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Solomon Owusu, Adam Szirmai and Neil Foster-McGregor

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Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT)
email: info@merit.unu.edu | website: http://www.merit.unu.edu

Boschstraat 24, 6211 AX Maastricht, The Netherlands
Tel: (31) (43) 388 44 00

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The Rise of the Service Sector in the Global Economy

Solomon Owusu[1], †Adam Szirmai, Neil Foster-McGregor[2]

Abstract

The paper 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 tertiarization 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 growth, and the potentially positive contributions of services to other sectors. The second half of the paper focuses on tertiarization 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, IO 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. 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 industrialization of Africa. But this potential remains to be realized.

Keywords: Service Sector, Sub-Saharan Africa, Global Economy, Structural Change, Baumol's Hypothesis

JEL Codes: O11, O14, O41, O47, C67, N17

[1] UNU MERIT, Boschstraat 24, Maastricht, Netherlands Email: owusu@merit.unu.edu
[2] UNU MERIT, Boschstraat 24, Maastricht, Netherlands. Email: foster@merit.unu.edu

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. Tertiarization 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 sectors 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; Hoekman 2017; Di, Berardino and Onesti 2018; Stiglitz 2018, Carmignani and Mandeville 2014; 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 (Hjort & Poulsen 2019; van Ark et al. 2008; Jones 2011; Beverelli et al. 2017; Hoekman & Shepherd 2017). The rise of global value chains, growing geographical fragmentation of production, and increasing complexity in the organization of manufacturing production and distribution have increased the service contents of many manufactured goods (Miozzo & Soete 2001; Di Berardino & Onesti 2018; Arnold & Lipscomb 2016; Arnold et al. 2011; Duggan et al. 2013; Park 1989; Guerrieri & Meliciani 2005; Francois & Reinert 1996).

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 (OECD, 2015; Eifert et al 2005; 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, characterized by low development levels as well as early deindustrialization 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 paper, therefore, takes a two-pronged approach. It analyses tertiarization in the global economy, but also zooms in on tertiarization in developing countries in sub-Saharan Africa, representing low-income economies. African economies are characterized by early deindustrialization and an increasing share of services in GDP at low levels of per capita income. Countries in sub-Saharan Africa have deindustrialized since 1990[3] 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 (Rodrik 2016; Cadot et al. 2015; 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 industrialization 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)[4]. 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 (Stiglitz 2018[5]; Mensah et al. 2018; de Vries et al. 2015; Ghani & O'Connell 2014; Newfarmer et al. 2018).[6] 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.

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

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[3] When using output shares.

[4] 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).

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

[6] 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.

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 paper is structured as follows: Section 2 discusses the rise of the service sector in the global economy; Section 3 zooms in on tertiarization in sub-Saharan Africa by discussing and analysing structural change, inter-industry linkages, service sector efficiency, and industrial performance. Section 4 summarizes and concludes.

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 Kuznetz, 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 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 tertiarization of the global economy. This aggregate table of course 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.[7]

Table 1: Sectoral Value-Added Shares in Global GDP (in 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: 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 (Rodrik 2016; Diao et al. 2017; McMillan & Rodrik 2011). Baumol (1967) categorizes economic activity into two classes, namely the technological progressive manufacturing sector and the technologically stagnant service sectors. At the deindustrialization stage, employment and value-added shares in manufacturing fall, while employment and value-added shares in services rise.

According to Baumol,[8] deindustrialization and the resultant tertiarization 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

[7] Authors' calculations using data from Groningen Growth and Development Centre (GGDC). Shares of value-added are weighted average shares.
[8] 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 criticized (Acemoglu et al. 2014; Lavopa & Szirmai, 2018). 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 (2018) 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).[9] 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 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 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 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.

[9] 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 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: Authors 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.[10] He concluded that deindustrialization will not depress economic growth as long as productivity growth in the service sectors that feed manufacturing remains positive. Francois & Reinert (1995), Francois & Woerz (2008), and the OECD (2015) efficient service sectors are essential for the revival and competitiveness of manufacturing sectors.[11]

The density of inter-industry linkages between manufacturing and services has continued to increase rapidly in recent decades (O'Mahony & Timmer 2009; Francois & Woerz 2008). 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 (Di Berardino & Onesti 2018; Lanz & Maurer 2015). 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 & 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 & Lipscomb 2016; Arnold et al. 2008).

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' 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

[10] 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.

[11] See Oulton (2001) and Sasaki (2007) for the theoretical derivation of this relationship.

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).

Guerrieri & Meliciani (2005) find important complementarities in the organization 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 & Lipscomb 2016; Arnold et al. 2011; Duggan et al. 2013).

In a related study, Di Berardino & Onesti (2018) use an Input-Output (IO) 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 (Di Berardino & Onesti 2018; Timmer et al. 2014).

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).

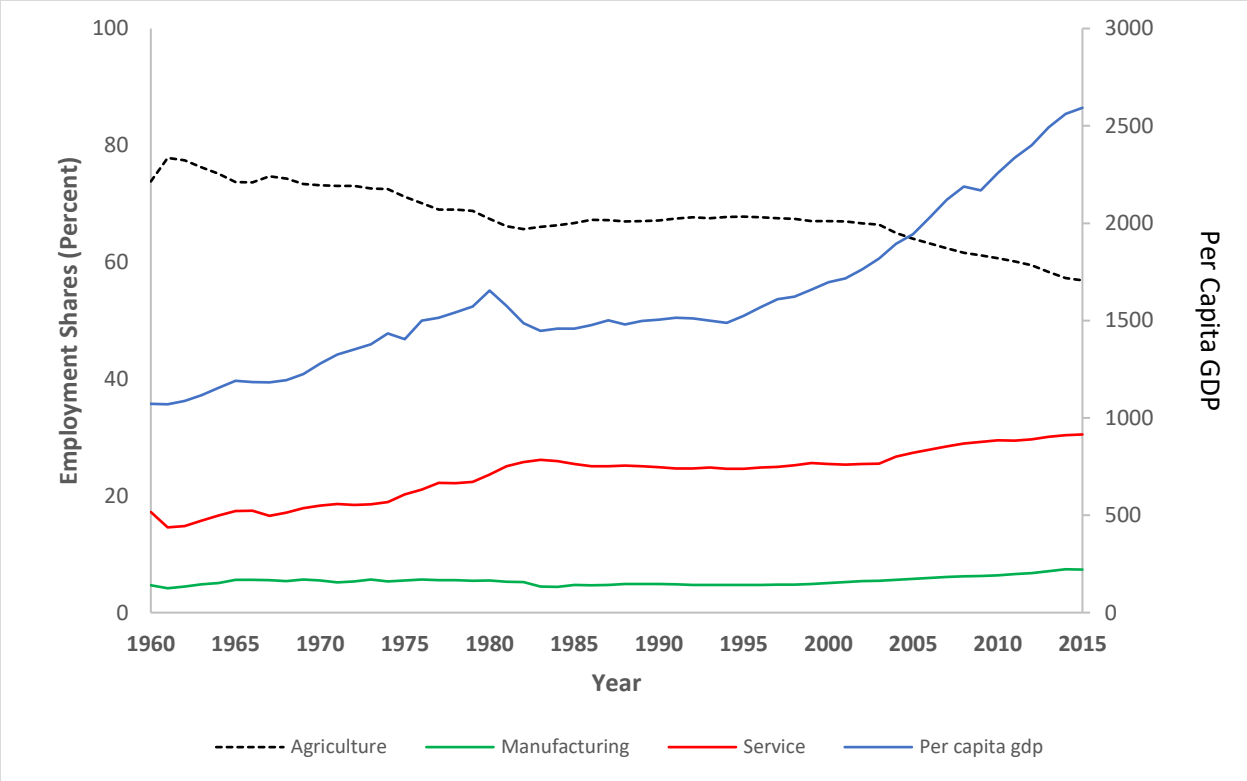
The findings and recommendations in these papers are very important for designing sector-specific policies particularly in sub-Saharan Africa where manufacturing firms are highly informal, small, have low productivity levels and growth rates, produce non-traded goods, export little, and only have competitive 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 industrialization of Africa. But this potential remains to be realized.

3. The Role of the Service Sector in Sub-Saharan Africa

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

Figure 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 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 3 provides a more detailed breakdown of six major sectors.

Figure 1: Weighted Average Sectoral Employment Share and Per Capita Income in Sub-Saharan Africa



Note: Country sectoral shares weighted by country shares in total employment.
Source: Author's calculation based on Extended African Sector Database and World Bank WDI.

Table 3: Employment Shares in Sub-Saharan Africa, 1960-2010

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: Country shares weighted by the employment shares of countries in total employment
Source: Author's calculation based on Extended Africa Sector Database

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; Chenery & Taylor 1968; Kuznets 1966; 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 deindustrialization reaching the peak and turning point of industrialization 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, industrialization has never lived up to expectations. Although the share of manufacturing has sometimes increased in some countries, one cannot call such trends successful industrialization (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 deindustrialization 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) and labour shares continued to increase until 2015 (see Table 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: Sectoral Value-Added Shares in Sub-Saharan 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 Extended Africa Sector Database.

Productivity trends are presented in Table 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.[12] 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.

[12] In contrast with Table 2, where productivity in global manufacturing is just as high as in services. Annex Figure A.1 shows how the dispersion of labour productivity in sub-Saharan Africa is increasing over time.

Table 5: Labour Productivity in Major Sectors of the African Economy, 1965-2010

Sectors	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	Growth rate
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	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/

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 of course 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 (Wang & Lan 2011; Kumar & Russell 2002; Coelli et al. 1998). 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 efficiency 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 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 6 shows that no African country is on the African production efficiency frontier. This reflects the widespread technical and allocative inefficiencies on the continent.[13] 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 6: Productive Efficiency in Sub-Saharan 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
South Africa	1970	0.77	0.49	0.98	0.77	0.47	0.93	0.82	0.47	1.00

[13] The DEA defines the frontier as the best possible outcoming 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.

	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 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 using data from Extended Africa Sector Database and Penn World Tables.

In Table 7, we examine the extent to which the patterns of productive efficiency in Table 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 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.

Technological progress has contributed positively to the productivity growth of relatively highly capitalized countries and relatively rich countries in Africa (e.g. Botswana, Namibia, and South Africa).[14] The same cannot be said for relatively poor countries that experienced productivity improvements over the same period largely explained by the contribution of efficiency change. 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 & Russell 2002, p. 538).

[14] 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 7: Contribution of Technological and Efficiency Growth to Total Factor Productivity Growth in Africa

Country	Total Productivity Growth (1970-2014, in per cent)	Growth of Technology (in per cent)	Growth of Efficiency (in per cent)
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.
Source: Authors calculation using data from the Extended African Sector Database and Penn World Tables.

In Table 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 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 8: Productive Efficiency in Sub-Saharan 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

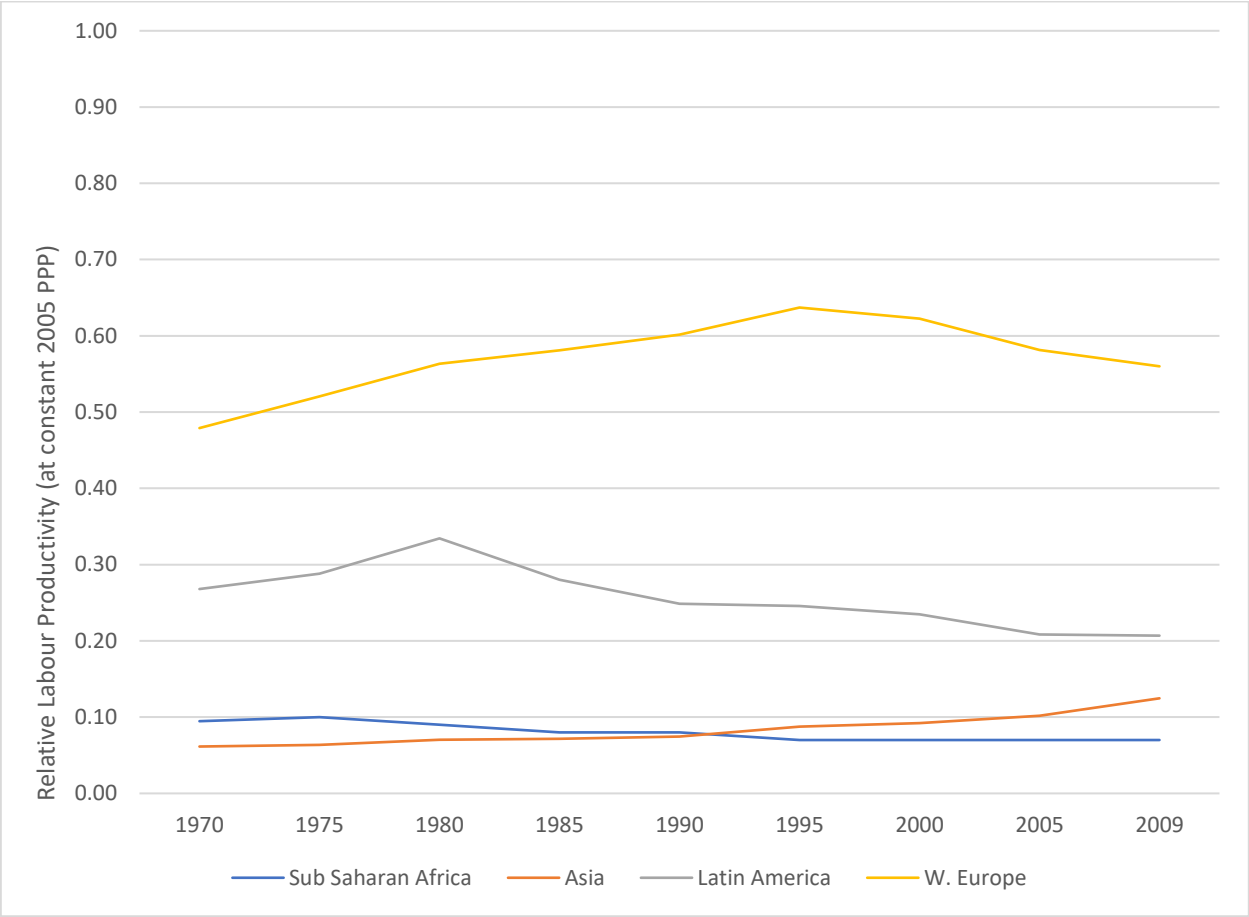
Note: We use bias- corrected radial measures of technical efficiency. The sectoral efficiency index is calculated by maximizing output given labour inputs of each of the ten sectors in each country separately for the years 1970 and 2015.
Source: Author's calculation using data from the Extended African Sector Database.

We further observe a sizable increase in the productive efficiency of labour in all sectors, particularly since 2000,[15] 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 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 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.[16] 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 paper, trade and business services have shown signs of catch-up to the global frontier.

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

Figure 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/

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 3.1), with a part of this productivity growth being driven by relatively high levels of efficiency in the services sector (Sub-section 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[17] 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[18]) 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 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

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

[18] 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 organization 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 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

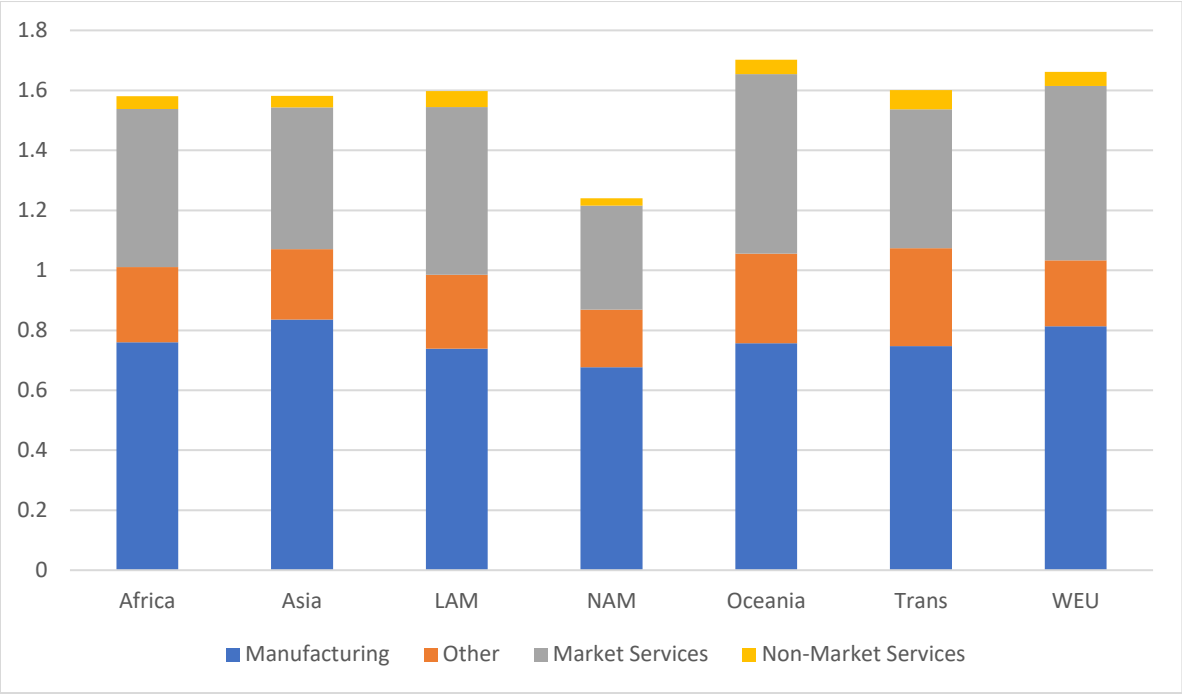
Market Services: Maintenance and Repair, Wholesale Trade, Retail Trade, Transport, Post and Telecommunications, Financial Intermediation and Business Activities

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 3: Output Multipliers in Manufacturing, 2015



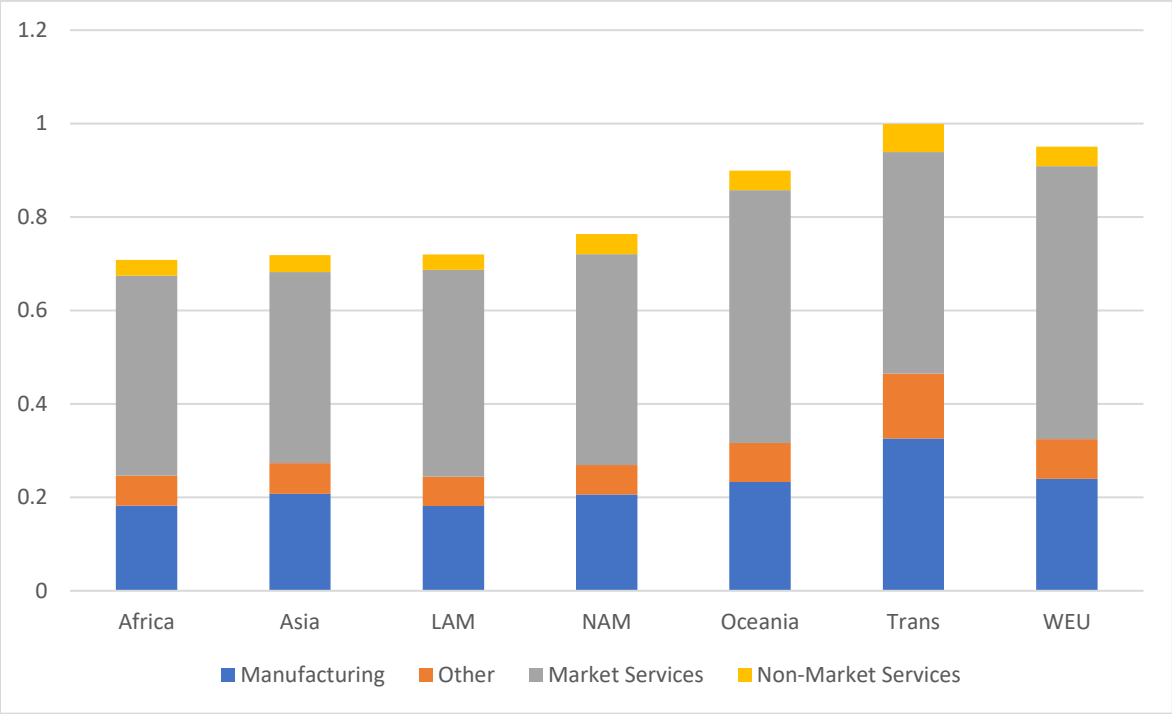
Notes: LAM refers to Latin America, NAM to North America, Trans to transition countries and WEU to Western Europe.
Source: Author's calculations based upon Eora

We now turn to the results for the output multipliers. Figure 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.[19] 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

[19] 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—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: 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: Author's calculations based upon Eora

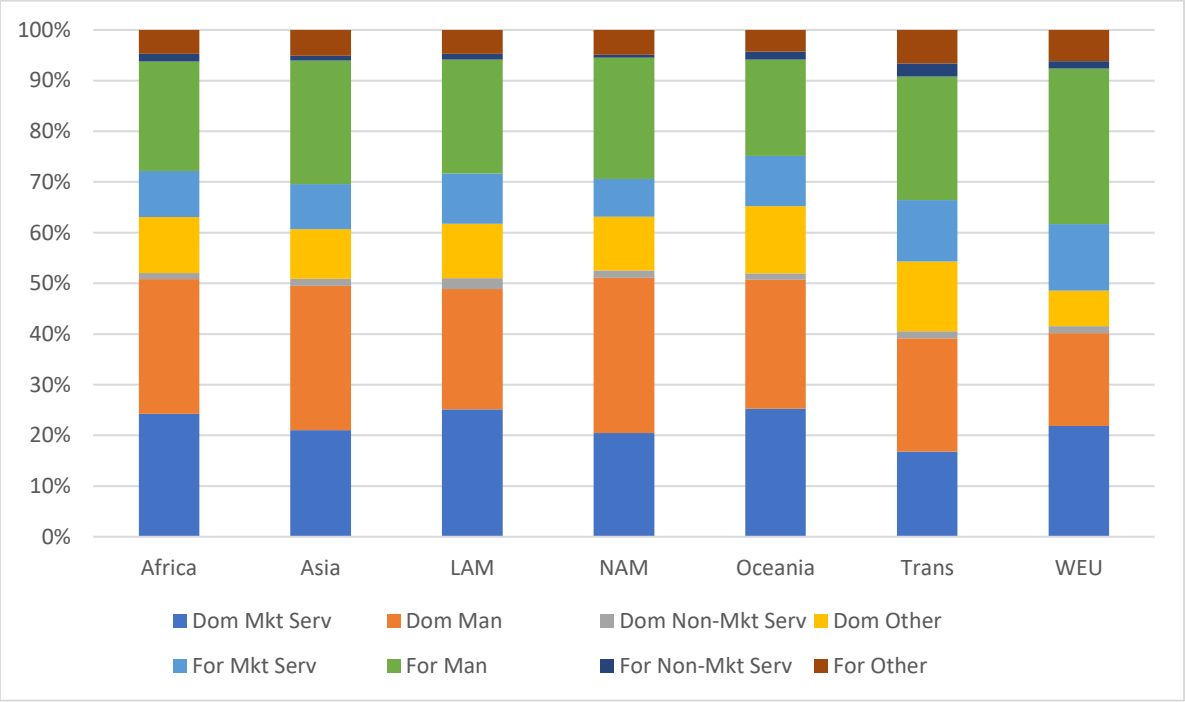
Figure 4 reports similar results to those in the previous figure but for market services rather than manufacturing.[20] A first thing to note is that the output multipliers are generally lower than for manufacturing, confirming existing evidence that linkages are stronger for manufacturing than for services.[21] 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).

Finally, we consider the possibility of leakages, by further decomposing the output multipliers reported in Figures 3 and 4 into a domestic and foreign component. Figure 5 reports this decomposition for

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

the manufacturing output multiplier, while Figure 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 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.[22]

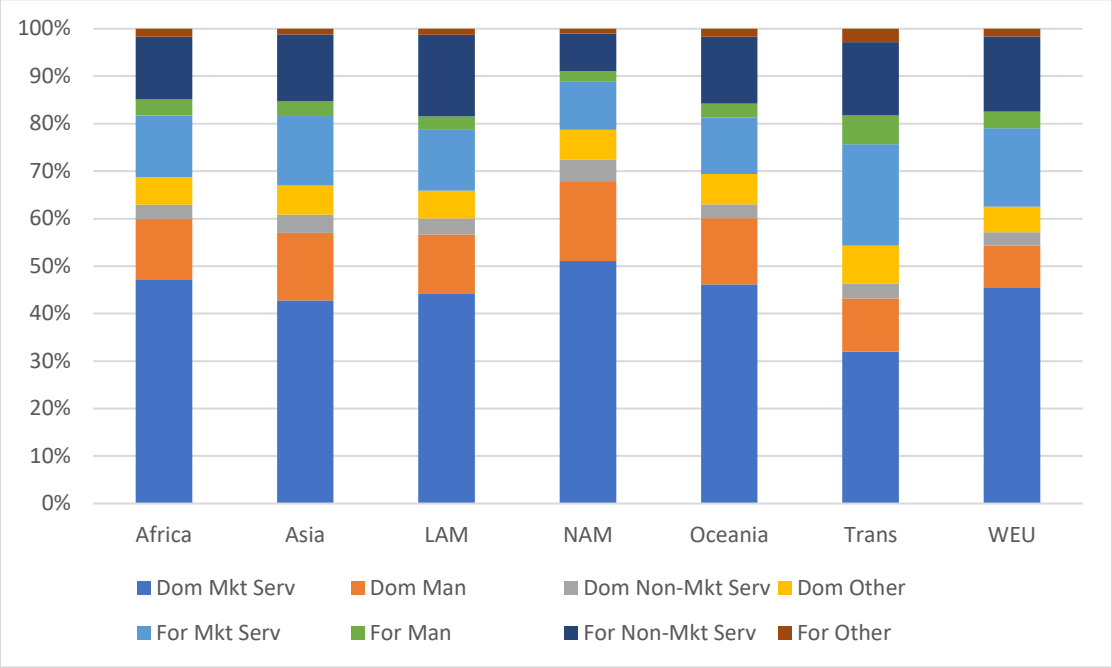
Figure 5: Decomposition of Output Multiplier for Manufacturing, 2015



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

[22] 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 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. Conclusion

This chapter provides an in-depth investigation of the dynamic contributions of the growing service sector. The first part of the paper 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 paper 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 deindustrialization, 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 deindustrialization 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[23]. 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 industrialization.

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[23] 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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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[24] 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 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.[25] 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.

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:

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

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.

[24] 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).

[25] 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 are able to estimate a virtual worldwide production frontier for a hypothetical population rather than a sample (c.f. van Dijk & Szirmai, 2011).

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:

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

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:

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

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:

$$\mathbf{y} = \mathbf{Ay} + \mathbf{f} = \mathbf{A}^D\mathbf{y} + \mathbf{f}^D + \mathbf{A}^F\mathbf{y} + \mathbf{f}^F \quad (9)$$

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:

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

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.

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