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Powering structural transformation and economic development in Africa

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Powering Structural Transformation and Economic Development in Africa: The Role of Services, Manufacturing and Global Value Chains

Solomon Owusu

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Powering Structural Transformation and Economic Development in Africa: The Role of Services, Manufacturing and Global Value Chains

DISSERTATION

to obtain the degree of Doctor at Maastricht University,
on the authority of the Rector Magnificus, Prof. Dr. Rianne M. Letschert,
in accordance with the decision of the Board of Deans,
to be defended in public on Tuesday, 12 October 2021, at 10:00 hours

by

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Dr. Bruno Martorano
Prof. Dr. Andy Sumner (King's College London)
Prof. Dr. Fiona Tregenna (University of Johannesburg, South Africa)

Summary

This thesis focuses on structural transformation and economic development in Africa[1], by examining the contributions of services, manufacturing and global value chains to economic development. This is a research area that has gained importance in recent years, particularly in the context of Africa, and will no doubt continue to attract interest. There was a time that manufacturing powered the economic growth of many advanced economies. Today, many researchers and policymakers are now questioning the role of manufacturing in development. This is because, since the 1990s, except in Asia, other regions of the world have seen a decline in the share of manufacturing output and a rise in the share of services in total economic output. Particularly in Africa, the predominant narrative is that most countries have experienced pre-mature (early) deindustrialisation.

Given the historical importance of manufacturing to growth, what does this mean for jobs, inclusive growth, and poverty reduction in Africa? Does industrialisation represent a viable path to structural transformation in Africa? Does the question of whether services can play a positive role in economic development merit special attention in the sub-Saharan African context? Could the expansion of global value chains (GVCs) fast-track Africa's structural change and industrialisation prospect? The overarching objective of the thesis is to find answers to these questions.

Chapter 1 provides a general introduction and thesis outline. Chapters 2 provides evidence on the patterns of structural change, productivity growth and labour market outcomes in Africa. The analysis in chapter 2 shows that the agriculture sector is shedding more workers, but most of those workers have tended to move to the urban sector to engage in informal trading activities rather than in manufacturing. This contrasts with the experience of early industrializers in advanced countries and East Asia. As a result of this, the region has recorded slow productivity growth with only a moderate contribution from structural change. However, the contribution of structural change has been increasing in the past three decades and is higher than that reported in previous studies due to the structural undercounting and, particularly, the failure to properly account for the important contribution of the rising modern market services to Africa's productivity growth.

We probe this observation further in chapters 3 and 4 of the thesis by examining the rising dominance of the service sector in Africa and its implication for economic growth, productive efficiency and catch-up within Africa and the global frontier. The analysis in these chapters showed that the perceptions of services as stagnant and productivity resistant do not apply to all service sub-sectors. Productivity growth in modern, dynamic, and tradable services is equal to or higher than that in manufacturing and other sectors. The important contribution of the services sector was also evident in the region's catch-up process. Whiles still performing below the frontier, we observe that in most of the countries in the region, agriculture and manufacturing have fallen further behind over time, while trade and business services have shown signs of catch-up to the global frontier. This played a key role in the moderate contribution of structural change in catch-up in Africa observed in chapter 3. We also found evidence of strong linkages between services

[1] Throughout the thesis, I use both Africa and sub-Saharan Africa (SSA) interchangeably. Where Africa is use, this is referring to our sample countries in SSA only.

and manufacturing. These attributes strongly suggest that services could act as a new or alternative engine of growth alongside manufacturing.

The expansion of global value chains (GVCs) and intermediate import sourcing has in recent years received attention in the discussion of structural change, productivity growth and industrialisation in Africa. Chapter 5 investigates this issue. The chapter examines how participation in GVCs affects aggregate labour productivity growth, further addressing how participation impacts upon the within and structural change components of labour productivity growth across countries in Africa with different natural resource endowments. Results in chapter 5 show that Africa's participation in GVCs is generally comparable to those of their counterparts in other developing regions. The chapter further reveals that non-resource intensive countries in the region participate in GVCs largely through backward participation allowing the import of essential intermediates needed for quality upgrading and productivity improvements. Contrary to this, in resource-based oil exporting countries, GVC participation is predominantly in upstream activities of the value chain, providing mainly primary inputs for the value chain. For this reason, we observe that the productivity growth effect of GVC participation accrues strongly through backward linkages and benefits mostly non-resource intensive countries. Results from the analysis of the within and structural change components of productivity growth show that GVC participation has a positive and significant effect on productivity growth by inducing an efficient reallocation of resources within sectors (intra-sector reallocation) but not across sectors (inter-sector reallocation).

The concluding remarks, policy implication and limitations of the thesis as well as areas for future research are presented in Chapter 6.

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Contents

Chapter 1: Introduction **1**
1.1. Introduction and Motivation 2
1.2. Contributions and Thesis Outline 4
References 8

Chapter 2: Structural Change, Productivity Growth and Labour Market Turbulence in Africa **11**
2.1. Introduction 13
2.2. The Expanded Africa Sector Database (EASD) 16
2.3. Productivity Growth Decomposition 20
2.4. Sectoral Reallocation and Labour Market Turbulence (LMT) in Africa 28
2.5. Job Reallocation and Productivity Growth in Africa: The Role of EPL 37
2.6. Conclusion 41
References 44
2.7. Appendix to Chapter 2 47
Chapter 3: Productive Efficiency, Technological Change and Catch-Up within Africa **53**
3.1. Introduction and Motivation 55
3.2. Data Sources and Description 59
3.3. Nonparametric Estimation of Technology Gaps in Africa 59
3.3.1. The DEA Model 60
3.3.2. Nonparametric Test of Returns to Scale 61
3.4. Efficiency Results 63
3.5. Dynamic Efficiency in Africa 67
3.5.1. Malmquist Productivity Index 70
3.5.2. Technological Catch-Up Within Africa 70
3.6. Catch-Up Within Africa: Is Structural Change Important? 74
3.6.1. Decomposition of Technological Catch-Up 74
3.6.2. Long-Run Relative Productivity Patterns and Technological Catch-Up in Africa 76
3.6.3. Catch-Up by Country 78
3.7. Conclusion 82
References 84
3.8. Appendix to Chapter 3 87
3.8.1. South Africa: A Leader in Education and Innovation 87
3.8.2. Robustness Checks of Efficiency Measures 89
3.8.3. Decomposition of Catch-Up by Country and Period 91
Chapter 4: The Rise of the Service Sector in the Global Economy and Africa **97**
4.1. Introduction 99
4.2. A Review of the Role of the Service Sector in the Global Economy 101
4.3. The Role of the Service Sector in Sub-Saharan Africa 107
4.3.1. Structural Change, Labour Productivity and Per Capita Income in Sub-Saharan Africa 107
4.3.2. Productive Efficiency 112
4.3.3. Linkages Between Services and Other Major Sectors of the Economy 119
4.4. Conclusion 125
References 127
4.5. Appendix to Chapter 4 131

4.5.1. Data Envelopment Analysis (DEA) 131
4.5.2. Decomposing Services Value-Added: Methodology 132

Chapter 5: Powering Structural Transformation and Productivity Gains in Africa: The Role of Global Value Chains and Resource Endowments **135**
5.1. Introduction 137
5.2. Constructing Global Value Chains Data 141
5.2.1. Classification of Countries by Natural Resource Endowment 144
5.2.2. Participation in GVC: Africa Compared to the World 144
5.2.3. Resource Endowment and GVC Participation in Africa 146
5.3. Methodology and Data 148
5.3.1. Shift and Share Decomposition 148
5.3.2. Econometric Model 149
5.3.3. Patterns of Structural Transformation and Productivity Development in Africa 151
5.4. Main Results 153
5.4.1. Results: Resource Groups 156
5.4.2. Results: GVC and Productivity Growth: Contri. from Within Effect 159
5.4.3. Results: GVC and Productivity Growth: Contri. from Structural Change 162
5.5. Conclusion 165
Reference 167
5.6. Appendix to Chapter 5 171
Chapter 6: Concluding Remarks **175**
6.1. Conclusion 176
6.2. Policy Implication of Thesis 178
6.3. Limitations and Suggestions for Future Research 182
7. Impact Statement **185**

List of Tables

Table 2.1: Sectoral Employment Shares in Africa 18
Table 2.2: Relative Productivity in Africa 19
Table 2.3: Decomposition of Labour Productivity Growth in Sub-Saharan Africa 22
Table 2.4: Job Creation, Job Destruction and Job Reallocation in Africa, 1960s–2015 31
Table 2.5: LMT in Africa: Lilien Index- Decomposition Results (percentages), 1960-2015 32
Table 2.6: Job Creation, Job Destruction and Job Reallocation in Africa, by Periods 36
Table 2.7: The Effect of EPL on Job Reallocation in Africa 41

Table 3.1: Test of Returns to Scale 63
Table 3.2: Descriptive Statistics 66
Table 3.3: Radial Measures of Technical Efficiency for African Countries 66
Table 3.4: Dynamic Efficiency in Africa 72
Table 3.5: Decomposition of Technological Catch-Up to SA 77
Table 3.6: Catch-Up by Country (average annual percentage change) 79

Table 4.1: Sectoral Value-Added Shares in Global GDP (in Percent) 102
Table 4.2: Labour Productivity in Major Sectors of the Global Economy, 1965-2010 104
Table 4.3: Employment Shares in Africa, 1960-2015 108
Table 4.4: Value-Added Shares in Africa, 1960-2015 110
Table 4.5: Labour Productivity in Major Sectors of the African Economy, 1965-2010 111
Table 4.6: Productive Efficiency in Africa: Economywide Analysis, 1970 and 2014 113
Table 4.7: Contribution of Technological and Efficiency Growth to TFP Growth in Africa 115
Table 4.8: Productive Efficiency in Africa: Sectoral Analysis, 1970 and 2015 116
Table 4.9: Share of Intermediates in Gross Output and its Composition (2000 and 2015) 120

Table 5.1: Classification of Countries by Natural Resource Endowment 144
Table 5.2: Contribution to Productivity Growth in Africa: Shift and Share Method Results 152
Table 5.3: GVC Participation and Labour Productivity Growth in Africa 155
Table 5.4: GVC Participation and Labour Productivity Growth in Africa: Resource Group 158
Table 5.5: GVC Participation and Labour Productivity Growth: Contri Within Effect 160
Table 5.6: GVC Participation and Labour Productivity Growth: Contri Within Effect 161
Table 5.7: GVC Participation and Labour Productivity Growth: Contri Structural Change 163
Table 5.8: GVC Participation and Labour Productivity Growth: Contri Structural Change 164

List of Figures

Figure 2.1: Labour Productivity Growth in West Africa, 1960s-2015 25
Figure 2.2: Labour Productivity Growth in East Africa, 1960s-2015 25
Figure 2.3: Labour Productivity Growth in Southern Africa, 1960s-2015 26
Figure 2.4: Scatterplot Showing EPL and Job Reallocation in Africa 39

Figure 3.1: Evolution of Output Per Worker 64
Figure 3.2: Evolution of Capital Per Worker 65
Figure 3.3: Output Per Worker 2014 Plotted Against Capital Per Worker 2014 72
Figure 3.4: Technology Change Between 1970-2014 Plotted Against Output Per Worker 1970. 73
Figure 3.5: Technology Change Between 1970-2014 Plotted Against Output Per Worker 2014. 73
Figure 3.6: Relative Labour Productivity as a Measure of Technology gap (SA=1) 77
Figure 3.7: Countries Falling Behind 82

Figure 4.1: Weighted Average Sectoral Employment Share and Per Capita Income in Africa... 108
Figure 4.2: Comparative Labour Productivity by Region, 1970-2009 (USA=1) 118
Figure 4.3: Output Multipliers in Manufacturing, 2015 121
Figure 4.4: Output Multipliers in Market Services, 2015 122
Figure 4.5: Decomposition of Output Multiplier for Manufacturing, 2015 123
Figure 4.6: Decomposition of Output Multiplier for Market Services, 2015 124

Figure 5.1: Participation in GVC: Africa Compared to the World (1990-2015) 145
Figure 5.2: Performance in GVC by Resource Groups in Sub-Saharan Africa 147
Figure 5.3: Non-Oil Resource Intensive Group…… ... 148
Figure 5.4: Resource-Poor Group…… 148
Figure 5.5: Oil Resource Intensive Group…….... 148
Figure 5.6: Marginal Effects of GVC Participation on Labour Productivity Growth 156

Chapter 1: Introduction

1.1 Introduction and Motivation

Central to the work on structural change was the premise that no country can achieve sustainable growth and development, create decent jobs, reduce poverty and inequality and promote inclusive growth without undergoing a successful conventional structural transformation—having an initial high share of employment and value-added in agriculture followed by a rise of the industrial sector and later services. There is no evidence of economies of the world that have achieved sustainable growth by following alternative roots.

In the framework of structural change, conventional development economics explains that modern economic development implies changes in the structure of the economy. An important dynamic in this transition process is the emergence of new modern industries with countries diversifying their economy as they advance in development. In other words, the reallocation of resources from less productive traditional sectors to more productive modern industries enable economies to progress, ensuring that productivity gains diffuse to the rest of the economy. Given that labour productivity in traditional sectors like the agricultural sector is low at early developmental stages, the relative importance of the agrarian sector declines while the more productive industrial sector increases leading to the so-called *structural change bonus* (Kuznets, 1966; Chenery & Taylor 1968; Timmer & Szirmai, 2000; McMillan & Rodrik, 2011; Szirmai, 2015). The structural change bonus is closely linked to the engine of growth hypothesis which sees the industrial sector, particularly the manufacturing sector, as the high road to development because it offers more scope for capital accumulation, employment, productivity growth, economies of scale and stronger spillover and linkage effects than other sectors (Szirmai & Verspagen, 2015). At a later stage of development, the service sector overtakes the industrial sector (i.e., in terms of employment and value-added shares).

I began to ask myself a series of questions, particularly about Africa, in the light of this body of evidence, especially when the process of structural transformation has stalled across much of Africa. In sub-Saharan Africa, it has been six decades since political leaders and policymakers in the region rolled out policies to power structural transformation, and industrialisation, but the consensus today is that this dream remains elusive. Many of the countries in the region have yet to build capabilities and shift enough of their manpower to more productive sectors to the extent that realizes this dream. The manufacturing employment share remains relatively small, and it is fair to say that many countries in the region are yet to have trends of successful industrialisation. An objective rather than a pessimistic projection of the future of industrialisation in the region suggests that such trends will persist, and it would be a prodigious leap of faith to believe in a complete reversal of these trends in the next decade or even two. The state of industrialisation in Africa is a microcosm of the world-wide phenomenon, especially in developing countries where the industrialisation led-growth model is seriously challenged (Fagerberg & Verspagen, 2000; Szirmai & Verspagen, 2015).

This is all happening at a time when Africa's service sector is experiencing a substantial rise. When one looks at the regions' structure of production, since the 1960s, farmers have moved out of traditional rural areas where subsistence farming is the predominant occupation and the share of agricultural in total employment has declined from almost 72 to 49 percent over the period 1960-

2015 (Mensah et al., 2018). The primary beneficiary of the outmigration of labour from the agricultural sector has been the service sector rather than manufacturing (Rodrik, 2016; Rodrik et al., 2017). Since the mid-1970s, precisely after the golden age of Africa's growth, industrialisation lost grounds in Africa (i.e., in terms of output, employment, diversity, and sophistication) with recent decades not seeing many encouraging recoveries (Page, 2012). In place of this has been the continuous rise of the service sector after the region rebounded to growth in the 1990s. Between 1990 and 2015 the share of the labour force in the region making their living by working in the service sector has increased from 24 to 36 percent (17 to 37 percent between 1960-2015) while the manufacturing share in total employment although marginally increasing has remained around less than 8 percent for the same time period. The sector currently contributes about 58 percent of the share of total value added in the region, compared to 10 percent for manufacturing and 17 percent for agriculture (Mensah et al., 2018). A similar observation is made for the sector's productivity growth.

The expanding service sector nowadays accounts for some 70 percent of GDP in advanced economies. In emerging economies and other low-income countries, the share of the service sector is also increasing rapidly, albeit from lower levels. Tertiarisation is a truly global phenomenon. The increasing dominance of the services sector in the African economy and its potential implication for the economic development of the region has been an issue of considerable policy debate in recent years. Up until now, the services sector has not been given much space in policy discussions due to earlier hasty and pessimistic conclusions about the potential of the sector to drive sustainable growth and development.

Baumol (1967) who is one of the earlier leading proponents of this debate categorizes economic activity into two—namely, the technologically progressive manufacturing sector and the technologically stagnant service sector. Following his classification, Baumol then argued that the transfer of labour and resources from the more productive manufacturing sector to the service sector could result in a *structural change burden,* as services offer little scope for productivity growth. For Baumol, de-industrialisation and the resultant '*tertiarisation'* will depress overall economywide growth given that the productivity growth of the rising service sector is not large enough to compensate for the decline in labour productivity of the manufacturing sector. As a result of this, the initial forecast of the shift of resources to the service industry was gloomy especially for countries at the early stages of development.

Over time, studies have produced evidence contrary to the argument of a stagnant services sector (see Oulton 2001; Miozzo & Soete 2001; Baumol 2002[2]; Sasaki 2007; Maroto & Cuadrado 2009; Marks 2009; Carmignani & Mandeville, 2014). These studies have argued that the service sector is very heterogeneous and with advances in technology and innovation in the sector, dynamic sub-sectors (modern services) could act as influential sectors of the economy in the future because of their potential for productivity growth. The complementary and interdependent role of the sector for the other sectors is also emphasized (Hoekman, 2017; Di, Berardino & Onesti, 2018).

[2] In 2002 Baumol rectified and clarified his initial position and admitted that the service sector is very heterogeneous and dynamic and that there are some services activities that have growth rates and productivity gains similar to or even greater than those of the manufacturing sector emphasizing the role of technology and innovation in the evolution of services.

Carmignani and Mandeville (2014) use aggregate data for 51 African countries for the period 1960 to 2008 and find that countries with increasing shares of the service have achieved the highest growth rates for the period considered. Altogether, recent sectoral studies have produced evidence that does not seem to fit so well with the growth-resistant view of the services sector. The role of the services sector to growth, therefore, has become an empirical question.

Recent policy to promote growth-enhancing structural changes in the region has also focused on exploring the potential of GVCs and foreign intermediate sourcing to fast-track this development. In many regards participating in GVCs is often seen as a less difficult route to industrialisation in developing countries, particularly in Africa. With global production now sliced into different stages of value-creating activities or tasks that are performed in different cost-saving locations across the world (Grossman & Rossi-Hansberg, 2008), integration into the global value chain is providing new windows of opportunity to create jobs and increase productivity in dynamic sectors (UNIDO, 2017b; World Bank WDR, 2020). The final chapter of the thesis examines these issues in-depth. What does all this mean for jobs, growth, development and policy in Africa? The chapters of the thesis investigate the role of services, manufacturing and global value chain in powering and fast-tracking Africa's transformation and economic development.

1.2 Contributions and Thesis Outline

Chapter 2: A number of studies have examined the role of structural change in economic growth in developing countries and in Africa in particular (McMillan & Rodrik, 2011; McMillan et al., 2014; De Vries et al., 2015). In these studies, a finding that the reallocation of resources to more dynamic and modern sectors has led to higher productivity growth is considered to be a case of successful structural change. While the above studies indicate that structural change has been an important phenomenon in the productivity growth of Africa, its impact on other outcomes – most notably labour market outcomes – are less well known. Particularly, structural change may enhance aggregate productivity, but the reallocation of resources could also generate labour adjustment and transitory costs which inevitably creates winners and losers. Therefore, in addition to examining the patterns of structural change and productivity in Africa, the chapter also investigates the job creation and job destruction effect of the observed patterns of structural change and productivity growth in Africa. Additionally, the data and representativeness of the samples used in these studies also form part of the debate. Although some of these studies have attempted to address the data issue, these contributions are limited in terms of the number of African countries for which data are available and the years covered (see Chapter 2 for more discussion on this). For instance, McMillan and Rodrik (2011) constructed data for a relatively large number of developing countries but for the period between 1990-2005. De Vries et al (2013; 2015) made a huge contribution and constructed data (African Sector Database-ASD) for 11 countries in Africa with data covering the period from 1960s-2010. The countries covered in this dataset tend to be the relatively rich countries in the region, however. Moreover, since the construction of the ASD, there has been a wave of statistical reforms in some of the countries in the ASD leading to significant revaluations of GDP that are not captured in the ASD database. These studies have also completely ignored how labour market institutional arrangements in countries in Africa have played a role in the patterns of structural transformation we observe in the region.

Chapter 2 of the thesis therefore first updates and extends the Africa Sector Database to include data for seven relatively poor African countries: Burkina Faso, Cameroon, Lesotho, Mozambique, Namibia, Rwanda and Uganda, thus addressing a criticism of existing studies that they are biased towards richer African countries. Together the updated and extended database covers 18 African countries (from 1960s-2015) that together contribute about 80% of the region's GDP. Using the resulting database, we decompose productivity growth into a within effect and a structural change effect following McMillan et al (2014) and De Vries et al (2015). The chapter finds that the region has recorded slow productivity growth with a moderate contribution from structural change. Although the general direction of structural change has not been towards the most productive sectors, the chapter finds that the extent of structural change has been higher than that observed in previous studies. Results of the labour market analysis complement these results, and further suggest that labour market institutional arrangements in many countries in SSA have played a significant role in these outcomes.

Chapter 3: Given the moderate but increasing contribution of structural change to economic growth across countries in Africa, chapter three examines whether countries in Africa are catching-up or falling behind the regional frontier and what role, if any, structural change plays in observed catch-up. The chapter also examines the role of efficiency change and technological change to catch-up in Africa. The novelty and motivation for examining productivity convergence and technological catch-up to a local frontier is based on the conjecture that the peculiar nature of African development presents unique technological challenges. This often requires African-induced innovation or a combination of frontier and local technologies to solve problems unique to Africa. However, most researchers study technological change in Africa in relation to some globally defined technology frontier. The diffusion of knowledge from this global frontier to other regions however decreases in intensity with geographic and relational distance. Given that African countries are geographically and relationally close to each other, Chapter 3 of the thesis departs from this existing literature and studies catch up within African by considering catch-up with respect to an African technology leader (South Africa). The chapter specifically examines the dynamics of productivity convergence and technology catch-up within Africa, shedding light on two important and inter-related issues that are central to Africa's growth: (i) convergence of relative productivity among African countries; (ii) underlying factors driving productivity change across and within African countries and sectors.

The chapter uses nonparametric methods (Data Envelopment Analysis) to estimate an African production frontier. The chapter further measures productivity growth in sub-Saharan Africa and disentangles the change due to general technological progress (shift in the frontier) and efficiency change (movement towards the frontier) using the Malmquist Productivity Index (MPI). Overall, the results indicate that Botswana and Mauritius are the only two countries in Africa that have managed to converge to the productivity level as well as the efficiency level of the frontier. This successful convergence is driven more by efficiency change and less by technological change. We explore the special role of structural change in the efficiency change using structural methods (shift and share catch-up decomposition) and decompose efficiency change into contributions from within-sector convergence, between-sector convergence (structural change) and initial specialization. The results highlight the special role of structural change in catch-up in Africa, suggesting that countries in Africa are eliminating the labour productivity gap with the frontier by

moving workers into sectors with a lower technology gap to the frontier or a decreasing technology gap to the frontier. Specifically, we find that whiles structural change is contributing to the closing of the productivity gap with South Africa, this is mainly through static reallocation (shifts of labour to sectors with smaller or decreasing productivity gaps and not necessarily due to shifts to sectors with expanding employment shares nor to sectors that shift from their initial specialization (i.e., laggard countries specializing in sectors that are dynamic in the frontier country) because the countries have not manage to maintain the initial technology distance with the frontier economy. The chapter contributes to recent evidence that suggests that countries can climb up the income ladder at a faster rate through a two-pronged transformation – i.e., structural change and within-sector catch-up.

Chapter 4: Chapter four of the thesis examines the question of whether services can play a positive role in economic development in the African context. The manufacturing sector has historically been the engine of growth, accounting for a substantial share of economy-wide productivity growth. But the share of manufacturing in GDP and employment has been declining in advanced economies, emerging economies and low-income developing countries. It is high time other sectors are examined to determine whether they could replace or complement manufacturing as engines of growth. African economies are characterised by early deindustrialisation and an increasing share of services in GDP and employment at low levels of per capita income. It is therefore increasingly necessary to examine the role of the expanding service sector.

In terms of contribution, the chapter takes a two-pronged approach to examine the implications of the rapid rise of the service sector in the economies of Africa and the world. First, it analyses tertiarisation in the global economy touching on key issues such as Baumol's hypothesis of a stagnant service sector, the contribution of the service sector to aggregate productivity and growth, and the potentially positive contributions of services to other sectors. The second half of the paper focuses on tertiarisation trends in Africa, representing the role of the service sector in low-income economies. Using a long series of sectoral employment and output data, input-output tables and multiple statistical analyses, the chapter finds that perceptions of services as stagnant and productivity resistant do not apply to all service sub-sectors. Productivity growth in modern, dynamic, and tradable services is equal to or higher than that in manufacturing and other sectors. These service sectors are innovative and might act as new or alternative engines of growth alongside manufacturing. The manufacturing sector in Africa still generates the strongest multipliers, including to market services. However, much of the manufacturing linkages are captured by foreign countries rather than domestic suggesting opportunities for a modern approach to import-substitution. While the multipliers in market services are relatively lower than those of manufacturing, they are comparable to those in many other regions of the world economy and more of the gains are captured by domestic firms which could encourage a self-reinforcing pattern of market service development. The chapter also finds evidence of strong inter-sectoral linkages between the service sector and manufacturing. Given the sector's mutually reinforcing interaction with the manufacturing sector, the growing service sector could potentially play a significant complementary role in the prospects for industrialisation of Africa. But this potential remains to be realized.

Chapter 5: The final substantive chapter of the thesis examines the contribution of trade, specifically the role of GVCs and foreign intermediate sourcing, in promoting growth-enhancing structural changes in the region. Participation in GVCs has recently been highlighted as a relatively easy path to productivity gains and structural change by acting as a catalyst for the process of economic transformation—hastening the reallocation of resources to higher productivity tasks and sectors whiles helping countries build internal capacity to enter and remain competitive internationally. Chapter 5 of the thesis comprehensively examines the impact of GVC participation on productivity growth and its two components—the within and structural change across countries in Africa with different natural resource endowments. The chapter specifically examines if the productivity growth and structural change effect of GVCs vary in resource rich and non-resource rich countries in the region. Resource endowments is argued in the literature to be an important determinant of a country's comparative advantage in trade, participation in GVCs, the type of GVC activity undertaken and are consequently a potential factor in the scale, timing or pattern of a country's industrialisation or any other form of structural transformation that it might undergo at particular stages of its development (Sachs & Warner 2001 ; IMF, 2012; World Bank, 2015; Venables, 2016). The chapter constructs indicators for GVC and uses long time-series of sectoral data for the period 1990-2015 and find evidence that Africa's GVC participation is encouraging. The region is heavily involved in GVCs, generally as high as those of their counterparts in other developing regions in South Asia, East Asia, and Latin America. Moreover, the level and dynamics of linkages to the regions' GVCs participation vary substantially between the natural- resource rich and non-resource rich country group and the countries within each group. Specifically, and contrary to the resource poor country group, GVC participation in the resource rich group predominantly lies in upstream activities of the value chain, providing mainly primary inputs for the value chain.

The chapter also finds robust evidence of a productivity growth effect from integration into GVCs. However, the positive productivity growth effect of GVC participation accrues strongly through backward linkages and benefits mostly non-resource based and non-oil-resource intensive countries. The positive effect is also stronger for countries that are further from the productivity frontier, a result interpreted as GVCs offering more scope for learning, particularly for the more laggard countries. Results from the analysis of the two components show that GVC participation has a positive and significant effect on the within effects component by inducing an efficient intra-sector reallocation of resources (suggesting that underlying productivity changes is attributed to important improvements in microeconomic efficiency, use of inputs and better organisational and managerial practices), but no such effects across sectors. **Chapter 6** discusses the concluding remarks of the thesis.

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Chapter 2: Structural Change, Productivity Growth and Labour Market Turbulence in Africa[3]

[3] Co-authored with Emmanuel Buadi Mensah, Neil Foster-McGregor and Adam Szirmai. My contribution includes conceptualisation, methodology, data curation, investigation and writing of the chapter.

Abstract

This chapter presents a shift-share decomposition of the role of structural change in driving labour productivity in sub-Saharan Africa (SSA). The chapter further examines the effect that the observed structural change has had upon the dynamics of labour markets in SSA. The analysis is based on a newly constructed dataset, the Extended Africa Sector Database. This database updates and extends the Africa Sector Database of the Groningen Growth and Development Centre. It includes 18 countries covering the period 1960-2015. Overall productivity growth is slow. There are large and persistent sectoral productivity gaps. The extent of structural change has been higher than that observed in previous studies. But while the share of employment and value added in agriculture has declined, resources have been pulled into certain service sectors that have relatively low productivity, thus limiting aggregate productivity improvements. The general direction of structural change has not been towards the most productive sectors. Results of the labour market analysis complement this analysis, and further suggest that labour market institutional arrangements in many countries in SSA have played a significant role in these outcomes.

2.1 Introduction

Interest has recently been renewed into the role that structural change plays in the development experiences of countries (e.g. Rodrik & McMillan, 2011; De Vries et al., 2013; 2015). Numerous reasons for this interest exist, with the evidence of premature deindustrialisation suggesting that the role of manufacturing as a driver of long-run development is diminishing. Structural shifts to other sectors, such as modern services are seen by some as an alternative to a manufacturing-based development strategy (Ghani & O'Connell, 2014; Hallward-Driemeier & Nayyar, 2018; Newfarmer et al., 2018). Stiglitz (2018), for example, argues that while manufacturing will still play a role it will become less important for development, with services and agro-industry being the major drivers of growth in the future, agriculture remaining an important source of employment, and mining an important source of foreign exchange. Such arguments highlight the need for a multipronged strategy for development, with industrial policy used to promote sectors that are crucial for a country's long-run development strategy (e.g., generating employment or foreign exchange, encouraging learning and spillovers, encouraging upgrading, etc).

Such arguments and concerns are particularly relevant in the case of Africa. Despite being among the fastest growing regions in the world in recent decades, concerns about the role of economic structure for development are particularly acute in the case of Africa. One reason for this is that the continent depends heavily on the production and export of primary commodities. As a result, many African countries are vulnerable to fluctuations in commodity prices (UNECA, 2016). This has raised questions about the sustainability of the recent growth performance and of the ability of this growth to eliminate poverty on the continent. It has been argued that for this recent growth to be sustainable, African countries must actively create unique pathways of structural transformation that involve diversification, export competitiveness, technological upgrading and improvements in human wellbeing (ACET, 2014). The key concern is whether this rapid growth is underpinned by growth enhancing changes in the production structure, technological dynamism, and job creation. A further concern is that the process of deindustrialisation has set in very early in the case of Africa, with certain services sectors – particularly non-tradable services that are often associated with high levels of informal employment – having grown relatively rapidly at the expense of manufacturing.

As a result of these concerns, African countries have implemented alternative transformative industrial policies aimed at upgrading and promoting the development of high-productivity sectors including manufacturing and high-end services. Several alternative strategies can be identified within Africa, with Ethiopia focusing on traditional labour-intensive industrialisation, Ghana following a multi-sector approach through the One District One Factory policy (1D1F), and Rwanda and many East African countries focusing on modern services (see Section 3 for further details).

Starting from the work of McMillan & Rodrik (2011), a number of studies have examined the role of structural change in fostering economic growth in Africa. For example, De Vries et al. (2013, 2015) show that after independence, African countries moved resources towards manufacturing industries, but that this process stalled from 1975 onwards before rebounding in the 1990s. Despite the renewed shift towards manufacturing in this latter time period, labour was mostly relocated to

informal trading activities. These services are neither tradable nor technologically dynamic (Rodrik, 2016), and as a result their productivity levels lag behind other sectors' productivity. McMillan et al (2014) find that the reallocation of workers across sectors was growth-reducing in the 1990s but growth-promoting in the 2000s, and that this improved performance in the 2000s may be more sustainable due to an expansion of the manufacturing sector.

These studies – and others – focus on the relationship between the extent of structural change and productivity growth, which further implies that the direction of structural change is also relevant (i.e., a shift towards or away from high productivity sectors). In these studies, a finding that structural change has led to higher productivity growth is considered to be a case of successful structural change. While the above studies indicate that structural change has been an important phenomenon in the productivity growth of Africa, its impact on other outcomes – most notably labour market outcomes – are less well known. There is an obvious link between structural change and labour mobility, with movements in labour in a sense defining structural change. Conversely, while structural change may enhance aggregate productivity, there is also the possibility that it helps generate transitory unemployment and may lead to a reallocation of workers to lower paid jobs or into the informal sector, leading to increased uncertainty for workers.
In this chapter, we provide a fuller picture of the role of structural change on economic performance by combining an analysis of structural change on productivity growth with an analysis of structural change on labour market outcomes. The chapter contributes to the literature in three important ways.

The first contribution relates to data collection. A shortcoming of much of the literature on structural change is the lack of long time-series on economic structure for a relatively large number of countries. McMillan & Rodrik (2011), for example, address this problem by constructing sectoral data from 1990 to 2005, but this period misses important development episodes, especially the import-substitution era and the lost decades.[4] A more comprehensive attempt was presented by the Africa Sector Database (ASD), developed by the Groningen Growth and Development Centre (GGDC), which provides long run sectoral data for 11 African countries from the 1960s to 2010. The database is constructed on the basis of an in depth study of available statistical sources on a country by country basis (De Vries et al, 2013). These contributions are limited in terms of the number of African countries for which data are available however, with the countries included also tending to be the relatively rich countries with Africa. Moreover, since the construction of the ASD, there has been a wave of statistical reforms in some of the countries in the ASD leading to significant revaluations of GDP. These reforms have provided a clearer picture of the size and structure of production of the countries involved (Sy, 2015). For example, in 2014, Nigeria revised its GDP estimates and recalculated historical data back to 1981, which resulted in Nigeria being classified as a service-based economy (and not an industry-based economy as the original ASD suggests). In this chapter we update and expand the ASD to include data for seven relatively poor African countries: Burkina Faso, Cameroon, Lesotho, Mozambique, Namibia, Rwanda and Uganda, thus addressing a criticism of existing studies that they are biased towards richer African countries (Diao et al., 2017:427). In doing so, we follow strictly the methodology of ASD, producing a database for 18 African countries (from the 1960s to 2015) covering about 80% of

[4] In this work 'lost decades' is defined as the period between 1975-1990.

GDP in Sub-Saharan Africa (SSA). Using the resulting database, we repeat and update the structural decompositions of McMillan et al (2014) and De Vries et al (2015), further considering the changing importance of structural change as a driver of productivity growth over time. The results indicate that, despite differences across country groups and across time, structural change has played an important role in driving the observed growth of labour productivity within Africa, particularly in East Africa, where structural change accounted for more than half of all productivity growth. The results thus provide stronger evidence in favour of a role for structural change in driving productivity growth than some recent studies.

The second contribution of the chapter is to examine the extent to which structural change within Africa is associated with labour market turbulence. While structural change is found to have been productivity enhancing, there has been a strong shift towards services, which may have important implications for labour market outcomes. As such, we construct various indicators of labour market turbulence and show that the effect of structural change on labour markets has been felt most strongly in the services sector, where employment has been subject to large fluctuations. Because of the labour intensive and weather-dependent nature of agriculture, jobs are relatively stable but less productive, penalizing overall labour productivity in Africa.

The third contribution of the chapter is to consider the determinants of labour market turbulence, and whether the presence of labour market rigidities can limit the extent of labour market turbulence in Africa. Given the observed labour market turbulence (increased job volatility across sectors), we consider whether there are policy responses that may alleviate the impact of recent structural changes on labour market turbulence. Lilien (1982) argues that sectoral shifts are the main culprits behind the 1970s unemployment fluctuations in the US because labour market frictions prevented displaced workers from immediately relocating from shrinking sectors to expanding sectors. It has been found that strict national employment protection legislation on regular contracts in the European Union adversely affects net reallocation of workers to the services sector (D'Agostino et al., 2006). McMillan et al (2014:12) also find that the rate of labour productivity growth due to structural change is directly related to the degree of labour market flexibility, with more flexible labour markets facilitating rapid structural change. Based upon these findings, we empirically examine the effect of labour market flexibility on labour market turbulence in Africa. We use weighted regression to account for the different shares of employment across sectors and countries, and time averages to minimize the possible impact of non-synchronized business cycle fluctuations in the years covered. We sweep out country-specific variation and common factors at the sectoral level by controlling for country and sector fixed effects. We further adjust for the degree of enforcement of labour market regulation across countries. Our findings indicate that a high level of Employment Protection Legislation (EPL) is associated with lower levels of job reallocation, which, on the one hand, makes it more difficult for countries to reallocate surplus labour to sectors where they could be more productive, but, on the other hand, may provide more job security and certainty for workers.

The remainder of the chapter is organized as follows: Section 2.2 briefly discusses the Expanded Africa Sector Database (EASD) and reports descriptive statistics and the long run stylized facts on sectoral development in Africa; Section 2.3 discusses the methodology and results of the productivity growth decomposition; Sections 2.4 and 2.5 describe the results of the analysis of

labour market turbulence and the effect of labour market flexibility on such turbulence; and Section 2.6 concludes.

2.2 The Expanded Africa Sector Database (EASD)

To examine the importance of structural change in Africa we construct a new sectoral database for 18 SSA countries. The output measures in the EASD include gross value added at current and constant prices while labour input is defined as total employment (persons aged 15 years and over). This allows us to derive labour productivity as gross value added per worker.

Our dataset is built using GGDC's ASD as a starting point. This dataset provides long term-series on sectoral developments in Africa for 11 countries from 1960 to 2010. As mentioned above, however, since the construction of the ASD many African countries in the database have revised their GDP estimates (Sy, 2015). Another concern in the literature is that countries in the ASD have relatively high per capita GDP, as well as educational, health and nutritional outcomes when compared with Africa as whole. This biases the sample in the ASD towards richer countries (Diao et al., 2017; Diao et al., 2018). Given these developments and concerns we expanded the ASD by adding sectoral data for seven poorer countries (Burkina Faso, Cameroon, Lesotho, Mozambique, Namibia, Rwanda, and Uganda) and updating the time coverage to cover the period 1960-2015. We strictly follow the ASD methodology to ensure data continuity, consistency and comparability (see De Vries et al., 2013), with the guiding principle for the construction of the database being to ensure data consistency over time, between input and output variables, and across countries.[5]

Consistent with the ASD methodology, the general approach is to use the most recent revisions of the national accounts as benchmarks and then apply historical growth rates to retropolate the benchmarks back to the 1960s. Value added in current and constant prices in recent years are taken from national accounts of the seven countries. Because the UN System of National Accounts (SNA) is used in compiling annual estimates of value added by sector, cross-country consistency is, in principle, achieved. However, the compilation of GDP estimates in these countries have gone through different phases with different coverage of economic activities, and different methods, base years and standards resulting in breaks and inconsistent series. For example, earlier estimates of GDP relied mostly on economic censuses which did not cover many activities in services and the informal sector, resulting in structural undercounting of these sectors. In the recent wave of statistical reforms across Africa, many African countries have updated their sampling frame to cover more economic activities, which were previously not covered, including entertainment, research, patents, property rights, and a broader coverage of informal activities. For example, activities of cottage industries, household production units, and micro enterprises are now covered in the estimate of GDP compared to the 1980s and 1990s when estimates of GDP relied on a census of firms with 20 or more workers. We use the recent estimates of sectoral value added in current and constant prices as benchmarks, then extrapolate backwards using the growth rate of historical series. This is the general approach we followed for the seven new countries. For the existing 11 countries in the ASD, we used the recent value-added estimates from national statistical institutes as benchmarks to account for post-ASD statistical revisions, then extrapolate backwards

[5] For more information on the reliability, consistency and international comparability of the database see de Vries et al. (2015).

to the 1960s using the growth rates of the ASD series. The advantage of this approach is that it repairs major breaks by adjusting levels of historical series to reflect current information, and the methodology and system of national accounts while maintaining historical growth rates. By repairing major breaks between recent series and historical series, we ensure data consistency over time.

We obtained recent information, which we used as benchmarks, mostly from the websites of National Statistical Institutes. Historical series were then collected from the UN Official Country Online Database, national historical sources and UN and Africa Statistical Yearbooks, which were mostly obtained from the SOAS University of London Library and the British Library. As with the ASD, employment in the EASD is defined as all persons engaged. This concept of employment covers paid employees, self-employment, and (un)paid family workers. To ensure coverage of all workers, we used sectoral employment data from population and housing censuses, sometimes complemented with data from labour force surveys, as our benchmark level estimates. The reliability of the employment series may depend on the consistency of the frequency of benchmark level estimates across countries. The frequency of benchmarks is mostly consistent across the seven new countries since for every decade there is at least one benchmark for each country.[6] We then identify trends in between benchmark years using trends in establishment/household surveys or labour productivity time series. In the case of agriculture, we use FAO estimates of the active population in agriculture to construct employment series in between benchmark years. The decadal benchmarks ensure the reliability of the employment series over time and hence long run productivity estimates. For existing countries in the ASD, we update the employment series using the most recent population and housing census or labour force survey as benchmarks then interpolate or extrapolate forward/backward using household surveys, labour productivity trends and FAO estimates of the economically active population in agriculture between 2010 and 2015. When recent population and housing census data is not available, we use the 2010 ASD estimates as benchmarks and extrapolate to 2015. Also, the use of persons engaged as our definition of employment ensures that the employment series and value-added series from national accounts are internally consistent. This allows us to derive labour productivity consistently as gross value added per worker. Employment data were sourced from National Statistical Institutes, Key Labour Market Indicators of the ILO, the FAO database on economically active population and IPUMS International, Minnesota Population Center.

The result of this empirical exercise is an Expanded Africa Sector Database with sectoral data on employment and value added for 18 important economies in Africa, covering about 80% of total GDP in Sub-Sahara Africa. The dataset covers measures of output and labour inputs for the 18 African countries at the 10-sector level usually from the 1960s to 2015. The Expanded Africa Sector Database (EASD) covers the following countries: Botswana, Burkina Faso, Cameroon, Ethiopia, Ghana, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Nigeria, Rwanda, Senegal, South Africa, Tanzania, Uganda and Zambia.

For more information on the reliability of value added and frequency of employment series, consistency and international comparability of the database see the accompanying sources and

[6] Except Cameroon in the 1990s.

methods document (Mensah & Szirmai, 2018). The advantage of the data construction approach used in this paper is that it maximises data consistency across countries, between value added and employment, over time. However, to arrive implicitly at a reliable coverage of informal activities, we use recent estimates of GDP by sector as benchmarks and extrapolate backward. This adjusts the levels in years (the 1980s and 1990s) that informal activities are undercounted to reflect current trends while maintaining historical growth rates. However, the reliability of this adjustment decreases as we go back in time. Also, the interpolation method for employment between benchmark linearizes the yearly employment growth rate between the benchmark years. While this may deviate from actual annual employment trends, it broadly reflects long run trends, allowing us to derived reliable estimates of long run productivity growth. Besides, population censuses or labour force surveys are not conducted every year in Africa.

An important aspect of structural change and job reallocation in SSA is the informal and formal sector transition. An ideal approach would be to construct reliable series of employment and value added by formality and sector. This would have enabled us to capture informal/formal dynamics through a detailed subsector level analysis based on a distinction between informal and formal activities especially in the context of SSA where the informal sector is significant. However, employment and value-added data by sector and formality are non-existent in most statistical databases in Africa. However, the EASD implicitly covers informal employment and value added as discussed above.

Table 2.1 reports information using the EASD on the shares of employment by sector for the set of African countries as a whole. The table reveals that SSA remains predominantly agrarian. While the agricultural employment share decreased from 71.9% in 1960 to 49.4% in 2015, this share is still 13 percentage points higher than the next largest aggregated sector, services. The primary beneficiary of the reallocation of these workers has been the services sector rather than the industrial sector (see De Vries et al., 2015; Rodrik et al., 2017). Of the 22.5% of the labour force that moved from agriculture during the period 1960-2015, the services sector received 19.1% and the industrial sector just 3.3%. Although the manufacturing share in total employment increased from 5.0% in 1960 to 7.6% in 2015, this change was not as rapid as the change in domestic trade services, which more than doubled within the same period.

Table 2.1: Sectoral Employment Shares in Africa

	Sectoral Employment Shares (in per cent)					
Sector	1960	1975	1990	2000	2010	2015
Agriculture	**71.9**	**69.6**	**64.8**	**60.2**	**53.4**	**49.4**
Industry	**10.8**	**10.2**	**11.2**	**11.1**	**12.5**	**14.2**
Manufacturing	5.0	5.5	6.4	6.8	7.4	7.6
Mining	2.9	1.4	1.3	0.9	1.1	1.5
Utilities	0.3	0.4	0.4	0.4	0.4	0.5
Construction	2.7	2.9	3.1	3.1	3.6	4.6
Services	**17.3**	**20.2**	**24.0**	**28.7**	**34.1**	**36.4**
Market Services	9.7	8.7	11.7	15.5	21.4	23.4
Trade, Restaurant and Hotels	7.3	6.0	8.5	11.0	15.2	16.7

Transport, Storage and Communications	1.8	2.0	2.0	2.4	3.0	3.0
FIRBS	0.6	0.7	1.2	2.1	3.2	3.8
Non-Market Services	7.5	11.5	12.3	13.1	12.8	13.0
Government Services	4.4	5.3	6.3	7.0	7.1	7.0
Community, Social and Personal Services	3.1	6.2	6.0	6.2	5.6	6.0

Note: This table reports the share of total employment by sector in sub-Saharan Africa. These percentages are unweighted averages of the 18 countries included in EASD. FIRBS stands for financial, real estate and business services.

Table 2.2 reports sectoral relative productivity levels for the aggregate of African countries, constructed from the EASD as the ratio of each sector's labour productivity to labour productivity in the total economy. Several patterns are immediately obvious. Despite advances in agricultural technology, relative productivity in agriculture has remained largely unchanged since independence, with average productivity in agriculture being 40% of the average productivity of the whole economy. Relative productivity in all other sectors is above one, with productivity in industry tending to be larger than that in services.[7]

Table 2.2 Relative Productivity in Africa

	Relative Productivity Levels					
Sectors	**1960**	**1975**	**1990**	**2000**	**2010**	**2015**
Agriculture	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**
Industry	**8.7**	**7.5**	**10.1**	**8.2**	**6.9**	**5.7**
Mining	14.2	14.2	22.9	13.4	8.9	7.4
Manufacturing	2.5	2.7	3.0	3.2	2.4	2.3
Utilities	9.6	7.0	10.5	13.0	14.0	10.8
Construction	8.5	6.1	4.1	3.1	2.3	2.5
Services	**5.7**	**5.2**	**5.0**	**4.1**	**3.9**	**3.2**
Market Services	8.2	7.5	6.9	5.6	5.4	4.4
Trade, Restaurants and Hotels	8.4	4.6	2.7	1.9	1.2	1.2
Transport, Storage and Communication	6.7	5.2	5.6	5.3	5.3	5.1
FIRBS	9.6	12.7	12.6	9.8	9.7	6.9
Non-Market Services	2.0	1.8	2.1	1.8	1.6	1.4
Government Services	2.5	2.6	2.9	2.5	2.1	2.0
Community, Social and Personal Services	1.4	1.0	1.2	1.1	1.0	0.8

Notes: Authors' calculation based on the Expanded Africa Sector Database (EASD). Relative productivity equals the ratio of each sectors output per worker to the output per worker of the whole economy. The figures are unweighted averages of the 18 sub-Saharan Africa countries included in EASD. FIRBS stands for financial, real estate and business services.

Within services, a number of sub-sectors perform relatively well however, the major example being FIRBS (Finance, Insurance, Real Estate, and Business Services). The relative productivity of Trade, Restaurants and Hotels saw a strong decline between 1960 and 2015, which reflects both the

[7] While the table reports information for the full set of African countries in our sample, comparison with country-specific studies suggests that our data are consistent. Ellis et al. (2017), for example, find that services are around 3.5 times more productive than agriculture in Tanzania, while they are half as productive as manufacturing. Our data for 2015 indicate that services are just over 4 times more productive than agriculture and slightly below half as productive as manufacturing.

relatively poor performance of these services in terms of productivity generally and that in the immediate period after decolonisation import and distribution licences were given to few corporations which were capital intensive and productive. Within industry, productivity is relatively high in the capital-intensive mining sector and to a lesser extent in utilities, with manufacturing productivity being significantly lower than in these two sectors. Relative productivity in manufacturing increased from 2.5 to 2.7 during the golden era of industrialisation in the 1960s despite the expansion in employment shares over this period, and further increased during the 1980s and 1990s, but its relative productivity level in 2015 was below that achieved in 1960. Overall, the table reveals large productivity differences across sectors. In 2015, the industrial sector was about 14 times more productive than the agricultural sector and 5.7 times more productive than the whole economy. The services sector is on average 8 times more productive than the agricultural sector and about 3 times more productive than the economy as a whole. These productivity gaps have persisted since the 1960s and while falling over time remain large. This is indicative of the allocative inefficiency that penalizes overall labour productivity in Africa (McMillan et al., 2014).

2.3 Productivity Growth Decomposition

Though the sectoral productivity gaps observed in Table 2.2 reflect duality and allocative inefficiencies, as emphasized by Lewis (1954), their presence could also be a potential source of productivity growth as workers move from less productive sectors such as agriculture to more productive sectors such as manufacturing and market services. We therefore employ the well-known productivity growth (shift-share) decomposition to study the productivity growth implications of structural change in the African economy. To begin, let Y_t and E_t be the total level of output (or value added) and total employment at time t, respectively. Economy-wide labour productivity y_t is given as:

$$y_t = {}^{Y_t}/_{E_t} = \sum_{i=1}^{N} y_{it} s_{it} \tag{1}$$

where y_{it} is labour productivity of sector i in time t, s_{it} is the sectoral share of employment for sector i at time t, and N is the number of sectors. Given the above, the growth rate of economy-wide labour productivity between time (T) and (0) can be expressed as:

$$\dot{y} = \frac{\Delta y}{y_0} = \sum_{i=1}^{N} \left[\frac{y_{iT} - y_{i0}}{y_0}\right] s_{i0} + \sum_{i=1}^{N} \left[\frac{s_{iT} - s_{i0})}{y_0}\right] y_{i0} + \sum_{i=1}^{N} \left[\frac{(s_{iT} - s_{i0}) \times (y_{iT} - y_{i0})}{y_0}\right] \tag{2}$$

The first component on the right-hand side is the sum of each sector's within-sector labour productivity growth rate, weighted by the sector's initial labour share in the economy. In other words, it is that part of overall productivity growth caused by productivity growth within sectors. The final two terms capture the structural change or between effect. The second term is the static reallocation effect, which 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. The third term—the interaction/dynamic reallocation effect—measures the joint effect of changes in employment shares and sectoral productivity. It captures whether

productivity growth is higher in sectors that are expanding in terms of employment shares. It is positive when labour move from sectors with lower productivity growth to sectors with higher productivity growth.

Our approach mimics the standard shift-share method (see Fabricant, 1942; Timmer & Szirmai, 2000; Sánchez & Roura, 2009; Rodrik & McMillan, 2011; De Vries et al., 2015), albeit with the introduction of a referenced or economy-wide productivity level, y^0 (Griliches & Regev 1995). The introduction of the referenced economy-wide productivity level helps to identify which of the sectors are contributing positively or negatively to the static shift effect. At the aggregate level, however, the sum of these positive and negative effects is the same as the unreferenced version.
In our analysis, we report results for the full period from 1960 to 2015, but also divide the full period into historical development episodes, namely: the import substitution era (1960-1975), the lost decades (1975-1990), the post structural adjustment era (1990-2000), and the recent or MDGs era (2000-2015). The whole period is divided according to the centrality of industrialisation within the prevailing national development strategy. Whilst the import substitution era saw the projection and promotion of industrialisation, the lost decades and the structural adjustment era have seen the marginalization of industrial development in favour of liberalization and privatization. However, since the failure of the structural adjustment programs, industrial policy has been part of national development strategies, developed around the MDGs, since the early 2000s.

In describing the results, we begin with a discussion of the results for the full sample of countries and both the entire time period and the different development periods, before comparing our results to those of existing studies. We then report results for sub-regions and individual countries. Table 2.3 reports the results from the shift-share analysis described above. The table reports the unweighted average productivity growth of the sample of 18 SSA countries, which allows for a ready comparison with the earlier results of De Vries et al. (2015). Over the period 1960-2015, annual average labour productivity growth was 1.9%, a rate which is low when compared with the rate of 3.73% for Asia reported in Timmer et al (2014). Of this 1.9%, productivity growth within sectors accounted for 1.0 percentage points with structural change accounting for 0.9 percentage points. For the entire period, therefore, structural change has been growth-enhancing, though in the context of weak overall productivity performance. This is obvious from the fact that the agricultural share of employment has fallen from 71.9% to 49.4%, the primary beneficiary being the service sector which is about 11 times more productive than the agricultural sector for the entire period. The observed structural change effect, however, has been driven by the static reallocation effect, with the dynamic effect being negative. The results thus suggest that structural change has involved a movement towards sectors with higher initial productivity levels, but with lower productivity growth rates.

Considering the different development epochs, we observe significant differences in productivity growth rates across the different periods. The period between 1960 and 1975 – the import substitution era – has been described as the golden age of Africa's growth performance, with an annual average GDP growth rate of 6% and according to our data a productivity growth rate of 2.5%. This was followed by disappointing growth across the region, chiefly attributed to the 1970s oil crisis, currency instability, political upheavals witnessed across the region from the mid-1970s, and the cumulative effect of inefficiencies and distortions introduced during the import-

substitution period (Ellis, 2002). This is reflected in our data, which shows a productivity growth rate of just 0.5% during the so-called 'lost years'. Productivity growth steadily picked up after the implementation of Structural Adjustment Programmes, with an average annual growth rate of 2.2% over the period 1990-2000. Data for the most recent period (2000-2015) show that the import substitution era is no more the golden era of Africa's development. We observe the highest rates of productivity growth – around 2.7% – during the MDGs era.[8]

Table 2.3: Decomposition of Labour Productivity Growth in Africa

	Period	Total Productivity Growth	Within	Between Static	Between Dynamic	Structural Change
EASD Data						
Entire Period	1960-2015	1.9%	1.0%	1.2%	-0.3%	0.9%
Import Substitution	1960-1975	2.5%	1.2%	1.5%	-0.2%	1.3%
Lost Decades	1975-1990	0.5%	0.1%	0.7%	-0.2%	0.4%
Post SAP	1990-2000	2.2%	1.3%	1.1%	-0.2%	0.9%
MDGs	2000-2015	2.7%	1.6%	1.6%	-0.5%	1.1%
de Vries et al. (2015)						
Entire Period	1960-2010	1.4%	0.8%	1.5%	-0.8%	0.6%
Import Substitution	1960-1975	2.9%	1.7%	1.6%	-0.4%	1.2%
Lost Decades	1975-1990	-0.2%	-0.4%	0.7%	-0.5%	0.2%
Post SAP	1990-2000	1.1%	0.8%	1.2%	-0.9%	0.3%
MDGs	2000-2010	2.6%	2.1%	1.4%	-0.9%	0.5%

Source: Author's computations based on the Expanded Africa Sector Database. The sum of the within and structural change equals total productivity. Structural change is the sum of the static reallocation and dynamic reallocation. Results using the EASD are for the 18 sub-Saharan Africa countries included in EASD and are weighted using total employment to aggregate across countries. Also reported in the table are (unweighted) results of de Vries et al. (2015) for purposes of comparison.

Turning to the productivity decomposition for the different sub-periods we observe static gains and dynamic losses from structural change across the different periods. While the service sector as a whole is more productive than the agricultural sector, the beneficiary of the reallocation has mostly been trade services which have productivity levels far below modern market services and manufacturing, though still higher than agriculture. This has been particularly the case after 1990, with rising employment shares and declining relative productivity levels in this sector. Whether structural change is growth-enhancing or growth-reducing depends on the structural balance i.e., the sum of static gains and dynamic losses. Throughout the different periods, structural change has been growth-enhancing. Even during the lost decades when productivity growth was low at 0.5%, structural change contributed 0.4% to productivity growth. The political turmoil and adverse economic conditions during the lost decades heavily impeded industrial innovation and technology

[8] Results using weighted data for this latter period suggest even higher productivity growth, at a rate of 3.6%. The 3.6% growth rate is chiefly driven by the weights of Nigeria and Ethiopia, the two most populous countries in Africa with a combined average employment share of 42.5% during the MDGs era and whose productivity grew by 5.3% and 5.4% per annum respectively during the same period.

adoption, and as a result within sectoral productivity increased at just 0.1% per annum. In the other periods, the within sector effect contributed significantly and positively to total productivity growth, with the impact being larger than the structural change or between effect in the import substitution and MDGs periods.

It is instructive to examine whether the results we obtain using the EASD, which includes more countries and a more recent time period than existing studies, differ significantly from other results in the literature. While our results are not directly comparable to those of McMillan et al. (2014), given the different split in time periods, both studies do find a higher growth rate of productivity in the post-2000 period, with a positive role for structural change in this latter period. In contrast to the results of McMillan et al. (2014), however, our results suggest a positive growth rate of labour productivity and a positive role for structural change in the 1990s.[9] Our results are more comparable with those of De Vries et al. (2015), with our results also being to a large extent consistent with those of De Vries et al (2015).[10] For comparison, we report the results of De Vries et al. (2015) in Table 2.3, from which we can see results that are quite similar in terms of productivity growth rates. The major exception is that our use of more recent data (up to 2015) and a larger country sample results in a higher productivity growth in the latest period, with the result that the MDGs era has a higher productivity growth rate than the import substitution era. Results for the decomposition also show many similarities, especially in terms of the contributions of the within and the static between effect. Relatively large differences exist when considering the dynamic between effect, however, with the study of De Vries et al. (2015) reporting generally larger negative dynamic between effects, further implying that overall structural change effects tend to be smaller in the case of De Vries et al. (2015), especially in the later periods. As such, our results using a broader and more recent sample of countries and time periods suggests a higher degree of growth promoting structural change than previous studies.

Moving beyond the aggregate effects for all countries, we further observe important differences in performance by sub-region and by country. The unweighted annual average growth rates of labour productivity, for example, show that East Africa grew by 1.85% per annum, southern Africa by 1.95% and West Africa[11] by 2.4% from 1960 to 2015. We now further consider the role of within and between sector effects in driving these differences in regional productivity dynamics. Figures 2.1-2.3 show labour productivity growth for the three regions and for the countries within each of these regions. In West Africa (Figure 2.1), significant productivity growth comes from within sector productivity growth. This is the case for the five countries studied in the region. In Ghana and Nigeria, 100% and 80% respectively, of average productivity growth comes from within-sector productivity growth. In Francophone West Africa, structural change tends to play a more significant role in the growth process, but within-sector growth still dominates. In Burkina Faso and Cameroon, a little over half of average productivity growth comes from within-sector productivity. Structural change tends to be growth-enhancing but within sector productivity

[9] In addition to the different time periods, there are many potential reasons for the differences in results, including the different country sample, different data sources, the statistical revisions that have been taken into account in our analysis, and our approach to retropolation/interpolation, for example.

[10] Note, however, that de Vries et al. (2015) report unweighted averages across countries, whereas we use total employment as weights.

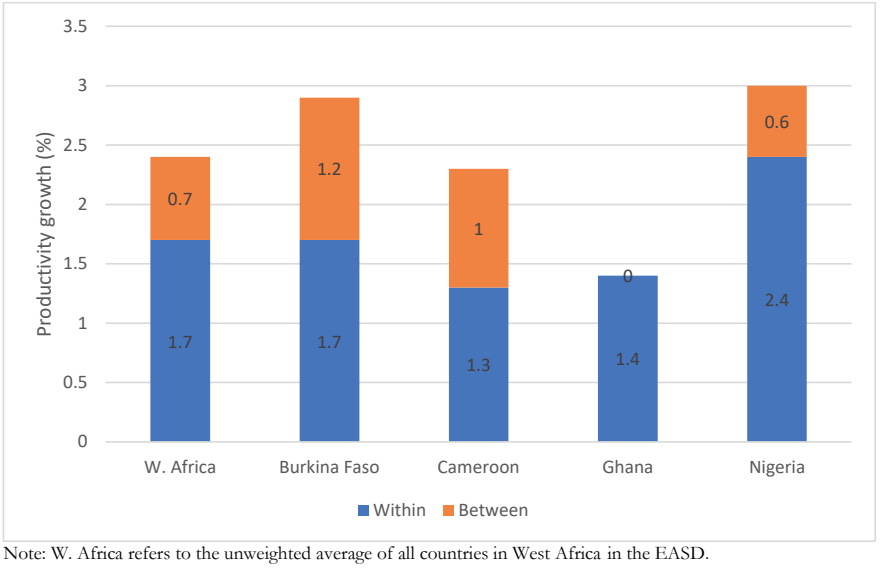
[11] Politically, Cameroon is not part of West Africa. It is part of Central Africa and shares a border with Nigeria but for convenience and analysis we added Cameroon to the group of countries that are politically part of West Africa.

changes tend to be growth-reducing in Senegal, resulting in low aggregate productivity growth. The strongest productivity growth in this region is found in Nigeria. This is driven by the 4.6% productivity growth rate during the import substitution era (1960-1975) and the 5.3% growth rate in the MDGs era (2000-2015).

In East Africa (Figure 2.2), structural change contributed more to labour productivity growth than within sector productivity in five of the six countries studied. In Ethiopia, Tanzania, and Uganda almost all the productivity gains were due to the movement of workers from low to high productivity sectors.[12] These differences are likely due to regional specialization patterns. In addition to the traditional primary products exported by most African countries, East African countries are specialized in services where jobs are currently being reallocated to, most notably travel, tourism, and transport services.[13] West and southern African countries, conversely, are specialized in mining, which is capital intensive, hence the high within effect.[14] In Rwanda, productivity growth was negative during the lost decades, but robustly increased to 5.9% during the MDGs era. Overall, however, more than half of the productivity gain in Rwanda has been due to structural change. In Mauritius, structural change is growth-enhancing but within sector productivity growth is dominant. This latter result is not surprising given the relatively low share of agricultural employment in the country (see Diao et al., 2017). The performance of Uganda was relatively poor, with productivity growth falling from 3.2% in the 1990s to -0.3% in the 2000s.

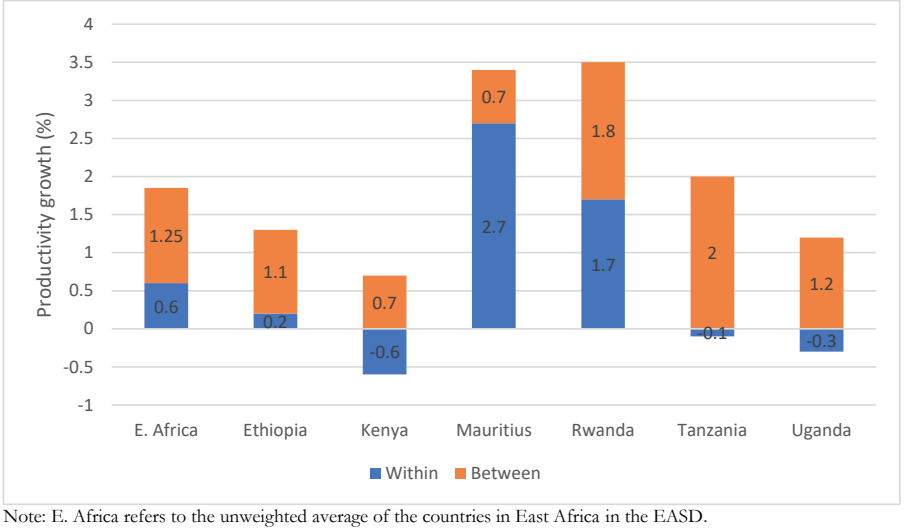
[12] Results for Tanzania suggest that structural change accounted for around 67% of productivity growth over the period 2000-2015. These numbers are not dissimilar to results found by Ellis et al. (2017) for the period 2002-2012, with their results indicating that structural change account for 76% of productivity growth in that period.
[13] Except Ethiopia, which has coffee as its major exports in 2015.
[14] Except Malawi, where 56% of exports in 2015 were accounted for by Tobacco and structural change accounts for all productivity growth.

Figure 2.1: Labour Productivity Growth in West Africa, 1960s-2015



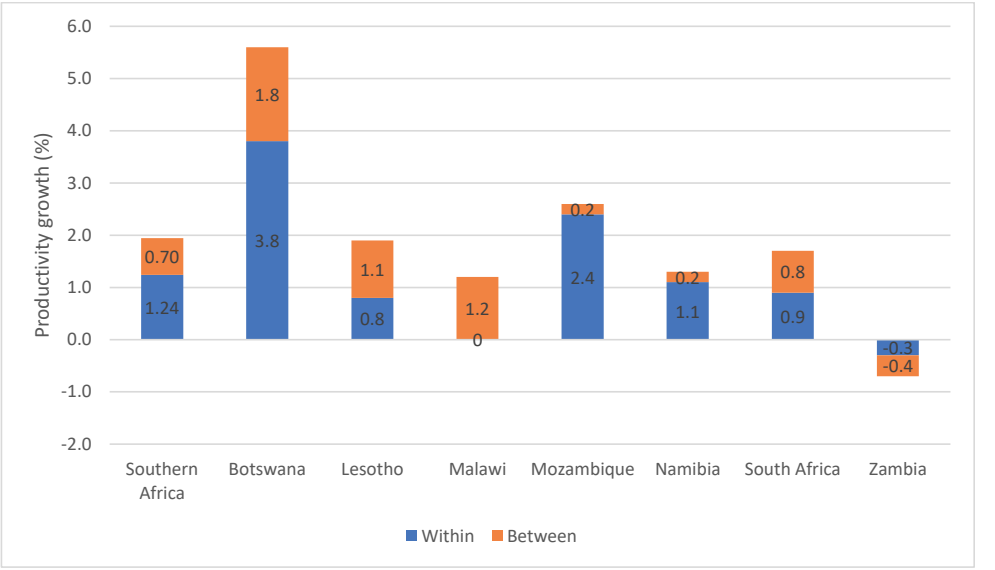
Note: W. Africa refers to the unweighted average of all countries in West Africa in the EASD.

Figure 2.2: Labour Productivity Growth in East Africa, 1960s-2015



Note: E. Africa refers to the unweighted average of the countries in East Africa in the EASD.

Figure 2.3: Labour Productivity growth in Southern Africa, 1960s-2015



Note: Southern Africa refers to the unweighted average of the countries in southern Africa in the EASD.

In southern Africa (Figure 2.3), within sector productivity contributes more to overall average productivity growth than structural change. However, individual country results are mixed. While structural change dominates in Lesotho and Malawi, within productivity growth dominates in Namibia, Mozambique, and South Africa. Botswana is not only an outlier in this region but also in Africa, with a relatively large growth rate of labour productivity, driven largely by within-sector growth. As is well-known productivity performance in the relatively advanced economy of South Africa is mediocre (Kaplan, 2015).

While not the major aim of this chapter, it is worth highlighting that some of the differences observed at the country level may relate to deliberate government policies, and to the strategy described by Stiglitz (2018), and discussed above, which stresses the need for countries to identify unique pathways in which they have dynamic comparative advantages and to use industrial policy to exploit such advantages. The focus of these policy approaches, despite varying across countries in the region, is to provide opportunities for employment creation, increased value addition, integration into the global trade network, boosting export earnings, and income generation (Chang et al., 2016). The approaches adopted have been quite heterogeneous and have had different outcomes. While it is perhaps too early to examine the success of these and other similar policies in other African countries, it is relevant to note the importance attached to policy in encouraging growth promoting structural change. For purposes of illustration, therefore, we describe here examples of specific policies, which have the aim of encouraging structural change.

In the case of Ethiopia, the policy approach has focused heavily on promoting manufacturing industries that provide linkages to the agricultural sector and integration of these industries into global value chains, while simultaneously investing in horizontal industrial policies, such as

education and infrastructure. For instance, Ethiopia's Growth and Transformation Plan II (GTP II) identifies the labour-intensive leather products and the textile and garments sector that use inputs from the livestock and cotton sector and employ labour from the agricultural sector as priority manufacturing industries.

Each priority manufacturing industry also receives extensive state support through institutions specifically set up to perform these functions. The financial support for theses priority industries comes mainly from two state-owned banks, the Commercial Bank of Ethiopia (CBE) and the Development Bank of Ethiopia (DBE), a developmental state-oriented industrial policy model that resembles the successful experience in East Asian economies such as the Republic of Korea and Taiwan, with a relatively 'authoritarian corporatist' structure (Wade, 1990; Ohno, 2011; Oqubay, 2015; Chang et al., 2016).

In Rwanda, despite being among the few countries in SSA with clearly defined national development goals and targets, plans to develop specific manufacturing sectors do not seem to feature prominently in the country's overall development plan although the country's Industrial Master Plan for 2009-2020 and National Industrial Policy of 2011 identify the manufacturing sector as a priority sector. As Chang et al (2016: 106) put it "the word manufacturing is mentioned twice in Rwanda's Vision 2020 plan, neither of which is indicative of any significant manufacturing development policy". Instead, the country's policy approach is focused on developing high-end services such as ICT-based and tourism services. The government, together with the private sector and international organisations, has made a huge investment in the ICT sector including initiating a national ICT plan in 2000 and completing a 2,300km nationwide fibre optic cable to provide faster internet access to a wider range of broadband services. This has spurred progress in the adaptation of innovative applications such as e-banking, e-agriculture, and e-trade. Mobile phone subscriptions for instance rose from 333,762 in 2006 to 5,690,751 in 2012 (UNCTAD, 2014; Chang et al., 2016). The country's tourism sector has been the stronger driver of the country's growth—thanks to the revenue generated from Gorilla viewing in the country. The tourism sector generated about $293m in export revenue in 2013, an amount which represents about 30 percent of the country's total export earnings and contributed to creating over 135,000 jobs in 2012, or 6.4 percent of total employment for that year (UNCTAD, 2014; Chang et al., 2016).

Ghana's industrial policy approach has gone through three main phases since its independence. In the first phase (1960-1983), Ghana adopted a state-led import substitution industrialisation (ISI) policy that emphasized public investment and protected infant industries. The second phase (1984-2000) was characterised by trade and market liberalization policies to conform to the structural adjustment programs of the international financial institutions at that time. Since 2000, the government has focused on private sector-led industrialisation strategy. The strategy has been to ensure rapid industrialisation driven by exports and strong linkages to the domestic economy, to agriculture and to other natural resource endowments (Arthur, 2006; UNIDO, 2013; Fenny, 2017; Dzansi, 2018).

Since 2016, the government of Ghana has launched an industrial policy "One District, One Factory" (1D1F) that seeks to support, guide, and facilitate the establishment of privately owned factories in all 260 districts of Ghana. The 1D1F is an industrialisation campaign across the

country, aimed at equipping and empowering communities to utilize their local resources in manufacturing products that are in high demand both locally and internationally. The policy broadly targets the following activities: input/raw material producer groups; agro-processing and business; textiles and clothing; ICT; pharmaceutical and cosmetics; waste management; distribution and trading; and tourism, arts, and crafts (Dzansi, 2018). This massive industrialisation drive is expected to increase efficiency in agricultural and manufacturing output and reduce the reliance on imports.

2.4 Sectoral Reallocation and Labour Market Turbulence (LMT) in Africa

In the preceding section we established that structural change is an ongoing process in Africa, being more rapid in East Africa than in other parts of Africa. The contribution of structural change to productivity growth is however lower than the experience of East Asia, in which there was a similar employment shift (of about 16%) from agriculture. Unlike the case of East Asia, where there was a shift towards manufacturing and high-tech services, in Africa there has been a strong shift towards lower paid jobs in services. Non-tradable services often associated with high levels of informality have grown relatively rapidly at the expense of tradable services and manufacturing. This may have important implications for labour market outcomes in Africa for several reasons. During structural transition, simultaneous job creation and job destruction could take place within narrowly defined industries or sectors (De Loecker & Konings, 2006). This could impact employment stability and the protection of workers within these sectors. To this end, we argue that the study of structural change needs to move beyond the usual labour productivity decomposition towards examining empirical relationships between sectoral shifts and key labour market outcomes. However, most studies of structural change in Africa neglect this important feature of structural change.

The effect of structural change on labour market outcomes such as the natural rate of unemployment and job mobility within and across sectors is well established in studies in advanced countries. Lilien (1982:777) argues that "most of the unemployment fluctuations of the seventies (unlike those in the sixties) were induced by unusual structural shifts within the U.S. economy". Diprete et al (1997) argue that job mobility is induced by either structural change (collectivist regime) or individual decisions (individualistic regime). Testing the sensitivity of the job mobility rate to structural change and individual choices in the US, Germany, Netherlands and Sweden they conclude that "U.S. rates of job mobility showed the greatest sensitivity to structural change and to the labour market resources of individual workers" (Diprete et al., 1997: 318). We fill this gap for Africa by examining the extent to which observed structural change within Africa is characterised by labour market turbulence. By analysing turbulence in the labour market, we are able to identify sectors where the labour force is most affected as well as highlighting the differences that exist in the expanding and contracting sectors (Bachmann & Burda, 2009).

To do this we estimate the labour turbulence effect of structural change in Africa appealing to the definition of Lilien (1982). The measures of job creation, job destruction and job reallocation follow Davis et al (1996); Bartelsman (2013), Bartelsman et al. (2013), Haltiwanger et al (2014) and are given as follows:

Job Creation by sector: $$JC_{it} = \sum_{i \epsilon J} EW_{it} \left(\Delta PE_{it} / \overline{l_{it}}\right) \quad (3)$$

where JC_{it} is the job creation effect of sector i (belonging to economy j) in year t, ΔPE_{it} is the sum of positive employment changes (employment gains) in an expanding sector over time, $\overline{l_{it}}$ is the sector's average employment over time and is given by $\overline{l_{it}}$ =0.5 ($l_{iT} + l_{i0}$), and EW_{it} is the sector employment weight and is given by the average or mean employment of sector i divided by the average employment of the aggregated economy j it belongs: ($EW_{it} = \overline{L_{it}} / \overline{L_{jt}}$).

Job Destruction by sector: $$JD_{it} = \sum_{i \epsilon J} EW_{it} \left(\Delta NE_{it} / \overline{l_{it}}\right) \quad (4)$$

where JD_{it} is the job destruction effect of sector i (belonging to the economy j) in year t, and ΔNE_{it} is the sum of the negative employment changes (employment losses in absolute value) in a contracting sector over time.

The difference between JC_{it} and JD_{it} is net employment growth (NEG), which shows the total employment change and is given by: $NEG_{it} = JC_{it} - JD_{it}$.
The sum of JC_{it} and JD_{it} is the gross job reallocation (GJR) rate, and measures the rate at which employment positions are reallocated across sectors and is given by:

$$GJR_{it} = JC_{it} + JD_{it} \quad (5)$$

Excess job reallocation (EJR) is the difference between the gross job reallocation rate and the absolute value of net employment growth. It is a measure of job reallocation which is in excess of the amount of job reallocation necessary to accommodate a given net employment growth rate (Masso et al., 2005; De Loecker & Konings, 2006). Such a measure indicates the magnitude of deep restructuring that needs to take place in order to accommodate a given aggregate employment growth rate (De Loecker & Konings, 2006) and is given by:

$$EJR_{it} = JC_{it} + JD_{it} - |NEG_{it}| \quad (6)$$

The average yearly job creation and job destruction rate is the sum of the positive and negative employment changes (employment losses in absolute value-levels) respectively in an expanding and a contracting sector divided by the number of years considered.
Further to this, we assess the dispersion in employment growth using the Lilien Index given by:

$$LMT_{jt} = [\sum_{i=1}^{k} s_{it} (\varpi_{it} - \varpi_{jt})^2]^{0.5} \quad (7)$$

where k is the number of (sub-)sectors, s_{it} is the share of the ith sub-sector employment in total employment of the aggregated sector j, ϖ_{it} is the rate of growth of employment in the ith sub-sector and ϖ_{jt} is the rate of growth of employment in the jth aggregated sector. The Lilien Index captures the structural shift of employment demand between sectors of the economy. This allows

us to see which sectors of the economy experience high or low dispersion in employment growth overtime.

The results of the LMT[15] analysis are reported in Tables 2.4, 2.5, and 2.6, with Table 2.4 reporting results for job creation, job destruction and job reallocation for SSA as a whole and for the different regions of Africa (for comparison with the results from the shift-share decomposition above). Table 2.5 reports results from the Lilien index for each of the countries in our dataset and for both the total economy and for the aggregated sectors, agriculture, industry and services. Finally, Table 2.6 reports the job creation, job destruction and job reallocation rates for SSA as a whole for the four different time periods used in the above analysis (i.e., the import substitution era, the lost decades, the post structural adjustment period, and the MDGs era).

[15] This is a proxy measure of LMT constructed at the aggregate level. The true measures of LMT are based on establishment or firm level data that tracks firm entry and exit in addition to job creation and job destruction in a given period.

Table 2.4: Job Creation, Job Destruction and Job Reallocation in Africa, 1960s–2015

SSA (1960s-2015)

Sector	JC	JD	NEG	GJR	EJR
Agriculture	1.2%	0.3%	0.9%	1.5%	0.4%
Mining	0.0%	0.0%	0.0%	0.1%	0.0%
Manufacturing	0.3%	0.1%	0.2%	0.4%	0.2%
Utilities	0.0%	0.0%	0.0%	0.0%	0.0%
Construction	0.1%	0.1%	0.0%	0.2%	0.2%
Trade services	0.4%	0.0%	0.4%	0.4%	0.0%
Transport services	0.1%	0.0%	0.1%	0.1%	0.0%
Business services	0.1%	0.0%	0.1%	0.1%	0.0%
Government services	0.2%	0.0%	0.2%	0.3%	0.1%
Personal services	0.2%	0.1%	0.1%	0.2%	0.1%
Total Economy	2.5%	0.2%	2.3%	2.7%	0.4%

West Africa Average (1960s-2015)

Sector	JC	JD	NEG	GJR	EJR
Agriculture	1.3%	0.5%	0.8%	1.8%	1.0%
Mining	0.0%	0.0%	0.0%	0.0%	0.0%
Manufacturing	0.3%	0.1%	0.2%	0.4%	0.2%
Utilities	0.0%	0.0%	0.0%	0.0%	0.0%
Construction	0.1%	0.0%	0.1%	0.1%	0.0%
Trade services	0.5%	0.1%	0.4%	0.6%	0.2%
Transport services	0.1%	0.0%	0.1%	0.1%	0.0%
Business services	0.0%	0.0%	0.0%	0.0%	0.0%
Government services	0.1%	0.0%	0.1%	0.1%	0.0%
Personal services	0.2%	0.0%	0.2%	0.2%	0.0%
Total Economy	2.6%	0.2%	2.4%	2.8%	0.4%

East Africa Average (1960s-2015)

Sector	JC	JD	NEG	GJR	EJR
Agriculture	1.2%	0.1%	1.1%	1.3%	0.2%
Mining	0.0%	0.0%	0.0%	0.0%	0.0%
Manufacturing	0.3%	0.1%	0.2%	0.4%	0.2%
Utilities	0.0%	0.0%	0.0%	0.0%	0.0%
Construction	0.1%	0.0%	0.1%	0.2%	0.1%
Trade services	0.4%	0.0%	0.4%	0.4%	0.0%
Transport services	0.1%	0.0%	0.1%	0.1%	0.0%
Business services	0.1%	0.0%	0.1%	0.1%	0.0%
Government services	0.2%	0.0%	0.2%	0.2%	0.0%
Personal services	0.1%	0.0%	0.1%	0.2%	0.0%
Total Economy	2.6%	0.1%	2.5%	2.6%	0.1%

Southern Africa Average (1960s-2015)

Sector	JC	JD	NEG	GJR	EJR
Agriculture	1.2%	0.2%	1.0%	1.4%	0.4%
Mining	0.1%	0.1%	0.0%	0.2%	0.2%
Manufacturing	0.2%	0.1%	0.1%	0.3%	0.2%
Utilities	0.0%	0.0%	0.0%	0.0%	0.0%
Construction	0.2%	0.1%	0.1%	0.3%	0.2%
Trade services	0.4%	0.1%	0.3%	0.5%	0.2%
Transport services	0.1%	0.0%	0.1%	0.1%	0.0%
Business services	0.1%	0.0%	0.1%	0.1%	0.0%
Government services	0.3%	0.1%	0.2%	0.4%	0.2%
Personal services	0.3%	0.1%	0.2%	0.4%	0.2%
Total Economy	2.4%	0.2%	2.2%	2.6%	0.4%

Note: Note: JC = job creation; JD = job destruction; NEG = net employment growth; GJR = gross job reallocation; EJR = Excess job reallocation. Relative contributions to the economy are calculated by dividing the variables by corresponding total economy values. West Africa Average for Burkina Faso, Cameroun, Ghana, Nigeria and Senegal. East Africa Average for Ethiopia, Kenya, Mauritius, Rwanda, Tanzania and Uganda. Southern Africa for Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa and Zambia.

Using the EASD, Table 2.4 shows that the annual job creation rate of the agriculture sector is 1.2 per cent, a figure that represents 48 per cent of the annual job creation rate in the region's economy over the period 1960s-2015.[16] This is followed by the service sector (aggregating the different service sectors) with an annual job creation rate of 1 per cent, the manufacturing sector with a job creation rate of 0.3 per cent, and the non-manufacturing industrial sector (mining, utilities and construction) with a job creation rate of 0.1 per cent over the same period (see Appendix A2.5 for actual employment levels across countries). Lewis (1954) argued that structural change, and the associated poverty reduction, is more rapid when agricultural transformation and industrialisation occur together. Increasing labour productivity in agriculture implies that fewer jobs are created in the sector, and that as a result labour is released for off-farm economic activities. Industrial hubs or urban growth poles draw this released rural labour into productive use (rural push versus urban pull effects) (Barrett et al, 2017). In the case of Africa, agricultural productivity has remained unchanged since independence (Table 2.2), while at the same time the agricultural sector is creating more jobs despite declining and shedding fewer workers (Table 2.4 and 2.6). Those workers that have moved have tended to move to the urban sector to engage in informal trading activities rather than in manufacturing. This is also true at the regional level where we observe the same trend. As a result, the rural push, urban pull effects suggested by Lewis (1954) and observed in East Asia in the last century are not observed in Africa, with rural stagnation and informal urban pull effects in Africa leading to a less rapid structural transformation compared to the East Asian experience. This trend to some extent has contributed to the moderate gains of structural change to productivity growth in the region over the period between 1960s-2015.

Job creation rates in general dominate job destruction rates in all sectors. The average annual job destruction rate in the agricultural sector is 0.3 per cent, considerably lower than the job creation rate. Though job creation is higher than job destruction, it is not sufficient to accommodate the 11 million young workers expected to enter the labour market each year for the next decade in SSA (ILO, 2018).

Table 2.5: LMT in Africa: Lilien Index- Decomposition Results (percentages), 1960-2015

Country / Region	Total Economy	Agriculture	Industry	Services
All Countries	3.75	1.07	2.08	2.47
Botswana	7.72	2.47	4.97	4.61
Burkina Faso	2.39	1.06	1.64	1.24
Cameroun	1.13	0.36	0.35	0.99
Ethiopia	3.76	0.60	1.71	3.13
Ghana	4.87	0.86	2.76	3.34
Kenya	3.16	1.33	1.51	2.30
Lesotho	3.14	0.46	1.49	2.48
Malawi	4.58	0.93	2.43	3.40

[16] Note that the estimated rates of job reallocation reported here are smaller than many found in the literature. This is likely because of the aggregated nature of our data, with most other studies constructing these indicators from firm-level data, thus accounting for job reallocation across firms within sectors (see for example, De Loecker and Konings, 2006; Bartelsman, 2013). There are certain consistencies with some of this existing literature, however, with our results also showing higher rates of job creation relative to job destruction in services and agriculture, and a higher rate of excess job reallocation in services relative to manufacturing, for example.

Mauritius	6.01	1.85	4.08	3.47
Mozambique	1.84	0.46	1.26	1.09
Namibia	4.18	1.56	1.66	3.25
Nigeria	4.95	1.46	3.01	3.10
Rwanda	2.16	0.65	1.04	1.64
Senegal	2.96	0.85	1.66	2.15
South Africa	4.17	1.86	2.39	2.45
Tanzania	3.79	0.76	2.02	2.82
Uganda	2.63	0.78	1.00	2.19
Zambia	4.13	0.91	2.37	3.03

Source: Author's computation based on the Expanded Africa Sector Database (1960-2015).

Agriculture in SSA is predominantly subsistence based, highly reliant on nature, being affected by natural disasters and drought in particular. The relative stability of jobs in agriculture is further shown by the Lilien Index reported in Table 2.5. The dispersion of the annual agricultural employment growth rate is 1.07% compared with 2.08% for industry and 2.47% for services. The sector remains one of the low productivity growth sectors because of its labour-intensive nature. Despite these results for SSA, we do however observe a relatively large (small) average JD (JC) rate and a negative NEG rate of the sector in countries such as Mauritius and South Africa signalling the significant positive structural change that these countries have achieved over the years as they have reallocated excess labour from the agricultural sector to more dynamic and productive sectors[17]. Excess job reallocation (EJR) in the agricultural sector, reported in Table 2.4, is 0.4 per cent, which is the highest of all the sectors reflecting significant underemployment within the agriculture sector. "It also signals the existence of barriers to more efficient allocation of factors of production" (Barrett et al., 2017: 14). The underemployment of labour explains the large productivity gap between agriculture and modern market activities.

In the manufacturing sector, the average yearly JC rate is 0.3%. At the same time, about one third of jobs created annually in the sector between the 1960s and 2015 have been destroyed. The sector recorded its highest annual job creation rate (0.4%) during the import substitution era. The years from the 1980s through to the year 2000 saw a sizable job destruction rate in the African manufacturing sector and a decline in the job creation rate as can be seen in Table 2.6. De Loecker & Konings (2006) find a similar result in many post-Soviet countries and attribute it to the downsizing that took place in the countries due to past labour hoarding in the sector. However, in Africa, this coincided with the economic and political crises witnessed in the region, the introduction of structural adjustment programs and neoliberal policies during this period. In addition to this, and perhaps contributing to an explanation, there is evidence of global de-industrialisation (Lavopa & Szirmai, 2018) and de-industrialisation in SSA, with many SSA countries reaching their peak and turning point of industrialisation at a relatively low per capita income, a level that is a fraction of that at which the advanced economies started to de-industrialize (Cadot et al., 2015; Rodrik, 2015). This trend only reversed during the MDGs era (2000-2015) as the sector recorded an increase in job creation and a decline in job destruction (see Table 2.6). This

[17] In Mauritius, the average yearly JC and JD rate in the agricultural sector is 0.2 per cent and 0.4 per cent respectively. Average yearly net employment growth of the sector is -0.2 per cent. In South Africa, the average yearly JC and JD rate in the agricultural sector is 0.4 per cent and 0.4 per cent respectively.

also coincided with the period in which the region recorded its highest labour productivity growth, with the contribution of structural change to productivity growth increasing to 1.4 per cent (see Table 2.3).

In the service sector, trade services generate the highest average annual job creation rate at 0.4 per cent, followed by government and personal services, with an annual job creation rate of 0.2 per cent. The lowest average annual JC rate in the sector is recorded in business services (0.1 per cent) over the period 1960s-2015, possibly as a result of the skilled-labour- and capital-intensive nature of the sector making it difficult for the sector to absorb labour released from the other sectors of the economy. The highest average annual job creation in the sector, particularly in tradable services (trade, business) is recorded in the MDGs era (2000-2015), the period in which the region recorded its highest labour productivity growth. Overall, the rates of job creation are insufficient, however, to absorb a growing labour force.

The relative high pace of GJR (i.e., the sum of JC and JD) in the service sector, particularly, in trade services gives an indication of the high degree of volatility associated with vulnerable employment growth in the sector. The dispersion of annual employment growth in the sector is 2.47%, the highest among the three major sectors. Two factors could explain this. Firstly, the service sector faces high volatility[18] in product demand in part as a result of rapid changes in fashion, tastes, lifestyles, and technological advancement which is increasingly changing the mode of production and delivery of services in the sector. Secondly, we could deduce that the trade and personal service sectors – where informality is high – seem to have a high GJR, which translates into relatively high fluctuations in employment growth.

Given that job turnover is high in trade and personal services where informality is high, it raises the question of whether worker movement to the sector is voluntary or not since firms in the informal sector are typically 'viewed as the unproductive employers of last resort' (La Porta & Shleifer, 2011; 2014; Diao et al., 2018). While we cannot directly infer from our data whether the job reallocation in Africa is voluntary or involuntary, we combine insights from the earlier literature on voluntary and involuntary job mobility into the informal sector and recent country case studies in Africa to provide some perspectives on the issue.

Three views explain voluntary and involuntary informal sector employment in developing countries. The classical view is that the reallocation of jobs into the informal sector is mostly involuntary in a segmented labour market, where, on one hand, there are well-paid formal sector jobs but there are significant barriers to entry, and on the other, there are many low-paid jobs in the informal sector with no entry restrictions. The preferred sector of employment is the formal wage sector but many workers do not have the human and social capital to overcome the entry barriers, locking many workers involuntarily in the informal sector (e.g., Lewis, 1954; Harris & Todaro, 1970). The second view is the expanded version of the classical view, which further segments informal labour markets into two: 'upper tier jobs' and 'free entry jobs'. Just like the formal wage jobs, the upper tier jobs in the informal sector are restricted but the free entry jobs

[18] Volatility is measured using the standard deviation of sectoral value-added shares. Volatility in the agriculture sector is 5.57 and 1.60 in the manufacturing sector.

are available to everyone, which people involuntarily take up (Fields, 2007; 1990). Finally, in contrast to the classical and expanded views, the revisionist view argues that, based on the characteristics of many workers in developing countries, the satisfaction derived from informal sector jobs is higher than formal ones, and as a result many workers in developing countries choose to work in the informal sector voluntarily (Maloney, 1999; 2004).[19]

Evidence on these hypotheses is limited in general.[20] In the case of Africa, evidence on involuntary and voluntary job mobility is non-existent, to the best of our knowledge. However, recent evidence on the proportion of small business owners who are willing to leave their businesses for a full-time salaried job, if given the opportunity, may give an indication of the involuntary job mobility in Africa. In a nationally representative survey of MSMEs in Tanzania, small business owners who predominantly operate in the informal sector were asked two questions: "What was your main occupation before you started this business?" and "If you were offered a full-time salary job, would you take it?". The first question gives us an indication of job mobility and the second question whether they are operating their businesses voluntarily or not. The responses to the questions show that 56.5 percent and 19.3 percent of small business owners in rural and urban areas outside of Dar es Salaam were farming prior to starting a business. Responses to the second question indicate that 46.6 percent of all small business owners would prefer full time salaried position to their current business (47.8% in rural areas, 48.6% in other urban areas and 37.7% in Dar es Salaam) (Diao et al., 2018). As in our analysis, there is significant job reallocation from farm to nonfarm business sectors, but about a half of these business owners are operating involuntarily. This may suggest that the majority of workers are moving into distributive trade services involuntarily.

Given the observed increased labour market turbulence in Africa, with more jobs created in the low and productivity resistant agriculture sector and in informal, vulnerable low paid jobs in non-tradable services, we further consider whether there are policy responses that may alleviate the impact of labour market turbulence. The next section of the chapter therefore examines the effect of labour market institutions on job reallocation.

[19] See Kucera & Roncolato (2008) and Lehmann & Pignatti (2007) for more detail review of the literature.
[20] See Lehmann & Pignatti (2007) for evidence in Ukraine

Table 2.6: Job Creation, Job Destruction and Job Reallocation in Africa, by Periods

Import Substitution Era (1960s-1975)

Sector	JC	JD	NEG	GJR	EJR
Agriculture	1.8%	0.1%	1.7%	1.9%	0.2%
Mining	0.1%	0.0%	0.0%	0.1%	0.1%
Manufacturing	0.4%	0.0%	0.4%	0.4%	0.1%
Utilities	0.0%	0.0%	0.0%	0.0%	0.0%
Construction	0.2%	0.1%	0.1%	0.2%	0.1%
Trade services	0.3%	0.1%	0.2%	0.4%	0.2%
Transport services	0.1%	0.0%	0.1%	0.1%	0.0%
Business services	0.0%	0.0%	0.0%	0.0%	0.0%
Government services	0.2%	0.0%	0.2%	0.3%	0.1%
Personal services	0.2%	0.1%	0.2%	0.3%	0.1%
Total Economy	3.0%	0.0%	2.9%	3.0%	0.1%

The Lost Decades (1975-1990)

Sector	JC	JD	NEG	GJR	EJR
Agriculture	1.8%	0.1%	1.7%	1.9%	0.2%
Mining	0.1%	0.0%	0.0%	0.1%	0.1%
Manufacturing	0.3%	0.1%	0.2%	0.4%	0.2%
Utilities	0.0%	0.0%	0.0%	0.0%	0.0%
Construction	0.2%	0.1%	0.1%	0.2%	0.1%
Trade services	0.4%	0.1%	0.3%	0.4%	0.1%
Transport services	0.1%	0.0%	0.1%	0.1%	0.0%
Business services	0.1%	0.0%	0.1%	0.1%	0.0%
Government services	0.3%	0.0%	0.3%	0.3%	0.0%
Personal services	0.2%	0.1%	0.2%	0.3%	0.1%
Total Economy	3.1%	0.1%	3.0%	3.2%	0.2%

Post Structural Adjustment (1990-2000)

Sector	JC	JD	NEG	GJR	EJR
Agriculture	1.2%	0.2%	1.0%	1.4%	0.4%
Mining	0.0%	0.1%	0.0%	0.1%	0.1%
Manufacturing	0.2%	0.1%	0.2%	0.3%	0.1%
Utilities	0.0%	0.0%	0.0%	0.0%	0.0%
Construction	0.1%	0.1%	0.1%	0.2%	0.1%
Trade services	0.5%	0.0%	0.5%	0.6%	0.1%
Transport services	0.1%	0.0%	0.1%	0.1%	0.0%
Business services	0.1%	0.0%	0.1%	0.1%	0.0%
Government services	0.2%	0.0%	0.2%	0.3%	0.1%
Personal services	0.2%	0.1%	0.1%	0.3%	0.1%
Total Economy	2.3%	0.1%	2.2%	2.4%	0.2%

MDGs (2000-2015)

Sector	JC	JD	NEG	GJR	EJR
Agriculture	1.2%	0.0%	1.1%	1.2%	0.1%
Mining	0.1%	0.0%	0.1%	0.1%	0.0%
Manufacturing	0.3%	0.0%	0.3%	0.3%	0.0%
Utilities	0.0%	0.0%	0.0%	0.0%	0.0%
Construction	0.2%	0.0%	0.2%	0.2%	0.0%
Trade services	0.9%	0.0%	0.9%	0.9%	0.0%
Transport services	0.1%	0.0%	0.1%	0.1%	0.0%
Business services	0.2%	0.0%	0.2%	0.2%	0.0%
Government services	0.3%	0.0%	0.3%	0.3%	0.0%
Personal services	0.2%	0.0%	0.2%	0.3%	0.0%
Total Economy	3.3%	0.0%	3.3%	3.3%	0.0%

Note: Note: JC = job creation; JD = job destruction; NEG = net employment growth; GJR = gross job reallocation; EJR = Excess job reallocation. Relative contributions to the economy are calculated by dividing the variables by corresponding total economy values.

2.5 Job Reallocation and Productivity Growth in Africa: The Role of Employment Protection Legislation

The theoretical model of Aghion and Howitt (1994) and the empirical work of Faggio and Konings (2003) predict that a higher pace of job reallocation is associated with higher growth. For this relationship to hold, however, it may be that labour market flexibility is needed, allowing labour resources to be reallocated to sectors where they are more productive (Masso et al., 2005). Some studies for developed countries find that stringent employment protection legislation adversely affects JR which could stifle economic growth (Micco & Pages 2007; Messina & Vallanti 2007; Haltiwanger et al., 2014).[21]

As explained by Haltiwanger et al (2014), standard labour market models predict that besides technology, entry costs and other market-driven factors, and the institutional and regulatory apparatus within which sectors operate shape the direcstion, speed and effectiveness of labour market outcomes (job flows) within these sectors. The general prediction of these models is that stringent employment protection legislation reduces job reallocation (cf. Messina & Vallanti, 2007; Micco & Pages, 2007). While beneficial for workers by guaranteeing job security, productivity growth could be penalized as a result, at least for countries at initial stages of development that require positive structural change to unleash productivity growth (cf. Hopenhayn & Rogerson, 1993).

Until now, SSA has not featured in these discussions even though many countries in the region are undergoing structural transformation with job reallocation that is taking place across sectors. But, to what extent do labour market regulations in Africa impact on this job reallocation? The World Bank's 2010 Doing Business (DB) report attributes employment creation and high labour productivity growth to flexible labour market regulations. In a related study, UNDP made a case for developing countries to do away with rigid labour market regulations, replacing them with simpler rules while ensuring stricter levels of enforcement (UNDP, 2004; Boni, 2010). In a similar study, Czegledi (2006) finds that regulating the labour market less rigidly but more coherently is associated with higher growth. The extension of OHADA[22] to include more member states in the harmonization of business law and labour codes in SSA continues to be a top priority for many donor and development agencies in Africa. Given the importance of labour market regulation for structural change and growth, we examine the effect of employment protection legislation (henceforth EPL) on job reallocation.

[21] On the other hand, some studies, e.g., Vergeer & Kleinknecht (2011) and Vergeer et al. (2015), find that high labour turnover reduces productivity growth. According to the authors, "high labour turnover makes firm-sponsored training less attractive and diminishes loyalty and commitment of people" (Vergeer and Kleinknecht 2011: 393). Exiting workers could easily leak tacit knowledge to competitors and harm productivity and innovation in routinized innovation regime sectors where continuous accumulation of knowledge is crucial (cf. Vergeer & Kleinknecht, 2011).

[22] Organisation for the harmonization of business law in Africa. It was created in 1993 in Port Louis (Mauritius). As of 2010, 16 Member States had joined the OHADA Treaty.

There are at least two factors that make the study of the relationship between EPL and job reallocation difficult in the context of SSA. Firstly, most employment relationships in SSA are informal. Available statistics indicate that the share of the labour force that earns a living working in the informal sector in SSA is about 80 per cent (African Development Bank, 2013). Working relationships in the informal sector are often based on casual employment and informal employment arrangements, where employment regulations are rarely enforced. Secondly, in countries where the level of formality is high such as South Africa, there is also another kind of employment protection, namely the "closed-shop arrangement", which protects jobs for the elite of the labour force in manufacturing, government and formal services and locks a huge number of informal workers out of the formal labour market, further reducing labour reallocation (Visagie et al., 2012). In this closed-shop agreement, a worker looking for formal employment must first be a member of a trade union before being considered for employment by an employer. The trade union thus becomes the sole agency for employers to recruit workers into their establishments.[23]

The high level of informality in some countries and the institutional frictions such as closed-shop arrangements suggest that there may be significant variation in the enforcement of labour market regulations across Africa. As highlighted in Haltiwanger et al. (2014), in developing regions and transition economies, evidence suggests that there is a significant variation in the degree of enforcement of laws and regulation. It is therefore common to find in these economies that even formally registered firms may not fully comply with existing rules and regulations. To account for variation in the enforcement of labour regulations, we follow the approach of Haltiwanger et al (2014). In this approach, the issue of whether EPL is binding on job reallocation depends on the degree of enforcement of labour regulations. Thus, we adjust the EPL to reflect the degree of enforcement across countries. The adjusted EPL index is computed as:

$$EPL_{adj} = \left(1 - \frac{law\&order}{10}\right) \times EPL \qquad (8)$$

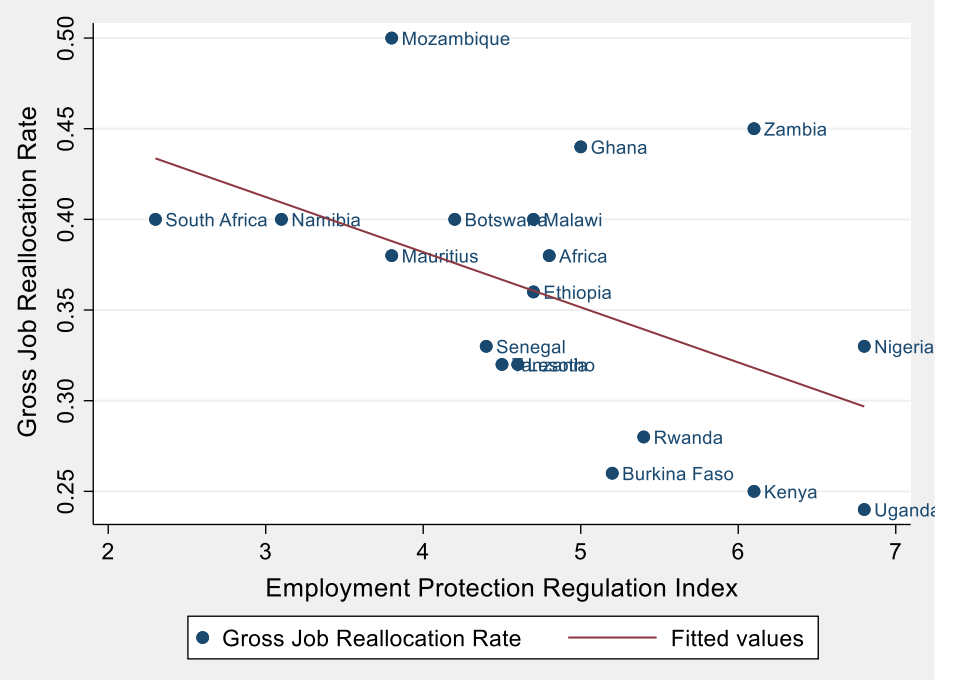
Intuitively, if the enforcement of regulation is low for various reasons – including, for instance, reasons related to informality and closed-shop arrangements – this adjustment discounts the overall value of EPL to reflect the lower de facto level of employment protection. For our analysis, we use EPL data from the Fraser Institute's Economic Freedom of the World (EFW) and use productivity and JR data from the preceding sections. The EFW compile data from third party sources, such as the International Country Risk Guide (ICRG), the Global Competitiveness Report, and the World Bank's Doing Business Project. An advantage of the EPL index is the transparency and easily replicable nature of the index.[24] In addition, compared to other indicators that measure labour market regulations in developing economies, the EFW has extended data that tracks employment regulation over time and serves the purpose of this analysis (cf. Haltiwanger et al., 2014). EPL is measured on a scale of 0 to 10, with 10 being the worst (most restrictive). The law-and-order indicator used to compute the

[23] http://www.labour.gov.za/DOL/legislation/acts/basic-guides/basic-guide-to-closed-shop-agreements(3/7/2018). http://www.tonyhealy.co.za/law/11-trade-unions/27-the-return-of-the-closed-shop.html (accessed 3/7/2018).

[24] More information on the EFW methodological approach can be found at: https://www.fraserinstitute.org/economic-freedom/approach (3/7/2018).

adjusted EPL is taken from the Political Risk Component I (Law and Order) of the International Country Risk Guide, the variable ranging from 0 to 10, with 10 being the worst.

Figure 2.4: Scatterplot Showing EPL and Job Reallocation in Africa



Source: Author's computation based on the Expanded Africa Sector Database and EPL data from Fraser Institute Economic Freedom of the World (EFW). The figure plots the EPL index against the gross job reallocation rate for each country in the sample.

To provide an initial insight, Figure 2.4 presents a simple scatterplot of job reallocation and (the unadjusted) EPL, with the plot suggesting a negative relationship between the two, thus providing some support for the argument that high EPL constrains the efforts of job reallocation and positive structural change, making it difficult to reallocate surplus resources into sectors where they could be more productive, further penalizing overall productivity growth (Hopenhayn & Rogerson, 1993). We now proceed to examine this relationship econometrically.

Our empirical strategy follows Messina & Vallanti (2007), Micco & Pages (2007) and Haltigwanger et al. (2014) but is modified to suit the purpose of our study. The complete specification yields the following model:

$$JR_{sc} = \beta_0 + \beta_1 EPL_{c,adj} + \sum_{s=1}^{S} \alpha_s T_s + \sum_{c=1}^{C} \gamma_c T_c + \varepsilon_{sc} \quad (9)$$

where JR is gross job reallocation in country c and industry s, T_s are industry dummies, T_c are country dummies, and EPL_{adj} is the adjusted index of employment protection legislation. As indicated in Haltiwanger et al (2014), controlling for country effects sweeps out any country-specific variation, while controlling for industry effects also sweeps out the large common factors associated with industry, allowing us to identify the effect of EPL on job reallocation. We estimate a weighted regression using employment shares in each industry as weights. Following Haltiwanger et al. (2014) we use time averages of all of our variables to eliminate the impact of non-synchronized business cycle fluctuations in the years covered in our analysis.

Econometric results are reported in Table 2.7. In Column 1, we find that on average a one-point increase in the adjusted EPL index is associated with a significantly lower annual job reallocation rate of 1.28 per cent. In Column 2, we introduce interactions between sectoral dummies (omitting the agriculture sector interaction) and the adjusted EPL to examine whether the association between EPL and job reallocation varies by broad sector. The coefficient on the EPL continues to be negative and significant, suggesting a negative relationship between EPL and job reallocation in agriculture (the omitted interaction). The results also suggest that compared to the agricultural sector, a one-point increase in the adjusted EPL is associated with significantly lower annual rate of job reallocation in the manufacturing industry of 0.25 per cent, in the non-manufacturing industrial sector (NMIS) of 0.31 per cent, in market services (MS) of 0.24 per cent, and in the non-market service sector (NMS) of 0.28 per cent. The similarity in terms of the coefficients for manufacturing and services are somewhat surprising, with the higher levels of unionisation in manufacturing expected to perhaps have a stronger effect on job reallocation.

The results are robust when we focus on data for two more recent sub-periods, 1990-2015 and 2000-2015, as shown in Table 2.7 columns 3-6.[25] The results are also robust to the use of the unadjusted EPL index and are in line with the findings of Messina & Vallanti (2007), Micco & Pages (2007) and Haltiwanger et al. (2014), suggesting that a more rigid labour market reduces the pace of job reallocation, which could limit the potential for structural change by making it difficult to reallocate surplus labour resources into sectors where they could be more productive. Finally, the results are robust to the removal of one country and one industry at a time from our model, with the results showing remarkable stability of the estimated coefficient to changes in the sample. See Appendix 2.7.1 for attempts to estimate model 9 using a difference-in-difference approach and the issues we encountered.

[25] The focus on these two sub-periods is important since the EPL data is generally not available for the earliest periods in the long sample, 1960-2015.

Table 2.7: The Effect of EPL on Job Reallocation in Africa

	1960s-2015		1990-2015		2000-2015	
	(1)	(2)	(3)	(4)	(5)	(6)
EPL (Adj)	-0.0128***	-0.0111***	-0.0072***	-0.0059***	-0.0139**	-0.0129**
	(0.0017)	(0.0031)	(0.0022)	(0.0016)	(0.0058)	(0.0049)
EPL (Adj) x MAN		-0.0025***		-0.0027***		-0.0031***
		(0.0005)		(0.0005)		(0.0010)
EPL (Adj) x (NMIS)		-0.0031***		-0.0030***		-0.0033***
		(0.0004)		(0.0005)		(0.0008)
EPL (Adj) x MS		-0.0024***		-0.0019***		-0.0019**
		(0.0004)		(0.0006)		(0.0009)
EPL (Adj) x NMS		-0.0028***		-0.0026***		-0.0027***
		(0.0003)		(0.0004)		(0.0007)
Constant	0.0739***	0.0658***	0.0455***	0.0391***	0.0734***	0.0674***
	(0.0081)	(0.0144)	(0.0091)	(0.0069)	(0.0222)	(0.0192)
Observation	148	148	148	148	148	148
Adjusted R-squared	0.774	0.698	0.675	0.595	0.578	0.518
Country effects	Yes	Yes	Yes	Yes	Yes	Yes
Sector effects	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. MAN=Manufacturing; NMIS= Non-Manufacturing Industrial Sector (construction, mining utilities); MS=Market services (Trade, Restaurants and Hotels; Transport, Storage and Communication; FIRBS): NMS=Non-market services (Government Services; Community, Social and Personal Services).

2.6 Conclusion

This chapter introduces a new sectoral dataset on African economic performance, and then uses the dataset to combine a standard decomposition of labour productivity with an analysis of labour market turbulence, thus allowing us to study the role of structural change and job reallocation in the economic growth of African countries in the past fifty years. Using both strategies, we examine the relative contribution of structural change and its characteristic labour market outcomes across different countries within three regions of Africa. The results indicate similar trends to those found in previous studies, but also reveal new trends and insights into long run structural transformation of African economies and sets a new research agenda.

Like previous studies (McMillan et al., 2014; De Vries et al., 2015; Daio et al., 2017) we document huge and persistent sectoral productivity gaps in Africa. The employment and value-added shares of agriculture have declined signalling the changing structure of production. However, the service sector is the main recipient of the workers exiting the agricultural sector. While some sub-sectors of services such as business and telecommunication are as dynamic as manufacturing, other sub-sectors such as trade, government and personal services are only marginally more productive than agriculture. A shift

of resources from agriculture towards these less dynamic sectors means that structural transformation has been weaker than it would have been if resources had shifted to manufacturing or high-tech services.

Despite this, structural change is found to be more important than previously estimated due to the undercounting of services in previous data. We have seen a massive exodus of agricultural workers to trade services and a moderate movement to ICT services. This systematic undercounting resulted in an underestimation of productivity levels, and hence an underestimation of productivity growth due to the reallocation of labour to these services. This suggests that in addition to manufacturing, dynamic services can play a key role in the transformation of African economies. This is beginning to show in the case of East African economies.

Our productivity decompositions further suggests that the golden era of African labour productivity growth is not the import-substitution era as suggested by De Vries et al (2015), with the highest productivity growth being achieved between 2000 and 2015. While this may raise some sense of optimism in the recent growth performance of African economies, given the moderate increase in the contribution of structural change to productivity growth in the region, primarily as a result of slight increase in job creation in manufacturing and business services recorded within the period, the general direction of change of the structure of African economies may not bode well for sustainable growth and poverty reduction in Africa.

In particular, there is still a strong shift towards services where the highest annual job creation in the sector is in wholesale and retail trade services (largely informal) and personal and government services due to potentially restrictive opportunities that limit the labour absorption into other dynamic modern market services. The expansion of these non-tradable services has crystallized concerns about the direction of structural change since jobs in these sectors are often temporary or part-time in nature, less paid and protected, and having few fringe benefits and opportunity for career development. This could increase earnings inequality and stall the expected poverty reduction associated with structural change because business services, which is a high-wage service sector is creating fewer opportunities compared with lower-wage non-tradable services.

The labour market institutional arrangements in many countries in SSA have played a significant role in these outcomes. Although our results provide a partial picture of the actual functioning of the labour markets of countries in SSA and cover only a minority of the labour force employed in the formal sector in the region, we find that rigid labour market institutional arrangements in the region discourage job reallocation, making it difficult to reallocate surplus labour into sectors where they could be more productive, penalising productivity growth as a result. For the region to experience the desired growth enhancing structural change will require not only a high degree of labour market flexibility that will drive this process, but also policies and reforms that will move labour into the formal sector, with a huge number of workers and held-back firms locked in the informal sector due to high entry costs and other regulations.

Due to negative consequences of this 'peculiar' structural change, the chapter sets a new research agenda by arguing that studies on structural transformation in Africa should move beyond a consideration of the extent of structural change and labour productivity to examine labour market outcomes as well. As a first step, we bring this to fruition by examining the labour market turbulence effect of structural change. A clear policy direction from this exercise is that while the main development framework in Africa should hinge on industrialisation, complementary policies and strategies should aim at agricultural transformation, improvement in intra-sectoral productivity and employment stability particularly within the service sector bearing in mind the different contexts and specific circumstances of the economies. This could be a potential way to achieve the rapid structural change and poverty reduction predicted by Lewis (1954) and growth with depth as emphasized by ACET (2014:1).

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2.7 Appendix to Chapter 2

Table A2.1 Sectoral Value-Added Shares in Africa

	Real Value-Added Shares (in per cent)					
Sector	1960	1975	1990	2000	2010	2015
Agriculture	**37.9**	**30.1**	**24.7**	**23.9**	**20.4**	**17.2**
Industry	**21.0**	**25.4**	**26.1**	**25.1**	**23.8**	**24.2**
Manufacturing	7.9	10.1	12.2	11.9	11.1	10.3
Mining	7.5	7.6	7.6	5.9	4.8	4.7
Utilities	0.5	1.3	1.8	2.7	2.4	2.3
Construction	5.1	6.4	4.5	4.6	5.5	6.8
Services	**41.1**	**44.6**	**49.2**	**51.0**	**55.8**	**58.7**
Market Services	29.8	30.6	31.9	34.7	40.0	42.8
Trade, Restaurant and Hotels	15.9	13.9	13.9	14.7	16.3	17.5
Transport, Storage and Communications	5.7	6.5	6.1	7.0	10.4	11.2
FIRBS	8.3	10.2	11.9	12.9	13.3	14.1
Non-Market Services	11.3	14.0	17.2	16.4	15.8	15.9
Government Services	8.6	11.6	14.6	13.5	12.8	12.7
Community, Social and Personal Services	2.7	2.4	2.7	2.8	3.0	3.2

Note: This table reports the share of total value added by sector in sub-Saharan Africa. These percentages are unweighted averages of the 18 countries included in EASD. FIRBS stands for financial, real estate and business services.

Table A2.2 Summary Statistics: 1960s-2015

Variable	Obs	Mean	Std. Dev.	Min	Max
Job creation rate	148	0.344	0.533	0.003	2.477
Job destruction rate	148	0.061	0.205	0.000	2.306
Net employment growth	148	0.284	0.501	-0.265	2.477
Job reallocation rate	148	0.405	0.633	0.003	4.614
Excess job reallocation rate	148	0.122	0.409	0.000	4.611
Labour market regulation	148	6.630	1.441	3.104	8.696
Law and order adj. labour market regulation	148	4.505	1.123	2.256	6.414
Law and order	148	0.334	0.109	0.167	0.500

Source: Author's calculation based on the described dataset.

Table A2.3 Summary Statistics: 1990-2015

Variable	Obs	Mean	Std. Dev.	Min	Max
Job creation rate	148	0.342	0.452	0.006	2.180
Job destruction rate	148	0.082	0.399	0.000	4.611
Net employment growth	148	0.260	0.517	-3.019	2.180

Job reallocation rate	148	0.423	0.678	0.006	6.203
Excess job reallocation rate	148	0.163	0.798	0.000	9.223
Labour market regulation	148	6.547	1.519	2.959	8.726
Law and order adj. labour market regulation	148	4.425	1.099	2.266	6.217
Law and order	148	0.327	0.098	0.200	0.500

Source: Author's calculation based on the described dataset.

Table A2.4 Summary Statistics: 2000-2015

Variable	Obs	Mean	Std. Dev.	Min	Max
Job creation rate	148	0.386	0.516	0.000	3.400
Job destruction rate	148	0.116	0.763	0.000	9.223
Net employment growth	148	0.270	0.760	-6.883	3.400
Job reallocation rate	148	0.503	1.058	0.005	11.562
Excess job reallocation rate	148	0.233	1.527	0.000	18.445
Labour market regulation	148	6.651	1.225	3.524	8.605
Law and order adj. labour market regulation	148	4.433	1.213	2.173	6.444
Law and order	148	0.334	0.109	0.167	0.500

Source: Author's calculation based on the described dataset.

Table A2.5 Employment Level/Counts in Africa

Year	Agric '000	Mining '000	Manu. '000	Utilities '000	Constr. '000	Trade '000	Transport '000	Business '000	Gov't '000	Personal '000	Economy '000
1960	24586	716	1562	66	652	3324	586	183	741	899	33315
1961	33701	742	1807	73	649	3481	664	206	922	1046	43290
1962	34151	721	1977	72	629	3558	693	214	972	1102	44089
1963	34614	718	2206	76	639	3999	731	221	1029	1165	45398
1964	35089	722	2377	76	668	4332	790	232	1132	1275	46692
1965	38162	807	2896	85	830	4716	863	260	1305	1854	51779
1966	40093	808	3071	95	866	4625	882	278	1575	2147	54439
1967	40704	773	3045	90	859	4234	817	274	1499	2210	54506
1968	41447	779	3009	104	855	4279	871	291	1778	2340	55753
1969	45116	792	3490	118	969	5055	942	342	2067	2594	61485
1970	53167	855	3994	140	1195	6060	1082	373	2596	3188	72649
1971	54216	848	3857	155	1313	6339	1127	386	2568	3390	74200
1972	55311	841	4048	177	1362	6178	1182	402	2691	3527	75718
1973	56424	865	4389	211	1417	6414	1271	408	2648	3681	77728
1974	57572	844	4247	220	1489	6617	1288	441	2821	3882	79423
1975	58366	800	4525	236	1478	7045	1369	477	3422	4263	81982
1960-1975	***702720***	***12630***	***50499***	***1994***	***15872***	***80258***	***15158***	***4987***	***29766***	***38561***	***952446***
1976	59260	880	4811	238	1559	7822	1435	491	3565	4475	84536
1977	60230	977	4833	258	1614	8788	1534	516	3778	4756	87284
1978	61248	1014	4960	270	1578	8569	1645	534	3962	4983	88762
1979	62176	1099	4946	306	1597	8745	1820	551	3948	5187	90374

1980	63301	1149	5186	316	1766	9797	2034	583	4153	5648	93933
1981	64211	1120	5159	350	1899	10623	2292	647	4701	6053	97055
1982	65252	1117	5176	377	1821	11366	2166	706	4827	6537	99345
1983	66408	1134	4516	382	1779	11705	2105	746	5033	6740	100548
1984	67543	1243	4468	395	1738	11764	2219	764	5167	6515	101815
1985	69563	1266	4918	420	1578	12078	2422	786	5223	6009	104262
1986	71646	1258	4999	356	1581	12440	2273	814	5253	5926	106548
1987	73784	1273	5205	371	1668	13186	2285	859	5359	5836	109827
1988	76044	1282	5546	374	1750	14059	2319	933	5527	5724	113557
1989	78331	1323	5740	382	1786	14675	2355	1028	5639	5634	116893
1990	80647	1391	5889	402	1871	14965	2409	1161	5776	5595	120106
1975-1990	***1019645***	***17526***	***76351***	***5196***	***25587***	***170583***	***31312***	***11118***	***71910***	***85620***	***1514846***
1991	82983	1399	5983	408	1853	15249	2432	1219	5878	5579	122982
1992	85242	1318	5959	431	1907	15448	2490	1294	6037	5781	125906
1993	86581	1260	6110	434	1987	15993	2547	1377	6135	5827	128251
1994	89126	1231	6245	451	2068	16123	2587	1450	6284	5982	131547
1995	91402	1204	6408	447	2125	16552	2659	1571	6260	6150	134777
1996	93681	1175	6551	460	2182	17025	2729	1703	6490	6445	138442
1997	95996	1145	6825	440	2262	17515	2824	1801	6693	6668	142168
1998	98272	1030	7001	409	2339	18109	2911	1873	6934	6942	145820
1999	100525	978	7370	393	2349	18856	3018	1889	7271	7370	150020
2000	102136	971	7735	381	2443	18722	2995	1961	7578	7504	152426
1990-2000	***925945***	***11711***	***66185***	***4254***	***21515***	***169592***	***27191***	***16139***	***65561***	***64247***	***1372339***
2001	103503	944	8059	395	2483	18754	3138	2134	7608	7546	154564
2002	105977	989	8548	408	2596	18964	3278	2340	7827	8039	158965
2003	107639	1026	8832	431	2789	19646	3265	2387	8022	8060	162098
2004	109684	1042	9444	464	3058	21981	3756	2572	8374	8364	168738
2005	111513	1069	10064	479	3408	23396	3921	2837	8776	8716	174178
2006	113796	1156	10672	489	3711	24857	4073	3066	9126	9084	180029
2007	116293	1198	11354	489	4078	26325	4342	3379	9524	9453	186435
2008	119243	1193	12065	515	4557	27775	4655	3851	9973	9783	193612
2009	121970	1237	12499	532	4889	28785	4793	4189	10476	10041	199411
2010	124903	1380	13128	547	5201	30098	5076	4413	10890	10279	205915
2011	127739	1776	14080	599	5723	30652	5104	4881	11461	10418	212433
2012	129536	1963	14728	666	6241	30984	5245	5412	11215	11743	217733
2013	131709	2183	16000	763	7235	32576	5484	5928	11645	12411	225934
2014	133893	2426	17366	781	8326	34277	5648	6400	11740	12882	233739
2015	130305	1763	16912	843	9361	33215	5504	7026	11404	12736	229069
2000-2015	***1787703***	***21345***	***183750***	***8403***	***73657***	***402284***	***67281***	***60814***	***148061***	***149555***	***2902853***

Note: Data is based on the 18 sub-Saharan Africa countries in the EASD and PWT 9.0.

2.7.1. *Econometrics: Robustness Check Attempt: Implementing Haltiwanger et al (2014) Procedure*

In a previous attempt, we tried re-estimating model 9 using a difference-in-difference approach (see Haltiwanger et al (2014). The approach explores the observed variation in job reallocation across industries in each country. As argued in Mico and Pages (2007) and Haltiwanger et al (2014), to identify intrinsic volatility, the authors assume that in a frictionless world the ranking of industry variability would be the same across countries. Given this, relative industry reallocation in countries with low

adjustment costs provides a good proxy of the intrinsic volatility of industries. Therefore, as identification strategy and as done in both papers, we use the US as our benchmark because its labour market is the least regulated compared to other countries. In other words, by interacting US job reallocation and enforcement adjusted EPL index, the approach estimates the difference in job reallocation in an industry with a high flexibility requirement (90^{th} percentile of the flexibility distribution in the US) and industry with low flexibility requirement (10^{th} percentile) of the same distribution on job reallocation in a country at the 90^{th} percentile of the index compared with a country at the 10^{th} percentile of the same index.

Following the procedure in Haltiwanger et al. (2014), before implementing the difference-in-difference estimation, an intermediate test for a positive and significant correlation between cross industry gross job flow between the US and countries in our sample is required. To do this we estimated the regression equation below:

$$JR_{sc} = \beta_0 + \beta_1 USJFlow_s + \sum_{c=1}^{C} \gamma T_c + \varepsilon_{sc}$$

where $USJFlow_s$ is the US job reallocation variable in industry s, T_c are country c (c=1….,C) dummies, and ε_{sc} is the error. The results show that the estimated coefficient of the US job flow is negative and significant. When we allow the coefficient on the US job flow variable to vary by industry the estimated coefficient is negative but not significant except for the agriculture industry. The test, therefore, fails the requirement of proceeding to perform the Diff-in-Diff estimation using the US as the benchmark country.

As second-best solution we use other countries with lower levels of employment protection legislation as an alternative benchmark. Given data limitations, the selection of these countries is done based on whether there is the availability of long-run sectoral data for the country in the GGDC 10 sector database. After a careful search using these criteria, we choose two countries—South Korea and Egypt as potential alternative benchmark countries. We then perform the same intermediate test as we did for the US. The results with this approach shows that the estimated coefficient of the South Korea job flow is negative and significant. When we allow the coefficient to vary by industry (column 4) the estimated coefficient is positive but not significant except for the agriculture industry. The test, therefore, fails the requirement of proceeding to perform the Diff-in-Diff estimation using South Korea as the benchmark country. The test also fails the requirement to use Egypt as the benchmark country.

As the last attempt to find a good benchmark country we perform the test using the gross job flows of South Africa and the average gross job flows of all countries in our sample. At the total economywide level, the test fulfills the requirement of proceeding to estimate the Diff-in-Diff using South Africa or the average gross job flows of all countries in our sample as the benchmark. The test, however, breaks down at the industry level.

Given that the test is fulfilled at the total economywide level, we proceed to estimate the effect of EPL on job reallocation using the Diff-in-Diff estimator and using the average gross job flows of all countries in our sample as our benchmark by estimating the regression below:

$$JR_{sc} = \beta_0 + \beta_1(SSAJR_s \text{ x } EPL_{c,adj}) + \sum_{s=1}^{I\ x\ S} \alpha T_s + \sum_{c=1}^{C} \gamma T_c + \varepsilon_{sc}$$

where $SSAJR_s$ is the average job reallocation variable of all SSA countries in our sample in industry s. T_s are industry effect dummies, T_c are country dummies, EPL_{adj} is the adjusted index of employment protection legislation, α is the coefficient of the industry effect dummies and γ is the coefficient of the country dummies, ε_{sc} is the error term.

Consistent with our results in Table 2.7, the estimated coefficient on the interaction between average SSA job reallocation and the enforcement-adjusted EPL index is negative and significant at the economywide level. For instance, using the coefficient on the interaction term, we estimate that the difference in job reallocation in the industry with a high flexibility requirement (90th percentile of the flexibility distribution in SSA, corresponding to a job reallocation of 1.19%) and industry with low flexibility requirement (10th percentile, corresponding to a job reallocation of 0.02%) will be cut by about 2.63 percentage points in a country at the 90th percentile of the EPL index compared with a country at the 10th percentile of the same index[26].

However, when we allow the coefficient of the interaction between average SSA job reallocation and the enforcement-adjusted EPL index to vary by industry, the result breaks down and is no more consistent with industry results in Table 2.7. A potential first-hand explanation of this is because our intermediate test breaks down at the industry level. We do not include the tables with results but are available upon request.

[26] The estimated value is obtained using the formular:
$\beta[(SSAJR^{90th} - SSAJR^{10th})\ (EPLadj^{90th} - EPLadj^{10th})]$ where β is the estimated coefficient, $SSAJR$ is average job reallocation in sub-Saharan Africa, $EPLadj$ is the enforcement-adjusted labour market regulation, respectively.

Chapter 3: Productive Efficiency, Technological Change and Catch-up within Africa[27]

[27] Co-authored with Neil Foster-McGregor and Emmanuel Buadi Mensah. My contribution includes conceptualisation, methodology, data curation, investigation and writing of the chapter.

Abstract

The peculiar nature of African development presents unique technological challenges. This often requires African-induced innovation or a combination of frontier and local technologies to solve problems unique to Africa. However, most researchers study technological change in Africa in relation to some globally defined technology frontier. The diffusion of knowledge from this global frontier to other regions however decreases in intensity with geographic and relational distance. Given that African countries are geographically and relationally close to each other, this chapter makes a departure from this existing literature and studies technological change and technological catch up within African by considering catch-up with respect to an African technology leader. We do this by using structural methods (Shift and Share catch-up decomposition) and nonparametric methods (Data Envelopment Analysis) to estimate an African production frontier. We further measure productivity change in Africa and disentangle the change due to general technological progress and efficiency change using the Malmquist Productivity Index (MPI). Our results show that Botswana and Mauritius are the only two countries in Africa which have converged to the productivity level as well as the efficiency level of the frontier. This successful convergence is driven more by efficiency catch-up and less by technological change. We explore the special role of efficiency catch-up by decomposing it into within-sector convergence, between -sector convergence and initial specialization. The results highlight the special role of structural change in catch-up. This chapter contributes to recent evidence suggesting that countries can climb up the income ladder at a faster rate through a two-pronged transformation – i.e., structural change and technological catch-up.

3.1. Introduction and Motivation

Evidence of cross-country (spatial) externalities is suggestive of the importance of global technological interdependence. Technological advancement in one country depends on the level of technological development in another country (Ertur & Koch, 2007), with technological spillovers flowing in particular from advanced countries to developing countries. This is due to the fact that advanced countries, particularly the US, are considered to operate on the technology frontier while developing countries, including those in Africa, operate inside the technology frontier (Kumar & Russell, 2002; Caselli & Coleman, 2006; Filippetti & Peyrache, 2017). With technological progress playing a crucial role in the long run growth of countries (Romer, 1990, 1994; Grossman & Helpman, 1991a), developed countries at the technological frontier rely on R&D investments to shift the frontiers of knowledge in order to generate long-run growth, while developing countries are able to assimilate technologies already developed in advanced countries to generate growth, especially if they have developed their absorptive capacity to a level that is necessary and sufficient to benefit from existing technologies (Abramovitz, 1986; Cohen & Levinthal, 1989). The non-rival nature of technology makes this relation feasible as developed countries' investment in new knowledge does not only benefit these advanced countries but also contributes to the global knowledge pool that can spill over to developing countries if conditions allow (Keller, 2004). Endogenous growth models have emphasized that the international spillover of knowledge is a major source of productivity growth in receiving countries. These international spillovers from advanced countries are received in developing countries through human capital interactions, international trade, and foreign direct investment (Coe & Helpman, 1995; Borenszteinet al., 1998; Keller, 1998; 2009; Keller & Yeaple, 2013).

Given the recent pace of technological change and globalizatison, African countries are expected to adopt, assimilate, and ultimately benefit from technology developed in frontier countries without much friction. Thus, the geographic distance between Africa and frontier countries should not matter for the technology diffusion process if "there is a global pool of technological knowledge or a country's technology level depends on only idiosyncratic non-spatial factors" (Keller, 2002:120). However, the international diffusion of knowledge is not global. Keller (2002) established that the international diffusion of technology is geographically localized in the sense that knowledge gained from R&D decreases with geographic distance. Thus the "spatial diffusion of technological knowledge may be geographically bounded, so that the stock of knowledge in one region may spill over into other regions with an intensity which decreases with geographical distance" (Basile et al., 2011:21). "Technology diffusion declines with distance because in equilibrium technology transfer to remote locations is relatively costly, so there is less of it" (Keller, 2009: 59).

Recent exogenous growth models consider technological interdependence between countries by modelling spatial externalities. The implication of the spatially augmented Solow model is that "the stock of knowledge in one country produces externalities that may cross national borders and spill over into other countries with an intensity which decreases with distance"(Ertur & Koch, 2007). Ertur and Koch (2007) tested the spatially augmented Solow model and found spatial externalities to be statistically significant.

While geographical proximity is essential for knowledge spillovers, Basile et al. (2011:21) have shown that not all mechanisms underlying knowledge spillovers can be explained by geographical proximity alone. Gravity models (Ertur & Koch, 2007; Keller & Yeaple, 2013) are often used to capture the spatial dimension of knowledge spillovers, but gravity models do not explain an important component of technological spillover i.e. "the learning processes of agents and contexts". Two countries at the same geographical distance from the technological leader may benefit differently from technology that spills over from the frontier because of the different learning processes and institutional contexts. To capture the learning process in the technology diffusion framework, Basile et al. (2011:21) introduced the concept of *relational proximity*. Relational proximity is defined as "the similarities of two areas in terms of shared behavioural codes, common culture, mutual trust, sense of belonging and cooperation capabilities." Relational proximity facilitates cooperative learning processes through which knowledge accumulation takes place. Their empirical analysis showed that relational proximity is not only crucial in the knowledge absorption process but that it also complements the positive effect of geographical proximity. Finally, evolutionary theory suggests that technological diffusion is difficult if the technology gap between the frontier and the laggard country is large. Beyond a certain threshold, this technology gap widens over time (Verspagen, 1991). The technology gap between African countries and the US - normally considered in the catch-up literature as the frontier – is huge, persistent, and widening over time.

The peculiar nature of African development presents unique technological challenges. This often requires African-induced innovations. These innovations could facilitate knowledge accumulation and catch-up because of the closeness of African countries in terms of geography, institutions, and the technology gap. For example, because of geography and idiosyncratic reinforcing factors such as institutions, the disease burden of Africa is relatively high compared to other regions. Effective treatment and medicines are, therefore, needed. However, it is estimated that 42% of detected counterfeit – i.e., substandard or falsified – pharmaceutical drugs occurred in Africa (WHO, 2017). While pharmaceutical counterfeiting is common in all developing countries, the risk of penetration is high for most African countries. Most Food and Drugs Boards (FDBs) and crime units responsible for fighting this crime are not well-equipped to mitigate this public safety risk. As a result, an estimated 64-158 thousand lives are lost annually to malaria alone in Africa due to fake drugs (ENACT, 2018). To crackdown on this crime, mPedigree developed a technological platform that stores pedigree information of pharmaceutical products of participating manufacturers in a central registry and connects this registry to GSM mobile networks so that with a simple short code, consumers can verify the authenticity of the drugs or products they are buying. mPedigree observed this peculiar problem in Ghana, but because of the relational proximity – institutional similarity – to other countries, similar levels of penetration of counterfeit pharmaceutical drugs were observed in most African countries. To fight the menace, the technology has been adopted in most African countries and has extended its application to other sectors such as Agro-industries (seeds), textiles, and comestics. In particular, the Nigerian National Agency for Food and Drug Administration and Control (NAFDAC) formed a consortium including mPedigree and other technology companies to roll out the mobile medicine authentication process in Nigeria since 2014.

In relation to the counterfeiting problem, multiple infections are common in Africa. While it is rare to find someone in advanced countries infected with malaria, Hepatitis, Zika, and HIV at the same time, it is common in Africa. In the traditional medical system, a person living with two or more infectious diseases needs to test for each of them in the laboratory separately. In the wake of the rapid spread of the Ebola virus in Guinea, Liberia, and Sierra Leone, Doctor Nyan[28] developed a rapid diagnostic test that can detect up to seven infections in about ten to forty minutes (Economist, 2017). The battery-powered technology provides a fast and cheap alternative to the traditional laboratory test, which remains expensive to the poor and uninsured. (See the Economist (2017) for other technological innovations induced by specific problems in Africa).

Furthermore, before the mobile money revolution, the majority of Africans were unbanked due to high transaction costs emanating from high levels of perceived risks and information asymmetries for the traditional banking system leading to low levels of financial inclusion. The exclusion of the majority of people from the financial system means they cannot easily smoothen their income and consumption patterns over time, exposing them to potential shocks (Pelletier et al., 2019). The introduction of the MPesa in Kenya and the subsequent spread of mobile money services across the continent has revolutionized transactions across the continent, with the majority of digital-wallets users being previously unbanked. The unprecedented growth of mobile money services has modernized the banking system and supported rapid financial inclusion. For instance, the growth of mobile financial services has sped up and simplified remittance transactions and supported the growth of e-commerce in a way that would otherwise be impossible in Africa. These are a few examples of peculiar development problems and how African-induced innovations are helping to tackle them.

Given that African countries are geographically and relationally closer to each other than the US and given the huge productivity gap between Africa and the US, this chapter departs from the existing literature and studies technological change and technological catch-up within African by considering catch-up with respect to an African technology leader. We do this using a linear programming technique (i.e., data envelopment analysis (DEA)) to estimate a virtual production frontier for Africa, using this estimate to then construct the productive efficiency of each country relative to the frontier. The dynamic efficiency of each country is examined using the Malmquist productivity index to decompose total productivity growth into technological catch-up (movement toward or away from the frontier) and technological change (i.e., a shift of the frontier over time). One advantage of the DEA over the other usual approach of measuring technology gaps and catch-up relative to some defined frontier is that it defines best practice based on the sample. Unlike Stochastic Frontier Analysis (SFA), DEA does not require any assumption about market structure and functional specification of the production technology.

The analysis shows that Botswana and Mauritius are the only two countries in Africa that have successfully converged to the efficiency[29] level of the frontier. In 1970, South Africa, Rwanda and

[28] Dougbeh Chris Nyan is a Liberian medical doctor, a biomedical research scientist, social activist and inventor.
[29] Efficiency is achieved when the maximum possible number of goods and services are produced with a given amount of inputs. This will occur on the production possibility frontier and the lowest point of the average cost curve of the decision-

Zambia were on the African production possibility frontier. By 2014, Rwanda and Zambia had fallen behind while Botswana and Mauritius had caught up with South Africa. The Malmquist productivity decomposition indicates that productivity convergence of Botswana and Mauritius is driven more by a movement toward the production possibility frontier – i.e., technological catch-up – and less by the shift of the production possibility frontier – i.e., technological change. The productivity growth of almost all the countries in Africa in our dataset is driven more by improvements in efficiency change or technological catch-up.

To further understand the special role efficiency change (catch-up) played in the convergence of Botswana and Mauritius to the technology leader, we examine whether this process was driven by structural change. To determine the extent to which a transformation in production could contribute to catch-up, we follow the structural approach of Lavopa and Szirmai (2014) to estimate the annual rate of catch up to the frontier by decomposing relative labour productivity to the frontier into a catch-up rate due to the adoption of best practice within sectors (within), the catch-up rate due to the movement of workers to sectors with a smaller technology gap relative to the frontier (structural change), and due to initial specialization. By doing this, we trace the sectoral origin of aggregate efficiency change. In this estimation, South Africa (SA) is used as the technological frontier for two reasons[30]: First, the DEA analysis indicates that SA has been on the African production possibility frontier since 1970. Second, SA leads the rest of Africa in terms of innovation, intellectual property production, and education (Section Appendix). Successful catch-up to the technology leader (i.e., SA) has huge implications for (transitory) growth and development in Africa, implying a movement from the current average GDP per capita of $1500 to a GDP per capita of about $10000.

We find that structural change contributes more to technological convergence than the within and specialization effects. The potential explanations for these findings are as follows: the discovery of diamonds in Botswana and the development of an exporting manufacturing sector in Mauritius and subsequent movement of workers to these sectors led to the relatively successful transition of these two countries. Botswana's geographical and relational proximity to SA enabled effective development of the mining and auxiliary sectors since, by 1970, SA had established itself as a global leader in mining-related technology (Kaplan, 2012). By interacting with SA, Botswana adopted the appropriate technology and best management practices to explore its diamond deposits and launched itself upon

making unit. Productivity on the other hand, is a measure of how efficiently a country (or firm or industry) converts inputs into outputs.

[30]Some caveats around using South Africa as the technological frontier in Africa are, however, worth highlighting. Despite the supportive evidence of using South Africa as the technological frontier in Africa, it is also argued that South Africa is falling behind its peer countries internationally as well as the world technological frontier in most of the relevant metrics (see Figure A3.2). Therefore, the analysis here may as well be that we may be looking at other African countries catching up with a frontier that is falling behind its international peers. For instance, Table A3.6 shows the total catch-up rate of the 18 SSA countries relative to the productivity of the USA. The catch-up rate and speed were slower in South Africa compared to those observed in Botswana and Mauritius. Nevertheless, South Africa's convergence to the global frontier has been impressive than all the other countries in Africa, and even when it began falling behind (the most recent from 2010), the rate is somewhat comparable to catching-up countries in the region during this period (see Figure A3.2), hence further supporting our choice to use South Africa as the technological frontier in SSA.

a consistent growth path. In Mauritius, conversely, the policies deployed after the creation of the export processing zones (EPZs) in the early 1970s led to successful diversification and catch-up. For instance, duty-free access to capital goods and a raft of tax incentives granted to firms operating within the EPZs acted as subsidies to encourage export-oriented manufacturing. Mining-led and manufacturing-led catch-up in Botswana and Mauritius, respectively, may suggest that catch-up within Africa is a sector-specific phenomenon. This analysis reinforces the argument that developing countries can successfully climb up the income ladder through a two-pronged transformation – structural change and technological catch-up (Lavopa & Szirmai, 2018).

The rest of the chapter is structured as follows. Section 3.2 briefly discusses the datasets used for the analysis. Section 3.3, 3.4 and 3.5 analyse efficiency convergence and decomposes dynamic efficiency change in Africa. Section 3.6 decomposes the relative productivity to the frontier and explores the role of structural change in technological catch-up. Section 3.7 concludes.

3.2. Data Sources and Description

Data on value added and employment were sourced from the Expanded Africa Sector Database (EASD) presented in Chapter 2. We complement the EASD with capital stock data from the PWT 9.0 database. The EASD is converted from local currencies to international dollars using the 2011 PPPs. We did not use sector-specific PPPs constructed by the GGDC because the sector-specific PPPs are not available for the seven newly added countries in the EASD. The capital stock reported in the PWT 9.0 is measured in 2011 PPPs. Using 2011 PPPs to convert value added data therefore gives output and capital input in a single unit.

3.3. Nonparametric Estimation of Technology gaps in Africa

DEA is often used to measure the productive efficiency of a set of decision-making units (DMUs) with multiple inputs and outputs by employing standard mathematical linear programming algorithms (Coelli et al., 1998; Kumar & Russel, 2002; Wang & Lan, 2011). Originally proposed by Charnes et al. (1978) and later named the CCR model to reflect the acronyms of all the authors (Charnes-Cooper-Rhodes), the DEA approach has been improved and widely used in productivity analysis.

Using a linear programming technique, DEA envelops the dataset under consideration to construct a convex cone or piecewise hull (the technology frontier). The upper boundary of the convex cone represents the best practice (production frontier) and is made up of all technically efficient DMUs (Kumar & Russel, 2002; Van Dijk & Szirmai, 2011). By so doing, the DEA approach of measuring productive efficiency constructs a virtual production frontier for the sample of economies and associated efficiency indexes of individual economies. By constructing a virtual production frontier, we can measure how far or close each African economy is to the production frontier and how much inefficient economies need to adjust their production technology to become efficient. All African economies operating below the production frontier are considered technically inefficient as the combination of inputs yields output smaller than what could have been produced. Technically efficient economies operate on the production frontier. Technically efficient economies have an efficiency

index of 1, and technically inefficient economies have an efficiency index of less than 1. The efficiency index could be interpreted as encompassing both technological phenomena as well as the set of institutions and policies deployed in each economy to drive technical change (Kumar & Russel, 2002).

In summary, DEA has an advantage over standard methods of studying catch-up relative to some defined frontier, which reduces the best-practice frontier to a point and compares other countries to the point in terms of efficient and inefficient utilization of factor supplies (Kumar & Russel, 2002). Also, unlike standard stochastic frontier analysis (SFA) or econometric estimation of catch-up that assumes the shape of the production function, the nonparametric, data-driven DEA approach requires no specification of the functional form—an advantage DEA has over SFA and econometric approaches. Initially, an assumption about the returns to scale of technology is required, but with advances made in the statistical analysis of DEA, one can choose the appropriate returns to scale of a production technology through a formal statistical test (see test below). Assumptions about free disposability of inputs and outputs are, however, required (Kumar & Russel, 2002; Van Dijk & Szirmai, 2011).

3.3.1. The DEA Model

We calculate the Farrell (output-based) technical efficiency index of DMUs (countries) by solving the linear programming problem for each observation. We assume output (value added) is produced by two inputs (capital and labour). We also assume free disposability of inputs and outputs. We compute the efficiency indexes under constant returns to scale (CRS), variable returns to scale (VRS) and non-increasing returns to scale (NIRS). Suppose there are J countries to be evaluated, given n inputs and w outputs.

The technology set is defined as:

3.1 $$T\ (\theta^*) = E^t\ (L^t, K^t, Y^t | CRS) = \text{Minimize } \theta,$$

Subject to:

$$\sum_{j=1}^{J} \lambda_j Y_{wj}\ \geq Y_W, \qquad w = 1, \dots \dots \dots W$$

$$\sum_{j=1}^{J} \lambda_j L_j\ \leq \theta L_n, \qquad n = 1, \dots \dots \dots N$$

$$\sum_{j=1}^{J} \lambda_j K_{nj}\ \leq \theta K_n, \qquad n = 1, \dots \dots \dots N$$

$$\lambda_j \geq 0, j = 1, \ldots . J$$

Where L_{njt}, K_{njt} and Y_{wjt} are the labour, capital, and output of each country j in time t. The convex cone formed by these column vectors is the technology set $T(\theta^*)$, with λ being a $J \times 1$ vector of constants. The n and w inequalities capture the free disposability of inputs and output assumption and represent the nth inputs and wth output for DMUs, respectively. The value of θ that solves the linear program problem gives the technical efficiency index for each country j in time t.[31] If $\theta^*= 1$, the DMU is on the frontier, and current inputs cannot be reduced (proportionally). The DMU is below the frontier if $\theta^* < 1$. Equation (3.1) yields efficiency estimates under a constant returns to scale assumption. Efficiency estimates for other returns to scale specifications can be modelled by altering the constraint on the process operating levels vector, λ_j. For efficiency estimates under variable returns to scale – $E^t\ (L^t, K^t, Y^t|VRS)$ – the convexity constraint $\sum_{j=1}^{J} \lambda_j$=1 is imposed, whereas for efficiency estimates under nonincreasing returns to scale – $E^t\ (L^t, K^t, Y^t|NRS)$ – the inequality $\sum_{j=1}^{J} \lambda_j \leq 1$ is added to the set of constraints on inputs and output in equation (3.1)

3.3.2. Nonparametric Test of Returns to Scale

The returns to scale assumption used to specify the production technology is very important in DEA as efficiency estimates vary under different returns to scale assumptions (see Table 3.3). We, therefore, compute the scale efficiency for each country and test for the returns to scale assumption under which each country is scale efficient. The measures of (radial) technical efficiencies under CRS, NRS, and VRS returns scale explained above can be used to compute the scale efficiency defined by Färe & Grosskopf (1985) as follows:

3.2 $$SE_j^0(L^t, K^t, Y^t) = \frac{E^t\ (L^t, K^t, Y^t|CRS)}{E^t\ (L^t, K^t, Y^t|VRS)}$$

3.3 $$SE_j^1(L^t, K^t, Y^t) = \frac{E^t\ (L^t, K^t, Y^t|NRS)}{E^t\ (L^t, K^t, Y^t|VRS)}$$

Where the ratio SE_j^0 measures how close the data point – in our case – (k^t, y^t)[32] is to the maximum productive scale size. If $SE_j^0(L^t, K^t, Y^t)$=1, then the data point (k^t, y^t) is scale efficient. If $SE_j^0(L^t, K^t, Y^t)$>1, the data point (k^t, y^t) is scale inefficient because it is either operating on the

[31] This is from the optimistic DEA point of view since we maximize the efficiency of DMUs within the range of zero to one. In the case of the pessimistic DEA, the efficiency of DMUs is minimized relative to others within a range no less than one. For instance, measuring efficiency using the pessimistic DEA, a DMU will be pessimistically inefficient if the efficiency scores equal one and pessimistically efficient if efficiency score is greater than one (Wang & Lan, 2011).

[32] $\frac{K^t}{L^t} = k^t, \frac{Y^t}{L^t} = y^t$

decreasing portion of the technology, T (θ^*), i.e. if $SE_j^1(L^t, K^t, Y^t) = 1$, or on the increasing portion of the technology, T (θ^*), i.e. if $SE_j^1(L^t, K^t, Y^t) > 1$.

If the global technology T (θ^*) in equation (3.1) exhibits CRS, then the VRS estimator is less efficient than the CRS estimator and vice versa (Badunenko & Mozharovskyi, 2016). To impose the right returns to scale (RTS) assumption, Simar and Wilson (2002) suggest the following tests:

Test #1: H_0: T (θ^*) $is\ globally\ CRS$ versus H_1: T (θ^*) $is\ VRS$

If the null hypothesis is rejected, then the following less restrictive test is conducted:

Test #2: H_0: T (θ^*) $is\ globally\ NRS$ versus H_1: T (θ^*) $is\ VRS$

The test statistic for test #1 and test #2 is computed as follows:

3.4 $$\tau_1 = \sum_{j=1}^{J} SE_j^0(L^t, K^t, Y^t)\, J^{-1}$$

3.5 $$\tau_2 = \sum_{j=1}^{J} SE_j^1(L^t, K^t, Y^t)\, J^{-1}$$

Where τ_1 represents the average ratio of the technical efficiencies under CRS technology to technical efficiencies under VRS. If the null hypothesis is true, then the distance between the CRS and VRS frontier is negligible. If the alternative hypothesis is true, then the average ratio of technical efficiencies between both frontiers is significantly different from 1. If the alternative hypothesis is true, then test #2 is performed. Analogous to test #1, if the null hypothesis is true, then the mean distance between the NRS and VRS frontiers is statistically indifferent from 1. If the alternative is true, then the average distance between the NRS and VRS is statistically larger than 1.

A bootstrapping procedure is often used to calculate the test statistic of test #1 and test #2. Simar and Wilson (2000; 2011) provide a detailed explanation of the concept and implementation of the bootstrapping technique. The bootstrapping method for output-based efficiency estimates relies on one fundamental testable assumption, namely whether the output-based efficiency estimates are independent of the mix of outputs. In other words, the test shows whether all the countries in the sample are similar in terms of technology and characteristics (homogeneous) or are not similar (heterogeneous). If output-based efficiency estimates are independent of the mix of outputs, a homogeneous bootstrap technique is used in the statistical test. If output-based efficiency estimates are dependent on the mix of outputs, a heterogenous bootstrap technique is preferred. The Heterogeneous bootstrap is used in this case since a formal test of independence indicates output-based measures of technical efficiency are *not* independent of the mix of outputs (Badunenko & Mozharovskyi, 2016: 256). The test confirms the empirical reality that African countries are different in terms of the adoption and usage of technology as well as other idiosyncratic factors. The test of returns to scale assumption shows that all countries are statistically scale-efficient under constant

returns to scale technology in the heterogeneous bootstrap (see Table 3.1). Therefore, the preferred efficiency scores are the ones under constant returns to scale specifications.

Table 3.1: Test of Returns to Scale

Scale Analysis—1970			Scale Analysis—2014		
DMU	SE	Scale Efficient under CRS (Heterogeneous)	DMU	SE	Scale Efficient under CRS (Heterogeneous)
BWA	1.12	scale efficient	BWA	1.00	scale efficient
BFA	1.03	scale efficient	BFA	1.07	scale efficient
CMR	1.03	scale efficient	CMR	1.00	scale efficient
ETH	1.16	scale efficient	ETH	1.12	scale efficient
GHA	1.04	scale efficient	GHA	1.02	scale efficient
KEN	1.21	scale efficient	KEN	1.09	scale efficient
LSO	1.03	scale efficient	LSO	1.66	scale efficient
MWI	1.00	scale efficient	MWI	1.10	scale efficient
MUS	1.63	scale efficient	MUS	1.00	scale efficient
MOZ	1.03	scale efficient	MOZ	1.07	scale efficient
NAM	1.33	scale efficient	NAM	1.01	scale efficient
NGA	1.32	scale efficient	NGA	1.00	scale efficient
RWA	1.00	scale efficient	RWA	1.24	scale efficient
SEN	1.02	scale efficient	SEN	1.07	scale efficient
ZAF	1.00	scale efficient	ZAF	1.02	scale efficient
TZA	1.19	scale efficient	TZA	1.01	scale efficient
UGA	1.04	scale efficient	UGA	1.06	scale efficient
ZMB	1.00	scale efficient	ZMB	1.01	scale efficient

*SE= statistically scale efficient under CRS. CRS=Constant returns to scale.

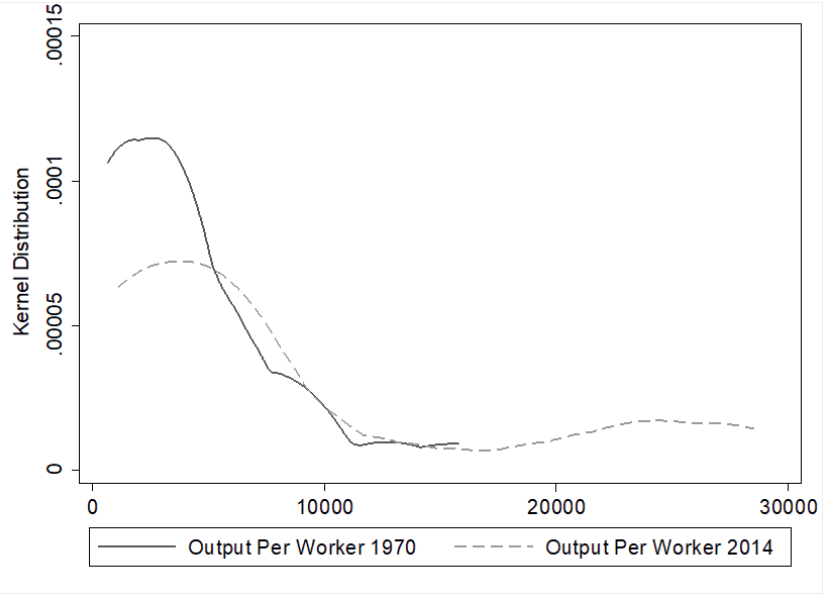
3.4 Efficiency Results

In figures 3.1 and 3.2, we analyse the evolution of the distribution of output per worker and capital per worker between 1970 and 2014, respectively. The distribution of output per worker (Figure 3.1) has shifted to the right, implying that labour productivity has improved over the period. The peak of the distribution increased from $3,833 to $8,490 (Table 3.2). While in 1970 there was no country in Africa with the productivity level of $10,000 or above, in 2014, a few countries reported a productivity level close to $30,000, a $20,000 change in productivity for the countries in the upper end of the distribution.[33] This transformation in labour productivity could be interpreted as the emergence of lower middle-income countries in the region.

[33] For purposes of comparison, this compares well with the change in labour productivity in the US, which increased by $33,712 – from $56,616 in 1970 to $90,338 in 2014.

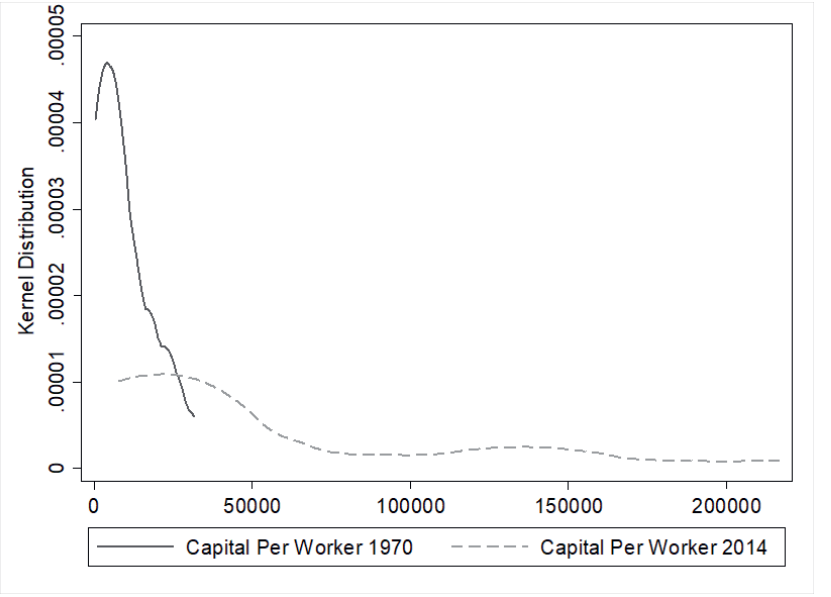
A similar observation is made in Figure 3.2, which shows that in 1970 many countries had a low capital stock and a resultant low capital per worker. By 2014, the distribution of capital per worker in Africa had transformed drastically, with labour having more capital to work with. On average, productive efficiency is unchanged, decreasing slightly from 0.71 to 0.70 (see Table 3.2). However, this average trend in efficiency differs by country.

Figure 3.1: Evolution of Output Per Worker



Note: A kernel density plot visualizing the distribution of output per worker in 1970 and 2014 based on the 18 sub-Saharan Africa countries in the EASD.

Figure 3.2: Evolution of Capital Per Worker



Note: A kernel density plot visualizing the distribution of capital per worker in 1970 and 2014 based on the 18 sub-Saharan Africa countries in the EASD and PWT 9.0.

Table 3.3 reports the radial technical efficiencies by country in 1970 and 2014, respectively. The radial index measures inefficiency in terms of distance to the production frontier, whereas the non-radial measure defines inefficiency in terms of efficient subsets as opposed to the production frontier. For robustness, non-radial measures are also reported in Table A3.3 & A3.4 in the appendix. The results of both radial and non-radial measures are quantitively and qualitatively the same. In 1970, Rwanda, South Africa, and Zambia were on the production frontier. By 2014, Rwanda and Zambia had fallen behind, with Botswana, Cameroon, Mauritius, and Nigeria joining South Africa as frontier countries. In terms of GDP per worker or GDP per capita, it is only Botswana and Mauritius that have converged to the level of SA. Therefore, it seems surprising to observe that Cameroon and Nigeria are on the production frontier.

Table 3.2: Descriptive Statistics

Variables	Observation	Mean	SD	Min	Max
Output per worker in 1970	18	3,833	3,978	650.7	15,780
Output per worker in 2014	18	8,490	9,225	1,101	28,556
Capital per worker in 1970	18	9,105	9,191	495.8	31,673
Capital per worker in 2014	18	51,958	61,798	7,725	216,694
Average efficiency index with only labour in 1970	18	0.292	0.307	0.0400	1
Average efficiency index with only labour in 2014	18	0.366	0.373	0.0500	1
Average efficiency index with only capital in 1970	18	0.626	0.264	0.210	1
Average efficiency index with only capital in 2014	18	0.615	0.242	0.300	1
Average efficiency index with both inputs in 1970	18	0.709	0.246	0.220	1
Average efficiency index with both inputs in 2014	18	0.703	0.257	0.350	1

Note: As a standard DEA procedure, the technical efficiency is computed for the beginning period and the end period based on the 18 sub-Saharan Africa countries in the EASD and PWT 9.0.

However, in a similar analysis of Kumar and Russell (2002), Sierra Leone, which is one of the most technologically backward countries in the world, was on the technology frontier with the US. The plausible explanation often stated for these peculiar observations is that the DEA is constructed such that it places a lower boundary on the frontier under the assumption of constant returns technology and as a result it may fail to identify the true but unknown frontier especially at low capital-labour ratios (Kumar & Russell, 2002).

Table 3.3: Radial Measures of Technical Efficiency for African Countries

	1970			2014		
DMU	TErdCRS_LK	TErdNRS_LK	TErdVRS_LK	TErdCRS_LK	TErdNRS_LK	TErdVRS_LK
Botswana	0.73	0.73	0.81	1.00	1.00	1.00
Burkina Faso	0.81	0.84	0.84	0.82	0.82	0.88
Cameroon	0.47	0.49	0.49	1.00	1.00	1.00
Ethiopia	0.86	1.00	1.00	0.37	0.42	0.42
Ghana	0.22	0.23	0.23	0.43	0.43	0.44
Kenya	0.44	0.53	0.53	0.70	0.76	0.76
Lesotho	0.97	0.97	1.00	0.60	0.60	1.00
Malawi	0.52	0.52	0.52	0.35	0.35	0.39
Mauritius	0.61	0.61	1.00	1.00	1.00	1.00
Mozambique	0.92	0.95	0.95	0.81	0.81	0.87
Namibia	0.75	0.75	1.00	0.84	0.84	0.85
Nigeria	0.76	1.00	1.00	1.00	1.00	1.00
Rwanda	1.00	1.00	1.00	0.81	0.81	1.00
Senegal	0.72	0.72	0.73	0.65	0.65	0.70
South Africa	1.00	1.00	1.00	1.00	1.00	1.00
Tanzania	0.38	0.45	0.45	0.36	0.37	0.37
Uganda	0.61	0.63	0.63	0.48	0.51	0.51
Zambia	1.00	1.00	1.00	0.43	0.43	0.43

* TErdCRS = the radial output-based measures of technical efficiency under the assumption of constant returns to scale
* TErdNRS = the radial output-based measures of technical efficiency under the assumption of non- increasing returns to scale
* TErdVRS = the radial output-based measures of technical efficiency under the assumption of variable returns to scale
* LK = both labour and capital used as inputs.
* Data is based on the 18 sub-Saharan Africa countries in the EASD and PWT 9.0.

In our case, while Botswana and Mauritius have the highest capital-labour ratios in our sample, Cameroon and Nigeria have ratios below the average of the sample. In the face of this observation, we conclude that Botswana and Mauritius are the two countries that have robustly converged to the efficiency level of the frontier. All the other countries are either slowly converging or falling away.

3.5. Dynamic Efficiency in Africa

The slow rate of technological catch-up is often stated as the main cause of nonconvergence or slow convergence of productivity. For example, in the earlier (mainstream) literature on convergence, the slow diffusion of technology is often cited as the main cause of the slow convergence of productivity (Mankiw et al., 1992; Barro & Sala-i-Martin, 1997). In the current context, technology is denoted by the state-of-the-art production frontier. A shift in the production frontier denotes technological change, and a movement toward the frontier represents technological catch-up. To understand why some African countries converged to the productivity level of the frontier while others did not, we decompose productivity growth into these two components – technological catch-up and technological change – using the Malmquist Productivity Index (MPI).[34] The DEA (distance function)-based MPI decomposes productivity changes attributable to changes in efficiency (technological catch-up) and changes in technology (shift of the frontier). In a broader sense, technological catch-up captures changes in a country's productive behaviour and performance over time due to policy initiatives. That is, the innovative initiatives of the country that lead to a productive reward. Conversely, technological change denotes general technical progress and the ability of countries to absorb this new knowledge to improve production. The change in efficiency is further decomposed into a pure efficiency and a scale efficiency change. Scale efficiency measures how close the data points of DMUs are to the potentially most productive or the optimal scale size and whether a DMU must reduce or increase its scale while maintaining the best practices it already has.

All assumptions made in constructing the DEA model above when estimating the Farrell (output-based) technical efficiency index of DMUs apply here. Suppose there are J DMUs to be evaluated given n inputs and W outputs in time periods t and $t+1$ respectively, four indicators of technical efficiencies are required: (1) technical efficiencies at the base-period, t, (2) technical efficiencies at the current-period, $t+1$, and two counterfactuals, (3) potential base-period efficiency of DMUs using current-period technology, (4) potential current-period efficiency of DMUs using base-period

[34] The MPI is originally named after Professor Sten Malmquist, whose idea the MPI is based upon. Originally used to estimate a consumer-based index by Professor Malmquist, Caves et al. (1982) replaced the indifference curve with a technology frontier to define a productivity index. Färe, Grosskopf, & Lindgren, (1992) made substantial efforts to combine the efficiency measurement of Farrell, (1957), Charnes et al (1978) and the productivity measurement of Caves et al. (1982) to come up with a DEA-based MPI (Wang & Lan, 2011).

technology. We denote inputs of DMUs by L_{njt}, K_{njt} and Y_{wjt}. The solution of the optimistic DEA-based MPI is given as follows.

Technical efficiencies of DMUs in the base-period (t):

3.6 $$E^t\ (L^t, K^t, Y^t | CRS) = \text{Minimise}\ \theta,$$

Subject to the following constraints:

$$\sum_{j=1}^{J} \lambda_j Y_{wj}^t \geq Y_W^t, \qquad w = 1, \dots \dots \dots, W$$

$$\sum_{j=1}^{J} \lambda_j L_{nj}^t \leq \theta L_n^t, \qquad n = 1, \dots \dots \dots, N$$

$$\sum_{j=1}^{J} \lambda_j K_{nj}^t \leq \theta K_n^t, \qquad n = 1, \dots \dots \dots, N$$

$$\lambda_j \geq 0, j = 1, \dots, J$$

Technical efficiencies of DMUs in the current period:

3.7 $$E^{t+1}\ (L^{t+1}, K^{t+1}, Y^{t+1} | CRS) = \text{Minimise}\ \theta,$$

Subject to the following constraints:

$$\sum_{j=1}^{J} \lambda_j Y_{wj}^{t+1} \geq Y_W^{t+1}, \qquad w = 1, \dots \dots \dots, W$$

$$\sum_{j=1}^{J} \lambda_j L_{nj}^{t+1} \leq \theta L_n^{t+1}, \qquad n = 1, \dots \dots \dots, N$$

$$\sum_{j=1}^{J} \lambda_j K_{nj}^{t+1} \leq \theta K_n^{t+1}, \qquad n = 1, \dots \dots \dots, N$$

$$\lambda_j \geq 0, j = 1, \dots, J$$

Technical efficiencies of DMUs in the base-period using current-period technology:

3.8 $E^{t+1}\ (L^t, K^t, Y^t | CRS) = \text{Minimise}\ \theta,$

Subject to:

$$\sum_{j=1}^{J} \lambda_j Y_{wj}^{t+1} \geq Y_W^t, \qquad w = 1, \dots \dots \dots, W$$

$$\sum_{j=1}^{J} \lambda_j L_{nj}^{t+1} \leq \theta L_n^t, \qquad n = 1, \dots \dots \dots, N$$

$$\sum_{j=1}^{J} \lambda_j K_{nj}^{t+1} \leq \theta K_n^t, \qquad n = 1, \dots \dots \dots, N$$

$$\lambda_j \geq 0, j = 1, \dots, J$$

Technical efficiencies of DMUs in the current-period using base-period technology:

3.9 $E^t\ (L^{t+1}, K^{t+1}, Y^{t+1} | CRS) = \text{Minimise}\ \theta,$

Subject to:

$$\sum_{j=1}^{J} \lambda_j Y_{wj}^{t} \geq Y_W^{t+1}, \qquad w = 1, \dots \dots \dots, W$$

$$\sum_{j=1}^{J} \lambda_j L_{nj}^{t} \leq \theta L_n^{t+1}, \qquad n = 1, \dots \dots \dots, N$$

$$\sum_{j=1}^{J} \lambda_j K_{nj}^{t} \leq \theta K_n^{t+1}, \qquad n = 1, \dots \dots \dots, N$$

$$\lambda_j \geq 0, j = 1, \dots, J$$

As explained above, $E^t\ (L^t, K^t, Y^t)$ and $E^{t+1}\ (L^{t+1}, K^{t+1}, Y^{t+1})$ measure efficiencies of DMUs in time periods t and $t+1$, respectively, $E^t\ (L^{t+1}, K^{t+1}, Y^{t+1})$ denotes efficiencies of DMUs in time $t+1$ using production technology of time t and $E^{t+1}\ (L^t, K^t, Y^t)$ efficiencies of DMUs in time t using production technology of time $t+1$ (Wang & Lan, 2011).

3.5.1. Malmquist productivity index

Proposed by Färe, Grosskopf, & Lindgren, (1992), the resultant Malmquist productivity index that measures productivity changes of DMUs in time periods t and $t+1$ takes the form:

3.10 $$\text{MPI}=[\left(\frac{E^{t}\left(L^{t+1},K^{t+1},Y^{t+1}\right)}{E^{t}\left(L^{t},K^{t},Y^{t}\right)}\right)\times(\frac{E^{t+1}\left(L^{t+1},K^{t+1},Y^{t+1}\right)}{E^{t+1}\left(L^{t},K^{t},Y^{t}\right)})]^{\frac{1}{2}}$$

There is an improvement in productivity growth between time periods t and $t+1$ if MPI (optimistic) is greater than 1. A value of MPI equal to one implies that productivity has stagnated, while a value less than one means that there has been a productivity decline. Färe, Grosskopf, & Lindgren, (1992) further decomposed the MPI (optimistic) into two separate components.

3.11 $$\text{MPI}=\left(\frac{E^{t}\left(L^{t+1},K^{t+1},Y^{t+1}\right)}{E^{t}\left(L^{t},K^{t},Y^{t}\right)}\right)\times[(\frac{E^{t}\left(L^{t},K^{t},Y^{t}\right)}{E^{t+1}\left(L^{t},K^{t},Y^{t}\right)})\times(\frac{E^{t}\left(L^{t+1},K^{t+1},Y^{t+1}\right)}{E^{t+1}\left(L^{t+1},K^{t+1},Y^{t+1}\right)})]^{\frac{1}{2}}$$

Where the first and second term on the right-hand side represent productivity changes attributable to efficiency change (whether or not a DMU is catching up to the frontier over time) and technology change (whether or not the frontier is shifting out over time) respectively. Using both CRS and VRS DEA frontiers to estimate the distance function in Equation (11), technical efficiency is further decomposed into a scale and a pure efficiency change given by:

3.12 Pure Efficiency Change = $$\frac{E^{t+1(vrs)}\left(L^{t+1},K^{t+1},Y^{t+1}\right)}{E^{t(crs)}\left(L^{t},K^{t},Y^{t}\right)}$$

3.13 Scale-Efficiency-Change=$$[\frac{E^{t+1(vrs)}\left(L^{t+1},K^{t+1},Y^{t+1}\right)/E^{t+1(crs)}\left(L^{t+1},K^{t+1},Y^{t+1}\right)}{E^{t+1(vrs)}\left(L^{t},K^{t},Y^{t}\right)/E^{t+1(crs)}\left(L^{t},K^{t},Y^{t}\right)}\times \frac{E^{t(vrs)}\left(L^{t+1},K^{t+1},Y^{t+1}\right)/E^{t(crs)}\left(L^{t+1},K^{t+1},Y^{t+1}\right)}{E^{t(vrs)}\left(L^{t},K^{t},Y^{t}\right)/E^{t(crs)}\left(L^{t},K^{t},Y^{t}\right)}]^{1/2}$$

A country which has a scale efficiency change equal to one means the country is operating at the optimum scale. Based on the statistical test of returns to scale above, we used constant returns to scale technology to estimate the MPI.

3.5.2. Technological Catch-up Within Africa

The result of the output based MPI for each of the 18 countries in our sample is reported in Table 3.4. As a standard procedure, the MPI is calculated using five-year intervals because technological change or efficiency change at the country level normally happens in the medium to long term. In confirmation of the existing finding that convergence is primarily driven by technological catch-up, the stellar total productivity growth of Botswana and Mauritius is driven more by technological catch-up and less by technological change. Total productivity growth grew by 7% and 9% every five years on average in Botswana and Mauritius, respectively, between 1970 and 2014. Of these, technological

catch-up accounts for 4% and 6% in Botswana and Mauritius, respectively. The MPI also shows that the total productivity of Cameroon and Ghana improved by 3.0 and 1.0% (quinquennially), respectively. In the case of Cameroon and Ghana, however, all productivity gains were due to improvements in efficiency levels (catch-up). Productivity in all the other countries, either stagnated or declined. Technological catch-up was significant in Cameroon (9%), Ghana (8%), Kenya (5%), and Nigeria (3%). However, this, in combination with a negative technical change (i.e., an inability to benefit from the shift in the production frontier), penalized overall total productivity growth in these countries. This is also reflected in the whole African average. For instance, the average result of the Malmquist productivity decomposition (average of five-year interval period) shows that Africa achieved a productivity decline of –4.0 percent between 1970 and 2014. The decline in productivity growth is almost entirely attributable to lack of technological progress and less to technological catch-up (see also Figure A3.1). This indicates that faster productivity convergence is possible through a combination of technical progress and technological catch-up. The ability of individual countries to benefit from general technological progress often depends on the level of capitalization of the country. Highly capitalized countries have the infrastructural architecture necessary to gain from the shift in the production frontier (Kumar & Russell, 2002). Botswana and Mauritius are highly capitalized, and as a result, they gained from the shift of the African production frontier.

The results are very interesting in the sense that while technological progress has contributed positively to productivity growth of these two relatively rich countries, the same cannot be said for the other two relatively poor countries (Cameroon and Ghana) that experienced productivity improvements over the same period but with a technological regression. What this means is that technological progress has disproportionately benefitted relatively rich countries in Africa. This supports the general conclusion that wealthy economies have benefitted from technological progress to a greater extent than poor economies (cf. Kumar & Russel, 2002: 538).

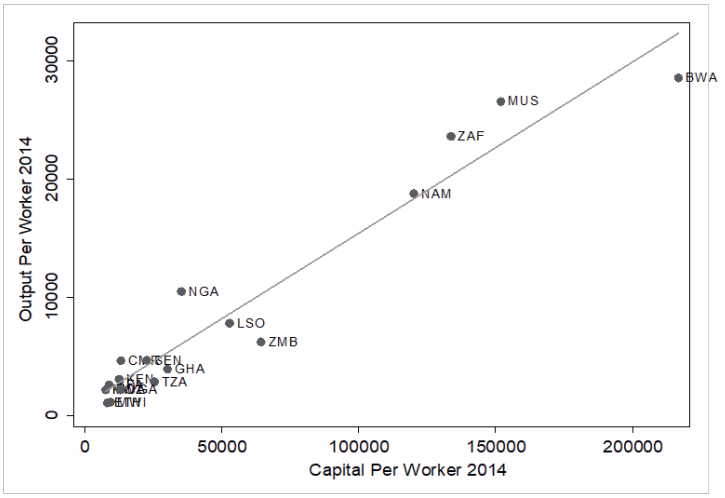
In Figure 3.3, we observe that highly capitalized economies tend to be wealthy economies with high per capita incomes in the context of Africa. In our sample, Botswana, Namibia, Mauritius, and South Africa could be classified as rich African countries given the relatively high per capita incomes of these countries within Africa. The rest of the countries could be classified as poor African countries, given their low per capita incomes. A substantial outward shift in the frontier (technological progress) in Botswana and Mauritius (see figures 3.4 & 3.5) at high capital-labour ratios (see fig 3.3) means that technological change tends to take place in highly capitalized economies which happen to be relatively wealthy economies. Thus, even in Africa, wealthy economies tend to benefit more from technological change if they are highly capitalized.

Table 3.4: Dynamic Efficiency in Africa

Country	Total Productivity Growth	Technology Change	Technological Catch-up (Efficiency change)	Catch-up (Efficiency Change)	
				Pure Efficiency	Scale Efficiency
Botswana	1.07	1.03	1.04	1.02	1.01
Burkina Faso	0.98	0.98	1.00	1.01	1.00
Cameroon	1.03	0.95	1.09	1.08	1.00
Ethiopia	0.88	0.97	0.91	0.91	1.00
Ghana	1.01	0.94	1.08	1.08	1.00
Kenya	0.98	0.93	1.05	1.04	1.01
Lesotho	0.91	0.96	0.95	1.00	0.95
Malawi	0.94	0.98	0.96	0.97	0.99
Mauritius	1.09	1.04	1.06	1.00	1.06
Mozambique	0.90	0.91	0.99	0.99	1.00
Namibia	0.97	0.96	1.01	0.98	1.03
Nigeria	0.99	0.96	1.03	1.00	1.03
Rwanda	0.89	0.91	0.98	1.00	0.98
Senegal	0.95	0.96	0.99	0.99	0.99
South Africa	0.99	0.99	1.00	1.00	1.00
Tanzania	0.92	0.92	1.00	0.98	1.02
Uganda	0.94	0.96	0.97	0.98	1.00
Zambia	0.87	0.95	0.91	0.911	1.00

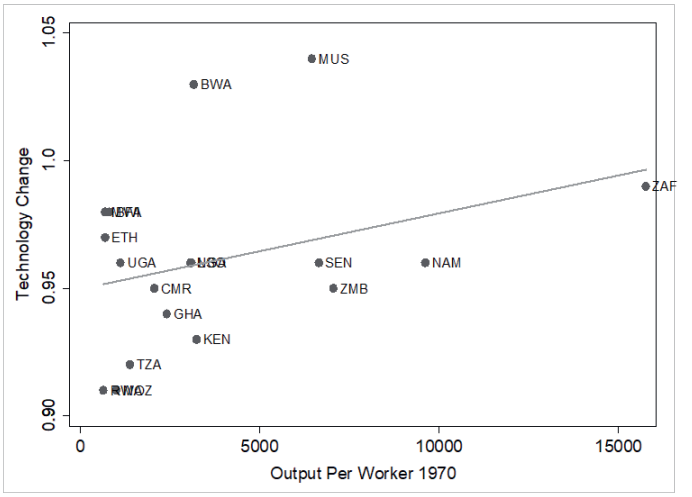
*Both L&K used in Malmquist. Note the effect of efficiency change and technology change is multiplicative. Data is based on the 18 sub-Saharan Africa countries in the EASD and PWT 9.0.

Figure 3.3: Output Per Worker 2014 Plotted Against Capital Per Worker 2014



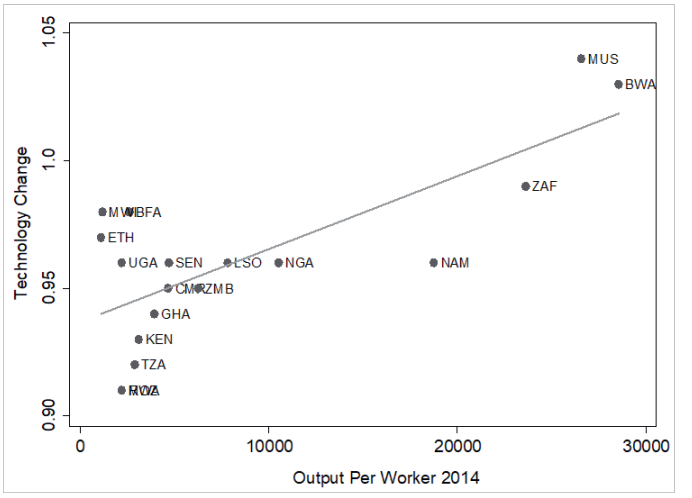
Note: Data is based on the 18 sub-Saharan Africa countries in the EASD and PWT 9.0.

Figure 3.4: Technology Change Between 1970-2014 Plotted Against Output Per Worker 1970



Note: Data is based on the 18 sub-Saharan Africa countries in the EASD and PWT 9.0.

Figure 3.5: Technology Change Between 1970-2014 Plotted Against Output Per Worker 2014



Note: Data is based on the 18 sub-Saharan Africa countries in the EASD and PWT 9.0.

3.6. Catch-up Within Africa: Is structural change important?

In the previous section, we established that technological catch-up, on average, has been more important than technological change in productivity convergence within Africa. For example, technological catch-up is the primary factor behind the successful convergence of Botswana and Mauritius. Technological catch-up was also important in countries such as Cameroon, Ghana, Kenya, and Nigeria, although, however, the positive gains from technological catch-up were outweighed by the negative contribution of technological change, slowing down the speed of productivity convergence. The convergence of countries to the productivity frontier through efficiency change and technological change is strongly underpinned by structural shifts of resources (both labour and capital) across sectors. Using a sample of 39 countries between 1973 and 1990, Fagerberg (2000) finds that structural change matters for overall growth and convergence and that countries that have managed to increase their presence in the technologically most progressive industries have experienced higher productivity growth. To understand further the importance of structural change to productivity convergence in Africa, we decompose technological catch-up using a structural shift-share model. This allows us to reflect on the role of structural change in the catch-up of the region. With this approach, we are able to examine if countries in the region are moving resources to sectors where the technology gap with the frontier is lower or decreasing over time.

Since the allocation of resources across sectors involves both labour and capital, the ideal strategy would be to use both inputs in our structural decomposition. However, due to data limitations on sectoral capital, we resort to the second-best solution, where we use only labour as inputs in the structural shift-share model. To this end and within the context of the structural model, we define technological catch-up as a process where a country eliminates the labour productivity gap with the frontier by moving workers into sectors with a lower technology gap with the frontier (i.e., a static effect) or a decreasing technology gap with the frontier (i.e., a dynamic effect). For this exercise, we use South Africa as the technological leader for two reasons: South Africa has been on the African technology frontier since 1970 (see section 3.3 DEA results in Table 3.3). Second, South Africa leads the rest of Africa in terms of quality education, innovation, and intellectual property production (see Appendix A for further explanation), this is particularly important for maintaining its technological hegemony in the region.

3.6.1. Decomposition of Technological Catch-up

The technology gap is measured as the aggregate labour productivity of each country relative to the aggregate labour productivity of South Africa (SA). This approach allows us to decompose annual catch-up (i.e., the percentage reduction in the technology gap) into an initial specialization effect, a reallocation effect and a within effect. This approach bears a resemblance to the shift-and-share methodology widely used in the literature to study productivity growth. However, this approach focuses on the technology gap instead of productivity growth (Lavopa, 2015).

The approach adopted was developed by Lavopa (2015) to study catch up by decomposing technology gaps in modern market activities within the context of high income and emerging countries. We adopt

this approach but focus on aggregate technology gaps within Africa. The aggregate technology gap is postulated as:

$$\theta_t^i = \frac{P_t^i}{P_t^f} \tag{3.14}$$

Where θ_t^i is the technology gap of country i in time t, P_t^i is the aggregate labour productivity of (laggard) country i in time t, and P_t^f is aggregate labour productivity of the frontier country f in time t, with SA being the frontier in this case. The aggregate productivity of country i is the sum of the sectoral productivities weighted by their employment shares (s_{kt}^i). This is given as:

$$P_t^i = \frac{Y_t^i}{E_t^i} = \sum_j \frac{Y_{kt}^i E_{kt}^i}{E_{kt}^i E_t^i} = \sum_j p_{kt}^i s_{kt}^i \tag{3.15}$$

Where Y is value added and s_{kt}^i is the employment share of sector k at time t. Substituting (3.15) into (3.14) gives:

$$\theta_t^i = \frac{\sum_k p_{kt}^i s_{kt}^i}{P_t^f} = \sum_k \frac{p_{kt}^i p_{kt}^f}{p_{kt}^f p_t^f}\, s_{kt}^i = \sum_k \theta_{kt}^i r_{kt}^f\, s_{kt}^i \tag{3.16}$$

The technology gap of an African country can be measured as the multiplication of the sectoral productivity relative to the frontier (θ_{kt}^i), the sectoral employment share in the laggard economy (s_{kt}^i), and the sectoral productivity of the frontier country relative to the aggregate frontier productivity (r_{kt}^f) and, as discussed, r_{kt}^f is the productivity of a particular sector in the frontier relative to the total economy productivity in the frontier. It is a proxy for the technological sophistication of the sector in question. Productivity improves if laggard countries reduce the technology gap with sectors of the frontier with higher r_{kt}^f. Taking the time difference of (3.16) with 0 and T as initial and final time gives:

$$\Delta\theta^i = \theta_T^i - \theta_0^i = \sum_k \theta_{kT}^i r_{kT}^f\, s_{kT}^i - \sum_k \theta_{k0}^i r_{k0}^f\, s_{k0}^i \tag{3.17}$$

Applying the idea of the shift-and-share method and manipulating equation (3.17), we decompose the technology gap into four components that explain the underlying drivers of technological catch-up within Africa as:

$$\Delta\theta^i = \sum_k s_{k0}^i r_{kT}^f\, \Delta\theta_k^i + \sum_k \theta_{k0}^i r_{kT}^f\, \Delta s_k^i + \sum_k r_{kT}^f \Delta\theta_k^i \Delta s_k^i + \sum_k \theta_{k0}^i\, s_{k0}^i \Delta r_k^f \tag{3.18}$$

The first component of the right-hand side is the sum of each sector's within-sector catch-up term. It is that part of the overall catch-up caused by the reduction of technology gaps at the sectoral level. The reduction of sectoral productivity gaps could be due to the introduction of new technology (e.g., resulting from the adoption of a mix of innovations), changes in organisational structure, downsizing (e.g., shedding surplus labour) or increased competition within a sector. The next two components

measure catch-up due to labour reallocation. The first term is the between static reallocation catch-up term. It captures whether workers move to sectors with a smaller or larger technological gap relative to the frontier economy. The reallocation of workers to sectors with a smaller (larger) gap will tend to reduce (increase) the aggregate gap (Lavopa, 2015). The second term is the dynamic reallocation catch-up term. It measures the joint effect of changes in both employment shares as well as changes in sectoral technology gaps during the period. It captures whether catch-up is higher or lower in sectors that expand in employment shares. The final term measures the effect of initial specialization. That is the effect of the structure of the economy at the initial period and the changes in the relative sectoral productivity of the frontier. If a country within Africa manages to maintain the initial technology distance with the leading economy and specializes in sectors that are dynamic in the leading economy, the initial specialization term will contribute positively to aggregate catch-up. However, if the technology gap widens, specializing in sectors that are dynamic in the leading economy may not contribute positively to catch up because the positive effect of specialization could be offset by the negative effect of increasing technology distance.

3.6.2. Long-run Relative Productivity Patterns and Technological Catch-up in Africa

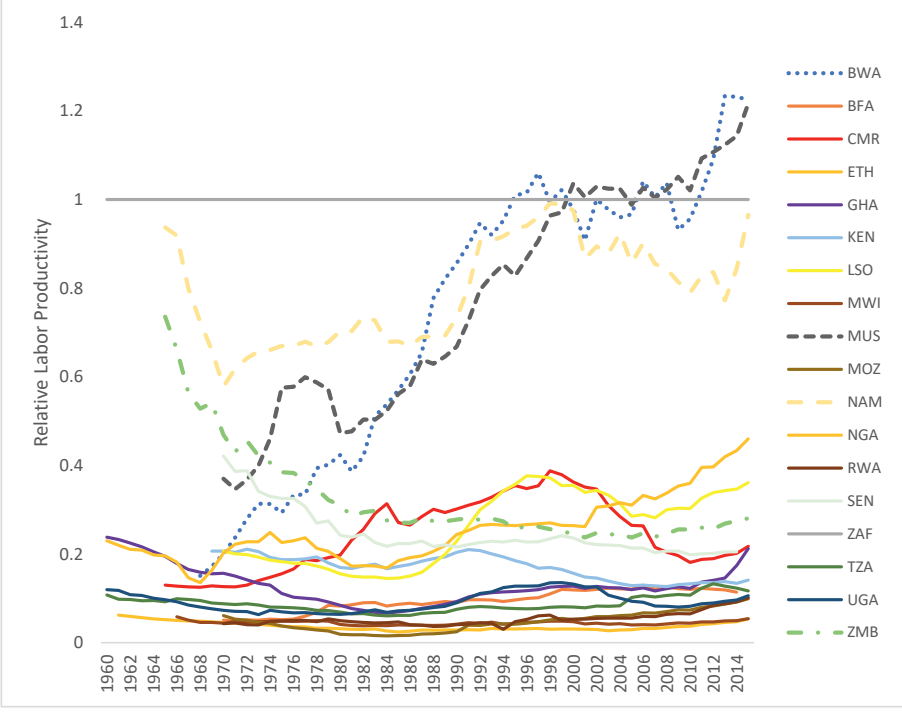
The long run trend of relative labour productivity to SA across the 17 African countries studied is depicted in Figure 3.6. The clear pattern shown is that three African countries have separated themselves from the rest of Africa with the productivity of Botswana (blue round dot line) and Mauritius (square dot line) converging to and leapfrogging the productivity level of the technology leader. Namibia shows signs of convergence but never really touching the productivity level of the technology leader. The rate of labour productivity growth differs among the three countries mentioned above in relation to South Africa. The annual average productivity growth of South Africa, Botswana, Mauritius, and Namibia between 1970 and 2014 was 1.05%, 5.2%, 3.5%, and 1.8%, respectively.

Since Botswana's annual rate of increase has been the fastest in Africa, by 1995, its productivity level had converged with the frontier (i.e., South Africa). This was followed by Mauritius, the second-fastest growing country, whose productivity converged to the productivity level of the frontier in 2000. Namibia (dashed line) has not been able to catch-up with South Africa, although the technology gap was small in the late 1990s and again by 2014. Another striking observation is that Zambia (green dash-dot line) had very good initial conditions, as measured by the initial technology gap, compared to Botswana and Mauritius. Despite this, Zambia has fallen behind the frontier, with its relative productivity decreasing from 0.66 in 1965 to 0.28 in 2015.

What underlies the successful catch up of Botswana and Mauritius and the relative failure of other countries such as Zambia in Africa? To understand the successful catch-up of Botswana and Mauritius and the falling behind of other African countries from a structural change perspective, we applied the methodology outlined above to the EASD data. We split the entire period into four distinct periods as in *Chapter 2*. We assess the degree of technological catch-up of the RoA with respect to SA for the

entire period (1960s-2015) as well as catch up during each of the sub-periods outlined above. The results are reported in Table 3.5.

Figure 3.6: Relative Labour Productivity as a Measure of Technology gap (SA=1)



Note: Data is based on the 18 sub-Saharan Africa countries in the EASD.

Table 3.5: Decomposition of Technological Catch-up to SA

Catch up to SA	Period	Catch-Up Rate	Within	Between Static	Between Dynamic	Initial Specialization
Rest of Africa (ROA)	1960-2015	1.0%	0.4%	1.2%	-0.3%	-0.4%
	1960-1975	-0.2%	-1.6%	1.8%	-0.2%	-0.2%
	1975-1990	0.3%	0.3%	0.6%	-0.2%	-0.4%
	1990-2000	2.4%	1.9%	1.1%	-0.1%	-0.5%
	2000-2015	1.1%	0.3%	1.7%	-0.5%	-0.3%

Notes: The table reports the decomposition of catch-up (relative labour productivity to SA) into within-sector catch-up, static between-sector catch-up, dynamic between-sector catch-up and initial specialization by period. Data is based on the 18 sub-Saharan Africa countries in the EASD. SA=South Africa.

The analysis shows that, on average, structural change contributes more to catch up than the within effect for the entire period. The African experience contradicts the observation for high-income countries where the within effect dominates the between effect (see Lavopa, 2015). This implies that most African countries are moving workers to sectors where the technology gap with SA is decreasing over time. We have seen the movement of workers mostly from agriculture to services across Africa, and over time, the productivity of labour in services in the RoA is converging towards that of SA, translating into the dominant reallocation effect. Though, on average, the within effect is not as strong as the between effect, the within effect was stronger than the between effect in the 1990s. The within effect has contributed positively to relative productivity growth in each sub-period except for the import substitution era. The protective policies implemented by most African countries led to inappropriate technology adoption (particularly in State-Owned Enterprises) that stifled innovation and hence technology growth within that period. The initial specialization effect has contributed negatively to technological growth in all periods. This means that most African countries are specializing in sectors where South Africa has not been very dynamic. Since Africa is highly specialized in agriculture, but South Africa is dynamic is mining activities, the initial specialization components tend to contribute negatively to technological catch-up. To summarize, while the within effect and the between effect help the RoA to catch up with SA, the initial specialization effect tends to be a drag on technological catch-up.

3.6.3. Catch-up by Country

Of the 17 countries studied in relation to SA, two countries (Botswana and Mauritius) converged to the productivity level of SA, four countries (Kenya, Malawi, Senegal, and Zambia) were found to fall further behind, and the other eleven countries were found to catch up with SA, but at a relatively slow pace (Table 3.6). Why have Botswana and Mauritius been successful while others been unsuccessful in catching-up? We speculate that Botswana's proximity to SA in combination with the discovery of diamonds in the late 1960s and Mauritius's industry-friendly policies adopted in the early 1970s played a significant role in the successful take-off and subsequent catch-up of these two countries.

Immediately after independence in 1966, Botswana discovered a huge diamond reserve. By that time, SA had established itself as a leader in mining-related technology in the sub-region. By interacting with SA, Botswana adopted the appropriate technology and best management practices to exploit its diamond deposits and launch itself upon a consistent growth path. In fact, Botswana's technological learning process has been strongly attributed to the "intensity of interactions" with SA as well as "investment and trade linkages to the SA economy" (Yaremye, 2008). Botswana's interactions with SA accounts for more than 70 percent of its capital imports, a major source of technology inflow (Yaremye, 2008).

After establishing a very productive mining sector through its technological interactions with SA, mining sector employment in Botswana increased from about 1000 in 1968 to about 10000 by 1976, or from 1.1% to 9.6% of total employment. The reallocation of workers to mining and auxiliary sectors in Botswana led to a rapid catch-up rate of 10.3% between 1968 and 1975. The between effect was

so strong that the countervailing forces of the within and specialization effects did not matter (See Table A3.6 in the Appendix). The strength of the between effect decreased over time, such that by 1990 it had become a drag on productivity growth (see also McCaig et al., 2015:6), partly due to the decline of the productive mining sector over time and the lack of diversification into other high productivity sectors.

Hillborn (2008) attempts to explain this more clearly. In 1968, agriculture dominated Botswana's economy, contributing more than 40% to the country's GDP only to decline to less than 3% in 2004. The agriculture sector continues to hold a very modest position in the country in terms of GDP contribution. The mining sector instead expanded, contributing about 8% of GDP in 1974/75 before expanding to 53% in 1988/89 only to shrink back again to roughly 35% in 2002 and 19.9% in 2017. Although the industrial sector has grown significantly in relative terms, it is mainly due to the expansion of the mining sector. At the same time, manufacturing maintains a share of around 6.4% of GDP in 2011, with figures falling in recent years (5.6% in 2017). The service sector now dominates the economy, accounting for about 65% of GDP in 2017, of which Wholesale and retail trade; repair of vehicles; household goods; restaurants and hotels accounts for 26.1%, Finance, real estate and business services (15.3), Transport, storage and communication (6.5%) and Public administration and defence, security and other services contributing about 21% of the GDP.[35] Some have argued that governments' effort to diversify the economy has failed and has left the economy of Botswana vulnerable in the long run (Siwawa-Ndai, 1997; Leith, 2005: 100).

Table 3.6: Catch-up by Country (Average Annual Percentage Change)

Country	Period	Catch-up Rate	Within	Between Static	Between Dynamic	Initial Specialization
Botswana	1968-2015	4.5%	3.3%	3.7%	-1.9%	-0.5%
Burkina Faso	1970-2015	2.0%	1.0%	1.4%	-0.2%	-0.3%
Cameroun	1965-2015	1.4%	0.3%	1.3%	-0.1%	-0.1%
Ethiopia	1961-2015	0.3%	-0.6%	1.2%	-0.2%	0.0%
Ghana	1960-2015	0.8%	0.8%	0.3%	-0.2%	-0.1%
Kenya	1969-2015	-0.8%	-1.0%	0.9%	-0.2%	-0.5%
Lesotho	1970-2015	1.1%	0.9%	1.3%	-0.2%	-0.9%
Malawi	1966-2015	-1.7%	-2.6%	1.6%	-0.4%	-0.3%
Mauritius	1970-2015	2.6%	2.4%	1.2%	-0.4%	-0.6%
Mozambique	1970-2015	1.8%	1.8%	0.3%	-0.1%	-0.1%
Namibia	1965-2015	0.7%	1.4%	0.5%	-0.4%	-0.8%
Nigeria	1960-2015	2.8%	2.1%	1.2%	-0.1%	-0.4%
Rwanda	1970-2015	2.6%	0.9%	1.9%	-0.1%	-0.1%
Senegal	1970-2015	-1.6%	-2.1%	1.0%	-0.1%	-0.3%
Tanzania	1960-2015	0.5%	-0.9%	2.1%	-0.3%	-0.3%
Uganda	1960-2015	0.7%	-0.2%	1.3%	-0.2%	-0.2%

[35] AfDB (2018). African Economic Outlook 2018: Botswana. Refer to this source for sectors contribution to GDP in 2011 and 2017.

Zambia	1965-2015	-1.3%	-0.6%	0.0%	-0.2%	-0.5%

Note: Data is based on the 18 sub-Saharan Africa countries in the EASD.

The experience of Mauritius is, however, quite different. After independence in 1968, Mauritius was a monocrop (i.e., sugar) economy, highly vulnerable to terms of trade shocks, and susceptible to potential conflict due to ethnic diversity. These unfavourable conditions led two Nobel laureates[36] to conclude that the economic future of Mauritius is a predictable dud (Subramanian, 2009). Contrary to this prediction, Mauritius has managed to sustain a high growth rate for over four decades leading to catch-up with the African frontier. The catch-up process in Mauritius was facilitated by reinforcement of both the within and the between effects. Between 1970 and 1975, the catch-up rate was 9.9%, with 8.4% of this percentage change being due to technological progress within sectors (Table A3.5). The years 1975-1990 saw the implementation of industrial policies and structural reallocation of resources across sectors in the country.

For this reason, out of the 1 percent productivity growth recorded in the country during this period, structural change contributed 70 percent, whereas the within effect contributed 30 percent (see Mensah et al. 2018). While reallocating resources across sectors, the effective industrial policies that were put in place made sure that over time the efficiency of firms improved, leading to a strong contribution of the within effect and a moderate contribution of the between effect to the country's productivity growth in the periods after 1990. For instance, between 1990 and 2000, productivity growth of the country was 4.3 percent. Out of this, the within effect contributed 3.1% while the between effect contributed 1.2%. Between 2000 and 2015, the within effect accounted for nearly all (1.8%) of the country's productivity growth of 1.9 percent (Mensah et al., 2018). Overall structural change was important in Mauritius's productivity growth (e.g., moving from sugar to textiles, tourism, finance, etc.) from the late 1970s to 1990, but later on, within effects started to dominate.

The strong within and moderate between effect is explained by the policies deployed after the creation of the export processing zones (EPZ) in the early 1970s. First, duty-free access was granted on all imported inputs. The free import of capital goods that embodied technological knowledge contributed positively to productivity growth and technological spillovers within sectors. Second, a raft of tax incentives was granted to firms operating in the EPZ. This had the same effect as export subsidies in encouraging exports. The effect of tax incentives on the growth of the export sector was complemented by the preferential market access granted by Mauritius' major trading partners, such as the European Economic Area and the USA (Subramanian, 2009)[37]. Exporting to the EU and the USA requires product certification that meets the market standards of these countries. To meet these standards, firms operating in an EPZ often adopt technological knowledge and management practices

[36] James Meade and V. S. Naipaul.

[37] Whiles Mauritius's development strategy was based on export promotion zones aimed at world markets where the proximity to other SSA seem to have mattered truly little, (Abreha et al., World Bank, forthcoming) demonstrate that countries located within Southern Africa (including Mauritius) are strongly connected to ZAF in the regional production system, sourcing substantial foreign value added from South Africa for their export.

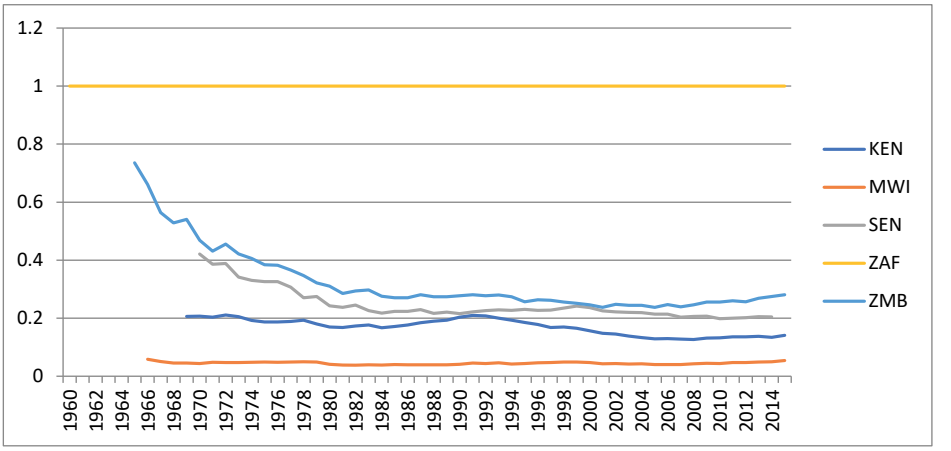
to improve existing production and delivery processes. This resulted in enhanced firm efficiency, and hence a strong within sector technological growth and moderate between effect. In summary, while the between effect created the technological momentum for catch up in Botswana, the within effect was the main driving force behind Mauritius' catch-up.

In contrast to the success of Botswana and Mauritius, the technology gap between Kenya, Malawi, Senegal, Zambia, and the technology leader is widening over time. They are falling behind at an average annual rate of 0.8%, 1.7%, 1.6% and 1.3% respectively (Table 3.6). The technology gap between Kenya and SA has increased from 0.79 in 1969 to 0.86 in 2015. That of Malawi has increased marginally from 0.94 in 1966 to 0.95 in 2015, while Senegal's productivity gap had widened by a third from 0.58 in 1970 to 0.80 in 2014. Finally, the most dramatic free fall of relative productivity is seen in the case of Zambia. Zambia's technology gap has increased from 0.26 in 1965 to 0.72 in 2015 (Figure 3.7).

Although there are country-specific idiosyncratic factors that may explain each country's technological decline, inappropriate technology policies adopted during the import substitution era and the structural adjustment era created an inertia that hampered technology growth. For example, during the import-substitution period, most governments imposed strict price controls and forced producers to purchase local intermediates input whenever available. This made domestic intermediates more expensive than what is available on the international market. This was exacerbated by foreign exchange controls where approval is required by government agencies before the allocation of foreign exchange needed for the purchase of essential intermediates input. Furthermore, infant industries were protected from competition, and as a result there was no urge to create a market niche through the adoption of efficient production techniques and processes. This set of policies implemented during the IS strategy hampered productivity growth during the era. For example, the relative productivity growth of Kenya, Senegal, and Zambia – three out of the four countries falling behind – decreased by 1.6%, 4.9%, and 4.2% respectively during the import-substitution era.

Most infant industries hardly broke even and consistently survived on the books of central governments. During the period of structural adjustment programs, almost all state-owned enterprises became targets for public sector rationalization. They were cleared off the book of central governments and subsequently collapsed. This caused a massive movement of workers from import substitution industries to the non-wage agricultural sector, the distributive trading sector, and other informal ventures. These sectors offer very little opportunity for technological learning. Finally, except for Botswana and Mauritius, all African countries witnessed political upheavals either during the 1970s, 1980s, or 1990s, which adversely affected the inflow of technologically embedded FDI into the region.

Figure 3.7: Countries Falling Behind



**Note: Malawi and Zambia's data start in the mid-1960s, Kenya's in 1969 and Senegal's in 1970.

3.7. Conclusion

Economic systems of Africa present unique technological challenges. This often requires a unique combination of technical knowledge developed in advanced countries or African-induced innovation to surmount the technological challenges. In this chapter, we have examined how African countries are catching-up with the best practice within Africa from a nonparametric perspective. The analysis shows that technological catch-up is an important driver of efficiency convergence within Africa. We further decomposed technological catch-up using a structural model. The results confirmed our conjecture that structural change is an important driver of technological catch-up within Africa. On average, structural change contributed more than half of the annual catch-up rate to the technology leader. However, the average productivity of the Rest of Africa (RoA) has not converged to the productivity level of the technology leader. Botswana and Mauritius are notable exceptions to this general trend. Botswana and Mauritius are the only two countries in Africa that have converged to the productivity level of the frontier. All the other countries have neither converged to the productivity level nor the efficiency level of the technology leader. In the case of Kenya, Malawi, Senegal, and Zambia productivity levels have fallen behind the productivity level of the leading economy. Protectionist policies implemented during the IS era led to the concentration of knowledge production and diffusion and slowed-down the catch-up rate. In this regard, the introduction and implementation of intraregional free trade agreement (AfCFTA) seems to be timely to boost catch-up efforts in the region.

In addition, the result of the Malmquist productivity decomposition for the countries in the sample shows that the combination of technological catch-up and technological progress has contributed to variation in the total factor productivity growth of countries in Africa. For instance, the total

productivity growth of Botswana and Mauritius is driven more by technological catch-up and less by technological change. In the case of Cameroon and Ghana, however, all productivity gains were due to improvements in efficiency levels (technological catch-up). Productivity in all the other countries, either stagnated or declined as technical change (i.e., an inability to benefit from the shift in the production frontier), penalized overall total productivity growth in these countries. The is reflected in the whole Africa productivity growth average. The result of the Malmquist productivity decomposition (average of five-year interval period) shows that Africa achieved a productivity decline of –4.0 percent between 1970 and 2014. The decline in productivity growth is almost entirely attributable to a lack of technological progress and less to technological catch-up. This contribution of technological regress to the region's productivity decline is primarily driven by the experience of relatively poor countries in the region rather than relatively wealthy and highly capitalized economies in the region. Two important lessons emerged from this exercise. First, successful productivity convergence requires the combination of technical progress and technological catch-up. Second, structural change exerts a significant influence on the speed of technological convergence.

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3.8. Appendix to Chapter 3

3.8.1. South Africa: A Leader in Education and Innovation

South Africa is the technological hub of Africa. It is home to world-class academic and research institutions that attract young talent from across Africa. The Times Higher Education (THE) and QS ranking consistently place seven of the top ten African universities in South Africa. The country has consistently been ranked among the most innovative countries in Africa by the Global Innovation Index, and in 2017 was ranked as the most innovative African country. While other highly innovative countries such as Mauritius, Botswana and Nigeria are performing below their level of development, South Africa is performing at a level consistent with its development (Global Innovation Index Report, 2017). Patent data at the US Patent and Trademark Office also shows that South Africa recorded the highest number of (residential) patents applications between 2001 and 2014 in Sub-Sahara Africa (see Table A2 in Appendix).

In addition to its leadership in education and innovation, South Africa has established itself globally in some technological domains – mining-related technology – that are particularly important for Africa. This is important because most of the economies of the other 17 countries in our sample depend heavily on mineral exports. South Africa has developed a globally competitive and advanced technological capacity in "mining equipment and specialist services sector". The share of mining-related technology patents is higher than other comparator countries which are considered to have technological leadership in mining (Table A1). The share of mining-related technology patents for SA is 4.5% compared with a global average of 0.54%. The revealed comparative advantage in mining-related innovations (RCAI) is therefore 8.4, which is higher than that of comparator countries which are considered to be global leaders in mining related technology. "This indicates that South Africa has a very significant global comparative advantage in mining related technology innovation" (Kaplan, 2012: 426).

Table A3.1: South Africa's Leadership in Mining and Related Services

Panel A: Patent Quantity				
Country	**All Patents**	**Mining Technology Patents**	**Share (%)**	**RCAI**
South Africa	3151	142	4.51	8.35
United States	1,587,915	7882	0.5	0.93
Australia	16,283	311	1.9	3.52
Canada	65,580	853	1.3	2.41
Global total/average	3,189,941	17,098	0.54	-----
Panel B: Patent Quality				
All countries	**All Patents**	**Mining-related tech. patents**	**Other patents**	
Citations received (not truncation corrected)				
South Africa	5.52	7.05	5.44	
United States	8.52	6.99	8.53	
Australia	5.39	4.15	5.41	
Canada	6.60	4.70	6.72	

Average	6.53	5.73	6.53
Citations received (truncation corrected)			
South Africa	7.95	9.01	7.90
United States	14.13	9.97	14.16
Australia	9.41	6.16	9.47
Canada	11.43	6.91	11.49
Average	10.73	8.01	10.76

Source: Kaplan (2012)

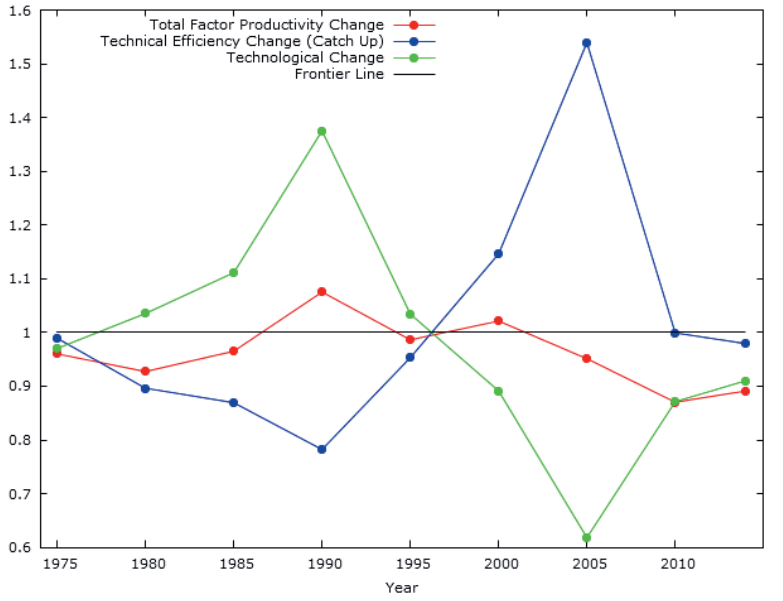
Note: The table show the number of patents and mining related patents granted at the USPTO 1976–2006 in South Africa and comparator countries. RCAI is ratio of the share of mining related patent granted to the average global share of mining related patents granted. "The truncation–correction refers to the fact that it takes time for citations to arrive. Older patents will naturally have more citations than younger ones. A truncation correction allows for a 'fairer' comparison between samples of patents with different age distributions".

Table A3.2: Ranking of Universities, Innovation, and Intellectual Properties in Africa

Panel A: Education					
QS Ranking 2018	Univeristy	Country	THE Ranking 2018	University	Country
1	University of Cape Town	South Africa	1	University of Cape Town	South Africa
2	Stellenbosch University	South Africa	2	University of the Witwatersrand	South Africa
3	University of the Witwatersrand	South Africa	3	Stellenbosch University	South Africa
4	The American of University in Cairo	Egypt	4	University of KwaZulu-Natal	South Africa
5	Cairo University	Egypt	5	Makerere University	Uganda
6	University of Pretoria	South Africa	6	The American University in Cairo	Egypt
7	University of Johannesburg	South Africa	7	Beni-Suef University	Egypt
8	Ain shams University	Egypt	8	University of Johannesburg	South Africa
9	Rhodes University	South Africa	9	University of Pretoria	South Africa
10	University of KwaZulu-Natal	South Africa	10	University of the Western Cape	South Africa
Panel B: Innovation			Panel C: Patents		
GII Rank 2017	Innovation Score	Country	Rank	Number of Patents Applications (2001-2014)	Country
1	35.80	South Africa	1	2050	South Africa
2	34.80	Mauritius	2	287	Mauritius
3	32.70	Morocco	3	75	Seychelles
4	31.00	Kenya	4	57	Kenya
5	30.00	Botswana	5	36	Niger
6	28.00	Tanzania	6	33	Nigeria
7	27.90	Namibia	7	23	Cote D'Ivoire
8	27.40	Rwanda	8	18	Cameroon
9	27.10	Senegal	9	13	Gabon
10	27.00	Uganda	10	12	Namibia

Source: The Times Higher Education and QS Ranking; Global Innovation Index Report (2017); and USPTO.
Note: The ranking of IP excludes North Africa.

Figure A3.1: Decomposition of Productivity Growth, Technology and Efficiency Indexes: Africa Period Averages: 1970-2014



Note: Data is based on the 18 sub-Saharan Africa countries in the EASD and PWT 9.0.

3.8.2 Robustness Checks of Efficiency Measures

Table A3.3: The Nonradial (Slack Based Measures) for Technical Efficiency for DMUs—1970

DMU	TEnrCRS_LK	TEnrNRS_LK	TEnrVRS_LK	TEnrCRS_L	TEnrNRS_L	TEnrVRS_L	TEnrCRS_K	TEnrNRS_K	TEnrVRS_K
BWA	0.73	0.73	0.81	0.20	0.20	0.49	0.41	0.42	0.42
BFA	0.81	0.84	0.84	0.05	0.05	0.05	0.61	0.75	0.75
CMR	0.47	0.49	0.49	0.13	0.13	0.13	0.27	0.44	0.44
ETH	0.86	1.00	1.00	0.04	0.07	0.07	0.74	1.00	1.00
GHA	0.22	0.23	0.23	0.15	0.15	0.16	0.09	0.21	0.21
KEN	0.44	0.53	0.53	0.21	0.21	0.21	0.23	0.49	0.49
LSO	0.97	0.97	1.00	0.20	0.20	1.00	0.56	0.56	1.00
MWI	0.52	0.52	0.52	0.04	0.04	0.05	0.35	0.43	0.43
MUS	0.61	0.61	1.00	0.41	0.41	1.00	0.27	0.34	0.34
MOZ	0.92	0.95	0.95	0.06	0.06	0.07	0.67	0.84	0.84
NAM	0.75	0.75	1.00	0.61	0.61	1.00	0.30	0.40	0.40
NGA	0.76	1.00	1.00	0.19	0.57	0.57	0.43	1.00	1.00
RWA	1.00	1.00	1.00	0.04	0.04	0.04	1.00	1.00	1.00

SEN	0.72	0.72	0.73	0.42	0.42	0.46	0.33	0.56	0.56
ZAF	1.00	1.00	1.00	1.00	1.00	1.00	0.38	1.00	1.00
TZA	0.38	0.45	0.45	0.09	0.09	0.09	0.22	0.43	0.43
UGA	0.61	0.63	0.63	0.07	0.07	0.07	0.38	0.52	0.52
ZMB	1.00	1.00	1.00	0.45	0.45	0.48	0.54	0.88	0.88

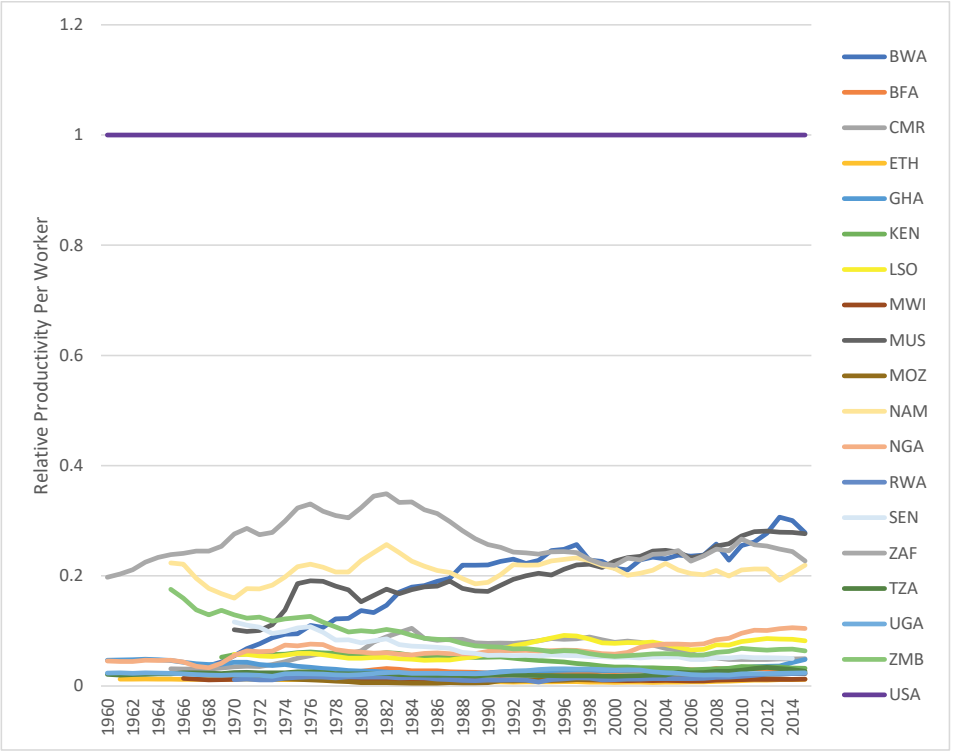
* TEnrdCRS = tenonradial output-based measures of technical efficiency under assumption of constant returns to scale
* TEnrdNRS = tenonradial output-based measures of technical efficiency under assumption of non- increasing returns to scale
* TEnrdVRS = tenonradial output-based measures of technical efficiency under assumption of variable returns to scale
* LK = both labour and capital used; L= only labour used; K = only capital used
* Note: Data is based on the 18 sub-Saharan Africa countries in the EASD and PWT 9.0.

Table A3.4: The Nonradial-Slack Based Measures for Technical Efficiency for DMUs—2014

DMU	TEnrCRS_LK	TEnrNRS_LK	TEnrVRS_LK	TEnrCRS_L	TEnrNRS_L	TEnrVRS_L	TEnrCRS_K	TEnrNRS_K	TEnrVRS_K
BWA	1.00	1.00	1.00	1.00	1.00	1.00	0.38	0.38	0.38
BFA	0.82	0.82	0.88	0.09	0.11	0.11	0.82	0.82	0.88
CMR	1.00	1.00	1.00	0.16	0.20	0.20	1.00	1.00	1.00
ETH	0.37	0.42	0.42	0.04	0.09	0.09	0.37	0.42	0.42
GHA	0.43	0.43	0.44	0.14	0.17	0.17	0.37	0.41	0.41
KEN	0.70	0.76	0.76	0.11	0.17	0.17	0.70	0.76	0.76
LSO	0.60	0.60	1.00	0.27	0.27	1.00	0.42	0.42	1.00
MWI	0.35	0.35	0.39	0.04	0.05	0.05	0.35	0.35	0.39
MUS	1.00	1.00	1.00	0.93	0.93	1.00	0.50	0.50	0.52
MOZ	0.81	0.81	0.87	0.08	0.09	0.09	0.81	0.81	0.87
NAM	0.84	0.84	0.85	0.66	0.66	0.66	0.45	0.45	0.47
NGA	1.00	1.00	1.00	0.37	1.00	1.00	0.85	1.00	1.00
RWA	0.81	0.81	1.00	0.08	0.09	0.09	0.81	0.81	1.00
SEN	0.65	0.65	0.70	0.16	0.19	0.19	0.59	0.59	0.60
ZAF	1.00	1.00	1.00	0.83	1.00	1.00	0.50	0.67	0.67
TZA	0.36	0.37	0.37	0.10	0.15	0.15	0.32	0.37	0.37
UGA	0.48	0.51	0.51	0.08	0.09	0.09	0.48	0.51	0.51
ZMB	0.43	0.43	0.43	0.22	0.26	0.26	0.28	0.30	0.30

* TEnrdCRS = tenonradial output-based measures of technical efficiency under assumption of constant returns to scale
* TEnrdNRS = tenonradial output-based measures of technical efficiency under assumption of non- increasing returns to scale
* TEnrdVRS = tenonradial output-based measures of technical efficiency under assumption of variable returns to scale
* LK = both labour and capital used; L= only labour used; K = only capital used.
* Note: Data is based on the 18 sub-Saharan Africa countries in the EASD and PWT 9.0.

Figure A3.2: Relative Labour Productivity as a measure of Technology gap: USA==1



Note: Data is based on the 18 sub-Saharan Africa countries in the EASD. USA data is from ASD (extrapolated).

3.8.3 Decomposition of catch-up by country and period

Table A3.5: Decomposition of Catch Up to SA for Whole Period and Sub-Periods

Country/Region	Period	Total Catch Up Rate	Within	Between Static	Between Dynamic	Initial Specialization
Rest of Africa (ROA)	1960-2015	1.0%	0.4%	1.2%	-0.3%	-0.4%
	1960-1975	-0.2%	-1.6%	1.8%	-0.2%	-0.2%
	1975-1990	0.3%	0.3%	0.6%	-0.2%	-0.4%
	1990-2000	2.4%	1.9%	1.1%	-0.1%	-0.5%
	2000-2015	1.1%	0.3%	1.7%	-0.5%	-0.3%
Botswana	1960-2015	4.5%	3.3%	3.7%	-1.9%	-0.5%
	1968-1975	10.3%	-0.1%	12.7%	-1.4%	-0.8%
	1975-1990	7.7%	8.3%	2.9%	-1.6%	-1.9%
	1990-2000	1.4%	0.7%	-0.2%	-0.4%	1.3%
	2000-2015	0.8%	1.6%	2.9%	-3.5%	-0.2%

Burkina Faso	1970-2015	2.0%	1.0%	1.4%	-0.2%	-0.3%
	1970-1975	0.3%	0.2%	0.0%	0.0%	0.1%
	1975-1990	4.1%	4.1%	-0.1%	0.0%	0.1%
	1990-2000	2.9%	2.2%	1.8%	-0.1%	-1.0%
	2000-2015	-0.4%	-2.9%	3.2%	-0.5%	-0.2%
Cameroun	1965-2015	1.4%	0.3%	1.3%	-0.1%	-0.1%
	1965-1975	3.2%	2.9%	0.0%	0.0%	0.3%
	1975-1990	4.8%	4.3%	1.1%	0.0%	-0.7%
	1990-2000	1.9%	-2.1%	4.0%	-0.4%	0.5%
	2000-2015	-3.2%	-3.2%	0.2%	0.0%	-0.2%
Ethiopia	1961-2015	0.3%	-0.6%	1.2%	-0.2%	0.0%
	1961-1975	-3.8%	-4.6%	0.6%	-0.1%	0.2%
	1975-1990	-1.5%	-2.3%	0.1%	0.0%	0.8%
	1990-2000	0.7%	0.3%	1.2%	0.0%	-0.8%
	2000-2015	3.9%	2.4%	2.5%	-0.6%	-0.5%
Ghana	1960-2015	0.8%	0.8%	0.3%	-0.2%	-0.1%
	1960-1975	-4.9%	-5.2%	0.3%	-0.1%	0.1%
	1975-1990	-1.0%	-1.1%	-0.1%	0.1%	0.1%
	1990-2000	3.3%	3.1%	0.6%	0.0%	-0.3%
	2000-2015	3.6%	4.1%	0.4%	-0.6%	-0.3%
Kenya	1969-2015	-0.8%	-1.0%	0.9%	-0.2%	-0.5%
	1969-1975	-1.6%	-1.6%	0.7%	-0.2%	-0.5%
	1975-1990	0.6%	-0.1%	1.1%	-0.2%	-0.2%
	1990-2000	-2.6%	-3.7%	2.6%	-0.3%	-1.1%
	2000-2015	-0.7%	0.0%	-0.3%	-0.1%	-0.4%
Lesotho	1970-2015	1.1%	0.9%	1.3%	-0.2%	-0.9%
	1970-1975	-5.2%	-4.5%	0.4%	-0.1%	-0.9%
	1975-1990	1.9%	1.8%	1.0%	0.0%	-0.8%
	1990-2000	4.7%	5.0%	1.2%	-0.1%	-1.5%
	2000-2015	0.1%	-1.0%	1.9%	-0.3%	-0.5%
Malawi	1966-2015	-1.7%	-2.6%	1.6%	-0.4%	-0.3%
	1966-1975	1.0%	-0.5%	1.6%	-0.1%	0.0%
	1975-1990	-7.7%	-6.9%	0.4%	-0.8%	-0.3%
	1990-2000	1.4%	0.5%	1.6%	-0.1%	-0.5%
	2000-2015	1.0%	-1.3%	2.9%	-0.4%	-0.3%

Mauritius	1970-2015	2.6%	2.4%	1.2%	-0.4%	-0.6%
	1970-1975	9.9%	8.4%	2.6%	-0.9%	-0.3%
	1975-1990	1.2%	1.1%	1.3%	-0.6%	-0.6%
	1990-2000	4.3%	4.2%	1.3%	0.0%	-1.1%
	2000-2015	0.4%	0.4%	0.4%	-0.3%	-0.2%
Mozambique	1970-2015	1.8%	1.8%	0.3%	-0.1%	-0.1%
	1970-1975	-9.2%	-10.0%	0.0%	0.0%	0.8%
	1975-1990	-1.9%	-1.7%	0.0%	-0.2%	0.0%
	1990-2000	9.2%	9.8%	0.0%	-0.1%	-0.5%
	2000-2015	4.3%	3.8%	0.8%	0.0%	-0.3%
Namibia	1965-2015	0.7%	1.4%	0.5%	-0.4%	-0.8%
	1960-1975	-0.9%	0.2%	0.4%	-0.2%	-1.3%
	1975-1990	0.6%	1.7%	0.0%	-0.1%	-1.0%
	1990-2000	3.0%	3.4%	0.5%	-0.3%	-0.7%
	2000-2015	0.1%	0.4%	1.1%	-1.0%	-0.4%
Nigeria	1960-2015	2.8%	2.1%	1.2%	-0.1%	-0.4%
	1960-1975	8.1%	3.7%	5.5%	0.1%	-1.2%
	1975-1990	0.7%	2.0%	-0.1%	-0.1%	-1.1%
	1990-2000	0.8%	0.6%	-0.3%	-0.1%	0.6%
	2000-2015	3.8%	2.4%	1.6%	-0.1%	-0.1%
Rwanda	1970-2015	2.6%	0.9%	1.9%	-0.1%	-0.1%
	1970-1975	3.3%	1.3%	0.0%	0.0%	2.0%
	1975-1990	-1.0%	-3.4%	1.7%	-0.2%	0.8%
	1990-2000	4.9%	6.8%	0.3%	0.0%	-2.2%
	2000-2015	4.4%	1.0%	3.9%	-0.3%	-0.3%
Senegal	1970-2015	-1.6%	-2.1%	1.0%	-0.1%	-0.3%
	1970-1975	-4.9%	-6.1%	0.8%	-0.1%	0.4%
	1975-1990	-2.6%	-2.9%	0.7%	0.0%	-0.4%
	1990-2000	0.9%	0.6%	1.2%	-0.1%	-0.8%
	2000-2015	-1.1%	-1.9%	1.3%	-0.3%	-0.1%
Tanzania	1960-2015	0.5%	-0.9%	2.1%	-0.3%	-0.3%
	1960-1975	-2.4%	-5.1%	3.3%	-0.5%	-0.1%
	1975-1990	-0.3%	-1.0%	0.8%	-0.1%	-0.1%
	1990-2000	0.7%	1.1%	0.6%	-0.1%	-0.9%
	2000-2015	2.7%	-0.1%	3.7%	-0.6%	-0.3%
Uganda	1960-2015	0.7%	-0.2%	1.3%	-0.2%	-0.2%

	1960-1975	-1.8%	-3.4%	1.6%	-0.3%	0.2%
	1975-1990	1.9%	-0.4%	1.8%	0.0%	0.5%
	1990-2000	4.0%	1.9%	3.0%	-0.2%	-0.6%
	2000-2015	-1.4%	0.0%	-0.4%	-0.2%	-0.7%
Zambia	1965-2015	-1.3%	-0.6%	0.0%	-0.2%	-0.5%
	1965-1975	-4.2%	-2.2%	-0.1%	0.0%	-1.9%
	1975-1990	-2.1%	1.5%	-2.0%	-0.1%	-1.5%
	1990-2000	-1.2%	-2.7%	0.2%	0.0%	1.3%
	2000-2015	0.8%	-0.6%	1.9%	-0.4%	-0.1%

Note: Data is based on the 18 sub-Saharan Africa countries in the EASD. SA= South Africa.

Table A3.6: Decomposition of Catch Up to USA for Whole Period and Sub-Periods

Country/Region	Period	Total Catch Up Rate	Within	Between Static	Between Dynamic	Initial Specialization
Africa	1960-2015	0.9%	-0.5%	1.2%	-0.3%	0.5%
	1960-1975	2.6%	1.0%	1.7%	-0.2%	-0.1%
	1975-1990	-0.3%	-1.3%	0.7%	-0.2%	0.6%
	1990-2000	0.9%	-0.9%	1.1%	-0.2%	0.9%
	2000-2015	1.3%	-0.1%	1.6%	-0.5%	0.3%
Botswana	1960-2015	4.5%	2.7%	3.7%	-1.9%	-0.1%
	1968-1975	13.5%	3.2%	12.7%	-1.0%	-1.4%
	1975-1990	6.7%	4.4%	2.9%	-1.4%	0.7%
	1990-2000	0.1%	0.4%	-0.2%	-0.5%	0.3%
	2000-2015	1.0%	2.3%	2.9%	-3.7%	-0.5%
Burkina Faso	1970-2015	1.9%	0.1%	1.4%	-0.2%	0.6%
	1970-1975	2.7%	3.3%	0.0%	0.0%	-0.6%
	1975-1990	3.2%	2.6%	-0.1%	0.0%	0.7%
	1990-2000	1.5%	-1.1%	1.8%	-0.1%	1.0%
	2000-2015	0.4%	-2.9%	3.2%	-0.5%	0.6%
Cameroun	1965-2015	1.3%	-0.7%	1.3%	-0.1%	0.8%
	1965-1975	6.2%	5.5%	0.0%	0.0%	0.7%
	1975-1990	3.9%	2.0%	1.1%	-0.1%	0.9%
	1990-2000	0.6%	-4.2%	4.0%	-0.4%	1.3%
	2000-2015	-3.1%	-3.8%	0.2%	0.0%	0.5%
Ethiopia	1961-2015	0.2%	-1.7%	1.2%	-0.2%	0.9%
	1961-1975	-1.0%	-2.8%	0.6%	0.0%	1.2%
	1975-1990	-2.4%	-3.6%	0.1%	0.0%	1.0%
	1990-2000	-0.6%	-3.0%	1.2%	0.0%	1.3%

	2000-2015	4.0%	1.5%	2.5%	-0.6%	0.5%
Ghana	1960-2015	0.6%	-0.3%	0.3%	-0.2%	0.9%
	1960-1975	-2.0%	-2.7%	0.3%	0.0%	0.4%
	1975-1990	-2.0%	-2.9%	-0.1%	0.0%	1.0%
	1990-2000	1.9%	0.2%	0.6%	0.0%	1.1%
	2000-2015	3.7%	3.0%	0.4%	-0.5%	0.8%
Kenya	1969-2015	-1.0%	-2.1%	0.9%	-0.2%	0.5%
	1969-1975	1.0%	0.4%	0.7%	-0.3%	0.2%
	1975-1990	-0.3%	-1.7%	1.1%	-0.2%	0.5%
	1990-2000	-3.9%	-6.8%	2.6%	-0.4%	0.7%
	2000-2015	-0.5%	-0.5%	-0.3%	-0.1%	0.4%
Lesotho	1970-2015	0.8%	-0.4%	1.3%	-0.2%	0.1%
	1970-1975	-2.9%	-2.9%	0.4%	-0.1%	-0.2%
	1975-1990	0.9%	0.0%	1.0%	-0.1%	0.0%
	1990-2000	3.2%	2.0%	1.2%	-0.2%	0.1%
	2000-2015	0.3%	-1.5%	1.9%	-0.3%	0.2%
Malawi	1966-2015	0.4%	-1.5%	1.6%	-0.4%	0.6%
	1966-1975	3.9%	1.9%	1.6%	0.0%	0.4%
	1975-1990	-1.9%	-2.0%	0.4%	-0.8%	0.5%
	1990-2000	0.1%	-2.3%	1.6%	-0.2%	1.0%
	2000-2015	1.1%	-2.0%	2.9%	-0.3%	0.5%
Mauritius	1970-2015	2.3%	1.2%	1.2%	-0.4%	0.4%
	1970-1975	12.5%	10.9%	2.6%	-0.9%	-0.1%
	1975-1990	0.2%	-1.1%	1.3%	-0.6%	0.5%
	1990-2000	2.9%	0.9%	1.3%	-0.1%	0.8%
	2000-2015	0.6%	0.5%	0.4%	-0.3%	0.0%
Mozambique	1970-2015	1.4%	0.5%	0.3%	-0.1%	0.7%
	1970-1975	-7.0%	-6.9%	0.0%	0.0%	-0.1%
	1975-1990	-3.0%	-3.7%	0.0%	-0.2%	0.8%
	1990-2000	7.5%	6.6%	0.0%	-0.2%	1.1%
	2000-2015	4.6%	3.1%	0.8%	0.0%	0.7%
Namibia	1965-2015	0.6%	0.6%	0.5%	-0.4%	-0.1%
	1960-1975	1.9%	2.1%	0.4%	-0.2%	-0.3%
	1975-1990	-0.2%	0.2%	0.0%	-0.1%	-0.3%
	1990-2000	1.6%	1.3%	0.5%	-0.4%	0.2%
	2000-2015	0.2%	-0.1%	1.1%	-0.9%	0.1%

Nigeria	1960-2015	2.7%	1.2%	1.2%	0.0%	0.3%
	1960-1975	11.4%	6.3%	5.5%	0.1%	-0.4%
	1975-1990	-0.3%	-0.1%	-0.1%	-0.1%	0.0%
	1990-2000	-0.5%	-1.2%	-0.3%	0.0%	1.1%
	2000-2015	4.0%	1.9%	1.6%	0.0%	0.5%
Rwanda	1970-2015	2.4%	-0.3%	1.9%	-0.2%	0.9%
	1970-1975	5.9%	6.0%	0.0%	0.0%	-0.1%
	1975-1990	-1.9%	-4.9%	1.7%	-0.2%	1.5%
	1990-2000	3.7%	2.5%	0.3%	0.0%	0.9%
	2000-2015	4.6%	0.4%	3.9%	-0.3%	0.5%
Senegal	1970-2015	-1.7%	-3.2%	1.0%	-0.2%	0.6%
	1970-1975	-2.7%	-3.7%	0.8%	0.0%	0.2%
	1975-1990	-3.5%	-5.0%	0.7%	0.0%	0.8%
	1990-2000	-0.4%	-2.5%	1.2%	-0.1%	1.0%
	2000-2015	-0.3%	-1.6%	1.3%	-0.3%	0.3%
South Africa	1960-2015	0.0%	-0.7%	0.7%	-0.2%	0.1%
	1960-1975	2.9%	2.2%	1.1%	0.0%	-0.4%
	1975-1990	-0.9%	-2.2%	1.3%	-0.1%	0.1%
	1990-2000	-1.3%	-1.6%	0.2%	-0.2%	0.4%
	2000-2015	0.3%	0.2%	0.2%	-0.3%	0.2%
Tanzania	1960-2015	0.5%	-1.9%	2.1%	-0.3%	0.6%
	1960-1975	0.4%	-2.9%	3.3%	-0.3%	0.4%
	1975-1990	-1.3%	-2.7%	0.8%	-0.1%	0.7%
	1990-2000	-0.6%	-2.3%	0.6%	-0.1%	1.1%
	2000-2015	3.0%	-0.5%	3.7%	-0.6%	0.4%
Uganda	1960-2015	0.6%	-1.2%	1.3%	-0.2%	0.7%
	1960-1975	1.1%	-1.2%	1.6%	-0.3%	0.9%
	1975-1990	0.9%	-1.7%	1.8%	-0.1%	0.8%
	1990-2000	2.6%	-1.2%	3.0%	-0.3%	1.1%
	2000-2015	-1.2%	-0.8%	-0.4%	-0.1%	0.2%
Zambia	1965-2015	-1.4%	-1.3%	0.0%	-0.2%	0.1%
	1965-1975	-1.5%	0.3%	-0.1%	0.0%	-1.6%
	1975-1990	-3.0%	-0.8%	-2.0%	-0.1%	-0.1%
	1990-2000	-2.5%	-3.9%	0.2%	-0.1%	1.3%
	2000-2015	1.1%	-0.8%	1.9%	-0.4%	0.3%

Note: Data is based on the 18 sub-Saharan Africa countries in the EASD. USA data is from ASD (extrapolated).

Chapter 4: The Rise of the Service Sector in the Global Economy and Africa[38]

[38] Co-authored with Adam Szirmai and Neil Foster-McGregor. My contribution includes conceptualisation, methodology, data curation, investigation and writing of the chapter.

Abstract

The chapter takes a two-pronged approach to examine the implications of the rapid rise of the service sector in the economies of the world. First, it analyses tertiarisation in the global economy touching on key issues such as Baumol's hypothesis of a stagnant service sector, the contribution of the service sector to aggregate productivity and growth, and the potentially positive contributions of services to other sectors. The second half of the chapter focuses on tertiarisation trends in sub-Saharan Africa, representing the role of the service sector in low-income economies. Using a long series of sectoral employment and output data, I-O tables and multiple statistical analysis, we find that perceptions of services as stagnant and productivity resistant do not apply to all service sub-sectors. Productivity growth in modern, dynamic, and tradable services is equal to or higher than that in manufacturing and other sectors. These service sectors are innovative and might act as new or alternative engines of growth alongside manufacturing. The manufacturing sector in Africa still generates the strongest multipliers, including to market services. However, much of the manufacturing linkages are captured by foreign countries rather than domestic suggests opportunities for a modern approach to import-substitution. While the multipliers in market services are relatively lower than those of manufacturing, they are comparable to those in many other regions of the world economy and more of the gains are captured by domestic firms which could encourage a self-reinforcing pattern of market service development. We also find robust evidence of strong inter-sectoral linkages between the service sector and manufacturing. Given the sector's mutually reinforcing interaction with the manufacturing sector, the growing service sector could potentially play a significant complementary role in the prospects for industrialisation of Africa. But this potential remains to be realised.

4.1 Introduction

The manufacturing sector has historically been the engine of growth, accounting for a substantial share of economy-wide productivity growth. But the share of manufacturing in GDP and employment has been declining in advanced economies, emerging economies, as well as low-income developing countries. It is high time to examine whether other sectors can replace or complement manufacturing as engines of growth. In particular, it is necessary to examine the role of the expanding service sector. The service sector nowadays accounts for some 70 percent of GDP in advanced economies. In emerging economies and low-income countries, the share of the service sector is also increasing rapidly, albeit from lower levels. Tertiarisation is a truly global phenomenon.

The increasing dominance of the services sector in the global economy and its potential implication for economic development has not been sufficiently explored, particularly in Africa, due to earlier hasty and pessimistic conclusions about the potential of the sector to drive sustainable growth and development. In recent years, however, a growing literature has argued that the service sector is very heterogeneous and with advances in technology and innovation in the sector, the service sector could act as influential sector of the economy in the future because of its potential for productivity growth and the complementary and interdependent role of the sector for the other sectors of the economy as discussed below (Marks 2009; Carmignani & Mandeville 2014; Hoekman 2017; Di, Berardino & Onesti 2018; Stiglitz 2018; Newfarmer et al. 2018; Hallward-Driemeier & Nayyar 2018).

Heavily dependent on the performance of firms within the manufacturing sector itself, the productivity growth of the manufacturing sector is also affected by the availability of a range of high-quality upstream services as intermediate inputs (van Ark et al. 2008; Jones 2011; Beverelli et al. 2017; Hoekman & Shepherd 2017; Hjort & Poulsen 2019). The rise of global value chains, growing geographical fragmentation of production, and increasing complexity in the organisation of manufacturing production and distribution have increased the service contents of many manufactured goods (Park 1989; Francois & Reinert 1996; Miozzo & Soete 2001; Guerrieri & Meliciani 2005; Arnold et al. 2011; Duggan et al. 2013; Arnold & Lipscomb 2016; Di Berardino & Onesti, 2018).

An efficient financial sector ensures that firms not only obtain adequate capital for the day-to-day running of their activities but also that firms are able to allocate capital to where it will yield the highest possible returns. Efficient business services such as consulting, accounting, legal services, and business processing services ensure not only the enforcement of contracts and protection of property rights but also reduce the transaction costs of using the financial market. This has implications for firms' innovative activities and investment. Efficient telecommunication services generate huge multiplier gains for the economy, serving as intermediate inputs, as transmission mechanisms for information services delivery, and as sales platforms for businesses. Efficient transport services together with retail and wholesale distributions services provide important channels linking producers and consumers.

Through digital technology, online trading platforms are continually eliminating many of the geographical barriers that previously prevented manufacturing firms from accessing larger national and international markets. This has increased the proximity of businesses to markets and facilitated

the creation of new and efficient ways through which manufacturing firms can reach customers and communicate with suppliers (cf. Hoekman & Shepherd, 2017). Efficient service sectors are essential for the revival and competitiveness of the manufacturing sector (Eifert et al 2005; OECD, 2015; cf. Beverelli et al. 2017).

The contribution of services to growth and development is interesting in all regions of the world economy. It is of special relevance for developing regions such as sub-Saharan Africa, characterised by low development levels as well as early deindustrialisation and the expansion of services at low levels of GDP per capita. The question of whether services can play a positive role in economic development is especially pressing in Africa.

This chapter, therefore, takes a two-pronged approach. It analyses tertiarisation in the global economy, but also zooms in on tertiarisation in developing countries in sub-Saharan Africa, representing low-income economies. African economies are characterised by early deindustrialisation and an increasing share of services in GDP at low levels of per capita income. Countries in sub-Saharan Africa have deindustrialized since 1990[39] and recent decades have not seen many encouraging recoveries. Additionally, productivity growth in manufacturing has slowed down rather than increased, particularly among small firms that create the most manufacturing jobs in the region (Cadot et al. 2015; Rodrik 2016; Mensah et al., 2018; Diao et al., 2020). Given that manufacturing still serves as a major engine of growth (Szirmai & Verspagen 2015; Naudé, 2018), policies aimed at not only improving the productivity in the sector but also returning Africa to a path of industrialisation have been rolled out in various African countries. For the realization of this goal, improved efficiency in services is also important.

The region's service sector continues to expand (Mensah et al., 2018)[40]. Supported by technical progress and the strategic importance of the sector to the region's economy, the continuous rise of Africa's service sector could offer new development opportunities (Ghani & O'Connell 2014; De Vries et al. 2015; Stiglitz 2018[41]; Mensah et al. 2018; Newfarmer et al. 2018).[42] This has generated a great deal of euphoria and optimism regarding the sector's role in the development of the region.

Therefore, the question of whether services can play a positive role in economic development merits special attention in the sub-Saharan African context.

[39] When using output shares.

[40] Around 30 percent of the labour force in sub-Saharan Africa is employed in the service sector compared to around 7.5 percent for the manufacturing sector. The agriculture sector still employs around 56 percent of the region's labour force. In terms of value-added contributions, the service sector contributes about 59 percent of the region's value-added (comprising 43% from market services and 16% from non-market services) compared to around 17 and 12 percent value-added contributions from the agriculture and manufacturing sector respectively (see Mensah et al. 2018).

[41] Stiglitz (2018), http://acetforafrica.org/debate/who-said-what/services-not-manufacturing-will-be-growth-sector-for-africa-stiglitz-says/ (Accessed 30/08/2019).

[42] Carmignani & Mandeville (2014) use aggregate data for 51 African countries for the period 1960-2008 and find that countries with increasing service sector growth have achieved the highest growth rates for the period considered.

A number of key questions inform the analysis in this chapter:

1. Is the service sector as a whole a dynamic or a stagnant sector?
2. Are there subsectors of services which can act as engines of growth?
3. What are the contributions of services to the performance of other sectors and vice versa?

These questions require an analysis of long-run trends in structural change and productivity in major sectors. They are addressed in a review of the secondary literature as well as by using newly constructed tables and statistical analysis of global and African data.

Previewing our results, we find that perceptions of services as stagnant and productivity resistant are not applicable to all service sub-sectors. Productivity growth in modern, dynamic, and tradable services is equal to or higher than that in manufacturing and other sectors. These service sectors are innovative and might act as new or alternative engines of growth alongside manufacturing. We also find robust evidence of strong inter-sectoral linkages between services and manufacturing. The manufacturing sector in Africa still generates the strongest multipliers, including to market services. However, much of the manufacturing linkages are captured by foreign countries. While the multipliers in market services are relatively lower than those of manufacturing, they are comparable to those in many other regions of the world economy and more of the gains are captured by domestic firms which could encourage a self-reinforcing pattern of market service development. Finally, we also find robust evidence of strong inter-sectoral linkages between the service sector and manufacturing.

The remainder of the chapter is structured as follows: Section 4.2 discusses the rise of the service sector in the global economy; Section 4.3 zooms in on tertiarisation in sub-Saharan Africa by discussing and analysing structural change, inter-industry linkages, service sector efficiency, and industrial performance. Section 4.4 summarizes and concludes.

4.2. A Review of the Role of the Service Sector in the Global Economy

Colin Clark (1940) was one of the first economists to provide detailed statistics on the process of structural change in the context of the emerging art of national accounting. For Clark, the stages of economic development included transitions from the dominance of the primary sector (agriculture, mining) to the secondary sector (manufacturing) and subsequently services. Clark has influenced subsequent analysts of growth and development such as Kuznets, Rostow, and Maddison. Advanced economies are presently dominated by services, which account for around 70 percent of GDP, while the role of services in developing and emerging economies is also rapidly increasing.

Table 4.1 provides information on the share of major sectors in the global economy from 1950 to 2015. We distinguish six sectors: agriculture, mining, manufacturing, other industry, market services, and non-market services. The table shows that there has been a global decline in the share of agriculture. Manufacturing shows a slight increase in its share until 1965, followed by a decrease thereafter. The share of services increases systematically from 41.4% to 55% of GDP. In sum, there is a gradual tertiarisation of the global economy. This aggregate table ofcourse masks major differences

between some advanced economies with very high shares of services and many developing countries with lower, though increasing shares of services. In Africa and Latin America, the service sector accounts for almost 60 percent of GDP while accounting for almost half of GDP in Asia.[43]

Table 4.1: Sectoral Value-Added Shares in Global GDP (Percent)

Year	Sectors					
	Agriculture	Mining	Manufacturing	Other Industry	Market Services	Non- Market Services
1950	31.9	5.3	16.8	6.0	27.3	14.1
1955	28.6	5.5	18.0	6.5	28.5	14.5
1960	24.4	6.4	19.4	7.3	29.0	14.8
1965	23.9	6.4	19.4	7.5	28.7	15.4
1970	22.5	6.0	18.1	7.5	30.5	15.4
1975	21.1	9.1	17.2	7.9	29.8	15.0
1980	18.3	10.3	17.5	8.3	30.0	16.2
1985	17.6	8.5	18.1	7.8	31.8	16.5
1990	17.8	7.4	18.6	8.3	31.6	16.6
1995	16.4	6.5	17.6	8.1	35.5	15.8
2000	14.9	8.1	16.2	7.7	36.5	16.5
2005	13.3	8.9	15.4	8.1	37.5	16.2
2010	14.7	9.1	14.2	8.3	36.8	16.5
2015	18.5	6.7	12.7	9.8	39.5	15.5

Note: Shares are weighted average of country sectoral value-added shares at current international PPP dollars
Source: Szirmai, Structural Change Database, https://www.merit.unu.edu/themes/3-economic-development-innovation-governance-and-institutions/structural-change-database-1950-2016/)

One of the most important issues in the discussion of structural change is whether the service sector is a stagnant sector with low productivity growth and little scope for technological advancement. In modern terminology, is the structural shift to the service sector growth-enhancing or growth reducing (McMillan & Rodrik 2011; Rodrik 2016; Diao et al., 2017). Baumol (1967) categorizes economic activity into two classes, namely the technological progressive manufacturing sector and the technologically stagnant service sectors. At the deindustrialisation stage, employment and value-added shares in manufacturing fall, while employment and value-added shares in services rise.

According to Baumol,[44] deindustrialisation and the resultant tertiarisation will depress and slow down economy-wide growth, given that the productivity growth of the rising but technologically stagnant service sector is not rapid enough to compensate for the decline in the size of the manufacturing sector. The perception of services as a stagnant sector was enhanced by Solow who in a famous article

[43] Authors' calculations using data from Groningen Growth and Development Centre (GGDC). Shares of value-added are weighted average shares.
[44] Baumol (2002) rectified his initial position and admitted that the service sector is very heterogeneous and dynamic and that there are some services activities that have growth rates and productivity gains similar to, or even greater than, those of the manufacturing sector, emphasizing the role of technology and innovation in the evolution of services.

in the New York Review of Books (1987) wrote: 'You can see the computer age everywhere but in the productivity statistics.'

The view that the computer, communications and IT sector are technologically stagnant has since been criticised (Acemoglu et al., 2014; Lavopa & Szirmai, 2018 and in this chapter). According to Acemoglu et al (2014), IT services and the sectors making use of these services are experiencing major increases in productivity. But productivity increases are associated with declining output and even more rapidly declining employment. Lavopa & Szirmai make a distinction between modern market services (such as transport, storage, communication, financial, and business services) and non-modern services (such as restaurants, government, education, health care, and personal services).[45] Modern market services are very dynamic and can serve as engines of growth alongside manufacturing. Conversely, non-modern service activities are considered relatively stagnant, in which productivity improvements may take the form of quality reductions or the provision of fewer services for the same price.

Table 4.2 provides an overview of sectoral productivity trends in the global economy, with some interesting results immediately obvious. Productivity growth in services is just as high as in manufacturing (1.7% per year). But productivity levels in manufacturing are substantially higher than in services. Within the service sector, there is a huge gap between productivity growth in market services (2.3%) and non-market services (0.7%). Some service sectors are thus highly dynamic, while others are typical Baumol-type service sectors where productivity is very low and stagnant. Mining and construction have negative productivity growth in the long run. Agriculture has very low productivity growth (0.5%). Note that these are global averages that mask large differences between regions and between advanced and developing economies. Thus, in advanced economies productivity growth in agriculture has been more rapid than in manufacturing since 1973. The same is true for many middle-income countries in Asia and Latin America (Szirmai, 2012).

Table 4.2 helps us in our assessment of whether Baumol was right in his perspective of the service sector as a depressant on the rate of economic growth. On balance, our data in Table 2 indicate that he did not get it right. It is true that part of the service sector consists of personal services with relatively slow productivity growth (0.7%). It is hard to improve the productivity of musicians, educators, doctors, government administrators, psychiatrists, or lawyers. But these services (also referred to as non-market services) only account for a limited part of the service sector (15.5% in 2015, see Table 4.1). The service sector also includes very dynamic service sectors that show increasing returns, productivity growth and high rates of innovation. Productivity growth in market services was 2.3%. The average productivity growth in total services was 1.7%, just as high as in manufacturing.

[45] The use of the terms modern and non-modern can be qualified. Government, health and education are clearly modern. Lavopa & Szirmai (2018) provide justifications for the terms in the context of the study of development.

Table 4.2: Labour Productivity in Major Sectors of the Global Economy, 1965-2010

Sectors	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	Growth rate
Agriculture	1615	1669	1639	1368	1460	1521	2132	2120	2044	1991	
	100	103	101	85	90	94	132	131	127	123	0.5
Industry	2009	1863	1776	1686	1543	1467	1473	1567	1871	2191	
	100	93	88	84	77	73	73	78	93	109	0.3
Mining	3110	2214	1853	1707	1320	1085	862	778	1127	2016	
	100	71	60	55	42	35	28	25	36	65	-1.0
Manufacturing	2076	2636	2752	2833	2951	2979	3239	3660	4172	4505	
	100	127	133	136	142	143	156	176	201	217	1.7
Utilities	197	285	435	503	515	457	510	520	580	576	
	100	145	221	255	261	232	259	264	294	292	2.4
Construction	2651	2317	2066	1702	1387	1349	1279	1308	1606	1668	
	100	87	78	64	52	51	48	49	61	63	-1.0
Services	1498	1695	1753	1951	1976	1980	2125	2478	2887	3250	
	100	113	117	130	132	132	142	165	193	217	1.7
Market Services	1359	1545	1652	1926	2010	2084	2292	2834	3376	3843	
	100	114	122	142	148	153	169	209	248	283	2.3
Trade	1851	2119	2247	2514	2707	2831	3005	3756	4486	4842	
	100	114	121	136	146	153	162	203	242	262	2.2
Transport	747	818	847	957	959	993	1103	1378	1763	2596	
	100	110	113	128	128	133	148	184	236	348	2.8
FIRBS	1478	1697	1860	2306	2362	2428	2766	3369	3880	4090	
	100	115	126	156	160	164	187	228	263	277	2.3
Non-Market Services	1707	1919	1906	1989	1924	1825	1874	1943	2154	2362	
	100	112	112	117	113	107	110	114	126	138	0.7
Government	2889	3216	3168	3299	3136	2934	2971	3044	3397	3823	
	100	111	110	114	109	102	103	105	118	132	0.6
Personal	526	622	645	678	713	716	778	841	911	901	
	100	118	123	129	136	136	148	160	173	171	1.2

Note: The table reports labour productivity in both levels (weighted averages) and as index numbers (1965=100). Labour productivity is measured as value-added at constant 2005 PPP dollars divided by employment, weighted by sector shares in global employment. Growth rates are annual compound growth rates. The table is based on weighted averages for 42 countries.
Source: Author's calculations using data from Groningen Growth and Development Centre, Ten-Sector Database, https://www.rug.nl/ggdc/productivity/10-sector/

In the traditional literature on services, the service sector emerges at a late stage of development, after the share of manufacturing in GDP has started to decline. This paints a passive picture of the service sector as a latecomer. In the recent literature, services are seen as contributing much more positively to the dynamism of other sectors, both in the past and in the present (e.g. Marks, 2009). Oulton (2001) argued that Baumol arrived at simplistic conclusions because he thought the sector produced only final outputs. Oulton instead considered a case where most rapidly expanding service sectors (producer services) produce intermediate inputs for the manufacturing sector.[46] He concluded that deindustrialisation will not depress economic growth as long as productivity growth in the service sectors that feed manufacturing remains positive. Francois and Reinert (1995), Francois and Woerz (2008), and the OECD (2015) emphasized that services play a major role in boosting manufacturing performance. Efficient service sectors are essential for the revival and competitiveness of manufacturing sectors.[47]

The density of inter-industry linkages between manufacturing and services has continued to increase rapidly in recent decades (Francois & Woerz, 2008; O'Mahony & Timmer, 2009). On the output side, manufacturing firms increasingly offer services in combination with their products and/or services that are embedded in new manufactured products (Knudsen, 2002; Neely, 2008; Lanz & Maurer, 2015). Similar observations are made in the service usage intensity (intermediate inputs) across manufacturing industries (Lanz & Maurer, 2015; Di Berardino & Onesti, 2018). The increase in the use of services in manufacturing has also increased the demand for different categories of service occupations (producer services) in manufacturing (Falk & Peng, 2013). The role of ICT and ICT investment in explaining the increasing share of intermediate service inputs in manufacturing is also highlighted (Broersma & van Ark, 2007).

The dual role of services in the structure of production is also analysed by Bryson and Daniels (2010). According to these authors, services are incorporated in the structure of manufacturing production as intermediate inputs (production-related services) and as services developed to support products (product-related services, such as software, and training and maintenance support for new products). Production-related services typically include well-functioning information and telecommunication (ICT) systems and solutions, transportation insurance, finance and business services, legal consulting services, and maintenance and support services. The key message emerging from these studies is that services play a major role in the structure of production. Inefficient service delivery or disruptions in the provision of services result in costly delays in production and product delivery in manufacturing industries (Arnold et al., 2008; Arnold & Lipscomb, 2016).

There are several channels through which the efficiency of services affects the performance of manufacturing firms. For instance, both the agricultural and industrial sectors need efficient 'network'

[46] Another issue regarding the rise of the service sector in the global economy is correct measurement. In the past, many service activities used to be performed in-house within manufacturing establishments. As they began to be outsourced, this created the statistical illusion that the service sector was increasing its share in value added. What percentage of the increase in the service sector share is due to this statistical illusion still needs to be ascertained.
[47] See Oulton (2001) and Sasaki (2007) for the theoretical derivation of this relationship.

services, such as cargo transport, transportation insurance, and finance and business service systems for transfers between buyers and sellers, a well-functioning telecommunication infrastructure to monitor the delivery and receipt of goods, legal consulting services to take care of licenses, patents, and franchise issues, the availability of human capital, and finally, government services that guarantee property rights and contract enforcement and boost investor confidence. Overall, the service sector is the cement that binds the other sectors together (cf. Marks, 2009).

Efficient telecommunication systems make it easy for firms to coordinate effectively with clients and suppliers. They improve access to and use of information which reduces search costs and coordination difficulties among firms and clients, thereby increasing market efficiency. Efficient telecommunication systems also help downstream manufacturing firms to manage their supply chains (Aker & Mbiti, 2010). An adequate and uninterrupted power supply ensures production lines are uninterrupted and production assets are not left to lie idle. A combination of these mechanisms has major effects on the performance of downstream manufacturing firms (Arnold et al., 2008).s

Guerrieri and Meliciani (2005) find important complementarities in the organisation of manufacturing production and the use of service intermediate inputs. The authors show that knowledge-intensive industries (e.g., office and computing machinery, electrical apparatus and radio, TV and communication equipment, and industrial chemical and drugs) use more producer services. Labour and scale-intensive manufacturing industries appear to use less producer services. Based on such findings, the authors recommend that countries identify which service sectors are more important for specific manufacturing sectors and work towards developing a strong linkage effect between them (Guerrieri & Meliciani 2005, p. 493).

Park (1989) computes service usage intensities across manufacturing industries of both advanced and South East Asian developing countries. His findings reveal that although relatively small, the manufacturing sector obtained a considerable amount of its inputs from service industries. These services constitute a huge chunk of total intermediate input sales (forward linkages) of individual service industries needed to sustain the growth of output and employment in those service industries. Service sector reforms and the innovation that comes with them are found to have significant positive impacts on downstream manufacturing industries (Arnold et al., 2011; Duggan et al., 2013; Arnold & Lipscomb, 2016).

In a related study, Di Berardino and Onesti (2018) use an Input-Output (I-O) framework for seven large countries with high shares of manufacturing and services (Germany, Italy, France, Spain, the United Kingdom, and the United States) to provide evidence of the trend towards integration between manufacturing and services. The authors find that 'the service sector has become an important provider of intermediate inputs in the economic system whereas the opposite is true for manufacturing.' (Di Berardino & Onesti 2018, p. 8). This trend is, however, found to be both gradual and slowing down temporally, primarily as a result of the financial crisis in 2008. The findings hold for all countries irrespective of the choice of beginning and end years in the analysis (Timmer et al. 2014; Di Berardino & Onesti, 2018).

Moving from inter-industry to intra-industry transactions, a high level of intra-industry transactions is found across countries in services: United States (50%), Philippines (46%), Japan (42%), Korea (34%), Malaysia (31%), and Singapore (30%). This signifies a high degree of complementarity among service industries (Park, 1989). The demand for service intermediate inputs increases in tandem with overall development as seen in many advanced and developing economies.

At the establishment level, there is evidence of a significant and positive relationship between the performance of service industries and the productivity of manufacturing firms. This supports the argument that improvements in the technical efficiency of services and the availability and accessibility of quality services inputs translate into a positive performance of downstream manufacturing firms (Arnold et al., 2008; OECD, 2015).

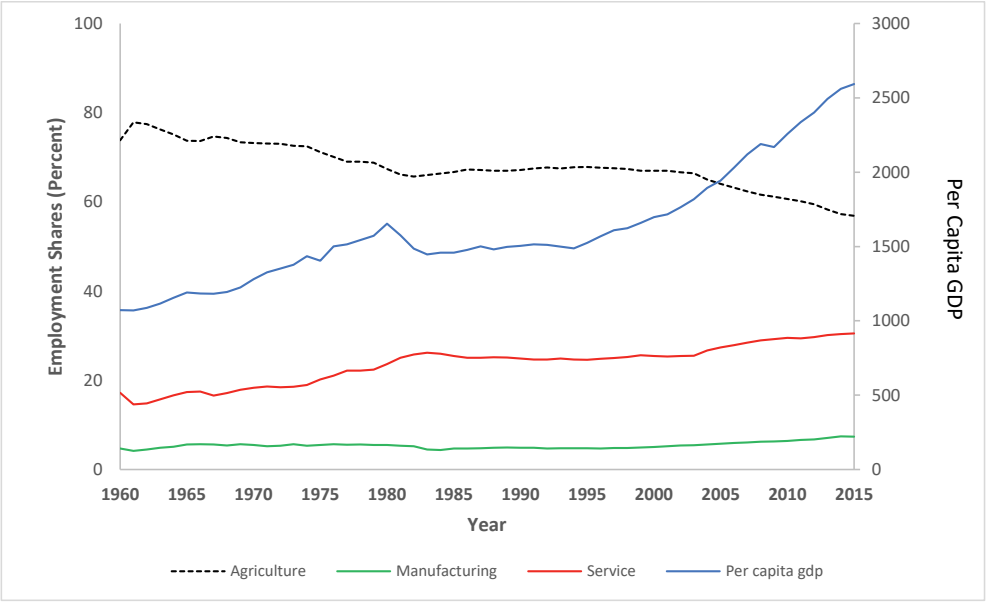
The findings and recommendations in these papers are very important for designing sector-specific policies particularly in sub-Saharan Africa where manufacturing firms are highly informal, small, have low productivity levels and growth rates, produce non-traded goods, export little, and only have competitive advantages in low-tech manufactures (Harrison et al., 2014). In Ethiopia and Senegal, the share of informal employment in overall manufacturing employment is 94 percent. Compared to modern manufacturing firms, these small informal firms do not have access to modern and sophisticated technology, markets, and finance (Rodrik, 2016). With the service sector becoming increasingly important in the region (Carmignani & Mandeville, 2014), and given the sector's mutually reinforcing interaction with the manufacturing sector, the growing service sector could potentially play a significant complementary role in the prospects for industrialisation of Africa. But this potential remains to be realized.s

4.3 The Role of the Service Sector in Sub-Saharan Africa

4.3.1 Structural Change, Labour Productivity and Per Capita Income in Sub-Saharan Africa

Figure 4.1 plots employment shares in agriculture, manufacturing, and services (on the left-hand axis) and the per capita income of eighteen sub-Saharan African (SSA) economies (on the right-hand axis). Figure 4.1 illustrates the consumption-income relationship that is one of the drivers of structural change. Employment data are from the updated and expanded GGDC ASD—Expanded Africa Sector Database (EASD) (Mensah & Szirmai, 2018). Income data are from the World Bank's World Development Indicators. An increase in per capita income is associated with a continuous but steady decline in the share of agricultural employment in the region. The continuous fall in agricultural employment in the region is welcome news as productivity growth in the sector is much lower than in manufacturing and services and has not changed much since independence (Gollin et al., 2014; Mensah et al., 2018). Table 4.3 provides a more detailed breakdown of six major sectors.

Figure 4.1: Weighted Average Sectoral Employment Share and Per Capita Income in Africa



Note: Sectoral shares weighted by country shares in total employment. GDP Per Capita is Constant 2010 US$.
Source: Author's calculation based on the 18 sub-Saharan Africa countries in the EASD and World Bank WDI.

Table 4.3: Employment Shares in Africa, 1960-2015

Year	Sectors					
	Agriculture	Mining	Manufacturing	Other Industry	Market Services	Non- Market Services
1960	73.8	2.1	4.7	2.2	12.3	4.9
1965	73.7	1.6	5.6	1.8	11.3	6.1
1970	73.2	1.2	5.5	1.8	10.3	8.0
1975	71.2	1.0	5.5	2.1	10.8	9.4
1980	67.4	1.2	5.5	2.2	13.2	10.4
1985	66.7	1.2	4.7	1.9	14.7	10.8
1990	67.1	1.2	4.9	1.9	15.4	9.5
1995	67.8	0.9	4.8	1.9	15.4	9.2
2000	67.0	0.6	5.1	1.9	15.5	9.9
2005	64.0	0.6	5.8	2.2	17.3	10.0
2010	60.7	0.7	6.4	2.8	19.2	10.3
2015	56.9	0.8	7.4	4.5	20.0	10.5

Note: Shares are weighted average shares in aggregate total employment. See Table 2.1 in chapter 2 for the unweighted average employment shares.
Source: Author's calculation based on the 18 sub-Saharan Africa countries in the EASD.

As economies achieve higher levels of per capita income, income growth drives the demand for services given the high-income elasticity of demand for services. Empirical evidence shows that real per capita incomes and real consumption are growing in Africa (Young, 2012). This trend is likely to generate further increased demand for services together with rising demand for service intermediate inputs by other economic sectors. This is a long-recognized feature of the historical experience of development across countries (see, for example, Lewis, 1954; Kuznets, 1966; Chenery & Taylor, 1968; Park, 1989; Foster-McGregor & Verspagen, 2016; Diao et al., 2017).

The manufacturing employment share remains relatively small in the region. Traditionally, the share of manufacturing employment increases, but after reaching a peak gradually declines as economies transit to high-income status (Foster-McGregor & Verspagen, 2016). Available data indicate that in the UK and Germany, manufacturing's share of employment peaked at more than 30 percent (between 1961 and 1970), with peaks of around 25 percent in Japan (in 1973), South Korea (in 1988), and the US (in the 1950s). In China, the labour share reached 15.8 percent in 1990 and subsequently continued to increase to 18.4 percent in 2014, albeit with some ups and downs. In the UK, Sweden, and Italy peaks were reached at income levels of around $14,000 in 1990 dollars (Rodrik, 2016). In sub-Saharan Africa, many economies have experienced early deindustrialisation reaching the peak and turning point of industrialisation at low income levels, examples including South Africa (17%), Ghana (13%), and Mauritius (32%) in the 1990s at an absurdly low average per capita income of between $500 and $700 (Cadot et al., 2016; Rodrik, 2016). In many other SSA countries, industrialisation has never lived up to expectations. Although the share of manufacturing has sometimes increased in some countries, one cannot call such trends successful industrialisation (Mensah & Szirmai, 2018; Naudé, 2018). An interesting phenomenon is that in ten SSA countries manufacturing labour shares continued to increase until 2015. This helps us understand the modest labour productivity increase in manufacturing.

Whether or not sub-Saharan Africa represents a clear case of premature deindustrialisation remains open to debate. It was premature in the sense that the decline in value-added shares took place at very low levels of per capita income. But the average manufacturing share in 1990 was a quite respectable 19.6 percent (see Table 4.4) and labour shares continued to increase until 2015 (see Table 4.3). Naudé (2018) paints a more positive picture of African manufacturing, arguing that its share is more stable than in other regions, with manufacturing value added increasing in absolute terms. New technologies are providing new windows of opportunity. But the overall picture remains rather bleak.

Table 4.4: Value-Added Shares in Africa, 1960-2015

Year	Sectors					
	Agriculture	Mining	Manufacturing	Other Industry	Market Services	Non- Market Services
1960	25.1	6.7	14.5	5.3	33.4	15.0
1965	44.5	3.5	10.6	6.2	25.1	10.1
1970	40.1	3.1	12.2	6.1	27.6	10.9
1975	32.5	4.8	14.8	6.6	29.0	12.2
1980	27.2	9.4	15.7	6.0	29.1	12.5
1985	22.5	7.6	17.9	6.1	30.9	14.9
1990	16.9	7.0	19.6	6.7	33.2	16.6
1995	18.8	7.1	16.7	5.8	35.6	16.0
2000	16.7	8.9	15.0	5.2	36.7	17.5
2005	18.5	9.0	12.5	5.0	40.1	15.0
2010	19.8	9.7	9.4	6.0	41.2	13.8
2015	19.7	5.6	9.1	8.3	43.0	14.2

Note: Weighted average sectoral value-added shares converted into current international PPP dollars.
Source: Author's calculation based on the 18 sub-Saharan Africa countries in the EASD.

Productivity trends are presented in Table 4.5. The results are quite striking. Productivity growth in services (1.6%) is higher than in manufacturing (0.5%), although the levels of productivity in manufacturing remain slightly higher. Dynamic service sectors such as transport and finance have the highest productivity growth rates. Both Agriculture and mining have low productivity growth (0.1%). Diao et al (2018) note that the marginal increase in productivity in the agricultural sector is associated with a decline in employment shares in the sector.

Table 4.5: Labour Productivity in Major Sectors of the African Economy, 1965-2010

Sectors	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	Growth
Agriculture	22215	21109	22624	17499	18870	21397	34688	31117	27295	23114	
	100	95	102	79	85	96	156	140	123	104	0.1
Industry	675146	525254	579210	447339	367756	314274	273057	308082	415417	620968	
	100	78	86	66	54	47	40	46	62	92	-0.2
Mining	2754927	1950232	2070787	1414275	1026877	863604	626943	658958	1412073	2843836	
	100	71	75	51	37	31	23	24	51	103	0.1
Manufacturing	146356	190329	215241	171376	235643	225796	177877	182904	187822	182940	
	100	130	147	117	161	154	122	125	128	125	0.5
Utilities	271947	485458	921203	1068282	878846	746899	823587	1042048	900933	937201	
	100	179	339	393	323	275	303	383	331	345	2.8
Construction	1552495	1050381	846675	476882	432406	363157	282546	272136	406582	382228	
	100	68	55	31	28	23	18	18	26	25	-3.1
Services	84260	86360	96653	124314	92733	85716	97724	117617	129604	173207	
	100	102	115	148	110	102	116	140	154	206	1.6
Market Services	123408	135273	158146	216415	155527	141392	165628	211339	226445	281990	
	100	110	128	175	126	115	134	171	183	229	1.9
Trade	102991	101777	110945	101729	106904	114724	104542	153539	184792	201109	
	100	99	108	99	104	111	102	149	179	195	1.5
Transport	300256	277447	244921	185612	177786	209786	189033	247474	314644	704628	
	100	92	82	62	59	70	63	82	105	235	1.9
FIRBS	213594	296950	434675	794573	492783	382268	534399	655450	632507	503782	
	100	139	204	372	231	179	250	307	296	236	1.9
Non-Market Services	77403	68341	68040	71229	60530	58916	61623	59179	73255	123734	
	100	88	88	92	78	76	80	76	95	160	1.0
Government	212436	185546	186868	201586	169098	161896	170925	161897	199273	339160	
	100	87	88	95	80	76	80	76	94	160	1.0
Personal	19675	19391	17164	12007	12412	14777	13864	15563	20399	31883	
	100	99	87	61	63	75	70	79	104	162	1.1

Note: The table reports labour productivity in both levels (unweighted averages) and as index numbers (1965=100). Labour productivity is measured as value-added at constant 2005 PPP dollars divided by employment. Growth rates are annual compound growth rates.
Source: Groningen Growth and Development Centre, Ten Sector Database, https://www.rug.nl/ggdc/productivity/10-sector/

4.3.2. Productive Efficiency

Reducing the distance to productive best practice is an important source of potential productivity change in developing countries. If countries are successful in absorbing state of the art technologies from more advanced economies, rapid catch up can be realized. This depends ofcourse on developing the right kind of capabilities (Abramovitz, 1989; Lee, 2019).

In the section, we use data envelopment analysis (DEA) to measure the productive efficiency of the service, manufacturing, and agriculture sectors—a set of decision-making units (DMUs) with labour as the input. The DEA approach of measuring productive efficiency constructs a virtual production frontier for the sample of DMUs and associated efficiency indexes of individual DMUs. By constructing a production frontier, we are able to measure how far or close each sector in African countries is to the African production frontier and by how much inefficient sectors need to adjust their production technology to become efficient (Kumar & Russell, 2002; Coelli et al., 1998; Wang & Lan, 2011). All sectors of the economy operating below the production frontier are considered to be technically inefficient as the labour input yields output smaller than what could have been produced. Technically efficient sectors operate on the production frontier, and thus have an efficiency index of 1, while technically inefficient sectors have an efficiency index of less than 1. Note that technical efsficiency is a comparative concept. It does not take movements of the frontier into account.

We calculate the Farrell (output-based) technical efficiency index of DMUs (countries and sectors) by solving the linear programming problem for each observation. We assume output is produced by labour and capital inputs at the economy-wide level and only by labour at the sectoral level. We also assume free disposability of inputs and outputs. We compute the efficiency indexes under constant returns to scale (CRS) (see the appendix for DEA equation and explanation).

The sectoral analysis uses only labour and output for the analysis due to the unavailability of data on capital at the sector level. Data on capital are however available at the country level. We, therefore, start the analysis at the economy-wide level where we measure the productive efficiency of each of the African economies relative to a virtual technology frontier using both labour and capital as inputs for 1970 and 2014 across the set of African countries.

The rationale for doing a regional DEA for Africa, rather than measuring efficiency relative to the global frontier is as follows. A regional DEA shows whether or not African economies are converging on each other. If efficiency is increasing over time, countries are getting closer to African best practice. A regional DEA might make more sense than a global DEA, because the technology gap with world best practice is so huge (Figure 2) that rapid catch-up based on the absorption of international capital is very unlikely. In other words, the degree of technological congruence with the technology of the global frontier being too small, with African countries potentially having more to learn from regional leaders.

Table 4.6 shows that no African country is on the African production efficiency frontier. This reflects the widespread technical and allocative inefficiencies on the continent.[48] The average productive efficiency in the region has remained almost unchanged since the 1970s. While it improved in many countries, it declined in others. Between 1970 and 2014, productive efficiency dropped by as much as 0.49 points in Zambia, 0.34 points in Lesotho, and 0.33 points in Ethiopia. In Nigeria, Namibia and South Africa productive efficiency increased by 0.16, 0.10, and 0.6 points respectively.

Table 4.6: Productive Efficiency in Africa: Economywide Analysis, 1970 and 2014

DMU	Year	Smoothed Homogeneous			Smoothed Heterogeneous			Sub-Sampling		
		BC	LB	UB	BC	LB	UB	BC	LB	UB
Africa	1970	0.62	0.47	0.70	0.60	0.46	0.68	0.63	0.46	0.71
	2014	0.63	0.48	0.70	0.60	0.45	0.68	0.63	0.45	0.70
Botswana	1970	0.65	0.53	0.73	0.66	0.56	0.72	0.66	0.54	0.73
	2014	0.82	0.53	0.98	0.74	0.37	0.94	0.90	0.48	1.00
Burkina Faso	1970	0.71	0.56	0.8	0.65	0.49	0.77	0.75	0.57	0.81
	2014	0.75	0.63	0.82	0.72	0.60	0.81	0.75	0.59	0.82
Cameroon	1970	0.43	0.35	0.48	0.43	0.37	0.47	0.43	0.35	0.47
	2014	0.89	0.75	0.98	0.87	0.73	0.96	0.90	0.73	1.00
Ethiopia	1970	0.73	0.54	0.85	0.65	0.46	0.81	0.78	0.57	0.86
	2014	0.35	0.29	0.38	0.33	0.27	0.37	0.35	0.27	0.37
Ghana	1970	0.19	0.14	0.22	0.19	0.14	0.22	0.19	0.12	0.22
	2014	0.37	0.30	0.42	0.39	0.33	0.42	0.38	0.29	0.43
Kenya	1970	0.38	0.30	0.43	0.39	0.32	0.43	0.39	0.27	0.44
	2014	0.63	0.53	0.69	0.61	0.51	0.68	0.63	0.51	0.70
Lesotho	1970	0.88	0.72	0.98	0.89	0.75	0.96	0.90	0.73	0.97
	2014	0.53	0.43	0.59	0.55	0.45	0.60	0.54	0.38	0.60
Malawi	1970	0.47	0.38	0.52	0.44	0.35	0.50	0.48	0.39	0.52
	2014	0.32	0.27	0.35	0.31	0.26	0.35	0.32	0.26	0.35
Mauritius	1970	0.54	0.40	0.61	0.54	0.4	0.60	0.53	0.33	0.61
	2014	0.82	0.55	0.98	0.75	0.4	0.92	0.90	0.49	1.00
Mozambique	1970	0.82	0.65	0.92	0.75	0.58	0.88	0.86	0.67	0.92
	2014	0.75	0.62	0.81	0.71	0.59	0.80	0.75	0.59	0.81
Namibia	1970	0.63	0.44	0.74	0.62	0.42	0.73	0.64	0.37	0.75
	2014	0.73	0.52	0.84	0.67	0.4	0.82	0.77	0.44	0.84
Nigeria	1970	0.69	0.56	0.76	0.69	0.59	0.75	0.69	0.57	0.76
	2014	0.85	0.67	0.99	0.89	0.75	0.97	0.87	0.66	1.00
Rwanda	1970	0.80	0.54	0.98	0.71	0.45	0.86	0.87	0.62	1.00
	2014	0.83	0.62	0.81	0.71	0.59	0.80	0.74	0.58	0.81
Senegal	1970	0.63	0.48	0.71	0.64	0.50	0.70	0.62	0.40	0.72
	2014	0.58	0.47	0.65	0.60	0.51	0.64	0.58	0.46	0.65

[48] The DEA defines the frontier as the best possible outcome using a given set of inputs. Thus, even a country with the highest productivity in the sample could have an efficiency of less than one.

South Africa	1970	0.77	0.49	0.98	0.77	0.47	0.93	0.82	0.47	1.00
	2014	0.83	0.57	0.97	0.76	0.43	0.94	0.90	0.50	0.98
Tanzania	1970	0.35	0.28	0.38	0.35	0.30	0.38	0.35	0.29	0.38
	2014	0.32	0.26	0.36	0.33	0.29	0.36	0.32	0.26	0.36
Uganda	1970	0.55	0.47	0.61	0.54	0.44	0.59	0.57	0.47	0.61
	2014	0.43	0.36	0.48	0.42	0.35	0.47	0.43	0.35	0.48
Zambia	1970	0.85	0.67	0.98	0.88	0.72	0.97	0.88	0.63	1.00
	2014	0.38	0.30	0.43	0.39	0.30	0.43	0.39	0.27	0.43

Notes: Inputs are capital and labour; BC refers to the bias-corrected radial measures of technical efficiency; LB refers to the lower-bound estimate for radial measures of technical efficiency; and UB to the upper-bound estimate for radial measures of technical efficiency. Smoothed homogeneous, smoothed heterogeneous and sub-sampling are all bias correction bootstrapping techniques implemented to provide valid statistical inference or correct the biasedness in the computed technical efficiency (TE) scores (see Badunenko & Mozharovskyi 2016).
Source: Author's calculation based on the 18 sub-Saharan Africa countries in the EASD PWT 9.0.

In Table 4.7, we examine the extent to which the patterns of productive efficiency in Table 4.6 together with technological change have contributed to the total productivity growth of each of the 18 countries in our sample. To do this, we use the output-based Malmquist Productivity Index (MPI). The MPI measures changes in productivity performance that are not a consequence of the growth in input quantities but rather to changes in efficiency (catch-up) and changes in technology (shift of the frontier) (Färe et al., 1992). We subsequently apply proportions of efficiency growth and growth of technology to real rates of total factor productivity growth. Table 4.7 shows important differences in TFP growth performance in Africa ranging from a high of 0.58 percent annual growth in Botswana to a low of 0.12 percent in Ghana and Kenya. On average, TFP growth is modest, but always positive. There are interesting differences in the role of efficiency and technical change. In twelve of the eighteen countries, efficiency change is more important than technological change, sometimes by a wide margin (as in Burkina Faso, Cameroon, and Rwanda). In five countries technical change makes the largest contribution, most notably in Namibia and Zambia[49]

[49] Results for Mauritius, Nigeria, and Zambia are quite puzzling. One would expect the contribution of technological change to productivity growth to be higher in Mauritius and less in Nigeria and Zambia.

Table 4.7: Contribution of Technological and Efficiency Growth to Total Factor Productivity Growth in Africa

Country	Total Productivity Growth (1970-2014, percent)	Growth of Technology (percent)	Growth of Efficiency (percent)
Botswana	0.58	0.30	0.28
Burkina Faso	0.20	0.04	0.16
Cameroon	0.15	0.03	0.12
Ethiopia	0.23	0.09	0.14
Ghana	0.12	0.04	0.08
Kenya	0.12	0.06	0.06
Lesotho	0.37	0.17	0.20
Malawi	0.21	0.06	0.14
Mauritius	0.35	0.13	0.22
Mozambique	0.20	0.09	0.11
Namibia	0.29	0.20	0.09
Nigeria	0.17	0.09	0.08
Rwanda	0.22	0.05	0.17
Senegal	0.16	0.07	0.09
South Africa	0.17	0.10	0.07
Tanzania	0.20	0.09	0.11
Uganda	0.23	0.08	0.15
Zambia	0.27	0.21	0.06

Note: We first estimate TFP growth and decompose the TFP growth into contributions due technology change and due to efficiency change using the proportions from the results of the Malmquist. Both labour and capital are used in the estimate of TFP and in the Malmquist. Total productivity growth now equals the sum of technology growth and efficiency growth. Growth refers to compound growth rates. In terms of contribution of efficiency change to TFP growth, results in Table 4.7 are similar to those reported in Table 3.4 in chapter 3 (although not exactly in terms of magnitude as we use different approaches. Whiles Table 4.7 focuses on TFP growth, Table 3.4 on the other hand focuses on dynamic TFP growth catch-up). In both tables for instance, in twelve or more of the eighteen countries, efficiency change is more important than technological change in terms of contribution to TFP growth.
Source: Author's calculation based on the 18 sub-Saharan Africa countries in the EASD and PWT 9.0.

In Table 4.8 we present results for sectoral productive efficiency (in terms of labour input only). Similar to the results from the economywide analysis, results in Table 4.8 show that on average all the sectors in the region are operating below the efficient production frontier. We also observe that in most of the countries in our sample, the productive efficiency of labour in services (particularly in tradable services) is higher than in agriculture and manufacturing.

Table 4.8: Productive Efficiency in Africa: Sectoral Analysis, 1970 and 2015

Country	Year	Productive Efficiency Index								
		Agriculture	Manufacturing	Service	Trade	Transport	Business	Government	Personal	Utilities
Africa	1970	0.42	0.47	0.47	0.64	0.42	0.42	0.46	0.43	0.28
	2015	0.59	0.64	0.71	0.44	0.82	0.82	0.78	0.69	0.92
Botswana	1970	0.49	0.18	0.20	0.59	0.10	0.10	0.22	0.01	0.07
	2015	0.79	0.42	0.80	0.38	0.94	0.94	0.94	0.80	0.89
Burkina Faso	1970	0.16	0.27	0.30	0.37	0.32	0.31	0.15	0.32	0.42
	2014	0.48	0.22	0.49	0.26	0.59	0.59	0.85	0.16	0.84
Cameroon	1970	0.14	0.22	0.58	0.24	0.75	0.75	n.a.	n.a.	0.34
	2015	0.49	0.33	0.25	0.22	0.27	0.26	n.a.	n.a.	0.10
Ethiopia	1970	0.85	0.75	0.48	0.97	0.33	0.33	0.18	0.58	0.91
	2015	0.60	0.37	0.85	0.46	0.96	0.96	0.91	0.97	0.99
Ghana	1970	0.42	0.97	0.52	0.98	0.37	0.37	0.41	0.46	0.25
	2015	0.64	0.73	0.86	0.56	0.96	0.96	0.99	0.82	0.97
Kenya	1970	0.55	0.49	0.79	0.79	0.72	0.72	0.91	0.80	0.56
	2015	0.42	0.22	0.46	0.31	0.61	0.61	0.62	0.14	0.84
Lesotho	1970	0.34	0.17	0.62	0.47	0.95	0.95	0.29	0.42	0.04
	2015	0.26	0.64	0.83	0.40	0.95	0.95	0.95	0.89	0.54
Malawi	1970	0.47	0.78	0.54	0.59	0.54	0.54	0.54	0.51	0.34
	2015	0.65	0.91	0.29	0.09	0.47	0.47	0.13	0.29	0.17
Mauritius	1970	0.04	0.35	0.28	0.69	0.17	0.17	0.31	0.05	0.11
	2015	0.95	0.96	0.95	0.99	0.95	0.95	0.95	0.90	0.97
Mozambique	1970	0.66	0.03	0.24	0.90	0.02	0.02	0.12	0.13	0.02
	2015	0.75	0.93	0.80	0.30	0.90	0.90	0.93	0.97	0.83
Namibia	1970	0.23	0.50	0.51	0.66	0.33	0.33	0.32	0.93	0.71
	2015	0.55	0.73	0.84	0.99	0.93	0.93	0.98	0.38	0.29
Nigeria	1970	0.27	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.05
	2015	0.61	0.95	0.89	0.83	0.88	0.88	0.93	0.92	0.83
Rwanda	1970	0.44	0.14	0.20	0.30	0.07	0.07	0.41	0.14	0.05
	2015	0.64	0.66	0.76	0.26	0.88	0.88	0.87	0.91	0.12
Senegal	1970	0.71	0.98	0.97	0.94	0.98	0.98	0.98	0.99	0.34
	2014	0.26	0.37	0.62	0.19	0.76	0.76	0.54	0.85	0.51
South Africa	1970	0.30	0.52	0.57	0.74	0.35	0.35	0.98	0.41	0.33
	2015	0.67	0.97	0.88	0.97	0.97	0.97	0.54	0.94	0.54
Tanzania	1970	0.49	0.81	0.65	0.90	0.76	0.76	0.62	0.20	0.37
	2015	0.67	0.59	0.63	0.25	0.80	0.80	0.37	0.95	0.15
Uganda	1970	0.52	0.25	0.66	0.88	0.39	0.39	0.74	0.87	0.06
	2015	0.55	0.66	0.60	0.08	0.93	0.92	0.95	0.12	0.96
Zambia	1970	0.49	0.99	0.34	0.45	0.29	0.29	n.a.	n.a.	0.12

2015	0.55	0.78	0.73	0.30	0.95	0.94	n.a.	n.a.	0.95

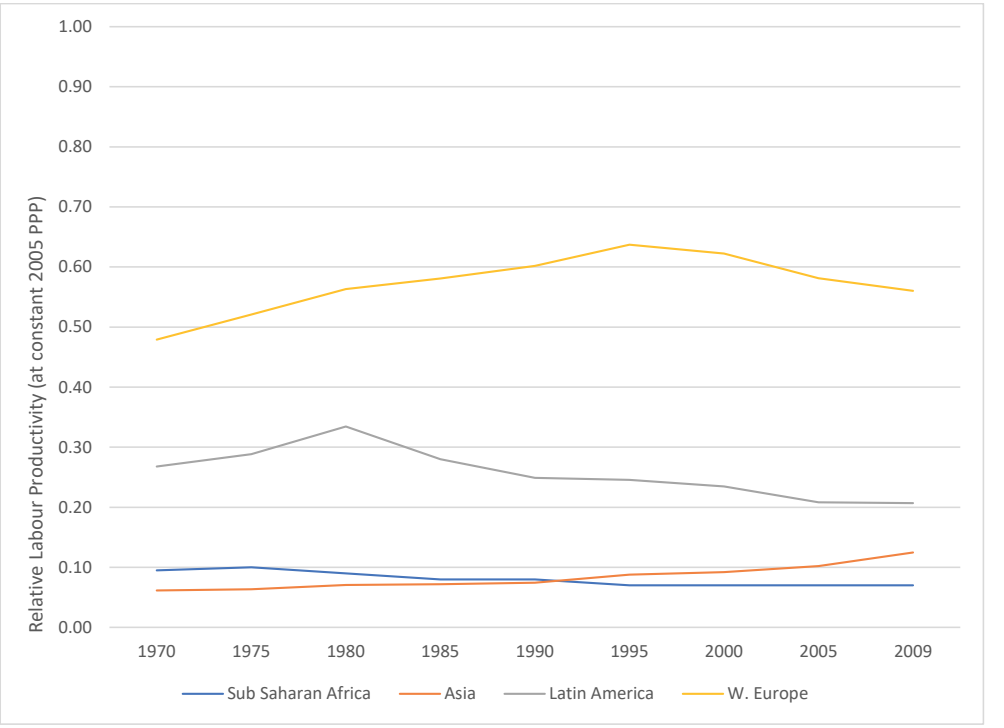
Note: We use bias- corrected radial measures of technical efficiency. The sectoral efficiency index is calculated by maximizing output given labour inputs of each of the ten sectors in each country separately for the years 1970 and 2015.
Source: Author's calculation based on the 18 sub-Saharan Africa countries in the EASD.

We further observe a sizable increase in the productive efficiency of labour in all sectors, particularly since 2000,[50] although most sectors are still performing below best practice. This implies that labour is being used more efficiently. The particularly strong increase in the productive efficiency of labour in all sectors between 2000 and 2015 (the Millennium Development Goals era) contributed to the productivity growth observed in the region in this period. In the study by Mensah et al (2018), Africa was found to have recorded its highest productivity growth during the MDGs era. In an earlier study by De Vries et al (2015), Africa recorded its second highest productivity growth during the MDGs era. The DEA analysis highlights that while some countries in Africa have moved towards the African efficiency frontier, others have either not moved or have regressed. Those countries that have seen improvements tend to be the relatively rich African countries.

DEA can inform us about whether or not countries are converging in their efficiency. The analysis above shows that though there is some average improvement in efficiency in sub-Saharan Africa, there is no general trend towards convergence. The DEA also shows that there has been a modest upward movement of the frontier. While the DEA analysis allows us to discuss the issue of catch-up to the frontier from a regional perspective, it says nothing about whether the region as a whole has exhibited catch-up to the global frontier. To provide insights into how Africa has performed relative to global best practice, we present data on comparative labour productivity in Figure 4.2, taking the USA as the benchmark. We see that relative productivity changes very little on average. Between 1970 and 2010 there is a small net decline in relative productivity from around ten per cent to eight per cent of the US level, most of the decline taking place before 1990. Figure 4.2 also reveals that sub-Saharan Africa was the region with the lowest relative productivity after 1990, compared to other regions in the global economy.[51] In terms of specific African countries, the most dramatic examples of catch-up are provided by Botswana and Mauritius, with significant catch-up also observed in Lesotho, Namibia, and Nigeria. Most other countries show little or no change, or even decline. In Zambia relative productivity declines from 12 percent in 1970 to 7 percent in 2010. In terms of catch-up at the sectoral level for Africa, we observe that agriculture, manufacturing, government, and personal services have fallen further behind over time, while mining, construction, and, most notably in the context of this chapter, trade and business services have shown signs of catch-up to the global frontier.

[50] Not visible in table. Annual data available on request.
[51] Information for specific African countries and on the sectoral catch-up of Africa over time is available upon request.

Figure 4.2: Comparative Labour Productivity by Region, 1970-2009 (USA=1)



Note: Value-added at constant 2005 LCU converted to international dollars using 2005 PPPs.
Source: Author's calculation based upon Groningen Growth and Development Centre, Ten Sector Database, https://www.rug.nl/ggdc/productivity/10-sector/

4.3.3 Linkages between Services and Other Major Sectors of the Economy

The previous two sub-sections have indicated that productivity growth in the services sector has been relatively high in Africa (Sub-section 4.3.1), with a part of this productivity growth being driven by relatively high levels of efficiency in the services sector (Sub-section 4.3.2). In this sub-section, we complement the above analysis by considering the linkages between services and other sectors in an input-output framework. In particular, we focus on the output multiplier, which captures the total value of production in all sectors of the (global) economy that is necessary to satisfy a dollar's worth of final demand for a particular sector's output. Using this multiplier, we analyse the extent to which output in services is responsible for generating production in other sectors—notably manufacturing—and the extent to which output in other sectors generates production in the service sector. To do this we use input-output table (IO) data from UNCTAD's Eora GVC database (see Lenzen et al., 2013). The dataset is a set of inter-country input-output tables covering 26[52] sectors in 189 countries for the years 1990-2015.

The output multiplier is calculated simply as the column sum of the Leontief inverse, $\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$, with $\mathbf{A}$ being the matrix of technical coefficients (i.e., the value of intermediates bought by a particular sector j from sector i as a share of gross output in sector j) and $\mathbf{I}$ an identity matrix. The elements of the Leontief matrix express the total output required both directly and indirectly to produce a unit of goods for final demand (Aslam et al., 2017). In the context of the global input-output tables of Eora, we can decompose the overall output multiplier into the impacts on individual sectors (or aggregated sector groups[53]) and are further able to distinguish between a domestic and foreign component, the latter component capturing leakages from the domestic economy in response to an increase in output of a particular sector (see appendix for full decomposition method).

Before discussing the results of the output multipliers, Table 4.9 reports information on the share of intermediates in gross output (averaged across countries) for a set of world regions and the decomposition of these intermediates into the four broad sectoral aggregates. Since the output multipliers are ultimately driven by intermediate use, it is instructive to examine the relative importance of intermediate versus final production, also in a temporal and cross-region perspective. Moreover, from a dynamic perspective, it is the changes in the intensity of intermediates use that ultimately allows us to examine whether production has been reorganized in the context of global value chains. The results in the table suggest that African countries have, on average, a relatively low share of intermediates in gross output and that between 2000 and 2015 this share has declined. Intermediate

[52] In our study we use data on 25 sectors over the period 1990-2015.

[53] In our analysis we distinguish between four aggregated sectors: (i) Other (i.e. Agriculture; Fishing; Mining and Quarrying; Electricity, Gas and Water; Construction); (ii) Manufacturing (i.e. Food and Beverages, Textiles and Wearing Apparel, Wood and Paper, Petroleum, Chemical and Non-Metallic Mineral Products, Metal Products, Electrical and Machinery, Transport Equipment and Other Manufacturing); (iii) Market Services (i.e. Maintenance and Repair, Wholesale Trade, Retail Trade, Transport, Post and Telecommunications, Financial Intermediation and Business Activities); and (iv) Non-Market Services (i.e. Hotels and Restaurants, Public Administration, Education, Health and Other Services and Private Households). Note that the final sector (Re-export and re-import) is dropped from the analysis.

shares in Asia and in transition economies tend to be larger. In the case of Asia, shares have risen relatively rapidly between 2000 and 2015. In terms of the organisation of production, we observe a slight increase in the share of intermediates from market services and other sectors in Africa, both at the expense of manufacturing. These results are in contrast to most other regions where manufacturing shares have been rising (most notably in Asia, but also in Latin America, North America and Western Europe). In most regions, however, services are the most important component of total intermediate production.

Table 4.9: Share of Intermediates in Gross Output and its Composition (2000 and 2015)

	Intermediate share in gross output		Decomposition of intermediates by broad sector 2000				2015			
Region	2000	2015	Man	Mkt Serv	Non-Mkt Serv	Other	Man	Mkt Serv	Non-Mkt Serv	Other
Africa	0.47	0.43	0.34	0.43	0.04	0.20	0.31	0.44	0.04	0.21
Asia	0.50	0.56	0.47	0.35	0.04	0.13	0.56	0.25	0.04	0.15
LAM	0.43	0.44	0.38	0.40	0.03	0.19	0.41	0.37	0.03	0.20
NAM	0.44	0.44	0.29	0.55	0.05	0.11	0.34	0.48	0.06	0.12
Oceania	0.53	0.52	0.29	0.52	0.05	0.15	0.28	0.52	0.05	0.14
Trans	0.54	0.53	0.49	0.28	0.02	0.22	0.47	0.29	0.03	0.21
WEU	0.48	0.50	0.38	0.44	0.05	0.12	0.41	0.43	0.05	0.12

Sectors are as follows:

Other: Agriculture; Fishing; Mining and Quarrying; Electricity, Gas and Water; Construction

Manufacturing: Food and Beverages, Textiles and Wearing Apparel, Wood and Paper, Petroleum, Chemical and Non-Metallic Mineral Products, Metal Products, Electrical and Machinery, Transport Equipment and Other Manufacturing

Services: Maintenance and Repair, Wholesale Trade, Retail Trade, Hotels and Restaurants, Transport, Post and Telecommunications, Financial Intermediation and Business Activities, Public Administration, Education, Health and Other Services and Private Households

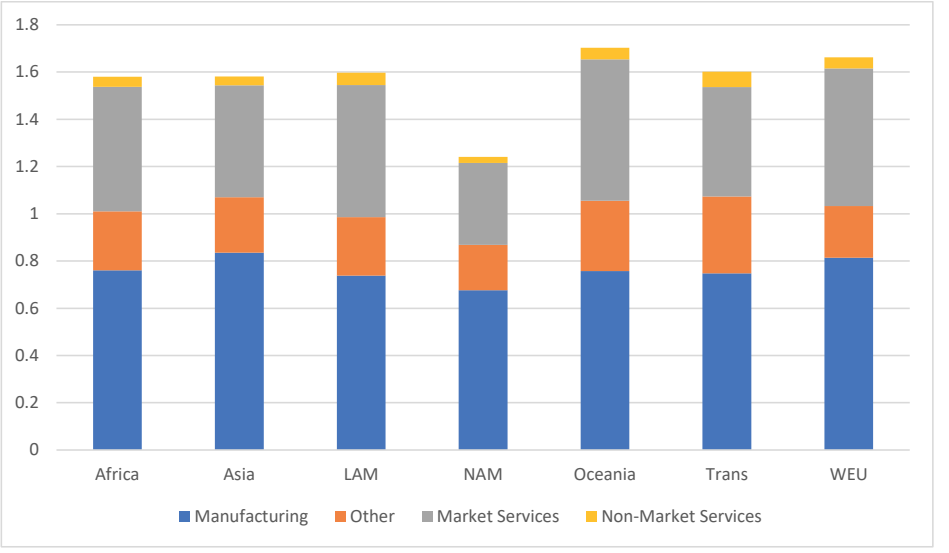
Market Services: Maintenance and Repair, Wholesale Trade, Retail Trade, Transport, Post and Telecommunications, Financial Intermediation and Business Activities

Non-Market Services: Hotels and Restaurants, Public Administration, Education, Health and Other Services and Private Households

The regions are Africa (51 African countries), Asia (44 countries), Latin America (LAM) (33 countries), North America (NAM) (2 countries), Oceania (8 countries), European transition countries (Trans) (15 countries) and Western Europe (WEU) (EU28 plus 8 other European countries)

Source: Author's calculations using Eora data.

Figure 4.3: Output Multipliers in Manufacturing, 2015



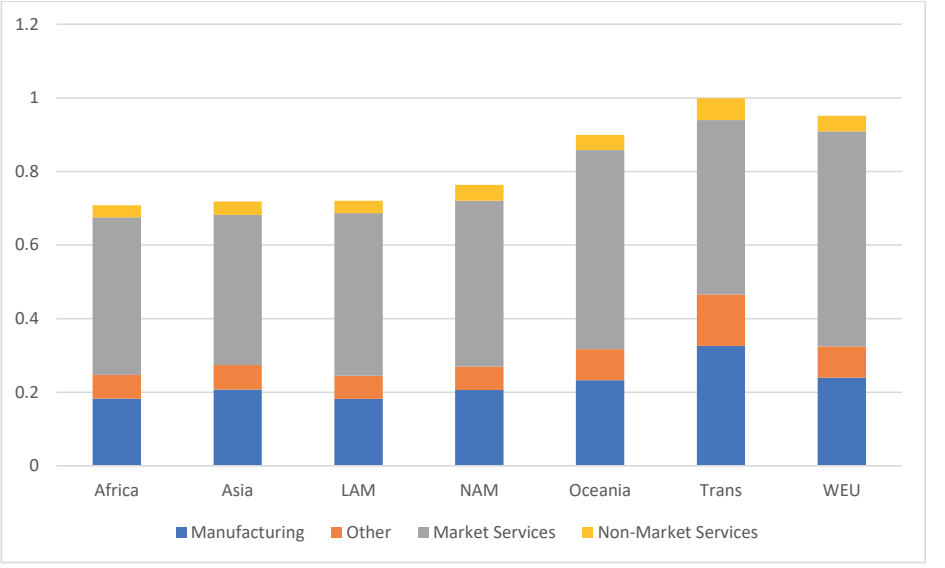
Notes: LAM refers to Latin America, NAM to North America, Trans to transition countries and WEU to Western Europe.
Source: Author's calculations based upon Eora

We now turn to the results for the output multipliers. Figure 4.3 reports the value of the output multiplier in response to an increase in manufacturing final demand of one dollar by region for 2015, further decomposing the multiplier effect into the contributions to our four broad sectors.[54] The figure reveals that the additional impact of a one dollar increase in manufacturing final demand (i.e., on top of the additional one-dollar increase) on total output in our sample ranges from around 1.2 to around 1.7. The value found for Africa is roughly the same as that observed for Asia and Latin America. Of this increase, the majority of the additional output, unsurprisingly, comes from manufacturing sectors, with the share of manufacturing ranging from 44% in transition economies to 53% in Asian economies. Around a third of the increase comes from market services, with the contributions from non-market services and other sectors generally being small. This pattern also holds for Africa, with the share of services in the change in output being relatively large (i.e., similar to the shares found in Western Europe and Oceania, and larger than those found in Asia and transition economies). Consistent with results for other regions, there has been a slight decline in the contribution of services to the increase in output following a manufacturing expansion for Africa between 2000 and 2015. In

[54] Note that data are averaged across sub-sectors and countries to arrive at the values for the region and for the different sub-sectors. Further note, that we subtract one from the multiplier for the own sector—i.e., manufacturing in Figure 4.3—in order to eliminate the effect of the initial one dollar increase in output in this sector and to make the differences between the effects on the aggregated sectors more comparable (i.e., the terms capture the additional output of aggregated sectors in response to a change in output in one sector beyond the initial change in output).

general, however, the figure supports the view that expansions in manufacturing can be a significant source of demand for services intermediates across regions.

Figure 4.4: Output Multipliers in Market Services, 2015



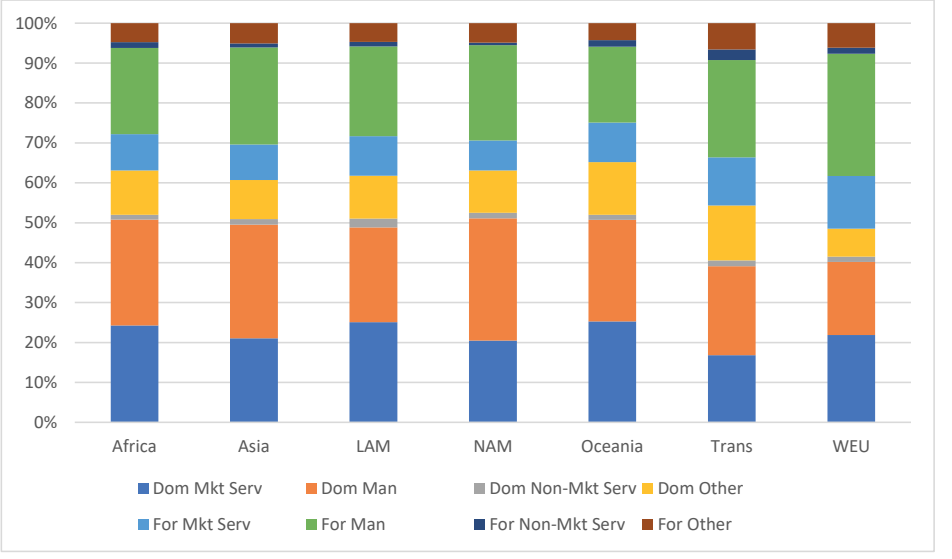
Notes: LAM refers to Latin America, NAM to North America, Trans to transition countries and WEU to Western Europe.
Source: Own calculations based upon Eora

Figure 4.4 reports similar results to those in the previous figure but for market services rather than manufacturing.[55] A first thing to note is that the output multipliers are generally lower than for manufacturing, confirming existing evidence that linkages are stronger for manufacturing than for services.[56] These linkages are particularly low in Africa at a value of 0.71. As with the previous results, the contribution of the own sector (i.e., market services) tends to dominate, accounting for between 47% (Transition economies) and 61% (Western Europe and Latin America) of the total additional output in response to a one dollar increase in final demand for market services. Manufacturing also makes a significant contribution to the overall term, however, ranging from a low of 25% (Western Europe and Latin America) to a high of 33% (Transition Economies). In terms of changes over time, there has been something of a decline in Africa in the contribution of manufacturing to the overall output multiplier in the case of market services (from 27.5% in 2000 to 25.8% in 2015).

[55] Results for non-market services and other sectors are not reported for reasons of brevity.
[56] Once again, we subtract one from—in this case—market services to make the decomposition more comparable across aggregated sectors.

Finally, we consider the possibility of leakages, by further decomposing the output multipliers reported in Figures 4.3 and 4.4 into a domestic and foreign component. Figure 4.5 reports this decomposition for the manufacturing output multiplier, while Figure 4.6 does the same for the output multiplier for market services. Concentrating initially on the output multiplier for manufacturing we see that the extent of leakages varies across regions: in Western Europe less than 50% of the output multiplier accrues to domestic sectors, with this share being highest at around 65% in Oceania, and 63% in the case of Africa. In comparison to the results for the output multipliers in market services (Figure 4.6), these results suggest that leakages are relatively high in manufacturing: the lowest share accruing to domestic sectors is 54% (Transition Economies) and the highest share is 79% (North America) in the case of market services, with 69% accruing to domestic sectors in the case of Africa. In the case of manufacturing output multipliers, the leakage from market services is relatively high across most regions including Africa: domestic market services account for around 35% of the overall output multiplier in response to a change in manufacturing output in Africa, with foreign market services accounting for over 9%, or, in other words, around 30% of the increased production in market services in response to an increase in manufacturing final demand accrues to foreign market services.[57]

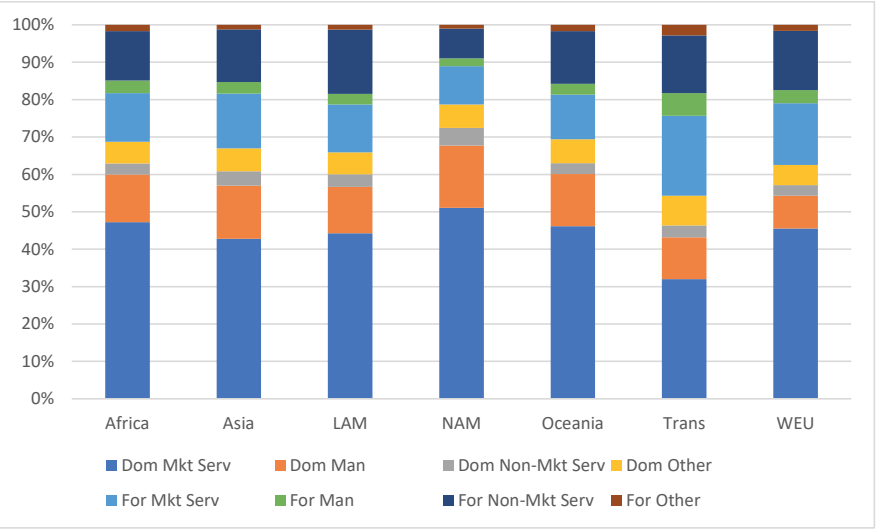
Figure 4.5: Decomposition of Output Multiplier for Manufacturing, 2015



Notes: Dom and For refer to domestic and foreign respectively, while Mkt Serv, Man, Non-Mkt Serv and Other refer to market services, manufacturing, non-market services, and other sectors respectively. LAM refers to Latin America, NAM to North America, Trans to transition countries and WEU to Western Europe.
Source: Author's calculations based upon Eora

[57] The share of the increase in manufacturing output that accrues to foreign manufacturing is even higher at 44% (excluding the initial one unit increase in final demand).

Figure 4.6: Decomposition of Output Multiplier for Market Services, 2015



Notes: Dom and For refer to domestic and foreign respectively, while Mkt Serv, Man, Non-Mkt Serv and Other refer to market services, manufacturing, non-market services, and other sectors respectively. LAM refers to Latin America, NAM to North America, Trans to transition countries and WEU to Western Europe.
Source: Author's calculations based upon Eora

In the case of market services, as already mentioned, the extent of leakages tends to be lower in general. For Africa, for example, just 31% of the output multiplier accrues to foreign countries instead of the 37% in the case of manufacturing. This is also true when we consider the contributions of aggregated sectors. In the case of market services and manufacturing, the contribution of domestic sources to the output multiplier in response to a change in market services output is over three and a half times larger than the contribution from foreign sources. Interestingly, non-market services tend to be an exception, with the major contribution from non-market services to the output multiplier associated with market services being larger for foreign than domestic sources.

To summarize, this sub-section has shown that increases in final demand for manufacturing can have significant effects on production within other sectors, most notably market service sectors. The effects of increases in final demand for market services are generally smaller, but can still have significant effects on manufacturing production, especially given the relative importance of market services in the economies of most regions, including Africa. While multipliers are larger for manufacturing, there are also higher leakages in this case, suggesting that many of the benefits of increased manufacturing final demand accrue to other countries. Leakages are generally lower in response to an increase in final demand for market services and may thus allow for greater benefits from increasing output in this broad sector. The result is a nuanced story: manufacturing generates the greater multipliers, including to market services—the dominant aggregated sector in Africa—but much of this effect may be

captured by foreign countries. Conversely, market services generate lower multipliers, but the gains are captured by domestic firms, which given the relatively large contribution of market services to the overall multiplier can encourage a self-reinforcing pattern of market services development.

4.4 Conclusion

This chapter provides an in-depth investigation of the dynamic contributions of the growing service sector. The first part of the chapter takes a global perspective and discusses the implications of the rise of the service sector in the global economy. The data indicate that the service sector is more dynamic than is usually assumed. Its productivity growth is just as high as that of manufacturing (1.7%). Dynamic market services sectors such as finance, information technology, transport, logistics, and business services have high rates of productivity growth. They are innovative and can serve as alternative engines of growth alongside manufacturing. Productivity growth in non-market services is low, but the share of non-market services in total service value added is limited. As far as the service sector as a whole is concerned, Baumol got it wrong. Also, the service sector makes important positive contributions to the performance of other sectors of the economy. There are interesting complementarities between services and manufacturing.

The second part of the chapter zooms in on the role of services in sub-Saharan Africa. The rationale for this focus on sub-Saharan Africa is that it represents a case of early deindustrialisation, where the shares of manufacturing value-added peaked at low levels of per capita income, while the shares of services increased. As described in the words of Stiglitz (2018), increase in manufacturing employment will not suffice to meet the need for new jobs, especially in Africa with its burgeoning population. There has to be another strategy—a carefully designed, coordinated multi-sector strategy. Given this, the study uses long time series of sectoral employment and output data for eighteen African countries, applies Data Envelopment Analysis (DEA) and Input-Output (IO) analysis to examine the impacts of development in services in the economies of Africa. The DEA is performed with African data. The IO-analysis is performed on a wider set of countries, with the aim of comparing Africa with other regions in the world economy.

The main focus of the DEA is the distance of a country to the productive frontier. The analysis reveals that in an African context efficiency in services has improved in the past and continues to improve in the present. The input-output analysis reveals a nuanced story. Manufacturing still generates the strongest multipliers, including to market services, the dominant sector in Africa in terms of value-added shares. This implies that early deindustrialisation is indeed a serious problem. However, much of the manufacturing linkages are captured by foreign countries. While the multipliers in market services are lower than those of manufacturing, they are comparable to those in many other regions of the world economy. Also, more of the gains are captured by domestic firms, which could encourage a self-reinforcing pattern of market service development. Finally, while improvements in services translate into significantly better manufacturing performance in the region via the use of intermediate service inputs in manufacturing, we observe that countries in the region differ in terms of which

specific service sectors matter more for manufacturing performance[58]. Countries in the region need to be aware of this heterogeneity in implementing sector-specific policies in the quest to improve manufacturing performance and promote industrialisation.

[58] The result is not shown in the paper but is available in an extended version of the paper where we estimate the effect of service sector efficiency and manufacturing performance in Africa using panel vector error correction model. The result is available upon request.

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4.5 Appendix to chapter 4

4.5.1 Data Envelopment Analysis (DEA)

Suppose there are S country-sectors to be evaluated given n inputs and w outputs. We denote labour by L_{nst}; capital $K_{n(s)t}$ by and output by Y_{wst}.

The technology set is defined as:

$$T\ (\theta^*) = \text{Maximize}\ \ \theta, \tag{1}$$

Subject to:

$$\sum_{s=1}^{S} \lambda_s Y_{ws}\ \geq Y_W, \qquad w = 1, \dots \dots \dots W \tag{2}$$

$$\sum_{s=1}^{S} \lambda_s L_{ns}\ \geq L_n, \qquad n = 1, \dots \dots \dots N \tag{3}$$

$$\sum_{s=1}^{S} \lambda_s K_{ns}\ \geq K_n, \qquad n = 1, \dots \dots \dots N \tag{4}$$

$$\lambda_S\ \geq 0, s = 1, \dots . S \tag{5}$$

Where L_{nst}, $K_{n(s)t}$ and Y_{wst} are the labour, capital and output of each country-sector in time t. The convex cone formed by these column vectors is the technology set $T\ (\theta^*)$. λ is J x 1 vector of constants. The n and w inequalities capture the free disposability of inputs and output assumption and represent the nth inputs and wth output for DMUs respectively. Solution value of θ in the linear program problem gives the technical efficiency index of each country-sector in time t. If $\theta^*= 1$, the DMU is on the frontier. DMU is below the frontier if $\theta^* < 1$. We report results of the bias-corrected efficiency index using heterogeneous bootstrapping under CRS assumption (the appropriate estimate) for the current output mix as indicated by the test. We also report the bias-corrected efficiency index under homogeneous bootstrapping and sub-sampling.

Although our computed efficiency scores are robust even after using the radial and non-radial slack[59] based measures (result not shown), it might still suffer from the DEA shortfall. A major shortfall of using the DEA approach to measure the efficiency of DMUs is that sampling error could cause

[59] The radial measure assumes proportionate change or reduction in inputs that can produce the current outputs. Non-radial model, (slacks-based measure-(SBM)) assumes that the inputs change or decreases non-proportionally to produce current outputs. The SBM is usually used in the management discipline and is a good indicator for managers so they will know how many inputs or output slacks remaining at the optimal efficiency. The main shortcoming of the radial measure is the neglect of non-radial slacks in reporting of the efficiency score. If these slacks have an important role in evaluating managerial efficiency, the radial approaches may mislead the decision when we utilize the efficiency score as the only index for evaluating performance of DMUs. In terms of the SBM approach, the extremely uneven change in inputs could be a shortcoming, especially when we observe efficiency change over time (Avkiran, Tone, & Tsutsui, 2008).

biasedness in the computed technical efficiency (TE) scores (Simar & Wilson, 2000; 2000). Substantial efforts have been made to develop bootstrapping methodologies in DEA models that construct confidence intervals around the efficiency indexes to correct for potential bias in the TE scores.[60] We follow the bias correction bootstrapping technique of (Badunenko & Mozharovskyi, 2016) implemented in the 'Stata' software package to provide valid statistical inference or correct the biasedness in the computed technical efficiency (TE) scores.

4.5.2 Decomposing Services Value-Added: Methodology

We begin by assuming that there are N countries, S industries in each country, and F production factors in each country-industry. Industry output in a particular country is produced using domestic production factors (i.e., domestic capital and labour) and intermediate inputs, which may be sourced either domestically or from foreign sources. The output produced in each industry can be used as either final demand or as intermediate inputs used in the production of other goods. Demand for final goods is assumed to come from three sources: households, government, and firms. When considering shipments of final goods and intermediates both within and across countries we need to distinguish between the source and destination country/industry. Following Los et al (2015) we use i to denote the source country, j the destination country, s the source industry and t the destination industry. It is assumed that markets clear and the additional assumption of a single price irrespective of a product's use is imposed. By definition, when markets clear, we can write the product market clearing condition as:

$$y_i(s) = \sum_j f_{ij}(s) + \sum_j \sum_r m_{ij}(s,t) \quad (6)$$

Here $y_i(s)$ is the value of output in industry s in country i, $f_{ij}(s)$ is the value of goods sold by this industry for final use in country j, and $m_{ij}(s,t)$ is the value of products sold by this industry for intermediate use by industry t in country j.

Los et al (2015) go on to express the market clearing conditions for each of the SN industries using matrix algebra. To do this, let $\mathbf{y}$ be the output vector of dimension $(SN \times 1)$, the elements of which represent output levels in each country-industry. A global input–output matrix $\mathbf{A}$ of dimension $(SN \times SN)$ is also defined. The matrix has elements $a_{ij}(s,t) = m_{ij}(s,t)/y_j(t)$, which capture the ratio of intermediate inputs per unit of output and are termed the technical coefficients. Los et al (2015) describe these terms as giving the cost shares of output from industry s in country i used by industry t in country j. The matrix $\mathbf{A}$ can be written as:

[60] Some papers use the software package FEAR 1.0, by (Wilson, 2008) embedded in the R-software package to calculate DEA scores after bootstrapping. By applying the bootstrapping method, these authors can estimate a virtual worldwide production frontier for a hypothetical population rather than a sample (c.f. Van Dijk & Szirmai, 2011).

$$\mathbf{A} \equiv \begin{bmatrix} \mathbf{A}_{11} & \mathbf{A}_{12} & \cdots & \mathbf{A}_{1N} \\ \mathbf{A}_{21} & \mathbf{A}_{22} & \cdots & \mathbf{A}_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{A}_{N1} & \mathbf{A}_{N2} & \ldots & \mathbf{A}_{NN} \end{bmatrix}$$

with $\mathbf{A}_{ij}$ being an $S \times S$ matrix with typical element $a_{ij}(s,t)$. Given this setup, it should be clear that the sub-matrices on the main diagonal contain the cost shares of domestically produced intermediate inputs, while those on the off diagonal contain the cost shares of foreign intermediate inputs. The matrix $\mathbf{A}$ thus summarizes the input requirements of all intermediate goods across industries and countries.

Using the matrix $\mathbf{A}$ we can express equation (6) in matrix form as:

$$\begin{bmatrix} \mathbf{y}_1 \\ \mathbf{y}_2 \\ \vdots \\ \mathbf{y}_N \end{bmatrix} \equiv \begin{bmatrix} \mathbf{A}_{11} & \mathbf{A}_{12} & \cdots & \mathbf{A}_{1N} \\ \mathbf{A}_{21} & \mathbf{A}_{22} & \cdots & \mathbf{A}_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{A}_{N1} & \mathbf{A}_{N2} & \ldots & \mathbf{A}_{NN} \end{bmatrix} \begin{bmatrix} \mathbf{y}_1 \\ \mathbf{y}_2 \\ \vdots \\ \mathbf{y}_N \end{bmatrix} + \begin{bmatrix} \sum_j \mathbf{f}_{1j} \\ \sum_j \mathbf{f}_{2j} \\ \vdots \\ \sum_j \mathbf{f}_{Nj} \end{bmatrix}$$

with $\mathbf{y}_i$ being the S-vector with production levels in country i, and $\mathbf{f}_{ij}$ being the S-vector of final demands in country j for the products of country i. This can be written as:

$$\mathbf{y} = \mathbf{A}\mathbf{y} + \mathbf{f} \tag{7}$$

Which can further be expressed as:

$$\mathbf{y} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} = \mathbf{B}\mathbf{f} \tag{8}$$

With $\mathbf{I}$ being an $SN \times SN$ identity matrix and $\mathbf{B} = (\mathbf{I} - \mathbf{A})^{-1}$ being the well-known Leontief inverse (Leontief, 1936) that captures the gross output values in all stages of production that are generated in the production process of one unit of final output.

Starting from this initial representation a number of decompositions are possible. The approach of Wang et al (2017), for example, decomposes production activities into three terms: (i) production for domestic demand; (ii) final goods exports; and (iii) intermediate exports (what they term GVC activities, and which may also involve the re-importation of intermediates at later stages of the production process). We adopt a similar approach to that of Wang et al (2017) by rewriting equation (2) as:

$$\mathbf{y} = \mathbf{A}\mathbf{y} + \mathbf{f} = \mathbf{A}^D\mathbf{y} + \mathbf{f}^D + \mathbf{A}^F\mathbf{y} + \mathbf{f}^F \tag{9}$$

Where $\mathbf{A}^D = \begin{bmatrix} \mathbf{A}^{11} & \mathbf{0} & \dots & \mathbf{0} \\ \mathbf{0} & \mathbf{A}^{22} & \dots & \mathbf{0} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{0} & \mathbf{0} & \dots & \mathbf{A}^{gg} \end{bmatrix}$ is a $GN \times GN$ diagonal block matrix of domestic input coefficients, $\mathbf{A}^F = \mathbf{A} - \mathbf{A}^D$ is a $GN \times GN$ off-diagonal block matrix of imported input coefficients, $\mathbf{f}^D = [\mathbf{f}^{11}\ \mathbf{f}^{22} \dots\ \mathbf{f}^{gg}]'$ is a $GN \times 1$ vector of final production for domestic consumption, and $\mathbf{f}^F = \mathbf{f} - \mathbf{f}^D$ is a $GN \times 1$ vector of final product exports.

Rearranging equation (4) gives:

$$\mathbf{y} = (\mathbf{I} - \mathbf{A}^D - \mathbf{A}^F)^{-1}\mathbf{f}^D + (\mathbf{I} - \mathbf{A}^D - \mathbf{A}^F)^{-1}\mathbf{f}^F$$

Let $\mathbf{L} = (\mathbf{I} - \mathbf{A}^D - \mathbf{A}^F)^{-1}$ be the Leontief inverse. We can then further split final demand – both domestic and foreign – into its constituent parts (e.g., final demand from manufacturing, from services, and from other sectors (e.g., agriculture, mining, etc.), such that:

$$\mathbf{y} = \mathbf{L}\mathbf{f}_A^D + \mathbf{L}\mathbf{f}_M^D + \mathbf{L}\mathbf{f}_S^D + \mathbf{L}\mathbf{f}_A^F + \mathbf{L}\mathbf{f}_M^F + \mathbf{L}\mathbf{f}_S^F \quad (10)$$

Where subscripts A, M and S refer to agriculture (and other sectors), manufacturing and services. Pre-multiplying by the matrix of value-added coefficients, $\mathbf{V}$, and diagonalizing certain vectors (e.g., $\mathbf{V}$ and $\mathbf{f}$) we can decompose the sources of demand for value-added. By summing up these sources of demand across certain sectors we can aggregate up to obtain the sources of demand for value-added from the set of services sectors (or manufacturing or agricultural sectors). This is the initial decomposition that allows us to split up the sources of demand for services into a domestic and foreign component, and into an agriculture, manufacturing and services component. We further consider developments over time in these sources of demand for value-added.

Chapter 5: Powering Structural Transformation and Productivity Gains in Africa: The Role of Global Value Chains and Resource Endowments

Abstract

Sixty years ago, many countries in Africa implemented various industrial policies to promote structural transformation and industrialisation, all aimed at generating productivity gains. Today, the consensus seems to be that the region has since recorded moderate productivity gains and industrialisation remains elusive. Participation in global value chains (GVC) has recently been highlighted as a pathway to fast-track development in terms of productivity gains and structural change in the region. This chapter builds on these arguments and investigates how participation in GVC affects aggregate labour productivity growth and its two sub-components: within and structural change. It further examines how this relationship differs with the extent of country's natural resource endowments. The results show that participation in GVCs has a significant positive effect on productivity growth in Africa. This gain is largely through backward participation and is stronger for countries that are further from the productivity frontier. The analysis using the sub-components of productivity growth also shows that GVC participation has a positive and significant effect on productivity growth by inducing an efficient reallocation of resources within sectors (intra-sector reallocation) but not across sectors (inter-sector reallocation). Moreover, these benefits arise mostly in non-resource intensive and non-oil resource intensive countries. Overall, the results indicate that GVC participation matters for productivity growth in Africa but highlights differences in the channel of impact across countries with different natural resource endowments.

5.1 Introduction

This chapter focuses on the impact of Global Value Chain (GVC) integration and resource endowments on structural change and productivity growth in Africa. Structural change and productivity growth are key and long-recognized features of economic development. In conventional development economics, modern economic development implies changes in the production structure of the economy that allows for the reallocation of resources from less productive traditional sectors to more productive modern sectors (Lewis, 1954; Kuznets, 1966; Chenery & Taylor, 1968; Park, 1989; Szirmai, 2015; Foster-McGregor & Verspagen, 2016). For these reasons, in the post-independence era, African political leaders embarked on a structural transformation and industrialisation agenda. Policies such as Import Substitution strategies (IS), Structural Adjustment Programs (SAPs) and the UN Economic Commission for Africa (ECA) African Alternative to Structural Adjustment Programs (AASAP) among others were put in place to realize these aims (ECA, 1989; Mkandawire, 2001; Geda et al., 2018; Geda, 2018b). More than five decades later, the consensus seems to be that industrialisation in the region remains elusive. Many of the countries in the region have yet to shift enough of their manpower to manufacturing and modern tradable services to the point where these sectors account for relatively high shares of national employment and output (De Vries et al., 2015; Rodrik, 2016; Diao et al., 2017; Mensah et al., 2018; Owusu et al., 2020).

Given these trends in the structure of production of African economies, the recent high growth across the region has demonstrated vulnerability to the risk of reversal (Diao & McMillan, 2015; Diao et al., 2017; Fosu, 2018; Rodrik, 2018). This in turn has presented challenges to governments in the region in terms of devising policies for promoting the growth-enhancing structural changes needed in order to shift workers from productivity resistant sectors to more productive and dynamic sectors and to diversify exports away from primary commodities. Recent policy discussion in this direction has focused on exploring the potential of GVCs to fast-track this development. In many regards participating in GVCs is often seen as an easier route to industrialisation in developing countries, particularly in Africa. With global production increasingly sliced into different stages of value-creating activities or tasks that are performed in different cost-saving locations across the world (Grossman & Rossi-Hansberg, 2008), integration into global value chains is providing new windows of opportunity to generate more jobs and increase productivity in dynamic sectors (World Bank, 2020).

This chapter is linked to an evolving strand of literature focusing on the relationship between GVC integration and jobs and productivity growth. Writing for the OECD, Jouanjean et al (2017) report that integration into GVCs can act as a catalyst for the process of economic transformation and productivity growth by hastening the reallocation of resources to higher productivity tasks and sectors. Sen (2019) finds that trade integration positively impacts on employment in developing countries via the scale and composition of production effect but has a negative impact via the labour intensity effect[61]. Lopez-Gonzalez (2016) finds a positive effect of intermediate imports on employment and

[61] Sen (2019) defines the scale effect as the increase in manufacturing employment that occurs purely because of the increase in aggregate manufacturing output. The composition effect on the other hand is defined as the increase in manufacturing employment that results from the shift in the composition of output from capital-intensive sectors to

value added, with particularly strong effects in services, albeit only in the short-run. In his contribution, Baldwin (2014) finds evidence of an initial productivity-enhancing and employment creation effect of GVC integration, but a possible stunted development in the long run as GVC integration makes industrialisation less meaningful since capacity building and upgrading through GVCs is not guaranteed as most value-added in the supply chain is captured by large multinationals in developed countries.

Contrary to the relatively positive but mixed picture painted above, UNIDO (2017a; 2017b) reports that integration in GVCs will not unambiguously strengthen growth-enhancing structural change and that for some countries integration in GVCs could accelerate the de-industrialisation process, as was evident in the case of non-central European countries. Stöllinger (2017) reports statistically weak support for a positive impact of GVC related trade on structural upgrading. Additionally, Rodrik (2018) asserts that the technologies associated with GVC participation are providing diminishing possibilities to substitute other factors of production with unskilled labour, suggesting that developing countries such as those in Africa may not be able to take advantage of GVC participation to create employment opportunities in modern and productive sectors. In a recent study, Pahl and Timmer (2019) find strong evidence for the positive effects of GVC integration on productivity growth in the formal manufacturing sector. The authors, however, found no evidence on employment creation.

In their study, Criscuolo and Timmis (2017) and Pahl and Timmer (2019) argued that little is known about the link between the broader aspects of GVC integration, structural change, and productivity, especially in developing countries, such as those in sub-Saharan Africa (henceforth SSA). The crucial role of resource endowments is also largely ignored in these extant studies. Accounting for the role of resource endowments in this relationship is important for several reasons. Resource endowments are often an important determinant of a country's comparative advantage in trade, participation in GVCs, the type of GVC activity undertaken (in terms of the sector and positioning within the GVC) and are consequently a potential factor in the scale, timing or pattern of a country's industrialisation or any other form of structural transformation that it might undergo at particular stages of its development (IMF, 2012; World Bank, 2015). The Heckscher-Ohlin theory also suggests that a country's factor endowments determine the relative costs of production and hence the pattern of specialization in GVC integration and exports. Consequently, the pattern of a country's GVC integration and the resultant productivity growth and structural change it may undergo are a function of its resource endowments (Krugman, 1980; Schott, 2008).

As highlighted in Pahl and Timmer (2019: 14-16) and also stressed, for example, in Havranek and Irsova (2011) and Ivarsson and Alvstam (2010) resource-intensive countries, particularly from developing countries are likely to experience different dynamic upgrading in GVCs. They engage differently in GVCs as forward suppliers, selling raw materials or basic inputs in the value chain which limits their opportunity for upgrading through GVC. Conversely, non-resource intensive countries on the other hand participate more through backward participation. These sets of countries are therefore

labour-intensive sectors. The labour intensity effect occurs when there is an increase in the demand for labour without a corresponding increase in output.

able to import essential intermediates needed for quality upgrading, boosting productivity, and economic diversification.

For many years, economists have also held the strong view that resource-intensive countries, particularly oil resource-intensive countries, could suffer negative long-term growth effects due to the so-called Dutch Disease phenomena, which brings about the appreciation of the exchange rate. Based on this, Sachs and Warner (2001) considered natural resources to be a 'curse' for development rather than a potential driver of development. For this reason, the rapid expansion of an economy's resource-intensive industries and the export of goods from these industries in the value chain was thought to lead to an increasing 'commoditization' of the production structure, supplying basic inputs in the value chain (Venables, 2016), with a subsequent slowdown of the transition to other more technologically dynamic and productive industries and fields of production.

In a recent paper, however, Katz and Pietrobelli (2018) argued that over the past two decades, resource-intensive industries, particularly non-oil resource-intensive industries, have become an important source of growth and innovation due to the technological transformation going on in the sector, primarily due to a rapid expansion of world demand and the drastic transformation in the way in which these commodities are being produced, exported and consumed which nowadays involves several agents comprising manufacturing enterprises producing the basic commodity – minerals, timber and forestry products, soybean oil among others – their suppliers of production equipment and engineering services and the public sector regulatory agencies monitoring their environmental impact. The above discussion shows that the impact of resource endowments on the GVC-productivity growth relationship remains unclear.

Existing studies have also paid little, if any, attention to countries in SSA due to data limitations. The use of proxy measures of GVC further adds to the limitation in extant studies. For this reason, little if anything is known of the mechanisms benchmarking the non-conclusive findings of what drives potential GVC associated productivity changes and structural change. This gap in the literature calls for improvements in the measurement of GVC integration and its subsequent impact on productivity and structural change in SSA and the mechanisms underlying such a potential relationship.

GVCs can stimulate productivity gains through different channels. First, integration into GVCs provides firms and countries with important opportunities to access international markets, access higher quality and sophisticated intermediate inputs, and benefit from knowledge spillovers and pro-competitive effects of global competition to stimulate productivity gains and expand the scale of exports (Collier & Venables, 2007; Schott, 2008; Criscuolo & Timmis, 2017; Constantinescu et al., 2019). There are a number of ways through which GVCs may impact upon productivity, some of which would be captured by (or impact on) the within effect and others the between effect (structural change effect). In terms of the former, to participate in GVCs, global lead firms require their suppliers (entrant firms) to have certain technological and managerial capabilities to enter and remain competitive in the value chain. Firms need specific capabilities for the specific GVC functions and activities they perform in the value chain. To remain competitive in the value chain, firms have to

introduce new technologies, adopt a mix of innovations, change their organisational structure and engage in the skill upgrading of their workers to utilize equipment and information efficiently. A great deal of industrial upgrading is involved in this process.

For instance, a typical GVC could involve process upgrading whereby production systems are made more efficient through the adoption of superior technology and through product upgrading in which firms move into more sophisticated product lines. The process involved in GVC participation could also involve functional upgrading in which firms within an industry acquire new functions such as moving from performing assembling activities to product design and redesign, logistics, after-sales services and repairs that facilitate the movement of workers into more sophisticated business functions in GVCs over time. (Humphrey & Schmitz, 2002; De Vries et al., 2019). All these processes and activities in GVCs involve industrial shifts in employment shares and value-added creation within industries, particularly in more knowledge and capital-intensive industries. This efficient reallocation of resources within sectors ultimately affects the performance of these firms (Lall, 1992; Morrison et al., 2008; Newman et al. 2016).

In terms of the latter, participating in GVCs can act as a catalyst for growth-enhancing structural change, allowing for the shifting of resources into more productive and dynamic sectors of the economy (movement of resources across sectors) (Baldwin, 2012; 2016, Allard et al., 2016; UNIDO, 2017a, 2017b; Criscuolo & Timmis, 2017; Jouanjean et al., 2017)[62]. This happens through chain or inter-sectoral upgrading, whereby firms move into completely new categories of production altogether (cf. Humphrey & Schmitz, 2002).

To understand better the relationship between GVCs, productivity gains, and structural change in countries in SSA, the chapter first computes indicators of GVC participation using the Eora Input-Output (IO) database. In our analysis, an aggregate GVC participation index is the main explanatory variable of interest. However, to present more comprehensive evidence on the relationship above and because we are interested in the mechanisms through which participation in GVCs can impact productivity growth, we also consider the independent effects of backward and forward participation. Second, the chapter decomposes labour productivity growth using a structural decomposition model (shift and share method) and examines the extent to which GVC participation affects productivity growth through the two channels—i.e., the contribution from structural change (between) and from the within effect. We also test if participation in GVCs offers more opportunity for learning, particularly for laggard countries as in Pahl and Timmer (2019).

In addition to the above, the need to understand how GVC integration could power structural change and productivity gains in SSA is crucial given the gains from trade and recent trends in GVC participation on the one hand and against the backdrop of the recent globalization backlash in advanced economies and growth of automation on the other. The World Bank WDR (2020) reports that value chains have matured, making further specialization more challenging. The push toward

[62] UNIDO. (2018). Forum on Globalization and Industrialization: https://www.unido.org/news/driving-structural-change-through-global-value-chains-integration. Accessed on 10/04/2018.

trade liberalization has also stalled. These concerns have raised the question of whether an important route for Africa's industrialisation take-off is now all but closed (The Economist, 2017), or whether in all this there is a reason for optimism, with Africa retaining a significant potential for long-term productivity gains in more dynamic and non-productivity resistant sectors through GVC integration, especially at a time when the region itself is moving towards becoming a free trade area under the African Continental Free Trade Area (AfCFTA).

To this end, the chapter contributes to the literature by examining the impact of GVC participation on labour productivity growth and its two components—the within and structural change components—across countries in SSA with different natural resource endowments using a representative sample of SSA countries that together contribute about 80 percent of the region's gross domestic product, for the period 1990 to 2015. Previewing our results, we find evidence that participation in GVCs has had a positive and significant effect on productivity growth in Africa, but strongly through backward participation, with the effects being stronger for countries in the region that are further from the productivity frontier. Results from the analysis of the two components also show that GVC participation has a positive and significant effect on the within component by inducing an efficient reallocation of resources within but not across sectors. These benefits arise mostly in non-resource based and non-oil resource exporting countries. Overall, the results indicate that GVC participation matters for productivity gains in Africa, but points to potential variation in the channel of impact across countries with different natural resource endowments.

The remainder of the chapter is structured as follows. Section 5.2 discusses the data and adopts a framework to group countries according to their natural resource endowments. The section then documents and examines SSA's integration into GVCs across the framework of country groupings. Section 5.3 discusses the econometric model, methodology and data. The section also discusses patterns of structural transformation and productivity growth across the framework of country groupings. Section 5.4 discusses the main econometric results. Section 5.5 rounds up with conclusions and policy implications of the chapter.

5.2. Constructing Global Value Chains Data

To compute the GVC indicators, we draw on the latest release of the Eora MRIO I-O database of the University of Sydney[63] which is a set of input-output tables covering 26[64] sectors in 187 countries for the period 1990-2015, providing the largest coverage of countries (including developing countries and countries in SSA) that we are aware of. The database is widely used (see UNCTAD, 2013; Islam et al., 2017 for the IMF; World Bank WDR, 2020) and the reliability and accuracy of the Eora database are discussed in detail in Lenzen et al (2013) where it compares very well with comparator databases such as the GTAP database, OECD–WTO data and the WIOD database (UNCTAD, 2013).

[63] Data is downloadable here https://worldmrio.com.
[64] In our study we use 25 sectors over the period 1990-2015.

Despite this, there are limitations or concerns about the quality of the Eora MRIO dataset. For many countries, especially those in developing countries, official national IO tables do not exist and so for these countries, much of this data is imputed following standard imputation and harmonization approaches. Whiles the database tries to achieve balanced tables, sometimes this is impossible due to lack of original data and conflicting data. Whiles this is not a problem at the country level, for some sectors imbalance remains. "Generally, this imbalance is small, e.g. <5% for bigger economies, but can be up to 20% in the worst case sectors. The current Eora tables have been constructed with an emphasis on fulfilling balancing conditions predominantly for large countries. Hence, balancing conditions are usually very well met (1% imbalance) for large economies such as the USA, Japan, China and Germany, but less well met for either small countries or countries where international trade is larger than GDP (up to 50% imbalance for example for São Tomé & Principe, Singapore and Hong Kong). The Rest of World (also called "Statistical Discrepancies" sector is introduced to absorb these imbalances"[65]. It is worth stressing that these drawbacks are not limited to only the Eora dataset but applies to the other MRIO dataset although the drawback in these other MRIO datasets is less severe and so eventually the Eora dataset compares very well with the other MRIO datasets (see Lenzen et al., 2013).

The columns of the MRIO table reports information on the sources (both foreign and domestic) of a sector's intermediate goods whiles the rows report where a sector supplies intermediates to. The difference between the gross output produced in a country and the sum of the domestic and foreign inputs necessary for its production yields the value-added generated in a country (UNCTAD, 2013). The information given by an MRIO can be translated into a standard IO matrix form by stacking all industries and countries, such that we have (n x i) rows and columns with n and i representing the number countries and industries repectively (Miller & Blair, 2009; Foster-McGregor et al., 2015). Borrowing the notation in UNCTAD (2013), gross output is as follows:

$$X = T + y$$

$$X = Ax + y$$

$$X = (I - A)x = y$$

$$X = (I - A)^{-1}y \;\; = \;\; Ly \qquad (1)$$

Where X is gross output, T is intermediate demand, y is final demand[66], I is the identity matrix, A is the technical coefficient matrix measured as the ratio of intermediate use to gross output and L is the Leontief inverse. We follow Hummels et al (2001), Koopman et al (2011, 2014), Foster-McGregor

[65] https://www.worldmrio.com/documentation/faq.jsp

[66] In Eora, 6 components make up final demand (FD): Household final consumption, Non-profit institutions serving households, Government final consumption, Gross fixed capital formation, Changes in inventories, Acquisitions less disposals of valuables.

(2015) and Aslam et al. (2017) to calculate trade in value-added, defined as the value-added embodied in gross trade flows. Three components are needed to calculate trade in valued-added (Tva), namely; the Leontief inverse matrix (L), a row vector or matrix, (V), with each element showing the share of value-added[67] per unit of output by country and industry, and a row vector or matrix, (E), with each element reporting aggregategross exports (i.e., sum of intermediates inputs exported abroad and exports of final goods). The Leontief matrix is recovered from the technical coefficients matrix (A) and obtained by summing across rows of the (A) matrix and subtracting all the elements on the diagonal of the square matrix from an identity matrix.. Tva is arrived by multiplying the two components L and V, and the diagonalized row vector of the total gross exports matrix (E)[68] (Foster-McGregor et al., 2015; Aslam et al., 2017) and is given as:

$$\begin{bmatrix} Tva^{11} & \cdots & Tva^{1n} \\ \vdots & \ddots & \vdots \\ Tva^{n1} & \cdots & Tva^{nn} \end{bmatrix} = \begin{bmatrix} V^1 & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & V^n \end{bmatrix} \begin{bmatrix} L^{11} & \cdots & L^{1n} \\ \vdots & \ddots & \vdots \\ L^{n1} & \cdots & L^{nn} \end{bmatrix} \begin{bmatrix} E^1 & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & E^n \end{bmatrix} \qquad (2)$$

with V^n and E^n as $(i \text{ x } 1)$ diagonalized row vectors of value-added shares per unit of output and gross exports for each industry and country n, respectively. L^{nn} is the $(i \text{ x } 1)$ Leontief inverse of country n. Given Tva, we decompose and compute the indicators for GVC participation. First is the indirect value-added (DVX), which is the row sum of the Tva matrix divided by gross exports, excluding diagonal terms, and is defined as the share of value-added used in the exports of third countries. DVX is used to measure forward participation. The second indicator is foreign value-added (FVA) in exports, which is the column sum of the Tva matrix, excluding diagonal terms, divided by gross export and is defined as the share of foreign value added used in a country's exports of the same GVC. FVA is used to measure backward participation. A country's overall rate of linkages to a GVC is the sum of the share of FVA and the share of DVX. The indicators are constructed at the country-industry level[69]. This is a standard measure of GVC[70] participation (UNCTAD, 2013; Foster-McGregor et al., 2015; Kummritz et al., 2017; Nduduisi & Owusu, 2021). It acknowledges that countries and firms

[67] There are 6 components that makes up the value added in Eora—compensation of employees, taxes on production, subsidies on production, net operating surplus, net mixed income, consumption of fixed capital.

[68] Each element on the diagonal of the gross export matrix gives the gross exports (sum of intermediate inputs exported and final demand exports) for corresponding country and industry.

[69] For purposes of exposition equation 3 is at the country level, but in the analysis, the indicators are constructed at the industry level.

[70] It is important to mention that the indicator of GVC participation is correlated with a country or an industry's participation in global trade in general. The difference, however, arises when one wants to examine what type of trade a country/industry is engaged in. For instance, is a country/industry participating in intra or inter industry trade or trading in task (value-added)? how connected is a country/industry the global production system—forward or backward or upstream and downstream? Although countries may have the same level of participation in trade, their participation in GVC (also via forward or backward) could be very different as seen in the case of SSA and East Asia and Latin America where participation in GVC is comparable but SSA's participation is more in forward participation supplying primary inputs in the value chain whiles the other regions are more integrated backward sourcing more intermediate inputs for their export. We control for trade openness in the baseline regression but results remain robust to its inclusion.

participate in GVC either as "buyers" or "sellers" or both (see for example in UNCTAD, 2013; Foster-McGregor et al., 2015; Kummritz et al., 2017)[71].

5.2.1 Classification of Countries by Natural Resource Endowment

The study adopts the classification used in Allard et al (2016) in grouping countries according to their natural resource endowments. Resource intensive countries are those for which non-renewable resource exports are 25 percent or more of goods exports on average (Allard et al., 2016: p. 2). The classification first divides countries in SSA into countries that are resource-intensive and countries that are not. It then differentiates within the first group, resource intensive countries that are oil exporters and those that are not. This results in three non-overlapping groups of countries represented in Table 5.1 below.

Table 5.1: Classification of Countries by Natural Resource Endowment

Natural Resource Endowment Group	Country
Oil-Exporters	Angola, Cameroon, Chad, Congo (Republic of), Equatorial Guinea*, Gabon and Nigeria
Non-Oil resource intensive countries	Botswana, Burkina Faso, Central African Republic, DRC, Ghana, Guinea, Mali, Namibia, Niger, Sierra Leone, South Africa, Tanzania, Zambia, Zimbabwe
Non-resource intensive countries	Benin, Cabo Verde, Comoros*, Cote d'Ivoire, Ethiopia, Eswatini, Gambia, The, Guinea-Bissau*, Kenya, Lesotho, Senegal, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Togo, Uganda

Note: *Data is not available for these countries.

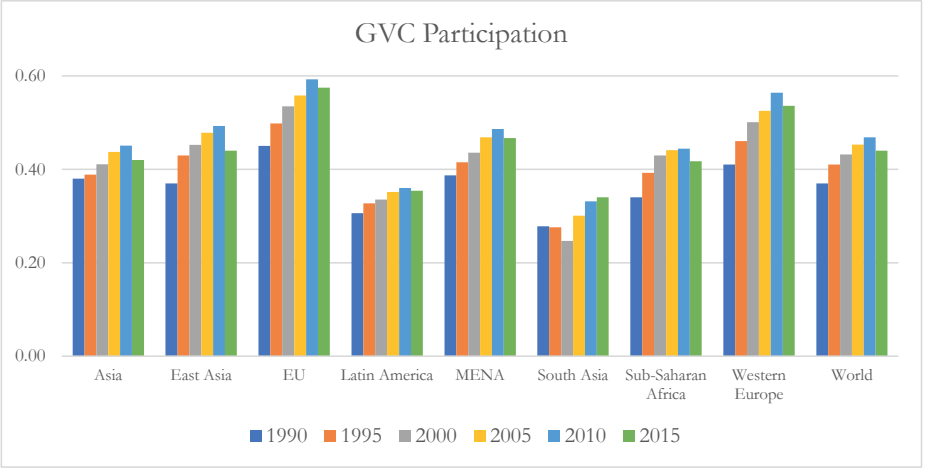
5.2.2 Participation in GVC: Africa Compared to the World

Countries participate in international trade by sourcing intermediate inputs to be used in their exports (backward participation or foreign value added in exports) or by supplying intermediates inputs to be used in the exports of third countries (forward participation). Combining these two components gives an indication of countries overall GVC participation and a clear picture emerges. The picture emerging from Figure 5.1 is clear and it suggests that the world has become more integrated in trade. Between 1990 and 2010, participation in GVCs in the world increased by 10 percentage points, from 37 percent

[71] More generally, some studies either focus on backward participation (Pahl and Timmer, 2019) or forward participation (Baldwin and Lopez-Gonzalez, 2015) as a proxy measure for GVC participation. In most cases, studies that use either of these measures, as opposed to the standard measure we use in our study, often cite a dearth of data and the objective of the study as the rationale for adopting these proxy measures. For example, Pahl and Timmer (2019) used only backward linkages (FVA in our case) as a proxy measure of GVC. In their paper (see page 5) the authors acknowledge the limitation of using this approach. Using their approach only captures a country's backward participation into GVC and ignores completely the country's forward participation in GVC and therefore gives a less than complete picture of a country's overall GVC participation. The authors mentioned that their measure of GVC is not well suited for analysis that involves many countries that are mostly involved with upstream activities in the value chain as sellers. In our case, we are interested in the benefits of participation in GVC, which can either be through backward and/or forward integration.

in 1995 to 47 percent in 2010. In terms of regions, Sub-Saharan Africa's GVC participation is very encouraging. The region is heavily involved in GVCs, generally as high as those of their counterparts in other developing countries in South Asia, East Asia, and Latin America. The finding is in line with the finding of Foster-McGregor et al (2015) and World Bank (2020). Overall participation in GVCs, however, has been highest in the countries of EU[72] while it has been lowest in South Asia and Latin America, although increasing. GVC participation in the EU increased from 45 percent in 1990 to 59 percent in 2010. In South Asia, GVC participation increased from 28 percent in 1990 to 33 percent in 2010.

Figure 5.1: Participation in GVC: Africa Compared to the World (1990-2015)



Source: Author's calculation based on UNCTAD-Eora GVC Database.

Emerging evidence, however, suggests that the proliferation of GVCs overall may have stalled since 2010 after a brief recovery from the dip during the global financial crisis of 2008-9. Between 2010 and 2015, GVC participation at the global level dropped by 3 percentage points, 2 percentage points in sub-Saharan Africa and Western Europe, 3 percentage points in Asia, 4 percentage points in East Europe, and a percentage point in Latin America (see Figure 5.1). Other studies have confirmed this. Hoekman (2015) finds that world trade, particularly, trade in intermediate inputs has stagnated since 2011. Timmer et al (2016), Criscuolo & Timmis (2017), UNCTAD, (2018), and recently the World

[72] Four factors could explain these variations, namely, size, geography, economic openness, and transport infrastructure. In contrast to countries in other regions, typically, many countries in Europe are small (in terms of population), open economies geographically close to each other and closer to larger European markets such as Germany and linked by very good transport infrastructures. These factors are undeniably pre-conditions for higher integration into GVCs and explain Europe's strongest and highest participation in GVCs compared to other regions of the world allowing countries in the region to easily source inputs from each other to be used their exports. At one extreme Criscuolo & Timmis, (2017: 63) reported a GVC participation rate of 71% for Luxembourg and 31% for New Zealand and argued that small open economies such as Luxembourg that are close to larger foreign markets in the EU are more likely to be more integrated into GVCs compared to large and remote countries in other regions (OECD, 2013a).

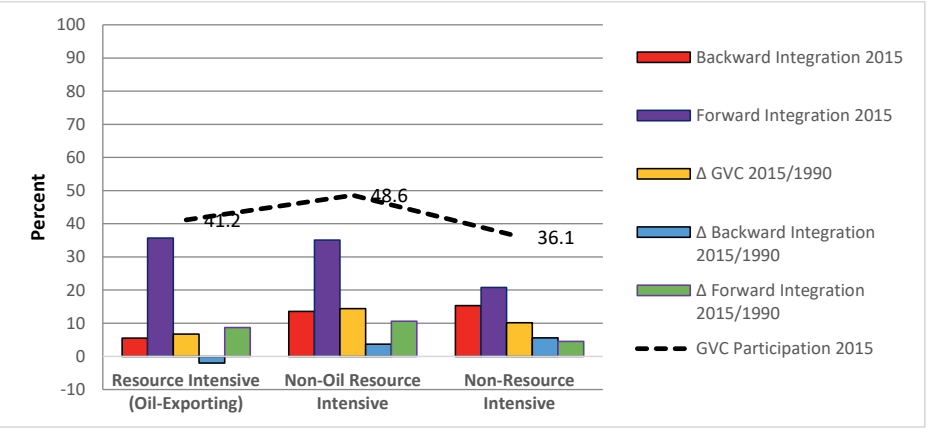
Bank WDR (2020) have all confirmed this. The slowdown of GVC activities is a reflection of what is going on with global trade in general. "In the aftermath of the global financial crisis of 2008-09, global trade has not grown at the same rate as in previous years"(Georgieva et al., 2018: 1). Between 1985 and 2007, global trade grew at an average of 6 percent, but since 2012 this growth has reduced to 3.1 percent. Factors such as a shift towards increasing protectionism, limited progress in multilateral and bilateral trade policy negotiations, automation and the possiblility of increased reshoring, weak demand in response to the crisis, declining commoditiy prices, macroeconomic rebalancing in China and the fact that existing chains may have matured making further expansion difficult are cited as among potential explanations for the decline or reversal in the international fragmentation of production. Investigating the driving factors influencing these trends in GVC participation is beyond the scope of this chapter although it remains an interesting area for future work. For a comprehensive overview of the factors and policies behind global trade slowdown see (Georgieva et al., 2018, World Bank, 2020).

5.2.3 Resource Endowment and GVC Participation in Africa

This section presents the findings of the analysis of the association between natural resource endowments and the participation of countries in GVCs. We compare trends in resource-intensive countries as a group to those in non-resource intensive countries. Despite being relatively well-integrated into GVCs, similar to the levels of comparator developing countries, the level and dynamics of linkages to the regions' GVCs participation vary substantially between the resource-intensive and non-resource intensive country group. Specifically, GVC participation is substantially higher in the resource-intensive group than in the non-resource intensive group. For this group and the region in general, the comparative advantage in GVC participation predominantly lies in forward participation in the value chain (Figure 5.2).[73] However, the strong forward participation of the resource-intensive countries, particularly in the oil resource-intensive country group, is associated with predominantly upstream activities of the value chain such as extraction and the export of raw materials (such as crude oil, natural gas, minerals) as basic inputs in the value chain. This comes with a risk as it exposes countries in this resource group to global commodity price volatility. Also, given that GVC participation of oil-resource intensive countries in the region via backward integration is the lowest amongst all resource groups in the region (see Figure 5.2), and declining, means this set of countries risks missing out on importing essential intermediates needed for quality upgrading, productivity, and economic diversification. Similar to the global trend, we see a decline in the proliferation of GVC activities across all resource groups since 2010 (see Figure 5A1 and Figure 5B1 and 5C1 in appendix).

[73] Except for countries in the EU where backward linkages dominate, this phenomenon is also observed in other developing countries where forward participation remains the highest contributor to GVC participation (see Table 1A and 1B).

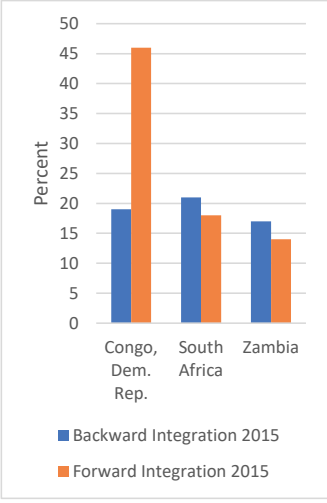
Figure 5.2: Performance in GVC by Resource Groups in Sub-Saharan Africa

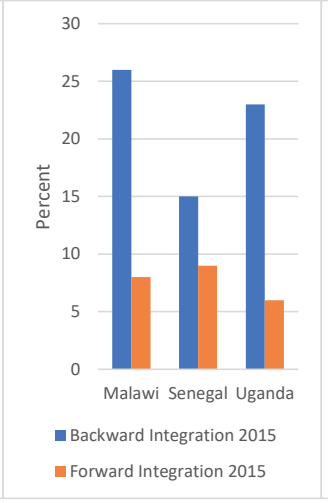


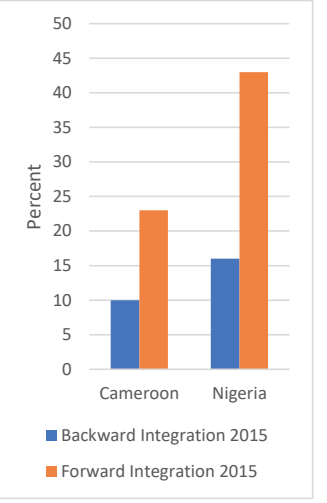
Note: Chart is based on weighted average data.
Source: Author's calculation based on UNCTAD-Eora GVC Database.

While substantial differences exist between the resource groups in their participation rates and changes in these rates, both sets of indicators vary substantially across countries within each group. Observations in the non-oil resource group show, for example, that DRC has greater participation rates in GVCs than South Africa and Zambia (see Figure 5.2). Likewise, within the same group, participation rates are higher for South Africa than for Zambia. The participation of South Africa and Zambia in GVCs is heavily through backward participation (see Figure 5.3). In non-resource intensive (resource poor countries), participation also varies across countries within the group. Similar to some countries in the non-oil resource-intensive group (South Africa, Zambia), countries within this group participate largely through backward participation (see Figure 5.4). These sets of countries are therefore able to import essential intermediates needed for quality upgrading, productivity improvements and economic diversification. This is not the case in oil-resource intensive countries where forward participation dominates the GVC participation of countries within the group, which may limit the opportunity for upgrading in these countries (see Figure 5.5).

Figure 5.3: Non-Oil Resource Intensive Group *Figure 5.4: Resource-Poor Group* *Figure 5.5: Oil Resource Intensive Group*







Note: Chart is based on weighted average data.
Source: Author's calculation based on UNCTAD-Eora GVC Database.

5.3 Methodology and Data

5.3.1 Shift and Share Decomposition

This section of the chapter examines the extent to which participation in GVCs affects productivity growth in SSA through the channels discussed above by regressing the three dependent variables (productivity growth, contribution to productivity growth through the within effect, and through the structural change effect) on GVC participation. To do this, we first employ the well-known productivity growth (shift and share method) decomposition (Fabricant, 1942; McMillan & Rodrik, 2011, De Vries et al., 2015; Mensah et al., 2018) to decompose productivity growth into the contribution from the within and the structural change effect. The structural shift and share model is given as follows:

$$\dot{lp} = \sum_{i=1}^{N}\left[\frac{lp_i^t - lp_i^0}{lp^0}\right]x_i^0 + \sum_{i=1}^{N}\left[\frac{(x_i^t - x_i^0)\times(lp_i^0 - lp^0)}{lp^0}\right] + \sum_{i=1}^{N}\left[\frac{(x_i^t - x_i^0)\times(lp_i^t - lp_i^0)}{lp^0}\right] \quad (3)$$

Where $\dot{lp}$ is labour productivity growth of sector i in time t, given by $lp_{it} = {}^{z_{it}}/_{c_{it}}$, z_{it} is sector i's value-added, c_{it} is the number of persons engaged in sector i and x_{it} is the sectoral share of employment in sector i at time t, with N being the number of sectors. The first component on the right-hand side is the sum of each sector's within-sector labour productivity growth, weighted by the sector's initial labour share in the economy. In other words, it is that part of overall productivity growth that is attributed to, among other things, the introduction of new technology, changes in

organisational structure, downsizing, reallocation of resources within sectors and increased competition (Disney et al., 2003). The second component is the structural change or between effect. It has two components. The first term. It captures whether workers move to sectors with above-average productivity. The second term—the interaction/dynamic reallocation effect—measures whether productivity growth is higher in sectors that are expanding in terms of employment shares. Employment and value-added data for the decomposition is based on a newly constructed dataset, the Extended Africa Sector Database (Mensah & Szirmai, 2018).

Based on the above, it is instructive to further test whether the effect of GVC on productivity growth and structural change differs depending on whether a country/sector is engaged in forward or backward participation. In this regard, the nascent literature has reported high positive productivity and upgrading gains to firms and industries through backward linkages and less so for other channels (Iršová & Havránek, 2013; Pahl & Timmer, 2019; Ndubuisi & Owusu, 2021). A case study of the textile and garment industry in Bangladesh has suggested that increasing the share or content of foreign intermediate inputs (backward integration) can be a good source of increased productivity (see Mottaleb & Sonobe, 2011; Pietrobelli & Rabellotti, 2011).

5.3.2 Econometric Model

The resulting regression model takes the following form:

$$\dot{lp}_{ist} = \beta_0 + \beta_1 GVC_{ist} + \beta_2 C'_{ist} + \gamma_i + S_s + u_t + \varepsilon_{ist} \quad (4)$$

$$\dot{lp}_{ist} = \beta_0 + \beta_1 FVA_{ist} + \beta_2 DVX_{ist} + \beta_3 C'_{ist} + \gamma_i + S_s + u_t + \varepsilon_{ist} \quad (5)$$

where $\dot{lp}$ is labour productivity growth or depending on the specification labour productivity growth attributable to the within or structural change/between effect, GVC is the global value chain integration indicator, FVA is the share of foreign value-added component used in a country's exports, and DVX the share of a country's value-added used in the export of third countries. The subscript i refers to country, s to sector, and t to time period, while γ_i capture country fixed effects, S_s sector fixed effects, u_t period fixed effect, and ε_{it} is the idiosyncratic error term. C'_{it} is a vector of control variables that includes human capital, measured by the gross secondary school enrolment rate, the quality of institutions (regulatory quality), and inflation rate, with data on these variables sourced from the World Bank's World Development Indicators (Zhu & Fu, 2013; Pahl & Timmer, 2019). We use cluster-robust standard errors to control for serial correlation and heteroscedasticity.

Given the fact that integration into the global production network could have divergent impacts on the structural developments and productivity growth of countries in different resource endowment groups as discussed in section 5.1, we run a baseline regression for all country groups in our sample and separately for the split samples of the natural resource groups according to the definition in Table 5.1. For instance, it is found in the literature that the association between GVC participation and labour productivity growth is lower in the resource-based exporting countries (Ivarsson & Alvstam

2010; Havranek & Irsova, 2011; Pahl & Timmer, 2019: 14-16). Also as shown in Figures 5.2, 5.3, 5.4 and 5.5, similar to some countries in the non-oil resource-intensive group (South Africa, Zambia), resource-poor countries participate more through backward participation. These sets of countries are therefore able to import essential intermediates needed for quality upgrading, boosting productivity, and economic diversification. This is not the case in oil-resource intensive countries where forward participation dominates GVC participation of countries within the group which limits the opportunity for productivity growth and upgrading for these countries.

For the estimation strategy, we first utilize panel fixed-effects models (FEM). One of the empirical challenges we face is that GVC participation may be endogenous. We anticipate our model to suffer from potential endogeneity, particularly because of reverse causality. Higher productivity growth may be a pre-requisite for higher GVC integration and vice versa. Our GVC indicators may also be endogenous due to other confounding factors such as omitted variable bias. As a caveat, therefore, the results we obtain using the FEM show an association between GVC integration and the outcome variables rather than a causal effect. To reduce the scale of this concern, we lag the GVC participation variables by one period. Moreover, besides mitigating the reverse causality concern, this empirical approach enables us to account for the time needed for knowledge and technology acquired through GVC participation to be used in industrial activities that would lead to productivity gains. To completely address this empirical challenge and claim a causal relationship from our estimates, we complement the FEM estimation with an instrumental variable (IV) method and report the results alongside those of FEM.

As instruments for GVC participation, we propose two instruments: a remoteness index and the weighted average GVC participation index for other countries. Beginning with the former, the index has been argued in the literature to be a theoretically consistent approximation for relative trade costs which hugely affects a countries' participation in international trade (Head 2003; Brun et al., 2003; Santos et al., 2006). In particular, countries that are more remote from the rest of the world are likely to participate less in the global trade network but will trade more with close neighbours that are also remote from the global trade network (Brun et al., 2005). In a recent study, Antras and de Gotare (2020) also showed that the participation of countries in GVCs is determined by their remoteness from the rest of the world. Consistent with this view, we argue that a country's remoteness from the rest of the world affects the extent to which it participates in GVCs but not the country's productivity and structural change, at least not directly.

To compute the remoteness index (RT), we use the CEPII gravity dataset that shows the annual GDP of different countries and the universe of distance (in kilometres) between country-pairs (Meyer & Zignago, 2011). Our computation of the index then follows Head (2003) and Brun et al (2005), who compute the index as: $RT_{it} = \sum_j z_{jt} D_{ij}$, where $z_{jt} = Q_{jt} / \sum_j Q_{jt}$, D_{ij} is the distance in kilometers between country *i* and partner country *j* (other countries in the world), and $Q_{i(j)t}$ is GDP of country *i*(*j*) at time *t*.

The second instrument, the weighted GVC participation for other countries is computed as $w_GVC_{it} = \sum_{j \neq i} GVC_{jt} D_{ij}$ where GVC_{jt} is the level of GVC participation of every other country *(j)* in the world in time t weighted by the distance in kilometres between country *i* and *j* given by D_{ij}. The latter is done to avoid our indicator being constant across countries. In other words, we use a distance weighted GVC indicator as our second instrument. For the relevance of this instrument, we build on the policy diffusion argument which is that countries learn from their neighbours. In which case, to the extent that high GVC participation reflects the existence of GVC friendly policies, other things equal, closely related countries are more likely to adopt similar policies, but this policy adoption effect decays with distance. Consistent with this view and to claim the validity of our chosen instrument, we assume that such trade costs affect a country's participation in GVC but not productivity and structural change, at least not directly.

Further to this, it is established in the literature that the impact of remoteness on economic development is not direct but conditioned on other factors such as—the volume of trade, accessibility to outside investors (see: Read, 2004; Armstrong & Read, 2004). Read (2004) for instance mention that size, remoteness and isolation do not appear to constitute an insurmountable obstacle to the growth success of these countries since a disproportionate number of these countries are found in the World Bank's Upper-Middle (Group 3) and High (Group 4) income classification. The author further argues that remoteness and isolation may have adverse effects on economic growth in remote countries not directly but via higher costs of transport and communications although a similar argument can also be applied to land-locked states. Armstrong and Read (2004) add that examining the relationship between remoteness and economic development is a more complex exercise than may appear at first sight. The authors argue that "sovereign microstates and dependent territories are extremely diverse in their geographical and economic characteristics. For example, whiles some remote countries (e.g., islands) are located in developing regions of the world, others are located further from developing countries. A simple comparison, therefore, of GNP per capita of these countries and attributing it directly to their remoteness would be extremely misleading". In Massimo and Mastinu (2015) the authors show graphically the variation in economic performance among remote countries (island) with some doing very well even at the level higher than some inland countries.

5.3.3 Patterns of Structural Transformation and Productivity Development in Africa

Table 5.2 below discusses the results of the shift-share decomposition showing patterns of structural transformation and productivity developments across the natural resource groups in Africa over the period 1960s-2015. The analysis is broken into periods to reflect the role of economic policies in post-independence Africa in explaining the observed patterns and why recent policies have focused on GVCs as an alternative path to bring about growth-enhancing structural change. The post-independence era in Africa was greeted with very much euphoria and optimism as most African political leaders embarked on structural transformation and industrialisation agenda. As Mkandawire (2001), Geda et al (2018) and Geda (2018b) have highlighted, the leaders were eager both in intent and practice to transform the region into an industrial hub by putting policies in place that will guide

this process. An outcome of this intent at the policy level was the import substitution strategy (IS) that was pursued by almost all the economies in the region between the period 1960 and 1975. While it is usually argued in the literature that the IS was a policy failure (see Mkandawire, 2001; Geda, 2018a), our results, however, gives a contrary account. The region and all the resource groups recorded one of the best productivity growth rates during this period with a substantial contribution from structural change, particularly in non-resource intensive and non-oil resource intensive countries (see also De Vries et al. 2015; Mensah et al. 2018). Ellis (2002) described the period between 1960 and 1975 as the golden age of Africa's growth performance—with an annual average GDP growth rate of 6%.

Table 5.2: Contribution to Productivity Growth in Africa, by Resource Endowment Groups: Results from Shift and Share Method

Natural Resource Endowment Group	Period/Era	Total Productivity Growth	Within	Between Static	Between Dynamic	Structural Change
Oil exporters	1960-1975[74]	5.3%	4.7%	0.8%	-0.1%	0.6%
	1975-1990	2.3%	2.0%	0.4%	-0.1%	0.3%
	1990-2000	1.3%	-0.1%	1.6%	-0.2%	1.4%
	2000-2015	1.8%	0.9%	0.9%	0.0%	0.9%
Non-Oil resource intensive countries	1960-1975	2.9%	0.8%	2.4%	-0.3%	2.1%
	1975-1990	1.2%	1.0%	0.4%	-0.3%	0.2%
	1990-2000	1.4%	1.1%	0.5%	-0.2%	0.3%
	2000-2015	2.9%	1.9%	2.0%	-1.0%	1.1%
Non-resource intensive countries	1960-1975	1.6%	0.6%	1.2%	-0.3%	1.0%
	1975-1990	-0.4%	-1.1%	0.9%	-0.2%	0.7%
	1990-2000	2.7%	1.5%	1.3%	-0.1%	1.2%
	2000-2015	3.0%	1.6%	1.7%	-0.3%	1.4%

Source: Author's calculation based on 18 countries sub-Saharan countries in EASD (Mensah & Szirmai, 2018).

The period between 1975 and 1990 has been tagged as the lost decades in SSA. Individual economies in the region recorded the worst figures for productivity growth for any of the periods. In all the resource country groups, productivity growth declined. The period also marked the turning point of industrialisation in the region, with most countries in the region starting to experience early deindustrialisation (Cadot et al., 2016; Rodrik, 2016). In the African policy discourse, the

[74] Average productivity growth in oil-exporting countries was highest in 1960-1975 period contrary to general pattern in the region where the highest productivity growth was recorded in 2000-2015. The result is driven by productivity growth in Cameroon during that period. For instance, productivity growth in Cameroon during 1960-1975 is 6.1% whiles it was -1.8% in 2000-2015. This is similar to the case where productivity growth in Botswana is also driving the productivity growth of non-oil resource intensive country group in 1960-1975. Productivity growth in Botswana is 14% in 1968-1975 whiles it is 2.3% in 2000-2015 (see Mensah et al., 2015).

implementation of the Structural Adjustment Programs (SAP) in the region during this period is usually blamed for this abysmal growth performance (see ECA, 1989; World Bank, 1989; Elbadawi, 1992; Mkandawire, 2001; Geda, et al., 2018; Geda, 2018b for a comprehensive discussion on this).

Since the post SAPs era (1990-onwards) growth has steadily rebounded in the region (De Vries et al., 2015, Mensah et al., 2018). Productivity growth returned to all the natural resource country groups, except for the resource-intensive oil-exporting countries (to 1.3% from 2.3%), with growth increasing to 1.4% from 1.2% in resource-intensive non-oil exporting countries, and to 2.7% from -0.4% in non-resource intensive countries. For most of the period before 1990, resource-intensive countries have performed better than non-resource intensive. The exception is the last 30 or so years, which represents the importance of the GVC era to productivity growth in the region. The moderate to high contribution of structural change to productivity growth within this period is also evident. The period also coincided with the beginning of the intensification of the fragmentation of global production and the time in which countries in the region increasingly connected to the global trade network (see appendix Figure 5A1). Below we present econometric results to highlight the impact of this increased GVC integration on productivity growth and structural change in the region since the region rebounded to growth in the 1990s to 2015.

5.4 Main Results

We first discuss the results for labour productivity growth. The baseline results for the entire economy are reported in Tables 5.3 and 5.4 (column 1-3). Starting with the main variable of interest, in all the models, the estimated coefficients on GVC participation is positive and statistically significant, suggesting that GVC participation increases productivity gains. Next columns 5-7 report regression results using the IV-2SLS estimator, our preferred estimator. In all columns, the estimated coefficient remains positive and statistically significant. Results in column (5) do not include any controls, (other than time, country and sector fixed effects), and indicate a positive and statistically significant relationship between GVC integration and labour productivity growth. On average, a one percent increase in the GVC participation index is associated with a 0.244 percent increase in labour productivity growth. The result is robust and consistent across the different models. Following Pahl and Timmer (2019), in column 7, we add the initial labour productivity level at the beginning of each period (measured relative to the global productivity frontier) and the interaction of it with GVC participation to investigate whether the productivity growth effect of GVC participation is dependent on the distance to the productivity frontier. This captures the idea that GVCs may offer scope for learning, particularly for laggard countries. Specifically, all else constant laggard countries that have a backlog of existing and unexploited knowledge are expected to benefit more from the free flow of technology through trade to grow faster than countries that are nearer to the frontier because they have a wider scope for further learning. Consistent with Pahl and Timmer (2019), the coefficient of the interaction between GVC participation and labour productivity is negative, suggesting that the effect of GVC participation is stronger for countries that are further from the productivity frontier as shown in Figure 5.6, which reports the marginal effects of GVC participation on labour productivity growth.

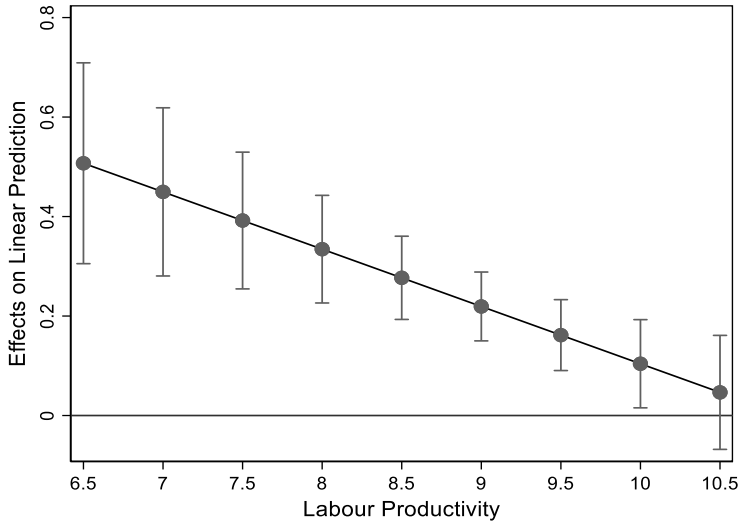
Countries and sectors participate in GVCs through either backward or forward participation. To this end, columns 4 and 8 show the regression results when we independently consider the effect of backward and forward GVC participation. In columns 4 and 8, the positive labour productivity growth effect of GVC participation accrues strongly through backward participation. Focusing on column 8, our preferred results, we find that on average a one percent increase in GVC participation index via backward participation increases labour productivity growth by 0.335 percent. The result is consistent with the broader GVC integration and labour productivity literature arguing that through backward participation, firms – or in more general terms, countries – are provided with important opportunities to access higher quality and sophisticated intermediate inputs, and benefits from new ideas, technology transfer, and spillovers to stimulate productivity growth (Collier & Venables, 2007; Schott, 2008; Halpern et al., 2015; Kummritz et al., 2017; Criscuolo & Timmis, 2017; Pahl & Timmer, 2019; Constantinescu et al., 2019). The validity of our instruments is also achieved. The first stage regression shows that the instruments are significantly correlated with the endogenous variable. The associated F-statistics of the first stage regression is greater than ten, a statistical proof that our instrument is also strong. The Sargan statistic test of overidentification reported in the respective columns of Tables 5.3-5.8 is statistically insignificant at all conventional levels, implying that the instruments are exogenous and uncorrelated with the error term.

Table 5.3: GVC Participation and Labour Productivity Growth in Africa

	Panel Fixed Effect				IV-2SLS			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GVC participation (ln)	0.2068***	0.1991***	1.2557***		0.2440**	0.2399**	0.1865*	
	(0.0884)	(0.0824)	(0.3327)		(0.1025)	(0.10242)	(0.1126)	
Backward participation				0.2472*				0.3349**
				(0.1297)				(0.1557)
Forward participation				0.1707				-1.9253
				(1.0754)				(5.4298)
Labour productivity (ln)			-0.8031				-0.0182**	
			(0.6038)				(0.0079)	
GVC participation x labour productivity			-0.1152***				-0.0196*	
			(0.0359)				(0.0120)	
Institutional Quality		-0.1031		-0.0963		-0.1954		0.0906
		(0.2014)		(0.2016)		(0.2406)		(0.3577)
Inflation		0.0017		0.0011		0.0002		0.0065
		(0.0025)		(0.0027)		(0.0028)		(0.0156)
Human Capital		1.1414		1.2267* (0.6849)		0.3308		-3.7690
		(0.7027)				(0.6045)		(4.3141)
Constant	0.2775	-1.5688	9.5267	-1.0934 (1.1515)	0.0789	-0.5240	0.1801**	-3.3179
	(0.2256)	(1.1196)	(6.2198)		(0.2497)	(1.0006)	(0.0729)	(10.9265)
Observation	1,756	1,756	1,419	1,752	1,617	1,617	1,416	1,326
Adjusted R-squared	0.032	0.034	0.119	0.035	0.036	0.037	0.028	0.020
Weak ID test (Stock-Yogo)					16.85	16.85	11.04	11.04
Sargan test (p-value)					0.503	0.927	0.950	0.969
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses: *** Significant at p<0.01, ** Significant at p<0.05, * Significant at p<0.10.

Figure 5.6: Marginal Effects of GVC Participation on Labour Productivity Growth



Note: The figure shows the marginal effect of GVC participation on labour productivity growth, by levels of labour productivity.
Source: Author's calculation based on Table 5.3 column 7.

5.4.1 Results: Resource Groups

Next, we explore the impact of GVC participation on productivity growth across the resource groups. As discussed above, the concentration of GVC activities differs across resource groups. Hence, while the results in Tables 5.3 suggest an overall positive effect of GVC participation on productivity growth, we also explore heterogeneities across resource groups. Results for this exercise are presented in Table 5.4. In section 2.1, we group countries into three non-overlapping groups of countries, namely, resource-intensive countries that are oil exporters, resource-intensive countries that are not oil exporters, and non-resource intensive countries. Relatedly, columns 1, 4, 7 and 9 report results for resource-intensive oil-exporting countries; columns 2 and 5 report results for non-oil resource-intensive countries and finally, columns 3, 6, 8 and 10 report results for non-resource intensive (resource-poor) countries. Similar to the baseline results, the estimated coefficients on GVC participation generally show that the productivity growth effect of GVC participation benefits non-resource intensive and non-oil resource-intensive countries compared to resource-intensive oil-exporting countries. The effect is also found to be stronger through backward participation. The result is consistent with our expectations and findings of the broader literature. In their study, Pahl and Timmer (2019) used only backward linkages (FVA or backward participation in our case) as a proxy measure of GVCs and find an unambiguously positive effect of backward participation in GVC on productivity growth. Further supporting our finding, we show in Figures 5.2, 5.3, 5.4 and 5.5 that

GVC participation of non-resource intensive and non-oil resource-intensive countries in Africa via backward participation is the highest and increased between 1990 and 2015 compared to oil-exporting resource-based countries where backward participation is lowest and declining.

Unlike non-resource intensive countries that participate more in GVCs through backward participation and are therefore able to access essential intermediates needed for quality upgrading, productivity improvements and economic diversification, the negative change in backward participation in oil-exporting resource-based countries in the region implies that these sets of countries risk missing out on importing essential intermediates needed for the quality upgrading and productivity enhancement of their produce and exports. The strong forward participation of exporting resource-based countries in GVCs is associated with predominantly upstream activities of the value chain such as extraction and the export of raw materials as basic inputs in the value chain and seems to have no significant positive impact on productivity gains as the opportunity for learning is limited. The result is consistent with studies that find that some countries in developing countries, and sub-Saharan Africa, in particular, despite their high integration in GVC could be locked into unproductive activities in low value-added stages of the value chain limiting the opportunity for upgrading (Foster-McGregor et al., 2015; Pahl & Timmer, 2019).

Table 5.4: GVC Participation and Labour Productivity Growth in Africa: Resource Group

	Panel Fixed Effects			IV-2SLS			Panel Fixed Effects		IV-2SLS	
	Resource intensive oil exporting	Resource intensive non-oil exporting	Resource poor	Resource intensive oil exporting	Resource intensive non-oil exporting	Resource poor	Resource intensive oil exporting	Resource poor	Resource Intensive oil exporting	Resource poor
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
GVC participation (ln)	0.2708	0.3136***	0.2620***	0.1508	0.3436***	0.6653**				
	(0.1731)	(0.0712)	(0.0681)	(0.19012	(0.1198)	(0.3328)				
Backward participation							-1.121	0.354**	-3.312 ***	0.479*
							(1.183)	(0.157)	(1.207)	(0.276)
Forward participation							0.226	0.135	0.073	0.396
							(0.249)	(0.196)	(0.186)	(0.304)
Constant	-0.3630	0.1358	0.6894*	-0.5313	0.2791	0.9159***	-3.109	1.315*	-8.367***	1.425
	(0.5132)	(0.2413)	(0.3681)	(0.5246)	(0.2680)	(0.1888)	(3.165)	(0.702)	(2.918)	(0.948)
Observation	208	620	928	192	572	853	208	924	192	846
Adjusted R-squared	0.168	0.073	0.106	0.149	0.074	0.070	0.174	0.057	0.150	0.057
Weak ID test (Stock-Yogo)				16.85	16.85	21.42			15.72	13.97
Sargan test (p-value)				0.627	0.527	0.261			0.190	0.248
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses: *** Significant at p<0.01, ** Significant at p<0.05, * Significant at p<0.10
Note: The Table shows the effect of GVC participation on labour productivity growth in Africa, by resource group.

5.4.2 Results: GVC and Productivity Growth: Contribution from Within Effect (Intra-Sector Reallocation)

An important part of the exercise in this chapter is to examine whether GVC participation affects productivity growth by inducing the efficient reallocation of resources within sectors, across sectors or both. To do this, we estimate the effect of GVC participation on these components of productivity growth using the baseline specification that controls for the country, sector, and time-fixed effects. The estimation results when we use the within component (intra-sector reallocation) variable as the dependent variable is presented in Table 5.5. In Table 5.6, we also explore the resource endowment group dimension of the same estimation. Tables 5.7 and 5.8 report results when we use the between component or the structural change component as the dependent variable. In Tables 5.5 and 5.6, in all the models, the estimated coefficient of GVC participation is positive and statistically significant suggesting that GVC participation increases productivity gains through intra-sector reallocation. In column 5, our preferred estimation, we find that on average and holding all else constant, the contribution of a one percent increase in GVC participation to productivity growth through the within-effect is 0.315 percent. Here also the results show that GVC participation has a positive and significant effect on within productivity but strongly through backward participation as shown in columns 3 and 6 respectively.

A potential explanation to the results is that not only does participation in GVC allows firms the opportunity to access quality intermediate inputs for productivity improvements, but also quality standardization requirements set by the global lead firms for their suppliers (i.e., firms wishing to enter and remain competitive in GVCs and reap the associated benefits thereof) induce these firms to improve the quality of their operations by investing in building specific technological and managerial capabilities for the specific GVC functions and activities they perform in the value chain including introducing new technologies, adopting a mix of innovations, changing the organisational structure and engaging in skill upgrading across the board of its workers. These investments made by firms and the resultant efficient reallocation of resources within the sector may ultimately affect their performance (Lall, 1992; Morrison et al., 2008; Newman et al. 2016). Similar to the baseline results, in all the models in Table 6, we find that the within productivity growth effect associated with GVC participation mostly benefits non-resource intensive countries. The effect is also stronger through the backward participation.

Table 5.5: GVC Participation and Labour Productivity Growth: Contribution through Within Effect

	Panel Fixed Effect			IV-2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
GVC participation (ln)	0.2316***	0.2231**		0.3169***	0.3149***	
	(0.0863)	(0.0848)		(0.1167)	(0.1139)	
Backward participation			0.2869**			0.4213**
			(0.1203)			(0.1632)
Forward participation			0.1947			-2.6390
			(1.0843)			(5.6893)
Institutional Quality		-0.2533	-0.2548		-0.3137	-0.1983
		(0.2265)	(0.2302)		(0.2489)	(0.3748)
Inflation		0.0052*	0.0045		0.0033	0.0110
		(0.0027)	(0.0027)		(0.0027)	(0.0164)
Human Capital		1.1594*	1.2539**		0.0381	1.3184
		(0.6274)	(0.6193)		(0.4697)	(4.5203)
Constant	0.1422	-1.8503*	-1.2956	-0.00383	-0.2614	-5.2221
	(0.2178)	(0.9929)	(0.9610)	(0.24526)	(0.7739)	(11.4486)
Observation	1,756	1,756	1,756	1,617	1,617	1,326
Adjusted R-squared	0.028	0.032	0.033	0.031	0.033	0.032
Weak ID test (Stock-Yogo)				16.85	16.85	11.04
Sargan test (p-value)				0.917	0.907	0.985
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes
Sector Effect	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses: *** Significant at p<0.01, ** Significant at p<0.05, * Significant at p<0.10
Note: The Table shows the effect of GVC participation on labour productivity growth in Africa through the within effect.

Table 5.6: GVC Participation and Labour Productivity Growth: Contribution through Within Effect

	Panel Fixed Effects			IV-2SLS			Panel Fixed Effects		IV-2SLS	
	Resource intensive oil exporting	Resource intensive non-oil exporting	Resource poor	Resource intensive oil exporting	Resource Intensive non-oil exporting	Resource poor	Resource Intensive oil exporting	Resource poor	Resource Intensive oil exporting	Resource poor
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
GVC participation (ln)	0.2635*	0.3452**	-0.0298	0.2166	0.4073**	0.5555*				
	(0.1572)	(0.1401)	(0.0656)	(0.1689)	(0.1844)	(0.2855)				
Backward participation							-0.041	0.322**	-1.649	0.567**
							(0.910)	(0.138)	(1.078)	(0.278)
Forward participation							0.226	0.114	0.161	0.292
							(0.124)	(0.190)	(0.166)	(0.306)
Constant	-0.7718*	0.1334	0.2736***	-0.6862	0.2442	0.6102***	-0.810	1.038	-4.549*	1.289
	(0.4659)	(0.3387)	(0.3601)	(0.4662)	(0.2155)	(0.1619)	(2.119)	(0.616)	(2.606)	(0.953)
Observation	208	620	928	192	572	853	208	924	192	846
Adjusted R-squared	0.202	0.058	0.094	0.177	0.059	0.011	0.199	0.052	0.171	0.048
Weak ID test (Stock-Yogo)				16.85	16.85	21.42			15.72	13.97
Sargan test (p-value)				0.455	0.580	0.287			0.747	0.484
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses: *** Significant at p<0.01, ** Significant at p<0.05, * Significant at p<0.10

Note: The Table shows the effect of GVC participation on labour productivity growth in Africa through the within effect, by resource group.

5.4.3 Results: GVC and Productivity Growth: Contribution from Structural Change (Inter-sectoral Reallocation)

The previous sections have examined the effect of GVC participation on productivity growth and intra-sector reallocation of resources (within effect). An important question yet to be answered is whether, in addition to increasing productivity growth and intra-sector reallocation, GVC participation also induces structural change or inter-sectoral reallocation of resources. This section investigates this relationship. Tables 5.7 and 5.8 report the results of this exercise and find no evidence of a positive and significant effect of GVC participation on productivity growth through the structural change channel (reallocation of resources across sectors). This finding holds for the baseline results in Table 5.7 and also holds in the analysis across the resource groups in Table 5.8. A potential explanation underlying this finding is advanced in Rodrik (2018) and confirmed in Pahl and Timmer (2019). The authors paint a pessimistic outlook on the potential of GVC participation for employment generation and structural change, particularly in developing countries. The authors assert that the technologies associated with GVC participation are providing diminishing possibilities to substitute other factors of production with unskilled labour, suggesting that developing countries such as those in Africa may not be able to take advantage of GVC participation to create employment opportunities, particularly in modern and productive sectors where the use of emerging technologies in GVCs (mostly labour saving) is very high. Also, the minimum threshold of skills and capabilities requirements needed to participate and remain competitive in GVCs will increasingly become so high that it may exclude most developing countries from using the opportunities afforded by GVCs to grow jobs in productive sectors for its relatively low skilled workforce to fast track structural transformation.

Another potential explanation for this finding is that, in general, structural change in Africa has been limited. While large and productive manufacturing firms and other tradable sectors in the region have a high probability to participate in GVCs (Abreha et al., 2020), they create fewer jobs in GVCs due to the potential use of labour-saving technologies in GVCs (Pahl & Timmer, 2019). In other words, GVCs offers these large and productive firms in the region the opportunity to improve productivity by inducing an efficient reallocation of resources within sectors. However, this comes at a cost as these firms and sectors shed workers and are limited in their capacity to absorb more labour.

Table 5.7: GVC Participation and Labour Productivity Growth: Contribution through Structural Change

	Panel Fixed Effect			IV-2SLS		
	(1)	(2)	(3)	(5)	(6)	(7)
GVC participation (ln)	-0.0247	-0.0240		-0.0729	-0.0750	
	(0.0784)	(0.0757)		(0.0589)	(0.0590)	
Backward participation			-0.0397			-0.0863
			(0.0715)			(0.0650)
Forward participation			-0.0239			0.7136
			(0.0469)			(2.2661)
Institutional Quality		0.1501	0.1585		0.1183	0.2889*
		(0.1893)	(0.1081)		(0.1169)	(0.1493)
Inflation		-0.0035	-0.0038**		-0.0031*	-0.0044
		(0.0025)	(0.0016)		(0.0017)	(0.0065)
Human Capital		-0.0180	-0.0273		0.2927	-5.0874***
		(0.4216)	(0.2671)		(0.2937)	(1.8005)
Constant	0.1354	0.2814	0.2022	0.08268	-0.2626	1.9041
	(0.1069)	(0.6363)	(0.4567)	(0.11371)	(0.4890)	(4.5602)
Observation	1,756	1,756	1,756	1,617	1,617	1,326
Adjusted R-squared	0.015	0.019	0.019	0.015	0.018	0.043
Weak ID test (Stock-Yogo)				16.85	16.85	11.04
Hansen-J test (p-value)				0.053	0.051	0.985
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes
Sector Effect	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses: *** Significant at p<0.01, ** Significant at p<0.05, * Significant at p<0.10
Note: The Table shows the effect of GVC participation on labour productivity growth in Africa through the structural effect.

Table 5.8: GVC Participation and Labour Productivity Growth: Contribution through Structural Change

	Panel Fixed Effects			IV-2SLS			Panel Fixed Effects		IV-2SLS	
	Resource Intensive oil exporting	Resource Intensive non-oil exporting	Resource poor	Resource intensive oil exporting	Resource Intensive non-oil exporting	Resource poor	Resource Intensive oil exporting	Resource poor	Resource Intensive oil exporting	Resource poor
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
GVC participation (ln)	0.0073	-0.0315	0.2919***	-0.0658	-0.0636	0.1097				
	(0.0872)	(0.0933)	(0.0467)	(0.0962)	(0.1032)	(0.2169)				
Backward participation							-1.079	0.033	-1.663***	-0.088
							(1.088)	(0.107)	(0.603)	(0.097)
Forward participation							0.0000343	0.021	-0.088	0.105
							(0.165)	(0.104)	(0.092)	(0.107)
Constant	0.4088	0.0025	0.4157**	0.1548	0.0349	0.3057**	-2.298	0.277	-3.818***	0.135
	(0.2587)	(0.2255)	(0.1889)	(0.2654)	(0.2308)	(0.1230)	(2.656)	(0.373)	1.457	(0.334)
Observation	208	620	928	192	572	853	208	924	192	846
Adjusted R-squared	0.040	0.024	0.025	0.033	0.025	0.061	0.075	0.026	0.058	0.031
Weak ID test (Stock-Yogo)				16.85	16.85	21.42			15.72	13.97
Sargan test (p-value)				0.286	0.675	0.491			0.054	0.378
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses: *** Significant at p<0.01, ** Significant at p<0.05, * Significant at p<0.10

Note: The Table shows the effect of GVC participation on labour productivity growth in Africa through the structural change effect, by resource group.

5.5. Conclusion

Economic growth and development require pragmatic and efficiently executed policies that transform a country's economic structure. This relies on, among other things, the improvement in productivity, building internal capacity, and critically diversifying into more and new productive sectors. After six decades of rolling out policies to power structural transformation and industrialisation in sub-Saharan Africa, the predominant narrative today is that this dream remains elusive. Many of the countries in the region have yet to build capabilities and shift enough of their manpower to more productive sectors to the extent that realizes this dream. Participation in GVCs has recently been highlighted as a pathway to fast-track development. Consequently, the current paper examines for the first time the impact of GVC participation on productivity growth and its two components—the within and structural change across countries in sub-Saharan Africa with different natural resource endowments. We specifically examine if the productivity growth and structural change effect of GVCs varies in resource-intensive and non-resource intensive countries in the region.

Using a representative sample of countries that together contribute about 80 percent of the region's GDP, for the period 1990 to 2015 we find evidence that sub-Saharan Africa's GVC participation is very encouraging. The region is heavily involved in GVCs, generally as high as those of their counterparts in other developing regions in South Asia, East Asia, and Latin America. Moreover, the level and dynamics of the regions' GVCs participation vary substantially between the resource groups and the countries within each group. Specifically, GVC participation is substantially higher in the resource-intensive group than in the non-resource intensive group. For the resource-intensive group, particularly for countries in the oil-resource intensive group, the comparative advantage in GVC participation predominantly lies in upstream activities of the value, providing mainly primary inputs for the value chain. There is therefore a need to strengthen participation through increasing value-added in exports and strategies to upgrade into knowledge-intensive industries in the value chain. The analysis shows that this is not happening at present, particularly among resource-based economies in the region.

These dynamics in participation reflect in our econometric estimates which show robust evidence that integration into GVCs is providing new windows of opportunity to increase productivity gains in the region. However, the positive productivity gains effect of GVC participation accrues strongly through backward linkages and benefits mostly non-resource based and non-oil-resource intensive countries. The positive effect is also stronger for countries in the region that are further from the productivity frontier, a result interpreted as offering more scope for learning, particularly for the more laggard countries. Results from the analysis of the two components show that GVC participation has a positive and significant effect on the within component by inducing an efficient intra-sector reallocation of resources, but not across sectors. The key lesson emerging from this study is that while GVC participation is very important for productivity gains in Africa, the result underlines a potential variation in the channel of impact across countries with different resource endowments.

The findings have policy implications. Similar to findings in other related studies (see for example Havranek and Irsova 2011; Kummritz, et al., 2017), our analysis shows that different types of GVC participation impacts productivity growth, and the two components of productivity growth, differently and demands different policy frameworks. Participation in GVCs as a buyer (backward participation) requires a focus on building the infrastructure and strengthening connectivity to global lead firms and global suppliers in the value chain to import world-class inputs. The inadequate supply of quality foreign intermediate inputs could be a constraining factor to productivity growth. Implementing the above policies together with other friendly input sourcing trade policies will contribute to the strategic integration of firms into GVCs to access these crucial foreign intermediate inputs. While GVC participation as a seller (forward participation) also hinges on a similar policy framework, the focus now shifts more towards policies that increase productivity to meet the global quality standards requirements set by lead firms for suppliers that want to enter and remain competitive in the value chain and the global marketplace (Taglioni & Winkler, 2016; cf. Kummritz et al., 2017).

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5.6 Appendix to chapter 5

Table 5A: Backward GVC participation, percent of gross export (1990-2015)

	1990	1995	2000	2005	2010	2015
Asia	0.22	0.19	0.18	0.19	0.19	0.18
East Asia	0.21	0.27	0.27	0.27	0.28	0.21
EU	0.29	0.30	0.32	0.33	0.36	0.35
Latin America	0.18	0.19	0.17	0.18	0.19	0.20
MENA	0.17	0.17	0.15	0.16	0.15	0.15
South Asia	0.15	0.10	0.10	0.12	0.13	0.15
Sub-Saharan Africa	*0.15*	*0.16*	*0.16*	*0.16*	*0.17*	*0.17*
Western Europe	0.23	0.3	0.27	0.28	0.31	0.30
World	0.20	0.21	0.21	0.22	0.22	0.21

Source: Author's calculation based on UNCTAD-Eora GVC Database.

Table 5B: Forward GVC participation, percent of gross export (1990-2015)

	1990	1995	2000	2005	2010	2015
Asia	0.16	0.19	0.23	0.25	0.26	0.24
East Asia	0.16	0.16	0.19	0.21	0.21	0.23
EU	0.17	0.19	0.21	0.22	0.24	0.23
Latin America	0.13	0.14	0.16	0.17	0.17	0.16
MENA	0.21	0.25	0.29	0.31	0.33	0.32
South Asia	0.13	0.15	0.15	0.18	0.20	0.19
Sub-Saharan Africa	*0.19*	*0.23*	*0.27*	*0.28*	*0.28*	*0.24*
Western Europe	0.18	0.21	0.23	0.24	0.26	0.24
World	0.16	0.19	0.23	0.24	0.25	0.23

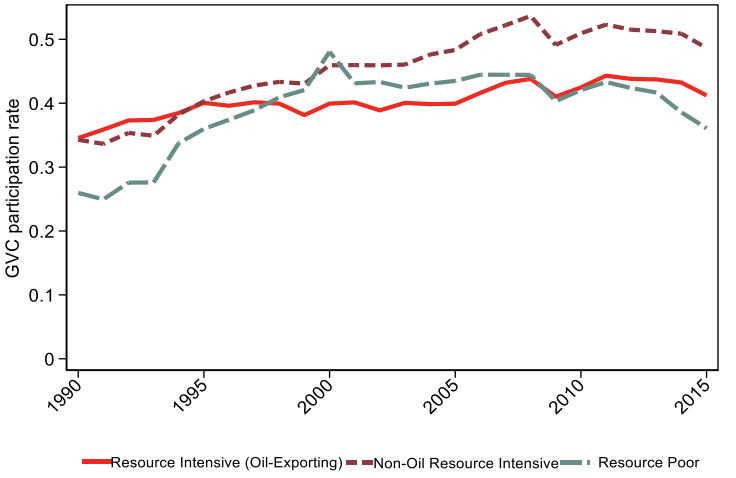
Source: Author's calculation based on UNCTAD-Eora GVC Database.

Table 5C: Summary Statistics: 1990-2015

Variable	Obs.	Mean	SD	Min	Max
GVC participation rate	1760	0.40	0.09	0.13	0.94
FVA share (backward participation)	1760	0.18	0.11	0.02	0.91
DVX share (forward participation)	1760	0.22	0.07	0.15	0.44
DVA share (Domestic Value Added)	1760	0.82	0.12	0.08	0.97
Log of labour productivity	1760	9.33	1.68	5.49	12.94
Human capital	1760	1.78	0.44	1.02	2.83
Institutional quality (-2.5-2.5)	1148	0.26	0.52	-1.35	1.12
Inflation (percentage rate)	1760	12.25	17.32	9.62	183.31

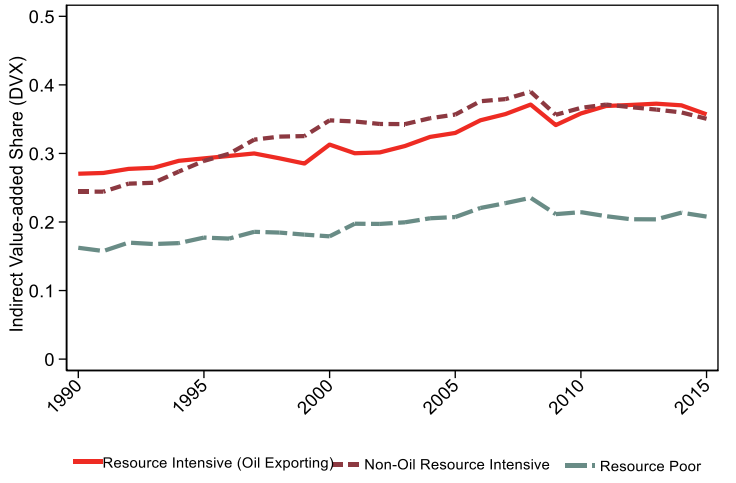
Source: Author's calculation based on the described dataset.

Figure 5A1: Trend in performance in GVC by resource groups in Sub-Saharan Africa



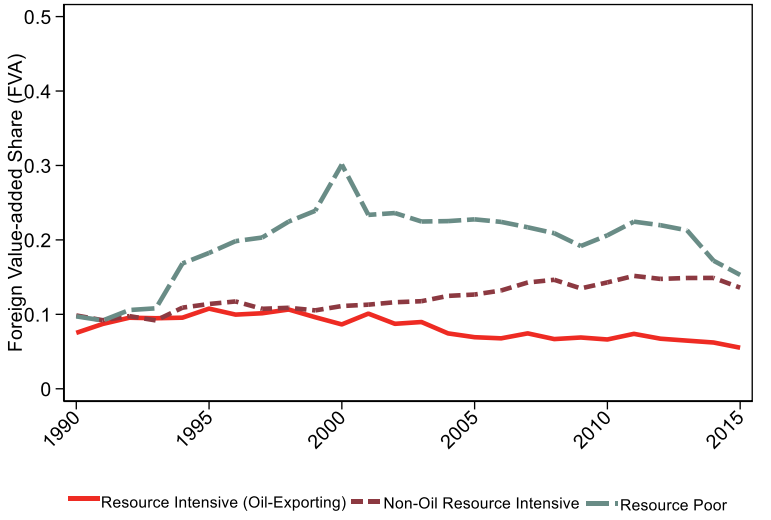
Note: Charts is based on weighted average data.
Source: Author's calculation based on UNCTAD-Eora GVC Database

Figure 5B1: Forward GVC participation, percent of gross export (1990-2015)



Note: Charts is based on weighted average data.
Source: Author's calculation based on UNCTAD-Eora GVC Database

Figure 5C1: Backward GVC participation, percent of gross export (1990-2015)



Note: Charts is based on weighted average data.
Source: Author's calculation based on UNCTAD-Eora GVC Database

Chapter 6: Concluding Remarks

6.1 Conclusion

This thesis has focused on structural transformation and economic development in Africa, by examining the contributing role of modern services, manufacturing and global value chains. This is a research area that stands to grow in the coming years. This is particularly evident in the increasing number of research projects currently ongoing in the field[75]—further justifying that the focus of this thesis is not only a concern in the academic community but also addresses key topics shaping the international development policy agenda.

The objective of the thesis was to examine first the patterns of structural transformation in Africa and investigate the role of services, manufacturing and global value in promoting growth-enhancing structural change in the region. To achieve this objective, the thesis drew heavily on macro-level data for a representative sample of countries in Africa that together contributes about 80 percent of the total economic output of the region. The thesis also drew on important theories in development economics, growth, and trade to study structural change or lack thereof, in African countries and its implications for economic development in the region.

Achieving growth-enhancing structural change in African countries remains a policy priority for sustained growth and poverty reduction in the region and requires close partnership and collaborative efforts on the part of the academia, international development institutions, national governments and private sector actors. The outcome of this thesis contributes to this effort and provides rigorous empirical insights which not only increase our understanding of structural change in Africa but also lay the foundation for further research that would make sound evidence-based policy recommendations to realize this goal.

The entire thesis was organized into six chapters. Chapter 1 provided a general introduction and thesis outline. Chapters 2 and 3 provided evidence of the patterns of structural change, productivity growth and labour market implication of the patterns observed in Africa and the implications of the patterns of structural change observed in Africa for technical efficiency and catch-up within Africa. Chapter 4 examined the rising dominance of the service sector in Africa and its implication for economic growth and development. Finally, Chapter 5 investigated the role of GVC and natural resource endowment in structural change and productivity growth in Africa.

We showed that while the agriculture sector still absorbs the majority of the region's workforce it is shedding more workers. This has had little impact on the productivity of the sector as agricultural productivity has remained unchanged since independence. The majority of those workers that have moved out of agriculture have tended to move to the urban sector to engage in informal trading activities rather than in manufacturing which is more dynamic and productive. This contrasts the experience of early industrializers in advanced countries and East Asia in the last century. For this reason, it is not surprising to see the slow productivity growth recorded in the region with only a

[75] AU Agenda 2063; The STEG project; World Bank JET project, World Bank industrialisation for jobs in Africa: seizing the opportunities in GVC project just to mention a few.

moderate contribution from structural change. This, however, does not necessarily imply that the prospects for structural change are all gloomy. This is evident in our results. As we showed in this thesis, the contribution of structural change to overall productivity growth in the region is not only increasing in the past three decades but also has been higher than that reported in previous studies, due to the structural undercounting in these existing studies, particularly, failing to properly account for the important contributing role of the rising market services to the region's productivity growth. Since 1990, the share of employment in market service (trade, telecommunication, real estate, transport, financial intermediation, insurance, business processing services) has increased from 11.7 percent to 23.4 compared to 6.4 to 7.6 percent in manufacturing over the same period. Over the same period, the sector's contribution to the region's value added increased from 34.8 to 44.4 percent whiles that of manufacturing declined from 11.5 to 10.1 percent. We probed this observation further in the thesis.

A further and thorough investigation of this observation revealed the perceptions of services as stagnant and productivity resistant do not apply to all service sub-sectors. Productivity growth in modern, dynamic, and tradable services is equal to or higher than that in manufacturing and other sectors. The increased productivity growth, tradability, and innovative potential of these service sub-sectors, in large part due to advances in digital technologies, the spread of the internet, and low-cost telecommunications strongly suggest that services might act as new or alternative engines of growth alongside manufacturing. We also show the important role of services embedded in the manufacturing process. We observed an increase in the share of intermediates from market services and other sectors in Africa, both at the expense of manufacturing. These results are in contrast to most other regions where the share of intermediates from manufacturing has been rising (most notably in Asia, but also in Latin America, North America, and Western Europe). In Africa, and most regions, however, we observed that services are the most important component of total intermediate production, accounting for a sizable amount of the value of exports by manufacturing firms. We also found that employment in manufacturing firms not only in Africa but also globally is found in service functions such as research and development, engineering, transport, logistics, distribution, marketing, sales, after-sale services, IT, management, administration, and back-office support.

The important contribution of the services sector was also evident in the region's catch-up process. In terms of specific African countries, the most dramatic examples of catch-up are provided by Botswana and Mauritius, with significant catch-up also observed in Lesotho, Namibia, and Nigeria. Most other countries show little or no change or even decline. In terms of catch-up at the sectoral level for Africa, we found that on average sectors in the region are operating below the efficient production frontier. While still performing below the frontier, we observed that in most of the countries in our sample, the productive efficiency of labour in services (particularly in tradable services) is higher than in agriculture and manufacturing. The agriculture, manufacturing, government, and personal services have fallen further behind over time, while mining, construction, and, most notably in the context of this thesis, trade and business services have shown signs of catch-up to the global frontier. The successful convergence recorded in Botswana and Mauritius was driven more by efficiency change and less by technological change. We further investigated the special role of

efficiency change by decomposing it into intra-sector convergence (within-effect), inter-sector convergence (structural change), and initial specialization. The results unambiguously confirm the special role of structural change in catch-up in Africa.

The thesis further examined the role of trade (global value chain-GVCs) in productivity and structural change in Africa. We showed that Africa is heavily involved in GVCs, generally as high as those of their counterparts in other developing regions in South Asia, East Asia, and Latin America. We also observed that substantial differences exist between resource groups and across countries within each group in their participation rates and changes in these rates. In contrast to the resource rich (oil) country group that has a comparative advantage in GVC participation predominantly in upstream activities of the value, providing mainly primary inputs for the value chain, resource-poor country groups participate largely through backward participation which has allowed these sets of countries the opportunity to import essential intermediates needed for quality upgrading, boosting productivity, and economic diversification. For this reason, we observed that the positive productivity gains effect of GVC participation accrues strongly through backward linkages and benefits mostly non-resource intensive and non-oil resource-intensive countries. Further analysis revealed that GVC participation increases productivity growth by inducing reallocation of resources within sectors (within effect) and not across sectors (structural change effect).

6.2 Policy Implication of Thesis

Beginning in the 1960s, Africa has implemented various industrial policies in pursuit of sustainable economic transformation and development. This appetite to industrialise is quite understandable both from a theoretical and historical lens. However, in contrast to the experience of early industrialisers and economies in East Asia, the consensus seems to be that industrialisation in Africa remains elusive. After six decades of active industrial policy, many of the countries in Africa, have yet to shift enough of their manpower to manufacturing to the point where the sector could create decent and sufficient jobs to accommodate the 11 million young workers expected to enter the labour market each year for the next decade in the region. Even when there is hope, the challenge to industrialisation led-growth is going to be more severe due to emerging global trends—including but not limited to the threat of the adoption of emerging labour-saving technologies to manufacturing employment, the calls for a reformulation of the traditional industrial policy due to the expansion of global value chains, emerging global shocks including COVID-19 and, most importantly and recently the rise of digital services as an alternative to manufacturing for achieving economic growth. The question that never goes away in all this is whether countries should still pursue industrialisation as a development strategy or consider other sectors (such as modern tradable services) as this thesis has shown to power growth and development?

Going forward manufacturing will still be important for Africa, since there remains a huge potential. There is a caveat, however. The sector will play a much weaker role in the economy of many countries in Africa in the coming decades if the same conventional but failed industrial policy approaches are implemented. Unless pragmatic and efficient policies are put in place, "an increase in manufacturing

employment won't suffice to meet the need for new jobs, especially in Africa with its burgeoning population" (Stiglitz, 2018). There is a reason to believe this. The African manufacturing sector is quite unique. Manufacturing jobs in the region are generated by small firms. These firms also dominate the share of manufacturing firms in the region. At the same time, these firms are largely informal and unproductive, have a shorter survival rate, and participate less in GVCs. On the other hand, large manufacturing firms in the region are more productive, have a high probability to participate in GVCs but create fewer jobs due to potentially use of labour-saving technologies in GVCs and manufacturing production (Diao et al., 2020[76]; Abreha et al, 2020). Any serious attempt to pursue industrialisation in the region should address the policy question of how to increase the productivity of small unproductive firms to survive and grow and how to get the large firms to create more jobs.

In light of this, the thesis has also shown evidence that some services sub-sectors could act as a new or alternative engine of growth alongside manufacturing and deserves full consideration from policymakers. There are examples of this already happening in East Africa (Kenya, Rwanda). From the account of this thesis and given the organisation of production structures in recent years, any meaningful policy to realize the goal of growth-enhancing structural change so much desired across countries in the region at present should consider policies that focus on carefully designed and co-ordinated multi-sector strategies, particularly sector-specific policies for services, agro-industry, and manufacturing. In this regard, this thesis found strong inter-sectoral linkages between the service sector and manufacturing and the potential complementary role services could play in the prospects for industrialisation of Africa. This potential remains to be realized and should occupy policymakers in the coming years. Successful execution of this strategy will require a competitive market and policies that allow for the proactive role of the state.

Indeed, sub-Saharan Africa remains as an agricultural economy and so far, there has been a limited structural transformation towards 'modern activities—tradable services and manufacturing' and cities. Any strategy to achieve inclusive growth and development that leaves no one behind would require a lot more structural transformation, and manufacturing has yet to perform its role as 'engine of growth'. Given the levels of employment that are being created in dynamic services due to the high skills levels that are required to work in these sectors, it will not be possible for them alone to become the 'engine of growth' that Africa requires. It is, however, important to mention that the same argument holds for large manufacturing firms in Africa. As discussed above, recent empirical evidence suggest that large manufacturing firms are the most productive and yet creates the least jobs due to the adoption of labour-saving technologies in production. If anything, it is the small and medium sized manufacturing firms that will create the jobs desperately needed across Africa. But these are also the least productive firms in manufacturing. This is similar to the case of wholesale and retail trade services that generates a sizable share of jobs in services but is largely informal and less productive. Until policies are put in place to address factors that limit the productivity growth of these key employment

[76] Diao, X., Ellis, M., McMillan, M., & Rodrik, D. (2020). Africa's manufacturing puzzle: Evidence from Tanzania and Ethiopia firms.

generating sectors and firms, the narrative of limited structural transformation in Africa will not change at least in the next few years.

This notwithstanding, to the extent that many of the dynamic services are linked to manufacturing activity it could be argued that a more pragmatic attempt to provide the 11 million jobs that Africa needs to create each year for the next decade will be with a rapidly growing manufacturing sector whiles leveraging on the potential linkages that these dynamic service sectors could provide. Jobs will come not only and perhaps not so much from direct manufacturing employment but from the multiplier effects manufacturing generates, although policy efforts should focus on 'internalising' productive activity.

It is also important to acknowledge in this discussion the variation and differences in the patterns and trends of industrialisation across the region. Specifically, the contribution of manufacturing to output has picked up moderately in Eastern and Central Africa, has remained flat in West Africa, and has declined in Southern Africa. What these differences imply is that whereas the prospect of industrialisation for structural transformation remains viable for some countries, the potential and strategy to industrialize will vary across countries in the region. For some countries (such as Rwanda, Kenya) that have focused on high-end services and Botswana that is very reliant on mining and now tourism and services, pushing for manufacturing to lead the way may be inconsistent with the industrial policy strategy of these countries, at least, presently. This, however, does rule out our believe in country's dynamic comparative advantage.

Successful structural transformation in the region would additionally rely on a battery of other policies, ranging from improving micro and macroeconomic efficiency to instruments to support shifts of labour from agriculture to industry and market services (training, finance, energy, infrastructure, taxation), legalisation and institutionalisation of labour and goods markets and approaches to maximise gains in global value chains among others. For instance, job growth in manufacturing in the region has been driven mainly by new and young firms over the past two decades as shown in Côte d'Ivoire and Ethiopia (Abreha et al., 2019)[77]. This job growth as seen in Ethiopia is achieved on account of relatively low wages, an opportunity that new and young firms seized. Whereas firms, for instance in Côte d'Ivoire appear to have taken advantage of low wages to invest in labour-intensive activities and techniques, evidence shows that the scope for job growth at low wages is not sustainable as average wages in the region have been rising in recent years (Abreha et al., 2019). Related to this Gelb et al (2020)[78] use a newly constructed panel of firm-level data from the World Bank's Enterprise survey to investigate labour costs in a range of low-and middle-income countries in Africa and elsewhere. The authors find that relative to comparator countries at comparable income levels, industrial labour is more costly for firms that are located in sub-Saharan Africa. The authors further argue that in the interim, countries in the region cannot resort to low wages to sustain manufacturing

[77] Abreha K., P. Jones, E. Lartey, T. Mengistae, and A. Zeufack. 2019. "Manufacturing job growth in Africa: What is driving it? The cases of Côte d'Ivoire and Ethiopia." World Bank, Washington, DC.

[78] Gelb, A., Ramachandran, V., Meyer, C.J., Wadhwa, D. & Navis, K. (2020). Can Sub-Saharan Africa be a manufacturing destination? Labor costs, price levels, and the role of industrial policy. *Journal of Industry, Competition and Trade*, 1-23.

and to create large numbers of industrial jobs. The authors, however, acknowledge the heterogeneity of countries in the region. In that regard, the paper finds that there are few countries in the region, such as Ethiopia, that may be potential candidates for low-wage manufacturing. Stephen et al. (2017)[79] arrived at a similar conclusion in an earlier study.

This, therefore, suggest that the broader policy implication for achieving job growth in manufacturing in new and young firms should target interventions that stimulate productivity growth and lower barriers to entry whiles approaching size-based schemes with caution. Such policies should also encompass policies that address bottlenecks to firm performance in the region—in finance, investments in energy and infrastructure as well as in digital technologies and skills linked to industrial policy strategies, addressing issues with tax administration constraints and rigid labour market arrangements that run counter to the goal of structural transformation in the region. For instance, using the latest available wave from the World Bank Enterprise Survey (WBES)[80] for 41 countries in SSA in the database shows that about 50 percent and 35 percent the share of manufacturing firms in SSA perceived electricity and finance as a major obstacle to their operation respectively. About 76 percent of all manufacturing firms in the region reported experiencing a power outage in a typical month, occurring about eighteen times in a typical month, with each power outage lasting for about nine hours. These power outages also cost firms 13 percent of losses in sales. Similarly, about 80 percent and 29 percent the share of manufacturing firms perceived macroeconomic instability and tax rates as a major obstacle to their operation. Although, the share of firms reporting these bottlenecks have declined in some countries (e.g., firms in Rwanda), policies and interventions to address these bottlenecks will go a long way to affect the performance of manufacturing firms whiles making them internationally competitive.

The thesis also makes a case for the important role of trade, particularly GVCs for structural change, jobs, and productivity growth. Greater integration in the value chain would require building more infrastructure and strengthening connectivity to global lead firms and global suppliers in the value chain to import world-class inputs. This should be complemented with other friendly input sourcing trade policies. A set of active policy reforms to improve the business climate to attract FDI is also needed. While GVC participation as a seller (forward participation) also hinges on a similar policy framework, the policy should be more targeted at getting firms in the region to a level that meet the global quality standards requirements set by lead firms for suppliers that want to enter and remain competitive in the value chain. The African Continental Free Trade Area (AfCFTA) will play a crucial role in all this to bolster and drive more production, processing, and higher value exports from and within the region, and facilitate structural change through trade and GVCs. At present, value chains in the region are very weak.

Other policies options are available for the region to exploit and maximise the gains in GVC. As demonstrated in the thesis, although SSA's participation in GVC is comparable to those in South Asia

[79] Stephen S. G., Ceglowski, J & Mbaye, A.A. (2017). Can Africa compete with China in manufacturing? The role of relative unit labour costs. *The World Economy*, 1-21.
[80] Own calculation based on WBES.

and East Asia, SSA's integration in GVC are in tasks that are predominantly in labour-intensive industries and natural resource-intensive sectors. While the immediate short-term strategy should target exploiting current comparative advantages to create jobs, the medium to long-term strategy would need instruments to support the strategic repositioning to upgrade into high-value-added tasks and industries in the value chains. This latter strategy would require coordinating and aligning industrial and trade policies with education and skills enhancement policies in the region. Expanding market access to advanced and emerging market economies through preferential trade agreements should also form an integral part of any such policy configurations as the region has generated jobs in GVC through GVC demand in the economies of these regions. Finally, the COVID-19 pandemic has disrupted global industrial production systems. Although it remains unclear what types, nature and forms of global industrial production systems will emerge post-pandemic, a restructuring of the global industrial production system and supply chains is expected and threatens the resilience of the global production system. Leveraging digital transformation and new technologies to build a resilient global production system would be key going forward and require critical investments in digital infrastructure and capacity development programmes aimed at skill upgrading to close the digital divide.

6.3 Limitations and Suggestions for Future Research

This thesis presented novel contributions to the literature on structural transformation and economic development in Africa, by examining the contributing role of modern services, manufacturing and global value chains. As is the case with all research, some limitations should be noted and spur additional research in under-researched areas in the topic. Future research on the topic will benefit from increased and better data. Particularly in our analysis of structural change and labour mobility, one challenged we faced and is yet to be addressed is whether the labour mobility we observe across and within the sectors was 'voluntary' or 'involuntary,' from the perspective of workers. Is it the self-employed who move across sectors, or wage workers? Are we seeing manufacturing employment moving out of large formal sector firms? Or out of artisanal production? What is the contribution of the informal sector to structural transformation in Africa? The currently available data does not allow for an answer to these questions, both at the macro and micro level, suggesting that we still know very little about structural transformation in Africa and call for a research agenda that not only addresses the data limitation problem but investigates the gaps identified.

Starting from the 1970s the world witnessed the digital revolution, a development that saw a shift from mechanical and analogue electronic technology to digital electronic technology—called the 'third industrial revolution' and recent development that saw the growth of emerging technologies (mostly labour-saving) such as additive manufacturing, advanced robotics, artificial intelligence, big data analytics, cloud computing, industrial internet-of-things, and machine learning—called the "fourth industrial revolution"[81]. The impact of this digital revolution on industrialisation and industrial policy in Africa has not been empirically investigated fully. There are also growing calls for a reformulation of the traditional industrial policy due to the expansion of global value chains and climate change

[81] Jostein Hauge. Industrialisation and industrial policy in the digital age. Forthcoming in *Third World Quarterly*.

concerns. This calls for rigorous empirical scrutiny to guide policy and needs to be addressed in future research on the topic.

In chapter 4 of the thesis, we examined the extent to which the use of capital and labour inputs explained the patterns of productive efficiency, technological change, and total productivity growth observed across countries in Africa. While the importance of capital (embodied and disembodied capital) for growth is emphasized in growth theories, the thesis could only investigate this at the country level due to the non-available of sectoral capital data. The thesis relied on labour inputs only in the sectoral analysis which gives a less than complete picture at the sector level and needs to be addressed in future research.

The thesis further suggests that future research also be conducted to provide an in-depth investigation of the contributions of the growing service sector to manufacturing performance and industrialisation in Africa. Given the heterogeneity at the country level in terms of this development, future research is needed to identify what specific service sectors matter more for manufacturing performance across the various countries in the region and to consider these trends in industrial policy design to achieve the optimal outcome from any such policy. It is important to also revisit the definition of what constitute non-tradable or non-market services. Currently and shown in the analysis of this thesis, sub-service sectors such as education and health are classified as non-tradable. To what extent is the sizable share of "education and health export" from the region accounted for in this definition? How is contribution of "education and health export" treated in national accounts and statistics? Future research on this topic should make attempts to reflect on these discussions.

7. Impact Statement

This thesis focused on structural transformation, productivity gains and economic development in Africa, by examining the contributing role of modern services, manufacturing and global value chains. This is a research area that stands to grow in the coming years. This is particularly evident in the increasing number of research projects currently ongoing in the field—including but not limited to the AU Agenda 2063; The STEG project; World Bank JET project, World Bank industrialisation for jobs in Africa: seizing the opportunities in GVC project, and ongoing structural transformation projects at the Africa Development Bank just to mention but a few. Within the United Nations Sustainable Developments Goals (SDGs), the content of the thesis is also very important for the SDG 8 'Decent work and economic growth' and SDG 9 'Industry, innovation and infrastructure'. This further justifies that the focus of this thesis is not only a concern in the academic community but also addresses key topics shaping the international development policy agenda in Africa.

About 11 million young workers are expected to enter the labour market each year for the next decade in Africa. There is also a need to improve the quality of jobs for the huge workforce who are underemployed or work in the informal sector. Accelerating structural transformation is the primary way to deliver on this goal to build back better, ensuring an inclusive and sustainable transformation of economies in the region. The outcome of this thesis, therefore, provides rigorous empirical insights which not only increase our understanding of structural change in Africa but also lay the foundation for sound evidence-based policy recommendations to realize this goal, whiles providing guidance for further research.

The content of the thesis has so far received key publicity and stimulated passionate and evidence-based debate on structural transformation, jobs, global value chains and growth in Africa. Chapter 2 of the thesis has received recognition in the policy space including but not limited to citations in The Economist, 2020 June 11th Edition: "How manufacturing might take off in Africa,"[82]; The 2020 World Bank global productivity study/report,[83]; The 2020 World Bank's report on the future of work in Africa[84]; the Brookings Institution's assessment of employment intensities of industries without smokestacks[85] and the forthcoming World Bank's flagship report focused on industrialisation for jobs: seizing opportunities in global value chains, under the supervision of the African Chief Economist's Office.[86] Besides recognition in the policy circle, the content of the thesis has also generated academic interests—cited in academic journals and working papers (see my google scholar page). The forthcoming World Bank's flagship report on "industrialisation for jobs in Africa: seizing

[82] See graphs (The Economist, 2020 June 11th Edition). "How manufacturing might take off in Africa"

[83] See (Editor: Alistair Dieppe, 2020). "Global Productivity: Trends, drivers and policy." The World Bank Group.

[84] See (Editors: Jieun Choi, Mark A. Dutz, Zainab Usman, 2020). "The Future of work in Africa: Harnessing digital technologies for all." Office of the Chief Economist, African Region, The World Bank Group.

[85] See (B. Coulibaly et al, 2020). "Job creation for the youth in Africa: assessing the potential of industries without smokestacks". AGI, Brookings Institution.

[86] Industrializing for jobs in Africa: seizing opportunities in global value chains. Forthcoming, Office of the Chief Economist, African Region, The World Bank Group.

opportunities in global value chains" benefited from the global value chain dataset I constructed and used in chapter 5 of the thesis.

Further to this, the findings and conclusion of the various chapters of the thesis have been presented at conferences and workshops to stimulate further discussions on the content of the thesis. In this regard, an earlier version of chapter 4 was presented at the UNIDO-UNU-MERIT Conference on the Future of Industrial Work (September 2019, UNIDO HQ, Vienna). Chapters 2 was presented at the CSAE Conference on Economic Development in Africa (2019, St. Catherine's College, Oxford University, UK); at the PEGNet/African School of Economics Conference on Improving the quality of education and learning outcomes in developing countries (2018, Cotonou, Benin) and the Development Studies Association Conference on Global Inequalities: Parallel Session on Structural Change Tensions and Tradeoffs (2018, University of Manchester, UK). Chapter 3 was presented at the GLOBELICS International Conference on Innovation, Economic Growth and Sustainable Development (2018, Accra, Ghana) and the MIT Media Lab and YSI Workshop on Innovation, Economic Complexity and Economic Geography (2018, Cambridge, USA). Chapters 2 and 3 were presented at the YSI Africa Convening (2018, University of Zimbabwe, Harare). Chapters 5 and 4 were also presented at the UNU-MERIT internal conference 2020 and the joint UNU-MERIT and Maastricht University SBE conference 2020.

Two chapters of the thesis (Chapter 2 and 5) have been submitted to academic journals. Chapter 4 of the thesis is published as a book chapter in "New perspectives on structural change: causes and consequences of structural change in the global economy" published in the Oxford University Press[87]. Chapter 3 is currently being prepared for submission.

[87] See chapter 13 (Editors: Neil Foster-McGregor; Ludovico Alcorta; Adam Szirmai, and Bart Verspagen, 2021). "New perspectives on structural change: causes and consequences of structural change in the global economy." Oxford University Press.

About the Author

Solomon Owusu is a Ph.D. Fellow in Economics at the United Nations University – MERIT/Maastricht University, The Netherlands. He holds Erasmus Mundus Advanced MSc in Economics from a consortium of three universities—Staffordshire University (UK), University of Cantabria (Spain) and University of Brasilia (Brazil). He also holds MA in Economics, Law and Politics from Leuphana University Lüneburg, Germany, and undergraduate training in Economics and Management from the University of Cape Coast, Ghana. He was also a World Bank Africa fellow.

Solomon's research interest focuses broadly on development economics in areas such as: the measurement and analysis of structural transformation, jobs and inclusive growth; global and regional value chains, international trade; and issues at the intersection of technology, human capital and productivity in developing countries with particular focus on countries in Africa. Solomon has teaching, research and policy related work experience from the World Bank, UNIDO, Ghana Statistical Service and UNU-MERIT/Maastricht University.

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