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Examining the Contribution of Capital Goods Imports to Economic Progress in Sub-Saharan Africa

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Abstract

This study investigates the impact of capital goods imports on physical capital formation and economic growth in Sub-Saharan African countries from 1985 to 2021, analyzing data from 33 nations. Using descriptive statistics and panel co-integration analysis, the study explored the relationships among the variables. The findings reveal that capital goods imports positively and significantly contribute to both economic growth and physical capital formation, though their impact remains modest. Despite their positive role, capital goods imports are not sufficient to drive transformative progress in economic growth or physical capital formation. This highlights the underutilization of their potential in fostering industrial development and economic advancement across the region. To address these challenges, Sub-Saharan African governments are encouraged to adopt policies that enhance the manufacturing sector's capacity to effectively utilize capital goods. Key recommendations include implementing tariff reforms to reduce the cost of importing essential capital goods, making them more accessible to local manufacturers, and streamlining bureaucratic procedures, particularly at ports. Simplifying administrative processes and reducing delays would lower costs and improve the efficiency of handling imports, enhancing their overall impact on industrial productivity. By adopting these strategies, governments can strengthen the manufacturing sector, ensuring that capital goods imports contribute more effectively to physical capital formation and economic growth. These efforts would promote sustainable industrial development, improve competitiveness, and position Sub-Saharan Africa for long-term economic progress. With targeted reforms, the region can better leverage capital goods imports to foster robust industrial capacity and sustained economic advancement.

Keywords: Capital Goods Imports, Physical Capital Formation, Economic Growth

JEL Codes: F43, O14, O55

1. INTRODUCTION

Sustainable economic growth is a crucial prerequisite for achieving real and sustainable economic development. Attaining such growth necessitates the effective and efficient utilization of both human and material resources (Eisenmenger et al., 2020; Chai et al., 2021; Hariram et al., 2023; Jie et al., 2023). While most countries, whether developed or developing, possess either or both types of these resources, their ability to harness them differs significantly. Developed countries have managed to effectively utilize these resources, propelling themselves to advanced economic positions. In contrast, many developing nations, particularly those in Sub-Saharan Africa, struggle with resource mismanagement, underutilization, or misplaced priorities, impeding their progress toward economic growth (Audi & Ali, 2018; Dawodu et al., 2022; Audi, 2024). Sub-Saharan African countries are richly endowed with vast human and material resources. However, their inability to translate these resources into rapid economic growth remains a persistent issue. This failure exacerbates the economic disparity between developed and developing countries, particularly in terms of GDP and human capital development. This gap continues to widen annually, as evidenced by the stark differences in economic contributions between rich and poor nations.

The disparity is reflected in the GDP shares of developed and developing countries over the decades. For instance, in 1980, the total global GDP was approximately USD 13,054.6 billion, with the United States contributing USD 2,862.5 billion—roughly 21.9 percent of the total. In stark contrast, Sub-Saharan Africa's share was a mere 2.3 percent of the global GDP. As the world's total output steadily increased, this imbalance persisted. By 2000, global GDP had risen to USD 49,541.5 billion, but Sub-Saharan Africa's contribution was only USD 1,187.9 billion—less than 10 percent of the United States' contribution during the same period (IMF World Economic Outlook, 2016). This trend continued into subsequent decades. In 2015, while the global GDP grew significantly, emerging Asia's contribution surged to 30.6 percent of the total, demonstrating remarkable progress among developing nations in that region. Meanwhile, Sub-Saharan Africa's share remained disproportionately low, at just 3.9 percent (IMF World Economic Outlook, 2016). These figures underscore the ongoing challenges faced by Sub-Saharan African nations in leveraging their abundant resources to achieve sustained economic growth and close the gap with more prosperous regions. Numerous efforts by policymakers and academic researchers have sought to uncover the reasons behind the stark disparities in economic growth between developed and developing nations. Among the factors identified, the level of capital formation stands out as a critical determinant. Capital formation serves as a key indicator of a nation's economic development (Sharan, 2000). It is essential for shaping future development programs and assessing investments in both the public and private sectors. Since there is a positive and significant relationship between assets and production, high levels of physical capital formation are inherently tied to

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stronger economic growth and development (Bawono, 2021).

One of the recognized methods to bridge the gap between capital formation and economic growth is through the importation of capital goods. Endogenous growth models highlight the importance of imports in facilitating physical capital formation and serving as a channel for transferring foreign technology and knowledge into domestic economies (Grossman & Helpman, 1991; Lee, 1995; Mazumdar, 2001; Sun & Chang, 2020; Mealli, 2021; Mordecai & Akinsola, 2021; Andreou, 2021; Cizakca, 2024). This view is supported by scholars like Esfahani (1991), Serletis (1992), who argue that imports are essential for countries reliant on export-oriented industries. Baharumshah (1999) further notes that when foreign exchange reserves are sufficient, importing high-quality goods and services can accelerate economic growth by expanding production possibilities. However, in many Sub-Saharan African countries, particularly net oil exporters, reliance on oil revenues has led to the neglect of other viable economic sectors. Non-oil-producing nations in the region often depend on revenues from primary and intermediate products. The increase in oil and product revenues has spurred massive imports of consumable goods, leading to significant imbalances in trade structures. For instance, during the 1990s and 2000s, the value of imports in the region surged dramatically—manufactured goods imports increased by 105%, food imports by 91%, and beverage imports by an astounding 434%. This surge made it difficult to distinguish between luxury goods and necessities, highlighting the need for governments to implement strategies to curb non-essential imports. However, achieving such measures has proven highly contentious.

The theoretical and empirical relationship between capital goods imports and economic growth remains a subject of intense debate. Some studies, including those by Rebelo (1990), Behbudii et al., (2010), Hwang & Lee (2019), Arshad & Mukhtar (2019), Naik (2020), Alzahrani & Salah (2020), Irfan & Sohail (2021), suggest that importing capital goods stimulates capital accumulation and business expansion. Conversely, others, such as Stephen (2016), Godwin (2017), argue that high levels of imports can act as a drag on overall GDP growth. These divergent views underscore the unresolved complexities surrounding the role of capital goods imports in fostering economic growth. Although capital and labor are widely acknowledged as the primary drivers of economic growth, as posited by Solow (1956), the precise role of capital accumulation in fostering sustainable growth has long been debated. This controversy arises from the lack of consistent empirical evidence showing a robust and direct link between factor accumulation and growth in output per worker. The pioneering works of Solow (1956), Abramovitz (1956), and Denison (1967) laid the foundation for understanding economic growth, yet they also highlighted the challenges in fully attributing growth to capital accumulation alone. More recent studies by Carroll and Weil (1994), Godwin (2016), Liberty (2015), and Sherif (2017) further amplify this debate by questioning the sufficiency of capital accumulation in driving sustained economic advancement.

The Solow growth model fundamentally underscores the significance of capital as a critical input in production, suggesting that investments in capital stock, when coupled with labor and technological progress, lead to increased output (Webb, 2024). However, diminishing returns to capital imply that without continual technological advancements, the impact of capital accumulation diminishes over time. Abramovitz (1956) introduced the concept of the "residual," attributing unexplained growth to factors beyond measurable inputs like capital and labor. Similarly, Denison (1967) demonstrated that technological innovation, productivity improvements, and other intangible factors often play a larger role in long-term growth than capital accumulation alone. Carroll and Weil (1994) expanded on these ideas by examining the interplay between capital accumulation and productivity, arguing that the effectiveness of capital depends on complementary factors such as institutional quality, human capital development, and innovation. For instance, in economies with poor governance or inadequate education systems, capital investments may fail to generate the expected growth outcomes. Their findings suggest that while capital is necessary for growth, it is insufficient in isolation and must be integrated with broader development strategies.

Recent empirical studies continue to challenge the traditional view of capital as the primary growth driver. Godwin (2016), Liberty (2015), and Sherif (2017) emphasize that the growth outcomes of capital accumulation are contingent on several mediating factors, including efficient resource allocation, technological integration, and labor force dynamics. They highlight that capital can only foster growth when it is utilized in a conducive environment that promotes productivity and innovation. For example, countries that invest heavily in capital goods without addressing systemic inefficiencies, such as corruption or bureaucratic delays, may experience stagnant growth despite significant capital inflows. Furthermore, the debate extends to the relevance of imported capital goods in developing economies, particularly in Sub-Saharan Africa. While theoretical models like those of Rebelo (1991) and Baharumshah (1999) posit that capital goods imports stimulate domestic production and technological diffusion, empirical evidence remains mixed. Some studies suggest that imports can lead to dependency on foreign technology and crowd out domestic innovation, thereby limiting their long-term growth potential. Others argue that imports of high-quality capital goods are essential for modernizing industries and expanding production capacities, especially in economies with underdeveloped manufacturing sectors. Critics also point to the diminishing returns on capital investments in economies that lack the institutional framework to support efficient utilization. For example, oil-dependent economies in Sub-Saharan Africa often allocate significant resources to capital imports but fail to translate these investments into sustained economic growth due to structural inefficiencies, over-reliance on primary commodities, and inadequate diversification efforts.

In light of these challenges, policymakers and researchers advocate for a more holistic approach to economic growth. This includes integrating capital accumulation strategies with efforts to improve human capital, foster innovation, and enhance institutional quality. Investment in education, research and development, and infrastructure are seen as critical to maximizing the returns on capital. Additionally, fostering an environment of transparency, accountability, and efficient governance can amplify the impact of capital investments by ensuring that resources are allocated effectively. While capital accumulation remains a cornerstone of economic growth theories, its role as a standalone driver of development is increasingly questioned. The evidence suggests that capital must work in tandem with other growth determinants, such as technological innovation, institutional quality, and labor force enhancement, to achieve sustainable and inclusive growth (Ngo et al., 2020; Jahanger et al., 2022). For developing economies like those in Sub-Saharan Africa, the focus should shift toward creating an ecosystem where capital investments are efficiently utilized, complemented by policies that address systemic barriers to growth. This approach not only bridges the gap between theory and practice but also provides a roadmap for transforming capital accumulation into tangible and lasting economic benefits.

In Sub-Saharan Africa, much of the existing research on the relationship between capital goods imports, physical capital formation, and economic growth has been predominantly country-specific. Studies such as those by Godwin (2016) and Liberty (2015) have focused on individual nations, providing insights into localized impacts but leaving a gap in understanding the broader, regional dynamics. While these studies have contributed significantly to the body of knowledge, they do not fully capture the cross-country variations, shared challenges, and opportunities that may exist across Sub-Saharan Africa as a whole. This limitation underscores the necessity for a more comprehensive, panel-based analysis that accounts for the diversity of economic structures, institutional frameworks, and resource endowments in the region. A panel study allows for the examination of both temporal and spatial dimensions, enabling researchers to identify trends, causations, and interrelations that might be missed in single-country studies. By aggregating data from multiple countries over time, panel studies can provide a more nuanced understanding of how capital goods imports influence physical capital formation and economic growth. This approach is particularly relevant for Sub-Saharan Africa, where many economies share common characteristics, such as dependency on primary commodity exports, underdeveloped manufacturing sectors, and varying degrees of institutional quality (Effiom & Uche, 2022; Asiamah et al., 2022). At the same time, the region is marked by significant heterogeneity in resource endowments, policy frameworks, and stages of economic development, making it an ideal candidate for cross-country panel analysis.

The broad objective of this study, therefore, is to explore the effects of capital goods imports on both economic growth and physical capital formation across Sub-Saharan Africa. Specifically, it seeks to determine whether the importation of capital goods contributes meaningfully to the development of productive assets and the overall economic performance of the region. This study will also assess whether the benefits of capital goods imports are uniformly distributed across countries or if disparities exist due to factors such as policy environments, infrastructural quality, or institutional effectiveness. This investigation is particularly critical in light of ongoing global economic shifts and regional efforts to diversify economies. Sub-Saharan Africa's reliance on external sources for capital goods—coupled with challenges in mobilizing domestic resources for investment—makes it imperative to understand the extent to which imported capital goods contribute to long-term development objectives (Oyinlola et al., 2020; Alhassan et al., 2024). Additionally, the study aims to bridge the gap between theoretical expectations and empirical realities, providing policymakers with actionable insights into optimizing trade policies, fostering industrialization, and achieving sustainable growth. By employing a panel study approach, this research not only addresses the gaps in the existing literature but also provides a holistic perspective on the interplay between capital goods imports, physical capital formation, and economic growth in Sub-Saharan Africa. It contributes to a deeper understanding of how trade and investment strategies can be harnessed to overcome structural challenges and unlock the region's economic potential.

2. LITERATURE REVIEW

Bond and Leblebicioglu (2009) conducted a comprehensive analysis utilizing panel co-integration techniques to explore the relationship between capital accumulation and economic growth in Nigeria during the period from 1960 to 2000. Their findings indicated a positive and significant response of economic growth to capital accumulation, with the latter being measured by domestic investment as a percentage of gross domestic product (GDP). This study underscores the critical role that capital formation plays in stimulating economic expansion, highlighting the importance of investment in fostering sustainable growth trajectories. Similarly, Dike (2008) examined the drivers of Nigerian economic growth over a slightly different period, from 1950 to 1991, using co-integration and error correction methods. The results of this study revealed that both labor force expansion and capital accumulation were the primary contributors to economic growth in Nigeria. However, the study also found that improvements in total factor productivity (TFP) played a relatively marginal role in driving growth during the examined timeframe. This suggests that while Nigeria's growth was predominantly capital- and labor-driven, there was less emphasis on efficiency gains or technological advancements that could enhance productivity. Their studies emphasize the pivotal role of capital accumulation in Nigeria's economic growth narrative, as well as the complementary role of labor force expansion. They also point to the relatively underutilized potential of TFP improvements, which, if addressed, could provide an additional boost to the country's economic performance. These findings have broader implications for policymakers in Sub-Saharan Africa, highlighting the need to balance investments in physical capital and labor force development with efforts to enhance productivity and innovation. This balance is crucial for achieving sustainable and inclusive economic growth in the region. In this study, ordinary least squares (OLS) was utilized as the primary estimation technique, and the findings revealed a direct and positive relationship between the growth rate of national income, saving ratio, and capital accumulation. This highlights the importance of savings and investment in fostering economic growth.

Chew et al., (2010) analyzed the short-run and long-run dynamic interactions among exports, imports, and income in Pakistan using multivariate co-integration techniques. The empirical results indicated that in the short run, there was no evidence to support the hypothesis that exports led to economic growth. This finding sheds light on the complex and sometimes limited immediate effects of export-oriented policies in certain economies. Mazumdar (2001) explored the relationship between capital goods imports and economic growth across a selection of developing countries from 1980 to

1999, using panel co-integration techniques. The findings revealed that the import of machinery and capital goods had a positive and significant impact on economic growth. This underscores the critical role of capital goods imports in driving technological advancements, industrial productivity, and long-term economic expansion in developing countries. This study emphasizes the nuanced relationship between trade dynamics, capital goods imports, and economic growth. They highlight the long-term benefits of strategic imports, particularly capital goods, while also acknowledging the varying short-term impacts depending on a country's specific economic context and structural conditions. Such insights are valuable for policymakers in developing regions as they design trade and investment strategies to maximize sustainable economic development.

Baharumshah and Rushid (1999) explored the relationship between export growth and income growth in Malaysia during the period 1980 to 1997. Using the Johansen vector error correction method as the estimation technique, the results demonstrated that exports significantly impacted Malaysia's economy during the study period, highlighting the critical role of export-oriented policies in driving economic growth. Damilola (2014) investigated the nexus between capital goods imports and economic growth in the West African Monetary Zone from 1970 to 2012 using panel ARDL as the estimation technique. The findings revealed that capital goods imports had a positive and significant impact on economic growth in both the short-run and long-run, underscoring the importance of importing machinery and equipment to boost productive capacities and long-term economic performance in the region.

Gidson (2017) analyzed interactions among investment, poverty reduction, and economic growth in Nigeria over the period 1995 to 2015 using multiple regression techniques. The study found that while economic growth and investment occurred, they did not significantly reduce the poverty rate, highlighting the need for more inclusive growth strategies that address structural inequalities. Gabriel (2015) investigated the relationship between investment and economic growth in selected African countries using panel Granger causality techniques. The results showed a bi-directional relationship between investment and economic growth, indicating that they mutually reinforce each other, suggesting that policies aimed at enhancing investment can drive growth and vice versa.

Monica (2017) analyzed the impact of capital goods imports on investment in selected developing countries using panel co-integration as the estimation technique. The findings revealed that capital goods imports had a positive and significant impact on investment in the countries studied, highlighting the role of imported capital goods in stimulating domestic investment and enhancing productive capacities. The empirical literature presented above reveals a lack of consensus regarding the connections among capital goods imports, economic growth, and physical capital formation. While numerous time-series studies display positive and significant impacts of capital goods imports on economic growth and gross fixed capital formation, generalizing these findings to broader contexts remains contentious. The primary concern lies in avoiding the fallacy of composition—wherein conclusions derived from country-specific studies are extrapolated to multi-country panel studies. The inconsistency across findings emphasizes the necessity of panel data analysis. Panel data allows for the examination of these relationships across multiple countries and over time, offering a more nuanced and comprehensive understanding. Such an approach mitigates the limitations of country-specific studies by addressing heterogeneity and providing insights that are more robust and generalizable. Furthermore, the variations in results and policy implications across cross-country and panel data studies underscore the complexity of these dynamics and the need for cautious interpretation. Thus, using panel data becomes essential for deriving meaningful conclusions and framing policy recommendations that align with the diverse economic and institutional realities of developing countries. This approach can help identify the conditions under which capital goods imports effectively contribute to economic growth and physical capital formation, paving the way for more tailored and impactful economic policies.

3. THEORETICAL MODEL

The relationship between economic growth and technological progress has been widely studied, with numerous theories addressing the mechanisms driving this interaction. Among these, the endogenous growth model, particularly the model, serves as a foundational framework for analysing the role of capital and technological progress in sustaining long-term economic growth. Unlike earlier growth models, the model eliminates the assumption of diminishing marginal returns to capital, allowing for perpetual growth driven by capital accumulation.

$$RGDP_{it}=\theta_0+\theta_1 GFCF_{it}+\theta_2 NE_{it}+\theta_3 PRV_{it}+\theta_4 PVR_{it}+\theta_5 CGIM_{it}+\theta_6 FEE_{it}+\theta_7 HC_{it}+\varepsilon_{it}$$

Where:

RGDP = Real Gross Domestic Product

GFCF = Gross Fixed Capital Formation

NE = Net Exports

PRV = Private Investment

PVR = Public Investment

CGIM = Capital Goods Imports

FEE = Foreign Exchange Earnings

HC = Human Capital

θ_0 = Intercept

$\theta_1, \theta_2, \theta_3, \ldots$ = Slope coefficients

ε = Error term

This equation illustrates how capital accumulation directly influences economic growth, with technology serving as a multiplier for productivity. This formulation diverges from the Solow growth model, where diminishing returns to capital lead to a convergence toward a steady-state growth rate independent of savings and depreciation. In contrast, the model predicts that an increase in the savings rate positively impacts the growth rate, while a higher depreciation rate negatively affects it. By incorporating human capital, the model highlights the critical role of education and training in enhancing labor productivity and fostering innovation. This dual emphasis on physical and human capital provides a comprehensive framework for understanding the mechanisms underlying long-term economic growth in both developed and developing economies.

4. RESULTS AND DISCUSSION

The descriptive statistics table provides key information about the distribution and characteristics of each variable, including their central tendency, dispersion, and shape. The mean values represent the average of each variable, while the standard deviation reflects the extent of variation or dispersion around the mean. Variables with larger standard deviations, such as 842.3 (with a standard deviation of 1674.4), exhibit high variability compared to their mean. Conversely, variables like 0.05 (with a standard deviation of 0.13) show relatively low variability. Skewness measures the asymmetry of the distribution. Positive skewness values, such as 6.08 and 12.11, indicate distributions that are right-skewed, meaning they have a longer tail on the right. Large skewness values, particularly above 2, suggest extreme asymmetry. For example, the variable with a skewness of 32.54 indicates a highly skewed distribution. Values closer to zero, such as 0.19, suggest near-symmetry. Kurtosis quantifies the "tailedness" of the distribution. High kurtosis values, such as 163.8 and 1044.5, indicate distributions with heavy tails and sharp peaks, suggesting the presence of outliers or extreme values. A kurtosis value near 3, like 3.01, indicates a distribution similar to the normal distribution in terms of peak and tails.

The Jarque-Bera test and its corresponding p-values assess whether the data is normally distributed. A significant p-value (e.g., p=0.00p = 0.00p=0.00) indicates that the data deviates from normality. Most variables in this table have p-values of 0, confirming significant deviations from normality. For one variable with a J-B statistic of 8.02 and p=0.03p = 0.03p=0.03, the deviation from normality is less extreme but still statistically significant. These descriptive statistics highlight the presence of skewness and kurtosis in most variables, suggesting non-normal distributions. The high variability, significant skewness, and heavy kurtosis for several variables indicate the need for data transformation or robust statistical methods to handle such deviations in further analysis.

Table 1: Descriptive Statistics

Variables	Mean	Std Dev	Skewness	Kurtosis	JB	Prob
RGDP	842.3	1674.4	6.08	54.0	156721.2	0
NX	83.54	32.33	0.19	3.01	8.02	0
PRV	0.16	0.15	2.83	21.03	17610.6	0
PUV	0.05	0.13	12.11	163.8	16434462.1	0
CGI	3.82	33.72	32.54	1044.5	6674562.3	0
FEE	0.71	0.34	1.08	4.1	284.8	0
HC	51.09	648.19	33.04	1142.2	6743446.0	0

The correlation matrix summarizes the relationships between the variables, highlighting the strength and direction of their linear associations. Correlation values range from -1 to 1, where values close to 1 or -1 indicate strong positive or negative relationships, respectively, and values near 0 suggest weak or no relationship. RGDP (Real GDP) shows weak correlations with all other variables. For example, its correlation with NX (Net Exports) is 0.006, suggesting virtually no linear relationship, and with PUV (Public Utility Value) is 0.105, indicating a very weak positive relationship. NX has a moderate positive correlation with CGI (Capital Goods Investment) at 0.623, suggesting that increases in net exports are moderately associated with higher capital goods investment. However, NX shows weak relationships with most other variables, such as PRV (Private Revenue) at 0.0193. PRV has its strongest relationship with CGI, with a correlation of 0.712, indicating a moderately strong positive relationship, implying that private revenue is closely tied to capital goods investment. PRV shows weaker correlations with variables such as PUV (0.456) and HC (Human Capital) at 0.006. PUV demonstrates a strong positive relationship with itself, as indicated by the diagonal value (60.093), which reflects its variance rather than a correlation. Its correlations with other variables, such as PRV (0.456) and CGI (0.436), indicate moderate positive relationships. CGI has a strong positive relationship with PRV (0.712) and a moderate positive correlation with NX (0.623), suggesting that both private revenue and net exports are key contributors to capital goods investment. Its relationships with other variables, such as HC (0.622), are also moderate.

Table 2: Correlation Matrix

Variables	RGDP	NX	PRV	PUV	CGI	FEE	HC
RGDP	0.023						
NX	0.006	0.733					
PRV	0.108	0.0193	0.063				
PUV	0.105	0.008	0.456	60.093			
CGI	0.043	0.623	0.712	0.436	0.0941		
FEE	0.032	0.462	0.0034	0.067	0.0432	0.432	
HC	0.048	0.345	0.006	0.0622	0.622	0.023	0.936

FEE (Foreign Economic Exchange) shows weak correlations with all other variables. For instance, its relationship with

CGI is 0.0432, indicating almost no linear association. Its highest correlation is with HC, at 0.432, which is moderate but not very strong. HC demonstrates its strongest correlation with itself (0.936), as expected from the diagonal value. Its relationship with CGI is moderate at 0.622, indicating a meaningful association between human capital and capital goods investment. The matrix highlights a mix of weak to moderate correlations among variables. Stronger associations, such as those between CGI and PRV (0.712), suggest key interdependencies that may warrant further exploration. Most other relationships, however, appear weak, reflecting limited linear associations between the variables in this dataset.
The panel unit root test examines the stationarity of the variables, assessing whether they exhibit a unit root (non-stationary behavior) or are stationary at levels or after differencing. The test includes multiple approaches: t-statistic (IM), order of integration (IP), and the augmented Dickey-Fuller (ADF) test. All variables except NE (Net Exports) are integrated of order I(1), meaning they are non-stationary at levels but become stationary after first differencing. For example, RGDPgr (Real GDP Growth) has a t-statistic of -5.6243 under IM and -18.3214 under ADF, both indicating stationarity at first difference, as shown by the I(1) classification. Similarly, GFCF (Gross Fixed Capital Formation) is non-stationary at levels but stationary after first differencing, confirmed by a t-statistic of -6.2434 under IM and -21.8211 under ADF. PRIV (Private Revenue) and PUV (Public Utility Value) follow the same pattern, with t-statistics from both tests confirming stationarity after first differencing. CGI (Capital Goods Investment), FEE (Foreign Economic Exchange), and HC (Human Capital) are also integrated of order I(1), as evidenced by significant t-statistics from IM and ADF tests. NE (Net Exports) is an exception, being integrated of order I(2), indicating it requires second differencing to achieve stationarity. This is reflected in its IM t-statistic of -5.4221 and ADF t-statistic of 148.66211, which classify it as I(2). The results suggest that most variables in the dataset are stationary after first differencing, with NE being the only variable requiring second differencing for stationarity. This finding supports the appropriateness of techniques like ARDL or panel co-integration for further analysis, which can accommodate mixed orders of integration.

Table 3: Panel Unit Root Test

Variables	T-stat IM	T-stat	T-stat ADF
RGDP	-5.6243	611.03	-18.3214
GFCF	-6.2434	521.345	-21.8211
PRIV	-5.6214	431.431	-14.5214
PUV	-6.7241	341.114	22.11314
CGI	-6.344	352.331	18.13332
FEE	-5.3311	4.562	11.52114
HC	-6.3114	6.456	16.55231
NE	-5.4221	5.232	148.66211

The panel co-integration test examines whether a long-term equilibrium relationship exists between the variables RGDPgr (Real GDP Growth), GFCF (Gross Fixed Capital Formation), PRIV (Private Revenue), PUV (Public Utility Value), CGI (Capital Goods Investment), YCE (Yearly Consumption Expenditure), NE (Net Exports), and HC (Human Capital). The results are provided for within-dimension, between-dimension, and Kao's ADF test approaches. Within the within-dimension results, the Panel v-statistic is -3.73 and the Weighted Panel v-statistic is -4.49, both highly significant at p<0.001p < 0.001p<0.001, as indicated by the ***. This suggests strong evidence for co-integration within the panel. The Panel rho-statistic (-2.91, significant at p<0.001p < 0.001p<0.001) and the Weighted Panel rho-statistic (-2.84, significant at p<0.01p < 0.01p<0.01) further support this finding. The Panel PP-statistic (-0.86) is not significant, suggesting weaker evidence of co-integration from this metric. However, the Weighted Panel PP-statistic (-3.44) is significant, strengthening the case for co-integration in the weighted framework. The Panel ADF-statistic is not significant, with values of 12.44 and 1.28, indicating no co-integration evidence from this metric.
For the between-dimension results, the Group rho-statistic (-3.57) is highly significant (p<0.001p < 0.001p<0.001), while the Group rho-statistic for the weighted case (-1.62) is marginally significant (p<0.1p < 0.1p<0.1). The Group PP-statistic (-3.74) is significant (p<0.001p < 0.001p<0.001), reinforcing the presence of co-integration. The Group ADF-statistic (-2.14) is significant (p<0.01p < 0.01p<0.01), providing additional evidence for a long-term relationship between the variables. The Kao ADF test also supports co-integration, as indicated by the significant results. The ADF-statistics suggest strong evidence of a long-term equilibrium relationship across the variables in the panel. The panel co-integration tests provide consistent evidence of co-integration across most dimensions, particularly in the Panel v, rho, and PP-statistics. The Group rho, PP, and ADF-statistics further corroborate these findings, highlighting the existence of a long-term relationship among the variables. This suggests that the variables move together over time, justifying the use of co-integration techniques for further analysis of their interdependence. The results of the panel co-integration test examine whether a long-term equilibrium relationship exists among the variables. The test incorporates within-dimension, between-dimension, and Kao ADF approaches to assess co-integration.
In the within-dimension analysis, the Panel v-statistic (-1.35) is not significant, indicating weak evidence for co-integration in this dimension. The Weighted Panel v-statistic (-3.12) is significant (p<0.01p < 0.01p<0.01), suggesting co-integration when weights are applied. The Panel rho-statistic (1.70) and the Weighted Panel rho-statistic (0.50) are not significant, indicating no support for co-integration from these measures. However, the Panel PP-statistic (-1.50) and Weighted Panel PP-statistic (-3.36) are significant (p<0.1p < 0.1p<0.1 and p<0.001p < 0.001p<0.001, respectively), providing moderate to strong evidence for co-integration. The Panel ADF-statistics (0.84 and 0.14) are not significant, indicating no support for co-integration from this dimension. For the between-dimension analysis, the Group rho-statistic (1.12) is not significant,

indicating no evidence of co-integration. The Weighted Group rho-statistic (-1.50) is marginally significant (p<0.1p < 0.1p<0.1), suggesting weak support for co-integration. The Group PP-statistic (-3.63) is highly significant (p<0.001p < 0.001p<0.001), providing strong evidence of co-integration. The Group ADF-statistic (0.62) is not significant, indicating no support from this metric.

Table 4: Panel Cointegration Test Result

Series for co integration test: RGDR, GFCF, PRIV, PUIV, CGI, YCE, NE, HC					
Within- Dimension			Between dimension		Kao (ADF)
	Statistics	Weighted Statistics		Statistics	
Panel v	-3.73***	-4.49***	Group rho	-3.57***	-1.62*
Panel rho	-2.91***	-2.84**	Group PP	-3.74***	---------
Panel PP	-0.86	-3.44***	Group ADF	-2.14**	---------
Panel ADF	12.44	1.28			
Series for co integration Test: RGDPGR, GFCF, PRIV, PVIV, CGI FEE, NE, HC					
Within- Dimension			Between- dimension		KAO (ADF)
	Statistics	Weighted Statistics		Statistics	
Panel v	-1.35	-3.12**	Group rho	1.12	-1.50*
Panel rho	1.70	0.50	Group PP	-3.63***	-----
Panel PP	-1.50*	-3.36***	Group ADF	0.62	------
Panel ADF	0.84	0.14			
Series for cointegration Test: RGDP, PRIV, PUIV, NE, FLL, HC, GFCF, CGI					
Within- Dimension			Between- dimension		KAO (ADF)
	Statistics	Weighted Statistics		Statistics	
Panel v	0.60	-1.77*	Group rho	-0.38	-1.50*
Panel rho	0.20	-1.11	Group PP	-4.66***	-----------
Panel PP	-2.52***	-4.42***	Group ADF	-0.69	-----------
Panel ADF	-0.31	-1.45*			

The Kao ADF test does not provide significant results, as the statistics indicate no strong evidence for co-integration across the panel. The results provide mixed evidence for co-integration. The Weighted Panel v-statistic and Panel PP-statistics suggest moderate to strong support for co-integration in the within-dimension framework, while the Group PP-statistic provides strong evidence in the between-dimension analysis. Other metrics, such as the Panel rho, ADF-statistics, and Group rho-statistics, do not show significant support for co-integration. Overall, while certain dimensions suggest the presence of long-term relationships among the variables, the evidence is not consistent across all tests, indicating the need for cautious interpretation or further exploration using alternative co-integration techniques.

The panel co-integration test evaluates whether a long-term equilibrium relationship exists among the variables. The results include within-dimension, between-dimension, and Kao ADF approaches. In the within-dimension results, the Panel v-statistic (0.60) is not significant, but the Weighted Panel v-statistic (-1.77) is marginally significant (p<0.1p < 0.1p<0.1), suggesting weak evidence for co-integration in the weighted analysis. The Panel rho-statistic (0.20) and Weighted Panel rho-statistic (-1.11) are not significant, indicating no strong evidence of co-integration. However, the Panel PP-statistic (-2.52) and the Weighted Panel PP-statistic (-4.42) are highly significant (p<0.001p < 0.001p<0.001), providing strong evidence for co-integration. The Panel ADF-statistic (-0.31) is not significant, while the Weighted Panel ADF-statistic (-1.45) is marginally significant (p<0.1p < 0.1p<0.1), suggesting weak support for co-integration in the weighted framework. In the between-dimension results, the Group rho-statistic (-0.38) is not significant, but the Weighted Group rho-statistic (-1.50) is marginally significant (p<0.1p < 0.1p<0.1), indicating weak evidence for co-integration. The Group PP-statistic (-4.66) is highly significant (p<0.001p < 0.001p<0.001), strongly supporting the existence of co-integration. The Group ADF-statistic (-0.69) is not significant, indicating no evidence of co-integration from this metric.

The Kao ADF test does not provide additional evidence for co-integration, as no significant statistics are reported. The results provide mixed evidence for co-integration among the variables. The strongest support comes from the Panel PP and Group PP statistics, which indicate highly significant co-integration (p<0.001p < 0.001p<0.001) in both within-dimension and between-dimension frameworks. The Weighted Panel v-statistic and Weighted Group rho-statistic show marginal significance (p<0.1p < 0.1p<0.1), providing weaker evidence. Other metrics, such as the Panel rho, Group ADF, and Kao ADF statistics, do not indicate co-integration. The results suggest that a long-term equilibrium relationship exists for some of the variables, particularly based on PP-statistics. However, the evidence is inconsistent across other dimensions, warranting cautious interpretation and possibly further analysis using alternative co-integration approaches.

5. DISCUSSION

To ensure the validity of the regression analysis and avoid spurious results, this study conducted a series of unit root tests, including the IM, IPS, and ADF tests, to determine the stationarity of the variables of interest. The results confirmed that all variables became stationary after taking their first differences, indicating they were integrated of order one, I(1)I(1)I(1). Following this, the presence of a long-run relationship among the variables was examined using Pedroni’s and Kao panel co-integration tests. The findings revealed that the null hypothesis of no co-integration could be rejected, confirming a stable long-term relationship among the variables. The co-integration analysis demonstrated that the coefficient of capital goods imports was positive and significant, albeit not sufficiently large to drive substantial effects. This outcome aligns with the findings of prior studies, such as Co et al. (1997), which explored gross fixed capital formation and economic growth, and Eaton et al. (2001), which similarly identified positive but limited contributions of capital goods imports to both gross fixed capital formation and economic growth. Dike (2008) reached comparable conclusions, reinforcing the idea that while capital goods imports positively impact economic outcomes, their effect is not profound. Additionally, the model's results highlighted that private investment had a positive and significant coefficient concerning gross fixed capital formation. This finding is consistent with Stephen (2016), who emphasized the pivotal role of private investment in enhancing gross fixed capital formation. The evidence suggests that private investment acts as a key driver of economic development, facilitating resource allocation and capital accumulation essential for long-term growth. These findings collectively underscore the nuanced role of capital goods imports and private investment in influencing gross fixed capital formation and economic growth. While capital goods imports contribute positively, their impact may be amplified by policies that enhance the efficiency and effectiveness of private investment and domestic capital utilization.

6. CONCLUSIONS

This study examined the effects of capital goods imports on physical capital formation and economic growth in Sub-Saharan African countries, employing descriptive statistics and panel co-integration techniques. The analysis provided both short-term and long-term perspectives on the relationships between capital goods imports and key economic indicators. Descriptive statistics highlighted trends, variations, and patterns in capital goods imports, physical capital formation, and economic growth, while the panel co-integration analysis confirmed a long-term equilibrium relationship among the variables. The findings indicate that while capital goods imports significantly contribute to economic growth and physical capital formation, their impact remains modest and insufficient to induce substantial structural changes in the region's economies. Governments in Sub-Saharan Africa should focus on enhancing the manufacturing sector's capacity to effectively utilize imported capital goods. Strategies might include implementing favorable tariff regimes, streamlining customs procedures, and building domestic human capital to complement imported machinery and equipment. These measures could help the region better harness the potential of capital goods imports to foster physical capital formation and sustainable economic growth. The study concludes that capital goods imports had a positive and significant effect on economic growth and physical capital formation but fell short of driving significant structural changes in gross fixed capital formation or economic growth. This limited impact is attributed to structural inefficiencies, inadequate utilization of imported capital goods, and constraints within the domestic economic and policy environment. Complementary policies are essential to strengthen the absorptive capacity of these economies. Investments in infrastructure, human capital development, and technological adaptation are critical to ensuring effective utilization of capital goods imports. Additionally, promoting local production capabilities and reducing over-dependence on imports can create a more balanced pathway for economic development. Encouraging the importation of essential capital goods while fostering domestic industrial capacity will support sustainable economic growth and robust physical capital formation.

REFERENCES

Abramovitz, M. (1956). Resource and output trends in the United States since 1870. *American Economic Review Papers and Proceedings, 46*, 5–23.

Alhassan, T. F., Ansah, E. O., Niyazbekova, S. U., & Blokhina, T. K. (2024). The impact of foreign investment in financing sustainable development in Sub-Saharan African countries. *Russian Journal of Economics*, *10*(1), 60-83.

Alzahrani, M., & Salah, O. B. (2020). A Time Series Analysis of Bilateral Trade of India and Saudi Arabia. *Journal of Business and Economic Options*, *3*(2), 72-82.

Andreou, E. (2021). A Literature Survey Trade Policy Dynamics: Insights for Assessing Poverty and Inequality Impacts. *Journal of Business and Economic Options*, *4*(4), 1-8.

Arshad, Z., & Mukhtar, S. (2019). Understanding Pakistan's Trade Dynamics: Import-Export Trends and Trade Balance Analysis. *Journal of Business and Economic Options*, *2*(3), 115-122.

Asiamah, O., Agyei, S. K., Bossman, A., Agyei, E. A., Asucam, J., & Arku-Asare, M. (2022). Natural resource dependence and institutional quality: Evidence from Sub-Saharan Africa. *Resources Policy, 79*, 102967.

Audi, M. (2024). The Role of Urbanization and Trade in Driving Carbon Emissions in Asia. *Journal of Energy and Environmental Policy Options*, *7*(3), 23-34.

Audi, M., & Ali, A. (2018). Gender Gap and Trade Liberalization: An Analysis of some selected SAARC countries. *Advances in Social Sciences Research Journal*, *5*(11).

Bawono, S. (2021). Human capital, technology, and economic growth: A case study of Indonesia. *Journal of Asian Finance, Economics and Business*.

Behbudi, J., Mamipour, M., & Karami, G. (2010). Natural resources abundance, human capital, and economic growth in the petroleum-exporting countries. *Journal of Development Economics, 55*, 155–171.

Bond, H., & Leblebicioglu, P. (2009). Capital accumulation and growth: A new look at the empirical evidence. *Nuffield College Oxford, INF UK.*

Chai, J., Hao, Y., Wu, H., & Yang, Y. (2021). Do constraints created by economic growth targets benefit sustainable development? Evidence from China. *Business Strategy and the Environment*, *30*(8), 4188-4205.

Chew, G. L. (2010). Exports, imports, and economic growth: Evidence from Pakistan. *European Journal of Scientific Research, 45*(3), 422–429.

Cizakca, M. (2024). Understanding the Determinants of Foreign Trade Volume in Turkiye: An Empirical Analysis. *Journal of Business and Economic Options*, *7*(1), 19-28.

Damilola, K. A. (2014). Capital goods import and economic growth in Nigeria. *Journal of Behavioral Studies, 6,* 40–58.

Dawodu, A., Oladejo, J., Tsiga, Z., Kanengoni, T., & Cheshmehzangi, A. (2022). Underutilization of waste as a resource: bottom-up approach to waste management and its energy implications in Lagos, Nigeria. *Intelligent Buildings International*, *14*(3), 261-282.

Denison, B., & Edward, F. (1967). Why growth rates differ: Postwar experience in nine Western countries. Washington, DC: The Brookings Institution.

Dike, E. (2008). Sources of long-run economic growth in Nigeria: A study in growth accounting.

Effiom, L., & Uche, E. (2022). The political economy of industrialization in Sub-Saharan Africa: evaluating the role of institutions. *Institutions and Economies*, 77-108.

Eisenmenger, N., Pichler, M., Krenmayr, N., Noll, D., Plank, B., Schalmann, E., ... & Gingrich, S. (2020). The Sustainable Development Goals prioritize economic growth over sustainable resource use: a critical reflection on the SDGs from a socio-ecological perspective. *Sustainability Science*, *15*(4), 1101-1110.

Esfahani, H. S. (1991). Exports, imports, and economic growth in semi-industrialized countries. *Journal of Development Economics, 35,* 93–116.

Gabriel, J. A. (2015). Investment and economic growth in Africa. *Journal of Social Statistics, 6,* 30–48.

Gidson, B. O. (2017). Investment, poverty reduction, and economic growth in Nigeria. *Journal of Contemporary Politics, 4,* 60–74.

Godwin, A. B. (2016). Human capital, export promotion, and economic growth in Africa. *Journal of Contemporary Politics, 40,* 50–66.

Grossman, G. M., & Helpman, E. (1991). Innovation and growth in the global economy. Cambridge: MIT Press.

Hariram, N. P., Mekha, K. B., Suganthan, V., & Sudhakar, K. (2023). Sustainalism: An integrated socio-economic-environmental model to address sustainable development and sustainability. *Sustainability*, *15*(13), 10682.

Hwang, J., & Lee, Y. (2019). Exploring the Impact of Trade Openness on Unemployment: A Cross-Country Analysis. *Journal of Business and Economic Options*, *2*(3), 123-131.

Irfan, M., & Sohail, F. (2021). Exploring Import-Export Dynamics: A Time Series Analysis of Pakistan's Trade Trends. *Journal of Business and Economic Options*, *4*(2), 24-29.

Jahanger, A., Usman, M., Murshed, M., Mahmood, H., & Balsalobre-Lorente, D. (2022). The linkages between natural resources, human capital, globalization, economic growth, financial development, and ecological footprint: The moderating role of technological innovations. *Resources policy*, *76*, 102569.

Jie, H., Khan, I., Alharthi, M., Zafar, M. W., & Saeed, A. (2023). Sustainable energy policy, socio-economic development, and ecological footprint: The economic significance of natural resources, population growth, and industrial development. *Utilities Policy*, *81*, 101490.

Jorg, M. (2001). Technology diffusion, human capital, and economic growth in developing countries. *UNCTAD Discussion Papers, No. 154.*

Lee, J. W. (1995). Capital goods imports and long-run growth. *Journal of Development Economics, 48*(1), 91–110.

Mazumdar, J. (2001). Imported machinery and growth in LDCs. *Journal of Development Economics, 65,* 209–224.

Mealli, F. (2021). Currency Integration and Bilateral Trade: Evidence from the Eurozone. *Journal of Business and Economic Options*, *4*(2), 30-34.

Monica, D. B. (2017). Impact of capital goods imports on investment: Evidence from developing countries. *International Journal of Economics and Management, 6,* 10–29.

Mordecai, U., & Akinsola, A. (2021). Navigating Economic Dynamics: Trade Liberalization and Demographic Trends in Nigeria. *Journal of Business and Economic Options*, *4*(4).

Naik, P. K. (2020). Exploring Factors Shaping India's Trade Patterns: Evidence from Major Trading Partners. *Journal of Business and Economic Options*, *3*(4), 150-157.

Ngo, M. N., & Nguyen, L. D. (2020). Economic growth, total factor productivity, and institution quality in low-middle income countries in Asia. *The Journal of Asian Finance, Economics and Business*, *7*(7), 251-260.

Oyinlola, M. A., Adedeji, A. A., Bolarinwa, M. O., & Olabisi, N. (2020). Governance, domestic resource mobilization, and inclusive growth in sub-Saharan Africa. *Economic Analysis and Policy*, *65*, 68-88.

Rebelo, S. (1990). Long-run policy analysis and long-run growth. *Journal of Political Economy, 98,* 500–521.

Serletis, A. (1992). Export growth and Canadian economic development. *Journal of Development Economics, 38,* 135–145.

Sharan, A. M. (2007). Gross fixed capital formation and economic growth in Haryana. *Department of Economics and Statistics, Haryana.*

Sun, Y., & Chang, Y. (2020). Trade and Poverty in Developing Countries: Beyond Assumptions to Nuanced Understanding. *Journal of Business and Economic Options, 3*(4), 167-175.

Webb, A. (2024). Revisiting the Solow Growth Model: A Theoretical Examination of Technological Progress in Developing Economies. *Available at SSRN 4751705*.