OPEN ACCESS
Global Journal of Research in Humanities & Cultural Studies
ISSN: 2583-2670 (Online)
Volume 06 | Issue 04 | July-August | 2026
Journal homepage: https://gjrpublication.com/gjrhcs/
Research Article

The Impact of Imports on the Technical Efficiency of Sudan's Economy

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DOI: 10.5281/zenodo.21630574 **Submission Date: 22 May 2026 | Published Date: 28 July 2026**

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Abstract

The main target of this article is to inspect the impact of imports on Sudan's technical efficiency by conducting frontier analysis on data from 1970 to 2023, using the transcendental logarithmic production function. This period commenced with the confiscation and nationalization of foreign firms, followed a few years later by full compliance with IMF and World Bank stabilization measures, which had a negative impact on the economy. The end of the research period coincided with the onset of political turmoil, which escalated into military conflict. Each of labor and capital exhibits positive coefficients that are statistically significant at the 1% level; however, their squared terms yield negative coefficients. Therefore, increases in these production factors enhance output at elevated levels; the rate of increase diminishes gradually, i.e., the law of diminishing marginal returns. On the other hand, the proportion of imports in GDP as an exogenous variable of the inefficiency term (u_i) had a negative sign and was statistically significant at the 1% level, showing that imports reduce inefficiency, as demonstrated by several academic research studies. The magnitude of the interaction elasticity of 0.35 between labor and capital in the model is a strong positive indicator that reflects the nature of the economic relationship between these two inputs.

Keywords: *import share, technical efficiency,* transcendental logarithmic *production function.*

INTRODUCTION

The connection between imports and technical efficiency is strong, especially in agriculture and manufacturing, where the imported inputs and acquisition of capital goods tend to maximize the firm's production for a given set of inputs. In more detail, the embodied technology in the imported materials lowers the waste and increases technical efficiency. Another benefit from imports is that they create a competitive environment for domestic firms with foreign ones. Therefore, effectively addressing inefficiencies is essential for competing with foreign competitors. One more aspect of imports is the transfer of research and development effort (R&D) via capital goods.

As stated by the World Bank (2025), the agricultural sector accounts for approximately 34.4% of the GDP and 80% of employment. Consecutive governments cultivated only 20% of the land. Farmers are subject to climate change and infections that reduce production. Hence, importing resistant seed varieties could facilitate the development of the agricultural sector by reducing the influence of these elements. Imports cover over 90% of fertilizers, as well as the vast majority of agrochemicals and heavy machinery. However, the main obstacles to this sector are war-related supply chain disruptions and crippling import tariffs (Hoffman et al., 2024). Moreover, alternating agricultural cycles and crop compositions enhance the efficiency and output of agricultural practices (Mubarak, 2018).

The industrial sector in Sudan depends on imported capital goods, machinery, and spare parts almost entirely sourced from abroad. Heavy industries and chemical manufacturing rely on imported raw materials for up to 70–80% of their production costs. The growth rate exceeds that of other sectors. The sector is labor-intensive. The sector is most in harmony with contemporary technologies and scientific progress. It establishes forward and backward interconnection, as well as inside and among sectors and their respective structures. The contribution of the industrial sector is evident in

both exports and import substitution, according to the Ministry of Industry. From independence in 1956 until the last quarter of 1999, the contribution of the industrial sector to the GDP did not exceed 9% and then rose to 14% after the export of oil (Jaami, 2025). The average share in GDP is 16.95% during the study period, according to the World Bank.

The service sector includes several key components: transport and communications, technology, the financial and banking sector, and tourism and hospitality. The sector has suffered from severe pressures as a result of its impact on security events, which led to a rise in poverty rates to reach 73. The average unemployment rate (17.7%) exceeds the average growth rate of 4.9% (Amin and Ahmed, 2019). The World Bank published the average share of services in GDP as 41.33% during the period 1982-2023. However, imports of Sudan's services sector are in the range of 12.5% to 15% of the country's total import bill in stable economic conditions.

This article seeks to answer the question: Do imports enhance the technical efficiency of Sudan's economy?

LITERATURE REVIEW

Jaamei (2025) studied the relationship between political stability and economic development in Sudan between 2000 and 2024 to clarify the notion of economic development and to examine its benefits and downsides. The key issues were about the impact of political stability on economic development and the obstacles experienced during this period. The research found a large gap in economic philosophy to form the legal and legislative basis of programs. The results showed a statistically significant positive relationship between political stability and economic progress. Macroeconomic stability can be achieved via economic reforms.

The use of the PESTEL framework by Marlyrets and Budrain (2024) was to assess the export-import potential of state-owned companies. Quantitative and qualitative analyses were used to evaluate the influence of political, economic, social, technological, legal, and environmental issues on the development of state-owned economic organizations. A sophisticated export-import monitoring technology was developed to explore potential and avoid adverse outcomes. For the strategy assessment, a SWOT analysis was used for estimation of strengths, weaknesses, opportunities, and threats of export-import planning of state-owned businesses with the use of multistage technology. SWOT analysis demonstrated that the proposed tool could be used to monitor the export-import potential of state-owned enterprises. They must know their export-import potential before the war. Profitable enterprises have multiplied due to military aggression. State-owned enterprises are the main employers and source of social stability. Investment in production and technological development has shrunk. Some territories are not suitable for economic activities. The economic entities are regulated by state law. The SWOT analysis showed the opportunity to implement the proposed instrument for monitoring the export-import potential of state-owned enterprises.

Macharia (2024) used a twofold bootstrap data envelopment analysis (DEA) on firm-level data from the World Business Environment Survey (WBES) to assess technical efficiency and its determinants in the service sectors of selected SSA countries. However, the empirical investigation was done at both the national and sub-sector levels. The nations of interest are Kenya, Uganda, Tanzania, Ghana, the Democratic Republic of the Congo, and Zambia. The recognized sub-sectors are hotel, retail, wholesale, information technology, automotive services, and transportation. The results show a significant possibility for Sub-Saharan Africa to increase technical efficiency.

Dhyne et al. (2023) highlighted the role of imports in boosting the efficiency of a firm’s product in Belgium between 1997 and 2007. They found that organizations are less efficient when producing things outside their core goods and tend to focus on their areas in the face of competition.

The empirical work of Yun (2026) underlined the function of imported capital goods as an effective route of technology transfer that resulted in the outward shift in the firm’s capabilities. Technical efficiency in Vietnam is increasing. Baku et al. (2025) showed the role of raw materials in the efficiency of the manufacturing sector. He discovered inefficiency in the Indonesian manufacturing sector. Conversely, imported resources led to higher export efficiency in Indonesia.

The use of cross-sectional survey data by Deraniyagala (2010) was to examine the impact of technology accumulation on technical efficiency at the firm level in the Sri Lankan textile and agricultural machinery industries. The econometric analysis of the economic effects of technical progress in developing countries is limited, and this study seeks to fill this gap in the literature. The data suggests that simple adaptive technical changes have a considerable positive impact on productivity in both industries. Moreover, in the arrangement of aspects related to technical competency and training, we found that the arrangement of aspects related to technical competency and training serves as a major predictor of efficiency.

Henry et al. (2003) estimated an international production frontier using data on inputs and outputs from 57 developing countries over the period 1970–1998 by controlling for region-specific and country-specific technical know-how and competitiveness. Capital imports provided the necessary technical know-how and competitiveness. through capital imports. Their results were consistent with similar investigations.

Theoretic Background

Technical efficiency is defined as the maximum output produced from a given set of inputs, where maximum output is achieved relative to potential output. It is basically related to productive efficiency, which emphasizes minimizing production costs, and allocative efficiency, which requires optimal resource distribution. The importance of efficiency is apparent in the available types, i.e., X-inefficiency, productive efficiency, allocative efficiency, dynamic efficiency, X-efficiency, scale efficiency, and social efficiency. Imports transfer advanced technology and increase competition, and the provision of raw materials. Nonetheless, dependence on imports solely may endanger the economy through shocks to supply chains. The impact of imports can be studied via sector-specific studies conducted in the USA, Vietnam, and Nepal. There are two main methodologies to measure efficiency: data envelopment analysis and stochastic frontier analysis.

Lovell (1995) converted the $y \leq f(x,z;\beta)$ into equality $y_i = f(x_i,z_i;\beta)exp\{v_i + u_i\}$ where $i = 1,\cdots,I; exp\{u_i\} \leq 1$. He assumed that the term v_i is identically and independently distributed as $N(0,\sigma_v^2)$. The term u_i is distributed independently from v_i and to satisfy $u_i \leq 0$. The nonpositive term u_i allows the observed output to fall to the maximum possible, which is not determined by the deterministic production function $f(x_i,z_i;\beta)$. But by the stochastic production frontier $f(x_i,z_i;\beta)exp(v_i)$. The econometric approach converts. u_i into a measure of technical efficiency of the relationship:

$$F_0(x,y,z;\beta) = \frac{f(x_i,z_i;\beta)exp\{v_i\}}{y_i} = exp\{-u_i\}$$

RESULTS

The Penn World Table version 11 (PWT) included data on real GDP (rgdpe), labor (emp), and capital stock (cn), which were then translated into natural logarithms, indicated as "y" for real GDP, "l" for labor, and "k" for capital stock, respectively. The import share of GDP was collected from the World Bank statistics. The sample period covered the years 1970 through 2023. The model includes two variables: random noise "v," which represents meteorological conditions, misclassification, omitted sudden market fluctuations, luck, or data measurement errors, and the inefficiency term "u."

The proposed model in transcendental logarithmic form:

$$ln(Q) = ln\beta_0 + \beta_1 ln(L)_i + \beta_2 ln(K)_i + \frac{1}{2}\beta_3 \ln(L)_i^2 + \frac{1}{2}\beta_4 \ln(K)_i^2 + \sum_{i=1}^{n} \beta_5\, ln(L)_i ln(K)_i$$

Table 1: Estimation Results

Stoc. frontier normal/half-normal model			Number of obs = 54	
			Wald chi2(5) = 1913.97	
Log likelihood = 28.444259			Prob > chi2 = 0.0000	
Y	Coefficient	Std. err.	Z	P>|z|
l	4.708143	1.917908	2.45	0.014
ls	-5.411034	1.745447	-3.10	0.002
k	4.673351	1.542309	3.03	0.002
ks	-.2181995	.0741154	-2.94	0.003
lk	.3507929	.1027311	3.41	0.001
cons	-17.89072	-17.89072	-2.08	0.038
lnsig2v				
cons	-3.959011	.2019787	-19.60	0.000
lnsig2u				
imp	-1.489931	-1.489931	-1.489931	0.000
sigma_v	.1381376	.0139504		

Source Stata 17

Together, labor and capital exhibit positive coefficients that are statistically significant at the 1% level; however, their squared terms were negative. This result means that while increases in these production factors enhance output at elevated levels, the rate of increase diminishes gradually, i.e., the law of diminishing marginal returns. The impact of labor on output is 1% greater than that of capital stock, while the increase in capital stock at the high level is diminishing less slowly than labor by 4%.

The interaction term between capital stock and labor dictates how effectively inputs are transformed into production. The magnitude of the interaction elasticity of 0.35 between labor and capital in the model is a strong positive indicator that reflects the nature of the economic relationship between these two inputs.

The negative sign of the import share to GDP of -1.49 means, from an economic impact perspective, that the variable leads to a reduction in inefficiencies, which is very positive for the economy. Thus, reducing inefficiency automatically means increasing technical efficiency.

The coefficient of sigma_v, 0.138, indicates the standard deviation of net idiosyncratic errors. Thus, all factors beyond control contribute to 13.8% oscillations in production. However, the small percentage means that the analyzed samples have statistically low noise and that the data are correct and dependable. This value cannot be read entirely on its own; it is always associated with the technical incompetence coefficient sigma_u.

DISCUSSION

The salient result was the obvious influence of imports on enhancing efficiency. Sudan requires modern technology to reach the development stage. Imports embody new technology, but they come at the cost of increasing trade expenses and existing disparities when exports fall short of imports. The worsening of the exchange rate and the rising cost of living may lead to inefficiency. The maximization of imports benefits the nation through improving the efficiency of the economy and the production system and prevents these negative aspects. Such a strategy would enhance exports and output, bridge gaps, and facilitate the acquisition of endogenous technical know-how.

There is a need for investment in production technologies, given the adverse effects of military aggression on economic viability and job stability in the state sector. Imports may assist in the fight against poverty and unemployment by raising productivity in small and medium-sized firms (SMEs) and families that have grown and are financed by specialized banks. Sudan needs projects with high labor intensity, i.e., projects with high human labor requirements and relatively higher labor costs than capital costs for machines. Traditional agriculture, infrastructure, textiles, manufacturing, and social services are labor-intensive projects. Economic crises around the world lead to poverty and unemployment, especially for young entrepreneurs. The multilevel monitoring technique developed by Malyarets and Budarin to assess the export-import potential of economic enterprises in the state sector could be used in the case of Sudan, where the PESTLE framework and the 17-step process that was developed to be consistent with export-import objectives, including SWOT analysis, are applicable.

CONCLUSION

The application of the translog production function displayed a positive impact of imports on the technical efficiency of Sudan's economy. The estimated elasticities of capital stock and labor were meaningfully positive, i.e., in line with economic theory. The estimated coefficient of the interaction between capital and labor commands how effectively inputs are transformed into production.

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CITATION
Arabi, K. A. M.& Moukhtar, A. M. A. (2026). The Impact of Imports on the Technical Efficiency of Sudan's Economy. In Global Journal of Research in Humanities & Cultural Studies (Vol. 6, Issue 4, pp. 44–48).
https://doi.org/10.5281/zenodo.21630574