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Industrial policy and labour productivity growth in Africa: does the technology choice matter?

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Abstract

The persistent gaps in African sectoral labour productivity and the disappointing growth in the manufacturing and service sectors have revived interest among academics and policymakers. In search of ways to boost labour productivity, this study explores how the technology choice as a proxy for industrial policy can affect labour productivity growth. First, I identify the different sources of growth with the decomposition method of shift–share analysis and a recent dataset from 1960 to 2017 of nine sectors. Then I investigate the impact of comparative advantage development strategy on growth components (within effects and structural effects). The shift and share decomposition analysis results suggest a changing role of growth components. While the structural change effect is driven by the "static gains" which still plays an important role, the within effect has been more prevalent during the MDGs and SDGs period. The empirical results indicate that defying comparative advantage hinders the within effect component mitigated by a weak and positive dynamic effect component. The evidence emphasises the design of industrial development based on the comparative advantage in SSA, complemented with policies and strategies aiming at increasing labour productivity in the agriculture sector due to its large employment share.

Keywords: Industrial policy, Technology Choice Index, African labour productivity, Shift and share analysis

1 Introduction

Scholars and policymakers, including international organisations, cannot overemphasise the role of labour productivity growth in economic development. The structural change literature argues that economy-wide productivity can be improved within existing economies activities through capital accumulation or technological change (within effect) and through the reallocation of labour from less productive to high productive activities (dynamic or structural change effect) (McMillan and Rodrik 2011; Diao et al. 2017). More importantly, the literature suggests that partial analyses of productivity performance within individual sectors (e.g., manufacturing) can be misleading when there are significant differences in labour productivities across economic activities (McMillan and Rodrik 2011; Diao et al. 2017).

It is well established from various studies that labour productivity disparities between sectors are common in developing countries and prominently in Africa. For example, McMillan and Rodrik (2011) highlight in their study the differences in average productivity between agricultural and non-agriculture sectors, discovering that labour productivity in the mining sector in Malawi is 136 times larger than in agriculture. Similar studies that pointed out the sectoral gaps in cross-country studies include Diao et al. (2017, 2021) and Mensah et al. (2018). The findings suggest that mining is the sector with one of the highest productivity levels on average, while agriculture remains the lowest. Despite the significant gaps between the sectors, a recent study by Diao et al. (2021) highlights the disappointing labour productivity growth within non-agricultural industries and, in particular, manufacturing and services in sub-Saharan African (SSA) countries.

Although labour productivity has been subject to many studies from different dimensions—macroeconomic, sectoral, and firm-level—and other perspectives such as the neoclassical growth[1] literature and the fundamental determinant[2] of differences in economic growth literature, the findings remain mixed and inconclusive. According to Dieppe (2021), a possible explanation includes the changing role of conventional factors and the structural changes that developing economies have undergone during the last decades. Another explanation is the growing literature on the New Structural Economics (NSE), which argues that economic outcomes are endogenous to a country's development strategies[3] and endowment structure and many developing countries failed to industrialise because of their approach to capital-intensive industries, which were not favourable to the endowment structures of their economies (Lin 2003).

Despite the theoretical and empirical evidence of the NSE, relevant studies are limited to macroeconomic outcomes, and little is known about the effect of development strategy on the sectoral contribution of aggregate growth using sector-level data. To the best of my knowledge, only the study from Gnangnon (2020) assessing the effect of comparative development strategy and Aid for Trade on structural change in production, and the study from Diao et al. (2021) are closely related to this paper. However, the study from Gnangnon (2020) uses two indexes as a measure of structural change in production—the Norm and Absolute Value Index and the Modified Lilien Index of structural change—and not the structural change component derived from the decomposition of growth using a shift and share analysis method, accounting for the reallocation of labour and the value added by sector. He finds that more prominent levels of Aid for Trade flows help foster structural change in production in countries that have embraced a comparative advantage development strategy.

Another study is that of Diao et al. (2021). They investigate the productivity growth in agriculture despite the declining employment and the declining productivity growth in manufacturing in Tanzania and Ethiopia. They find that large firms are more productive

[1] Studies related to the impact of neoclassical growth model factors include but are not limited to Belorgey et al. (2006), Supachet (2010), and Najarzadeh et al. (2014).

[2] Some examples of studies on the fundamental determinant of growth literature, see: (Bloch and Tang 2004; Rodrik 2003; Acemoglu 2009; Acemoglu et al. 2002; 2003).

[3] Development strategy in this context refers to industrial policy and other strategies toward industrialisation. This will be used interchangeably during the study.

with fewer employment opportunities. In contrast, small firms are less productive but absorb more employment. An additional examination of this contrast by comparing the capital–labour ratio of firms in Tanzania and Ethiopia reveals that large firms' capital–labour ratio in Tanzania and Ethiopia's manufacturing sectors is equivalent to that in considerably richer OECD countries. It has risen faster in Tanzanian and Ethiopian manufacturing than in the economy as a whole. However, this study is mainly restricted to a comparative analysis of the capital–labour ratio of manufacturing firms between Tanzania, Ethiopia, and the Czech Republic.

Against this backdrop, the paper contributes to the existing literature in the following ways. In the first part of this paper, I identify the sectoral contributions to aggregate labour productivity growth in 21 sub-Saharan African (SSA) countries over the 1960–2017 period. More specifically, I decompose the aggregate productivity growth into its main components and explore the role played by each component in contributing to growth in the long-term and also during each significant economic development period of SSA countries. The focus on analysing productivity growth is consistent with the global interest in improving labour productivity growth. Based on the shift–share decomposition analysis results, in the second part, I combine an econometric model to analyse the effect of comparative advantage development strategy on growth components. More specifically, I investigate the role of the Technology Choice Index (TCI)—a proxy for comparative advantage development strategy—on within effects, net or between static effects and the interaction or between dynamic effects.

The rest of the paper is organised as follows. The following section provides existing evidence on the role of growth components. It discusses the related literature on the NSEs and the link between TCI and macroeconomic outcomes. Section 3 describes the empirical strategy and data. Section 4 presents and discusses the results, and Sect. 5 concludes the paper.

2 Labour productivity growth and development strategy proxied by TCI

2.1 Existing evidence on shift–share decomposition and productivity growth

Productivity decomposition methods are valuable tools to shed light on the underlying causes of aggregate productivity movements (Bruhn et al. 2021). There is significant literature on the relationship between growth components[4] (within effects, static effects and structural change or dynamic effects) and productivity growth. A set of studies on the relationship between growth components and aggregate growth include the contributions of McMillan and Rodrik (2011), de Vries et al. (2015), and Diao et al. (2017).

McMillan and Rodrik (2011), for example, use a canonical decomposition method—originated from Frabicant (1942)—to decompose overall growth into within effects and structural change effect, and analyse the determinants of structural change in 38 countries from Africa, Latin America and Asia, over the 1990–2005 period. They find that structural change has been reducing growth in Africa and Latin America, with the most striking changes taking place in Latin America. De Vries et al. (2015) extend the

[4] It is worth mentioning that growth components are composed of within-effects, also known as intra-effect, and the effect of changes in the sectoral allocation of labour is called the structural change effect, also known as between-effect or shift-effect. Some studies decomposed the structural change effect into between-static-effect and between-dynamic-effect.

analysis of McMillan and Rodrik (2011) by considering the period 1960–2010 of 11 SSA countries and using an alternative decomposition method that explicitly decomposes the structural change effects into static and dynamic reallocation effects. They suggest that the structural term used in McMillan and Rodrik (2011) depends on differences in productivity levels across sectors and does not make the distinction in productivity growth. They further argue that distinguishing between static and dynamic reallocation effects makes a conceptual and empirical difference. The main findings suggest a movement of labour from sectors with productivity levels below the economy average to above the economy average (static reallocation gains) while sectors with productivity growth above average were shrinking (dynamic losses).

Diao et al. (2017) focus on the role of structural change in driving economy-wide labour productivity growth from a structuralist perspective by decomposing labour productivity growth into within-sector and inter-sectoral labour reallocation. They find a rapid within-sector labour productivity growth in Latin America or growth-increasing structural change in Africa, but rarely both of them simultaneously.

Other studies that are relevant in the context of growth decomposition that consider the critical role of growth components include Mensah et al. (2018), Owusu (2021), Azenui and Rada (2021), and Landesmann and Foster-McGregor (2021). In addition to decomposing labour productivity growth into within-effects and structural change effects, they further consider the relationship between growth components and several factors that have proven to influence labour productivity growth.

A recent study by Mensah et al. (2018) uses a standard decomposition method of labour productivity growth combined with a decomposition of labour market turbulence to investigate the role of structural change and job reallocation in 18 African countries' economic growth from 1960 to 2015. They find a positive contribution of structural change on labour productivity growth, with some heterogeneity across sub-regions. Further analyses suggest that countries with rigid labour markets reduce job reallocation across sectors; in other words, countries with low employment protection legislation induce high rates of job reallocation.

In another study using a dataset of SSA countries from 1990 to 2015, Owusu (2021) decomposes labour productivity growth using the shift and share decomposition method and then examines the impact of Global Value Chain participation on labour productivity growth and its components (structural change effect and the within effect). The paper finds that GVC participation induces labour productivity growth and the within effect, while there is no evidence of its impact on the structural change effect.

Azenui and Rada (2021) identify sectoral contributions to labour productivity growth in 30 SSA LDCs from 1991 to 2018 and then investigate the strength of the relation between aggregate labour productivity growth and its sectoral components and other determinants of economic development (manufacturing growth as an explanatory variable). The study finds that manufacturing growth is associated with labour productivity growth and its components.

Landesmann and Foster-McGregor (2021) consider the impact of trade liberalisation on labour productivity growth and its components in 42 countries over the period 1960 to 2005. The results indicate that trade liberalisation positively affects growth and its components, with the impact more significant from within-sector changes.

2.2 Comparative advantage development strategy and macroeconomic outcomes

Since the 1950s, development theory has seen considerable shifts, from the old structuralism approach championed by Lewis (1954) and Prebisch (1959) to neoliberalism in the 1990s, which has supported the Washington-Consensus promoted by the Bretton Woods institutions (the World Bank and the IMF). As a result of developing countries' failure to accomplish industrialisation and modernisation, and despite the implementation of both structuralism and neoliberalism, the New Structural Economics (NSE) has risen in the development literature as an alternative strategy to development (Lin 2019). By highlighting the relevance of economic structures and industry upgrading, the NSE draws on structural economics and the neoclassical approach (Lin 2010, 2019) to structural change in the process of economic growth. It regards economic development as a dynamic process defined by structural changes, industry upgrading, and hard and soft infrastructural improvements at all levels (Lin 2010).

Bruno et al. (2015) argue that the NSE approach is based on three elements: an understanding of comparative advantages as the evolving potential of a country's endowment structure; reliance on the market as an allocation mechanism at any stage of development; and the importance of the role of the state in facilitating the process of industrial upgrading. The cornerstone of the NSE development theory is based on the idea that a country's economic structure is endogenous to the structure of its factor endowments, and the market is the primary mechanism for successful resource allocation. In this context, the government's role should be limited to providing information about new industries, coordinating related investments across different firms within industries, compensating the information externalities, and fostering new industries through incubation and foreign direct investment incentives (Lin 2010).

As a result, development strategies may be classified as either Comparative Advantage Following (CAF) or Comparative Advantage Defying (CAD). The CAF development strategy encourages countries to promote industries, notably in the case of developing countries, labour-intensive sectors, based on their comparative advantage. The CAD approach entails building capital-intensive sectors that are incompatible with their comparative advantage assessed by the factor endowments. The CAF approach actively promotes structural improvements, such as upgrading and strengthening physical and soft infrastructure and supporting the market mechanism's role in assuring effective resource allocation.

2.3 TCI as a proxy for CAD/CAF development strategy

The concept of appropriate technology firstly emerged from Atkinson and Stiglitz (1969), who pointed out that technological change is not necessarily always beneficial for society as a whole, as it can lead to winners and losers depending on the distribution of market power and the ownership of technical innovations. Schumacher (2011) and other scholars, including Diwan and Rodrik (1991), Basu and Weil (1998), and Acemoglu and Zilibotti (1999) have made significant contributions to the theory.

For instance, Basu and Weil (1998) suggest that the limited capital stock in developing countries can hinder their adopting of advanced technology from developed

countries. They believe that developing countries can achieve a period of rapid growth by increasing their saving rate and utilising the technology from developed countries.

However, Lin (2003) suggests that their argument failed to account for the reasons why the efforts made by governments to enhance the savings rate in Latin America, Africa, and Asia, (excluding the Asia Tigers) did not result in an acceleration of the growth rate.

Rodrik (2000) additionally demonstrates that the relationship between growth and savings is such that growth causes savings, not the other way around. Therefore, it would be challenging to consider an increase in the saving rate as the cause of rapid economic growth.

By contrast, Acemoglu and Zilibotti (1999) highlighted the drawbacks of importing technology into developing countries. They argued that unskilled workers end up using the technology, resulting in a mismatch between labour skills and technology. This mismatch can lead to significant disparities in output per capita and total factor productivity (TFP). Therefore, enhancing the skill set and human capital of workers is vital for achieving income convergence. This argument is in line with Lucas (1988).

Lin (2003) contests the assumption made by Acemoglu and Zilibotti as too rigid because developing countries do not always adopt frontier technologies from developed countries; they may also adopt technologies that are within the frontier. Furthermore, the argument for appropriate technology does not address the question of what role the government of developing countries should play in promoting economic growth or what intervention affect economic growth, as well as what type of policies to improve the private sector's savings rate and human capital stock. Or should the government directly subsidise the adoption of high-tech industries?

In answering the above questions, Lin (2003) argues that developing countries failure to converge and catchup with developed countries is due to their governments' inappropriate strategies towards capital-intensive industries. The optimal industrial structure of an economy is endogenously determined by the economy's endowment structure. He further provided the theoretical and empirical relationship between firm's viability and comparative advantage in a labour-intensive or capital-intensive economy. For instance, a firm's decision on which industry or technology to pursue is influenced by the prices of capital, labour, and natural resources within the economy. This means that the company will only choose an industry or technology based on the economy's comparative advantages if the price structure accurately reflects the relative abundance of these resources. The price structure can only reflect this accurately if prices are determined through competitive markets. Therefore, the main role of the government in promoting economic development is to ensure that markets function effectively.

Assessing an implemented country's development strategy in regard to CAD or CAF appears challenging. As a result, Lin and Liu (2004) propose the TCI as a proxy for the development strategy for CAD or CAF, which is computed as follows:

$$\mathrm{TCI}_{it} = \frac{\mathrm{AVM}_{it}/\mathrm{LM}_{it}}{\mathrm{GDP}_{it}/L_{it}}, \tag{1}$$

where AVM_{it} is the added value of manufacturing industries of given country i, at time t; GDP_{it} is the total added value of the country i; LM_{it} stands for the labour in the manufacturing industry, and L_{it} is the total labour force.

Suppose a government implements a CAD strategy to support capital-intensive industries. In that case, the TCI in this nation is projected to be higher than otherwise. This is because, if a country implements a CAD strategy, the government may grant firms monopoly positions in product markets—allowing them to charge higher output prices—and provide them with subsidised credits and inputs to lower their investment and operation costs in order to overcome the viability issue of firms in the prioritised sectors of the manufacturing industries. The preceding policy initiatives will result in a higher AVM_{it} than would otherwise be the case. Other things being equal, investment in the priority manufacturing industry will be more capital-intensive and consume less labour. As a result, the numerator in the Equation will be more significant for a country that implements the CAD approach. Given the income level and other parameters, the size of the TCI may be used as a proxy for the extent to which a country pursues a CAD strategy.

2.4 Empirical studies

The link between development strategy (CAD/CAF) as proxied by TCI and economic outcomes has received significant attention in recent decades, with a great number of research outlining theoretical and empirical ways to contribute to economic outcomes. Relevant empirical studies are limited to macroeconomic outcomes, such as the growth of GDP per capita (Lin 2003; Bruno et al. 2015), poverty reduction (Lin and Liu 2006; Siddique 2016), structural change in production (Gnangnon 2020). However, the evidence on the impact of CAF/CAD remains mixed and inconclusive.

Lin (2003) suggests that a country's long-term economic development plan determines its economic outcomes endogenously. In research conducted utilising data from 51 economies from 1970 to 1992, the author discovered that a development strategy based on challenging the comparative advantage negatively influences annual growth rates of per capita real GDP. Lin and Liu (2006) studied the influence of CAD/CAF on poverty incidence in rural China (28 provinces). They found that TCI is both positively and strongly related to poverty. In other words, the greater a province's deviation from its comparative advantage, the higher the province's poverty rate. Another study with similar findings includes Siddique (2016), who investigated CAD effects on the poverty of 113 countries from 1980 to 2000. The study expanded on the work of Lin and Liu (2006) by doing a cross-country analysis since the Chinese experience could not be extrapolated to the rest of the globe. He discovered that cross-country poverty incidence was positively related to CAD development strategy. A high degree of financial development, on the other hand, mitigates the poverty-increasing impact of CAD adoption.

In the context of cross-country analysis, some studies provided mixed evidence of the relationship between development strategy (CAD/CAF) and economic outcomes. For example, Bruno et al. (2015) investigated the New Structural Economics (NSE) hypothesis by investigating the link between industrial policies, finance, and growth in 164 countries from 1963 to 2009. However, the detrimental effect of a higher TCI ratio on midterm growth is partially reduced by a moderate degree of financial distortions. An extended

analysis of transition economies yields some contradicting conclusions. For example, the study finds that TCI is positively associated with growth in Central and Eastern European (CEEB) nations while negatively influencing the Commonwealth of Independent States (CIS). They suggest that NSE concepts are more applicable to middle-income countries and less applicable to high-income countries and advanced economies.

Gnangnon (2020) uses the system GMM method and panel data in 81 countries from 1996 to 2016 and finds that defying a comparative advantage is associated with structural change. Further analyses find that defying the comparative advantage (CAD) or industrial development based on capital and technology-intensive is associated with structural change in production. However, the income level analysis results suggest that as a country develops, the extent of structural change in production is positively driven by industrial development based on labour-intensive. However, CAD induces a greater extent of structural change in production, mainly in low-income countries.

The discussions above highlight the critical role of within effect and structural change in driving productivity growth and as intermediate factors of other economic growth determinants. In summary, while the findings suggests that comparative advantage development strategy impacts structural change of production, the evidence in favour of other economic outcomes is at best mixed, with minimal evidence on within effects and structural change effects components. Therefore, I will consider the impact of development strategy on growth components, decomposing the effects into within and structural change (net or between static effect and interaction or between dynamic effect).

3 Methodology and data

3.1 Shift and share decomposition/productivity growth decomposition

In this section, I adopted the common shift and share method used in previous literature—mainly from recent studies (Mensah and Szirmai 2018; Owusu 2021)—to decompose productivity growth into the contribution from within and the structural change effect. The method is computed as follows:

Let LP_t and E_t be the total output level (or value-added) and total employment at time t. Economy-wide labour productivity lp_t at time t is given as:

$$\mathrm{lp}_t = \frac{\mathrm{LP}_t}{E_t} = \sum_i \mathrm{lp}_{it}\mathrm{s}_{it}, \tag{2}$$

where lp_{it} is labour productivity of sector i in time t given by $\mathrm{lp}_{it} = \frac{\mathrm{LP}_{it}}{E_{it}}$, with LP_{it} being sector i's value-added and E_{it} being the actual number of persons engaged in sector i at time t. s_{it} is the sectoral share of employment in total economy employment at time t. Given the above, the growth rate of economy-wide labour productivity between time (t) and (0) is given as follows:

$$\dot{\mathrm{lp}} = \sum_{i=1}^{N}\left[\frac{\mathrm{lp}_{it}-\mathrm{lp}_{i0}}{\mathrm{lp}_0}\right]s_{i0} + \sum_{i=1}^{N}\left[\frac{(s_{it}-s_{i0})\times(\mathrm{lp}_{i0}-\mathrm{lp}_0)}{\mathrm{lp}_0}\right] + \sum_{i=1}^{N}\left[\frac{(s_{it}-s_{i0})\times(\mathrm{lp}_{it}-\mathrm{lp}_{i0})}{\mathrm{lp}_0}\right], \tag{3}$$

where $\dot{\mathrm{lp}}$ is the overall growth of labour productivity, N is the number of sectors and lp_0 is economy-wide aggregate labour productivity at time 0. The subscript 0 and t refer to the initial and final years, respectively. The first component of the right-hand side is

the sum of each within-sector labour productivity growth rate, weighted by the sector's labour share in the economy. In other words, it is that part of the overall growth caused by productivity growth within sectors. Productivity within a sector can grow due to new technology, changes in the organisational structure, downsizing, and increased competition (Disney et al. 2003).

The final two components capture the structural change or between effects. The first term is the net or between static effect.[5] It measures the part of productivity growth arising from changes in the sectoral composition of employment. It captures whether workers move to above-average productivity sectors. This mimics the standard shift and share method (see Farbicant 1942; De Vries et al. 2015; McMillan and Rodrik 2011), albeit with the introduction of referenced or economy-wide productivity level, lp_0 (Griliches and Regev 1995). The introduction of the referenced economy-wide productivity level helps identify which sectors contribute positively or negatively to the static shift effect. At the aggregate level, the sum of these positive and negative effects is the same as the unreferenced version used by de Vries et al. (2015). The term reflects the fact that sectors' contribution to aggregate productivity growth can be both positive and negative depending on whether the productivity levels for sectors are above or below the referenced economy-wide productivity level. In other words, this decomposition strategy allows us to calculate the contribution of productivity level sectors.

The second term—the interaction or between dynamic effect—measures the combined effect of changes in employment shares and sectoral productivity. It captures whether productivity growth is higher in sectors expanding in terms of employment shares. It is positive when labour moves from sectors with less productivity growth to sectors with more productivity growth (Forster-McGregor and Verspagen 2016; De Vries et al. 2015).

3.2 Impact of TCI

I adopted the following econometric model to examine the effect of comparative advantage development strategy on productivity growth components (within effect, structural change effect):

$$y_{it} = \alpha + \beta_1 \mathrm{TCI}_{it} + \beta_2 X_{it} + \delta_i + \omega_t + \varepsilon_{it}, \tag{4}$$

where y_{it} is the labour productivity growth components by country i in year t. Depending on the specification, y_{it} is either the within effect, the static effect, the dynamic effect or the structural change effect (sum of static and dynamic effects). TCI, defined as Technology Choice Index, is used as a proxy for development strategy implemented in a country i in year t is the variable of interest. X is a vector of control variables, δ_i denotes a set of country-specific fixed effects, and ω_t is a vector of year fixed effects accounting for factors that are not controlled for through the inclusion of the explanatory variables. ε_{it} is an error term with a mean zero.

[5] We thank the reviewer for suggesting that the interpretation of the net or between static effect in our case is one out of several possible interpretations. Therefore, we caution when interpreting similar findings and reserved for further discussion or exploration, allowing for other potential interpretations to be considered.

3.3 Data and variables

The primary data source for the analysis is the nine-sector database compiled by Dieppe and Matsuoka (2020). It is originally derived from multiple sources, most notably the Expanded Africa Sector Database dataset from Mensah and Szirmai (2018) and other sources such as U.N. data and ILOSTAT. The database reports data for each of the nine sectors[6] on nominal value-added, real value-added, employment, labour productivity (2010 constant prices, local currency) and labour productivity (2011 international PPP exchange rate) by sector for 21 sub-Saharan African countries, available from 1960 to 2018. The 21 countries include nine low-income, eight lower-middle-income and four upper-middle-income countries. The dataset has the merit of easing the construction of the within and structural change components of productivity growth. The Technology Choice Index (TCI) is used as a proxy for industrial development based on comparative advantage (CAD/CAF). In addition to our variable of interest, the analysis accounts for several control variables (Gnangnon 2020). Those variables include trade openness (openness), the quality of institution (institution), human capital index (HCI), the depth of financial development (Findev_1), the population growth (POP). The description and source of all the variables and descriptive statistics are provided in Tables 7 and 8, respectively.

4 Results and discussion

4.1 Result of growth decomposition

Figures 1 and 2 show the results of the shift–share decomposition showing the patterns of growth and its components across sub-Saharan African countries over the 1960s to 2017 period and also during different periods in Africa's economic development following the examples of de Vries et al. (2015), Mensah et al. (2018) and (Owusu 2021). From 1960 to 2017 in Fig. 1, unweighted labour productivity grew by 1.21% per year. Of this, productivity growth within sectors accounted for 0.27%, with net or between static effect accounting for 1.18% and the interaction or between-dynamic for −0.24%. While structural change contributed positively during this period, it was mainly driven by the net static gains with some dynamic losses.

Figure 2 shows the results of the shift–share decomposition of growth and its components across sub-Saharan African countries over different economic development periods: the import substitution era (1960–1975), the lost decades (1975–1990), the post-structural adjustment era (1990–2000), and the MGDs and SDGs era (2000–2017). The positive labour productivity growth (1.68%) during the import substitution era (1960–1975) was caused by a decline in the dynamic shift effect (−0.31%), mitigated by a positive within-effect (0.75%) and a net or between static effect (1.24%).

During the lost decade, from 1975 to 1990, average labour productivity growth in most African countries experienced the worst productivity growth among all periods to a record of −1.16%. This was due to a negative contribution of within effect (−1.53%) and the interaction or between dynamic effect (−0.27), mitigated by some gains from the net or between static effect (0.64%).

[6] The nine sectors are agriculture, mining, manufacturing; utilities; construction; trade services; transport services, financial and business services, and other services.

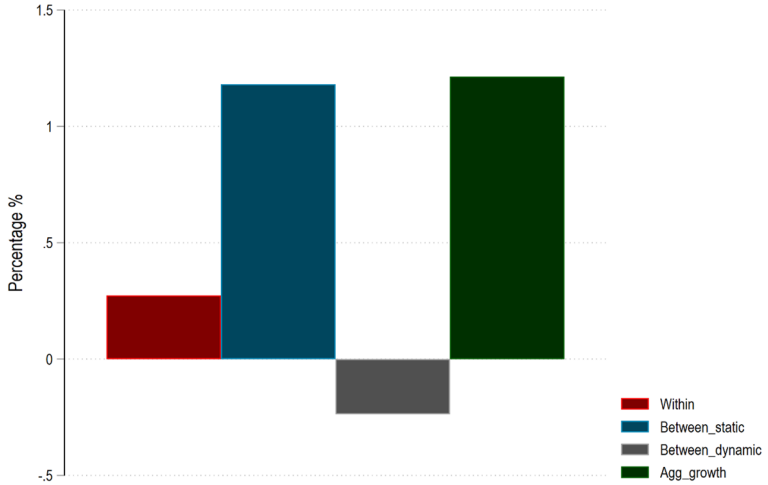

Fig. 1 Average labour productivity growth and its components 1960–2017. Decomposition results using Eq. (2). Agg_growth is the average productivity growth equal to the sum of all components (within, between_static and between_dynamic). Also, the structural change effect equals the sum of the net or between_static effect and the interaction or between_dynamic effect) (Sources: The author's computation is based on the compiled dataset from (Dieppe 2021) and (Mensah and Szirmai 2018))

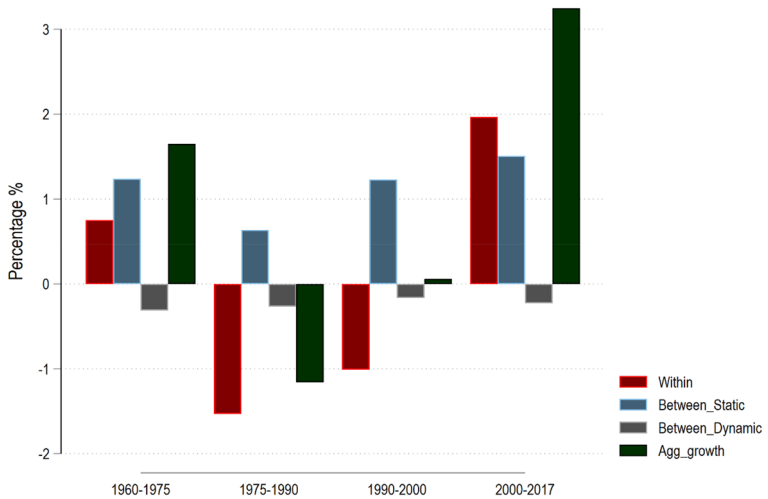

Fig. 2 Average labour productivity growth and its components by period. Decomposition results using Eq. (2). Agg_growth is the average productivity growth equal to the sum of all components (within, between_static and between_dynamic). Also, the structural change effect equals the sum of the net or between_static effect and the interaction or between_dynamic effect) (Sources: The author's computation is based on the compiled dataset from (Dieppe 2021) and (Mensah and Szirmai 2018))

A potential explanation for this performance is attributed to the oil crisis in the 1970s, combined with the currency crisis and other political instabilities across the region from the mid-1970s (Mensah et al. 2018). Among other explanations is the implementation of the Structural Adjustment Programs, as argued by many authors, including Owusu (2021). Compared to the disappointing growth in the previous period, average labour productivity growth during the post-structural adjustment period (1990–2000) slightly increased to 0.06%. It is driven by an increase in net or between static effects (1.23%) and a loss caused by a decline in within effect (− 1.01%)

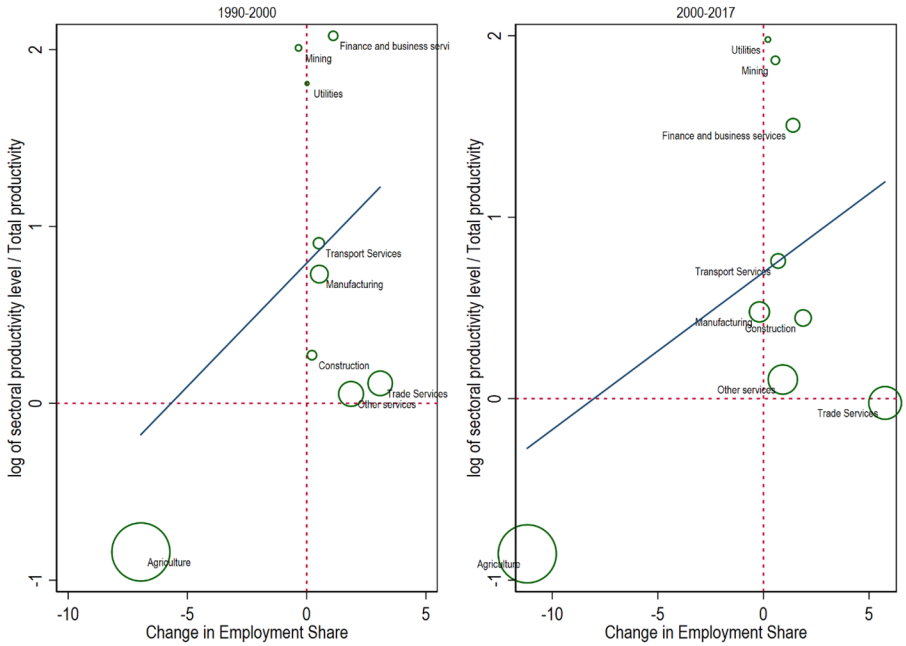

Fig. 3 Relative sectoral productivity and employment changes in Africa, 1990–2000 and 2000–2017. The relative productivity here is equal to the log of (sectoral productivity/total productivity). The estimated regression line, measuring the relationship between productivity and change in employment share by sector, is not statistically significant. The size of the bubbles indicates the employment size at the end-of-period. The detailed descriptions of the sectors are attached in Appendix (Sources: The author's computation is based on the compiled dataset from (Dieppe 2021) and (Mensah and Szirmai 2018))

and interaction or between dynamic effect (− 0.16%). Supported by previous studies, I find that the MDGs and SGDs era recorded the highest productivity growth rates of 3.25%. It is driven by the highest within-effect (1.97%) and the net or between effect (1.51%) of all periods, and yet a negative contribution of the interaction or between dynamic effect (− 0.23%).

In Figs. 3 and 4, I provide an overview of the degree of structural transformation components in SSA during the post-SAP (1990–2000) and MGDs and SGDs (2000–2017) by depicting the employment shift across sectors varying in terms of productivity levels and growth. This is done by plotting the sectoral productivity level relative to the total productivity level against the change in employment share within these sectors, and the sectoral productivity growth against the change in the employment share within these sectors, over the periods 1990 to 2010 and 2010 to 2017. In essence, the graphs show whether shifts in the structure of the economy, in terms of employment shifts across sectors, have been towards sectors whose productivity levels were above or below economy-wide average productivity level and whether the shift was towards sectors whose productivity growth was above or below the average productivity growth.

During the period 1990–2000 in Fig. 3, there is evidence that agriculture remains the largest employer while being the least productive sector in SSA. Besides, it has incurred the most considerable employment losses. Unfortunately, the most productive sectors, such as mining, have lost employment share. At the same time, it remains stagnant in utilities, compared to finance and businesses, which recorded an increase in

employment growth. Other sectors with above-average productivity levels, i.e. transport services, manufacturing, and construction, also recorded slight growth in employment shares. The biggest gainers of the loss of employment share in agriculture are trade services and other services.

During the MDGs and SDGs period (2000–2017) in Fig. 3, most sectors with above-average productivity levels recorded growth in employment share, except the manufacturing sector, which saw a decline in employment share. Unlike the post-SAP, particularly remarkable is the fall of trade services to below-average productivity levels with a sharp growth in employment share. At the same time, agriculture remained the most prominent employer despite the considerable loss in employment share.

Figure 4 shows the results of this shift of employment across sectors in terms of productivity growth during the post-SAP (1990–2000) and MGDs and SGDs (2000–2017). The shift of employment in both periods has been growth reducing. Except for other services in above-average productivity growth during the post-SAP, which induced some growth in employment share, mining and manufacturing remained stagnant in terms of employment share. Regarding sectors with below-average productivity growth, trade services induce the most significant proportion of employment share during the same period. Employment growth in sectors with above-average productivity growth during the 2000–2017 period remained stagnant, except for agriculture which shrank despite being the largest employer. Further evidence suggests that employment has shifted from above-average productivity growth (agricultural activities) to below-average productivity

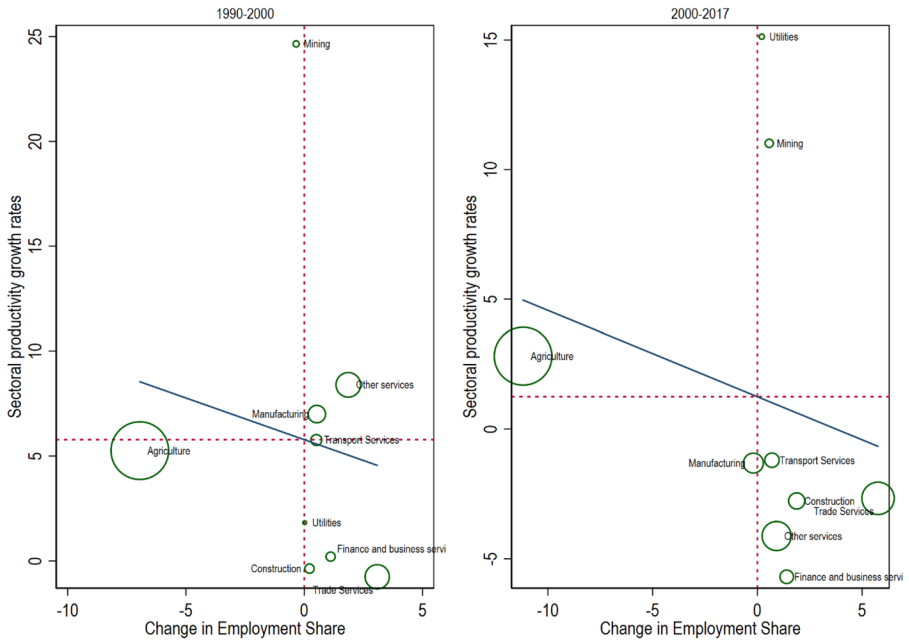

Fig. 4 Sectoral productivity growth and employment changes in Africa, 1990–2000 and 2000–2017. The horizontal dashed line represents the average labour productivity growth. Average productivity growth between 1990–2000 is 5.7 percent, and between 2000–2017 is 1.2 percent. The estimated regression line, measuring the relationship between productivity and change in employment share by sector, is not statistically significant. The size of the bubbles indicates the employment size at the end-of-period. The detailed descriptions of the sectors are attached in Appendix (Sources: The author's computation is based on the compiled dataset from (Dieppe 2021) and (Mensah & Szirmai 2018))

growth activities, mainly trade services which are the primary beneficiaries. Not only is manufacturing productivity growth below the average during this period, but it also has not been a source of employment growth.

Overall, the results described in Figs. 3 and 4 are in line with De Vries et al. (2015) and Mensah et al. (2018), who also find that workers moved from agriculture to the services sector. The shift of workers from agriculture during the 1990–2000 period happened during the trade liberalisation period while it expanded more than two times in the MDGs and SGDs period. Most African countries undertook market-oriented policies in the 1990s, which induced the demand for wholesale and retailing services. This was associated with increased agricultural productivity (Diao et al. 2018a), which induces demand for distributive trade services. For instance, recent evidence in the case of Tanzania found that small business owners in rural and urban areas were farmers before starting their trading activities (Diao et al. 2018b). In addition to this, another explanation is the 'negative rural push' theory which argues that rural poverty and other factors—natural disasters and land pressure—(Barrios et al. 2006; Poelhekke 2011) combined with a decrease in the agricultural wage incentivise the reallocation of workers from rural areas to cities to seek for employment in the modern sectors, with the unskilled workers being absorbed in the less productivity service sectors (Osei and Jedwab 2017).

Although trade services experienced the most significant expansion in both periods, labour productivity growth in the sector alongside other modern sectors has been disappointing. One explanation for the sluggish productivity growth in the service sector is the lack of additional investment in Information and Communication Technology (ICTs) (De Vries et al. 2015). In comparison, it is believed that the reallocation of workers towards the services sector will lead to a more labour-intensive and as a result, labour productivity will decline. Reallocating workers requires additional investment for average products in expanding sectors not to change (Chenery et al. 1986). For instance, the evidence suggests that the total spending on information and communication technology in wholesale and retail firms and other service sectors has remained the lowest for the past decades in African countries compared to other regions (WITSA 2010).

Unlike trade services, growth in labour productivity and employment in the manufacturing sector is due to some different reasons. On one hand, deindustrialisation, or premature deindustrialisation—due to the import competition imposed by globalisation—has been highlighted as a primary cause of low productivity growth and employment growth in the manufacturing sector (Rodrik 2016). However, it is also suggested that the effect of globalisation on the pattern has been a function of domestic choices, policies, and growth strategies that may have also played a significant role (McMillan and Rodrik 2011). In addition, the inappropriate technologies choice theory has been suggested to be another reason for the decline in productivity and employment in the manufacturing sector. For example, a recent study of Tanzanian and Ethiopian firms in the manufacturing sector reveals that the capital–labour ratio is higher in large firms and growing faster than the capital–labour ratio in the whole economy compared to small/medium and informal firms which account for a large proportion of firms (Diao et al. 2021). Also, the study finds that large firms are more productive but not a source of employment, while small and medium firms are less productive but a significant source

Table 1 Baseline estimation of TCI effect on labour productivity growth components 1990–2017

Variables	(1) Within effect	(2) Within effect	(3) Static effect	(4) Static effect	(5) Dynamic effect	(6) Dynamic effect	(7) Structural change	(8) Structural change
TCI	−2.712*** (0.815)	−2.880*** (1.048)	−0.225 (0.202)	−0.286 (0.260)	0.125** (0.052)	0.112* (0.067)	−0.100 (0.196)	−0.174 (0.252)
Constant	5.662*** (1.452)	5.951*** (1.843)	1.804*** (0.361)	1.910*** (0.457)	−0.422*** (0.092)	−0.399*** (0.118)	1.382*** (0.349)	1.512*** (0.443)
Observations	560	560	560	560	560	560	560	560
R-squared	0.073	0.149	0.218	0.285	0.143	0.204	0.210	0.276
Country F.E	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year F.E	No	Yes	No	Yes	No	Yes	No	Yes

The variable TCI is presented in the log. Standard errors in parentheses. Significance level at *** $p<0.01$, ** $p<0.05$, * $p<0.1$

of employment. They argue that this is due to the shift to capital and skill-intensive technologies available to firms on the world markets. In other words, there has been a 'technological biased' towards capital and skill intensive in the labour-intensive sectors.

While different reasons have been highlighted in the previous section, we intend to test the theory of the inappropriate technology choice or capital–labour ratio in manufacturing on the components of labour productivity growth. This aspect has been neglected in the previous literature; therefore, we address the gap in the next section.

4.2 Estimation results of the effect of TCI on growth components

Table 1 reports the results from the baseline regression model described in Eq. 3, with the dependent variables being the within effect, the static effect, the dynamic effect, and the structural change effect. The results in columns 1 and 2 indicate a strong and negative relationship between TCI and within effect, robust to the various fixed effects.

This implies that a country defying its comparative advantage when designing an industrial policy induces a negative contribution to within effects. A 10% increase in TCI decreases within effect contribution to growth by around 0.28 percentage points. In columns 3 and 4, the coefficients of TCI on the net or between static effect are negative but insignificant, even when controlling for a set of fixed effects. The effect of TCI on the interaction or between dynamic effect is reported in columns 5 and 6 and is positive and significant. This implies that defying the comparative advantage with an increase of TCI by 10%, increase the interaction or between dynamic effect by 0.012 percentage point. In columns 7 and 8, the coefficients of TCI on structural change are negative but insignificant.

Table 2 reports the results of the relationship between TCI and the within effect, with a set of control variables added while holding the country and year effect fixed. Similar to the results in Table 1, TCI is negative and significant from columns 1 to 5. The negative effect of TCI on the within effect can be explained by the "inappropriate technologies and excessive capital-intensive modes of production", as suggested by Diao et al. (2021). In theory, an increase in TCI is an indication of a higher capital–labour ratio in

Table 2 Estimation of TCI on within effect

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Within effect	**Within effect**	**Within effect**	**Within effect**	**Within effect**	**Within effect**	**Within effect**
TCI	−2.880*** (1.048)	−2.594** (1.042)	−2.249** (1.052)	−2.197** (1.111)	−2.300** (1.168)	−1.668 (1.303)	−1.559 (1.324)
Population growth (annual %)		1.266*** (0.389)	1.272*** (0.389)	1.273*** (0.390)	1.257*** (0.396)	1.023** (0.409)	0.931** (0.424)
Institution			0.289* (0.148)	0.291* (0.150)	0.297* (0.158)	0.504*** (0.174)	0.555*** (0.186)
Human Capital Index				−0.604 (4.128)	−0.343 (4.203)	−2.210 (4.731)	−2.534 (4.823)
Domestic credit to private sector by banks (% of GDP)					0.038 (0.064)	0.016 (0.067)	−0.000 (0.071)
Trade openness						−0.486 (2.992)	−0.433 (3.048)
Manufacturing share in GDP (%)							−0.141 (0.176)
Constant	5.951*** (1.843)	2.511 (2.111)	1.316 (2.182)	2.287 (6.984)	1.320 (7.245)	4.306 (8.290)	6.984 (9.018)
Observations	560	560	557	557	545	508	491
R-squared	0.149	0.166	0.167	0.168	0.162	0.179	0.184
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The variable TCI is presented in the log. Standard errors in parentheses. Significance level at *** $p<0.01$, ** $p<0.05$, * $p<0.1$

the manufacturing sector relative to the whole economy, implying a concentration of the capital per labour in certain firms in the manufacturing sector.

For instance, in the case of Ethiopia and Tanzania, Diao et al. (2021) find that the contribution of within-sector labour productivity growth in the non-agricultural sector is close to zero. However, evidence from firms in the manufacturing sector suggests a dichotomy between small and unproductive firms absorbing more labour in contrast to larger and exporting firms that are highly productive with no employment generating opportunities. Also, the distribution of the firms reveals that large firms are more capital and skill intensive while small firms are more informal but more predominant. Hence the concentration of capital per labour in larger firms contributed to the limited within growth effect. However, in column 6, the significance vanishes, and the effect reduces when I control for trade openness, which is negative but insignificant. Another finding is the positive and significant effect of institutions on the within effect. This could be due to the institutional and governmental reforms implemented in the 1990s in many African countries as requested by the Bretton Woods institutions. Institutional factors such as protection of property rights, the rule of law, and efficient bureaucracy have been identified as factors limiting the influence of foreign aid and education, among others (Easterly 2001). Previous studies have also suggested that a lack of property rights

Table 3 Estimation of TCI on net or between static effect

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Static effect	**Static effect**	**Static effect**	**Static effect**	**Static effect**	**Static effect**	**Static effect**
TCI	−0.286 (0.260)	−0.267 (0.261)	−0.302 (0.259)	−0.146 (0.272)	−0.027 (0.285)	−0.118 (0.319)	−0.092 (0.322)
Population growth (annual %)		0.085 (0.097)	0.108 (0.096)	0.112 (0.095)	0.103 (0.097)	0.024 (0.100)	−0.018 (0.103)
Institution			−0.102*** (0.036)	−0.095*** (0.037)	−0.091** (0.039)	−0.066 (0.042)	−0.082* (0.045)
Human Capital Index				−1.826* (1.011)	−1.683 (1.026)	−1.139 (1.157)	−1.205 (1.173)
Domestic credit to private sector by banks (% of GDP)					−0.009 (0.016)	−0.008 (0.016)	−0.018 (0.017)
Trade openness						−1.966*** (0.732)	−2.125*** (0.741)
Manufacturing share in GDP (%)							−0.110** (0.043)
Constant	1.910*** (0.457)	1.679*** (0.528)	1.933*** (0.536)	4.868*** (1.711)	4.597*** (1.769)	5.233** (2.028)	7.125*** (2.194)
Observations	560	560	557	557	545	508	491
R-squared	0.285	0.286	0.309	0.313	0.300	0.298	0.311
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The variable TCI is presented in the log. Standard errors in parentheses. Significance level at *** $p<0.01$, ** $p<0.05$, * $p<0.1$

protection hinders investment in physical and human capital which are the main drivers of the within growth effect (see North and Thomas 1973; Jones 1981).

Table 3 indicates a negative but not significant relationship between TCI and the net or between static effect contribution to growth. The possible reason for a negative sign is that the productivity level in the manufacturing sector is above that of agriculture, and it can absorb the surplus of labour. However, the defiance of the comparative advantage strategy will limit the employment absorptive capacity due to the nature of technology and capital used. Another finding is the negative and significant relationship between the institution and static effect, with the significance disappearing when I control for trade openness. The results in column 6 indicate that the more open a country, the lower the contribution of the static effect to growth.

The results of the effect of TCI on the interaction or between dynamic effect are reported in Table 4. From columns 1 to 6, there is a positive and significant effect, with the effect slightly larger when I control for trade openness. This result implies that an increase of 10% of TCI increases the contribution of the interaction or between dynamic effect by around 0.02 percentage points. The positive result can be explained by the nature and intensity of capital invested in the manufacturing sector. The small coefficient of TCI reflects the limited impact due to the employment share in the sector.

Table 4 Estimation of TCI on the interaction or between dynamic effect

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dynamic effect	Dynamic effect	Dynamic effect	Dynamic effect	Dynamic effect	Dynamic effect	Dynamic effect
TCI	0.112* (0.067)	0.116* (0.067)	0.129* (0.068)	0.127* (0.072)	0.141* (0.075)	0.171** (0.086)	0.171* (0.088)
Population growth (annual %)		0.019 (0.025)	0.019 (0.025)	0.019 (0.025)	0.018 (0.025)	0.024 (0.027)	0.025 (0.028)
Institution			0.013 (0.010)	0.013 (0.010)	0.013 (0.010)	0.012 (0.011)	0.012 (0.012)
Human Capital Index				0.025 (0.267)	0.029 (0.270)	0.097 (0.312)	0.112 (0.320)
Domestic credit to private sector by banks (% of GDP)					−0.001 (0.004)	−0.001 (0.004)	−0.001 (0.005)
Trade openness						0.254 (0.198)	0.264 (0.202)
Manufacturing share in GDP (%)							0.003 (0.012)
Constant	−0.399*** (0.118)	−0.452*** (0.136)	−0.504*** (0.141)	−0.544 (0.451)	−0.547 (0.465)	−0.912* (0.547)	−0.992* (0.599)
Observations	560	560	557	557	545	508	491
R-squared	0.204	0.205	0.207	0.207	0.211	0.214	0.215
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The variable TCI is presented in the log. Standard errors in parentheses. Significance level at *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Regarding the structural change effect, the results reported in Table 5 indicates a negative but not significant from column 1 to 4. However, the effect becomes positive when I control for financial development measured by the domestic credit to the private sector by banks (%GDP) and trade openness in columns 5 and 6. Turning to the coefficients on the institution variable, I find a negative and significant effect from columns 3 to 5, while the significance level vanishes when I control for trade openness in column 6. Another finding is the negative and significant coefficient of trade openness on structural change. The coefficient indicates that openness to trade is associated with a decrease in the structural change effect of growth by 0.17 percentage points when trade openness increases by 10%.

5 Conclusion

This paper uses a recent and expanded sectoral database of 21 sub-Saharan African countries from 1960 to 2017, combined with a shift and share decomposition method of labour productivity growth, to study the role of comparative advantage development strategy on growth and its components.

The first finding is the changing role of labour productivity growth components identified through the shift and share decomposition method. Structural change

Table 5 Estimation of TCI on structural change effect

Variables	(1) Structural change	(2) Structural change	(3) Structural change	(4) Structural change	(5) Structural change	(6) Structural change	(7) Structural change
TCI	−0.174 (0.252)	−0.151 (0.253)	−0.173 (0.251)	−0.018 (0.264)	0.114 (0.276)	0.053 (0.309)	0.079 (0.312)
Population growth (annual %)		0.105 (0.094)	0.127 (0.093)	0.131 (0.093)	0.121 (0.094)	0.047 (0.097)	0.008 (0.100)
Institution			−0.089** (0.035)	−0.082** (0.036)	−0.078** (0.037)	−0.053 (0.041)	−0.070 (0.044)
Human Capital Index				−1.801* (0.981)	−1.654* (0.994)	−1.042 (1.122)	−1.093 (1.137)
Domestic credit to private sector by banks (% of GDP)					−0.011 (0.015)	−0.009 (0.016)	−0.018 (0.017)
Trade openness						−1.713** (0.710)	−1.862*** (0.719)
Manufacturing share in GDP (%)							−0.107** (0.041)
Constant	1.512*** (0.443)	1.227** (0.512)	1.430*** (0.520)	4.324*** (1.659)	4.050** (1.714)	4.321** (1.966)	6.133*** (2.127)
Observations	560	560	557	557	545	508	491
R-squared	0.276	0.278	0.301	0.306	0.292	0.289	0.302
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The variable TCI is presented in the log. Standard errors in parentheses. Significance level at *** $p<0.01$, ** $p<0.05$, * $p<0.1$

driven by the net or between static gains contributed to a large extent to productivity growth. Compared with previous studies, de Vries et al. (2015) estimate that structural change contributes 25% of total labour productivity growth recorded in Africa from the 1960s to 2010; Mensah et al. (2018) find that almost 50% of the labour productivity growth in Africa during the period of 1960s to 2015 is due to structural change, while I find that 77% (0.94/1.22) of total labour productivity growth from 1960s to 2017 is driven by structural change. In other words, this implies that the gains in labour productivity due to the reshuffling of labour from less productive sectors to higher productivity sectors were more relevant than the gains due to the within growth. This pattern is prevalent across the first three different periods. However, during the MDGs and SDGs era, it is instead the gains from the within (due to technological change, changes in organisational structure, human capital improvement) that are more relevant for the growth of labour productivity.

In the empirical analysis, I show the effect of defying comparative advantage development strategy on labour productivity growth components in those of the within effect, the net or between static effect, the interaction or between dynamic effect, and the structural change effect. The key finding is that industrial development based on capital and technology-intensive mode of production reduces the within

effect component mitigated by a weak and positive relationship of the interaction or between dynamic effect components. This finding implies that both the within effect and net or between dynamic effect components are essential channels through which industrial development based on capital and technology-intensive mode of production affects labour productivity growth by preventing an efficient intra-sectoral reallocation of resources with the former while weakly inducing the inter-sectoral reallocation of resources across the sector with the above-average productivity growth with the latter.

The findings can inform policy implications to promote labour productivity growth and industrial policy. While there is a potential for structural transformation due to the high employment share in low-productivity agriculture, studies suggest that helping workers transition out of agriculture to higher productive manufacturing firms remains a high-hanging fruit. Therefore, industrial development should be based on comparative advantage, complemented with policies and strategies to increase labour productivity in the agriculture sector (Otchia and Asongu 2020). This could be a viable option based on the economic structure of achieving rapid economic growth and creating more jobs, as emphasised by Lin and Liu (2006), and a "high level of productiveness" as predicted by Smith (1776, as cited by Landesmann and Foster-McGregor 2021).

Appendix

See Tables 6, 7, 8.

Table 6 Economic sectors categories. Source: APO; EASD; GGDC; ILO; KLEMS; National sources; OECD; United Nations; World Bank. As cited in Dieppe and Matsuoka (2020)

Sector name	Description
1. Agriculture	Agriculture, forestry, and fishing
2. Mining	Mining and quarrying
3. Manufacturing	Manufacturing
4. Utilities	Electricity, gas, steam and air conditioning supply
5. Construction	Construction
6. Trade services	Wholesale and retail trade; repair of motor vehicles and motorcycles; accommodation and food service activities
7. Transport services	Transportation and storage; information and communication
8. Financial and Business services	Financial and insurance activities; real estate activities; professional, scientific and technical activities; administrative and support service activities
9. Other services	Public administration and defense; compulsory social security; education; human health and social work activities; arts, entertainment, and recreation; other services activities; activities of households as employers; undifferentiated goods- and services-producing activities of households for own use; activities of extraterritorial organisations and bodies

Table 7 Variable description and sources

No.	Variables	Label	Definition	Sources
Dependent variables				
1	Within effect	Within	See Sect. 3	Authors based on Dieppe et al. (2020)
2	Static effect	Static	See Sect. 3	Authors based on Dieppe et al. (2020)
3	Dynamic effect	Dynamic	See Sect. 3	Authors based on Dieppe et al. (2020)
4	Structural change effect	Structural	See Sect. 3	Authors based on Dieppe et al. (2020)
Independent variables				
5	Technology Choice Index	TCI	It is computed based on the formula in the methods section	Authors based on WDI
6	Institution	Institution	The Quality of Government is measured by the revised combined Polity Score	Basic Dataset, University of Gothenburg
7	Trade openness	openness	Export plus imports divided by total GDP (all in current US$)	Computed based on WDI
8	Human capital	HCI	Human capital index, based on years of schooling (Barro & Lee, 205. and assumed returns, based on Mincer equation estimates around the world	Robert J. Barro and Jong-Wha Lee: http://www.barrolee.com/ (WDI)
9	Population growth (annual %)	pop	Annual population growth rates. The population is based on the facto definition, which counts all residents regardless of legal status or citizenship	WDI 2020
10	Financial development	Findev_1	Domestic credit to the private sector by banks (% of GDP)	WDI 2020
11	Manufacturing share in GDP (%)		Manufacturing value-added as share of GDP (%)	WDI 2022

Table 8 Descriptive statistics and correlation matrix of variables

Variables	Mean	S.D	Min	Max	Within	Static	Dynamic	Structural	TCI (log)	Pop	Institution	HCI	FINDEV_1	Openness
Within	0.97	8.42	− 40.5	55.06	1									
Static	1.42	2.28	− 10.86	10.94	0.001	1								
Dynamic	− 0.21	0.56	− 3.93	3.32	0.092	− 0.266	1							
Structural	1.21	2.2	− 12.33	8.84	0.025	0.970	− 0.023	1						
TCI (log)	1.73	0.77	0.39	4.22	− 0.179	0.112	0.074	0.134	1					
Pop	2.34	1.16	− 6.77	8.12	0.096	0.094	0.068	0.115	0.069	1				
Institution	2.18	5.65	− 9	10	0.141	− 0.146	− 0.095	− 0.175	− 0.242	− 0.172	1			
HCI	1.77	0.43	1.03	2.89	0.069	− 0.260	− 0.104	− 0.296	− 0.34	− 0.313	0.545	1		
FINDEV_1	20.16	19.02	1.47	106.26	0.023	− 0.078	− 0.153	− 0.12	− 0.358	− 0.365	0.479	0.523	1	
Openness	0.68	0.32	0.2	1.76	0.046	− 0.233	− 0.016	− 0.246	− 0.196	− 0.395	0.284	0.39	0.333	1

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Competing interests
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