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UNU-WIDER

WIDER Working Paper 2023/104

Impact of trade and structural change on the sub-Saharan African economies

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August 2023

Abstract: Sub-Saharan African economies have experienced accelerated economic growth in the past two decades. In this paper we study the impact of trade-induced structural change on employment and value-added shares in sub-Saharan African economies. We find that sub-Saharan African economies have increasingly become net importers of manufacturing goods. Similar to other countries, an increase in manufacturing imports negatively impacts manufacturing employment shares. In contrast, an increase in exports positively impacts agricultural employment shares. We further find that neither exports nor imports affect value-added shares in manufacturing. Based on our empirical findings, we propose a quantitative trade model that explains how an increase in trade can reduce employment shares in the manufacturing sector, leading to structural transformation and potentially explaining Rodrik's 'African manufacturing puzzle'.

Key words: trade, structural change, sub-Saharan African economies

JEL classification: H6, O14, O55

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This study has been prepared within the UNU-WIDER project ETD – Economic Transformation Database.

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ISSN 1798-7237 ISBN 978-92-9267-412-0

https://doi.org/10.35188/UNU-WIDER/2023/412-0

Typescript prepared by Gary Smith.

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The Institute is funded through income from an endowment fund with additional contributions to its work programme from Finland and Sweden, as well as earmarked contributions for specific projects from a variety of donors.

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1 Introduction

International trade is one of the primary forces that has led to structural transformation in many countries. Structural economic changes, in turn, may lead to faster economic growth as resources are allocated more efficiently, fuelled by countries specializing in goods in which they have comparative advantages. Therefore, studying the link between international trade, structural change, and the potential acceleration of economic growth is important. However, the existing literature on trade and structural transformation has only focused on industrialized countries (e.g., Uy et al. (2013) for South Korea, Sposi et al. (2018) for middle-income countries, and Cravino and Sotelo (2019) for the United States), lacking studies analysing the impact of trade on structural change in low- and middle-income countries.

In this paper we ask the following research questions: How much did international trade and structural changes lead to accelerated economic growth in sub-Saharan African countries? Is trade boosting African economies as much as it did for the East Asian Tigers?[1] We quantify the impact of globalization and structural changes in African economies through a series of reduced-form empirical analyses and a quantitative trade model.

Considering sub-Saharan African economies is important in two ways. First, several sub-Saharan African countries have been experiencing unprecedented economic growth in the past few decades. Some of the countries experiencing the highest levels of economic growth are now called the 'African Lions', analogous to the 'East Asian Tigers'.[2] These countries are registering annual growth rates of around 3–4 per cent, with a quintessential structural change scenario—the labour force is switching out of agriculture and moving into manufacturing and services, and the population is shifting to urban city centres. Understanding how their growth is related to structural change and how much international trade has contributed to it through structural change is thus important.

Second, the growth of the sub-Saharan African economies is unique compared to other previous developing economies. Unlike the East Asian Tigers, the African Lions are experiencing a puzzling phenomenon: Africa's manufacturing puzzle, noted by Diao et al. (2021). Even though these countries have experienced accelerated growth in the past few decades, their labour productivity in modern sectors, particularly manufacturing, has been significantly low. Diao et al. (2021) hypothesize that an increase in the capital-intensiveness of African manufacturing sectors may have been one of the primary culprits for the labour productivity puzzle, and trade has been fuelling capital-biased structural changes. They further hypothesize that there is a loss in the gains from trade due to losing 'comparative advantage in traditionally labor-intensive manufacturing [...] and constraining the capacity of manufacturing to absorb labor productivity'. This claim requires further investigation; do we indeed observe a 'loss' in the manufacturing sector in the gains from trade, and how big of a loss do the sub-Saharan African economies face?

To answer our research question we document key features in the data and perform empirical analyses to understand how international trade affects structural change in sub-Saharan African economies. First, we compare international trade and economic growth patterns between the East Asian Tigers and the African Lions during their respective growth miracle periods. We find that the sub-Saharan African economies have become net importers in the manufacturing sectors during their economic growth period between 2001 and 2018. Unlike the sub-Saharan African economies, the Asian economies between the 1970s and the 1990s became, on average, manufacturing sector net exporters. Second, the East Asian Tigers experienced increased employment and value-added shares in their manufacturing sectors in the

[1] South Korea, Hong Kong, Taiwan, and Singapore comprise the East Asian Tigers.

[2] The African Lions consist of Ethiopia, Ghana, Kenya, Mozambique, Nigeria, and South Africa.

1970s, while the African Lions had not in the past two decades. This is the opposite of what we would have expected in 'standard' growth miracle episodes based on what we have observed.

To understand how trade affects economic growth, we perform a Frankel and Romer (1999) regression in our analysis. To further address endogeneity concerns we use natural disasters as an instrumental variable (IV), suggested by Felbermayr and Gröschl (2014), to understand how international trade affects structural change through the lens of changes in employment and value-added shares. We document that increases in exports decrease employment shares in countries, while increases in imports increase employment shares, which reaffirms the findings in the existing literature. We find that sub-Saharan African economies have a similar impact—increases in imports negatively affect employment shares while having no impact on value-added shares. Combined with the previous analysis, where sub-Saharan African economies are increasingly becoming net importers of manufacturing goods, we find suggestive evidence that stagnant manufacturing productivity may be correlated with the trade-induced structural change in sub-Saharan African economies.

Motivated by our empirical analyses, we develop a multi-country quantitative trade model that allows us to capture the patterns of trade and changes in labour and capital allocations in different sectors, following the models of Eaton and Kortum (2002), Parro (2013), and Cravino and Sotelo (2019) to quantify how changes in trade cause structural change across different sectors in sub-Saharan African economies. Furthermore, we distinguish agriculture, manufacturing, services, and mining and commodities as separate sectors, with input–output linkages between them. This sectoral division differs from Parro (2013) to emphasize that sub-Saharan African economies rely much more on agricultural and commodities sectors in production and trade than do developed economies.

We discuss two critical mechanisms of the model: trade costs and capital–labour complementarity. First, trade costs between countries determine how much each country is globalized; the lower the trade costs are, the more the trade affects the country's economic growth: cheaper intermediate inputs from abroad will negatively impact employment share in the manufacturing sector as relative input costs for workers increase as firms substitute away from labour to become more intermediate-intensive. Another crucial mechanism in our model is capital–labour complementarity; we allow the model to have labour and capital as substitutes in order to understand the role of cheaper capital in sub-Saharan African economies.

We calibrate our quantitative trade model using various macroeconomic data to test how much trade affects economic growth and structural change in sub-Saharan African economies. We use the hat-algebra method developed by Dekle et al. (2007) to calculate the counterfactual exercises. Previous literature on quantitative models of international macroeconomics and trade (Eaton et al. 2016; Ko 2020; Parro 2013; Reyes-Heroles 2016; Sposi et al. 2018; Uy et al. 2013) have done similar types of estimations to study the impact of trade on macroeconomic dynamics.

Our paper contributes to two strands of literature. The first strand studies the impact of structural change in large open economies. Matsuyama (2009) argues that large open economy models are needed to understand how a country's manufacturing sector productivity and its employment shares are related. Uy et al. (2013) use non-homotheticity to introduce income effects to induce the structural change. Święcki (2017) finds that asymmetric growth in sectoral productivity is the primary determinant for structural change, and trade also plays an important role. Some open economy literature focuses on developing economies; Amiti and Konings (2007) and Topalova and Khandelwal (2011) focus on the impact of international trade on Indonesia and India, respectively. However, there is still much to be studied regarding the impact of trade on developing economies. While the previous literature has predominantly focused on developed countries, this paper contributes to the open economy structural change literature by quantifying the impact of trade on developing economies, especially sub-Saharan African countries.

The second strand of literature that we contribute to is explaining the causes and consequences of the African manufacturing puzzle. First proposed by Rodrik (2018), even though the African Lion economies have experienced significant economic growth in the past two decades, their manufacturing productivity has been flat. Diao et al. (2021) argue that structural change in sub-Saharan Africa has been due to increased demand for goods and services rather than increasing productivity in modern sectors. Gelb et al. (2020) argue that labour costs in sub-Saharan Africa are a primary reason we observe stagnant manufacturing productivity. We contribute to this literature by considering how international trade plays a role in changing employment and value-added shares in sub-Saharan African economies through the approach suggested by Felbermayr and Gröschl (2014), using natural disasters as our IV.

This paper is organized as follows. Section 2 documents the macroeconomic facts between Asian Tiger and African Lion economies and discusses how exports and imports affect various sectors in sub-Saharan African economies. Section 3 describes the quantitative model we use for analysis, and Section 4 discusses the simple mechanism of our model. Section 5 concludes.

2 Empirical evidence

2.1 Comparison between 'Asian Tiger' and 'African Lion' economies

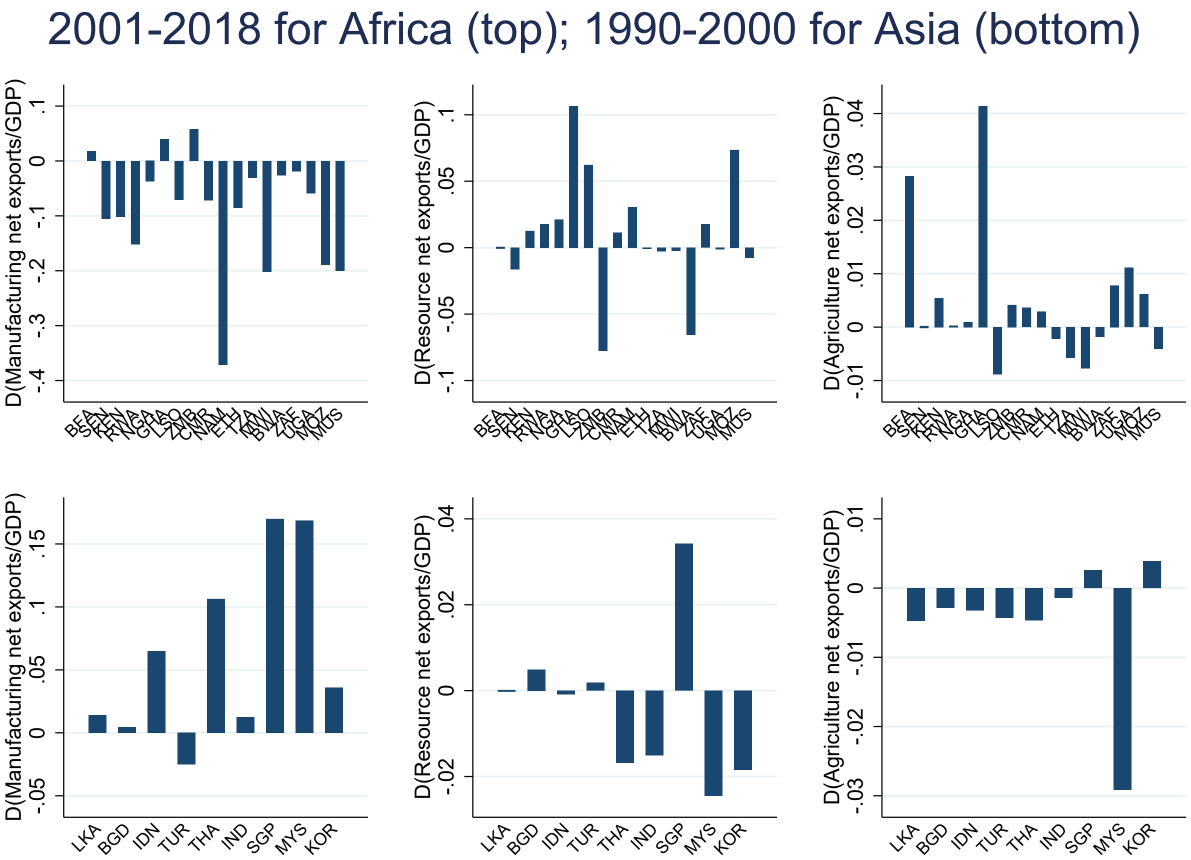
This section highlights a difference in changes in trade patterns between Asian countries during the 1990s and African countries from 2001 to 2018, periods when they achieved rapid economic growth. In our analysis the Asian countries include Sri Lanka, Bangladesh, India, Turkey, Indonesia, Singapore, Malaysia, and South Korea. The African countries include Burkina Faso, Senegal, Kenya, Rwanda, Nigeria, Ghana, Lesotho, Zambia, Cameroon, Namibia, Ethiopia (excludes Eritrea), Tanzania, Malawi, Botswana, South Africa, Uganda, Mozambique, and Mauritius.

Trade data are from UN Comtrade, where industries are classified by ISIC rev. 3, at the two-digit level. When defining more aggregated sectoral trade, resource sectors include 10, 11, 12, 13, and 14, agriculture sectors include 01, 02, and 05, and manufacturing sectors are all remaining sectors except 40. The main outcome variable is the change in sectoral net exports (exports minus imports) to GDP ratio over the corresponding periods. The GDP measure is obtained from the World Development Indicators.

Figure 1 provides the change in net exports to GDP ratio for African countries from 2001 to 2018 in the first row and for Asian countries during the 1990s in the second row. We can see at least three things. First, the African countries become net importers in the manufacturing sectors when they experience rapid economic growth from 2001 to 2018, while the Asian countries changed their trade structures towards being net exporters in these sectors during the 1990s. This pattern in Asia was a key driver of Asia's rapid economic growth, consistent with the findings of Connolly and Yi (2015), among others. Second, the African countries changed their structures towards being net exporters of resource sectors from 2001 to 2018, while the Asian countries become net importers. These patterns suggest that the role of international trade in their rapid economic growth and structural changes could be different. Third, while the Asian countries became net importers and the African countries became mostly net exporters in agricultural sectors, these changes are relatively small.

Figure 2 shows the change in net exports to GDP ratio for African and Asian countries, but decomposes the total change into those from different destination regions. One thing to notice is that China contributes a lot to African countries' net imports.

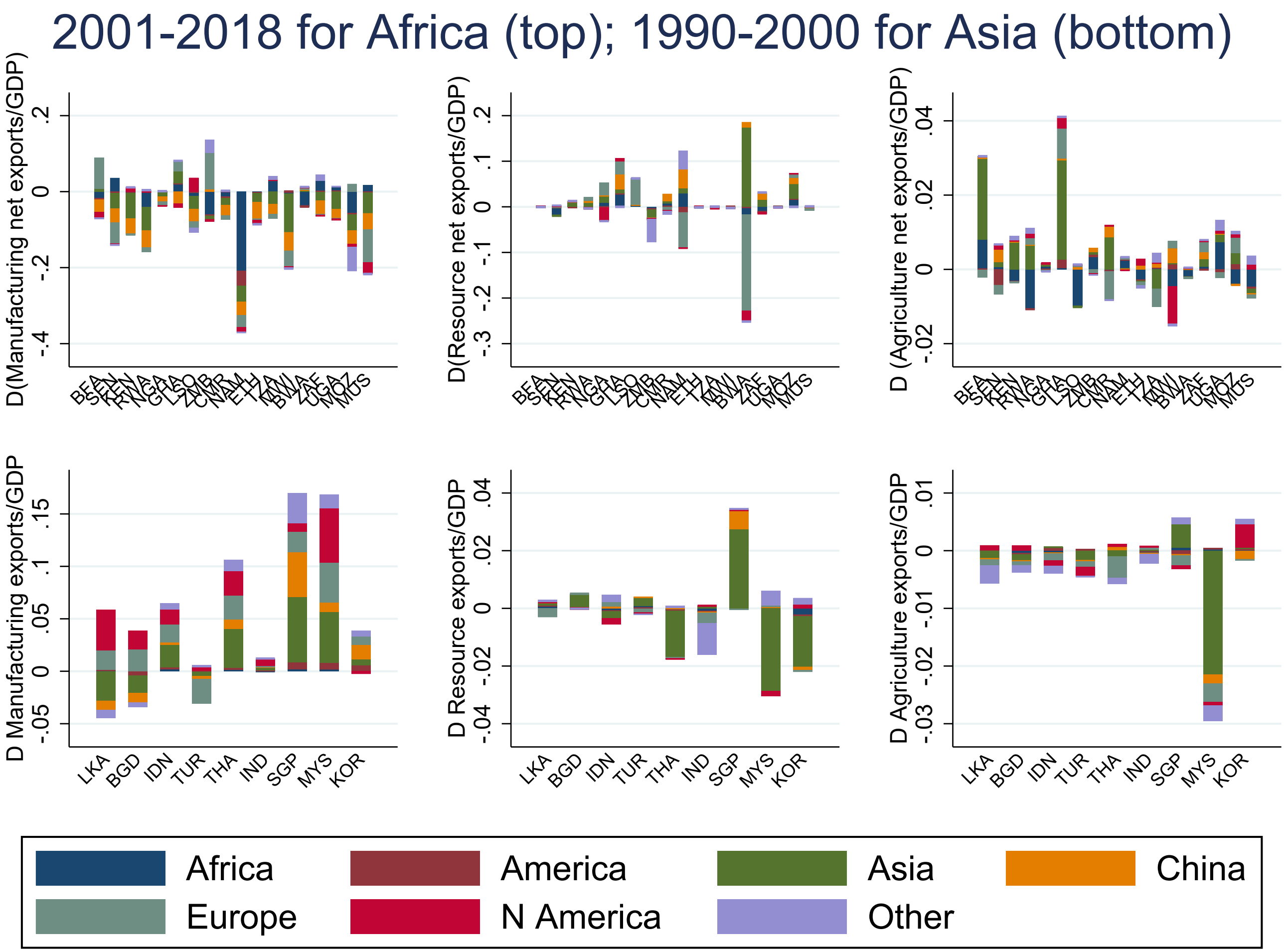
Figure 1: Change in net exports to GDP ratio



Note: the figure shows the changes in net exports to GDP ratio for African countries from 2001 to 2018 (top row) and Asian countries during the 1990s (bottom row). The left-hand two graphs show the ratio for manufacturing sectors, the middle two graphs are for resource sectors, and the right-hand two graphs are for agriculture sectors.

Source: authors' compilation.

Figure 2: Change in net exports to GDP ratio for each destination region

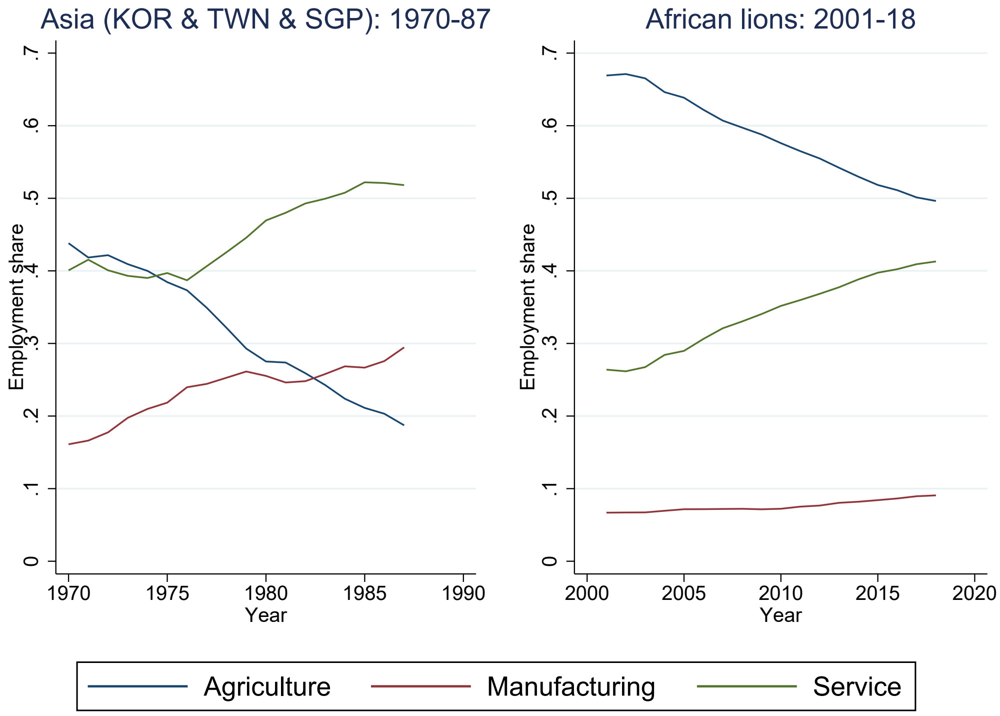


Note: the figure shows the changes in net exports to GDP ratio for African countries from 2001 to 2018 (top row) and Asian countries during the 1990s (bottom row). The left-hand two graphs show the ratio for manufacturing sectors, the middle two graphs are for resource sectors, and the right-hand two graphs for agriculture sectors. Each bar is decomposed into the changes resulting from different regions. Blue is a contribution from the African region, brown from Central and South America, green from Asia, orange from China, grey from Europe, red from North America, and purple from other regions.

Source: authors' compilation.

Figures 3, 4, and 5 provide the aggregate transition of employment share, value-added share, and labour productivity for Asian and African economies, respectively. In particular, we compare these transitions for three economies among the Asian Tigers—South Korea, Taiwan, and Singapore—from 1970 to 1987 with those for six African Lions—Ethiopia, Ghana, Kenya, Mozambique, Nigeria, and South Africa. Figures 3 and 4 demonstrate that the Asian Tigers experienced a rapid expansion of their manufacturing sectors in terms of both employment and value-added shares during their rapid economic growth, but the African Lions did not. Figure 5 makes it clear that labour productivity in the Asian Tigers increased by about 17 times, while that in the African Lions only grew by about 4 times.

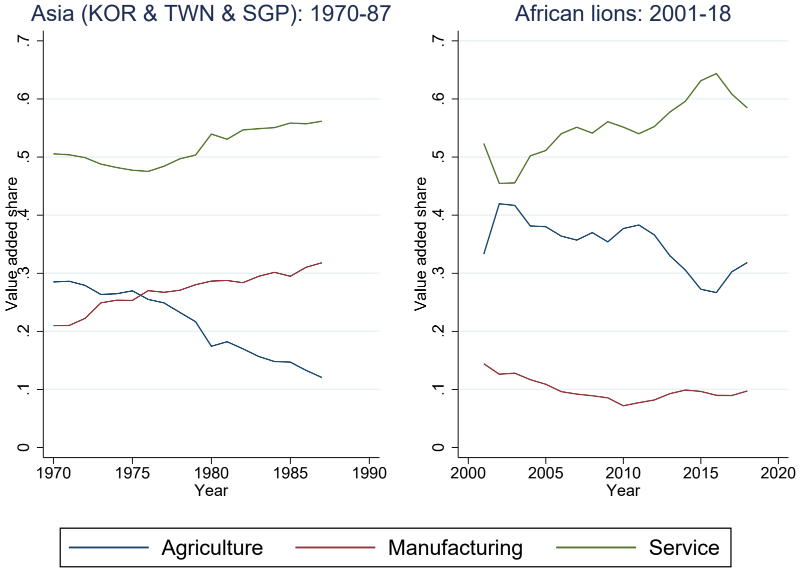
Figure 3: Change in employment share across sectors



Note: the figure shows the change in employment share across agriculture, manufacturing, and service sectors. The agriculture sector includes agriculture and mining, and the service sector includes utilities construction, trade services, transport services, business services, government services, and personal services in ISIC rev. 3.1 categories. The left window shows the aggregate transition of employment shares from 1970 to 1987 for three Asian Tigers: South Korea, Taiwan, and Singapore. The right window shows the aggregate transition of employment shares from 2001 to 2018 for the African Lions: Ethiopia, Ghana, Kenya, Mozambique, Nigeria, and South Africa.

Source: authors' compilation.

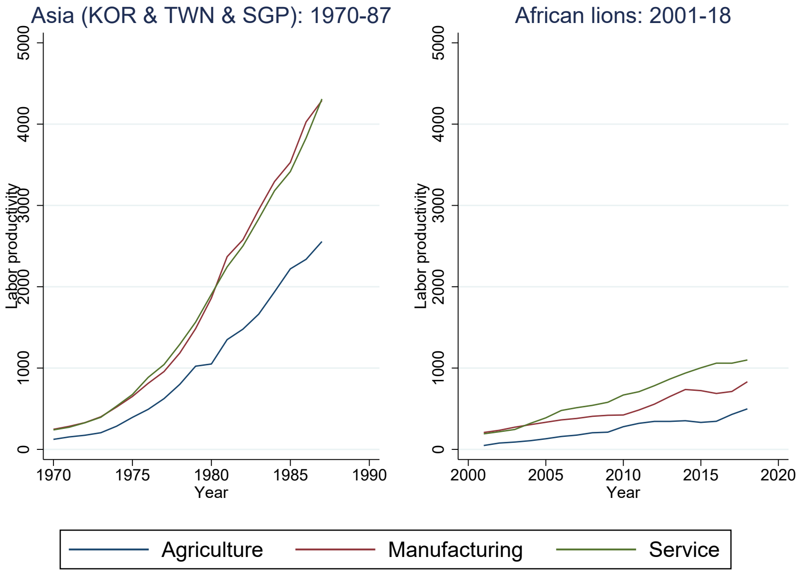
Figure 4: Change in value-added share across sectors



Note: the figure provides the change in value-added across agriculture, manufacturing, and service sectors. The agriculture sector includes agriculture and mining, and the service sector includes utilities construction, trade services, transport services, business services, government services, and personal services in ISIC rev. 3.1 categories. The left window shows the aggregate transition of value-added shares from 1970 to 1987 for three Asian Tigers: South Korea, Taiwan, and Singapore. The right window shows the aggregate transition of value-added shares from 2001 to 2018 for the African Lions: Ethiopia, Ghana, Kenya, Mozambique, Nigeria, and South Africa.

Source: authors' compilation.

Figure 5: Change in labour productivity across sectors



Note: the figure provides the change in labour productivity, defined by the value-added divided by the number of employees, across agriculture, manufacturing, and service sectors. The agriculture sector includes agriculture and mining, and the service sector includes utilities construction, trade services, transport services, business services, government services, and personal services in ISIC rev. 3.1 categories. The left window shows the aggregate transition of labour productivity from 1970 to 1987 for three Asian Tigers: South Korea, Taiwan, and Singapore. The right window shows the aggregate transition of labour productivity from 2001 to 2018 for the African Lions: Ethiopia, Ghana, Kenya, Mozambique, Nigeria, and South Africa.

Source: authors' compilation.

2.2 Further evidence on the impact of trade on structural change

We now conduct a regression analysis using the cross-country data. In particular, our specification examines how trade openness in a country affects the share of employment and value-added in the country as follows:

$$\text{share}_{it} = \alpha_i + \alpha_t + \beta \text{Open}_{it} + \eta \ln\text{Pop}_{it} + \gamma \text{disaster}_{it} + \varepsilon_{it} \tag{1}$$

where share_{it} is the share of employment or value-added in sector i at time t (i.e. agriculture, manufacturing, or service sector). $\ln \text{Pop}_{it}$ is population in country i at time t, and disaster_{it} is the number of natural disasters. Open_{it} is defined by $\text{Open}_{it} = \frac{\text{Import}_{it}+\text{Export}_{it}}{\text{GDP}_{it}}$. α_i and α_t are country and time fixed effects. The country fixed effect controls for time-invariant country-specific factors, such as geographic characteristics. The data are five-year averages in order to purge the data of the influence of business cycles. We focus on the coefficient of the trade openness measure, β, which represents the effect of a change in trade openness on structural transformation since our identification comes from within-country over-time variations of trade openness by including the country fixed effect.

A potential concern is the endogeneity of Open_{it}. For instance, there may be an omitted variable bias where an unobservable change in a country's comparative advantage affects both the sectoral share of employment and trade openness. This may lead to a correlation between the error term and the trade openness measure and thus cause a biased estimate. To address this endogeneity concern, we use the IV approach of Frankel and Romer (1999) and Felbermayr and Gröschl (2014) to estimate the causal effect of trade openness on structural transformation. In particular, we use geographic factors between countries i and j, and natural disasters in country j as exogenous variations that affect trade openness in country i in period t.

The variable is constructed first by estimating the following gravity equation, as a data reduction device, with the pseudo Poisson maximum likelihood (PPML) approach to account for zero trade flows (Silva and Tenreyro 2006):

$$\omega_{ijt} = \exp[\delta_1 \text{disaster}_{jt} + \delta_2^{'} \text{disaster}_{jt} \times \Sigma_{ijt} + \delta_3^{'} Z_{ijt} + \mu_i + \mu_j + \mu_t] + \varepsilon_{ijt} \tag{2}$$

where $\omega_{ijt} = \frac{\text{Import}_{ijt}+\text{Export}_{ijt}}{\text{GDP}_{it}}$ and Σ_{ijt} includes financial remoteness of country, area, and population of country j, and a contiguity dummy between countries i and j. Z_{ijt} includes log of population in countries i and j, distance, and a contiguity dummy. disaster_{jt} denotes the number of natural disasters that occurred in foreign country j at time t. Thus, δ_1 and $\delta_2^{'}$ represent the effect of natural disasters in country j on the sum of imports and exports between countries i and j normalized by country i's GDP.

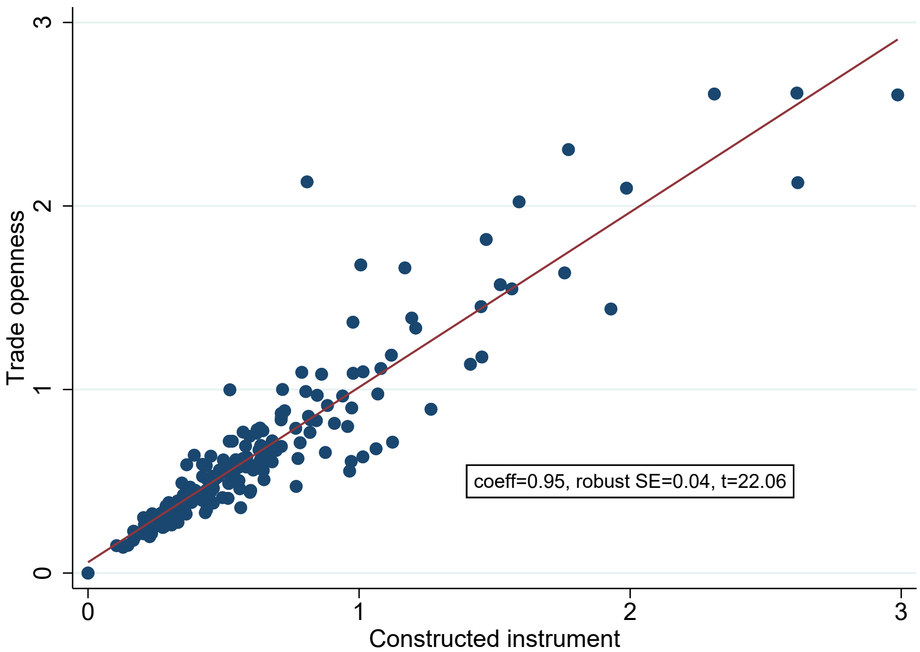
The fitted value of the gravity equation $\hat{\omega}_{ijt}$ is then used to construct an exogenous proxy for multilateral openness Ω_{it} by

$$\Omega_{it} = \sum_{j \neq i} \hat{\omega}_{ijt} \tag{3}$$

This is our IV. The identification assumption is that, conditional on second-stage controls, foreign disasters, population, and bilateral geographic factors have no effect on the employment or value-added share in each sector other than through trade openness.

Figure 6 shows the substantial predictive power of our instrument for trade openness. We also provide F-statistics in the regression tables (Tables 1–4).

Figure 6: Plot on the first-stage regression



Note: the figure shows a scatterplot and its fitted line for the relationship between the trade openness measure and the constructed IV. Each point corresponds to a country–time value. The slope coefficient, standard error, and t-statistics of the fitted line are reported within the box.

Source: authors' compilation.

Data

Our data on trade openness is from BACI by the CEPII, which covers more than 200 countries and 5,000 products from 1995 to 2021 (Gaulier and Zignago 2010). The natural disaster information comes from the Emergency Events Database EM-DAT by the Center for Research on the Epidemiology of Disasters. Following Felbermayr and Gröschl (2014), our natural disaster measure is constructed by the number of large natural disasters categorized as drought, earthquake, volcanic activity, and storm. The 'large' disaster is defined as (1) caused 1,000 or more deaths; or (2) injured 1,000 or more people; or (3) affected 100,000 or more people. The gravity variables, such as distance, population, and contiguity, are from the CEPII (Conte et al. 2022). The financial remoteness measure is from Rose and Spiegel (2009). Finally, the data on structural transformation are from the GGDC/UNU-WIDER Economic Transformation Database (ETD) (Kruse et al. 2022). The ETD has information on the share of employment and value-added for 12 sectors in 51 economies in Africa, Asia, and Latin America.

Our final dataset is constructed by merging these data. The sample period is 1995–2010.

Results

Table 1 shows the effect of trade openness on sectoral employment share. The first three columns are the results from the fixed effect estimation; columns 4–6 are those from the IV regression; and columns 7–9 are those from the IV regression using import openness ($= \frac{\text{import}_{it}}{\text{GDP}_{it}}$) and export openness ($= \frac{\text{export}_{it}}{\text{GDP}_{it}}$) separately. In addition, we report the results on the employment share in the agricultural sector in columns 1, 4, and 7; that in the manufacturing sector in columns 2, 5, and 8; and that in the service sector in columns 3, 6, and 9.

The results from the fixed effect estimations show that, while all of them are statistically insignificant, trade openness is positively associated with the manufacturing employment share and negatively associated with the agricultural employment share. However, if trade openness is positively related to an unobservable change in a country's comparative advantage in the manufacturing sector that is included in the error term, the estimate for the manufacturing employment share may be biased upward. For similar reasons as above, the estimate for the agricultural employment shares may be biased downward.

The results from the IV regression mitigate such concerns (columns 4–6). As expected, the estimate for the manufacturing employment share is negatively associated with trade openness. The magnitude of the coefficient suggests that an increase in trade openness by one standard deviation (= 0.47 in our sample) corresponds to a decrease in the manufacturing employment share by 2.8 pp ($= -0.059 \times 100 \times 0.47$). Because the median of the manufacturing employment share is 11.1 per cent, the effect seems sizeable.

To investigate further how trade openness causes such a sizeable change in the sectoral employment share, columns 7–9 show the results when we include the effect of export openness and import openness separately. As we can see, the manufacturing employment share is negatively affected in a statistically significant way with import openness, but is not affected by export openness. The magnitude suggests that an increase in import openness by one standard deviation (= 0.28 in our sample) leads to a decrease in the manufacturing employment share by 2.2 pp ($= -0.077 \times 100 \times 0.28$). Similarly, the agricultural employment share is positively affected by import openness, but not affected by export openness.

Table 1: Employment shares

Variables	(1) FE	(2) FE	(3) FE	(4) IV	(5) IV	(6) IV	(7) IV	(8) IV	(9) IV
omega_exp							0.00967	0.0275	–0.0371
							(0.117)	(0.0792)	(0.0717)
omega_imp							0.0738*	–0.0772***	0.00340
							(0.0385)	(0.0193)	(0.0279)
lnpop_o	–0.196***	0.111**	0.0847	–0.170**	0.0876*	0.0826	–0.172**	0.0890*	0.0828
	(0.0656)	(0.0421)	(0.0519)	(0.0717)	(0.0458)	(0.0526)	(0.0815)	(0.0482)	(0.0610)
disaster_large	–0.00260	–0.000604	0.00320	0.000872	–0.00379	0.00291	0.000423	–0.00321	0.00279
	(0.0106)	(0.00436)	(0.00708)	(0.0102)	(0.00495)	(0.00682)	(0.0119)	(0.00534)	(0.00791)
omega	–0.0142	0.0134	0.000778	0.0651	–0.0592*	–0.00583			
	(0.0158)	(0.0138)	(0.0125)	(0.0532)	(0.0349)	(0.0310)			
Observations	197	197	197	197	197	197	197	197	197
R-squared	0.707	0.143	0.799	0.614	–0.515	0.798	0.990	0.924	0.993
Number of origin_id	50	50	50	50	50	50			
F-stat export							23.365	23.365	23.365
F-stat import							27.028	27.028	27.028
F-stat trade				11.853	11.853	11.853			

Note: clustered robust standard errors at the country level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: authors' compilation.

Table 2 shows the effect on sectoral value-added share. The estimates from the fixed effect estimation give us a positive relationship between trade openness and manufacturing value-added share (column 2). However, once we take the endogeneity concern into account by the IV regression, the positive relationship becomes smaller and statistically insignificant (column 5). Even after including import openness and export openness separately, the estimates on these terms are statistically insignificant (columns 7–9).

In combination with the results on the employment share in Table 1, the results on the value-added share in Table 2 suggest that a larger import openness causes employment reallocation from manufacturing to agriculture sectors, but does not lead to changes in value-added shares in these sectors. This may be consistent with the idea that imports cause substitution from labour to imported intermediate inputs or to capital within the manufacturing sector. Furthermore, the results so far imply that labour productivity in the manufacturing sector increases as a result of increasing imports, while labour productivity in the agricultural sector decreases as countries import more.

Table 2: Value-added shares

Variables	(1) FE	(2) FE	(3) FE	(4) IV	(5) IV	(6) IV	(7) IV	(8) IV	(9) IV
omega_exp							–0.0192	0.130	–0.111
							(0.155)	(0.101)	(0.121)
omega_imp							–0.00618	–0.0192	0.0253
							(0.0369)	(0.0213)	(0.0262)
lnpop_o	–0.00414	–0.0681	0.0722	–0.00369	–0.0714	0.0751	–0.00477	–0.0717	0.0765
	(0.0685)	(0.0438)	(0.0562)	(0.0682)	(0.0431)	(0.0580)	(0.0798)	(0.0500)	(0.0624)
disaster_large	–0.00330	–0.00256	0.00585	–0.00324	–0.00300	0.00624	–0.00343	–0.00249	0.00592
	(0.00672)	(0.00355)	(0.00686)	(0.00680)	(0.00385)	(0.00712)	(0.00815)	(0.00479)	(0.00788)
omega	–0.00701	0.0235**	–0.0165	–0.00562	0.0134	–0.00774			
	(0.0140)	(0.0111)	(0.0130)	(0.0321)	(0.0273)	(0.0339)			
Observations	197	197	197	197	197	197	197	197	197
R-squared	0.083	0.301	0.334	0.083	0.293	0.331	0.961	0.938	0.960
Number of origin_id	50	50	50	50	50	50			
F-stat export							23.365	23.365	23.365
F-stat import							27.028	27.028	27.028
F-stat trade				11.853	11.853	11.853			

Note: clustered robust standard errors at the country level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: authors' compilation.

Results for sub-Saharan African economies

To investigate the effect of trade openness on structural transformation, particularly in sub-Saharan African countries, we additionally include in Equation (1) the trade openness measure interacted with the African country dummy variable. The coefficient on the interaction term represents the effect of trade openness on employment or value-added share in African countries compared to the effect on an average country.

Table 3 shows the results on employment shares, especially for the sub-Saharan African economies, by including the interaction terms. Shown in columns 7–9, import openness negatively affects the manufacturing employment share. We find that the coefficient on the interaction term with import openness with the sub-Saharan African dummy variable is not significant; this tells us that even for sub-Saharan African economies increasing imports negatively affects employment shares in the manufacturing sector. For the agricultural sector we find that sub-Saharan African economies experience similar effects to the average effect.

We show the results for sub-Saharan African economies with the value-added shares in Table 4. We find that for sub-Saharan African economies neither exports nor imports affect value-added shares, which is similar to the average effect. However, when we look at the impact of aggregate trade openness on the value-added share, there are positive effects on the manufacturing sector when we perform fixed effects regression, as shown in columns 1–3. We also analyse the impact of trade in detail for 12 sectors, shown in Appendix A.

The combination of Tables 3 and 4 tells us that larger import openness creates labour to be reallocated from the manufacturing sector, but trade openness is causing value-added share in the manufacturing sector to expand in sub-Saharan African economies. This reaffirms our theory that firms are substituting away from labour to either cheaper capital or intermediate inputs. We add this result to our initial empirical findings, comparing sub-Saharan African economies with the Asian Tiger economies between the 1970s and the 1990s. We have found that sub-Saharan African economies, in their accelerated economic growth, have increasingly become net importers of manufacturing goods, which along with the IV regression results show that international trade is a potential channel that has negatively impacted manufacturing labour productivity, which alludes to the 'African manufacturing puzzle' suggested by Rodrik (2018) and Diao et al. (2021).

Table 3: Employment shares

Variables	(1) FE	(2) FE	(3) FE	(4) IV	(5) IV	(6) IV	(7) IV	(8) IV	(9) IV
omega_exp							0.0116	0.0309	–0.0425
							(0.130)	(0.0823)	(0.0815)
omega_imp							0.0737*	–0.0772***	0.00346
							(0.0402)	(0.0196)	(0.0301)
omega_exp_Africa							–0.0206	–0.0432	0.0638
							(0.179)	(0.0984)	(0.177)
omega_imp_Africa							0.102	0.0895	–0.192
							(0.118)	(0.0727)	(0.148)
lnpop_o	–0.205***	0.113***	0.0914	–0.183*	0.0590	0.124*	–0.198*	0.0716	0.127
	(0.0709)	(0.0400)	(0.0602)	(0.103)	(0.0589)	(0.0735)	(0.106)	(0.0559)	(0.0801)
disaster_large	–0.00282	–0.000551	0.00337	0.000671	–0.00423	0.00355	0.000643	–0.00279	0.00214
	(0.0105)	(0.00434)	(0.00704)	(0.0121)	(0.00551)	(0.00824)	(0.0127)	(0.00560)	(0.00873)
omega	–0.0166	0.0140	0.00263	0.0649	–0.0596	–0.00522			
	(0.0176)	(0.0149)	(0.0121)	(0.0630)	(0.0407)	(0.0385)			
omega_Africa	0.0150	–0.00356	–0.0115	0.0246	0.0539	–0.0785			
	(0.0390)	(0.0262)	(0.0472)	(0.0663)	(0.0421)	(0.0532)			
Observations	197	197	197	197	197	197	197	197	197
R-squared	0.707	0.144	0.799	0.989	0.896	0.992	0.990	0.926	0.992
Number of origin_id	50	50	50						
Trade open + Trade open*Africa	–0.002	0.01	–0.009	0.089	–0.006	–0.084			
s.e.	0.036	0.025	0.046	0.033	0.015	0.043			
Export open + Export open*Africa							–0.009	–0.012	0.021
s.e. exp							0.122	0.06	0.149
Import open + Import open*Africa							0.176	0.012	–0.188
s.e. imp							0.112	0.07	0.146
F-stat export							38.386	38.386	38.386
F-stat export-africa							36.311	36.311	36.311
F-stat import							219.096	219.096	219.096
F-stat import-africa							125.68	125.68	125.68
F-stat trade				19.269	19.269	19.269			
F-stat trade-africa				199.486	199.486	199.486			

Note: clustered robust standard errors at the country level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: authors' compilation.

To better understand these forces we turn our attention to a trade model to quantify how trade has affected employment and value-added shares in sub-Saharan African economies.

Table 4: Value-added shares

VARIABLES	(1) FE	(2) FE	(3) FE	(4) IV	(5) IV	(6) IV	(7) IV	(8) IV	(9) IV
omega_exp							–0.0206	0.135	–0.115
							(0.169)	(0.112)	(0.133)
omega_imp							–0.00658	–0.0185	0.0251
							(0.0364)	(0.0210)	(0.0266)
omega_exp_Africa							0.0260	–0.0822	0.0562
							(0.221)	(0.213)	(0.182)
omega_imp_Africa							0.0700	–0.00458	–0.0654
							(0.135)	(0.173)	(0.0857)
lnpop_o	–0.0162	–0.0767	0.0929	–0.0261	–0.0677	0.0938	–0.0321	–0.0515	0.0835
	(0.0725)	(0.0481)	(0.0588)	(0.0840)	(0.0575)	(0.0795)	(0.0795)	(0.0565)	(0.0811)
disaster_large	–0.00361	–0.00278	0.00638	–0.00358	–0.00295	0.00653	–0.00365	–0.00173	0.00538
	(0.00672)	(0.00363)	(0.00692)	(0.00795)	(0.00462)	(0.00838)	(0.00893)	(0.00554)	(0.00868)
omega	–0.0104	0.0211*	–0.0108	–0.00595	0.0134	–0.00746			
	(0.0157)	(0.0123)	(0.0119)	(0.0378)	(0.0320)	(0.0404)			
omega_Africa	0.0208	0.0149	–0.0357	0.0423	–0.00697	–0.0353			
	(0.0328)	(0.0203)	(0.0331)	(0.0370)	(0.0376)	(0.0490)			
Observations	197	197	197	197	197	197	197	197	197
R-squared	0.086	0.303	0.341	0.961	0.936	0.957	0.961	0.937	0.959
Number of origin_id	50	50	50						
Trade open + Trade open*Africa	0.01	0.036	–0.046	0.036	0.006	–0.043			
s.e.	0.029	0.016	0.032	0.021	0.026	0.038			
Export open + Export open*Africa							0.005	0.053	–0.059
s.e. exp							0.14	0.167	0.114
Import open + Import open*Africa							0.063	–0.023	–0.04
s.e. imp							0.127	0.171	0.084
F-stat export							38.386	38.386	38.386
F-stat export-africa							36.311	36.311	36.311
F-stat import							219.096	219.096	219.096
F-stat import-africa							125.68	125.68	125.68
F-stat trade				19.269	19.269	19.269			
F-stat trade-africa				199.486	199.486	199.486			

Note: clustered robust standard errors at the country level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: authors' compilation.

3 Quantitative model

We consider a world economy that consists of N countries indexed by $i, n \in \{1, 2, \ldots, N\}$, with four sectors: agriculture (AG), natural resources and commodities (C), manufacturing (M), and services (S). We use j as an index for sectors. In each sector $j \in J$, a continuum of varieties $\omega \in [0, 1]$ are produced, denoted as ω^j. While agriculture, commodities, and manufacturing goods are traded, services are not traded. Each market is perfectly competitive, and each location has labour, L_n, and capital K_n. The model is static, and we take the amount of labour and capital in each country as exogenous.

3.1 Intermediate production

Intermediate producers in country n of sector j produce according to the following constant returns-to-scale production function:

$$q_n^j(\omega^j) = z_n^j(\omega^j)\left(V_n^j(\omega^j)\right)^{\alpha_n^j}\left(\prod_{j' \in J}^{J}\left(M_n^{jj'}(\omega^j)\right)^{\gamma_n^j}\right)^{1-\alpha_n^j} \tag{4}$$

where $V_n^j(\omega^j)$ is a constant elasticity of substitution function of a factor input bundle:

$$V_n^j(\omega^j) = \left[\beta_n^j\left[L_n^j(\omega^j)\right]^{\frac{\sigma-1}{\sigma}} + (1-\beta_n^j)\left[K_n^j(\omega^j)\right]^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \tag{5}$$

Producers in country n in sector j of variety ω^j use labour ($L_n^j(\omega^j)$), capital ($K_n^j(\omega^j)$), and intermediate inputs ($M_n^{jj'}(\omega^j)$) in their production. For intermediate inputs we denote $M^{jj'}(\omega^j)$ as the amount of intermediates that comes from sector j' used to create sector j variety. We further define $z_n^j(\omega^j)$ as the productivity of producing variety ω^j drawn from the Fréchet distribution:

$$\Pr(z_n^j(\omega^j) < z) = \exp(-T_n^j z^{-\theta^j}) \tag{6}$$

We consider a nested constant elasticity of substitution (CES) production function instead of a standard Cobb–Douglas functional form to take into account that capital and labour can work as either complements or substitutes. If $\sigma > 1$, the production function of good ω^j exhibits capital–labour complementarity.

3.2 Sectoral final production

Production of the tradable and non-tradable sectoral final production is a CES function of the following form:

$$Y_n^j = \left[\int_0^1 \left(y_n^j(\omega^j) \right)^{\frac{\eta-1}{\eta}} d\omega \right]^{\frac{\eta}{\eta-1}} \tag{7}$$

where $y_n^j(\omega^j)$ is the consumption of intermediate variety ω^j of sector j in country n. Each variety ω^j is potentially produced in each country, but the final sectoral production is not traded. The final output from each sector can be used for either consumption or as intermediates:

$$Y_n^j = C_n^j + M_n^j \tag{8}$$

where M_n^j is the quantity of the final output of sector j that is used as intermediate inputs.

3.3 International trade

Only intermediate varieties in agriculture, commodities, and manufacturing can be traded internationally, while service sector varieties cannot be traded. Delivering a unit of variety ω^j in sector j from country i to country n requires producing $d_{ni}^j \geq 1$ of the good. Trading domestically is costless, which is denoted as $d_{ii}^j = 1$.

3.4 Preferences

The utility of the representative household in country n is given by a CES production function:

$$U_n = \varphi_n \left[\sum_{j=1}^{J} \left(C_n^j \right)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}} \tag{9}$$

with ρ dictating the elasticity of substitution across sectoral consumption amount C_n^j out of final sectoral production.

The household's budget constraint is given by

$$\sum_{j \in J} P_n^{C,j} C_n^j + NX_n = w_n L_n + r_n K_n \tag{10}$$

where each country's income consists of the sum of aggregate labour and capital income, which is used to consume sectoral consumption and net exports. We denote w_n and r_n as wage rates and rental rates for capital, respectively. NX_n denotes net exports or net transfers. NX_n can be negative if country n is running a trade deficit.

3.5 Model equilibrium

Now we define the equilibrium in our model. The model equilibrium consists of a set of aggregate prices $\{P_n^C, w_n, r_n\}_{n\in N}$ and $\{P_n^j, c_n^j, c_n^{V,j}\}_{j\in J, n\in N}$, aggregate quantities $\{C_n, X_n^j, Y_n^j\}_{j\in J, n\in N}$, aggregate factors $\{L_n^j, K_n^j\}_{j\in J, n\in N}$, bilateral trade shares $\{\pi_{ni}^j\}_{jinJ, n, i, \in N}$, factor supplies $\{L_n, K_n\}_{n\in N}$, technologies $\{A_n^j\}_{j\in J, n\in N}$, bilateral trade costs $\{d_{ni}^j\}_{j\in J, n, i\in N}$, and net exports $\{NX_n^j\}_{j\in J, n, i\in N}$. We now consider the equilibrium first-order conditions in our model.

Intermediate producers. Intermediate variety producers minimize their costs by solving their profit maximization problem. The cost of the factor unit input bundle is equal to

$$c_n^{V,j} = \left[\beta_n^j \big(w_n\big)^{1-\sigma} + (1-\beta_n^j)\big(r_n\big)^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \tag{11}$$

where w_n and r_n are wages and rental rates of capital in each country n, respectively. Since labour and capital are freely mobile across j sectors, wages and rental rates should be equalized across sectors. Then, the cost of the unit input bundle for intermediate production is equal to

$$c_n^j = B_n^j \big(c_n^{V,j}\big)^{\alpha_n^j} \left(\Pi_{j\in J} \big(P_n^j\big)^{\gamma_n^j}\right)^{1-\alpha_n^j} \tag{12}$$

where B_n^j is some constant equal to $B_n^j = (\alpha_n^j)^{-\alpha_n^j}(1-\alpha_n^j)^{-(1-\alpha_n^j)}$. The price of the intermediate variety ω^j in country n is given by

$$p_n^j(\omega^j) = \min_i \{c_{ni}^j(\omega^j)\} \tag{13}$$

Following derivations from Eaton and Kortum (2002), we can derive the intermediate aggregate price index of sector j in country n as

$$P_n^j = \left[\sum_{i\in N} \left(\frac{c_i^j d_{ni}^j}{A_i^j}\right)^{-\frac{1}{\theta^j}}\right]^{-\theta^j} \tag{14}$$

where the aggregate price index in country n depends on the costs, productivities, and bilateral trade costs of all of the origin countries that country n engages in trade with. From here, we can also derive the bilateral import shares as well:

$$\pi_{ni}^j = \left(\frac{c_i^j d_{ni}^j}{A_i^j P_n^j}\right)^{-\frac{1}{\theta^j}} \tag{15}$$

where π_{ni}^j denotes an import share of country i on the destination country n in sector j. This bilateral trade share formation is crucial in our analysis. Equation (15) is dictated by changes in productivity shocks A_i^j and bilateral trade costs d_{ni}^j.

Households optimization. Households maximize utility subject to their budget constraints. We get the following aggregate equilibrium conditions. Household maximization delivers:

$$\frac{P_n^{C,j} C_n^j}{\sum_{j'} p_n^{C,j'} C_n^{j'}} = \left[\frac{p_n^{C,j}}{P_n^C}\right]^{1-\rho} \tag{16}$$

Then, we also have the household budget constraint that needs to be satisfied for each country n:

$$\sum_j p_n^{C,j} C_n^j + NX_n = w_n L_n + r_n K_n \tag{17}$$

where $NX_n = \sum_{j \in J} NX_n^j$.

Market clearing. We need the following markets to clear to close our model. First, we need the labour market to clear in each country n:

$$w_n L_n = \sum_{j \in J} \beta_n^j \left(\frac{c_n^{V,j}}{w_n} \right)^{\sigma - 1} \left(\alpha_n^j \right) Y_n^j \tag{18}$$

where $L_n = \sum_{j \in J} L_n^j$. The left-hand side of Equation (18) is the total wage compensation in country n (labour supplied), which should be equal to the total labour demanded, which is the right-hand side of the equation. We also need the capital market to clear:

$$r_n K_n = \sum_{j \in J} \left(1 - \beta_n^j \right) \left(\frac{c_n^{V,j}}{r_n} \right)^{\sigma - 1} \left(\alpha_n^j \right) Y_n^j \tag{19}$$

where $K_n = \sum_{j \in J} K_n^j$. The interpretation of the capital market clearing condition is analogous to the labour market clearing condition. We also have to consider intermediate input markets clearing, which is given by

$$X_n^j = X_n^{F,j} + \sum_{j' \in J} M_n^{jj'} + NX_n^j \tag{20}$$

Then we need the world market for each sector to clear, which is given by

$$Y_n^j \; = \; \sum_{i \in N} \pi_{ni}^j X_n^j \tag{21}$$

4 Simple illustrative mechanism

In this section we simplify the model to show the mechanisms in the paper. Let's consider two sectors: manufacturing (M) and commodities (C). We further assume that there are no intermediate inputs in the model ($\alpha_n^j = 1$); then we have that sectoral value-added is equal to sectoral consumption expenditures. We also assume that the commodities sector primarily uses capital, and the manufacturing sector primarily uses labour.

$$\frac{r_n K_n}{w_n L_n} = \frac{P_n^C C_n^C}{P_n^M C_n^M} = \left(\frac{P_n^C}{P_n^M} \right)^{1-\rho} C_n \tag{22}$$

where P_n^j and C_n^j denote price indices and consumption levels of sector j products in country n. Following Eaton and Kortum (2002), we know that price index is proportional to domestic expenditure shares:

$$P_n^j \propto \frac{c_n^j}{A_n^j} \left(\pi_{nn}^j \right)^{\theta} \tag{23}$$

where c_n^j is the unit-cost bundle for sector j in country n, and A_n^j is the productivity shocks from our Fréchet distributional assumption. π_{nn}^j is the domestic absorption share in country n. Plugging Equation (23) into (22), we get that

$$\frac{P_n^C}{P_n^M} = \frac{r_n}{w_n} \frac{A_n^M}{A_n^C} \left(\frac{\pi_{nn}^C}{\pi_{nn}^M} \right)^{\theta} \tag{24}$$

Suppose trade costs for commodities drop relative to trade costs for manufacturing ($d^C < d^M$); then the domestic absorption for commodities would decrease relative to domestic manufacturing absorption

($\pi_{nn}^C < \pi_{nn}^M$). Relative prices of commodities to manufacturing $\left(\frac{P_n^C}{P_n^M}\right)$ would decrease. Plugging this into Equation (22), we obtain

$$\frac{r_n K_n}{w_n L_n} = \left[\frac{L_n}{K_n}\frac{A_n^M}{A_n^C}\left(\frac{\pi_{nn}^C}{\pi_{nn}^M}\right)^{\theta}\right]^{\frac{1-\rho}{\rho}} \tag{25}$$

This derivation is analogous to Cravino and Sotelo (2019). If manufacturing and commodities are complements ($\rho < 1$), more trade in commodities relative to manufacturing is associated with greater capital spending relative to compensation for labour. Furthermore, the value-added portion of the manufacturing sector decreases.

Equation (25) captures the essence of the stories that we want to tell in our paper, which is *trade-induced Dutch disease*. When we observe an export-driven expansion in the commodities sector, we would expect the domestic shares of the commodities sector to decrease. This would induce the capital compensation relative to labour compensation to increase, which reduces the manufacturing employment and value-added. This, in turn, induces labour productivity in the manufacturing sector to not grow.

Equation (25) also captures how domestic-driven structural change affects labour and capital allocations. When there is an increase in productivity in the manufacturing sector it would also induce an increase in demand for the commodities sector since manufacturing and commodities are complements. This would induce capital income to increase relative to labour income, which in turn would decrease the value-added portion of the manufacturing sector.

5 Conclusion

Even though many sub-Saharan African economies have experienced accelerated economic growth in recent decades, little is known about the causes and consequences of this phenomenon. In this paper we ask how trade-induced globalization has shaped economic growth and labour reallocation across sectors. We find that trade patterns between East Asian Tigers in the 1970s–1990s and African Lions in the 2000s–2020s were substantially different; sub-Saharan African economies have been predominantly net importers of manufacturing goods, while East Asian Tigers were net exporters of manufacturing goods.

To establish a more causal relationship, we construct an IV using the trade destination country's natural disasters, suggested by Felbermayr and Gröschl (2014). We find a couple of empirical results. First, we find that imports have negative effects while exports positively affect employment shares in sub-Saharan African economies. Tying this to our initial empirical findings that sub-Saharan African economies are increasingly becoming net importers of manufacturing goods, we conclude that firms are substituting labour for other inputs—capital or intermediates. Second, we find that overall trade openness expands value-added shares in the manufacturing sector.

We tie our empirical analysis to a quantitative trade model to study how increased trade integration in commodities and manufacturing sectors affects the capital–labour premium. We further show that a simple mechanism that reduces trade barriers in commodities and manufacturing sectors in sub-Saharan Africa can potentially lead to a decrease in employment in the manufacturing sector, which in turn leads to dampened growth in labour productivity in the manufacturing sector for the sub-Saharan African economies. To expand our analysis we plan to fully calibrate the model for future updates of this working paper.

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Appendix A: results with each of 12 sectors

Table A1: Employment share

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Outcome						Employment share in						
Variables	Agriculture	Mining	Manufacturing	Utilities	Construction	Trade	Transport	Business	Finance	Real estate	Government	Other
Export open$_{it}$	0.0157	–0.00415	0.0266	–0.00422	0.0137	–0.0171	0.000887	–0.0179	–0.0126*	–0.0113*	–0.000762	0.0110
	(0.108)	(0.00582)	(0.0711)	(0.00410)	(0.0210)	(0.0479)	(0.0198)	(0.0180)	(0.00705)	(0.00629)	(0.0342)	(0.0167)
Import open$_{it}$	0.0748**	–0.000495	–0.0775***	–0.000166	–0.0242**	–0.00236	–0.0305***	0.00396	0.0282***	0.0233***	0.0112	–0.00622
	(0.0340)	(0.00233)	(0.0171)	(0.00111)	(0.0110)	(0.0143)	(0.00906)	(0.00558)	(0.00229)	(0.00192)	(0.0124)	(0.00940)
Export open$_{it}$ × Africa$_i$	–0.0646	0.0313*	0.0173	0.00654	–0.00269	–0.0280	–0.00934	–0.0204	0.00678	0.00798	0.00163	0.0535
	(0.147)	(0.0184)	(0.0908)	(0.00574)	(0.0274)	(0.0723)	(0.0246)	(0.0247)	(0.00919)	(0.00705)	(0.0517)	(0.0586)
Import open$_{it}$ × Africa$_i$	–0.0445	–0.0188	0.0630	–0.00310	0.0152	0.0209	0.0262*	0.0116	–0.0301***	–0.0207***	0.0248	–0.0443
	(0.0895)	(0.0136)	(0.0447)	(0.00348)	(0.0185)	(0.0415)	(0.0141)	(0.0161)	(0.00395)	(0.00328)	(0.0317)	(0.0368)
Population$_{it}$	–0.156*	0.0112*	0.0658	0.00200	–0.000560	0.0786*	0.00500	–0.0583***	0.00368	0.000410	–0.0192	0.0674**
	(0.0915)	(0.00628)	(0.0472)	(0.00267)	(0.0283)	(0.0454)	(0.0151)	(0.0178)	(0.00481)	(0.00420)	(0.0350)	(0.0295)
Disaster$_{it}$	–0.000277	0.000989	–0.00335	–4.67e-05	–0.000252	0.00509	–0.00200	–0.000345	–0.000199	0.000943**	0.000418	–0.000963
	(0.0104)	(0.000603)	(0.00465)	(0.000237)	(0.00411)	(0.00400)	(0.00156)	(0.00155)	(0.000513)	(0.000447)	(0.00241)	(0.00174)
Observations	197	197	197	197	197	197	197	197	197	197	197	197
No. origin_id	50	50	50	50	50	50	50	50	50	50	50	50

Note: clustered robust standard errors at the country level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: authors' compilation.

Table A2: Value-added shares

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Outcome						Value-added share in						
Variables	Agriculture	Mining	Manufacturing	Utilities	Construction	Trade	Transport	Business	Finance	Real estate	Government	Other
Export open$_{it}$	–0.0451	0.0153	0.133	0.0218**	–0.0243	–0.0272	0.0167	0.000744	–0.0632***	–0.00512	–0.0317	0.00922
	(0.137)	(0.0427)	(0.0945)	(0.00996)	(0.0633)	(0.0451)	(0.0529)	(0.0308)	(0.0161)	(0.0269)	(0.0225)	(0.0158)
Import open$_{it}$	0.0247	–0.0318*	–0.0188	–0.00164	–0.0220	0.0520***	–0.0166	0.00570	0.0541***	–0.0399***	–0.00214	–0.00370
	(0.0275)	(0.0162)	(0.0181)	(0.00837)	(0.0152)	(0.0177)	(0.0101)	(0.00889)	(0.0109)	(0.0111)	(0.0165)	(0.00496)
Export open$_{it}$ $\times$ Africa$_i$	–0.0119	0.163*	–0.0458	–0.0123	0.0769	–0.141**	–0.0423	–0.0595	0.0119	0.0290	0.0739	–0.0424*
	(0.135)	(0.0940)	(0.118)	(0.0196)	(0.0713)	(0.0665)	(0.0565)	(0.0617)	(0.0329)	(0.0615)	(0.0529)	(0.0231)
Import open$_{it}$ $\times$ Africa$_i$	0.0594	–0.148**	0.00992	0.0176	–0.00464	0.0183	0.0158	0.00681	0.00189	0.0205	0.00667	–0.00470
	(0.0454)	(0.0572)	(0.0713)	(0.0146)	(0.0338)	(0.0420)	(0.0213)	(0.0275)	(0.0281)	(0.0389)	(0.0358)	(0.0164)
Population$_{it}$	–0.0327	0.0201	–0.0642	–0.00942	0.0495	0.116***	–0.0192	0.00450	–0.0232	–0.00913	–0.0502**	0.0185
	(0.0602)	(0.0361)	(0.0465)	(0.0125)	(0.0325)	(0.0383)	(0.0246)	(0.0381)	(0.0206)	(0.0297)	(0.0247)	(0.0204)
Disaster$_{it}$	–0.00118	–0.00368	–0.00206	0.00126	–0.00503*	0.00497	–0.000638	0.00504**	0.00281	0.000183	–0.00235	0.000680
	(0.00536)	(0.00400)	(0.00464)	(0.000877)	(0.00273)	(0.00352)	(0.00185)	(0.00244)	(0.00190)	(0.00349)	(0.00280)	(0.00123)
Observations	197	197	197	197	197	197	197	197	197	197	197	197
No. origin_id	50	50	50	50	50	50	50	50	50	50	50	50

Note: clustered robust standard errors at the country level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: authors' compilation.