economies

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Why Has Trade Barely Moved Sub-Saharan Africa to Its Economic Potential?

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Abstract: The rise in global trade volumes since the early 90s has been welcomed by many under the notion that trade helps countries edge closer to their economic potential. A concerning observation, however, is that while Asia, Latin America, and Europe seem to have witnessed a discernible rise in per capita income during this period and moved closer to their economic potential, sub-Saharan Africa (SSA) does not seem to have recorded as much success. Defining economic potential as maximum possible income from given resources and existing technology, the results presented here for a panel of 22 sub-Saharan countries observed between 1995 and 2021 confirm that the region's ability to edge closer to its full potential was heavily undermined by its small and shrinking manufacturing sector, a result that is replicated by counterfactual methods. In policy senses against this background, SSA may need to reconsider its widespread deindustrialization model and rejuvenate manufacturing. This policy implication feeds into the broader discussion of premature deindustrialization in SSA and its economic consequences. Evidence suggests that reversing this trend through expanding manufacturing potentially lifts about 50% of the sampled countries (including Rwanda, Togo, Guinea, Niger, Sierra-Leone, Gambia, Benin, Uganda, and Mozambique) from low-income status to middle-income status.

Keywords: international trade; the manufacturing sector; deindustrialization; economic potential; sub-Saharan Africa

JEL Classification: E30; E52; E4

Citation: Mazorodze, Brian Tavonga. 2023. Why Has Trade Barely Moved Sub-Saharan Africa to Its Economic Potential? *Economies* 11: 259. https://doi.org/10.3390/economies11100259

Academic Editor: Bruce Morley

Received: 20 June 2023
Revised: 15 September 2023
Accepted: 19 September 2023
Published: 20 October 2023

1. Introduction

One of the old propositions in economics is that international trade helps countries move closer to their production frontier. The World Bank and the International Monetary Fund (IMF) both seem to take an affirmative stance on this view, a position which, to a larger extent, motivated their push for structural adjustment programs in the early 90s. MacDonald (2018), Deputy Division Chief in the IMF's External Sector Unit opines, in support of this viewpoint, that nations are almost always better off when they buy and sell from one another, a narrative which is not far off from the World Bank's regard of trade as an avenue through which poor regions can grow and catch up with richer ones.

While the above proposition is mostly popular in the Global North, a puzzling question for those in the Global South is, if trade helps countries move closer to their full potential, why has sub-Saharan Africa barely benefited in practice? The region has mostly enjoyed a good spell of international trade since the early 90s supported by trade liberalization and to a large extent favourable commodity prices. Yet it remains, by all accounts, one of the poorest regions in the world. Looking at the numbers from the World Bank, there is little debate that the trade pay-off was, in the last three decades, noticeable in Asia, Latin America, and Europe and considerably less so in sub-Saharan Africa. Between 1970 and 2021 for instance, Latin America combined with the Caribbean region remarkably registered a 95% growth in real per capita income from about USD 4134 in 1970 to USD

8022 in 2021. South Asia climbed by a staggering 365% from USD 396 per person in 1970 to USD 1843 in 2021. Europe and Central Asia's per capita income jumped by 131% from USD 10,455 to USD 24,168. For sub-Saharan Africa, real per capita income only upped by a mere 16.7% from USD 1367 in 1970 to USD 1598 in 2021 which is a barely discernible improvement in comparison to what transpired elsewhere.

Several explanations have been suggested in the literature against the above background. McMillan et al. (2014) for example attribute this unwelcoming experience to sub-Saharan Africa's odd structural transformation that moved labour in the wrong direction, i.e., from high- to low-productivity activities. This, by implication, would have either reversed or at least neutralized the ability of international trade to lift sub-Saharan Africa. Another possible explanation subsequently raised in Rodrik (2016) relates to premature deindustrialization, a phenomenon in which Africa's industrialization is argued to have peaked sooner and at relatively lower levels. This would suggest in the context of globalization that sub-Saharan Africa may have failed to benefit massively from global trade due to premature deindustrialization which constrained the region's productive capacity in the tradable sector.

Reacting to the above background and building on the later explanation, this paper raises the following research question: did the size of Africa's manufacturing sector influence the ability of trade to push Africa toward its economic potential? Based on this research question, the paper tests the hypothesis that Africa's share of manufacturing may have plummeted to a level that is incapable of providing the much-needed productive capacity in the wake of increased trade intensities. Defining economic potential as the maximum possible level of output from given resources and existing technology, it complements both firm-level and industrial-level studies linking trade and technical efficiency (Tybout et al. 1991; Mok et al. 2010; Chu and Kalirajan 2011; Yang et al. 2013; Chaudhuri 2016; Mazorodze 2020; Mazorodze et al. 2021) by shedding light on whether micro-efficiency gains arising from international trade confirmed in these studies ultimately move countries at macro level closer to their production frontier.

The rest of the paper is organised as follows: Section 2 begins by providing a confirmation of SSA's relative backwardness and its relatively small manufacturing sector. Contained in the same section is a theoretical model on which the empirical analysis will be based. The methodology and results presentation are covered in Sections 3 and 4, respectively, before the concluding remarks and policy implications in Section 5.

2. International Trade, Industrialization and Productivity: Setting the Scene

2.1. Evolution of SSA's Trade and Manufacturing

Sub-Saharan Africa, a region of 49 countries, has made discernible progress in global markets. This section descriptively demonstrates that the region's progress in global markets did not culminate in the much-needed productivity growth due to the region's concomitant decline in the share of manufacturing. Although not causal, this demonstration is necessary to the extent that it (i) graphically illustrates the degree to which Africa lagged other regions with respect to per capita income and economic potential despite having expanded trade volumes significantly and (ii) shows that Africa's share of manufacturing was one of the lowest in relative terms. The region's exports and imports have steadily increased in nominal terms since the 1940s thanks to the remarkable increase in trade integration (see Figure 1).

Despite the impressive trade volumes displayed in Figure 1, sub-Saharan Africa continues to lag the rest of the world economically. This lagging can be demonstrated in two ways. One, the region had one of the lowest per capita incomes in comparison to other regions. Two, the region travelled the least distance toward an estimated economic frontier relative to other regions. Figure 2 demonstrates the former. Evidently, SSA together with Oceania has had the lowest per capita income since the early 1970s.

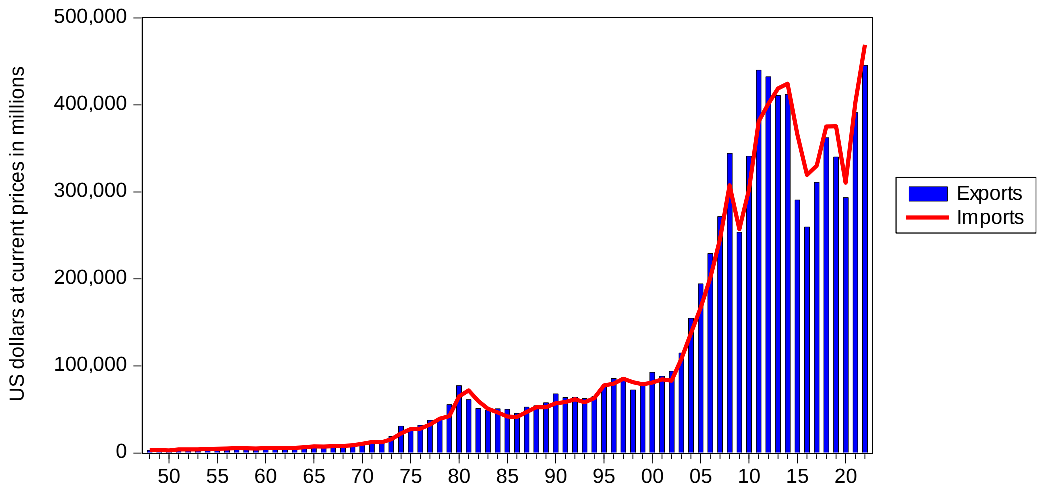

Figure 1. Sub-Saharan Africa's trade performance 1948–2022. Author's computation using data from UNCTAD.

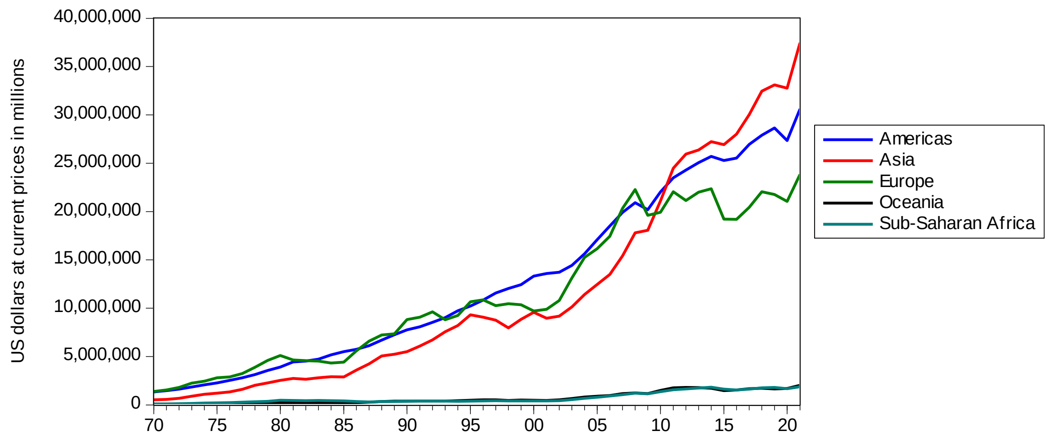

Figure 2. Evolution of regional income per capita (1970–2010). Source: own computation using data from WDI.

Figure 3 shows the average observed per capita income for each region as a share of potential income between two periods (before 2005 and after 2005) where potential income is estimated through[1] a true fixed effects panel stochastic frontier model. Asia moved from 0.77 to 0.88 between the two periods. Europe impressively moved from 0.87 to 0.98, which represents an output shortfall of only 2 percentage points. The Americas (North and South) moved moderately from 0.79 to 0.84. Worrisomely for SSA, observed income only upped from 0.73 to 0.75.

In differences, this means Asia and Europe closed their productivity gap by a similar magnitude, 11 percentage points, followed by the Americas, 5 percentage points. Sub-Saharan Africa only marginally closed its productivity gap by 2 percentage points, which is the lowest in relative terms (see Figure 4).

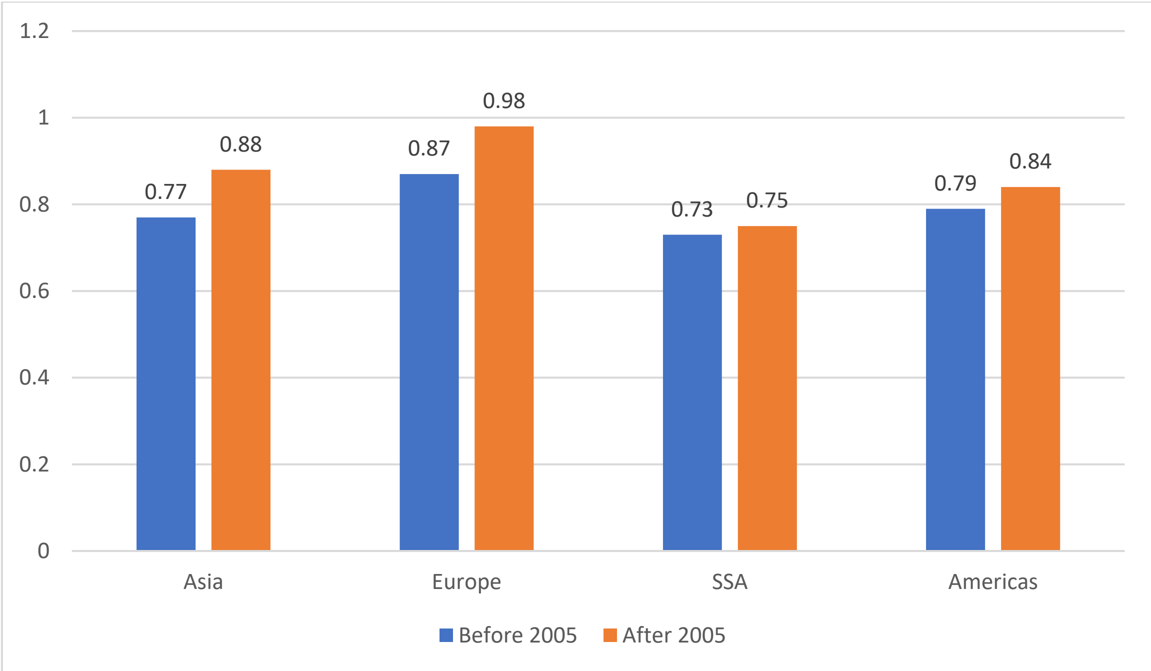

Figure 3. Observed regional income as a share of potential income. Source: authors' estimations based on a stochastic frontier model.

Figure 4. Change in observed income towards the frontier income. Source: authors' estimations based on a stochastic frontier model.

The hypothesis raised here is that the region's ability to benefit from trade with respect to moving toward its economic potential may have been undermined by a relatively small share of manufacturing. In addition to being the smallest in relative terms, the region's share of manufacturing declined for the best of the period since 1970 (see Figure 5).

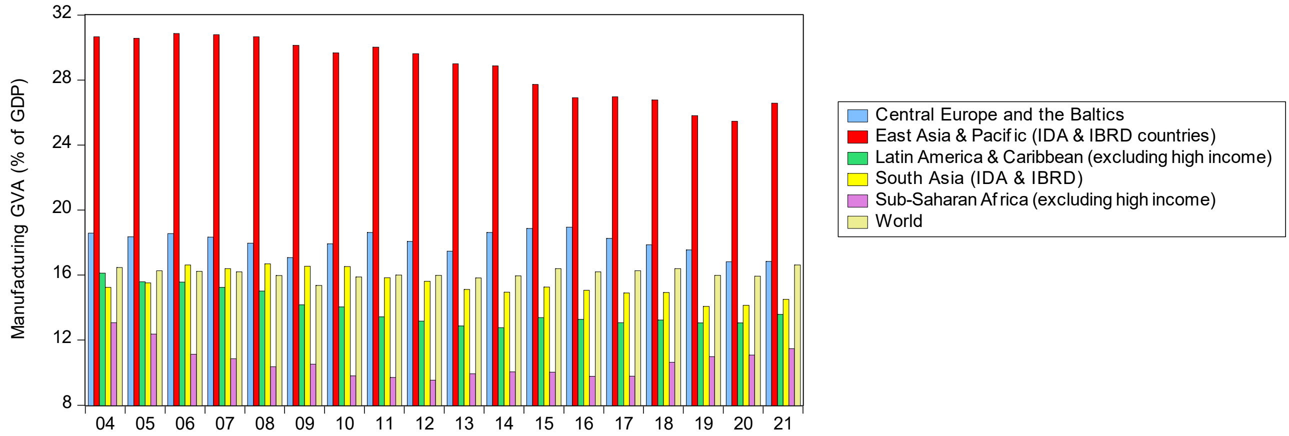

Figure 5. The regional shares of manufacturing GVA on GDP. Source: own computation using data from WDI.

The research hypothesis raised here stems from the widespread observation in which the dominant developmental role of manufacturing activities such as rubber and textile in South Africa, iron ore and steel and metal fabrication in Zimbabwe, apparel in Kenya, and footwear in the DRC has been largely inherited by services and perhaps prematurely so. The contribution of service industries in most African countries has expanded at the expense of manufacturing. This is concerning on at least four accounts. One is the well-documented role of manufacturing as a productivity escalator, a role that holds ancestry in dual economy models of Lewis (1954). Key to this role is the manufacturing sector's possession of several attributes that distinguish it from the rest of the economy while placing it at the centre of economic development particularly in countries pursuing an outward growth orientation. Two is the argument raised by Rodrik (2008) that the expansion of manufacturing industries for developing regions not only improves resource allocation but also dynamic gains over time. Three, the manufacturing sector is tradable and therefore unconstrained by domestic demand. Four, the manufacturing sector has a higher ability to employ workers with limited formal education and is therefore likely to pull people with limited skills into the middle class. Agriculture and mining are equally tradable, but their developmental role is limited as countries integrate into the global economy. The former is tradeable, but productivity growth is traditionally low, and workers tend to earn lower wages in relative terms. The latter is tradeable, but its capital-intensive nature places a relatively lower employment ceiling. In addition, despite being tradeable like manufacturing, its growth engine quickly runs out of steam as the exploration for minerals comes at the cost of degradation and depletion of the environment.

These attractive features of manufacturing which Africa hardly maximised are evident in international experiences. One clear case is that of China. The now Asian giant had an illustrious three decades of stellar growth. Key to its remarkable economic progress was an initial focus on the labour-intensive light manufacturing in the 1980s and early 1990s. Manufactured goods such as apparel, footwear, furniture, and toys were as dominant in the early stages of China's success, just as they had been for Korea and Japan. Similarly, Thailand has transformed itself into an economic powerhouse, growing, according to World Bank data, at a rate of 5 percent annually between 1999 and 2005, creating millions of jobs that helped lift millions out of poverty. Key to its success was an export-led growth model that culminated in job creation for workers with limited skills within the manufacturing sector. The once poor Asian nation continues to rely increasingly on the manufacturing sector both in terms of supplying goods for domestic consumption and as a foreign currency earner on the export market. As traditional industries such as agriculture play a proportionally smaller role in the economy overall, manufacturers are taking up an increasingly large share of exported goods and accounted for around 88% of total free-on-board export value in 2015, according to Bank of Thailand statistics. These experiences raise the question, could a shrinking manufacturing sector have robbed Africa the opportunity to fully benefit from trade? The next section outlines the theoretical model from which this hypothesis is tested.

2.2. Theoretical Model

In this section, I attempt to provide intuition to my hypothesis that manufacturing matters. Because I am assuming, as I will justify later, output-oriented technical efficiency, I must theoretically present a case in which a sub-Saharan economy can logically raise output without necessarily accumulating more input factors. In practice, output depends on several inputs, but for the purpose of instilling intuition to my exposition, I only demonstrate using a case of capital. Although this has a virtue of simplicity, it can also be generalised to a multi-input case without loss of generality. As a starting point, it is necessary to acknowledge that the output-oriented technical efficiency assumption requires one to explain how an economy can close its productivity gap without necessarily having to increase its stock of capital and adopt new technology. To explain this, I break down an economy into two broad sectors, namely tradable (T) and non-tradable (N) sectors. The former can include mining and agriculture, but I deliberately stick to manufacturing (M) for reasons given in the previous section. The latter can take the shape of services (S) such as banking, finance, real estate, and so on. Because the economy's stock of capital is fixed by assumption ($\bar{k}$) (to allow for output-oriented technical efficiency gains), observed output is by implication possible with a reallocation of capital between manufacturing (M) and the service sector (S). This again rests, for simplicity, on the assumption that investors treat manufacturing and services as substitutes, i.e., they cannot invest in both sectors and that there are no transactional costs involved in reallocating capital from services to manufacturing and vice versa. While the former is a strong assumption, it is generally consistent with most sub-Saharan cases where savings rates are low, as recently confirmed in Loko et al. (2022), and investors must choose between competing sectors when making investment decisions.

Like Rodrik (2008), I further assume that the allocation of capital between manufacturing and the service sector depends on the relative demand for the two goods produced in respective sectors and on the relative profitability of producing them. There are two ways to proceed from here which yield similar implications. One way is to assume that services are constrained by domestic demand and that profitability in manufacturing is partly a function of the demand for services. In this case, private firms in manufacturing will retain a share of $1 - D_s$, where Ds is the demand for services proxied by the share of services GVA on total output. This means the share retained by firms in manufacturing will increase with a smaller Ds, the demand for services. Because the demand for manufacturing is unconstrained by domestic demand, and the high degree of tradability to some extent prevents or at least delays diminishing returns to capital, the reallocation of capital from services to manufacturing will increase aggregate output and therefore move the economy closer to its production frontier. Consumers spend their income on a single final good by assumption, whose production makes use of both tradable and non-tradable inputs. Their intertemporal utility function is time-separable and logarithmic and takes the form

$$\mu = \ln c_t e_t^{-\rho} dt,$$

where c_t is consumption at time t and ρ is the discount rate. Maximizing utility subject to an intertemporal budget constraint yields the familiar growth equation

$$\dot{c}_t / c_t = r_t - \rho$$

where r is the marginal product of capital which positively relates with an economy's growth rate. This feature is central to the model in so far as it plays a part in incentivizing investors to reallocate capital from services to manufacturing and vice versa. On the production side, the economy produces a single final good using both tradable and non-tradable goods as inputs based on a Cobb–Douglas technology. Further assumed is that capital bears external economies in the production of the final good to accommodate an endogenous growth process. This yields a production function of the form

$$y = \bar{k}^{1-\varphi} y_T^{\alpha} y_N^{1-\alpha} \tag{1}$$

where y_T and y_N represent the quantities of tradable and non-tradable goods used in the production of the final good y, k is the capital stock which is exogenous to each final good producer, and α is the share of y_T in the production costs so that $1-\alpha$ becomes the share of y_N by complementarity. In addition, y_T and y_N are in turn produced using capital alone subject to decreasing to returns to scale as follows.

$$q_T = A_T k_T^{\varphi} = A_T \left(\theta_T \bar{k}\right)^{\varphi} \tag{2}$$

$$q_N = A_N k_T^{\varphi} = A_T \left[(1-\theta_T)\bar{k}\right]^{\varphi} \tag{3}$$

where k_T and k_N denote the capital stock employed in the tradable and the non-tradables sector, respectively; θ_T is the share of capital employed in tradables, $0 < \theta < 1$ and $0 < \varphi < 1$. In addition, q_T used as inputs in y can only be domestically sourced by definition, and since they do not enter consumption directly, we have

$$q_N = y_N \tag{4}$$

Because tradables are unconstrained by domestic demand, a transfer term can be introduced into the model whose inward magnitude is b. This term essentially allows the economy to either receive from or pay the rest of the world (ROW, hereafter). With b, the material balances equation in y_T becomes

$$q_T + b = y_T$$

For convenience, this b can be viewed as a share γ of aggregate domestic demand for y_T, which means we can write $b = \gamma y_T$. The equality between demand and supply in tradables then becomes

$$\frac{1}{1-\gamma} q_t = y_T \tag{5}$$

Using Equations (2) through (5), one can express the aggregate production function as

$$y = (1-\gamma)^{-\alpha} A_T^{\alpha} A_N^{1-\alpha} \theta_T^{\alpha\varphi} (1-\theta_T)^{(1-\alpha)\varphi} \bar{k}. \tag{6}$$

Net output $\widetilde{y}$ differs from gross output in that it either pays the ROW for the transfer of b or receives payment from it in cases where $b < 0$. This payment can be expressed in the general form assuming that it represents a share (σ) of the transfer's contribution to gross output. In equivalent terms,

$$\sigma \times (\partial y/\partial b) \times b = \sigma \times (\partial y/\partial y_T) \times \gamma y_T = \sigma \times (\alpha/y_T) y \times \gamma y_T = \sigma\alpha\gamma y$$

and

$$\widetilde{y} = (1-\sigma\alpha\gamma)(1-\gamma)^{-\alpha} A_T^{\alpha} A_N^{1-\alpha} \theta_T^{\alpha\varphi} (1-\theta_T)^{(1-\alpha)\varphi} \bar{k} \tag{7}$$

Because the production function ends up being of the Ak type, that is, linear in capital, we arrive at an endogenous growth model with no transitional dynamics in which the (net) marginal product of capital (r) is essentially the first derivative of the net output function $\widetilde{y}$ with respect to $\bar{k}$. This yields

$$r = \partial\widetilde{y}/\partial\bar{k} = (1-\sigma\alpha\gamma)(1-\gamma)^{-\alpha} A_T^{\alpha} A_N^{1-\alpha} \theta_T^{\alpha\varphi} (1-\theta_T)^{(1-\alpha)\varphi} \tag{8}$$

which is independent of the capital stock but depends on the allocation of capital between y_T and y_N, θ_T, as well as on the net value of the transfer from abroad.

$$\frac{d\ln r}{d\theta_T} \propto \left[\left(\frac{\alpha}{\theta_t}\right) - \left(\frac{1-\alpha}{1-\theta_t}\right)\right],$$

with

$$\frac{d\ln r}{d\theta_T} = 0 \Leftrightarrow \theta_T = \alpha$$

This implies that the return to capital is maximized when the share of the capital stock allocated towards tradables (θ_T) is exactly equal to the input share of tradables in final production (α). This rate of return, and ultimately the economy's growth rate, will be suboptimal when tradables receive a smaller share of capital. Figure 6 attempts to illustrate the model's mechanics in a crude way. On the left is a country's aggregate production function in which point C is a point of inefficiency and C-B and C-A are distances from the economic frontier $y = f(x)$. For a sub-Saharan country operating below its economic potential at point C, reaching potential income can be attained through either getting more from the fixed input $\bar{k}$ and moving from Y^i to Y^o or attaining the same level of income Y^i but with fewer inputs (i.e., moving from C to B). Here, the analysis pursues the first route, getting more from given inputs. On the right is a country-level isoquant which, in this case, shows how the reallocation of capital from the service sector increases the stock of capital in manufacturing. Moving from k^* to k^o therefore signals the influx of capital into the manufacturing sector which in turn, driven by the higher productivity of capital in manufacturing, leverages aggregate income from C to A.

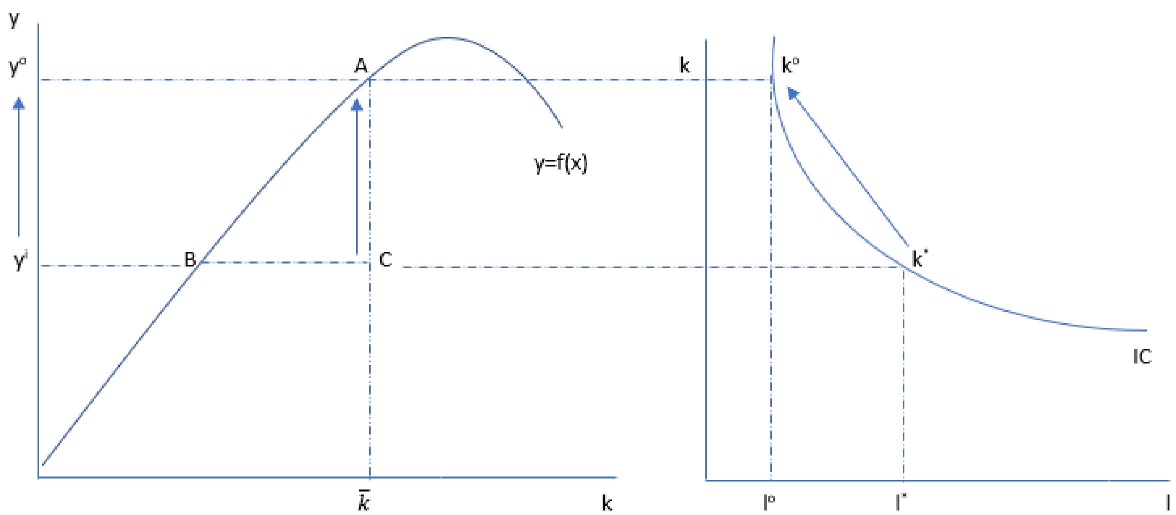

Figure 6. The model's crude mechanics. Source: author's illustration of the model's mechanics.

The allocation of capital between the tradable and the non-tradable sectors will depend both on the relative demand for the two goods and on the relative profitability of producing them. Because manufacturing is tradeable and therefore unconstrained by domestic demand, we assume that firms may be incentivized to allocate capital into manufacturing to take advantage of this provision. This brings an additional implication which is that sub-Saharan countries may have failed to take advantage of increased trade intensity because of a shrinking manufacturing sector which was in turn deprived of capital formation relative to services. In other words, the latter suggests that capital may have been disproportionately allocated towards services as part of deindustrialization.

3. Data Description

We have an annual panel dataset comprising 22 sub-Saharan countries[2] observed between 1995 and 2021. The selection of the sampling period and the 22 countries was based on data availability. Our variables are GDP per capita at constant prices, total labour force, gross capital formation, government general consumption, trade, and gross value added of the manufacturing sector. Apart from GDP per capita and labour force, all other variables are percentages of GDP. Data on all our variables were sourced from the World Development Indicators (WDI). From the WDI, manufacturing is recorded at one digit level, and it refers to the sum of industries belonging to ISIC divisions 15–37. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3.

Our hypothesis is that SSA did not significantly edge toward its economic potential in the wake of increased trade intensities owing to a small manufacturing sector. It is therefore necessary from this hypothesis to begin with defining and measuring economic potential. Empirically, economic potential is unobservable and must be estimated. We define it in this regard as the maximum possible output from given resources and existing technology. In addition, the gap between each African country's per capita income and the estimated potential income is treated here as the response variable which is commonly referred to as technical efficiency. The extent to which this variable responds to changes in trade volumes and the share of manufacturing is essential to answering the research hypothesis. Because, as alluded to shortly, the variable is unobservable, the entry point of the model specification section involves the measurement of each country's output shortfall from an estimated frontier based on a production function approach that decomposes output deviations from the frontier into two parts, namely stochastic deviations and inefficiency.

Measuring Technical Efficiency

The gap between observed output and potential output is broadly measured using two approaches, namely the Stochastic Frontier Analysis (SFA) and the Data Envelopment Analysis (DEA). The latter is largely deterministic, which makes it likely to exaggerate the levels of technical inefficiencies due to its inability to separate noise from inefficiencies. The SFA method used in this paper addresses this limitation by decomposing the error term into two parts, the stochastic component and the inefficiency component. In the main, the SFA by Farrell (1957), Aigner et al. (1977), and Battese and Coelli (1992) uses a microeconomic approach to measure technical efficiency (Kumbhakar et al. 2015), but it has been applied at country level in Mastromarco and Ghosh (2009), Jin and Kim (2019), and more recently, Sun et al. (2020) and Auci et al. (2021). In a standard stochastic frontier setting, estimating country-level technical efficiency would imply a country-level production function in which per capita income is a function of labour and capital.

$$y = f(x) \tag{9}$$

From Equation (9), y is output, and x is a vector of inputs comprising labour and capital. We extend the standard use of labour and capital at country level by adding government spending in a bid to capture the heavy presence of the state in sub-Saharan Africa. Because much policy interest on sub-Saharan Africa's sluggish economic performance raised recently at the 2023 World Economic Forum has revolved around the question of how the region can get the best out of its available resources to meet the demands of a growing population, we find it reasonable to assume output-oriented technical efficiency. Regarding the selection of the functional form, which is critical (Battese and Broca 1997; Giannakas et al. 2003; Van Nguyen et al. 2021; Aigner et al. 1977; Stevenson 1980), we start off with the Translog version of the stochastic frontier specification, which takes the following specific form.

$$\begin{aligned}\log(output)_{it} + \beta_i + \beta_1 \log(labour)_{it} + \beta_2 capital_{it} + \beta_3\, g\_spending_{it} \\ +\beta_4 year + \tfrac{1}{2}\delta_1 \log(labour)_{it} \times \log(labour)_{it} \\ +\tfrac{1}{2}\delta_2 capital_{it} \times capital_{it} \\ +\tfrac{1}{2}\delta_3 g\_spending_{it} \times g\_spending_{it} + \tfrac{1}{2}\delta_4 year \times year \\ +\tfrac{1}{2}\gamma_1 \log(labour)_{it} \times capital_{it} \\ +\tfrac{1}{2}\gamma_2 \log(labour)_{it} \times g\_spending_{it} \\ +\tfrac{1}{2}\gamma_3 \log(labour)_{it} \times year + \tfrac{1}{2}\gamma_4 capital_{it} \times g\_spending_{it} \\ +\tfrac{1}{2}\gamma_5 capital_{it} \times year + \tfrac{1}{2}\gamma_6 g\_spending_{it} \times year + v_{it} - u_{it}\end{aligned} \tag{10}$$

$$i = 1, \ldots, 22;\; t = 1995, \ldots, 2021$$

$$v_{it} \sim iid\; N\left(0, \psi^2\right)\; u_{it} \sim iid\; F_u(\sigma)$$

where year is included to capture potential frontier shifts and its interaction with frontier variables is meant to capture Hicks non-neutral technical change. Technical efficiency scores were then computed via Jondrow et al. (1982) as

$$TE_{it} = exp(-u_{it})$$

The generated technical efficiency scores[3] were subsequently used as the dependent variable to establish how international trade influences technical efficiency below and above an estimated threshold of industrialization. To this effect, we estimate both a dynamic and a static specification assuming in separate variants a kink and a jump for robustness purposes. Following Seo and Shin (2016), the kink dynamic threshold model takes the following form.

$$y_{it} = x'_{it}\beta + \kappa(q_{it} - \gamma)1\{q_{it} > \gamma\} + \mu_i + \varepsilon_{it} \tag{11}$$

$$i = 1, \ldots, n; t = 1, \ldots, T$$

where x contains trade (as a percentage of GDP) and the lagged dependent variable (TE_{it-1}) and q_{it} is the threshold variable (manufacturing sector's gross value added as percentage of GDP). The discontinuity model without a kink is of the following form.

$$y_{it} = \beta_0 + x'_{it}\beta + q'_{it}\omega + (\delta_0 - \delta'_1 x_{it} + \delta'_2 q_{it})1\{q_{it} > \gamma\} + \mu_i + \varepsilon_{it} \tag{12}$$

First, differencing Equations (11) and (12) removes the incidental parameter μ_i, while endogeneity is taken care of through the GMM estimation which ensures consistency and unbiasedness on β, δ, and γ (Seo and Shin 2016). This yields Equations (13) and (14), respectively.

$$\Delta y_{it} = \beta_0 + \Delta x'_{it}\beta + \Delta q'_{it}\omega + (\delta_0 - \delta'_1 x_{it} + \delta'_2 q_{it})1\{q_{it} > \gamma\} + \Delta\varepsilon_{it} \tag{13}$$

and

$$\Delta y_{it} = \Delta x'_{it}\beta + \kappa(q_{it} - \gamma)1\{q_{it} > \gamma\} + \Delta\varepsilon_{it} \tag{14}$$

The dynamic threshold model in Equations (12) and (13) requires one to first test for non-linearity using a bootstrap algorithm that is based on the following null hypothesis:

$$H_o : \delta_0 = 0,\; \text{for any}\; \gamma \in \Gamma,$$

where Γ denotes the parameter space for γ against the alternative hypothesis:

$$H_a : \delta_0 \neq 0,\; \text{for some}\; \gamma \in \Gamma,$$

To take care of the loss of identification under the null, a supremum-type statistic is employed, and it takes the following form.

$$\text{supW} = \sup_{\gamma \in \Gamma} W_n(\gamma)$$

where $W\ (\gamma)$ is the standard Wald statistic for each fixed γ. Diagrammatically, the methods applied in this paper can be crudely presented as shown in Figure 7.

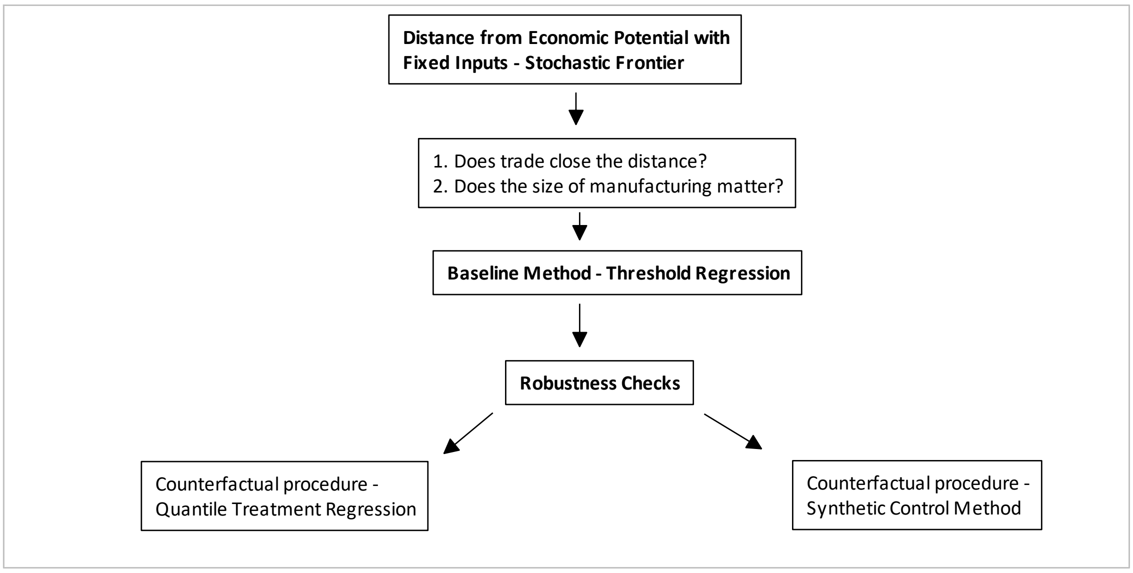

Figure 7. Analytical framework. Source: author's own illustration.

It is necessary to highlight how this methodological exposition is linked to the theoretical model outlined in Section 2.2. Intuitively, the theoretical model demonstrated that at aggregate level with fixed inputs, a reallocation of resources from say services to manufacturing should increase growth and observed output. Since an increase in growth and observed output signals a move toward economic potential by the definition of technical efficiency, one would expect the size of the manufacturing sector to play a role in influencing the extent to which sub-Saharan countries move toward their economic potential in the wake of increased trade intensity. Trade primarily raises aggregate income by expanding tradable sectors; hence, its expansion may not aid the movement of sub-Saharan countries toward economic potential if the manufacturing sector is too small to provide the much-needed lift.

It is also methodologically important to mention at this stage that the baseline method largely ignores stationarity issues, a limitation which may prompt some to regard the results as spurious. This potential criticism makes it necessary to consider additional methods for robustness purposes. In this regard and in addition to the Hansen approach, the analysis considered counterfactual procedures based on quantile regression and the synthetic control method. The analysis is conducted using STATA 17.

4. Empirical Findings

Table 1 shows that a typical sub-Saharan country in the sample had, on average, an income per capita of USD 2114, a labour force comprising about 8.5 million people, investment share of 21 percent of GDP, government spending share of 22 percent of GDP, trade share of 65 percent of GDP, and a 12 percent share of manufacturing gross value added on GDP. The highest income per capita of USD 10,959 is from Mauritius observed in 2019, while the lowest income per capita is from Mozambique recorded in 1995. The smallest share of manufacturing is from Sierra Leone, while the highest share is from

Eswatini (formerly Swaziland). The average share of trade reconfirms the extent to which sub-Saharan countries have intensified trade in the last three decades.

Table 1. Summary statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Gdppc (2015 = 100)	594	2114.334	2739.181	217.6248	10,959.34
Labour force	594	8,465,686	1.16×10^7	269,775	7.06×10^7
GCF	594	21.46502	8.508312	2.424358	60.05831
GCONS	594	14.37496	5.618962	0.9112346	36.21686
Trade_share	594	65.34951	27.81098	16.35219	175.798
Manuf	594	11.4658	5.995024	1.532609	35.21546

Note: Gdppc = gross domestic product per capita, GCF = gross capital formation, GCONS = general government consumption, Manuf = the share of manufacturing GVA on GDP.

Table 2 presents the results on diagnostic tests from functional form, nature of technical changes to the presence of technical efficiencies. The Wald test for joint significance of additional Translog terms enters with a probability value of 0.0000, which strongly suggests rejection of the null hypothesis. This result essentially provides statistical evidence in favour of the Translog specification over the Cobb–Douglas functional form.

Table 2. Diagnostic tests.

Null Hypothesis	*p*-Value	LR Statistic	Decision
$\delta_1 = \delta_2 = \delta_3 = \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = \gamma_6 = 0$	0.00000		Translog
5% LR critical value [9 restrictions] =16.274		2478.31 **	Translog
$\gamma_3 = \gamma_5 = \gamma_6 = 0$	0.00000		Hicks non-neutral technical changes
$\beta_4 = 0$	0.00000		Technical changes
5% LR critical value [1 restriction] = 7.045		7.3074 **	Technical inefficiencies

Note: ** denotes rejection at 5% level.

Next, we estimated the Translog specification with the inefficiency term assumed to follow a half-normal, exponential, and truncated normal distribution. Looking at the results presented in Table 3, both the AIC and BIC values are lowest in the truncated normal distribution case relative to the half-normal and truncated distributions. The Translog specification with a truncated normal distribution was therefore preferred in the estimation of the frontier model and generation of technical inefficiency scores.

Table 3. AIC and BIC tests for model selection.

Distribution	AIC	BIC
Half normal	734.83	900.36
Exponential	260.56	426.10
Truncated normal	−999.31	−829.30

Frontier estimates are not presented here as they were only meant to generate efficiency scores that would be used as the dependent variable in the next step. The generated efficiency scores displayed in Table 4 suggest that efficiency averaged 0.75. This implies that a typical sub-Saharan country produced only three-quarters of its potential output level during the sampling period. To some, an efficiency score of 0.75 might be taken as evidence to suggest that sub-Saharan countries did not, on average, perform poorly as the figure is closer to 1 than it is to 0. Algebraically, however, this average efficiency score means that the average distance to the estimated frontier was, in monetary terms, USD 727, implying that an average sub-Saharan country was short of its economic potential by USD 727 per person. To note the significance of this loss, USD 727 would have moved Rwanda, Togo, Tanzania, Guinea, Niger, Sierra-Leone, Gambia, Benin, Uganda, and Mozambique from low-income status to lower-middle-income status. Namibia would have moved from a lower-middle-income country to an upper-middle-income country. In other words, 50% of the countries in the sample would have moved to a higher income bracket looking at their average income levels during the sampling period had they operated at their maximum level. While earlier studies, such as Ghura and Hadjimichael (1996), Gyimah-Brempong and Wilson (2004), and more recently Nketiah-Amponsah and Sarpong (2019), identified limited investment as growth constraining factors in sub-Saharan Africa, evidence tells a different story in so far as it suggests that the region's case is more than just a story of limited factor accumulation. The region has additionally been underutilizing its available resources and therefore producing below its full potential.

Table 4. Summary statistics of technical efficiency scores.

Variable	Obs	Mean	Std. Dev.	Min	Max
Efficiency	594	0.7524164	0.1705611	0.2337386	0.9999995

From a tabulation of average efficiency scores shown in Table 5, South Africa was the most efficient country during the sampling period, followed by Gabon, Mauritania, Gambia, and Cameroon. The bottom five, i.e., the most inefficient countries, included Kenya, Mozambique, Zimbabwe, Uganda, and Rwanda.

Table 5. Efficiency ranking (1995–2021).

Rank	Country Name	Average Technical Efficiency
1	South Africa	0.900058
2	Gabon	0.881168
3	Mauritania	0.878073
4	Gambia	0.874137
5	Cameroon	0.828581
6	Eswatini	0.81668
7	Benin	0.808758
8	Niger	0.771839
9	Togo	0.760335
10	Botswana	0.759361
11	Ghana	0.756308
12	Namibia	0.745751
13	Nigeria	0.726598
14	Mauritius	0.72161
15	Tanzania	0.714385
16	Guinea	0.699858
17	Sierra Leone	0.694809
18	Kenya	0.689548
19	Mozambique	0.675626
20	Zimbabwe	0.632022
21	Uganda	0.629153
22	Rwanda	0.610353

Having generated the technical inefficiency scores, the next step involved testing for non-linearity. From the results, the null hypothesis of a single threshold is strongly rejected, which essentially means that the share of manufacturing has a non-linear effect on technical efficiency. The analysis proceeded to test the suitability of double and triple threshold models. In both cases, the evidence is in favour of a single threshold model.

On the back of the linearity tests presented in Table 6, single threshold results are presented in Table 7. In total, four regression variants were estimated. The first two variants are from a dynamic threshold model, while the last two are from Hansen's threshold model. Evidently from the first variant, the dynamic threshold model with a kink, the lagged inefficiency term enters positively and significantly at 1% level. The positive sign could reflect efficiency gains emanating from learning over time. Regarding the variable of interest, the threshold point, r, ranges from 0.13 to 0.16, which translates to 13–16 percent share of manufacturing on GDP. Interestingly, the trade share slope before the estimated turning point is negative and statistically significant at the 1% level in three out of three variants, suggesting that trade had a negative association with technical efficiency in countries where the share of manufacturing was below 13–16% of GDP between 1995 and 2021. The slope of the kink in the first variant interestingly turns out to be significantly positive, as does the trade_share_d gauging the effect of trade share on technical efficiency in the remaining three variants. Note that trade_share_d essentially gauges the association between international trade and technical efficiency when the share of manufacturing is above the estimated threshold level. Put together, therefore, the results emanating from both the dynamic and Hansen static model suggest that trade moves countries closer to their economic potential when the percentage of manufacturing value added on GDP is above 13–16%. The inclusion of two controls, government general consumption (gcons), capturing the effect of fiscal policies, and gross capital formation (gcf), capturing the level of domestic investment in the last regression variant, does not seem to significantly alter the basic result. A sizeable share of the manufacturing sector is necessary for sub-Saharan countries to significantly benefit from international trade. This observation agrees with Van Van Ark et al. (2008), who find a large fraction of productivity growth originating in the manufacturing sector. The result is also consistent with structuralist theories of economic development (Kaldor 1966; Thirlwall 1983; Atesoglu 1993; Ocampo et al. 2009) in which a sizeable share of manufacturing plays a key role in fostering overall productivity growth.

Table 6. Linearity tests.

Threshold	RSS	MSE	F-Stat	Prob	Crit10	Crit5	Crit1
Single	0.0004	0.0000	59.38 ***	0.0000	32.0216	37.6719	45.5497
Double	0.0004	0.0000	24.34	0.1867	29.8902	34.2523	56.4326
Triple	0.0004	0.0000	11.20	0.7700	29.3202	33.0772	47.5187

Note: *** denotes $p < 0.01$. Standard errors are in parentheses.

Table 7. Dynamic threshold model results—trade, manufacturing, and efficiency.

	Dynamic Threshold Model		Hansen Static Model	
	Kink	Jump	Jump Without Controls	Jump With Controls
Lag_y_b	0.0602 *** (0.014)	0.971 *** (0.250)		
Trade_share_b	−0.0008 *** (0.0003)	−0.200 ** (0.093)	−0.1244 ** (0.058)	−0.0467 (0.044)
kink_slope	0.0216 * (0.011)			
Trade_share_d		0.3907 *** (0.094)	0.234 *** (0.053)	0.1568 *** (0.040)
GCONS				0.0002 (0.009)
GCF				0.005 *** (0.001)
Cons_d			−0.7176 (0.302)	−0.4377 (0.242)
r	0.152 *** (0.015)	0.136 *** (0.046)	0.1601 [0.1508; 0.1608]	0.1601 [0.1508; 0.1609]
Obs	572	594	594	594

Note: *, **, *** denote $p < 0.1$, $p < 0.05$, and $p < 0.01$, respectively. Standard errors are in parentheses.

The above results are therefore indicative of how a declining share of the manufacturing sector undermines the ability of sub-Saharan countries to climb the productivity ladders that international trade typically provides. Worrisomely, more than three-quarters (77%) of the sampled countries' shares of the manufacturing sector were below 15% of GDP. This suggests that trade may have not facilitated as much efficiency gains in sub-Saharan Africa in comparison to what we saw in Asia partly because the manufacturing sector was not sizeable enough to provide the much-needed productive capacity.

If we separate average efficiency scores for countries whose average manufacturing share on GDP was below 15% and those whose share of manufacturing averaged above 15%, we find the average efficiency level of the former lower than that of the latter by roughly 3 percentage points (see Table 8). Algebraically, this translates to a mean income difference of USD 115. This means countries with a share of manufacturing above 15% would have, on average, needed to add USD 651 to reach their economic potential. Those with a share of manufacturing below 15% would have on top of this USD 651 needed to add a further USD 115 per person to reach their economic potential.

Table 8. Average efficiency scores by size of manufacturing.

Manufacturing Share > 15%		Manufacturing Share < 15%		
Average Efficiency Score	**Mean Income Loss in USD (Distance from the Economic Potential)**	**Average Efficiency Score**	**Mean Income Loss in USD (Distance from the Economic Potential)**	**Difference in USD**
0.77	USD 651	0.74	USD 766	USD 115

As an additional econometric exercise complementary to Table 8, the analysis subdivided the total sample into sample A comprising shares of manufacturing > 15 of GDP and sample B comprising shares of manufacturing $\leq$ 15% of GDP with and without controls. The two specifications were estimated through the feasible generalized least squares technique in the interest of guiding against potential cross-sectional dependence, heteroscedasticity, and autocorrelation. The results presented in Table 9 are supportive of Table 8 as trade enters significantly positive only in specifications (A) where the share of manufacturing is above the 15% estimated threshold level. In these specifications in particular, a percentage point increase in the share of trade is estimated to move an average country closer to its economic potential by 0.228 percentage points. The inclusion of government consumption and investment reduces the size of the coefficient from 0.228 to 0.0761 (as we similarly saw in Table 7) and reduces the significance of the coefficient from 1 percent to 10 percent, but the coefficient remains positive. Put differently, the inclusion of additional controls does not particularly eliminate the significance of trade in leveraging countries towards their economic frontier. If anything, this could be an indication that the pair might be additional channels through which trade influences efficiency. Noteworthy, however, is that the trade coefficient ceases to be significant once the sample is limited to cases in which the share of manufacturing is $\leq$15% of GDP. This is a clear validation of the result observed in Table 7.

We proceed to present graphical displays of two sub-Saharan countries, one which, from the efficiency ranking, operated closer to its economic potential and the other which operated far from its potential output. The aim is to determine whether we can see a descriptive pattern that corroborates the regression results presented in Table 7. Although all countries in the top and bottom five from Table 5 virtually had corroborative displays, what we found more interesting are the cases of South Africa and Zimbabwe. Recall that the former, in addition to being the most economically efficient country, had an average share of manufacturing above the threshold level of 15% estimated by the first variant of Table 7, while the latter's share of the manufacturing sector on GDP averaged about 13%, which is slightly below the threshold level. A quick visual inspection of Figure 8 clearly shows an interesting pattern in which an increase in South Africa's share of trade on GDP was associated with a movement towards the country's economic potential, while a decrease in the share of trade was mostly associated with a movement away from the country's frontier output. Because these positive comovements are from a country whose average share of manufacturing on GDP exceeded the threshold level of 15%, the graph can therefore be taken as evidence in support of the results presented in Table 7 in which trade raises a country's ability to close its productivity gap when the share of manufacturing on GDP is above 15% of GDP.

Table 9. Trade, manufacturing, and efficiency.

	(A)	(B)	(A)	(B)
	>15% of GDP	**≤15% of GDP**	**>15% of GDP**	**≤15% of GDP**
Trade_share	0.228 *** (0.0492)	0.0122 (0.0772)	0.0761 * (0.0437)	0.0600 (0.0472)
GCF			0.00320 * (0.00179)	0.00939 *** (0.00161)
GCONS			0.0018 (0.00217)	0.0110 (0.02336)
Constant	0.0639 (0.0391)	0.167 *** (0.0623)	0.0190 (0.0458)	0.336 *** (0.0486)
Time dummies	yes	yes	yes	yes
Observations	113	481	113	481

Standard errors in parentheses. *** $p < 0.01$, * $p < 0.1$.

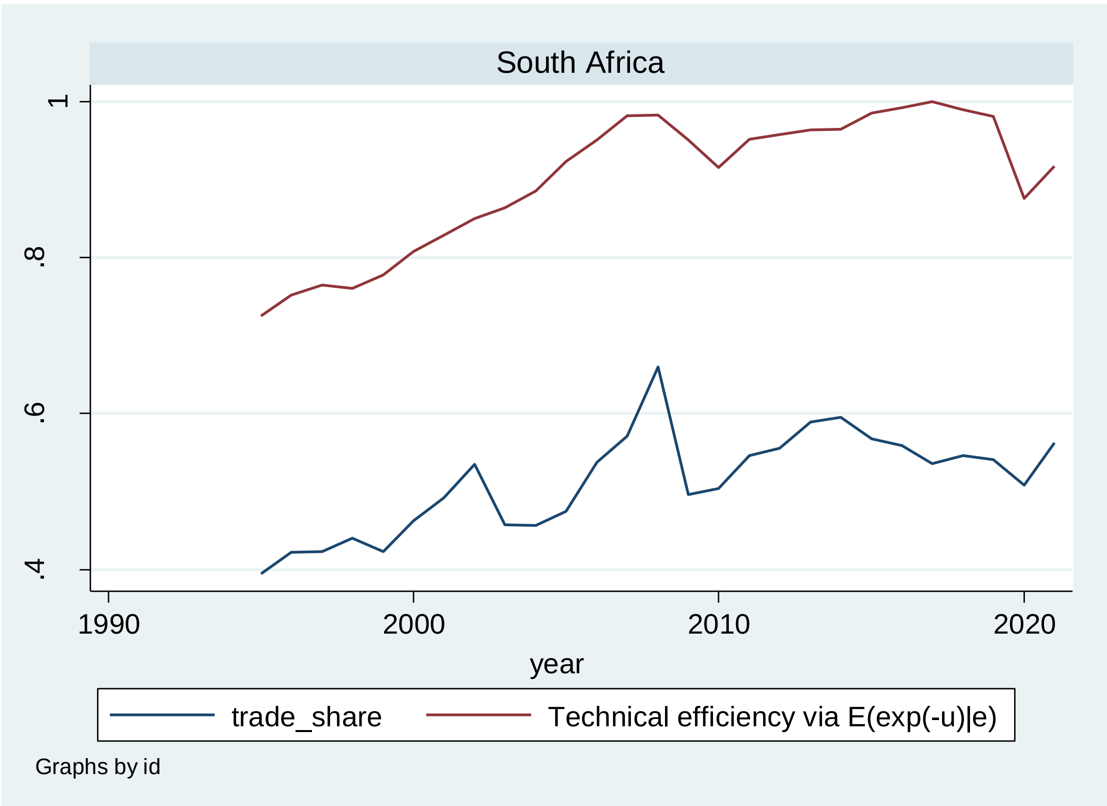

Figure 8. South Africa's trade and technical efficiency.

For Zimbabwe, a country whose share of manufacturing averaged below the estimated threshold level, the positive comovements we saw for South Africa completely vanish (see

Figure 9). In most cases, particularly in the late 90s, early to mid-2000s and from 2010 to around 2017, the opposite appears to be true as rising shares of trade on GDP seem to have coincided with movements of Zimbabwe away from its economic potential, while declining shares of international trade on GDP were accompanied by movements towards the country's economic frontier. Simply put, Zimbabwe's experience demonstrated in Figure 9 corroborates the regression results presented in Table 7 in so far as it demonstrates a non-existing positive effect of trade on a country's ability to close its productivity gap when the share of manufacturing is below the 15% threshold level. Zimbabwe's deindustrialization mainly kicked in shortly after the country's controversial land reform exercise in 2000, which distorted productivity in agriculture and crippled manufacturing due its forward and backward linkages with agriculture. A volatile macroeconomic environment between 2000 and 2008 characterised by severe government price controls, hyperinflation, black markets, and an unstable currency added to the demise of the manufacturing sector. The results presented here therefore indirectly imply that Zimbabwe's macroeconomic developments which hampered manufacturing deprived the country's ability to benefit significantly from global trade.

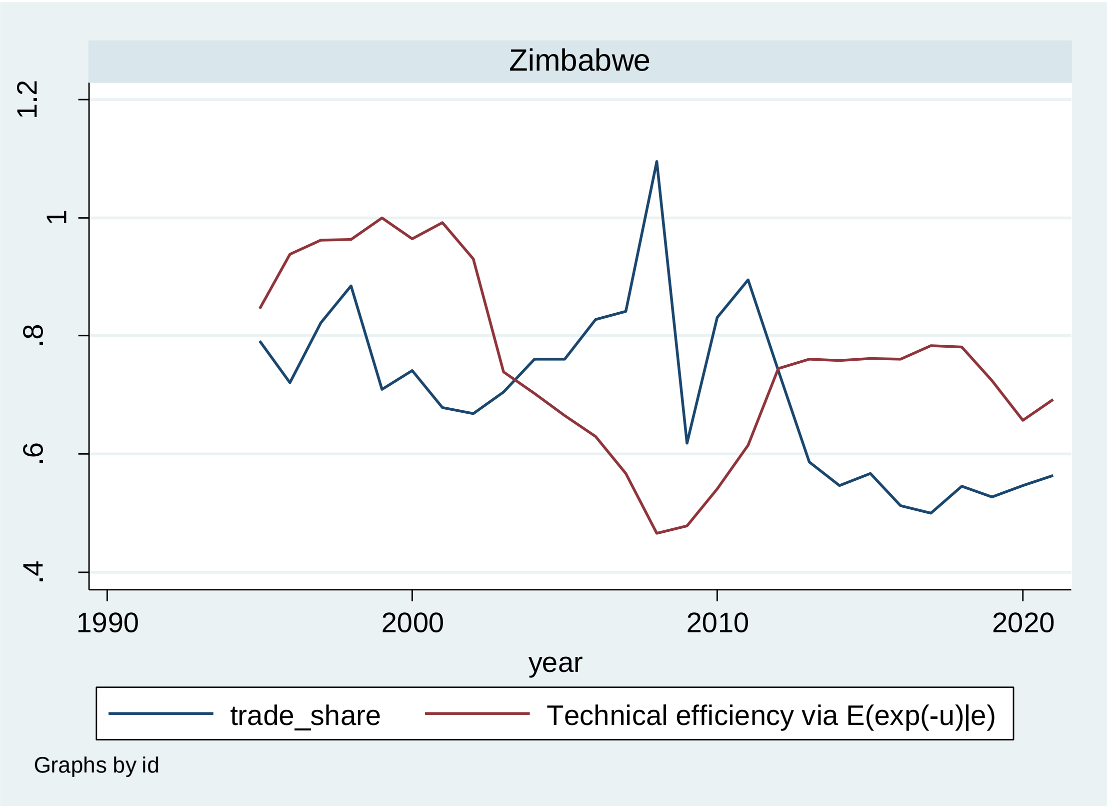

Figure 9. Zimbabwe's share of trade and technical efficiency.

Next, we considered an ad hoc counterfactual procedure which essentially seeks to ask how efficient countries would have been during years in which the share of manufacturing sector exceeded 15% of GDP had the share of manufacturing not exceeded the 15% threshold level. In other words, for each country, we create a dummy which takes the value 1 for years in which the manufacturing sector exceeded 15% of GDP and trade experienced growth, i.e., trade share(t)-trade share(t-1) > 0, and the value 0 for years in which the share of manufacturing sector was 15% and below. The dummy is therefore defined as dummy = 1 if manuf > 15% of GDP and zero if manuf $\leq$ 15% of GDP. Having generated this variable, the idea was to probe how distant a country would have been from its economic potential had the share of manufacturing not exceeded the 15% threshold level in years in which trade intensity increased. A complete description of this counterfactual method can be found in Chernozhukov et al. (2013). In the main, the technique estimates the effects of changes in the distribution of independent variables on the distribution of the dependent variable. Noteworthy is that the population with group = 0, i.e., the untreated group is the reference population and the population with group = 1 is the counterfactual population. This means that the conditional model is estimated using the observations with group = 0, and the counterfactual marginal distribution is estimated using the observations with group = 1. Interestingly, from the results displayed in Figure 10, the lower quantile effects are negative, while the median and upper quantile treatment effects are positive. This technically means that in a world where the observed distribution of years in which manufacturing > 15% was to be $\leq$15%, the most efficient years would have had relatively lower efficiency scores. The positive median value of 0.005 suggests that the median distance from a country's economic frontier would be 0.5% lower.

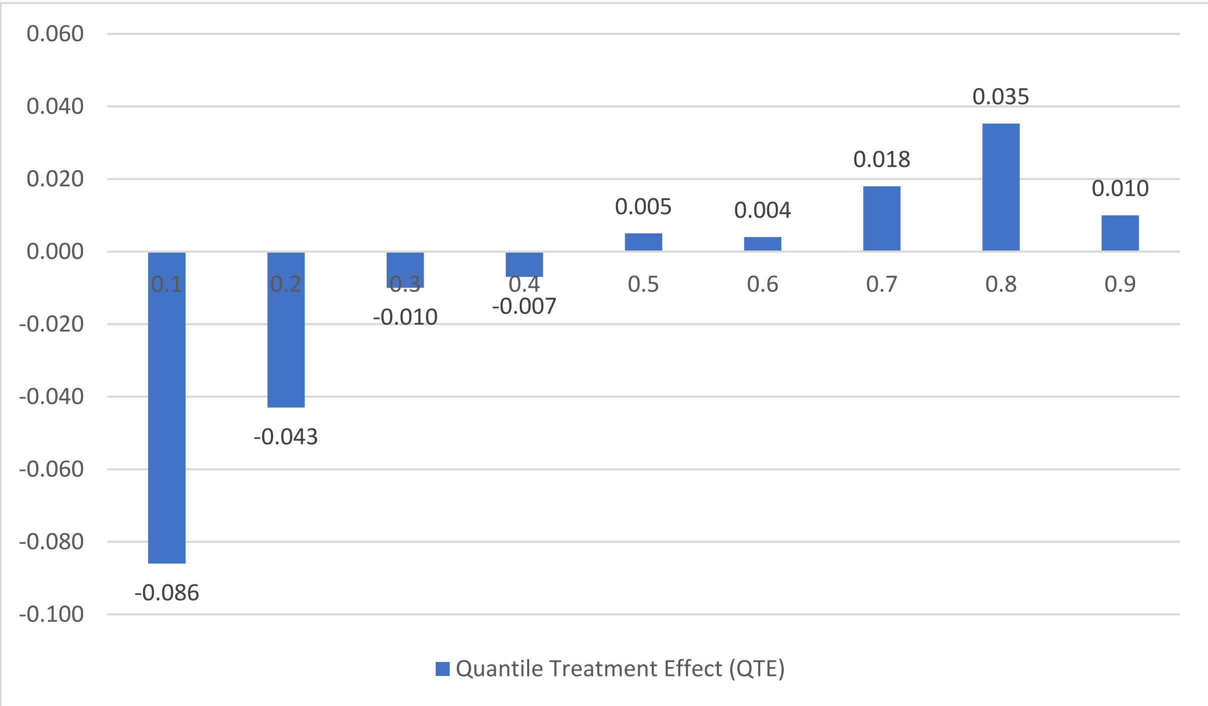

Figure 10. Quantile treatment effects. Source: own computation from estimation results.

To determine whether the results are sensitive to our proxy of industrialization limited to the share of manufacturing on GDP, we gathered data on the share of industry on GDP. Use of this alternative measure is derived from the empirical literature in which the two are often used interchangeably as measures of industrialization (see, for example, Rodrik 2008). Although this exercise led to the dropping of countries such as Zimbabwe on account of data unavailability, it has the virtue of validating or refuting the hypothesis in question with a different sample size and a different approach. With this additional exercise, whose results are displayed in Figure 11, it is comforting and reassuring to note how the use of industrial shares on GDP hardly brings any discernible changes to the distributional effects. The quantile treatment effects are slightly lower starting from the median value, but the pattern remains the same; the distance from the economic frontier would have been bigger, i.e., technical efficiency levels would have been lower. In the main, this provides corroborative results in so far as they suggest an important role of having a larger share of manufacturing and industry on GDP. Smaller shares of these twin industrialization measures appear to be accompanied by a bigger distance between a country's observed output and its economic potential during years in which trade would have expanded. This is particularly true for both the median value with a QTE of 0.3% and the top end of the distribution, which technically represents the treated group comprising cases of high efficiency (i.e., smaller distances between observed output and potential output). These groups located in the upper end of the distribution would not have been as efficient if one had to counterfactually change their distribution to that of the reference group where the share of manufacturing was ≤15%. The 95% confidence intervals, both pointwise and functional, were similarly suggestive of significant quantile treatment effects as the lower and upper limits did not contain a zero across all the quantiles.

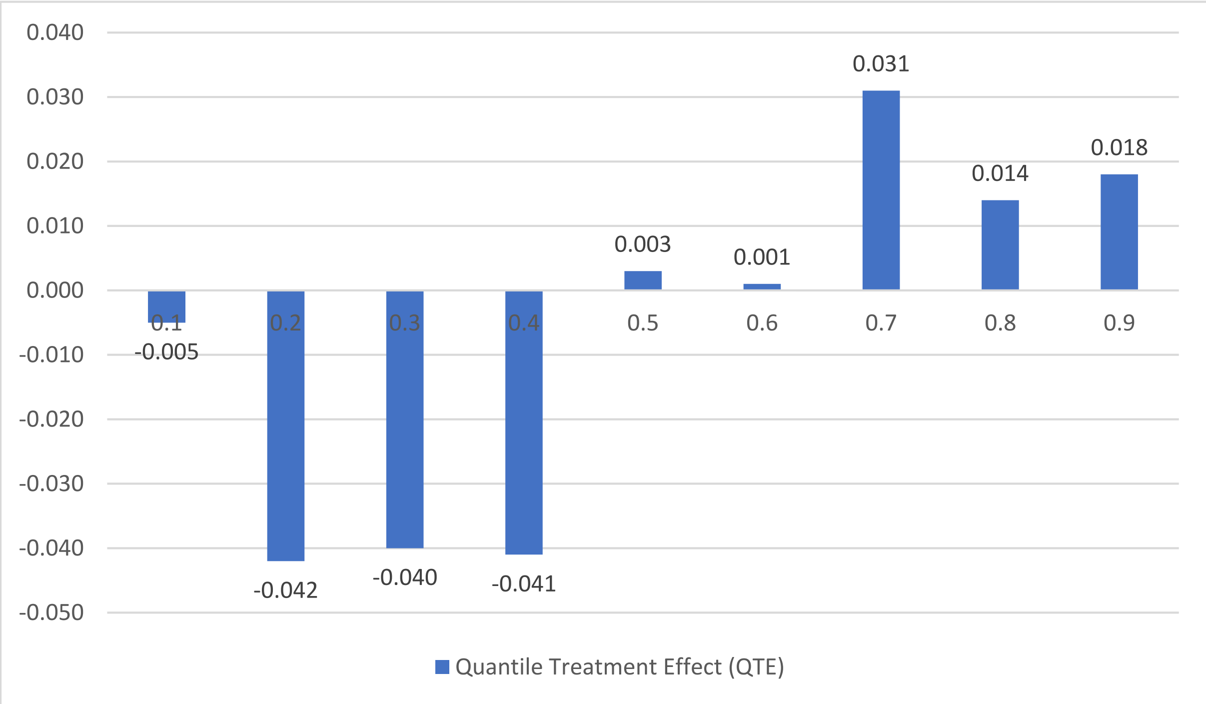

Figure 11. Quantile treatment effects with the industry GVA measure. Source: author's computation from estimation results.

In addition, within this framework, the analysis redefined the categorization of groups by slightly modifying the trade intensity condition from trade(t)-trade(t-1)> 0 to trade(t)-trade(t-1) > 5% and changing the manufacturing share condition from 1 being >15% to 1 being ≤15%. This categorization helps us counterfactually probe what would have happened to countries that experienced trade growth of at least 5% but with smaller shares of manufacturing had they had larger shares of manufacturing. In this experiment, the 5% trade growth is arbitrarily selected as an attempt to simply probe whether the level of intensity matters. In addition, the analysis reverted to the baseline measure of industrialization, namely the share of manufacturing sector, in the interest of having a relatively large sample size. Interestingly, from the results displayed in Figure 12, all the quantile treatment effects turn out to be negative with non-zero containing 95% confidence intervals across all the quantiles. Recall that the conditional model is estimated using the observations with group = 0 and the counterfactual marginal distribution is estimated using the observations with group = 1. The negative quantile treatment effects therefore entail efficiency gains for the treated group, corroborating the results presented earlier that trade benefits inefficient countries when the share of manufacturing is above 13–16% of GDP. This implicitly and crudely suggests that manufacturing is indeed central to ensuring that inefficient countries benefit from international trade and edge to their frontier output.

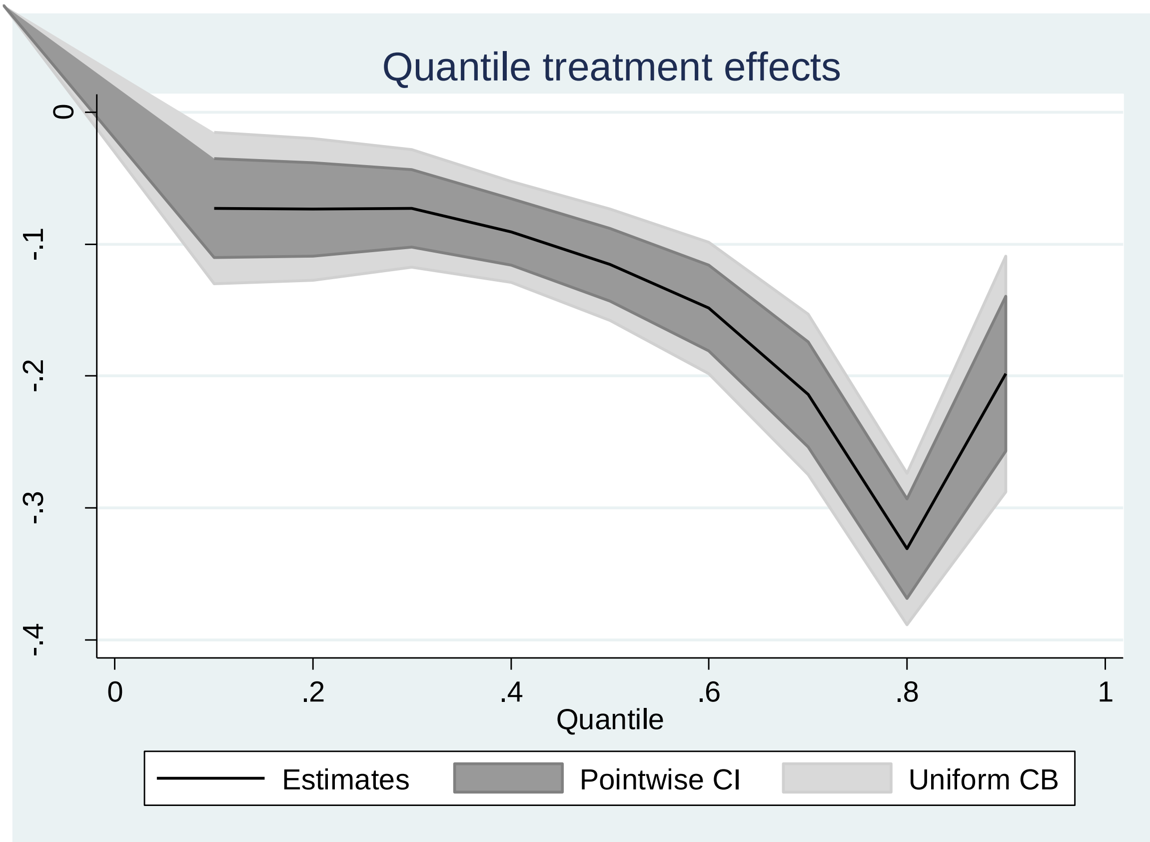

Figure 12. Quantile treatment effects with 95% confidence intervals. Source: estimation results.

From the line graphs of 22 sub-Saharan countries in the sample, the analysis went on to probe the same question albeit in a different framework, the synthetic control method. This time, the idea was to informally look for an episode that plausibly resembles an experience in which the share of manufacturing had an abrupt growth spurt and try to probe what would have happened in the absence of the spurt. Intuitively, with some abuse of the term, the growth spurt would crudely serve as an intervention of some sort which led to a higher level of manufacturing. From Figure 13 displayed below, Gabon and Uganda appear to have noticeable growth spurts in the shares of manufacturing which saw the shares of manufacturing maintain a relatively higher level post the growth spurt. From these two cases, we limit to the case of Gabon, the second most efficient country from the results presented in Table 5. There appears to have been an abrupt increase in manufacturing share sometime in the late 90s to early 2000s. A review of Gabon's macroeconomic history has clues regarding the potential source of this spurt. Gabon received assistance from the African Development Bank in three cycles of a three-year program, namely 1996–1998, 2003–2005, and 2006–2010. The analysis particularly and plausibly assumes that the spurt in Gabon's manufacturing sector witnessed in the late 1990s to early 2000s may have resulted from the 1996–1998 intervention by the African Development Bank. The plausibility of this assumption draws from the program objectives which, among other things, sought to improve the competitiveness of Gabon's industrial sector. Given the timing of the program, we use 1998 as the treatment period.

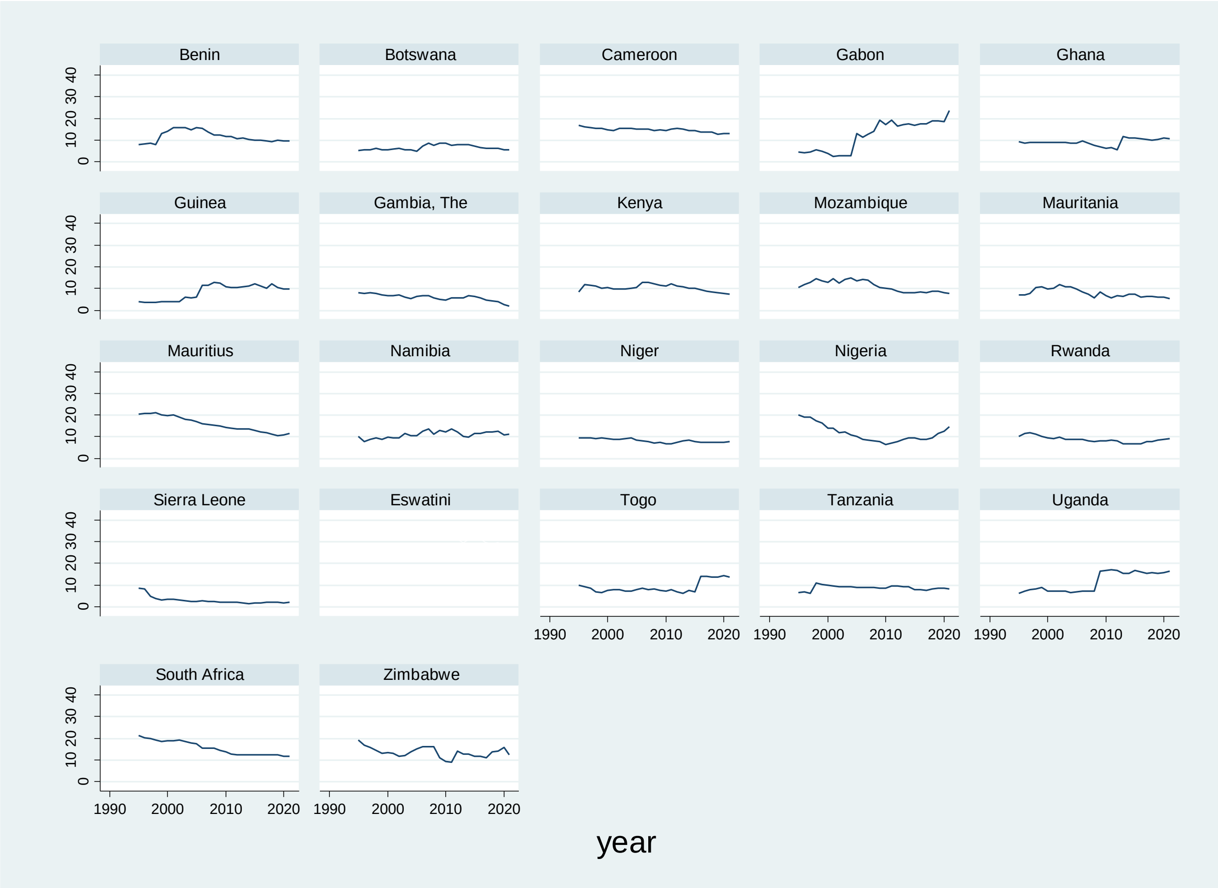

Figure 13. Shares of manufacturing—22 sub-Saharan countries.

The synthetic control method which we use for this additional robustness compares what would have happened to Gabon's efficiency scores had it not witnessed what we assume was an intervention that led to the growth spurt in manufacturing. The rationale of this robustness test draws from the fact that Gabon witnessed a rise in trade intensity during the same period from 95% of GDP in 1998 to 102% of GDP in 2000. The logic therefore is that if one is to assume that the increase in efficiency during the same period was a result of increased trade intensity aided by the expansion of the manufacturing sector, would we have witnessed a different outcome in the absence of an intervention which expanded the manufacturing sector? Figure 14 displays an interesting observation. The solid line is the efficiency scores estimated earlier using the stochastic frontier method, while the dashed line represents the counterfactual trend of efficiency in the absence of the identified intervention which elevated manufacturing. The confidence and reliability of the counterfactual levels of efficiency largely draw from the extent to which the counterfactual trend (the synthetic control unit) tracks the efficiency scores prior to the intervention period. As Figure 14 shows, the synthetic control unit almost perfectly tracks Gabon's levels of efficiency between 1995 and 1998. After 1998, a visual look at Figure 14 shows that Gabon's efficiency levels would have been considerably lower had its share of manufacturing not expanded beyond 15% on the back of the 1998 intervention regardless of its increased trade intensities during the same period. This result matters in so far as it confirms earlier results. Trade intensity may not be helpful in the absence of a sizeable and supportive manufacturing sector.

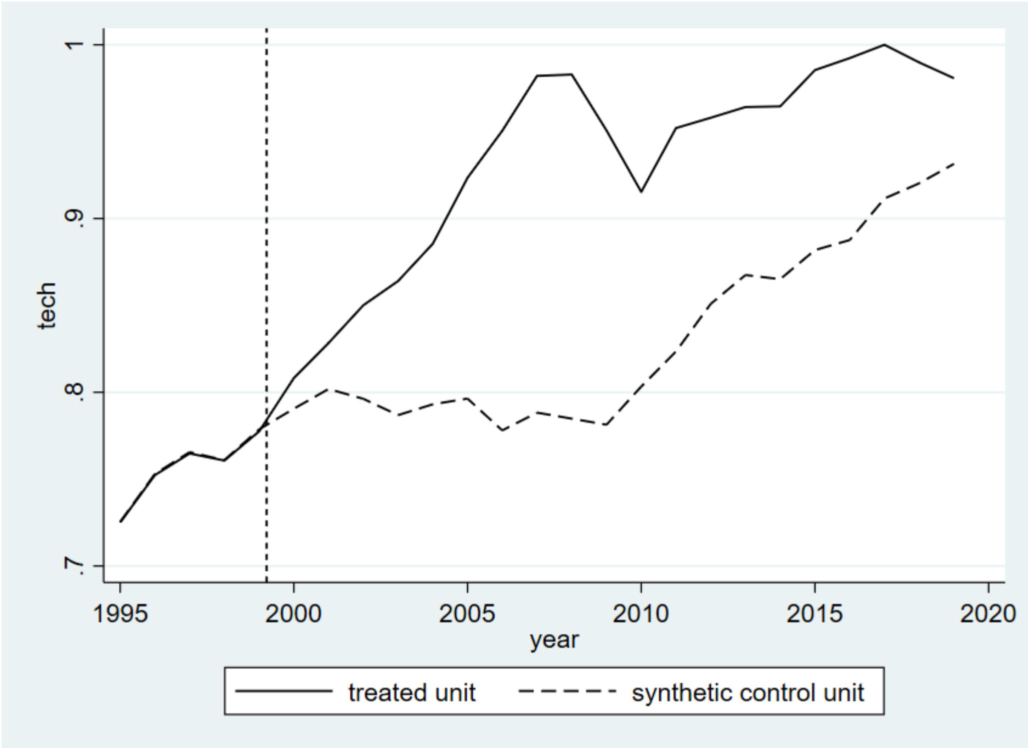

Figure 14. Counterfactual efficiency scores for Gabon.

From the existing body of knowledge, the results presented here validate micro conclusions in which trade leverages efficiency (Martin and Page 1983; Tybout 1992; Bernard et al. 2003; Dai and Yu 2013). They are also comparable to studies such as Olamade and Oni (2016), Ossadzifo (2018), and Opoku and Yan (2019) who document an important role of manufacturing in lifting African countries toward their economic potential. Opoku and Yan (2019) in fact argue that Africa skipped the industrial stage which should have provided, together with increased trade intensity, many African countries the ability to grow faster and close the gap between observed and potential income. In addition, the main finding supports the view that developing regions integrating into the global economy should disregard manufacturing at their own peril. The manufacturing sector being tradable is central to sub-Saharan Africa's ability to close its productivity gap and catch up with regional peers. This result agrees with Austin et al. (2015) who, after comprehensively studying the patterns of manufacturing growth in sub-Saharan Africa, come to two complementary conclusions. One is that sub-Saharan Africa has had the lowest manufacturing output per capita of any inhabited region on the planet and that most African economies, in contrast to the Asian NICs, have largely failed to supplement agricultural and extractive output by expanding higher-value-added manufacturing industries. Two is that from the perspective of mainstream growth theory, this feature appears to be an important proximate cause of comparative African backwardness. More importantly, as supported by Rodrik (2013), they argue that Africa's failure to catch up in aggregate economic terms with other regions is not because manufacturing industries in the 'periphery' are underperforming but rather because the proportion of manufacturing has remained too small to offer a substantial push to aggregate growth. Historical highways travelled by some of the most advanced countries today are complementary to this result in so far as they suggest an important role played by the manufacturing sector as a complement to outward orientation given its high degree of tradability.

In closing, it is worth mentioning that the region's limited value addition may be plausibly cited as another potential reason why trade did not significantly provide the much-needed lift. While data on global value chains (GVCs) do suggest and accurately so that sub-Saharan Africa lags everyone in this respect, the hypothesis on its own is problematic for at least two reasons. Firstly, it makes it hard to explain how several Latin American countries that are largely and equally dependent on commodities with limited value addition such as Brazil and Argentina had a breakthrough under similar circumstances. Data from the OECD database indicate that Brazil's participation in GVCs is primarily downstream and largely characterised by natural resources that are used by other countries as intermediate inputs. In 2009, Brazil's foreign value added accounted for only 13% according to OECD data, which is not significantly different from an average sub-Saharan country. Yet, Brazil made significant progress during the sampling period relative to sub-Saharan countries. Secondly, China has, until recently, hardly been a significant participant in GVCs. During the early to mid-stages of globalization where trade intensified, China was, to a large extent, dependent on textiles and apparel in general. It is mainly after the turn of the century when China's model transformed into one that is characterised by value addition in electrical equipment and assembly activities. Yet, it posed a stellar economic performance during a period where its trade was mostly typified by limited value addition. The question then becomes, if China succeeded under these circumstances, what dragged sub-Saharan Africa? With China's share of manufacturing having averaged 30% during the same period, a plausible conclusion reconciling with the results presented here is that sub-Saharan Africa's limited share of manufacturing, which averaged 11%, may have been a suspect.

In our results, an average sub-Saharan country needed to have a manufacturing share of about 15% to significantly benefit from trade. Reallocating the fixed resources from non-tradable sectors to tradable sectors might be worth pursing looking at the disproportionate distribution of resources in most African countries. South Africa provides crude indications that are suggestive. Figure 15 particularly shows that tertiary services had relatively higher capital stock compared to manufacturing during the entire sampling period.

Figure 15. South Africa's capital stock by sector (1995–2020). Source: author's computation using data from Quantec.

When expressed as a ratio, Figure 16 similarly confirms that the manufacturing sector's fixed capital stock has fallen significantly relative to the tertiary sector's capital stock in the last three decades.

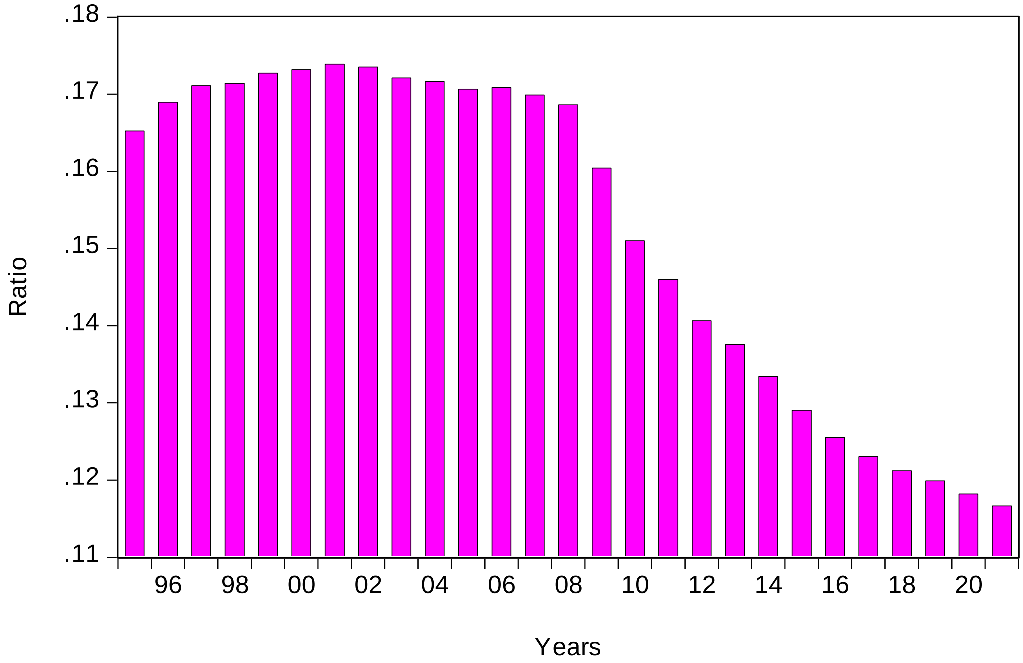

Figure 16. Manufacturing capital stock as a share. Source: author's computation using data from Quantec.

Reallocating capital from services to manufacturing should therefore leverage the manufacturing sector to a level where trade intensity raises aggregated output and escalate a country towards its economic potential.

5. Conclusions

This study has sought to explain sub-Saharan Africa's sluggish trajectory toward economic potential in the wake of increased trade intensities. The results from several empirical exercises establish three central findings. One is the confirmation that sub-Saharan countries did indeed operate below their economic potential. The second and perhaps most important result is that the increased trade intensities only significantly pushed countries whose manufacturing share was at least 15% closer to their economic potential. The third is that nearly 75% of the sample sub-Saharan countries did not meet this condition, suggesting that the region's inability to benefit from trade and close its productivity gap may have resulted from a small manufacturing sector.

Several policy implications can be drawn from these findings. Given the general perception that SSA needs external support and foreign direct investment to leverage its production, the first finding reveals that the region has a sizeable scope to increase its production using its existing internal resources. Rwanda, Togo, Tanzania, Guinea, Niger, Sierra-Leone, Gambia, Benin, Uganda, and Mozambique can graduate from low-income status to lower-middle-income status through using internal resources and existing technology efficiently without necessarily seeking external support. The second policy implication is that policies that expand the share of manufacturing on GDP have the potential to enhance the extent to which sub-Saharan countries can benefit from global trade. These policies could simply imply reallocating resources from non-tradable sectors (which benefit very little from trade) to manufacturing, which is highly tradable and unconstrained by domestic demand. Part of the reasons why trade did not significantly push sub-Saharan countries toward their economic potential is that the era of trade integration was accompanied by a deindustrialization wave that shrunk the share of manufacturing on GDP in an average sub-Saharan country.

The third implication of the results is that sub-Saharan Africa's pursuance of deindustrialization means the region has and will likely continue to miss the potential gains from trade that countries in other regions took full advantage of. History, backed by results presented here, suggests that successful countries today expanded their feet in foreign markets and maximized output on the back of a sizeable and supportive manufacturing sector. By prematurely deindustrializing, the results presented here suggest that sub-Saharan countries may have missed this window of opportunity.

For future research, we have not accommodated the potential role that sub-Saharan Africa's limited value addition may have played during this period. Although we have argued that the experiences of Brazil and China (during its early stages of economic development) downplay a potentially significant role of value addition, it would be interesting to have hard evidence in support of this. In addition, we have assumed in our analysis that sub-Saharan Africa may have been denied the opportunity to achieve productivity gains from trade due to deindustrialization. It may also be interesting for future research to accommodate the potential role that sub-Saharan Africa's technology absorption capacity (which is limited) may have played.

Funding: This research received no external funding. The APC was funded by Sol Plaatje University's Research Office.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data supporting the results of the study are publicly available at the World Bank's World Development Indicators.

Acknowledgments: This work benefited from comments received at the University of KwaZulu-Natal Macroeconomic Research Unit seminar held on the 26 May 2023. The comments raised by Harold Ngalawa, Chris Tipoy, and several other participants added immense value to this work. The author is equally gratefully to some of the informal discussions held with Harris Maduku and Emannuel Mabugu on this piece of work at an early stage.

Conflicts of Interest: The author declares no conflict of interest.

Notes

1. Each region comprised a panel of countries. Asia had 43 countries in the sample, Americas had 26, Europe had 38, and SSA had 22.
2. Cameroon, Benin, Botswana, Mauritania, South Africa, Namibia, Kenya, Niger, Guinea, Uganda, Eswatini, Tanzania, Sierra Leone, Togo, Nigeria, Ghana, Gambia, Mozambique, Mauritius, Rwanda, Zimbabwe, and Gabon.
3. We experimented with lagging the input variables in the frontier estimation to crudely circumvent the endogeneity problem but hardly noticed any discernible changes to the average efficiency score.

References

Aigner, Dennis, C. A. Knox Lovell, and Peter Schmidt. 1977. Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics* 6: 21–37. [CrossRef]

Atesoglu, H. Sonmez. 1993. Manufacturing and economic growth in the United States. *Applied Economics* 25: 67–69. [CrossRef]

Auci, Sabrina, Laura Castellucci, and Manuela Coromaldi. 2021. How does public spending affect technical efficiency? Some evidence from 15 European countries. *Bulletin of Economic Research* 73: 108–30. [CrossRef]

Austin, Gareth, Ewout Frankema, and Morten Jerven. 2015. Patterns of Manufacturing Growth in Sub-Saharan Africa. In *The Spread of Modern Industry to the Periphery Since*. Working Paper No. 71. Oxford: Oxford University Press.

Battese, George E., and Sumiter S. Broca. 1997. Functional forms of stochastic frontier production functions and models for technical inefficiency effects: A comparative study for wheat farmers in Pakistan. *Journal of Productivity Analysis* 8: 395–414. [CrossRef]

Battese, George E., and Tim J. Coelli. 1992. Frontier production functions, technical efficiency and panel data: With application to paddy farmers in India. *Journal of Productivity Analysis* 3: 153–69. [CrossRef]

Bernard, Andrew B., Jonathan Eaton, J. Bradford Jensen, and Samuel Kortum. 2003. Plants and productivity in international trade. *American Economic Review* 93: 1268–90. [CrossRef]

Chaudhuri, Dipayan Datta. 2016. Impact of economic liberalization on technical efficiency of firms: Evidence from India's electronics industry. *Theoretical Economics Letters* 6: 549–60. [CrossRef]

Chernozhukov, Victor, Iván Fernández-Val, and Blaise Melly. 2013. Inference on counterfactual distributions. *Econometrica* 81: 2205–68. [CrossRef]

Chu, Son Ngoc, and Kaliappa Kalirajan. 2011. Impact of trade liberalisation on technical efficiency of Vietnamese manufacturing firms. *Science, Technology and Society* 16: 265–84. [CrossRef]

Dai, Mi, and Miaojie Yu. 2013. Firm R&D, absorptive capacity and learning by exporting: Firm-level evidence from China. *The World Economy* 36: 1131–45.

Farrell, Michael James. 1957. The measurement of productive efficiency. *Journal of the Royal Statistical Society: Series A (General)* 120: 253–81. [CrossRef]

Ghura, Dhaneshwar, and Michael T. Hadjimichael. 1996. Growth in sub-saharan Africa. *Staff Papers* 43: 605–34. [CrossRef]

Giannakas, Konstantinos, Kien C. Tran, and Vangelis Tzouvelekas. 2003. On the choice of functional form in stochastic frontier modeling. *Empirical Economics* 28: 75–100. [CrossRef]

Gyimah-Brempong, Kwabena, and Mark Wilson. 2004. Health human capital and economic growth in Sub-Saharan African and OECD countries. *The Quarterly Review of Economics and Finance* 44: 296–320. [CrossRef]

Jin, Taeyoung, and Jinsoo Kim. 2019. A comparative study of energy and carbon efficiency for emerging countries using panel stochastic frontier analysis. *Scientific Reports* 9: 6647. [CrossRef]

Jondrow, James, C. A. Knox Lovell, Ivan S. Materov, and Peter Schmidt. 1982. On the estimation of technical inefficiency in the stochastic frontier production function model. *Journal of Econometrics* 19: 233–38. [CrossRef]

Kaldor, Nicholas. 1966. Marginal productivity and the macro-economic theories of distribution: Comment on Samuelson and Modigliani. *The Review of Economic Studies* 33: 309–19. [CrossRef]

Kumbhakar, Subal C., Hung-Jen Wang, and Alan P. Horncastle. 2015. *A Practitioner's Guide to Stochastic Frontier Analysis Using Stata*. Cambridge: Cambridge University Press.

Loko, Boileau, Nelie Nembot, and Marcos Poplawski Ribeiro. 2022. *Private Savings and COVID-19 in Sub-Saharan Africa*. Working Paper WP/22/176. Washington, DC: International Monetary Fund.

Lewis, William Arthur. 1954. Economic Development with Unlimited Supplies of Labour. *The Manchester School* 22: 139–91. [CrossRef]

MacDonald, Brad. 2018. Back to Basics Compilation: Nations Are almost always Better Off When They Buy and Sell from One Another. Available online: https://www.imf.org/en/Publications/fandd/issues/Series/Back-to-Basics/Trade (accessed on 23 May 2023).

Martin, John P., and John M. Page. 1983. The impact of subsidies on X-efficiency in LDC industry: Theory and an empirical test. *The Review of Economics and Statistics* 65: 608–17. [CrossRef]

Mastromarco, Camilla, and Sucharita Ghosh. 2009. Foreign capital, human capital, and efficiency: A stochastic frontier analysis for developing countries. *World Development* 37: 489–502. [CrossRef]

Mazorodze, Brian. 2020. Trade and efficiency of manufacturing industries in South Africa. *The Journal of International Trade & Economic Development* 29: 89–118.

Mazorodze, Brian, Irrshad Kaseeram, and Lorraine Greyling. 2021. Trade and profit efficiency of manufacturing industries in South Africa. *The Journal of International Trade & Economic Development* 30: 707–24.

McMillan, Margaret S., Dani Rodrik, and Íñigo Verduzco-Gallo. 2014. Globalization, structural change, and productivity growth, with an update on Africa. *World Development* 63: 11–32. [CrossRef]

Mok, Vincent, Godfrey Yeung, Zhaozhou Han, and Zongzhang Li. 2010. Export orientation and technical efficiency: Clothing firms in China. *Managerial and Decision Economics* 31: 453–63. [CrossRef]

Nketiah-Amponsah, Edward, and Bernard Sarpong. 2019. Effect of infrastructure and foreign direct investment on economic growth in Sub-Saharan Africa. *Global Journal of Emerging Market Economies* 11: 183–201. [CrossRef]

Ocampo, José Antonio, Codrina Rada, and Lance Taylor. 2009. *Growth and Policy in Developing Countries: A Structuralist Approach*. New York: Columbia University Press.

Olamade, Olumuyiwa, and Oluwasola Oni. 2016. Manufacturing and economic growth in Africa: A panel test of kaldor's first growth law. *Journal of Economics and Sustainable Development* 7: 126–40.

Opoku, Eric Evans Osei, and Isabel Kit-Ming Yan. 2019. Industrialization as driver of sustainable economic growth in Africa. *The Journal of International Trade & Economic Development* 28: 30–56.

Ossadzifo, Kwami. 2018. Industrialization and economic growth in sub-Saharan Africa: The role of human capital in structural transformation. *Journal of Empirical Studies* 5: 45–54.

Rodrik, Dani. 2008. The real exchange rate and economic growth. *Brookings Papers on Economic Activity* 2008: 365–412. [CrossRef]

Rodrik, Dani. 2013. Unconditional convergence in manufacturing. *The Quarterly Journal of Economics* 128: 165–204. [CrossRef]

Rodrik, Dani. 2016. Premature deindustrialization. *Journal of Economic Growth* 21: 1–33. [CrossRef]

Seo, Myung Hwan, and Yongcheol Shin. 2016. Dynamic panels with threshold effect and endogeneity. *Journal of econometrics* 195: 169–86. [CrossRef]

Stevenson, Rodney E. 1980. Likelihood functions for generalized stochastic frontier estimation. *Journal of Econometrics* 13: 57–66. [CrossRef]

Sun, Huaping, Bless Kofi Edziah, Xiaoqian Song, Anthony Kwaku Kporsu, and Farhad Taghizadeh-Hesary. 2020. Estimating persistent and transient energy efficiency in belt and road countries: A stochastic frontier analysis. *Energies* 13: 3837. [CrossRef]

Thirlwall, Anthony Philip. 1983. Foreign trade elasticities in centre-periphery models of growth and development. *BNL Quarterly Review* 36: 249–61.

Tybout, James, Jamie De Melo, and Vittorio Corbo. 1991. The effects of trade reforms on scale and technical efficiency: New evidence from Chile. *Journal of International Economics* 31: 231–50. [CrossRef]

Tybout, James R. 1992. Linking trade and productivity: New research directions. *The World Bank Economic Review* 6: 189–211. [CrossRef]

Van Ark, Bart, Mary O'Mahony, and Marcel P. Timmer. 2008. The productivity gap between Europe and the United States: Trends and causes. *Journal of Economic Perspectives* 22: 25–44. [CrossRef]

Van Nguyen, Quang, Sean Pascoe, Louisa Coglan, and Son Nghiem. 2021. The sensitivity of efficiency scores to input and other choices in stochastic frontier analysis: An empirical investigation. *Journal of Productivity Analysis* 55: 31–40. [CrossRef]

Yang, Shu-Fei, Kun-Ming Chen, and Tai-Hsin Huang. 2013. Outward foreign direct investment and technical efficiency: Evidence from Taiwan's manufacturing firms. *Journal of Asian Economics* 27: 7–17. [CrossRef]