and A. Razzaq. 2022. 'Influence of Economic Policy Uncertainty and Financial Development on Renewable Energy Consumption in the BRICST Region.' *Renewable Energy* 201:526–33.

Zhao, X., S. Muhammadullah, E. Kazemzadeh, I. Kostakis, S. Ghosh, and B. Doğan. 2025. 'Economic Growth and Sustainable Development: The Role of Financial Inclusion, FinTech, Eco-Innovation, and Economic Complexity.' *Sustainable Development* 34 (S2): 1233–58.



# *The Effect of Corruption on the Nexus Between Public Health Expenditure and Economic Growth in Sub-Saharan Africa*

Omobola H. Arowolo  
Redeemer's University, Nigeria  
arowolo11396@run.edu.ng

Sunday O. Adewara  
Redeemer's University, Nigeria  
adewaras@run.edu.ng


Government expenditure on health is an essential factor for the growth of any economy. However, the health system in sub-Saharan Africa (SSA) has not been receiving enough attention. The direct effect of public health expenditure and corruption on economic growth, as well as the role of corruption in the relationship between public health spending and economic growth in 32 sub-Saharan African countries from 2000 to 2022, is examined by this study using fixed effect and the Generalised Method of Moments (GMM) as an estimation technique. The results show that both public health expenditure and corruption negatively impact economic growth, while the joint effect of public health spending and corruption enhances economic growth in SSA. Furthermore, the findings reveal that inflation hurts economic growth whereas gross capital formation and trade openness have a positive effect on economic growth. It is recommended that the government should formulate policies that will control corruption and raise the level of institutional quality in the SSA region.

*Keywords:* GMM, health expenditure, economic growth, corruption

*JEL Classifications:* B40, H51, O40, D73

Received 2025/10/23 · Revised 2026/01/03 · Accepted 2026/02/11

Published online 2026/06/30 © Author

 <https://doi.org/10.26493/1854-6935.24.227-254>

## **Introduction**

The nexus between public health spending and economic growth has drawn the attention of policymakers and researchers in recent decades, especially in developing regions such as sub-Saharan Africa (SSA). Health, as an important part of human capital, has a direct impact on the level of production, the stability of economic activities, and the long-term economic growth of any country or region (Karaman et al. 2020). Therefore, investment in health is crucial for any country or region in achieving the goals of improving the well-being of its population, re-

ducing poverty, and also attaining sustainable economic growth and development (Boachie and Ramu 2015; Grossman 1972; World Bank 1993). Health expenditure, according to the World Health Organisation (2022), can be defined as the final consumption of health goods and services (i.e., current health expenditure), including personal health care (curative care, rehabilitative care, long-term care, ancillary services and medical goods) and collective services (prevention and public health services as well as health administration).

Health expenditure can either be private or public spending on health-care services, infrastructure, and resources (World Bank 2022). Public health spending, which is the focus of this study, is the expense incurred by the government at all levels (local, regional and central) of a country on healthcare services, infrastructure, and resources in order to improve the health status of the people (United Nations 2021). Heavy investment in health is vital in SSA, where there is a prevalence of health challenges such as infant and maternal mortality, infectious diseases, and malnutrition (World Bank 2022; UNICEF 2021). Despite this, various factors are affecting the capability of public health spending to positively enhance economic growth (Kurniawan et al. 2020).

Corruption is one of the factors identified that weakens the possible gains of health spending in SSA (World Health Organization 2022; Di Tella and Savedoff 2001). Corruption leads to the diversion of funds meant for providing health goods and services to private pockets, which results in inadequate provision of healthcare goods and services. According to Makar et al. (2023), the existence of corruption in the healthcare sector destroys public health trust, restricts access to important health services, and leads to a reduction in the overall quality of healthcare services. Similarly, Šumah (2018) stated that corruption prevents improvement in health outcomes, which is necessary to foster a healthy and productive workforce (human capital) and boost economic growth.

Many studies have investigated the connection between public health spending and economic growth (e.g. Aboubacar and Xu 2017; Adewara 2021; Adewara and Oloni 2012; Akinbode et al. 2021; Odhiambo 2021). Similarly, several studies have examined the impact of corruption on economic growth (e.g. Aidt et al. 2008; Cieřlik and Goczek 2018; Malanski and Póvoa 2021; Spyromitros and Panagiotidis 2022). In addition, some studies have considered the role of corruption in the relationship between government spending and economic growth (e.g. d'Agostino et al. 2016; Nguyen and Bui 2022). However, studies have not paid attention

to the intermediary role of corruption in the relationship between public health spending and economic growth in SSA. According to Hodge et al. (2011) and d'Agostino et al. (2016), corruption can indirectly affect economic growth through government expenditure.

However, whether corruption will enhance or reduce the impact of public health expenditure on economic growth in SSA is not known. There are two hypotheses on the effect of corruption in the literature. The first hypothesis is 'sand the wheels', which emphasises that corruption hinders economic growth, creates new distortions, and erodes institutional trust. For instance, corruption can limit the efficiency of public health expenditure through misallocation of funds and leakages, thereby harming economic growth. Dzhumashev (2014) and Keefer and Knack (2007) stated that corruption limits the efficiency of government expenditure. Piabuo and Tieguhong (2017) stated that the positive impact of public health spending on economic growth can be negatively affected due to the prevalence of corruption. Many empirical studies, such as Qehaja et al. (2023), Beylik et al. (2022), Adewara (2021), Adewara and Oloni (2012) and Piabuo and Tieguhong (2017), have suggested that countries where the level of corruption is low tend to have better health outcomes and stronger economic growth, while there is a significant reduction in the returns on public health expenditure in countries or regions where the level of corruption is high (Uche 2020; Rispel et al. 2016). Corruption can also lead to the diversion of public health expenditure from investment in both physical and human capital for private gains, and thereby harm economic growth. D'Agostino et al. (2016) emphasised that a low level of corruption can reduce the level of the negative impact of government expenditure on economic growth. Corruption can serve as an obstacle to economic growth through public health, as it can allow government officials to allocate expenditure to unviable projects where they can collect bribes. Makar et al. (2023) likewise claimed that corruption can lead to poor health outcomes, which would negatively affect labour productivity and absenteeism and reduce the potential for human capital development.

In contrast to the first hypothesis, the second hypothesis, 'grease the wheels', places interest in the potential benefits of corruption. According to this viewpoint, corruption can be used to get around institutional flaws and advance progress. For example, some studies, such as Aidt et al. (2008), Méon and Weill (2010) and Huang (2016), have shown that corruption is not a threat to economic growth in countries with weak

institutional quality, like SSA countries. Some studies have argued that corruption can enhance economic growth directly or indirectly through 'grease the wheels', which implies that corruption in some instances helps to remove obstacles and foster innovation, growth and development (Egger and Winner 2005; Kato and Sato 2015; Leff 1964; Lui 1985; Méon and Weill 2010). Based on this perspective, it can be argued that corruption might not be a threat to the growth impact of health expenditure in SSA. Corruption could positively enhance the growth impact of public health expenditure by avoiding bureaucratic delays in disbursing funds, which is common in developing countries. In line with this, Acemoglu and Verdier (1998) stated that corruption can be desirable as it works somewhat like a piece rate for bureaucrats, which increases the provision efficiency of government services.

As the SSA region continues to face poor health outcomes, low labour productivity, and slow economic growth in spite of huge investments in the healthcare system in the region, there is a need to investigate the role of corruption in the relationship between public health expenditure and economic growth. Therefore, the objective of this study is to examine both the direct effect of public health expenditure and corruption on economic growth as well as their indirect effect on economic growth. This study will contribute to the literature in the following ways. First, this study will examine the direct impact of corruption and public health expenditure on economic growth in SSA countries. Second, this study will examine the role of corruption on the effect of public health expenditure on economic growth in SSA by considering the joint effect of corruption and public health expenditure on economic growth in SSA. As stated earlier, most of the previous studies have focused on the interaction effect of government expenditure and corruption on economic growth without considering public health expenditure. However, knowing the role of corruption in the relationship between public health expenditure and economic growth in SSA will assist policymakers in formulating policies that will enable public health expenditure to have an optimal impact on economic growth.

The other sections of the study are organised in this order. Section 2 deals with the literature review. Section 3 presents the methodology of the study. Section 4 highlights the estimation procedure. Section 5 focuses on the analysis of the study. Section 6 deals with the conclusion and recommendation of the study.

## Literature Review

The review of literature in this section is divided into three parts. The first part of the review focuses on the studies that examine the relationship between health expenditure and economic growth. The second section focuses on the studies that examine corruption and economic growth. The third part of the review are the studies that focus on government health spending, corruption and economic growth.

### GOVERNMENT HEALTH SPENDING AND ECONOMIC GROWTH

Employing data between 1995 and 2011, Apanisile and Akinlo (2014) studied how health-related inputs and outcomes affected the economic growth of thirty SSA nations. Using GMM methodologies, the results of their findings showed that there is a negative relationship between government spending and the growth of the economy in the region. Halici-Tülüce et al. (2016) carried out an investigation on the nexus between private health spending and public health spending on economic growth in twenty-five high-income countries from the period between 1995 and 2012 and nineteen low-income countries between 1997 and 2009. Their findings showed a negative nexus between private healthcare financing and economic growth, whereas it was revealed that government health spending affects economic growth positively. Aboubacar and Xu (2017) examined the relationship between health spending and economic growth in sub-Saharan Africa from 1995 to 2014 using the Generalised Method of Moments technique. Their findings indicated that the association between healthcare financing and the growth of the economy is positive and statistically significant. Ali and Ogeto (2020) found that both public and private health spending had a positive and significant impact on economic growth in 38 SSA countries from 2000 to 2016 using the linear dynamic Generalised Method of Moments–Instrumental Variable (GMM-IV) method for analysis. Yusuf (2020) investigated the effect of government health expenditure on economic growth in Nigeria. Ordinary Least Squares (OLS) regression was employed to analyse data between 1981 and 2016. The findings showed that government health financing has a positive impact on economic growth. Beylik et al. (2022) looked at the relationship between health expenditure measures and economic growth in 21 OECD nations. They analysed the data using the Driscoll-Kraay standard method, and their results demonstrated a

positive relationship between healthcare expenditures and economic growth of the countries examined. Qehaja et al. (2023) evaluated the association between government healthcare spending and growth of the economy in Western Balkan nations between 2000 and 2020. The result revealed that government healthcare spending has a positive effect on local economic growth. Piabuo and Tieguhong (2017) did a comparative analysis of the effects of health spending on economic growth between the CEMAC (Central African Economic and Monetary Community) countries and five other African nations that have ratified the Abuja Declaration. The study found that health spending has a positive and significant impact on economic growth in both samples. Furthermore, it was found that both sets of nations had a long-term correlation between health spending and economic growth. Akinola and Ohonba (2025) investigated the interrelation between government expenditure, health outcomes, and economic growth in Nigeria, using data spanning from 1980 to 2021. The study employed the ARDL model and found that real government recurrent expenditure contributed to growth in both the short and long-term. The study equally found that health sector output similarly exhibits a positive and significant effect on economic growth across both time frames. Odhiambo (2021) examined the causal relationship between health expenditure and economic growth in SSA for the period 2008–2017. The study considered both public health expenditure and private health expenditure. Using a panel ECM-based Granger causality model, the study found a unidirectional causality from public health expenditure to economic growth in the low-income countries, while no causality was found in the middle-income countries. However, a short-run causality from economic growth to private health expenditure is found to prevail in middle-income countries, but no causality is found to exist in low-income countries.

Based on the findings from the studies reviewed, the first hypothesis is stated as:

- H1* Government expenditure has a positive impact on economic growth in SSA.

#### CORRUPTION AND ECONOMIC GROWTH

The nexus between corruption and economic growth in 46 SSA countries was evaluated by Ceesay (2019). The study found that the growth

of the economy is impeded in the presence of corruption. Machoski and de Araujo (2020) investigated the effects of corruption on the growth of the economy in Brazil. The study examined data gathered between 2009 and 2010 from the Office of the Comptroller General audits in the health and sanitation domains using quartile and OLS regressions. The conclusion of the study demonstrated that corruption had a detrimental effect on both public health and economic progress. Kurniawan et al. (2020) analysed data from 2009 to 2018, using the multiple linear regression technique. Their findings demonstrated that whereas the development of humans has a positive and considerable influence on economic growth, corruption does not have a noticeable impact. Hoinaru et al. (2020) conducted a study on the effect of corruption and the shadow economy on economic and sustainable development. They employed pooled OLS, random effect and fixed effect as techniques of analysis for data obtained from 185 countries between 2005 and 2015. The results showed that corruption negatively impacts economic and sustainable development. Spyromitros and Panagiotidis (2022) examined the effect of corruption on economic growth in 83 developing countries between 2012 and 2018 using Autoregressive (AR1) and FMOLS as analysis techniques. Their findings showed that the impact of corruption on economic growth is negative in different regions. Makar et al. (2023) investigated the effect of corruption on economic growth in Nigeria. Data from 1986 to 2019 was analysed using the Johansen cointegration test and vector error correction tests. The results suggested that corruption has a negative impact on economic growth in the long run. Lucarelli et al. (2024) examined the impact of corruption on economic growth in 8 Balkan countries using Autoregressive Distributed Lag (ARDL). The findings showed that in the short-term, corruption has the tendency to improve economic growth, while in the long-term corruption has a detrimental impact on economic growth. Gebresilassie et al. (2024) examined the nexus between corruption and economic growth in 37 SSA countries between 2012 and 2022. Using a two-step system GMM as a method of data analysis, the results of their findings showed that corruption and government intervention are detrimental to economic growth.

Hence, hypothesis 2 is stated as:

*H2* Corruption has a negative effect on economic growth in SSA.

**GOVERNMENT EXPENDITURE, CORRUPTION AND ECONOMIC GROWTH**

Nguyen and Bui (2022) analysed the role of corruption control in the relationship between government expenditure and economic growth. The study consisted of 16 emerging markets and developing economies (EMDES) in Asia over the period 2002–2019. The study employed GMM and a threshold model for the analysis. The study found that government expenditure has a negative effect on economic growth. Similarly, corruption control is found to have a negative impact on economic growth. The study found that the interaction term of government expenditure and corruption control reduces the level of the negative impact of these two factors on economic growth. The results from threshold estimation show that government expenditure will enhance economic growth when control of corruption is above the threshold level of 0.01. Iliyasu and Muhammed (2023) examined the role of corruption on the relationship between government expenditure and economic growth in Nigeria during the period from 1990 to 2020. The study employed ARDL, FMOLS and DOLS estimation techniques. Individually, government expenditure contributes to economic growth in the long-run, while its effect is insignificant in the short-run. The study also found that corruption is hindering economic growth in Nigeria. Regarding the joint effect of government spending and corruption, the study found that low corruption enhances the effect of government expenditure on economic growth. D'Agostino et al. (2016) investigated the interaction of government spending and corruption on economic growth for the period 1996–2010. The study applied GMM on a panel of 106 countries and found that interaction between corruption and both investment and military spending produced a negative impact on economic growth. Okunlola et al. (2024) considered the role of corruption and conflict in the relationship between government expenditure and economic growth in 15 ECOWAS (Economic Community of West African States) nations during the period from 1999 to 2021. POLS, FMOLS, and DOLS estimations were employed in obtaining the results. The results showed that government expenditure enhances economic growth in ECOWAS countries. It was also found that low corruption enhances the impact of government expenditure on economic growth.

Evidence from the literature reviewed shows that studies have not considered the role of corruption on the relationship between public health expenditure and economic growth in SSA. Also, evidence from the stud-

ies that considered the role of corruption on the relationship between government expenditure and economic growth is mixed. Some studies found that corruption acts as ‘sand the wheels’, while other studies found that corruption acts as ‘grease the wheel’ in the relationship between government expenditure and economic growth.

Hence, the third hypothesis is stated as:

- H3 Corruption augments public health expenditure to positively affect economic growth.

### Methodology

Endogenous growth models capture the process through which economic growth and development are affected by investments in public health. These models have emphasised the significance of human capital to the growth of the economy. Economic growth as regards the level of savings and population growth is explained by neoclassical growth models. Solow (1956) posited that every other thing being equal, countries will have higher per capita income as a result of higher savings. The major determinants of per capita income across countries according to Solow’s model are the rate of savings and population (Hashmati 2001). A theoretical model was built by Buchanan (1965) urging government agencies to enhance government expenditure on health not depending on demand. Inadequate delivery of healthcare services, according to this theory, should not be limited to scarcity of healthcare services, but factors like inequitable distribution of health workers, reduction in quality of healthcare delivery, overcrowding, infrastructure, etc., should also be considered.

Hence, the total output of the economy generated by the Cobb-Douglas production function is considered by this study in the following form:

$$Y_{it} = A(K_{it}^{\alpha} (HL_{it})^{1-a})^{1-\gamma} G_{it}^{\gamma}, \quad 0 < a < 1, 0 < \gamma < 1, \tag{1}$$

where A refers to technology,  $K_{it}$  represents capital input,  $L_{it}$  stands for the labour input,  $H_{it}$  stands for the human capital, and  $G_{it}$  represents government spending on health. Assuming that usually all variables are measured in per-capita terms, divide  $Y_{it}$  by  $L_{it}$ . Subscript  $i$  denotes cross-sectional units measured for dated periods and the subscript  $t$  signifies time.

$$y_{it} = A(k_{it}^{\alpha} (H)^{1-a})^{1-\gamma} G_{it}^{\gamma}, \tag{2}$$

where  $y_{it} = Y/L$  and  $k_{it} = K/L$  depict output and capital per capita, respectively.

Logarithms of both sides of the equation are taken as:

$$\ln y_{it} = \ln A + \alpha(1 - \gamma)\ln k_{it} + (1 - \alpha)(1 - \gamma)\ln H_{it} + \gamma \ln G_{it}. \quad (3)$$

Apart from physical and human capital and expenditure on health, output is also influenced by other factors at a given period of time; all these factors are captured in 'A' (Solow residual). In particular, Ductor and Grechyna (2013) posited that 'A' could reflect the state of progress in technology in the real sector, and the institutions' quality. Corruption in the economy is depicted as 'A' in order to achieve the objective of this study. Therefore, by substituting corruption (COR) for A and  $HEXP$  for G in equation (3) and by adding lag of GDP, it becomes:

$$\ln y_{it} = COR_{it} + \alpha(1 - \gamma)\ln k_{it} + (1 - \alpha)(1 - \gamma)\ln H_{it} + \gamma \ln HEXP_{it}. \quad (4)$$

It is evident from Aizenman et al. (2013), Adewara and Oloni (2012) and Adeusi and Aluko (2015) that there are various other factors that are significant determinants of the economic growth. Trade openness (OPEN) and inflation (INF) are added to the model to serve as control variables. The error term is also included in the equation in order to express the equation in econometrics form. Therefore, the equation to be examined becomes:

$$\ln y_{it} = COR_{it} + \alpha(1 - \gamma)\ln k_{it} + (1 - \alpha)(1 - \gamma)\ln H_{it} + \gamma \ln HEXP_{it} OPEN_{it} + INF_{it} + \varepsilon_{it}. \quad (5)$$

Examination of the effect of corruption on the nexus between government health spending and economic growth is the main aim of this study. This hypothesis is tested by adding an interaction term of government health spending and corruption to equation (5).

$$\ln y_{it} = \alpha_1 COR_{it} + \alpha_2 \ln HEXP_{it} + \alpha_3 (COR_{it} \cdot \ln HEXP_{it}) + \alpha(1 - \gamma)\ln k_{it} + (1 - \alpha)(1 - \gamma)\ln H_{it} + \gamma OPEN_{it} + INF_{it} + \varepsilon_{it}. \quad (7)$$

Equation (6) will be estimated using a fixed-effects model and random effect.

However, to provide a robust check for fixed effect and random effect estimations, this study employed the GMM technique. Therefore, the lagged dependent variable is added to equation 6 and it becomes:

$$\begin{aligned} \ln y_{it} = & y_{it-1} + \alpha_1 COR_{it} + \alpha_2 \ln HEXP_{it} + \alpha_3 (COR_{it} \cdot \ln HEXP_{it}) \\ & + \alpha(1 - \gamma) \ln k_{it} + (1 - \alpha)(1 - \gamma) \ln H_{it} + \gamma OPEN_{it} \\ & + INF_{it} + \varepsilon_{it}. \end{aligned} \quad (7)$$

### Estimation Procedure

A difference GMM that makes use of instrumental variables to verify the GMM of corresponding moment condition was recommended by Arellano and Bond (1991) so as to reduce the problem of endogeneity. This method is adopted to eliminate the individual fixed effect in order to continue with the first difference of the regression equation. Subsequently, the lagged variable will be considered as the corresponding instrumental variable of the endogenous variable in the difference equation. However, according to Bond et al. (2001), this method suffers from weak instrument problems, mainly in a fixed sample, thereby resulting in poor estimates. A system GMM estimator in which GMM is applied to a system of two equations – an equation in differences instrumented by lagged levels and an equation in levels instrumented by lagged differences – was introduced by Arellano and Bover (1995) and Blundell and Bond (1998) in order to solve this problem. The problems of heterogeneity, omitted variable bias, error of measurement and possible endogeneity issues that often affect growth models when using static models can be resolved using system GMM (Bond et al. 2001).

We employed unbalanced panel data from 2000 to 2022. The period was chosen because of the availability of data. The variables include:

- GDP growth (annual %) – this is the annual percentage growth rate of GDP at market prices based on constant local currency.
- Corruption (COR) – this measures the level of corruption within the political system and concern with corruption in the form of excessive patronage, nepotism, job reservations, and ‘favour-for-favours’. Corruption from the International Country Risk Guide is rated between 0 and 6. A score of 6 signifies a low level of corruption, while a low score of 0 indicates a high level of corruption.
- Public Health expenditure (HEXP) – this is the current health expenditure per capita (current US\$).
- Gross Capital Formation (GCF) as a % of GDP – this is the addition to the fixed assets of the economy plus net changes in the level of inventories.
- Human capital (HUM) – this is measured by the total labour force in millions.

- Trade openness (OPEN) – this is the addition of imports and exports of goods and services as a % of GDP.
- Inflation (INF) – this is the consumer price index (annual %).

The data on GDP per capita, human capital, health expenditure, trade openness and inflation are sourced from the World Development Indicators (WDI). Data on corruption is from the International Country Risk Guide (ICRG). The descriptive statistics of the variables are presented in table 1. The list of the SSA countries used for this study is in the appendix.

The results in table 1 show that the series have a high level of consistency, as the values of their mean and median are constantly within the least and highest values of these series. The deviations of actual data from their mean values are very small, as shown by the relatively low standard deviations for all the series. It was also revealed from the result that all the variables except inflation are kurtoses, as their kurtoses are below three.

## Results

### CORRELATION MATRIX

To determine the possible direction of association among the variables, the correlation matrix is obtained and presented in table 2. Generally, the results in table 2 showed that the coefficients in terms of magnitude are mixed, as some are positive and some are negative. The correlation matrix shows that public health expenditure is negatively correlated with economic growth. Similarly, corruption, human capital, openness and inflation are positively correlated with economic growth. Gross capital formation and public health expenditure have an inverse correlation with economic growth.

TABLE 1 Descriptive Statistics of the Variables

	Mean	Median	Max	Min	Std. Dev.	Skew.	Kurtosis	Obs.
GDP	0.653	0.722	1.332	-1.471	0.334	-2.292	11.740	372
COR	2.691	2.500	6.000	1.000	1.148	0.589	2.991	372
HEXP	1.702	1.603	2.841	0.638	0.448	0.803	3.065	372
GCF	9.536	9.526	10.810	8.087	0.595	-0.189	2.928	372
HUM	6.708	6.860	7.723	5.589	0.547	-0.526	2.204	372
OPEN	1.766	1.758	2.087	1.525	0.135	0.192	2.036	372
INF	0.644	0.726	2.037	-1.393	0.482	-0.889	4.798	372

TABLE 2 Correlation Matrix

Variables	GDP	COR	HEXP	GCF	HUM	OPEN	INF
GDP	1.0000						
COR	0.070699	1.0000					
HEXP	-0.1944	0.02766	1.0000				
GCF	-0.02765	0.06328	0.09437	1.0000			
HUM	0.1445	-0.0841	-0.2550	-0.0889	1.0000		
OPEN	0.17337	-0.1001	-0.5400	-0.35435	0.05987	1.0000	
INF	0.05875	0.0810	-0.0931	-0.11437	0.26325	0.01217	1.0000

PANEL UNIT ROOT TEST

This study performs the panel unit root test. The test is conducted because it is crucial to ascertain if the variables are stationary or not. To accomplish this, two different panel unit root tests, namely, Augmented Dickey–Fuller (ADF Fisher) and Philips–Perron (PP Fisher), are employed. The results are shown in table 3. The results of the test showed that GDP, COR, HEXP and INF are stationary at level, while other variables such as GCF, HUM and OPEN are only stationary at first difference. The results showed that none of the variables are I(2).

TABLE 3 Panel Unit Root Test Results

Variables	ADF Fisher		PP Fisher		
	Level	1st Diff	Level	1st Diff	
GDP	382.672***	762.242***	399.323***	1295.47***	I(0)
COR	135.027***	283.028***	198.407***	323.804***	I(0)
HEXP	86.69986***	367.672***	152.432***	393.321***	I(0)
GCF	46.97327	322.872***	46.5680	363.925***	I(1)
HUM	29.750499	262.771***	25.0301	266.266***	I(1)
OPEN	46.4982	290.146***	23.87769	295.758***	I(1)
INF	233.002***	572.364***	232.819***	832.570***	I(0)

NOTE \*\*\* signifies significance at 1% levels.

PANEL CO-INTEGRATION ANALYSIS

After the determination of the variables’ stationarity, we performed a cointegration test. This is needed in determining if the variables employed have a long-run relationship among them. This study considered the Pedroni cointegration test. The results of the co-integration test are shown in table 4, and the results of panel v-statistics, panel rho-statistics, panel pp-statistics, panel adf-statistics, group rho-statistics, group

TABLE 4 Pedroni Cointegration Test

GDP, COR, HEXP, GCF, HUM, OPEN, INF	Test	Intercept and trend
		Within
	Panel-v	-230.29986
	Panel-rho	3.5502
	Panel-pp	-3.2696***
	Panel-ADF	-2.12658***
	Group-rho	4.6995
	Group-PP	-8.1224***
	Group-ADF	-1.8251***

NOTE \*\*\* indicates significance at 1%.

PP-statistics, and group ADF-statistics rejected the null hypothesis of no cointegration, as four out of the seven statistics are significant. Therefore, it could be concluded that there is a long-run relationship among the variables based on the results of the cointegration tests.

#### PUBLIC HEALTH EXPENDITURE, CORRUPTION AND ECONOMIC GROWTH

The result of the effect of corruption on the nexus between government health spending and economic growth in sub-Saharan Africa between 2000 and 2022, using a fixed effect estimation, is presented in table 5.

Table 5 consists of three models.

- Corruption and the interaction term are excluded in model 1. In model 2, only the interaction term is excluded. The coefficient of corruption in model 2 is insignificant, while it is positive and significant in model 3. This indicates that corruption has a positive effect on economic growth according to fixed-effect estimation. The coefficient of the interaction term in model 3 is negative but insignificant.
- Public health financing has a significant positive relationship with economic growth in all the models. The coefficient of public health financing is significant at 1% in model 1 and at 5% in models 2 and 3. This suggests that a 1% increase in public health spending will lead to a 0.35108%, 0.3403% and 0.3281% increase in economic growth in models 1, 2 and 3, respectively.
- The coefficient of GCF in all the models is positive and significant at 1%. According to this finding, a 1% increase in GCF will increase economic growth by 0.4471%, 0.4951% and 0.49765% in models 1, 2 and 3, respectively.

TABLE 5 Public Health Expenditure, Economic Growth, and Corruption

	FIXED EFFECT Model		
	1	2	3
C	-3.5251 (-0.9096)	-2.67437 (-0.5914)	-2.760595 (-0.610095)
COR	-	-0.0060 (-0.27106)	0.0113*** (0.31798)
HEXP	0.3508*** (2.8920)	0.3403** (2.4272)	0.3281** (2.3163)
HEXP*COR	-	-	-0.0100 (-0.6272)
GCF	0.4471*** (4.1683)	0.4951*** (3.87549)	0.49765*** (3.8823)
HUM	-0.4792 (0.9147)	-0.6342 (-1.0323)	-0.6193 (-1.0064)
OPEN	1.5430*** (3.8517)	1.42106*** (3.06768)	1.4181*** (3.05986)
INF	-0.0309 (-0.6993)	-0.0292 (-0.5764)	-0.03768 (-0.70766)
Hausman test	53.09 (0.0000)	42.82 (0.0000)	42.82 (0.0000)
No. of observations	481	371	390
No. of countries	32	32	32

NOTES The *t*-values for all the estimations are in brackets. The significance of the individual coefficients at the 1%, 5%, and 10% levels are represented by \*\*\*, \*\* and \*, respectively.

- The coefficient of human capital is negative but not statistically significant in all the models.
- The coefficient of trade openness is positive and significant at 1% in all the models. This implies that trade openness significantly enhances economic growth in SSA.
- The coefficient of inflation is negative in all the models, but it is not significant. The Hausman test indicates that the fixed effect model is preferable to random effect results, as it is significant in all the models.

To provide a robust check for static estimation in table 5, this study employed the GMM technique to estimate the effect of corruption on the relationship between health expenditure and economic growth in SSA. This study employs GMM due to the weakness of static estimations to handle the problem of autocorrelation and heteroscedasticity.

Table 6 presents the results of the two-step system Generalised Method of Moment (GMM). It comprises three models. In model 1, corruption and the interaction term are excluded. In model 2, corruption is included while the interaction term is excluded. In model 3, both corruption and the interaction term are included in the estimation.

- The coefficient of public health expenditure is positive but insignificant in model 1. However, it has a negative sign and is significant in models 2 and 3. Although the negative impact of government health spending on economic growth is contrary to a priori expectation, the negative impact may be due to inappropriate allocation and misappropriation of public funds in the health system.
- From table 6, corruption negatively and significantly impacts economic growth in SSA. This is based on the negative coefficient of corruption in models 2 and 3. This finding contradicts the fixed effect results where the coefficient of corruption is positive. The possible reasons might be that the fixed effect results might be suffering from an autocorrelation problem.
- The impact of the coefficient of the interaction term on economic growth is significant and positive at 1%. This finding suggests that corruption does not limit the growth impact of public health spending in SSA. This finding suggests that control of corruption enhances the effect of health spending on economic growth in SSA.
- The coefficient of GCF is insignificant in models 1 and 2, but it is positive and significant at 10% in model 3. This suggests that GCF enhances economic growth according to model 3, as economic growth will increase by 0.0601% at a 1% increase in GCF.
- The coefficient of human capital in all the models is insignificant. The coefficient of trade openness is significant and positive in all the models. The coefficient of trade openness is significant at 1% in models 1 and 3, while it is significant at 5% in model 2. This shows that trade openness enhances economic growth in SSA.
- The coefficient of inflation is not significant in models 2 and 3, but it is negative and significant at 5% in model 1. This shows that inflation hurts economic growth in SSA.

On the diagnostics tests of the panel estimates, the p-values of first-order autocorrelation ( $AR(1)$ ) are significant in all the models, which confirms the presence of first-order autocorrelation in the models. The p-values of second-order autocorrelation  $AR(2)$  in models 1, 2 and 3 are

TABLE 6 Public Health Expenditure, Economic Growth and Corruption

	GMM	GMM	GMM
	Model 1	Model 2	Model 3
LAG GDP	-0.1074** (-2.12879)	-0.33218*** (-5.7260)	-0.280796*** (-6.0340)
HEXP	0.24655 (1.370696)	-0.25326*** (-2.85655)	-0.2952*** (-6.0800)
COR	-	-0.065980*** (-5.85218)	-0.08970*** (-10.22217)
HEXP*COR	-	-	0.0389*** (3.3989)
GCF	-0.0089 (-0.18109)	0.0404 (0.71657)	0.0601* (1.8120)
HUM	-0.15768 (-1.67109)	0.0880 (1.0972)	0.0373 (0.6152)
OPEN	0.8845*** (5.0491)	0.31547* (1.72346)	0.3724*** (2.98439)
INF	-0.13546** (-2.41546)	-0.09327 (-1.6750)	-0.04985 (-0.87349)
AR(1)	0.002	0.003	0.003
AR(2)	0.184	0.633	0.860
Hansen Test ( <i>p</i> -values)	0.063	0.407	0.459
No. of observations	426	329	329
No. of countries	32	32	32
No. of groups	31	31	31
No. of instruments	24	30	30

NOTES The *t*-values for all the estimations are in brackets. The significance of the individual coefficients at the 1%, 5%, and 10% levels are represented by \*\*\*, \*\* and \*, respectively. The Arellano–Bond test of first-order and second-order autocorrelation are represented by AR(1) and AR(2), respectively. LAG GDP represents lagged GDP; all other acronyms are explained in previous tables.

0.184, 0.633 and 0.860, which are insignificant. The insignificance of the *p*-value of AR(2) implies that second-order autocorrelation is absent in the model. The presence of the first-order autocorrelation and the absence of second-order autocorrelation meet the condition of the validity of GMM estimations. The *p*-value of the Hansen test is insignificant, which implies that the model is correctly specified and the instruments used are valid. Also, the number of instruments is kept below the number of groups, which also satisfies the validity of GMM estimates.

## DISCUSSION

This study obtained a slight difference between fixed effect and system GMM. The differences are due to the issue of autocorrelation and heter-

oscedasticity, which the static estimations are weak to control; in such case, this study based its conclusion on the GMM estimations. According to Bond et al. (2001), the system GMM is capable of addressing issues like heterogeneity problems, omitted variable bias, measurement error, and potential endogeneity problems which static methods could not address in growth models. The study obtained conflicting results from fixed and GMM estimations on the impact of public health spending on economic growth. While the fixed effect supports a positive connection between public health expenditure and economic growth, the GMM confirms a negative association. The negative effect of public health spending on economic growth does not support the hypothesis one (H<sub>1</sub>) of this study. The negative effect of GMM estimation is in line with Aisa and Pueyo (2006) and Eggoh et al. (2015), as they found a negative relationship between public health expenditure and economic growth. The possible reasons why public health spending has a negative impact on economic growth in SSA might be due to wasteful or misallocated public health expenditure. The misallocation of public health expenditure on ineffective and unviable healthcare programmes and projects will harm economic growth, as the effect of that spending will not yield the expected outcomes in the economy. Also, the frequent abandoning of projects due to changes in government or political stability might likely affect the impact of public health expenditure on economic growth in the region. The lack of continuity of projects will lead to a waste of resources and time. This finding is very significant in the SSA region, as previous studies are primarily focused on the general government expenditure on economic growth.

From the fixed-effect estimation, the study found that corruption enhances economic growth while it has a detrimental effect on economic growth in GMM estimation. However, we based our conclusion on the GMM estimations because of its ability to effectively handle the problems of autocorrelation and heteroscedasticity. The negative effect of corruption on economic growth based on GMM estimation supports the hypothesis two (H<sub>2</sub>) of this study. The negative effect of corruption on economic growth found in this study is consistent with Akinlo et al. (2021), Farag et al. (2013), Ceesay (2019) and Makar et al. (2023), who found that corruption impedes economic growth. This is an indication that corruption limits the allocation of government resources, which in turn can inhibit economic growth. This finding contradicts studies which claim that in developing countries whose institutional quality is

weak, corruption can be directly useful in 'greasing the wheels' in economic growth.

The study found that the interaction of corruption and public government expenditure enhances economic growth in SSA. This indicates that corruption enhances the impact of public health expenditure on economic growth in SSA, which might be due to the current low level of corruption. This finding supports the hypothesis three (H<sub>3</sub>) of this study. Based on this finding, it shows that corruption is directly harmful to economic growth while it is beneficial to the growth impact of public health expenditure. This finding is in line with Iliyasu and Muhammed (2023), who found that corruption promotes the effect of government spending on economic growth in Nigeria. This finding suggests that corruption is not harmful to the impact of public health spending on economic growth but rather enhances the growth impact of public health expenditure, i.e 'greasing the wheels'. The possible reason for this might be that corruption is helpful in overcoming inefficiency resulting from bureaucratic bottlenecks which slow down the execution of health projects and implementation of health policies. Also, the level of the corruption in SSA might not so high to the point where it can cause public health expenditure to negatively impact economic growth.

The positive effect of human capital on economic growth is insignificant. This finding contradicts Akinlo and Oyeleke (2020) and Riaz et al. (2022), who found that human capital impacts economic growth positively. However, this finding is consistent with Karambakuwa et al. (2019), who found that human capital has an insignificant effect on economic growth in SSA. Karambakuwa et al. (2019) explained that human capital development has been improving in the region over the years. However, the improvement of human capital might not have significant impact on economic growth without building proper supporting structures. Also, Ahsan and Haque (2017) stated that the relevance of human capital in enhancing economic growth in the SSA region is contingent on the level of development. This implies that economies in the SSA region need to attain a certain level of development before reaping the economic rewards of human capital development.

The results also reveal that physical capital enhanced the growth of the economy in sub-Saharan Africa during the period under study. This finding is in line with Kadir et al. (2018), Adewara and Oloni (2012), Akinlo and Oyeleke (2020), Mhaka and Runganga (2023), and Bhattacha-

rjee et al. (2022), who found a positive relationship between physical capital and economic growth. This finding indicates the importance of physical capital in economic growth in SSA. Garzarelli and Limam (2019) stated that physical capital is the primary driver of economic growth in SSA. Availability of infrastructure, such as good roads, storage facilities, electricity and health facilities, can reduce the cost of production and thereby boost the national output. Also, infrastructure can promote efficiency in the economy.

The positive effect of trade openness on economic growth in the region shows that trade is a major driver of economic and social improvements because there will be higher results, such as greater access to international markets, foreign investment and technology. Trade openness is very germane to the growth of productivity in sub-Saharan Africa. This is evident from the results obtained from the two estimations. Trade openness can promote economic growth by boosting productivity. Trade openness offers the economies in the SSA region the opportunity to export their products to other countries, which can lead to an increase in output and further investment.

The results show that inflation harms economic growth. This is in line with Xesibe and Nyasha (2020), Dada and Akinlo (2023), Adewara and Oloni (2012), Mandeya and Ho (2021), and Gokal and Hanif (2004), but in contrast to Mhaka and Runganga (2023), who found that inflation impacts economic growth positively. This finding is also consistent with Phiri (2018), who found that inflation harms economic growth when inflation is above the threshold level of 5.30%. Inflation hurts economic growth because it creates price instability and reduces purchasing power, thereby weakening economic growth. It was also revealed in the results that corruption and the interaction of public health spending and corruption have mixed impacts.

### **Conclusion**

This study uses fixed-effect and GMM estimations to examine how public health spending affects economic growth in 32 SSA nations between 2000 and 2022 when corruption is present. It was revealed from GMM estimation that public health spending impacts economic growth negatively in sub-Saharan Africa during the period of study. The study found that corruption harms economic growth in SSA according to GMM estimation. The results also showed that interaction of corruption with public health expenditure enhances economic growth. Human capital is

found to be insignificantly impacted by economic growth. Both physical capital and trade openness impact economic growth positively, while inflation has an inverse relationship with economic growth.

In line with findings from this study, the following recommendations are suggested.

- First, the negative effect of public health expenditure on economic growth suggests that an increase in public health spending may not always lead to economic growth except where the public health funds are effectively used. Therefore, governments in the SSA region must ensure that the funds allocated to the improvement of the healthcare system are effectively utilised and channelled to projects that will enhance economic growth. Governments in SSA need to ensure that there is accountability and transparency in the healthcare system to minimise mismanagement and waste. Additionally, the public should have access to clear and widely disseminated information regarding the allocation of funds to the health sector. Policymakers need to implement digital financial systems, routine audits, community oversight, and e-procurement to track healthcare spending. These will enable health expenditure to produce a healthy workforce and higher productivity, and hence economic growth. A well-utilised health expenditure can also improve health infrastructure which can attract businesses and investors and thereby create jobs and promote economic growth.
- Second, the direct negative impact of corruption on economic growth suggests that policymakers in SSA need to improve the quality of control of corruption in the region. Corruption has been one of the major obstacles to economic growth in the SSA region and requires necessary actions to reduce it. Appropriate punishment must be administered to corrupt officials rather than the selective punishment whereby some corrupt individuals are untouchable. This will create fear and promote accountability and efficiency in the management of funds. The mechanism for effective monitoring of allocation of funds and execution of projects across sectors in the economy needs to be adopted. This will ensure that the government's resources will be allocated more efficiently and also contribute significantly to stimulating private investment, which is an important prerequisite for improving economic growth.
- Third, since this study found that corruption enhances the impact of public health spending on economic growth, policymakers need to

strengthen institutional quality, particularly government efficiency, political stability, effective regulation and bureaucracy reduction, while targeting the reduction of corruption in the region. Strong institutional quality will help to remove bureaucracy, administrative bottlenecks and other obstacles that can limit the impact of public health spending on economic growth. Any policy that targets the reduction of corruption without improving the institutional quality variables will cause public health expenditure to have an undesirable effect on economic growth.

This study has some limitations which are related to the scope of this study, the number of countries and the measurement of corruption. This study could not cover the period before the year 2000 and the period after 2022 due to data availability. Therefore, it restricted the period of this study to 23 years. Similarly, the study included 32 sub-Saharan African countries out of a possible 54 countries. The limitation is due to the unavailability of data for some of the sub-Saharan countries. Some sub-Saharan African countries have experienced war in previous years, which affects data availability in those countries. Also, the use of corruption data from ICRG shows that future studies need to consider alternative measures.

Based on the focus of this study and its limitations, this study highlights some areas for future research. It might be interesting for future studies to consider this topic based on income classifications in sub-Saharan Africa. This will enable us to discover if the influence of corruption on the relationship between public health expenditure and economic growth depends on the level of incomes in sub-Saharan Africa.

### References

- Aboubacar, B., and D. Xu. 2017. 'The Impact of Health Expenditure on Economic Growth in SSA.' *Theoretical Economics Letters* 7 (3): 615–22.
- Acemoglu, D., and T. Verdier. 1998. 'Property Rights, Corruption and The Allocation of Talent: A General Equilibrium Approach.' *The Economic Journal* 108 (450): 1381–403.
- Adeusi, S. O., and O. A. Aluko. 2015. 'Relevance of Financial Sector Development on Real Sector Productivity: 21st Century Evidence from Nigerian Industrial Sector.' *International Journal of Academic Research in Business and Social Sciences* 5 (6): 118–32.
- Adewara, S. O. 2021. 'Nigerian Economy During Colonial Era: An Overview.' In *Nigerian Politics: Advances in African Economic, Social and Political Development*, edited by R. Ajayi and J. Y. Fashagba. Springer.

- Adewara, S. O., and E. F. Oloni. 2012. 'Composition of Public Expenditure and Economic Growth in Nigeria.' *Journal of Emerging Trends in Economics and Management Sciences* 3 (4): 403–7.
- Ahsan, H., and M. E. Haque. 2017. 'Threshold Effects of Human Capital: Schooling and Economic Growth.' *Economics Letters* 156:48–52.
- Aidt, T., J. Dutta, and V. Sena. 2008. 'Governance Regimes, Corruption and Growth: Theory and Evidence.' *Journal of Comparative Economics* 36 (2): 195–220.
- Aisa, R., and F. Pueyo. 2006. 'Government Health Spending and Growth in a Model of Endogenous Longevity.' *Economics Letters* 90 (2): 249–53.
- Aizenman, J., B. Pinto, and V. Sushko. 2013. 'Financial Sector Ups and Downs and the Real Sector in the Open Economy: Up by the Stairs, Down by the Parachute.' *Emerging Markets Review* 16:1–30.
- Akinbode, S. O., A. O. Dipeolu, T. M. Bolarinwa, and O. B. Olukowi. 2021. 'Effects of Health Outcomes on Economic Growth Sub-Saharan Africa: A System Generalized Method of Moments Approach.' *Journal of Economics and Development* 23 (3): 254–66.
- Akinlo, T., and O. J. Oyeleke. 2020. 'Human Capital Formation and Economic Growth in Sub-Saharan Africa Countries: An Empirical Investigation.' *The Indian Economic Journal* 68 (2): 249–68.
- Akinlo, T., D. O. Yinusa, and A. V. Adejumo. 2021. 'Financial Development and Real Sector in Sub-Saharan Africa.' *Economic Change Restructuring* 54 (2): 417–55.
- Akinola, G. W., and A. Ohonba. 2025. 'The Dynamics of Health Outcomes, Government Spending, and Economic Growth in Nigeria.' *African Journal of Business and Economic Research* 20 (2): 103–31.
- Ali, B. Y., and R. M. Ogeto. 2020. 'Healthcare Expenditure and Economic Growth in Sub-Saharan Africa.' *Asian Journal of Economics, Business and Accounting* 13 (2): 1–7.
- Apanisile, O. T., and T. Akinlo. 2014. 'Growth Effects of Health Inputs and Outcomes in Sub-Sahara African countries.' *Asian Economics and Financial Review* 4 (6): 705–14.
- Arellano, M., and S. Bond. 1991. 'Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations.' *The Review of Economic Studies* 58 (2): 277–97.
- Arellano, M., and O. Bover. 1995. 'Another Look at the Instrumental Variable Estimation of Error-Component Models.' *Journal of Econometrics* 68 (1): 29–52.
- Bhattacharjee, P., J. Akter, and N. Jahan. 2022. 'Human Capital and Physical Capital Nexus with Economic Growth: An Analysis of Bangladesh.' *Journal of Economic Studies and Financial Research* 3 (2): 21–31.
- Beylik, U., U. Cirakli, M. Cetin, E. Ecevit, and O. Senol. 2022. 'The Relationship Between Health Expenditure Indicators and Economic

- Growth in OECD Countries: A Driscoll-Kraay Approach.' *Frontiers in Public Health* 10:1050550.
- Blundell, R., and S. Bond. 1998. 'Initial Conditions and Moment Restrictions in Dynamic Panel Data Models.' *Journal of Econometrics* 87 (1): 115–43.
- Boachie, M. K., and K. Ramu. 2015. 'Public Health Expenditure and Health Status in Ghana.' MPRA Paper No. 66371, Munich Personal REPEC Archive.
- Bond, S., R., A. Hoeffler, and J. Temple. 2001. 'GMM Estimation of Empirical Growth Models.' CEPR Discussion Paper No. 3048, CEPR Press.
- Buchanan, J. M. 1965. 'An Economic Theory of Clubs.' *Economica* 32 (125): 1–14.
- Ceesay, L. 2019. 'Corruption in Sub-Saharan Africa – An impediment to economic growth.' *European Scientific Journal* 15 (10): 16–26.
- Cieřlik, A., and L. Goczek. 2018. 'Control of Corruption, International Investment and Economic Growth – Evidence from Panel Data.' *World Development* 103:323–335.
- Dada, J. T., and T. Akinlo. 2023. 'Remittances-Finance-Growth Trilogy: Do Remittance and Financial Development Complement or Substitute Each Other to Affect Growth in Nigeria?' *Economic Annals* 68 (236): 105–38.
- d'Agostino, G., J. P. Dunne, and L. Pironi. 2016. 'Government Spending, Corruption and Economic Growth.' *World Development* 84:190–205.
- Di Tella, R., and W. D. Savedoff. 2001. 'Shining Light in Dark Corners.' In *The Corruption that Compromises Health: Studies of Public Hospitals in Latin America*, edited by R. Di Tella and W. D. Savedoff. Inter-American Development Bank.
- Ductor, L., and D. Grechyna. 2013. 'Financial Development, Technological Progress and Economic Growth.' <http://dx.doi.org/10.2139/ssrn.1997526>.
- Dzhumashev, R. 2014. 'Corruption and Growth: The Role of Governance, Public Spending, and Economic Development.' *Economic Modelling* 37:202–15.
- Egger, P., and H. Winner. 2005. 'Evidence on Corruption as an Incentive for Foreign Direct Investment.' *European Journal of Political Economy* 21 (4): 932–52.
- Eggoh, J., H. Houeninvo, and G.-A. Sossou. 2015. 'Education, Health and Economic Growth in African Countries.' *Journal of Economic Development* 40 (1): 93–111.
- Farag, M., A. K. Nandakumar, S. Wallack, D. Hodgkin, G. Gaumer, and C. Erbil. 2013. 'Health Expenditures, Health Outcomes and the Role of Good Governance.' *International Journal of Health Care Finance Economics* 13 (1): 33–52.

- Garzarelli, G., and Y. R. Limam. 2019. 'Physical Capital, Total Factor Productivity, and Economic Growth in Sub-Saharan Africa.' *South African Journal of Economic and Management Sciences* 22 (1): a2309.
- Gebresilassie, Y. H., H. G. Gebrihet, and G. Woldu. 2024. 'Corruption and Growth in Sub-Saharan African Countries: Do Differences in Government Effectiveness Matter?' *Journal of Social Economics Research* 11 (1): 45–59.
- Gokal, V., and S. Hanif. 2004. 'Relationship Between Inflation and Economic Growth.' Working Paper No. 4, Reserve Bank of Fiji .
- Grossman, M. 1972. 'On the Concept of Health Capital and the Demand for Health.' *Journal of Political Economy* 80 (2): 223–55.
- Halici-Tülüce, N. S., İ. Doğan, and C. Dumrul. 2016. 'Is Income Relevant for Health Expenditure and Economic Growth Nexus?' *International Journal of Health Economics and Management* 16 (1): 23–49.
- Hashmati, A. 2001. 'On the Causality Between GDP and health Care Expenditure in Augmented Solow Growth Model.' SSE/EFI Working Paper Series in Economics and Finance No. 423, Stockholm School of Economics.
- Hodge, A., S. Shankar, D. S. Prasada Rao, and A. Duhs. 2011. 'Exploring the Links Between Corruption and Growth.' *Review of Development Economics* 15 (3): 474–90.
- Hoinaru, R., D. Buda, S. N. Borlea, V. L. Văidean, and M. V. Achim. 2020. 'The Impact of Corruption and Shadow Economy on the Economic and Sustainable Development. Do they “sand the wheels” or “grease the wheels”?' *Sustainability* 12 (2): 481.
- Huang, C.-J. 2016. 'Is Corruption Bad for Economic Growth? Evidence from Asia-Pacific Countries.' *The North American Journal of Economics and Finance* 35:247–56.
- Iliyasu, I., and I. Muhammed. 2023. 'Growth Effects of Government Expenditure in Nigeria: Does the Level of Corruption Matter?' *Asian Journal of Economics and Empirical Research* 10 (1): 1–10.
- Karambakuwa, T., R. Ncwadi, and A. Phiri. 2019. 'The Human Capital-Economic Growth Nexus in SSA Countries: What Can Strengthen the Relationship?' MPRA Paper No. 95199, Munich Personal REPEC Archive.
- Kadir, S. A., Azwardi, R. S. Wardhani, N. Novalia, and A. Maulana. 2018. 'The Impact of Physical and Human Capital on the Economic Growth of Agricultural Sector in South Sumatera.' *International Journal of Economics and Financial Issues* 8 (4): 322–26.
- Karaman, S., D. Ürek, İ. Bilgin Demir, Ö. Uğurluoğlu, and O. Işık. 2020. 'The Impacts of Healthcare Spending on Health Outcomes: New Evidence from OECD Countries.' *Erciyes Medical Journal* 42 (2): 218–22.
- Kato, A., and T. Sato. 2015. 'Greasing the Wheels? The Effect of Corruption in Regulated Manufacturing Sectors of India.' *Canadian Journal of Development Studies* 36 (4): 459–83.

- Keefer, P., and S. Knack. 2007. 'Boondoggles, Rent-Seeking, and Political Checks and Balances: Public Investment Under Unaccountable Governments.' *The Review of Economics and Statistics* 89 (3): 566–72.
- Kurniawan, Y., R. Ratnasari, and H. Mustika. 2020. 'The Relevance of Corruption and Human Development to Economic Growth of OIC Countries.' *Jurnal Ekonomi dan Bisnis Islam* 6 (2): 189–200.
- Leff, N. H. 1964. 'Economic Development Through Bureaucratic Corruption.' *American Behavioral Scientist* 8 (3): 8–14.
- Lucarelli, S., K. Muço, and E. Valentini. 2024. 'Short Run and Long Run Effects of Corruption on Economic Growth: Evidence from Balkan Countries.' *Economies* 12 (4): 86.
- Lui, F. T. 1985. 'An Equilibrium Queuing Model of Bribery.' *Journal of Political Economy* 93 (4): 760–81.
- Machoski, E., and J. M. de Araujo. 2020. 'Corruption in Public Health and Its Effects on the Economic Growth of Brazilian Municipalities.' *The European Journal of Health Economics* 21 (5): 669–87.
- Makar, T. A., A. Ngutsav, V. U. Ijirshar, and J. M. Ayaga. 2023. 'Impact of Corruption on Economic Growth: An Empirical Evidence from Nigeria.' *Journal of Public Administration, Finance and Law* (27): 254–76.
- Malanski, L. K., and A. C. S. Póvoa. 2021. 'Economic Growth and Corruption in Emerging Markets: Does Economic Freedom Matter?' *International Economics* 166:58–70.
- Mandeya, S. M. T., and S.-Y. Ho. 2021. 'Inflation, Inflation Uncertainty and the Economic Growth Nexus: An Impact Study of South Africa.' *MethodsX* 8:101501.
- Méon, P. G., and L. Weill. 2010. 'Is Corruption an Efficient Grease?' *World Development* 38 (3): 244–59.
- Mhaka, S., and R. Runganga. 2023. 'Impact of Agricultural Production on Economic Growth in Zimbabwe.' *Managing Global Transitions* 21 (4): 303–28.
- Nguyen, M.-L. T., and N. T. Bui. 2022. 'Government Expenditure and Economic Growth: Does the Role of Corruption Control Matter?' *Heliyon* 8 (10): e10822.
- Odhiambo, N. M. (2021) 'Health Expenditure and Economic Growth in Sub-Saharan Africa: An Empirical Investigation.' *Development Studies Research* 8 (1): 73–81.
- Okunlola, O. C., I. U. Sani, O. A. Ayetigbo, and O. O. Oyadeyi. 2024. 'Effect of Government Expenditure on Real Economic Growth in ECOWAS: Assessing the Moderating Role of Corruption and Conflict.' *Humanities and Social Sciences Communications* 11:768.
- Phiri, A. 2018. 'Nonlinear Impact of Inflation on Economic Growth in South Africa: a Smooth Transition Regression Analysis.' *International Journal of Sustainable Economy* 10 (1): 1–17.

- Piabuo, S. M., and J. C. Tieguhong. 2017. 'Health Expenditure and Economic Growth – A Review of the Literature and an Analysis Between the Economic Community for Central African States (CEMAC) and Selected African Countries.' *Health Economics Review* 7 (1): 23.
- Qehaja, S. S., D. Qehaja, A. Hoti, and E. Marovci. 2023. 'The Relationship Between Government Health Expenditure and Economic Growth: Evidence from Western Balkan Countries.' *International Journal of Applied Economics, Finance and Accounting* 15:10–20.
- Riaz, Z., U. Nizar, and H. Yasmeen. 2022. 'Impact of Human Capital and Social Capabilities on Economic Growth of Pakistan: A Time Series Analysis.' *Journal of Education and Social Studies* 3 (1): 18–30.
- Rispel, L. C., P. De Jager, and S. Fonn. 2016. 'Exploring Corruption in the South African Health Sector.' *Health Policy and Planning* 31 (2): 239–49.
- Solow, R. M. 1956. 'A Contribution to the Theory of Economic Growth.' *Quarterly Journal of Economics* 70 (1): 65–94.
- Spyromitros, E., and M. Panagiotidis. 2022. 'The Impact of Corruption Economic Growth in Developing Countries and a Comparative Analysis of Corruption Measurement Indicators.' *Cogent Economics and Finance* 10 (1): 2129368.
- Šumah, Š. 2018. 'Corruption, Causes and Consequences.' In *Trade and Global Market*, edited by V. Bobek. IntechOpen.
- Uche, A. O. 2020. 'Public Health Spending and Health Outcome in Nigeria: The Role of Governance.' *International Journal of Development Issues* 20 (1): 95–112.
- United Nations. 2021. *The Sustainable Development Goals Report 2021*. United Nations.
- UNICEF. 2021. *UNICEF Annual Report 2021: Protecting child rights in a time of crises*. UNICEF
- World Bank. 1993. *World Development Report 1993: Investing in Health*. Oxford University Press.
- World Bank. 2022. *The World Bank Annual Report 2022: Helping Countries Adapt to a Changing World*. The World Bank Group.
- World Health Organization. 2022. *WHO's Response to Health Emergencies: Annual Report 2022*. World Health Organization.
- Xesibe Z., and S. Nyasha. 2020. 'Unemployment and Economic Growth in South Africa: A Re-Examination.' *International Journal of Sustainable Economy* 12 (2): 101–16.
- Yusuf, P. 2020. 'Impact of Government Health Expenditure on Economic Growth in Nigeria 1981–2016.' Master's Thesis, University of Jos.

**Appendix****List of Countries**

---

Angola	Mali
Botswana	Mozambique
Burkina Faso	Namibia
Cameroon	Niger
Côte d'Ivoire	Nigeria
Democratic Republic of Congo	Republic of the Congo
Ethiopia	Rwanda
Gabon	Senegal
Gambia	Sierra Leone
Ghana	South Africa
Guinea	Sudan
Guinea Bissau	Tanzania
Kenya	Togo
Lesotho	Uganda
Madagascar	Zambia
Malawi	Zimbabwe

---

# *Migration and Human Capital Development in Africa: The Brain Drain to Brain Gain Philosophy*

Uche Abamba Osakede  
Bowen University, Nigeria  
uche.osakede@bowen.edu.ng

Johnson Olaosebikan  
Bowen University, Nigeria  
johnson.olaosebikan@bowen.edu.ng

Joel Tobiloba Adeyemo  
Bowen University, Nigeria  
joel.adeyemo@bowen.edu.ng

Akanni Olayinka Lawanson  
University of Ibadan, Nigeria  
ao.lawanson@ui.edu.ng

Opeyemi Eunice Olagunju  
Bowen University, Nigeria  
opeyemi.olagunju@bowen.edu.ng

Olanrewaju Olaniyan  
University of Ibadan, Nigeria  
o.olaniyan@ui.edu.ng

Olayinka Omolara Adenikinju  
Bowen University, Nigeria  
olayinka.adenikinju@bowen.edu.ng

Evidence on the effect of remittances on human capital development in Africa remains mixed, with limited evidence on the educational attainment of most African migrants. Understanding these patterns is crucial to assessing whether migration leads to brain drain or brain gain. This study examines labour migration from Africa and the role of remittances in shaping school enrolment rates. Using the panel-corrected standard error (PCSE) and feasible generalized least squares (FGLS) methods, the analysis accounts for heteroscedasticity, autocorrelation, and cross-sectional dependence, providing reliable estimates. The results indicate that most African migrants have attained secondary level of education, while remittances significantly improve primary and secondary enrolment, with no significant effect on tertiary education. Findings also showed that real GDP, government expenditure, and access to electricity enhance enrolment outcomes. These findings suggest that while remittances build foundational human capital, policy interventions are needed to channel resources toward educational outcomes, particularly higher education, to ensure sustainable growth in Africa.

*Keywords:* migration, brain drain, brain gain, PCSE, FGLS

*JEL Classifications:* F22, F24, I25

Received 2025/12/18 · Revised 2026/03/25 · Accepted 2026/04/01

Published online 2026/06/30 © Author



<https://doi.org/10.26493/1854-6935.24.255-279>

## Introduction

Beyond theoretical assertions, empirical evidence has shown that human capital plays a pivotal role in driving sustained economic growth and development (Mankiw et al. 1992; Keji 2021; Adeyemi and Ogun-sola 2016). In Africa, however, human capital remains notably under-developed, which is often cited as a significant factor contributing to the region's sluggish economic growth compared to other parts of the world (Blanco-Moreno 2024; World Bank 2024). Despite the low levels of human capital, there is a significant outflow of labour, worsening the economic development gap between Africa and other global regions (IOM, UN Migration 2021). This migration, particularly of skilled labour, is often perceived as a 'brain drain', which further deteriorates economic conditions in the region (Mjelva and Carling 2023).

The rationale behind labour migration is twofold: migrants are often motivated by the potential to send remittances back home, which can benefit their families, and these remittances may be used to invest in human capital, possibly turning the 'brain drain' into a 'brain gain'. However, whether this hypothesis holds true for Africa remains uncertain, especially given the region's persistent issue of low-skilled labour. This paper explores the relationship between migration and human capital development by addressing two key research questions: (i) How is the emigration of skilled labour (brain drain) affected by human capital development in Africa, and (ii) Can migrant remittances contribute to a 'brain gain' by enhancing human capital development in the region?

To address the research questions, the study applies the panel-corrected standard error (PCSE) and the feasible generalized least squares (FGLS) methodologies. These methods are employed to provide a comprehensive analysis of the impact of migration on human capital development. PCSE and FGLS are applied to control for heteroscedasticity and cross-sectional dependence common in panel data (Wooldridge 2013; Gujarati and Porter 2008; Prais and Winsten 1954). This study focuses on Africa, covering 54 countries over a time range from 1980 to 2022. The data is sourced from the World Bank database and provides a comprehensive picture of migration patterns and their impact on human capital development.

The significance of this study rests on several key gaps in the extant literature. While a growing body of empirical work has examined the migration–development nexus, much of the recent literature has focused either on the macroeconomic and growth effects of remittances or on

the welfare implications of migration, often treating human capital as a secondary or indirect outcome (Makwembere et al. 2024; Weeraratne 2024; Usman 2023; Gajurel and Chindengwike 2025; Oyadeyi et al. 2024; Al Mosharrafa et al. 2024). Furthermore, existing studies frequently rely on single-country analyses or short time horizons, which limit their ability to capture the long-run and cross-country dynamics that characterise migration and human capital development, particularly in Africa (Makwembere et al. 2024; Gajurel and Chindengwike 2025; Al Mosharrafa et al. 2024; Dharmadasa et al. 2019; Mawuena and Okey 2021; Cebotari 2020). Again, the theoretical debates on brain drain versus brain gain remain inconclusive, particularly in contexts such as African economies, where educational systems, labour markets, and institutional quality are weak. In addition, the extant literature provides a narrow conceptualisation of brain drain, which predominantly emphasises tertiary and postgraduate migrants (Docquier and Rapoport 2009). This focus overlooks the African context, where secondary education often enables international mobility and contributes to labour market value (Mastercard Foundation 2020). Consequently, limiting the analysis to highly educated migrants may understate the broader developmental implications of human capital outflows.

This underscores the need for a more inclusive approach that captures human capital formation across all educational levels. By explicitly modelling both the drivers of skilled labour emigration and the potential feedback effects of remittances on human capital accumulation across a large panel of African countries and over four decades, this study advances the literature in several ways. First, it provides a more recent and comprehensive regional perspective that captures the migration human capital nexus in Africa, across countries and over time. Second, it empirically evaluates the dual role of migration as both a potential constraint and a catalyst for human capital development, thereby moving beyond the simplistic dichotomy of brain drain versus brain gain. Third, the findings are shown for the brain-drain-to-gain philosophy across different levels of educational attainment to capture the pipeline of human capital outflow and formation in the African region. Fourth, the study employs advanced methodologies for panel data analysis, including PCSE and FGLS, which account for heterogeneity in cross-sectional data and autocorrelation that are common challenges in time series analysis. This robust approach ensures that the estimates are consistent and reliable. These contributions position the study as a timely and policy-relevant

addition to the literature on migration, human capital, and economic development in Africa.

The remainder of the paper is structured as follows: Section 2 presents the literature review, Section 3 outlines the methodology, Section 4 discusses the empirical results, and Section 5 provides the conclusion.

### **Literature Review**

Many developing countries, particularly in Africa, seek alternative funding sources to support human capital development, specifically in education and healthcare. This effort is driven by the need to reduce poverty and enhance the well-being of their populations, given the low revenue base resulting from the highly informal economies in the region (International Labour Organization 2022). Over time, remittances have emerged as a significant tool for improving prosperity and as an alternative means to finance investments in Africa. In terms of the effect of migration on human capital, findings in the literature remain inconclusive. The results in the existing literature are summarised below.

#### **POSITIVE EFFECTS OF REMITTANCES ON HUMAN CAPITAL**

A prominent strand of the literature highlights the potential positive role of migration in human capital development, particularly through return migration. Studies argue that skilled migrants who return to their home countries often bring enhanced knowledge, technical skills, and international exposure that improve the quality of human capital and production processes (Stark and Fan 2007; Docquier and Rapoport 2007; Delavande 2023). However, such gains depend on migrants' ability to acquire valuable skills abroad and their willingness to reintegrate into domestic labour markets. In practice, destination-country policies aimed at retaining skilled migrants may limit return migration while increasing remittance flows, potentially offsetting human capital losses through financial transfers but also contributing to depopulation and long-term growth constraints in sending countries (Docquier 2014; Milleris 2019).

Empirical evidence largely supports the view that remittances positively influence human capital development. Gyimah-Brempong and Asiedu (2015) and Azam and Raza (2016) show that remittance inflows enhance educational outcomes, and this in turn enhances economic growth. Using both symmetric and asymmetric frameworks, Xia et al. (2022) confirm these findings for major remittance-receiving countries

over the period 1980–2019. Shafiq et al. (2022), using dynamic panel GMM techniques, also find that remittances significantly raise education expenditure across developing countries. Similar results were reported by Amega (2018) for sub-Saharan Africa (SSA) and by Azizi (2018) for a broad set of developing countries, with remittances shown to improve both education and health outcomes.

Country-specific studies further corroborate these findings. For instance, findings by Dharmadasa et al. (2019) demonstrate that migration and remittances increase school enrolment among children left behind in rural Sri Lanka. Similar results are shown by Mawuena and Okey (2021) in Togo, and Cebotari (2020) in Ghana, indicating that remittance-receiving households are more likely to invest in education.

While the positive role of remittances is well-documented, several studies reveal that these effects vary across educational levels and demographic groups. Amakom and Iheoma (2014) find that remittances exert a stronger influence on secondary school enrolment than on primary enrolment in Nigeria. Similar conclusions are drawn by Zhunio et al. (2012) and Lu and Treiman (2007), who show higher probabilities of secondary education attainment in remittance-receiving households. Gyimah-Brempong and Asiedu (2015) also show that female-headed households are more likely to allocate remittances towards children's education, highlighting gender-based differences in investment behaviour.

Recent cross-country studies reinforce these heterogeneous effects. Aregbeshola (2022) provides evidence from 18 African countries that remittances improve access to education, while Feldmann (2025) shows that personal remittances significantly increase primary and secondary enrolments globally, with stronger effects for girls at the primary level. Williams (2025) further demonstrates that remittances improve secondary and tertiary education outcomes in developing countries, particularly for females, although negative effects are observed in some regions such as Latin America and the Caribbean.

#### INSIGNIFICANT AND NEGATIVE EFFECTS OF REMITTANCES ON HUMAN CAPITAL

In contrast to the predominantly positive narrative, a growing body of literature documents weak, insignificant, or even negative effects of remittances on educational attainment. Köllner (2013), using household-level data from Tajikistan, finds that remittances do not significantly promote human capital investment when education is voluntary,

underscoring the role of household preferences. Similarly, Oda (2023) identifies gender disparities in Pakistan, with remittances failing to improve educational outcomes for females due to entrenched social norms. Evidence from Moldova (Pilařová and Kandakov 2017) also points to insignificant effects of remittances on high school attendance.

McKenzie and Rapoport (2011) document negative impacts of migration and remittances on schooling in rural Albania, attributing this to low perceived returns to education and a preference for immediate consumption. However, they note that remittances may still relax credit constraints for poorer households, particularly benefitting younger girls from less-educated families. These findings challenge the assumption of a linear and uniformly positive remittance–education relationship and emphasise the importance of heterogeneity in household decision-making.

Existing studies also suggest that migrants are disproportionately drawn from higher educational groups due to the costs of migration and greater awareness of overseas opportunities (Organisation for Economic Co-operation and Development (OECD) 2017). Aydemir et al. (2022) confirm that higher education significantly increases migration likelihood, particularly among males. In a related study, Latukha et al. (2022) showed that industry and individual-level factors promote migration intentions among talented graduates in leading Russian Universities. The findings, however, indicate that strengthening talent development as a form of human capital, alongside policies that attract and retain talented graduates, can help reverse the adverse effects of brain drain and reduce migration intentions. The results highlight the risk of brain drain in emerging economies and demonstrate that strategic actions can be effective in mitigating it.

#### GAPS IN THE LITERATURE

Despite extensive evidence on remittances and education, the literature presents mixed and context-dependent findings on the impact of remittances on human capital development, alongside limited empirical evidence on the educational profile of African migrants. There is also a clear gap in understanding whether migration from Africa is predominantly characterised by skilled labour outflows and whether remittances can effectively generate a compensating brain gain across different levels of educational attainment. Addressing these gaps is particularly important given the scale of labour migration from Africa and its implications

for long-term human capital formation and sustainable development in the region.

Generally, the classical brain drain literature focuses on highly educated migrants, particularly those with tertiary and postgraduate qualifications (Docquier and Rapoport 2009). This approach underestimates the developmental implications of human capital outflows in low-income settings. This is because, in many African economies, completion of secondary education significantly increases international migration probabilities and often constitutes the minimum threshold for skilled emigration (Mastercard Foundation 2020). In labour markets characterised by structural skill shortages, even mid-level educated workers are internationally mobile and economically valuable. Therefore, restricting the concept of brain drain to postgraduate education may understate the implications of human capital outflows in low-income economies. From a development perspective, enrolment rates at primary, secondary, and tertiary levels capture the pipeline of human capital formation, which directly affects future migration potential. Hence, analysing migration–human capital dynamics using enrolment across educational tiers and in a region characterised by population growth is hypothetically appropriate and policy relevant.

This study hence incorporates primary, secondary, and tertiary enrolment as measures of human capital development. This does not constitute a redefinition of brain drain; rather, it reflects a broader analytical perspective on human capital formation and its interaction with migration dynamics in Africa. Exploring these linkages is crucial, particularly given the ongoing labour migration from the region to developed countries. This area of research is essential for making projections to improve human capital and achieve sustainable development in Africa.

## **Methodology**

### **THEORETICAL FRAMEWORK**

The theoretical framework for this study is based on the aspirations-capabilities framework, as articulated by De Haas (2021). This framework addresses the limitations of functionalist and historical-structural theories, which often conceptualise migration as a uniform response to external stimuli, predictable and consistent across different contexts (De Haas 2021). The aspirations-capabilities framework provides a more nuanced understanding of the concept of migration by considering how migrant aspirations are influenced by a variety of factors, including culture, edu-

cation, personal disposition, identity, information, and the images people encounter.

According to this framework, educated individuals are more likely to migrate due to their enhanced skills, knowledge, and awareness of alternative lifestyles. They are exposed to various images of a desirable life, which can heighten their aspirations to move abroad. This is because education not only provides the qualifications needed for migration but also broadens individuals' perspectives on life opportunities available in other regions.

This framework also considers the reverse aspect of migration, where individuals return to their home countries intending to enhance human capital. This return can be motivated by personal disposition and a desire to contribute to their homeland. Additionally, migrants may send remittances back home, driven by strong cultural ties or family bonds, to improve the well-being of their families left behind. The aspirations-capabilities framework thus encapsulates the dynamic interplay between individual aspirations and the broader socio-economic factors that influence migration and its impacts.

To further substantiate this conceptual foundation, the endogenous growth theory offers valuable insights. This theory posits that long-term economic growth is primarily driven by internal factors, notably the accumulation of knowledge, innovation, and human capital (Romer 1986; Mankiw et al. 1992). Unlike exogenous growth models that treat technological progress as external, endogenous growth theory internalises human capital as a production input, emphasising its self-reinforcing role in economic development. In this light, migration-induced changes in education and skills acquisition can directly feed into the growth process. Hence, when individuals migrate and send back remittances used to finance education, it initiates a virtuous cycle: improved educational outcomes strengthen the stock of human capital, which enhances productivity, fosters innovation, and supports sustained growth. This connection forms the foundation for exploring the 'brain gain' argument; that migration, while initially seen as a drain on domestic talent, can indirectly benefit origin countries by enhancing investment in education and skill formation.

Taken together, the aspirations-capabilities framework and the endogenous growth theory form a cohesive analytical lens for this study. The former helps to understand why migration occurs and how aspirations are shaped by educational exposure, while the latter explains how the

outcomes of migration, particularly remittances, can influence the development trajectory through investment in human capital. This dual framework underpins the study's twofold inquiry: first, to assess how differences in school enrolment at primary, secondary, and tertiary levels affect migration flows from Africa; and second, to evaluate the impact of migrant remittances on school enrolment and human capital accumulation in the region.

EMPIRICAL MODEL SPECIFICATION

The empirical model of this study is grounded in the aspirations-capabilities framework. We adapt the model for brain drain following the approach outlined by Aydemir et al. (2022). For brain gain, we modify the model based on the framework developed by Amega (2018). Both models are further refined by incorporating control variables that influence the respective outcome variables. The baseline model for brain drain is specified for the period 1980–2022.

The model specification for brain drain is stated as:

$$netmig_{i,t} = \alpha + \tau Schlenrol_{i,t} + \phi X_{i,t} + \mu_{it} \tag{1}$$

$$i = 1, 2, \dots, N, \quad t = 1980, \dots, 2022,$$

where  $netmig_{i,t}$  denotes net migration, and  $Schlenrol_{i,t}$  represents school enrolment, which is captured separately for primary, secondary and tertiary school levels.  $X_{i,t}$  is the vector of control variables, including per capita real GDP, labour force participation, control of corruption, and population growth.

The model for brain gain is specified as:

$$Schlenrol_{i,t} = \beta + \gamma Rem_{i,t} + \theta Y_{i,t} + \mu_{it} \tag{1}$$

$$i = 1, 2, \dots, N, \quad t = 1980, \dots, 2022,$$

where  $Rem_{i,t}$  denotes personal remittances, and  $Y_{i,t}$  is the vector of control variables, including access to electricity, labour force participation, per capita real GDP, and government spending on education.

ESTIMATION TECHNIQUE

The empirical models adopted in this study are analysed using the panel-corrected standard error (PCSE) methodology, with the robustness of

the estimates further tested using the feasible generalized least squares (FGLS) technique. The PCSE method is preferred over other panel data methods due to its capacity to address heteroscedasticity and autocorrelation, which are prevalent in cross-sectional and time series data, respectively (Wooldridge 2013). The FGLS approach is employed for robustness checks, given its effectiveness in controlling for both heteroscedasticity and autocorrelation in the error term (Bai et al. 2009).

While techniques such as instrumental variable (IV) regression and dynamic panel estimators like the generalized method of moments (GMM) are widely recognised for addressing endogeneity, they often rely on strong instruments and strict assumptions about data properties that may not always hold. In contrast, the PCSE and FGLS estimators are more suitable for the structure of this study's dataset, particularly given the moderate time dimension and cross-sectional variation (Gujarati and Porter 2008). These methods are efficient in mitigating serial correlation and heteroscedasticity without introducing the biases that weak instruments or overfitting might cause in IV or GMM frameworks. The PCSE and FGLS are also preferred over the GMM techniques as they accommodate challenges with cross-sectional dependence (CSD) and panel-specific heteroscedasticity that are common in panel data, and hence provide more consistent and reliable estimates. Controlling for CSD is important to avoid biased estimates that may arise from high dependence across countries. This study's use of PCSE and FGLS offers an alternative yet complementary pathway to robust inference, particularly when the primary concern is correcting for CSD, contemporaneous correlation and heteroscedastic errors rather than dynamic endogeneity.

#### DATA SOURCE

The data for this study encompasses all countries in Africa and spans the period from 1980 to 2022. The data is sourced from the World Development Indicators (WDI) provided by the World Bank (2023).

## Results and Discussion

#### SUMMARY STATISTICS

Table 1 presents the summary statistics for various variables related to net migration, remittances, and education metrics. The variable 'Net-Mig', which measures net migration, has a mean of 10,356.6, indicating a general trend of emigration across the sample. The large standard devi-

ation (105,984.4) and extreme minimum and maximum values suggest significant variability in migration patterns among the observed countries.

Personal remittances (PsRem) have a mean of \$751 million, reflecting substantial remittance inflows. The wide range, from \$0 to over \$32 billion, and the high standard deviation (2.85 billion) highlight considerable disparities in remittance receipts among countries. Access to electricity (Elec), with a mean of 42.28% and a standard deviation of 29.78%, shows considerable variation in infrastructure development, ranging from minimal access to full coverage.

The measures of educational attainment, specifically primary (EnrPrim), secondary (EnrSec), and tertiary (EnrTer) school enrolments, have means of 0.87, 0.79, and 0.62, respectively, showing a progressively smaller number of persons with higher educational attainment. The high standard deviations across these indices indicate significant differences

TABLE 1 Summary Statistics

Variable symbol and description	Obs	Mean	Std. dev.	Min	Max
NetMig: Net migration	2,322	-10,356.6	105,984.4	-2,162,873	1,372,202
PsRem: Personal remittances received in current US\$	2,322	7.51E+08	2.85E+09	0	3.23E+10
Elec: Access to electricity (% of population)	2,322	42.2789	29.7816	0.5339	100
EnrPrim: School enrolment primary (gross), Gender Parity Index (GPI)	2,322	0.8728	0.1522	0.3796	1.4115
EnrSec: School enrolment secondary (gross), Gender Parity Index (GPI)	2,322	0.7889	0.2534	0.1799	1.5265
EnrTer: School enrolment tertiary (gross), Gender Parity Index (GPI)	2,322	0.6201	0.36978	0.0617	1.7289
CC: Estimate of the Control of corruption	2,322	-0.6268	0.6295	-1.9165	1.6334
Geduc: Government expenditure on education, total (% of government expenditure)	2,322	16.1852	5.7549	0.8334	37.5210
Pgrowth: Population growth (annual %)	2,322	2.4754	1.4006	-16.8806	16.6255
LFP: Labour force participation rate, total (% of total population, ages 15+) (modelled)	2,322	62.7060	13.1056	30.751	90.122
RGDP: GDP per capita (constant 2015 US\$)	2,322	2048.12	2537.761	165.9344	17117.03

in educational access among countries. Control of corruption (CC) has a mean of  $-0.63$ , indicating weak governance quality. The substantial range in the minimum and maximum values suggests variability in the quality of governance over the study period and across countries. Government expenditure on education (Geduc) averages 16.19% of total expenditure, with a notable range, indicating differing national priorities in educational investment. Finally, 'Pgrowth' and 'LFP' reflect population growth and labour force participation with means of 2.48% and 62.71%, respectively, showing a rise in population size in the region and more than half of the population in economic employment activities.

#### PRE-ESTIMATION TEST

Before conducting panel data estimation, we first present some diagnostic tests for CSD, unit roots, and cointegration. The CSD test is essential in panel data; otherwise, the results may be inconsistent and biased. The CSD test evaluates the null hypothesis of either weak or strict CSD (Pesaran 2004; De Hoyos and Sarafidis 2006). The results presented in table 2 indicate significant CSD among the selected countries, as evidenced by the rejection of the null hypothesis at the 1% significance level. This implies that shocks in one country can easily be transmitted to others. To address this, the study employs the Pesaran cross-sectionally augmented Dickey-Fuller test for panel unit roots on variables exhibiting CSD. The second-generation unit root test results show that most variables are stationary at level, except for personal remittances, the labour force participation rate, and real GDP, which were stationary at the first difference. Additionally, the Westerlund cointegration test confirms that the selected variables are cointegrated, as the null hypothesis of no cointegration is rejected at the 5% significance level.

#### PCSE AND FGLS REGRESSION RESULTS

This section provides a comprehensive analysis of the regression results examining the relationship between human capital and migration using the PCSE and FGLS methodologies. These methods address issues of heterogeneity and autocorrelation in the panel data under study.

Table 3 presents the results of the brain drain model, focusing on the relationship between net migration and its determinants: school enrolment (separately categorised into primary, secondary, and tertiary), per capita real GDP, labour force participation, control of corruption, and population growth. The regression results are reported for both the main and robust-

TABLE 2 Cross-Sectional Dependence (CD)

Variable	CSD Statistics	PESCADF		Westerlund
		Level	1st Diff.	Statistics
NetMig	0.798	-17.488***	-33.798***	-26.768 ***
PsRem	25.014***	14.9412	-27.5900***	
Elec	45.878***	-2.2591***	-24.3026***	
EnrPrim	56.105***	-6.6807***	-32.2219***	
EnrSec	56.914***	-14.1272***	-33.1436***	
EnrTer	31.441***	-16.3560***	-33.3509***	
CC	-1.157	-12.6068***	-36.6348***	
Geduc	1.107	-13.9729***	-33.0760***	
Pgrowth	13.111***	-7.9575***	-25.0068***	
LFP	8.1***	0.5185	-27.1054***	
RGDP	43.495***	4.6372	-26.1071***	

NOTES \*\*\* indicates statistical significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

ness checks. Columns 1 through 3 display the main regression results using PCSE, while columns 4 through 6 provide robustness checks using FGLS.

In the main regression results, column 1 shows a significant negative relationship between primary school enrolment and net migration. Column 2, however, indicates a negative but insignificant effect. This suggests that populations with higher primary school attendance are less likely to migrate, supporting the notion that emigrants often have higher educational attainment (OECD 2017; Aydemir et al. 2022). Secondary

TABLE 2 Cross-Sectional Dependence (CD)

Variable	CSD Statistics	PESCADF		Westerlund
		Level	1st Diff.	Statistics
NetMig	0.798	-17.488***	-33.798***	-26.768 ***
PsRem	25.014***	14.9412	-27.5900***	
Elec	45.878***	-2.2591***	-24.3026***	
EnrPrim	56.105***	-6.6807***	-32.2219***	
EnrSec	56.914***	-14.1272***	-33.1436***	
EnrTer	31.441***	-16.3560***	-33.3509***	
CC	-1.157	-12.6068***	-36.6348***	
Geduc	1.107	-13.9729***	-33.0760***	
Pgrowth	13.111***	-7.9575***	-25.0068***	
LFP	8.1***	0.5185	-27.1054***	
RGDP	43.495***	4.6372	-26.1071***	

NOTES \*\*\* indicates statistical significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

TABLE 3 PCSE and FGLS Regression Estimates: Brain Drain

Variables	PCSE			FGLS		
	Main Regression			Robustness Check		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
EnrPrim	-66,117*** (17,807)	-38,471 (30,057)	-54,148* (29,848)	-66,117*** (19,873)	-3,238 (6,600)	-4,124 (5,291)
EnrSec	56,740*** (14,738)	15,174 (18,526)	29,228 (18,221)	56,740*** (14,969)	9,461** (4,570)	2,206 (2,908)
EnrTer	3,535 (8,649)	12,617 (11,275)	9,935 (9,923)	3,535 (8,608)	9,071*** (2,567)	1,947 (1,751)
RGDP	11,146*** (2,315)	15,069** (6,039)	14,557** (5,823)	11,146*** (2,569)	9,654*** (1,136)	8,814*** (1,495)
LFP	-4.101 (243.5)	79.20 (340.1)	146.8 (365.0)	-4.101 (185.3)	174.2** (74.28)	-53.79 (88.70)
CC	25,911*** (6,254)	15,895** (7,327)	15,521** (7,526)	25,911*** (4,438)	1,214 (1,647)	2,005* (1,131)
Pgrowth	39,059*** (3,038)	40,290*** (4,633)	42,669*** (3,377)	39,059*** (1,411)	20,734*** (1,059)	26,465*** (1,118)
Constant	-159,451*** (28,942)	-199,813*** (55,367)	-193,015*** (54,535)	-159,451*** (26,649)	-149,530*** (11,768)	-132,140*** (13,675)
Observations	2,322	2,322	2,322	2,322	2,322	2,322
R-squared	0.253	0.183	0.286			
Number of ID	54	54	54	54	54	54

NOTES Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$  ID denotes the unique identifier for countries in the study.

school enrolment exhibits a significant positive relationship with net migration in column 1, indicating that a 1% increase in secondary school enrolment leads to a 56,740 increase in net migration of individuals from African countries. This finding aligns with the expectation that increased education correlates with higher migration rates. Tertiary education enrolment shows a non-significant positive relationship with net migration in the main results. This weak linkage may reflect indirect or delayed migration responses to higher education, consistent with the notion of a backdoor brain drain, whereby human capital accumulation does not immediately translate into outward migration but still generates long-term skill losses (Stark and Byra 2012).

The results show an interesting mix of relationships between education and migration in Africa. For primary school enrolment, the negative

relationship ( $-66,117$ ;  $p < 0.01$ ) indicates that areas with higher primary school attendance tend to have lower migration rates, possibly because emigrants typically have higher levels of education. On the other hand, the positive relationship with secondary school enrolment is notable ( $56,740$ ;  $p < 0.01$ ); this means that as more people enrol in secondary education, migration tends to increase, possibly because better education expands opportunities for migration. However, for tertiary education, the effect on migration is not significant, suggesting that higher education may not play as big a role in driving migration as secondary education. In sum, the findings indicate that levels of educational attainment influence migration differently across the region.

Per capita real GDP demonstrates a positive and significant relationship with net migration (estimates ranging from 11,146 to 15,069) across columns 1 to 3, suggesting that economic growth enhances human capital, leading to increased migration. Conversely, the labour force participation rate shows both negative (column 1) and positive (columns 2 and 3) effects on net migration but remains insignificant throughout the main estimates. The control of corruption exhibits a consistently positive effect on net migration in all main estimates, indicating that effective corruption controls may attract migrants seeking reputable environments. Additionally, population growth shows a positive and significant relationship with net migration across all main estimates, suggesting that a growing population contributes directly to migration.

The robustness check using FGLS confirms the main regression results, with primary school enrolment maintaining its significant negative relationship with net migration. Secondary school enrolment also remains positively significant, consistent with the main results. Population growth, control of corruption, and economic growth similarly show consistency with the main findings. However, tertiary school enrolment, initially showing a positive but insignificant relationship with net migration in the main results, becomes significant in column 5 of the robustness check. Finally, the labour force participation rate shows mixed effects in the robustness test, with negative insignificant and positive significant effects in columns 4 and 5.

To illustrate the brain gain model, table 4 presents estimates of the relationship between remittances and primary school enrolment. The main results indicate that remittances have a positive and statistically significant effect on primary school enrolment in Africa. This finding is consistent with expectations, as remittances directly enhance house-

hold income and living standards, making education more affordable (Stark and Wang 2002). Specifically, a 1% increase in remittances leads to a  $3.50e^{-12}$  increase in the number of persons with primary school enrolment. Although the magnitude of the effect is quite small, the positive impact of remittances on primary school enrolment is corroborated by Amakom and Iheoma (2014) and Feldmann (2025). The estimated coefficients indicate that while remittances exert a statistically significant effect on primary school enrolment, the economic magnitude is negligible, implying that remittance inflows translate into only marginal enrolment gains at the aggregate level.

Access to electricity, as anticipated, shows a positive relationship with primary school enrolment in column 1, although columns 2 and 3 display a positive but insignificant effect. The results reveal that a 1% increase in access to electricity corresponds to a 0.0001% rise in primary school enrolment in Africa. This small effect suggests that infrastructure improvements enhance learning conditions but are insufficient on their own to substantially raise enrolment. The labour force participation rate shows a positive relationship with primary school enrolment in the main estimates, but it is insignificant across columns 1 to 3.

Furthermore, real GDP and government spending on education are positively and significantly related to primary school enrolment across columns 1 to 3. This outcome aligns with the *a priori* expectation that economic growth and increased investment in education improve educational attainment.

For the robustness check, the results for remittances remain consistent with the main regression, showing a positive and significant relationship with primary school enrolment in columns 4 and 5. Similarly, the effect of access to electricity remains positive and significant.

Table 5 presents findings for the brain gain model in terms of the effect of remittances on secondary school enrolment using both the PCSE and FGLS methods. The results reveal a significant positive impact of remittances on secondary school enrolment, as shown in column 1 of the main regression. Specifically, remittances have a statistically significant positive effect on secondary school enrolment, indicating that households receiving remittances experience improved educational outcomes. The results demonstrate that a 1% increase in remittances induces a  $2.87e^{12}$  increase in the number of persons with secondary school enrolment. The estimated coefficient implies that a 1% increase in remittances translates into only a marginal rise in enrolment, suggesting that while remittances

TABLE 4 PCSE and FGLS Regression Estimates: Brain Gain (Primary School Enrolment)

Variables	PCSE			FGLS		
	Main Regression			Robustness Check		
	(1)	(2)	(3)	(4)	(5)	(6)
PsRem	3.50e-12*** (8.80e-13)	2.07e-12 * (1.21e-12)	1.70e-12 (1.33e-12)	3.50e-12*** (1.04e-12)	1.79e-12 * (1.08e-12)	1.70e-12 (1.16e-12)
Elec	0.0001*** (0.0002)	0.0001 (0.0001)	0.0001 (0.0001)	0.0006*** (0.0002)	0.0003*** (0.0001)	0.0003*** (8.54e-05)
LFP	0.0004 (0.0004)	0.0002 (0.0004)	0.0001 (0.0003)	0.0004 (0.0003)	0.0005* (0.0003)	0.0001 (0.0002)
RGDP	0.0600*** (0.0071)	0.0382*** (0.0054)	0.0356*** (0.0046)	0.0600*** (0.0037)	0.0343*** (0.0045)	0.0330*** (0.0038)
Geduc	0.0039*** (0.0006)	0.0008* (0.0004)	0.0007* (0.0004)	0.0039*** (0.0007)	0.0004 (0.0003)	0.0003 (0.0003)
Constant	0.380*** (0.0777)	0.562*** (0.0538)	0.592*** (0.0480)	0.380*** (0.0345)	0.581*** (0.0419)	0.610*** (0.0354)
Observations	2,322	2,322	2,322	2,322	2,322	2,322
R-squared	0.137	0.434	0.922			
Number of ID	54	54	54	54	54	54

NOTES Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . ID denotes the unique identifier for countries in the study

help ease household constraints and support schooling decisions, their standalone capacity to substantially expand secondary enrolment is limited. Findings for positive effects of remittances on secondary enrolments align with those of Zhunio et al. (2012), Lu and Treiman (2007), Feldmann (2025) and Williams (2025).

Access to electricity also shows a significant positive influence on secondary school education, suggesting that improved access to electricity enhances secondary school enrolment and, consequently, educational attainment. Additionally, both the labour force participation rate and government spending on education exhibit a significantly positive relationship with secondary school enrolment in the main regression estimates. Real GDP consistently demonstrates a positive and significant relationship with primary school enrolment across columns 1 through 3, aligning with expectations that educational attainment improves with economic growth.

In the robustness checks, the outcomes for remittances and the labour force participation rate remain consistent with the main regression

TABLE 5 PCSE and FGLS Regression Estimates: Brain Gain (Secondary School Enrolment)

Variables	PCSE			FGLS		
	Main Regression			Robustness Check		
	(1)	(2)	(3)	(4)	(5)	(6)
PsRem	2.87e-12** (1.17e-12)	6.81e-13 (1.81e-12)	1.05e-12 (1.74e-12)	2.87e-12** (1.46e-12)	4.68e-13 (1.65e-12)	7.24e-13 (1.61e-12)
Elec	0.0005* (0.0002)	0.0007*** (0.0003)	0.0008*** (0.0002)	0.0005** (0.0002)	0.0007*** (0.0002)	0.0009*** (0.0002)
LFP	0.0001*** (0.0003)	0.0003 (0.0005)	6.90e-05 (0.0005)	0.0001*** (0.0004)	0.0002 (0.0004)	-2.83e-05 (0.0004)
RGDP	0.0673*** (0.0078)	0.0542*** (0.0086)	0.0618*** (0.0080)	0.0673*** (0.0053)	0.0454*** (0.0072)	0.0456*** (0.0068)
Geduc	0.0052*** (0.0010)	0.0005 (0.0009)	-0.0002 (0.0007)	0.0052*** (0.0001)	0.0013** (0.0006)	0.0008 (0.0005)
Constant	0.144* (0.0803)	0.339*** (0.0790)	0.295*** (0.0733)	0.144*** (0.0484)	0.400*** (0.0652)	0.408*** (0.0609)
Observations	2,322	2,322	2,322	2,322	2,322	2,322
R-squared	0.136	0.115	0.661			
Number of ID	54	54	54	54	54	54

NOTES Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . ID denotes the unique identifier for countries in the study

results, showing a positive and significant relationship with secondary school enrolment in column 4. Similarly, access to electricity maintains a positive and significant effect across all columns. The results for real GDP also continue to show a positive and significant impact, consistent with the main findings. Finally, government spending on education shows consistent positive significance in column 4 of the robustness check and is significant in column 5 as well.

Findings for the brain gain model in terms of the effect of remittances on tertiary enrolment are presented in table 6. In the main regression results, personal remittances exhibit a positive but statistically insignificant coefficient. This suggests that while remittances have the potential to enhance tertiary education, they are primarily allocated to basic education, as supported by findings in tables 4 and 5. Given earlier results, the differential effects of remittances on school enrolments appear mixed. The findings indicate that remittances have a positive and statistically significant effect on primary and secondary school enrolment in Africa, supporting the idea that increased household income from remittanc-

es makes education more affordable and accessible. As remittances enhance the living standards of recipient households, they enable families to invest in education, particularly at the primary and secondary levels. The improvement in educational outcomes is a direct consequence of the financial support provided, which helps cover school fees, purchase learning materials, and even support transportation costs. These benefits underscore the role of remittances in reducing barriers to education for many households, providing a vital resource for children to continue their schooling in regions where access to education can be limited by financial constraints.

However, in terms of tertiary education, the coefficient of personal remittances is positive but statistically insignificant, suggesting that remittances have a limited or negligible impact on tertiary school enrolment. One reason for this could be the high costs associated with tertiary education, which often exceed what can be provided by remittances alone. Additionally, migrants' altruistic motives may play a role in how remittances are allocated (Azam and Gubert 2006; Clemens and McKenzie 2018; Adda et al. 2022), as they often prioritise the immediate welfare of their families, such as providing for daily living expenses, healthcare, and housing, over longer-term investments like tertiary education. While migrants often maintain emotional and cultural ties to their home country, their financial contributions might prioritise family welfare and community development over investing in higher education, especially given the limited job opportunities available for graduates. The lack of return on investment in tertiary education, coupled with the high costs, may discourage migrants from directing remittances toward higher education, leading to a preference for more immediate needs, such as primary and secondary schooling, which have more direct benefits. Findings for the insignificant effect of remittances on tertiary education contrast with those of Williams (2025), showing that remittances improve tertiary educational outcomes in developing economies.

The availability of electricity is associated with an increased likelihood of enrolling students in tertiary institutions. Additionally, real GDP and government expenditures on education positively and significantly impact tertiary education attainment. Our results also indicate that an increased labour force participation rate contributes to improved tertiary education, suggesting that greater workforce engagement motivates higher education.

TABLE 6 PCSE and FGLS Regression Estimates: Brain Gain (Tertiary School Enrolment)

Variables	PCSE			FGLS		
	Main Regression			Robustness Check		
	(1)	(2)	(3)	(4)	(5)	(6)
PsRem	1.63e-12 (1.44e-12)	1.37e-12 (1.83e-12)	2.35e-12 (2.62e-12)	1.63e-12 (1.98e-12)	-1.21e-12 (1.69e-12)	1.46e-13 (2.26e-12)
Elec	0.0017*** (0.0003)	0.0017*** (0.0004)	0.0001*** (0.0004)	0.0017*** (0.0003)	0.0018*** (0.0003)	0.0012*** (0.0003)
LFP	0.0009** (0.0004)	-0.0011 (0.0008)	-0.0019*** (0.0006)	-0.0009* (0.0005)	-0.0006 (0.0006)	0.0013*** (0.0005)
RGDP	0.0880*** (0.0069)	0.0787*** (0.0118)	0.0746*** (0.0103)	0.0880*** (0.0071)	0.0628*** (0.0099)	0.0621*** (0.0088)
Geduc	0.0037*** (0.0013)	0.0037*** (0.0014)	0.0025** (0.0012)	0.0037*** (0.0013)	0.0006 (0.0011)	0.0006 (0.0009)
Constant	0.0071 (0.0594)	0.0867 (0.106)	0.206** (0.0866)	0.0071 (0.0657)	0.246*** (0.0872)	0.312*** (0.0728)
Observations	2,322	2,322	2,322	2,322	2,322	2,322
R-squared	0.198	0.085	0.510			
Number of ID	54	54	54	54	54	54

NOTES Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$  ID denotes the unique identifier for countries in the study.

The robustness check results in table 6, obtained using the FGLS test, generally confirm the main regression findings. However, there are notable differences: the coefficient for remittances turns negative in column 5, and the labour force participation rate turns negative in column 4, indicating variability in the effects depending on the estimation method used.

### Conclusion

This study explored the relationship between migration and human capital development through the lens of brain drain and brain gain. The findings indicate that individuals with secondary education are more likely to migrate, underscoring the risk of losing semi-skilled labour. At the same time, remittances were shown to significantly improve primary and secondary school enrolments, suggesting that migration indirectly supports foundational education at home. However, the absence of significant effects on tertiary education highlights a gap that could limit long-term human capital growth. To mitigate brain drain, governments must improve domestic conditions that push skilled individuals

to migrate. Increased investment in tertiary education, better job opportunities for graduates, and stronger links between higher education and labour markets are essential to retain talent and ensure productive outcomes. While remittances support basic education, policy actions should ensure that the flows are also channelled into higher education, scholarships, and research initiatives. This is to ensure that the region strengthens its human capital base and promotes inclusive development in the face of continued labour migration.

The results of the study are presented using the FGLS and PCSE techniques to verify the consistency of the estimated relationships across different econometric specifications and to strengthen the robustness of the empirical findings. However, potential endogeneity between migration, remittances, and human capital development may not be fully addressed in this study. Future research could address this limitation by employing instrumental variable approaches. In addition, the study focuses on a regional assessment by examining the full sample of countries in Africa, with robustness checks conducted using alternative estimation techniques. Future studies could extend this analysis through sub-sample examinations, such as by country income groups, to provide further insights into heterogeneity across countries in the region. Migration and remittance data may not fully capture informal flows, which could influence the measured effects on human capital development. However, due to the difficulty of tracking informal transfers, such flows could not be accounted for in the analysis. Again, enrolment rates reflect access to education and do not reflect its quality. While obtaining comprehensive data on education quality remains a challenge, enrolment rates are widely regarded as a reliable proxy for the overall level of educational attainment.

#### **Acknowledgements:**

1. Funding: This study received no external funding.
2. Competing interests: Authors declare no competing interest of any form.
3. Availability of data: Data is publicly available on the World Bank site.
4. Acknowledgement regarding the use of AI: The authors acknowledge the use of ChatGPT, developed by OpenAI, to assist with language editing and improve the readability of the manuscript. The authors take full responsibility for the conceptualisation, writing the original draft, analysis, interpretation of the results, and the conclusions of the study.

## References

- Adda, J., C. Dustmann, and J. S. Görlach. 2022. 'The Dynamics of Return Migration, Human Capital Accumulation, and Wage Assimilation.' *The Review of Economic Studies* 89 (6): 2841–71.
- Adeyemi, P. A., and A. J. Ogunsola. 2016. 'The Impact of Human Capital Development on Economic Growth in Nigeria: ARDL Approach.' *IOSR Journal of Humanities and Social Science* 21 (3): 1–7.
- Al Mosharrafa, R., M. Sahabuddin, and N. Saha. 2024. 'Migrant Workforces, Foreign Remittance, and Economic Growth Nexus in an Emerging Country.' *Journal of International Migration and Integration* 25 (4): 2321–37.
- Amakom, U., and C. G. Iheoma. 2014. 'Impact of Migrant Remittances on Health and Education Outcomes in Sub-Saharan Africa.' *IOSR Journal of Humanities and Social Science* 19 (8): 33–44.
- Amega, K. 2018. 'Remittances, Education and Health in Sub-Saharan Africa.' *Cogent Economics & Finance* 6 (1): 1516488.
- Aregbeshola, R. A. 2022. 'Interplay of Poverty, Remittances and Human Capital Development: Panel Evidence from Selected Sub-Saharan African Countries.' *International Migration* 60 (6): 250–71.
- Aydemir, A. B., M. G. Kırdar, and H. Torun. 2022. 'The Effect of Education on Internal Migration of Young Men and Women: Incidence, Timing, and Type of Migration.' *Labour Economics* 74:102098.
- Azam, J.-P., and F. Gubert. 2006. 'Migrants' Remittances and the Household in Africa: A Review of Evidence.' *Journal of African Economies* 15 (2): 426–62.
- Azam, M., and S. A. Raza. 2016. 'Do Workers' Remittances Boost Human Capital Development?' *The Pakistan Development Review* 55 (2): 123–49.
- Azizi, S. 2018. 'The Impacts of Workers' Remittances on Human Capital and Labor Supply in Developing Countries.' *Economic Modelling* 75:377–96.
- Bai, J., C. Kao, and S. Ng. 2009. 'Panel Cointegration with Global Stochastic Trends.' *Journal of Econometrics* 149 (1): 82–99.
- Blanco-Moreno, A. C. 2024. 'Inter-Regional Graduate Migration, Subjective Expectations, and Human Capital Mobility.' *Regional Science Policy & Practice* 16 (10): 100110.
- Cebotari, V. 2020. 'Migration, Remittances, and Child Education in Ghana: Evidence from a Longitudinal Study.' In *Migration, Remittances, and Sustainable Development in Africa*, edited by M. Konte and L. M. Mbaye. Routledge.
- Clemens, M. A., and D. McKenzie. 2018. 'Why Don't Remittances Appear to Affect Growth?' *The Economic Journal* 128 (612): F179–F209.

- De Haas, H. 2021. 'A Theory of Migration: The Aspirations-Capabilities Framework.' *Comparative Migration Studies* 9 (1): 8.
- De Hoyos, R. E., and V. Sarafidis. 2006. 'Testing for Cross-Sectional Dependence in Panel-Data Models.' *The Stata Journal* 6 (4): 482–96.
- Delavande, A. 2023. 'Expectations in Development Economics.' In *Handbook of Economic Expectations*, edited by R. Bachmann, G. Topa and W. van der Klaauw. Academic Press.
- Dharmadasa, R. A. P. I. S., H. M. T. R. Herath, J. I. U. Jayalath, and K. K. H. M. Rathnayake. 2019. 'The Impact of Migration and Remittances on Education of Children Left-Behind: Evidence from the Rural Sector of Sri Lanka.' In *Proceeding of International Conference on Contemporary Management (ICCM): Reshaping Human Capital Towards Better Future*. University of Jaffna.
- Docquier, F. 2014. 'The Brain Drain from Developing Countries.' *IZA World of Labor* 31. <http://dx.doi.org/10.15185/izawol.31>.
- Docquier, F., and H. Rapoport. 2007. 'Skilled Migration: The Perspective of Developing Countries.' IZA Discussion Paper No. 2873, The Institute for the Study of Labor.
- Docquier, F., and H. Rapoport. 2009. 'Documenting the Brain Drain of "la crème de la crème": Three Case-Studies on International Migration at the Upper Tail of the Education Distribution.' Working Paper, No. 25, Bar-Ilan University, Department of Economics.
- Feldmann, H. 2025. 'The Effects of Remittances on School Enrolment Rates: A Global Perspective.' *International Review of Economics and Finance* 101:104175.
- Gajurel, R. P., and J. D. Chindengwike. 2025. 'Remittance-Growth Nexus: Does Financial Development Mediate? Evidence from Nepal and Tanzania.' *African Development Finance Journal* 8 (9): 213–38.
- Gujarati, D. N., and D. C. Porter. 2008. *Basic Econometrics*. McGraw-Hill.
- Gyimah-Brempong, K., and Asiedu, E. 2015. 'Remittances and Investment in Education: Evidence from Ghana.' *The Journal of International Trade and Economic Development* 24 (2): 173–200.
- International Labour Organization. 2022. *Informal Economy in Africa: Which Way Forward? Making Policy Responsive, Inclusive and Sustainable*. International Labour Organization.
- IOM, UN Migration. 2021. 'Steady Increase in Labour Migration in Africa, New Report Reveals.' 22 November. <https://ehsa.iom.int/news/steady-increase-labour-migration-africa-new-report-reveals>
- Keji, S. A. 2021. 'Human Capital and Economic Growth in Nigeria.' *Future Business Journal* 7 (1): 49.
- Köllner, S. 2013. 'Remittances and Educational Attainment: Evidence from Tajikistan.' *Wirtschaftswissenschaftliche Beiträge*, No. 124. Bayerische Julius-Maximilians Universität Würzburg.

- Latukha, M., M. Shagalkina, E. Mitskevich, and E. Strogetskaia. 2022. 'From Brain Drain to Brain Gain: The Agenda for Talent Management in Overcoming Talent Migration from Emerging Markets.' *The International Journal of Human Resource Management* 33 (11): 2226–55.
- Lu, Y., and D. J. Treiman. 2007. 'The Effect of Labor Migration and Remittances on Children's Education Among Blacks in South Africa.' On-Line Working Paper 1, California Center for Population Research.
- Makwembere, S., P. Acha-Anyi, A. J. Asaleye, and R. Garidzirai. 2024. 'Can Remittance Promote Tourism Income and Inclusive Gender Employment? Function of Migration in the South African Economy.' *Economies* 12 (7): 162.
- Mankiw, N. G., D. Romer, and D. Weil. 1992. 'A Contribution to the Empirics of Economic Growth.' *The Quarterly Journal of Economics* 107 (2): 407–37.
- Mastercard Foundation. 2020. *Secondary Education in Africa: Preparing Youth for the Future of Work*. Mastercard Foundation.
- Mawuena, K. K., and M. K. N. Okey. 2021. 'The Effect of Remittances on Education in Togo.' *Theoretical Economics Letters* 11 (6): 1293–311.
- McKenzie, D., and H. Rapoport. 2011. 'Can Migration Reduce Educational Attainment? Evidence from Mexico.' *Journal of Population Economics* 24 (4): 1331–58.
- Mileris, R. 2019. 'Population Migration Flows in European Union: Economic Factors and Perspective Statistical Trends.' *Managing Global Transitions* 17 (2): 163–88.
- Mjelva, M. B., and J. Carling. 2023. 'Surveys on Migration Aspirations, Plans and Intentions: A Comprehensive Overview.' *Open Research Europe* 3:145.
- Oda, H. 2023. 'An Analysis of the Impact of International Remittances on Child Education: Evidence from Pakistan.' In *Migration in South Asia: IMISCOE Regional Reader*, edited by S. I. Rajan. Springer.
- Organisation for Economic Co-operation and Development. 2017. *Interrelations Between Public Policies, Migration and Development*. OECD Publishing.
- Oyadeyi, O. O., I. A. Adediran, and B. A. Kabir. 2024. 'Remittance and Macroeconomic Performance in Top Migrating Countries.' *Social Sciences* 13 (5): 239.
- Pesaran, M. H. 2004. 'General Diagnostic Tests for Cross Section Dependence in Panels.' IZA Discussion Paper, No. 1240, The Institute for the Study of Labor.
- Pilařová, T., and A. Kandakov. 2017. 'The Impact of Remittances on School Attendance: The Evidence from the Republic of Moldova.' *International Journal of Educational Development* 55:11–16.

- Prais, S. J., and C. B. Winsten. 1954. 'Trend Estimators and Serial Correlation.' Cowles Commission Discussion Paper No. 383, Cowles Commission.
- Romer, P. M. 1986. 'Increasing Returns and Long-Run Growth.' *Journal of Political Economy* 94 (5): 1002–37.
- Shafiq, M. N., X. Yang, and M. A. Nawaz. 2022. 'Do Remittances Promote Education? Empirical Evidence from Developing Countries.' *Pakistan Journal of Humanities and Social Sciences* 10 (2): 830–41.
- Stark, O., and L. Byra. 2012. 'A Backdoor Brain Drain,' *Economics Letters* 116 (3): 273–76.
- Stark, O., and C. S. Fan. 2007. 'Losses and Gains to Developing Countries from the Migration of Educated Workers: An Overview of Recent Research, and new Reflections.' ZEF Discussion Papers on Development Policy No. 116, University of Bonn.
- Stark, O., and Y. Wang. 2002. 'Inducing Human Capital Formation: Migration as a Substitute for Subsidies.' *Journal of Public Economics* 86 (1): 29–46.
- Usman, K. 2023. 'The Nexus Between Remittance, Exchange Rate and Economic Growth of E7 Economies: Frequency Domain Analysis.' *Heliyon* 9 (11): e21554.
- Weeraratne, B. B. 2024. 'Migration and Development: The Role of Remittances.' In *Handbook of Migration and Globalisation*, edited by A. Triandafyllidou. Elgar.
- Williams, K. 2025. 'Do Migrants' Remittances Improve Educational Attainment in Developing Countries?' In *Economic Challenges in Early 21st Century Guyana: Post-Independence Growth and Development*, edited by D. DaSilva-Glasgow, T. Khemraja and D. Thomas. Palgrave Macmillan.
- Wooldridge, J. M. 2013. *Introductory Econometrics: A Modern Approach*. 5th ed. South-Western Cengage Learning.
- World Bank. 2023. *World Development Indicators*. World Bank Group.
- World Bank. 2024. *Migration and Remittances Overview: Development News, Research, Data*. World Bank Group.
- Xia, C., M. Qamruzzaman, and A. H. Adow. 2022. 'An Asymmetric Nexus: Remittance-Led Human Capital Development in the top 10 Remittance-Receiving Countries: Are FDI and Gross Capital Formation Critical for a Road to Sustainability?' *Sustainability* 14 (6): 3703.
- Zhunio, M. C., S. Vishwasrao, and E. P. Chiang. 2012. 'The Influence of Remittances on Education and Health Outcomes: A Cross-Country Study.' *Applied Economics* 44 (35): 4605–16.



# *Education and Youth Unemployment in South Africa after COVID-19: Evidence from the General Household Survey (GHS)*

Lana Erasmus  
Nelson Mandela University,  
South Africa  
s217503276@mandela.ac.za

Andrew Phiri  
Nelson Mandela University,  
South Africa  
phiricandrew@gmail.com

Clement Moyo  
Nelson Mandela University,  
South Africa  
clementmoyoz@yahoo.com

Youth unemployment remains a major challenge in South Africa, and the COVID-19 pandemic has further disrupted education and labour-market transitions. This study investigates how educational attainment influences youth unemployment in the post-COVID period using the nationally representative 2021 General Household Survey. A sample of 3,652 youths was analysed using logit and probit models across three specifications that incorporate education, demographic factors, and household welfare characteristics. The results show that higher education significantly reduces the likelihood of unemployment, with the strongest effects for diploma and degree holders. However, these effects vary across provinces. Youth in Free State, Northwest, and Limpopo experience high unemployment even with higher qualifications, indicating weak regional labour markets. A sensitivity analysis reveals that returns to education are lower in mining-dependent provinces. The study concludes that expanding education alone is insufficient without addressing provincial labour-market constraints.

*Keywords:* education, youth unemployment, General Household Survey (GHS) data, post COVID-19, South Africa

*JEL Classifications:* J64, I26, J24, R23, J13, O15

Received 2025/11/25 · Revised 2026/03/06 · Accepted 2026/03/30

Published online 2026/06/30 © Author



<https://doi.org/10.26493/1854-6935.24.281-304>

## **Introduction**

South Africa has high unemployment, particularly among youth, and the COVID-19 pandemic exacerbated this crisis by disrupting both education and labour markets (Habiyaremye et al. 2022; de Jongh et al.

2024). In the aftermath of the pandemic, the government has expanded several large-scale interventions aimed at supporting young people, including the Presidential Youth Employment Initiative, which has created more than 1.5 million temporary earning and skills-building opportunities, and the renewed National Youth Service, which seeks to provide structured work experience for unemployed youth (Zikhali and Matziliza 2024). Despite these efforts, youth unemployment remains persistently high, with recent labour force data showing that nearly half of all young people remain jobless, which signifies the failure to attain the sustainable development goal (SDG) 8 of ‘attaining full and productive employment and decent work for all’ (Mudiriza and de Lannoy 2023, 2). These conditions have intensified debates about whether education is still an effective pathway into employment, particularly for households facing structural and localised labour-market constraints (Mselaku 2024). This context highlights the importance of re-examining the relationship between educational attainment and youth unemployment using detailed household-level data.

Our study investigates the relationship between educational attainment and youth unemployment across South Africa’s provinces, utilising logit and probit models to analyse the factors influencing unemployment outcomes. By using household-level survey data collected across nine provinces, we aim to explore how educational qualifications interact with local labour market conditions. In particular, we focus on the intersection of education, regional economic structures, and dominant industry sectors, which provides new insight into how location and sectoral composition influence the returns to education. Theoretically, our study draws on human capital theory which suggests that higher education should lead to better employment opportunities and lower unemployment rates (Becker 1962). However, empirical evidence suggests that the relationship between education/skills and employment is not always straightforward, as contextual factors such as regional economic performance, industry composition, and household-level resources influence the returns to education (Loss et al. 2024; Ebrahim and Pirttilä 2025).

Notably, most previous studies on youth unemployment and education in South Africa have focused on household-level data (Naudé and Serumaga-Zake 2001; Mlatsheni and Rospabé 2002; Lam et al. 2009; Yu 2013; Dagume and Gyekye 2016; Baldry 2016; Mlatsheni and Ranchhod 2017; Mpendulo and Mang’unyi 2018; Habiyaemye et al. 2022; Ntini and Kappo-Abidemi 2025), and yet these studies rely on datasets collected

before COVID-19 or small-scale surveys with limited coverage. Therefore, these datasets cannot capture the post-pandemic labour market realities, including changes in schooling, sectoral shifts in employment, and regional disparities in job opportunities. By using the nationally representative 2021 GHS, our study provides one of the first analyses of youth unemployment in the post-COVID era, allowing for a more accurate assessment of how education influences job prospects in contemporary South Africa.

Our preliminary findings indicate a strong negative association between higher education levels and youth unemployment across most provinces. Youth with post-secondary qualifications are consistently less likely to be unemployed, although the size of this effect varies geographically. Provinces such as Free State, Northwest, and Limpopo show higher youth unemployment rates despite higher education levels, highlighting the importance of local economic conditions and regional structures in shaping labour market outcomes.

Naturally, the results of this study have important implications for policymakers and the South African Department of Education. By clarifying how educational attainment affects youth unemployment at the provincial level, our research informs policies aimed at improving employability, addressing regional disparities, and designing targeted education and workforce development interventions. Moreover, the study provides evidence for assessing the effectiveness of post-pandemic educational and employment initiatives in meeting labour market needs and promoting inclusive economic growth.

The remainder of the paper is structured as follows. The next section presents the literature review of the paper. Section 3 outlines the methodology. Section 4 presents the results and section 5 concludes the study.

### **Literature Review**

Understanding the relationship between education and unemployment has long been central to labour market research, particularly in developing economies where structural constraints shape youth outcomes. The Human Capital Theory of Becker (1962) provides one of the foundational explanations, asserting that investments in education enhance individual productivity and, in turn, improve employment prospects and lifetime earnings. In line with this view, Dagume and Gyekye (2016) show that educational attainment significantly reduces the likelihood of youth unemployment in South Africa, hence reflect-

ing the important role of skills and training in shaping labour market absorption.

However, despite rising educational attainment over the past two decades, South Africa continues to experience some of the highest youth unemployment rates globally. This paradox has led researchers to explore labour market dynamics that go beyond the human capital framework. Labour Queue Theory, initially developed by Thurow (1976), suggests that employers rank job applicants based on educational credentials, often using qualifications as a screening device rather than as a measure of job-relevant competencies. The expansion of higher education has intensified this ranking process, contributing to what some scholars describe as an educational arms race (Büchel and Mertens 2004). In this context, individuals pursue increasingly higher qualifications to maintain competitiveness even when the labour market does not generate sufficient skilled employment opportunities (Markussen et al. 2024).

Signalling Theory provides another perspective by proposing that education functions primarily as an indicator of an individual's trainability and productivity rather than as a direct source of skills (Spence 1973; 2002). However, as more individuals obtain diplomas and degrees, the signalling value becomes diluted. This phenomenon, often referred to as diploma inflation, complicates the relationship between education and employment outcomes (Araki and Kariya 2022). In South Africa, the situation is further complicated by long-standing inequalities. Race, gender and socio-economic background continue to shape hiring processes and access to opportunities (Mseleku 2022a; 2022b).

Notably, a number of empirical studies have examined the effect of education on unemployment in South Africa (see table 1 for a summary). One of the earliest studies was done by Naudé and Serumaga-Zake (2001) using the 1993 SALDRU survey, 1995 Statssa and their own survey conducted in 1997. The authors find that education significantly improves the likelihood of being employed. Similarly, Mlatsheni and Rospabé (2002) use the 1999 October Household Survey (OHS) and concluded that increased human capital reduces youth unemployment. Also, Lam et al. (2009) use the 1995 to 2005 OHS to show that schooling plays a crucial role in shaping early transitions into the labour force for young people.

Other national studies reinforce these findings. Using labour force surveys from 2008 to 2012, Yu (2013) found that education consistently decreases the probability of unemployment. Conversely, Baldry (2016) identifies demographic and socio-economic characteristics as stronger

predictors of graduate unemployment than academic performance or field of study. Moreover, Mlatsheni and Ranchhod (2017), relying on the National Income Dynamics Survey (NIDS), find that education reduces unemployment, although the quality of schooling plays a major role in determining the extent of this effect.

Some researchers have focused on smaller geographic areas or specific groups and have also reported mixed results. For example, Mpendulo and Mang'unyi (2018) found a positive association between educational attainment and employment in small towns in the Eastern Cape using a cross sectional survey. Ntini and Kappo-Abidemi (2025) found similar results in a rural area of Mpumalanga. In contrast, Habiyaemye et al. (2022) identified no significant relationship between educational achievement and employment for a sample of programme alumni. Time series studies have also produced conflicting results. Falakahla (2018) found no long-run relationship between education and youth unemployment using the autoregressive distributive lag (ARDL) model, while Patel and Choga (2018), using the vector error correction model (VECM), found that education reduces unemployment.

A key observation from this body of literature is that most studies rely on datasets that are now considerably outdated. Many analyses were conducted using early labour force surveys, provincial surveys, or the first waves of the NIDS data. Several other studies used small or localised samples that limit the generalisability of their findings. Most importantly, no study has fully examined the relationship between education and unemployment using nationally representative data from the post-COVID period, despite the major disruptions that the pandemic brought to the labour market.

The present study addresses these gaps by using the 2021 General Household Survey (GHS) collected by Statistics South Africa. This dataset is nationally representative and provides timely insight into youth labour market experiences after the COVID-19 shock. The study is the first to use this specific dataset to examine the relationship between educational attainment and youth unemployment in the post-pandemic environment. By employing logit and probit models, the analysis offers robust and comparative evidence on the determinants of youth unemployment. In doing so, the study contributes new empirical insights into whether education continues to function as an effective pathway into employment in South Africa or whether structural constraints and labour market mismatches have weakened its protective effect.

TABLE 1 Summary of Previous South African Literature

Name	Scope	Methods	Results
Naudé and Serumaga-Zake (2001)	North-west province: 1993 SALDRU survey, 1995 Statssa, and 1997 own survey	Probit	Education lowers unemployment
Mlatsheni and Rospabé (2002)	South Africa: October household survey (OHS) 1999	Probit	Education improves employment except for secondary education
Lam et al. (2009)	South Africa: October household survey (OHS) 1995, 1999, 2002, 2005	Probit	Grade 10 or 11 insignificant yet grade 12 or higher significant
Yü (2013)	South Africa: 2000 LFS and 2011 QLFS	Probit	Primary, secondary, tertiary have positive effect, with higher levels having stronger effect
Dagume and Gyekye (2016)	Vhembe district Limpopo: 2013 questionnaire (580 youth)	Probit	Insignificant relationship between education and unemployment
Baldry (2016)	South Africa: 1,175 graduates between 2006 and 2012	Probit	Significant positive relationship after 2 or 3 years of graduating but in the 1st year after graduating
Mlatsheni and Ranchhod (2017)	South Africa: NIDS 2008, 2011/12, 2012	OLS	Matric and tertiary increases employment but going to a historically disadvantaged school does not
Mpendulo and Mang'anyi (2018)	Eastern Cape: 120 survey questionnaires	OLS	Education attainment reduces unemployment
Falakahla (2018)	South Africa: 1991–2017	ARDL	No relationship between education and unemployment
Patel and Choga (2018)	South Africa: 2008–2015	VECM	Negative relationship between education and unemployment
Habiyaremye et al. (2022)	South Africa: 324 programme alumni	Probit	Insignificant relationship between education achievement prior to joining skills development programme and employment
Ntini and Kappo-Abidemi (2025)	Mpumalanga: South Africa: 106 participants	Correlation Coefficients	Positive correlation between education qualification level and employment status

## Methods

We employ logit and probit models (Aldrich and Nelson 1984) to examine the effect of educational attainment and other socio-economic factors on youth unemployment in South Africa. The dependent variable is binary, taking the value 1 if an individual is unemployed and 0 if employed, which makes nonlinear probability models more appropriate than ordinary least squares. Unlike the linear probability model, logit and probit ensure that predicted probabilities lie between 0 and 1 and account for the nonlinear relationship between the explanatory variables and the probability of unemployment. The logit model allows interpretation in terms of odds ratios, offering clear insights into how explanatory variables influence the likelihood of unemployment, while the probit model provides a robustness check under an alternative distributional assumption. The explanatory variables include education level, province, race, age, gender, type of institution, Internet access, electricity access, and household income.

### MODEL SPECIFICATION

Let  $Y_i$  represent the employment outcome, where:

$$Y_i = \begin{cases} 1 & \text{if youth } i \text{ is unemployed} \\ 0 & \text{if youth } i \text{ is employed} \end{cases} \quad (1)$$

and  $X_i$  is a vector of explanatory variables capturing educational, demographic, social, and economic characteristics. The general functional form estimated in both logit and probit models is:

$$P(Y_i = 1 | X_i) = F(X_i\beta), \quad (2)$$

where  $F(\cdot)$  is a cumulative distribution function and  $\beta$  is a vector of estimated coefficients. The overall functional relationship for the latent variable is given by:

$$Y_i = X_i\beta + e_i$$

with:

$$Y_i = \begin{cases} Y_i > 0 \\ Y_i \leq 0. \end{cases} \quad (3)$$

The study estimates the following three structured specifications:

*Model 1:* focuses on educational characteristics:

$$Y_i = \beta_0 + \beta_1(\text{education level}) + \beta_2(\text{institution type}) + e_i \quad (4)$$

*Model 2:* adds demographic and regional characteristics:

$$\begin{aligned} Y_i = & \beta_0 + \beta_1(\text{education level}) + \beta_2(\text{institution type}) \\ & + \beta_3(\text{province}) + \beta_4(\text{race}) + \beta_5(\text{age}) + \beta_6(\text{gender}) \\ & + e_i \end{aligned} \quad (5)$$

*Model 3:* adds household and welfare factors:

$$\begin{aligned} Y_i = & \beta_0 + \beta_1(\text{education level}) + \beta_2(\text{institution type}) \\ & + \beta_3(\text{province}) + \beta_4(\text{race}) + \beta_5(\text{age}) + \beta_6(\text{gender}) \\ & + \beta_7(\text{internet access}) + \beta_8(\text{electricity access}) \end{aligned} \quad (6)$$

#### LOGIT MODEL

The logit model uses the logistic cumulative distribution function to translate the probability of unemployment into the odds that an individual is unemployed versus employed. The logistic function is given as:

$$P(Y_i = 1) = \frac{e^{X_i b}}{1 + e^{X_i b}} \quad (7)$$

where the odds of unemployment are expressed as:

$$\frac{P_i}{1 - P_i} \quad (8)$$

The logit transformation, which is the natural logarithm of the odds, is specified as:

$$\text{Logit}(P_i) = \ln\left(\frac{P_i}{1 - P_i}\right) = X_i b \quad (9)$$

The logit is linear in both the explanatory variables and the parameters. As the probability changes from 0 to 1, the logit ranges from  $-\infty$  to  $+\infty$ . A positive coefficient indicates that an increase in the corresponding variable raises the log-odds and therefore the probability of being unemployed, while a negative coefficient indicates the opposite. Logistic

regression also allows for the interpretation of effects through odds ratios, which describe how the likelihood of unemployment changes relative to reference categories.

#### PROBIT MODEL

The study also estimates a probit model, which assumes that the probability of unemployment follows a standard normal cumulative distribution function. The probit model is expressed as:

$$P(Y_i = 1) = f(X_i b), \quad (4)$$

where  $\phi$  is the standard normal cumulative distribution function. The probit model is appropriate when the underlying tendency toward unemployment is assumed to follow a normal distribution and serves as an alternative specification to assess the robustness of the logit results.

### Data and Results

#### DATA SOURCE

Our analysis draws on cross-sectional microdata from the 2021 General Household Survey (GHS) collected by Statistics South Africa (Stats SA). The GHS is an annual household survey designed to measure a wide range of living conditions and socio-economic indicators, including education, access to services, household income, and labour market participation (Omotayo et al. 2019). This makes the dataset particularly suitable for examining patterns of youth unemployment and its association with educational attainment across South Africa's diverse population groups and provinces (Jackson and Yu 2023).

The GHS has been conducted annually since 2002 and provides a nationally representative snapshot of households through a multi-stage stratified sampling design. Over time, the survey has undergone refinements in questionnaire structure, sampling methodology and the classification of key labour market indicators, which are documented in Stats SA's metadata and technical reports (Fransman and Yu 2019). The 2021 wave is collected under the post-2015 survey redesign, which standardised several core modules, including education and labour market variables, thereby ensuring comparability with recent waves.

For the purposes of this study, we restrict the sample to individuals aged 15 to 34 years, aligning with South Africa's official definition of youth. The publicly accessible microdata were obtained from the Da-

taFirst repository, which disseminates harmonised versions of Stats SA datasets for research use. The 2021 GHS offers consistent and detailed information on educational attainment, type of educational institution, household characteristics and access to basic services, allowing us to construct the variables required for the econometric analysis with minimal issues of discontinuity or missing information.

The use of the 2021 dataset also ensures that the definition of unemployment corresponds to the most recent official standards applied by Stats SA, which distinguish between labour force participation, active job search behaviour, and availability for work. Furthermore, the harmonised structure of the 2021 GHS facilitates integration with other recent survey waves should future extensions of the analysis be pursued.

#### DESCRIPTIVE ANALYSIS

Table 2 presents a summary of the demographic, educational and socio-economic characteristics of youth aged 15 to 34 years included in the study. The total sample consists of 1,524 respondents, of whom only 61.55% were employed, while an overwhelming 38.45% reported being unemployed. The extremely high unemployment share in the sample reflects the broader crisis of youth joblessness in South Africa, where young individuals continue to struggle to secure stable employment opportunities in both the formal and informal sectors.

The distribution of education levels reveals that the majority of youth have relatively low levels of formal attainment. Approximately 43.50% have not completed Grade 12, indicating that most young people remain outside the threshold typically required for labour market entry or skills-intensive occupations. A further 40.94% have completed matric, while only very small proportions hold post-school qualifications. Higher national certificates, diplomas and undergraduate degrees account for less than 15% collectively, and postgraduate qualifications are represented by only a handful of respondents. These patterns reflect persistent structural barriers in the education system, where many youths remain unable to access or complete higher education, ultimately contributing to their vulnerability in the labour market.

Provincial representation shows a broad geographic spread across South Africa. Gauteng records the largest share of youth in the sample (26.44%), followed by KwaZulu-Natal (18.57%), Mpumalanga (11.68%), and Limpopo (10.63%). The Eastern Cape accounts for 9.71% of the sample, while the Western Cape represents 8.33%. Smaller provinces such as

the Free State (5.25%), Northwest (4.79%), and Northern Cape (4.59%) make up comparatively smaller shares of the sample. The distribution highlights provincial disparities in access to educational and employment opportunities, which may influence youth labour market outcomes.

Gender distribution is almost perfectly balanced, with males making up 56.36% and females 43.64% of the sample. Age distribution is skewed toward older youth within the sample, with 46.33% aged 30–34 years and 36.35% aged 25–29 years. Youth aged 20–24 represent 15.35%, while only a very small proportion (1.94%) fall within the 15–19 age bracket. This indicates that a large proportion of the sample consists of young individuals who may not yet have completed schooling or fully transitioned into the labour market, which can partly explain the high unemployment levels observed.

With respect to racial composition, the majority of the sample (90.68%) identify as Black African, reflecting the demographic structure of South Africa's youth population and the persistent historical inequalities that shape socio-economic outcomes. Coloured youth represent 5.38% of the sample, followed by White (2.95%) and Indian/Asian youth (0.98%).

The data also provide insight into the type of educational institutions attended. An overwhelming 98.03% of youth reported attending public institutions, while only 1.97% attended private institutions. This reflects the strong reliance on the public education system and suggests limited access to private schooling due to cost, geographic availability or other barriers.

Access to basic services remains uneven. Internet access is particularly limited, with only 4.92% of respondents reporting any form of internet connectivity, while 95.08% have no access. In a context where digital skills and online resources are increasingly critical for education, job searching and participation in the modern economy, this lack of connectivity represents a major constraint for youth. In contrast, access to electricity is relatively widespread, with 93.31% of respondents residing in households that have electricity, although a small share (6.69%) still live in energy-deprived conditions.

#### EMPIRICAL RESULTS

Table 3 reports the findings from both logit and probit models. The results show a clear and consistent pattern across all three models. In Model 1, which focuses only on education, higher levels of schooling strongly reduce the chances of being unemployed. Matric, higher certificates,

TABLE 2 Descriptive Profile of Youth Respondents (age 15–34) from the 2021 GHS

Categories	Variables	F	%
Employed/unemployment	Youth employed	938	61.55
	Youth unemployment	586	38.45
Education level	No schooling/Less than Grade 12 (1)	663	43.50
	Matric (2)	624	40.94
	Higher national certificate (3)	72	4.72
	Diploma (4)	76	4.99
	Undergraduate degree/Higher diploma (5)	72	4.72
	Honours/ Post graduate diploma (6)	12	0.79
	M-Tech and masters (7)	5	0.33
Province	Western Cape (1)	127	8.33
	Eastern Cape (2)	148	9.71
	Northern Cape (3)	70	4.59
	Free State (4)	80	5.25
	KwaZulu-Natal (5)	283	18.57
	Northwest (6)	73	4.79
	Gauteng (7)	403	26.44
	Mpumalanga (8)	178	11.68
	Limpopo (9)	162	10.63
Gender	Male (0)	859	56.36
	Female (1)	665	43.64
Age	15–19 years (1)	30	1.94
	20–24 years (2)	234	15.35
	25–29 years (3)	554	36.35
	30–34 years (4)	706	46.33
Race	Black/African (1)	1,382	90.68
	Coloured (2)	82	5.38
	Indian/Asian (3)	15	0.98
	White (4)	45	2.95
Type of institutions	Public institution (0)	1,494	98.03
	Private institution (1)	30	1.97
Access to internet	Internet access (0)	75	4.92
	No Internet access (1)	1,449	95.08
Access to electricity	Access to electricity (0)	1,442	93.31
	No access to electricity (1)	102	6.69

diplomas, undergraduate degrees, honours/postgraduate diplomas, and M-Tech/Master's qualifications all show large and significant negative effects. These results support human capital theory (Becker 1962) and match earlier South African findings such as Naudé and Serumaga-Zake (2001), Mlatsheni and Rospabé (2002), Yu (2013), and Patel and Choga

(2018). As education increases, the probability of unemployment falls, with the largest gains found at diploma level and above. Type of institution has no clear effect, suggesting employers place more weight on education level than on the institution attended. However, it should be noted that some of the higher education categories, particularly post-graduate qualifications, contain relatively small numbers of observations in the sample. Consequently, the coefficients for these categories should be interpreted cautiously as they may reflect limited observations rather than stable population relationships.

Model 2 adds demographic and regional factors. After including these variables, some education coefficients shrink, especially for matric and higher certificates, showing that demographic and regional disadvantages reduce the value of lower and mid-level qualifications. Diplomas and higher levels remain strongly significant, confirming that higher education is increasingly required to compete in the labour market (Baldry 2016; Mlatsheni and Ranchhod 2017).

Significant regional differences appear. Compared with Western Cape, youth in Free State, North West, Limpopo, and KwaZulu-Natal face higher unemployment risks. These patterns highlight the influence of local labour market conditions and regional economic structures on employment opportunities for young people. Race also emerges as an important factor in the models. The estimates suggest that White youth experience a lower probability of unemployment relative to African youth. However, this result should be interpreted cautiously given the relatively small number of White respondents in the sample compared with African youth, which may affect the stability and generalisability of the estimated coefficients.

Age effects indicate that youth aged 25–29 and 30–34 are less likely to be unemployed than those aged 20–24, reflecting challenges in the school-to-work transition (Lam et al. 2009). Gender, which is often found to be a strong determinant of labour market outcomes in South Africa, is not statistically significant in some of the baseline specifications but becomes significant once additional demographic controls are introduced. This pattern suggests that gender differences in youth unemployment may partly operate through other structural factors captured in the model, including education levels, geographic location, and household conditions. In other words, once these structural factors are accounted for, the independent statistical effect of gender may diminish. This finding should therefore not be interpreted as evidence that gender

TABLE 3 Regression Estimates

Variables	Dependent variable: Youth Unemployment					
	Logit model			Probit model		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Matric	-0.3865726***	-0.4053553***	-0.1937298	-0.23976***	-0.244789***	-0.1446702*
Higher national certificate	-0.0292117	-0.1415683	0.2800325	-0.0198074	-0.0878395	0.1294088
Diploma	-0.7286356***	-0.6623619**	0.0260818	-0.442093***	-0.4100973**	-0.042444
Undergraduate degree / Higher diploma	-1.331485***	-1.018804***	-0.0178668	-0.8003502***	-0.6088961**	-0.11276194
Honours / Post graduate diploma	-2.097463**	-1.694304	0.0958573	-1.204978**	-0.989487*	-0.1434709
M-Tech and master's degree	-1.186814	-1.171599	0.1267247	-0.7164788	-0.7505489	-0.1250275
Type of institution	-0.8027986	-1.033834*	2.780762	-0.4714632	-0.6226873**	1.499739**
Eastern Cape		0.4039775	0.2293864		0.2466271	0.1773689
Northern Cape		0.0995741	0.0970511		0.0662839	0.0622568
Free State		0.6366918**	0.5882928*		0.4011081**	0.3679023*
KwaZulu-Natal		0.0020578	0.0913254		0.0105089	0.070944
Northwest		0.1197696	0.0533285		0.0789679	0.0475933
Gauteng		0.5021895**	0.635104**		0.3086419***	0.3977671***
Mpumalanga		1.114286***	1.053054***		0.6829364***	0.6509908***
Limpopo		0.2656923	0.1594755		0.1647191	0.126098
Gender		0.6844261***	0.7541698***		0.4160824***	0.4622077***
20-24 years		-0.7535787	-0.7334617		-0.4651617*	-0.6126235
25-29 years		-1.744193***	-1.797019***		-1.067507***	-1.254445***
30-34 years		-2.115899***	-2.137114***		-1.293967***	-1.463825***
Coloured		-0.0122921	0.456079		-0.0008431	0.231917
Indian/Asian		-1.804269	-1.022699		-0.8837505	-0.466165
White		-2.133025*	-0.75416		-1.157304***	-0.5484977
Internet access			0.8283848			0.5056135
Access to electricity			-0.3223873			-0.1642869
Household income			-0.0001438***			-0.000061***
Constant	-0.19948***	0.8623373*	0.5865591	-0.1251424***	0.5322419*	0.3978796
Pseudo R <sup>2</sup>	0.0217	0.1106	0.1825	0.0217	0.1106	0.1722
Number of observations	1,524	1,524	1,524	1,524	1,524	1,524

NOTE \*\*\*, \*\*, \* denote 1%, 5%, and 10% significance, respectively.

inequalities are absent in South Africa's labour market, but rather that they may be mediated through broader socio-economic conditions included in the analysis.

Model 3 adds household and welfare factors. The results still show that higher qualifications reduce unemployment even after accounting for household conditions although the magnitude and statistical significance of some education coefficients decline. In particular, the coefficient for matric becomes weaker once additional controls are introduced. This pattern is consistent with recent research suggesting that the labour market value of matric has gradually eroded as the number of matriculants has increased and labour market competition has intensified (de Lannoy 2025). While matric may still provide a basic signal of labour market readiness, it appears increasingly insufficient on its own to secure employment in a highly competitive labour market.

Provincial and racial patterns also hold, showing structural inequalities persist. Internet and electricity access do not have significant effects, possibly because many job seekers rely on shared or public facilities. Household income has a small but significant negative effect, indicating higher income slightly reduces unemployment risk, though the effect is minor.

The increase in pseudo  $R^2$  from Model 1 to Model 3 shows that unemployment is influenced by more than education alone. Structural factors like region, race, and household conditions continue to affect labour market outcomes even for educated youth.

Altogether, these results provide new post-COVID evidence using the 2021 GHS. While past studies using older data sets like NIDS or small local surveys also found that education reduces unemployment, our findings show that only higher education levels (diploma and above) offer strong protection. Lower and mid-level qualifications no longer guarantee better outcomes. At the same time, the relatively small number of respondents in some higher education categories means that the magnitude of these estimated effects should be interpreted cautiously. Overall, these results highlight ongoing qualification inflation and show that education alone cannot overcome deep regional and racial inequalities in South Africa's youth labour market.

#### SENSITIVITY ANALYSIS

To test the robustness of our main findings, we divide the sample into two groups based on the dominant industry in each province. The first

group includes youth living in provinces where mining is not dominant (Eastern Cape, Western Cape, Gauteng, KwaZulu-Natal, and Free State), while the second group covers youth in provinces where mining is the primary industry (Northwest, Limpopo, Mpumalanga, and Northern Cape). Tables 4 and 5 report the logit and probit model estimates, respectively.

For provinces without mining activities, Model 1 shows a strong negative effect of education on unemployment across all levels. Matric, higher certificates, diplomas, undergraduate degrees, honours/postgraduate diplomas, and M-Tech/Master's degrees all significantly reduce the probability of being unemployed. This effect persists in Model 2 after adding demographic and regional factors, although the magnitude decreases for matric and higher certificates. Model 3 confirms that higher education remains the most important protective factor even after including household and welfare variables. These findings align with the main results and previous South African studies (Naudé and Serumaga-Zake 2001; Mlatsheni and Rospabé 2002; Lam et al. 2009; Yu 2013). Type of institution and gender are not significant, while older youth (25–29 and 30–34 years) are significantly less likely to be unemployed than those aged 20–24. Race remains a strong determinant, with Coloured and White youth having lower unemployment probabilities than African youth. Household income shows a small negative effect, suggesting better financial conditions slightly reduce unemployment risk.

For provinces where mining dominates, the education effect is weaker. Only diplomas and undergraduate degrees remain consistently significant, and the coefficients for matric and higher certificates are no longer significant after adding demographic and household variables. This suggests that in mining-dependent regions, lower and mid-level qualifications provide limited protection from unemployment. This phenomenon can be explained by the structure of mining-dependent economies, which are often characterised by 'Dutch Disease' effects where resource extraction dominates the economy, limiting the growth of diversified service-sector and knowledge-based jobs that typically absorb educated youth (Corden and Neary 1982). Consequently, the local labour market offers fewer opportunities where higher education is rewarded, and many graduates may compete for a narrow set of positions, reducing the returns to lower and mid-level qualifications. Age effects are stronger, particularly for youth aged 30–34, who experience a much lower probability of unemployment than those aged 20–24. Race effects are more

TABLE 4 Sensitivity Analysis (Logit models)

Variables	Dependent variable: Youth Unemployment					
	Province without mining activities			Province with mining activities		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Matric	-0.5070104**	-0.5376197***	-0.2964564*	-0.941228	-0.0467966	0.2764947
Higher national certificate	-0.1345794	-0.1164495	0.4148745	0.2006277	0.1659426	0.5423813
Diploma	-0.1345794**	-0.7592865**	0.0660563	-0.869087*	-0.6676365	0.0286387
Undergraduate degree/ Higher diploma	-1.182061	-0.7680868**	0.2838035	-1.836868**	-1.785503**	-1.122972
Honours/ Post graduate diploma	-1.709716	-0.968688	0.3068408	0	0	0
M-Tech and master's degree	-1.160037	-1.240013	0.045597			
Type of institution	-0.83918	-0.7762257	2.958053	-0.5499734	-0.8445297	2.494258
Gender		0.6891943***	0.750117***		0.7582361***	0.9650077***
20-24 years		-0.5033876	-0.3611831		-1.429138	-2.337405
25-29 years		-1.563332***	-1.533807**		-2.165521**	-2.894631
30-34 years		-1.911357***	-1.824556***		-2.55126**	-3.3873*
Coloured		-0.7073858*	-0.3307485		0.2266055	0.7936079*
Indian/Asian		-1.876714	-1.364164		0	0
White		-2.155694***	-0.9853729		0	0
Internet access			0.6398712			0
Access to electricity			0.4394199			-1.773235***
Household income			-0.0001152***			-0.000026***
Constant	-0.2262571**	1.045269**	0.7025362	-0.151549	1.695906	3.419874*
Pseudo [Eq]	0.0229	0.1035	0.1687	0.0189	0.0760	0.2130
Number of observations	1,041	1,041	1,041	480	476	471

NOTE \*\*\*, \*\*, \* denote 1%, 5%, and 10% significance, respectively

TABLE 4 Sensitivity Analysis (Logit models)

Variables	Dependent variable: Youth Unemployment					
	Province without mining activities			Province with mining activities		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Matric	-0.5070104***	-0.5376197***	-0.2964564*	-0.941228	-0.0467966	0.2764947
Higher national certificate	-0.1345794	-0.1164495	0.4148745	0.2006277	0.1659426	0.5423813
Diploma	-0.1345794**	-0.7592865**	0.0660563	-0.8690877*	-0.6676365	0.0286387
Undergraduate degree/ Higher diploma	-1.182061	-0.7680868**	0.2838035	-1.836868**	-1.785503**	-1.122972
Honours/ Post graduate diploma	-1.709716	-0.968688	0.3068408	0	0	0
M-Tech and master's degree	-1.160037	-1.240013	0.045597			
Type of institution	-0.83918	-0.7762257	2.958053	-0.5499734	-0.8445297	2.494258
Gender		0.6891943***	0.750117***		0.7582361***	0.9650077***
20-24 years		-0.5033876	-0.3611831		-1.429138	-2.337405
25-29 years		-1.563332***	-1.533807**		-2.165521**	-2.894631
30-34 years		-1.911357***	-1.824556***		-2.55126**	-3.3873*
Coloured		-0.7073858*	-0.3307485		0.2266055	0.7936079*
Indian/Asian		-1.876714	-1.364164		0	0
White		-2.155694***	-0.9853729		0	0
Internet access			0.6398712			0
Access to electricity			0.4394199			-1.773235***
Household income			-0.0001152***			-0.000026***
Constant	-0.2262571**	1.045269**	0.7025362	-0.151549	1.695906	3.419874*
Pseudo [EQ]	0.0229	0.1035	0.1687	0.0189	0.0760	0.2130
Number of observations	1,041	1,041	1,041	480	476	471

NOTE \*\*\*, \*\*, \* denote 1%, 5%, and 10% significance, respectively

TABLE 5 Sensitivity Analysis (Probit models)

Variables	Dependent variable: Youth Unemployment					
	Province without mining activities			Province with mining activities		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Matric	-0.3127981***	-0.3205948***	-0.1984803**	-0.058856	-0.0314803	0.1463536
Higher national certificate	-0.0870247	-0.0781861	0.2122724	0.1279881	0.095668	0.567129
Diploma	-0.3999785**	-0.4617626**	-0.0944174	-0.5334282**	-0.4210184	-0.0247469
Undergraduate degree/ Higher diploma	-0.7158154***	-0.4913495**	0.01813	-1.076644***	-1.014069**	-0.6764983
Honours/ Post-graduate diploma	-1.003903*	-0.6163004	0.0456155	0	0	0
M-Tech and master's degree	-0.699551	-0.7876834	-0.1433288			
Type of institution	-0.4833268	-0.4616268	1.434163**	-0.3647068	-0.4970925	0.9348778
Gender		0.4157165***	0.4625949***		0.4656172***	0.5955648***
20-24 years		-0.317635	-0.399431		-0.8487333	-1.102549
25-29 years		-0.9610889***	-1.110176***		-1.304055**	-1.429784*
30-34 years		-1.171043***	-1.291557***		-1.541976***	-1.71288**
Coloured		-0.4049596*	-0.2100503		0.140343	0.4591969*
Indian/Asian		-0.9473803*	-0.6406984		0	0
White		-1.156072***	-0.645869		0	0
Internet access			0.4090565			0
Access to electricity			0.2895094*			-1.054324***
Household income			-0.0000503***			-0.0001315***
Constant	-0.1420702**	0.6431777**	0.5010904	-0.0949309	1.015657*	1.652784**
Pseudo R2	0.0229	0.1031	0.1610	0.0190	0.0760	0.2057
Number of observations	1,041	1,041	1,041	480	476	471

NOTE \*\*\*, \*\*, \* denote 1%, 5%, and 10% significance, respectively

muted; White youth have a smaller advantage over African youth, and Coloured youth show only marginal improvements. Interestingly, access to electricity has a significant negative effect on unemployment in Model 3, possibly reflecting infrastructure challenges that affect labour market participation in these provinces. Household income remains a small but significant protective factor.

All in all, the sensitivity analysis confirms that the protective effect of education is context-dependent. In provinces without mining activities, higher education significantly reduces youth unemployment, consistent with the main analysis. In contrast, in mining-dependent provinces, only higher qualifications offer meaningful protection, highlighting structural limitations in these local labour markets. The findings illustrate that regional economic composition, particularly the dominance of extractive industries, can fundamentally constrain the returns to education, emphasising the need to account for sectoral structure when designing policies to improve youth employment outcomes. These results emphasise the importance of considering regional economic structure when evaluating the returns to education and suggest that policy interventions may need to be tailored to the dominant local industry.

### **Conclusion**

Our study set out to examine the relationship between educational attainment and youth unemployment in South Africa using the 2021 General Household Survey (GHS), one of the first nationally representative datasets to capture the post-COVID labour market. Across all estimated models, we find that higher levels of education reduce the likelihood of unemployment, but the strength of this effect varies sharply across provinces. Young people with diplomas, degrees, and postgraduate qualifications face significantly lower unemployment probabilities, yet this benefit is uneven, with much weaker returns in provinces dominated by mining. These results highlight a reality that national discussions often miss: education matters, but where young people live and the structure of their local economy matter just as much.

The sensitivity analysis reinforces this point. In provinces with more diversified economies, post-secondary education consistently protects youth from unemployment. In provinces where mining remains the central industry, the same qualifications offer less security. This suggests that regional labour demand, sectoral concentration, and limited job pathways undermine the returns to education for many young people. In

other words, education reduces unemployment risk, but it cannot offset structural constraints when entire local economies offer few opportunities for new entrants.

Our findings carry important implications for policy. Since the pandemic, South Africa has rolled out several large programmes aimed at rebuilding youth employment, such as the Presidential Youth Employment Initiative, the Basic Education Employment Initiative, the National Pathway Management Network, and the Youth Employment Service. Together, these programmes have created millions of temporary earning and training opportunities. However, our results suggest that the benefits of these initiatives are not evenly distributed. Many placements remain short-term, and most opportunities cluster in provinces with stronger institutional capacity and more diversified labour markets.

Strengthening these programmes therefore requires a more deliberate focus on where educated youth remain unemployed despite their qualifications. Mining-dependent provinces should receive targeted placement pipelines that connect young graduates to alternative industries, including digital services, logistics, renewable energy, public administration, and small-enterprise development. Expanding long-term placements, improving career progression within public employment programmes, and aligning training with the actual hiring patterns of local employers would make these initiatives far more effective.

Lastly, it is important to acknowledge that the 2021 GHS data were collected during a period still heavily affected by COVID-19-related lockdowns and school disruptions. Some of the patterns observed, particularly high unemployment among younger youth, may reflect temporary shocks rather than permanent structural shifts. This limitation opens an important avenue for future research: longitudinal studies or follow-up surveys could examine whether the relationships between education, regional economic conditions, and youth unemployment persist once the effects of the pandemic fully subside, thereby distinguishing short-term pandemic impacts from long-term labour market trends.

## References

- Aldrich, J. H., and F. D. Nelson. 1984. *Linear Probability, Logit, and Probit Models*. Sage.
- Araki, S., and T. Kariya. 2022. 'Credential Inflation and Decredentialization: Re-Examining the Mechanism of the Devaluation of Degrees.' *European Sociological Review* 38 (6): 904–19.

- Baldry, K. 2016. 'Graduate Unemployment in South Africa: Social Inequality Reproduced.' *Journal of Education and Work* 29 (7): 788–812.
- Becker, G. S. 1962. 'Investment in Human Capital: A Theoretical Analysis.' *Journal of Political Economy* 70 (5): 9–49.
- Büchel, F., and A. Mertens. 2004. 'Overeducation, Undereducation, and the Theory of Career Mobility.' *Applied Economics* 36 (8): 803–16.
- Corden, W. M., and Neary, J. P. 1982. 'Booming Sector and De-Industrialisation in a Small Open Economy.' *The Economic Journal* 92 (368): 825–48.
- Dagume, M. A., and A. B. Gyekye. 2016. 'Determinants of Youth Unemployment in South Africa: Evidence from the Vhembe District of Limpopo Province.' *Environmental Economics* 7 (4): 59–67.
- de Jongh, J. J., P. Mncayi-Makhanya, and P. Mdluli-Maziya. 2024. 'Antecedents of Youths Who are not in Employment, Education or Training: Micro-Level Evidence.' *Journal of Economic and Financial Sciences* 17 (1): a899.
- de Lannoy, A. 2025. 'A Generation on Hold? Profiling the Persistent Crisis of Youth not in Employment, Education or Training (NEET) in South Africa.' SALDRU Working Paper No. 320, Southern Africa Labour and Development Research Unit, University of Cape Town.
- Ebrahim, A., and J. Pirtilä. 2025. 'A Policy for the Jobless Youth in South Africa.' *Journal of Development Economics* 172:103394.
- Falakahla L. 2018. 'The Causality Between Youth Unemployment, Education Attainment and Labour Force Participation: Evidence from South Africa.' MPRA Working Paper No. 92562, Munich Personal REPEC Archive.
- Fransman, T., and D. Yu. 2019. 'Multidimensional Poverty in South Africa in 2001–16.' *Development Southern Africa* 36 (1): 50–79.
- Habiyaremye, A., T. Habanabakize, and C. Nwosu. 2022. 'Bridging the Labour Market Skills Gap to Tackle Youth Unemployment in South Africa.' *The Economic and Labour Relations Review* 33 (4): 786–805.
- Jackson, S., and D. Yu. 2023. 'Re-Examining the Multidimensional Poverty Index of South Africa.' *Social Indicators Research* 166 (1): 1–25.
- Lam, D., M. Leibbrandt, and C. Mlatsheni. 2009. 'Education and Youth Unemployment in South Africa.' In *Labour Markets and Economic Development*, edited by R. Kaubur and J. Svejnar. Routledge.
- Loss, G., S. Naicker, L. Richter, and G. Fink. 2024. 'Early Life Determinants of Social Disparities Among Young Adults: A Longitudinal Study in Vulnerable Communities in South Africa.' *World Development* 175:106465.
- Markussen, S., M. Nareklshvili, and K. Røed. 2024. 'Overeducation and Economic Mobility.' *Economics of Education Review* 103:102595.

- Mlatsheni, C., and S. Rospabé. 2002. 'Why is Youth Unemployment so High and Unequally Spread in South Africa?' DPRU Working Paper No. 65, Development Policy Research Unit, University of Cape Town.
- Mlatsheni, C., and V. Ranchhod. 2017. 'Youth Labour Market Dynamics in South Africa: Evidence from NIDS 1-2-3.' RED13X3 Working Paper No. 39, Southern Africa Labour and Development Research Unit, University of Cape Town.
- Mpendulo, G., and E. E. Mang'anyi. 2018. 'Exploring Relationships Between Education Level and Unemployment.' *Journal of Social Sciences (COES&RJ-JSS)* 7 (2): 86-102.
- Mseleku, Z. 2022a. 'From Workplace to Joblessness: The Determinants of Post-Internship Graduate Unemployment in South Africa.' *Academic Journal of Interdisciplinary Studies* 11 (2): 330-40.
- Mseleku, Z. 2022b. 'Youth High Unemployment/Unemployability in South Africa: The Unemployed Graduates' Perspectives.' *Higher Education, Skills and Work-Based Learning* 12 (4): 775-90.
- Mseleku, Z. 2024. 'Transitioning from Higher Education to the Labour Market: The Role of Graduate Internship on Youth Graduate Employability.' *Cogent Education* 11 (1): 2428069.
- Mudiriza, G., and A. de Lannoy. 2023. 'Profile of Young People not in Employment, Education or Training (NEET) in South Africa: An Update.' SALDRU Working Paper No. 298, Southern Africa Labour and Development Research Unit, University of Cape Town.
- Naudé, W., and P. Serumaga-Zake. 2001. 'An Analysis of the Determinants of Labour Force Participation and Unemployment in South Africa's North-West Province.' *Development Southern Africa* 18 (3): 261-78.
- Ntini, P., and C. Kappo-Abidemi. 2025. 'The Synergy Between Educational Qualification Levels and Youth Employability: The Case of Kanyamazane, Mpumalanga Province, South Africa.' *International Journal of Learning, Teaching and Educational Research* 24 (3): 758-84.
- Omotayo, A. O., A. I. Oggunniyi, and A. O. Aremu. 2019. 'Data on Food Insufficiency Status in South Africa: Insight from the South Africa General Household Survey.' *Data in Brief* 23:103730
- Patel, D. P. C., and I. Choga. 2018. 'Determinants of Youth Unemployment in South Africa.' In *Proceedings of Economics & Finance Conference*, edited by R. Holman. International Institute of Social and Economic Sciences.
- Spence, M. 1973. 'Job Market Signalling.' *The Quarterly Journal of Economics* 87 (3): 355-74.
- Spence, M. 2002. 'Signaling in Retrospect and the Informational Structure of Markets.' *American Economic Review* 92 (3): 434-59.
- Thurow, L. C. 1976. *Generating Inequality: Mechanisms of Distribution in the U.S. Economy*. Basic Books.

- Yu, D. 2013. 'Youth Unemployment in South Africa Since 2000 Revisited.' *Stellenbosch Economic Working Paper No. 4*, Stellenbosch University.
- Zikhali, A., and N. S. Matsiliza. 2024. 'An Evaluation of the Presidential Youth Employment Initiative in Addressing Youth Unemployment at Winnie Madikizela-Mandela Local Municipality.' *International Journal of Development and Sustainability* 13 (6): 455–81.

### **Dvojni učinek SIFIDE na Portugalskem: spodbujanje raziskav in razvoja ter optimizacija davkov**

*Pedro Feliciano, Cristina Sá in José Luís Martins*

Gospodarska rast je tesno povezana z inovacijami, pri čemer imajo raziskave in razvoj (RR) ključno vlogo pri ustvarjanju novega znanja, izdelkov in procesov. Na Portugalskem javne politike RR podpirajo s finančnimi spodbudami in z davčnimi ugodnostmi. Pričujoči članek preučuje razmerje med gospodarsko rastjo in naložbami v RR z makroekonomskega ter mikroekonomskega vidika, pri čemer se osredotoča na nacionalne rezultate in uspešnost podjetij ter poudarja vlogo davčnih spodbud pri zasebnih vlaganjih v RR. Z uporabo linearnega regresijskega modela ugotavljamo, da inovacijsko intenzivna podjetja, ki vlagajo v RR, izkazujejo višjo raven davčnega načrtovanja, kar je delno posledica neposrednega učinka davčnih spodbud za RR (port. Sistema de Incentivos Fiscais à Investigação e Desenvolvimento Empresarial – SIFIDE) in je lahko povezano tudi z natančnejšimi praksami davčnega upravljanja. Naše ugotovitve so skladne z mednarodnimi dokazi, hkrati pa zapolnjujejo vrzel v portugalskem kontekstu. Ugotovitve ponujajo pomembna spoznanja za odločevalce in poslovne voditelje ter poudarjajo potrebo po spremljanju zasebnih naložb v RR, podprtih s programom SIFIDE, in ocenjevanju njihovega dejanskega gospodarskega učinka glede na znatne fiskalne stroške tega sistema.

*Ključne besede:* gospodarska rast, davčno načrtovanje, raziskave in razvoj (RR), davčne ugodnosti, SIFIDE

*Klasifikacija JEL:* M48; O38

*Managing Global Transitions* 24 (2): 171–201

### **Povečanje obsega prehoda na čisto energijo v Turčiji: vloga finančnega razvoja, zelenih tehnologij in gospodarske kompleksnosti**

*Foday Joof in Mehdi Seraj*

Prehod na nizkoogljično gospodarstvo za Turčijo predstavlja pomemben izziv in hkrati priložnost, saj njena energetska mešanica v več kot 90 % temelji na fosilnih gorivih. V tem kontekstu je cilj pričujoče raziskave analizirati vlogo finančnega razvoja (angl. *financial development* – FD), gospodarske kompleksnosti (GK) in okoljskih tehnologij (PET) pri rabi obnovljivih virov energije (OVE) v Turčiji v obdobju od leta 1980 do

2020. Pristop Fourier Bootstrap ARDL (FBARDL), nova metoda, ki lahko zazna do pet gladkih strukturnih prelomov in odpravi pristranskosti majhnih vzorcev, kaže, da obstaja pomembna »zelena strukturna zaklenjenost«, kjer enoodstotno povečanje FD in GK povzroči zmanjšanje OVE za 1,12 oz. 0,70 %. Z drugimi besedami, finančni razvoj in gospodarska kompleksnost Turčije sta še vedno vezana na porabo fosilnih goriv. Nasprotno pa PET pozitivno vpliva na RVE, saj enoodstotno povečanje PET povzroči 0,12odstotno rast OVE. Test Grangerjeve vzročnosti dodatno potrjuje, da imata FD in PET enosmerno vzročnost do OVE. Raziskava prispeva k obstoječi literaturi o turškem energetskem ravnovesju ter ponuja prepotrebno protiutež prevladujočim predpostavkam o »pozitivnih učinkih financ« v nečlanicah OECD.

*Ključne besede:* finančni razvoj, obnovljiva energija, okoljske tehnologije, Turčija, Fourier Bootstrap ARDL

*Klasifikacija JEL:* C22, G20, Q42, Q43

*Managing Global Transitions* 24 (2): 203–225

### **Vpliv korupcije na povezavo med javno porabo za zdravstvo in gospodarsko rastjo v podsaharski Afriki**

*Omobola H. Arowolo and Sunday O. Adewara*

Državna poraba za zdravstvo je bistven dejavnik rasti vsakega gospodarstva. Vendar pa zdravstveni sistem v podsaharski Afriki (angl. *sub-Saharan Africa* – SSA) ni bil deležen zadostne pozornosti. Pričujoča raziskava preučuje neposredni vpliv javne zdravstvene porabe in korupcije na gospodarsko rast ter vlogo korupcije v odnosu med javno porabo za zdravstvo ter gospodarsko rastjo v 32 državah podsaharske Afrike v obdobju od leta 2000 do 2022. Analiza temelji na metodi fiksnih učinkov in generalizirani metodi momentov (angl. *Generalised Method of Moments* – GMM) kot ocenjevalni tehniki. Rezultati kažejo, da tako javna poraba za zdravstvo kot korupcija negativno vplivata na gospodarsko rast, medtem ko skupni učinek javne zdravstvene porabe in korupcije spodbuja gospodarsko rast v SSA. Poleg tega ugotovitve razkrivajo, da inflacija negativno vpliva na gospodarsko rast, medtem ko bruto investicije v osnovna sredstva in odprtost trgovine pozitivno vplivajo nanjo. Priporočeno je, da vlade oblikujejo politike, ki bodo omejile korupcijo ter izboljšale raven institucionalne kakovosti v regiji SSA.

*Ključne besede:* GMM, izdatki za zdravstvo, gospodarska rast, korupcija

*Klasifikacija JEL:* B40, H51, O40, D73

*Managing Global Transitions* 24 (2): 227–254

## Migracije in razvoj človeškega kapitala v Afriki: filozofija preobrazbe bega možganov v pridobivanje znanja in talentov

*Uche Abamba Osakede, Joel Tobiloba Adeyemo, Opeyemi Eunice Olagunju, Olayinka Omolara Adenikinju, Johnson Olaosebikan, Akanni Olayinka Lawanson in Olanrewaju Olaniyan*

Dokazi o vplivu denarnih nakazil migrantov na razvoj človeškega kapitala v Afriki so še vedno mešani, pri čemer je dokazov o izobrazbeni ravni večine afriških migrantov malo. Razumevanje teh vzorcev je ključno za oceno, ali migracije vodijo v beg možganov ali v pridobivanje znanja in talentov. Pričujoča raziskava preučuje delovne migracije iz Afrike ter vlogo denarnih nakazil migrantov pri oblikovanju stopenj vpisa v izobraževanje. Z uporabo metod panelno korigiranih standardnih napak (angl. *panel-corrected standard error* – PCSE) in izvedljivih posplošenih najmanjših kvadratov (angl. *feasible generalized least squares* – FGLS) analiza upošteva heteroskedastičnost, avtokorelacijo in medsektorsko odvisnost, kar zagotavlja zanesljive ocene. Rezultati kažejo, da ima večina afriških migrantov doseženo srednješolsko izobrazbo, medtem ko denarna nakazila pomembno povečujejo vpis v osnovno- in srednješolsko izobraževanje, vendar nimajo pomembnega vpliva na terciarno izobraževanje. Ugotovitve prav tako kažejo, da realni BDP, državna poraba in dostop do električne energije izboljšujejo izobraževalne rezultate. Ti rezultati nakazujejo, da denarna nakazila prispevajo k razvoju temeljnega človeškega kapitala, vendar so potrebni politični ukrepi za usmerjanje sredstev v izobraževalne izide, zlasti na ravni visokega šolstva, da bi zagotovili trajnostno rast v Afriki.

*Ključne besede:* migracije, beg možganov, pridobivanje znanja in talentov, PCSE, FGLS

*Klasifikacija JEL:* F22, F24, I25

*Managing Global Transitions* 24 (2): 255–279

## Izobraževanje in brezposelnost mladih v Južni Afriki po covidu-19: dokazi iz splošne ankete o gospodinjstvih

*Lana Erasmus, Clement Moyo in Andrew Phiri*

Brezposelnost mladih v Južni Afriki ostaja velik izziv, pandemija covid-19 pa je dodatno porušila izobraževalne poti in prehode na trg dela. Pričujoča raziskava preučuje, kako dosežena izobrazba vpliva na brezposelnost mladih v obdobju po covidu-19 z uporabo nacionalno reprezentativne splošne ankete o gospodinjstvih (angl. *General Household Survey* – GHS) iz leta 2021. Vzorec 3.652 mladih je bil analiziran z uporabo logitnih in probitnih modelov v treh specifikacijah, ki vklju-

čujejo izobraževanje, demografske dejavnike in značilnosti blaginje gospodinjstev. Rezultati kažejo, da višja izobrazba bistveno zmanjšuje verjetnost brezposelnosti, pri čemer so učinki najmočnejši pri osebah z diplomami in univerzitetnimi nazivi. Vendar se ti učinki med provinčami razlikujejo. Mladi v provincah Free State, Northwest in Limpopo se tudi ob višjih kvalifikacijah soočajo z visoko brezposelnostjo, kar kaže na šibke regionalne trge dela. Analiza občutljivosti razkriva, da so donosi od izobraževanja nižji v provincah, odvisnih od rudarstva. Raziskava zaključuje, da širitev izobraževanja sama po sebi ni zadostna, ne da bi se ob tem naslovalo omejitve na ravni regionalnih trgov dela.

*Ključne besede:* izobraževanje, brezposelnost mladih, podatki splošne ankete o gospodinjstvih (GHS), obdobje po covidu19, Južna Afrika

*Klasifikacija* JEL: J64, I26, J24, R23, J13, O15

*Managing Global Transitions* 24 (2): 281–304