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博士論文

Diversity of Industrialization in Africa: Transformation of Employment and Emergence of Telecommunication (1960-2021)

アフリカにおける工業化の多様性： 雇用の変革と通信の出現(1960-2021年)

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Doctoral Dissertation

Diversity of Industrialization in Africa: Transformation of Employment and Emergence of Telecommunication (1960-2021)

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Abstract

Industrial Revolution (IR) and industrialization are the most central issues in economic history. However, the counting of the IR is a controversial matter among scholars. Several studies refer to our current era as the Fourth Industrial Revolution while the three previous ones have still not yet been fully fathomed out. In this thesis, we explore the question of industrial revolutions globally and focus on its expansion to African countries. We discuss sectoral changes, manufacturing development, telecommunication and the leapfrogging effect. Industrialization in Africa being a complex, dynamic and very broad topic, we ensure from each chapter to approach a specific independent aspect all connected under the shade of industrialization. The thesis is structured as follows. Chapter 1 review in detail the literature on the industrial revolutions globally and the situation of industrialization in Africa, particularly. Two main strategies were identified in the case of African industrialization. The first is manufacturing, which corresponds to the first and second industrial revolutions and the second is ICT development, which corresponds to the third industrial revolution. In Chapter 2 we present the sectoral shifts that have occurred in Africa in the recent decades employing ternary graphs for a clear visual description. We examine industrialization in 52 African countries and present four models of African industrialization that differ from the classic Three Sector Model (known in Japan as Petty-Clark's Law) used in Western developed countries. The 4 models identified include the least industrializing countries, the slowly industrializing countries, the de-industrializing countries, and the industrializing countries. Chapter 3 analyzed the pattern of industrialization based on manufacturing data with a focus on 9 African countries considered as representative of the different industrial stages from the three most significant categories of the previous chapter 3. The findings of this chapter reveal that the African model of industrialization is a resource-based industrialization whereby countries' manufacturing sectors use local agricultural resources (Kenya, Benin, Senegal) or mineral resources (South Africa, Nigeria, Egypt, Tunisia, Morocco, Senegal) in industries. Chapter 4 reviews the question of telecommunication which is an important field of industrialization experience in Africa pointing out the leapfrogging experience and appropriate technology adoption in the field. The findings in Chapter 4 also reveal that there is a varied correlation between the GDP per capita and mobile subscription respectively for African countries. Mauritius shows a strong correlation while South Africa, Egypt, and Tunisia have a weak correlation and, countries such as Senegal, Kenya, and Benin rather have no correlation between the two variables. Besides it was found that although mobile subscriptions are high in African countries, the number

of internet users remains low. Chapter 5 presents a case study on telecommunication companies' performance in Benin, a West African country with a dual French-English influence. The analysis reveals the importance of experience and strategic investments in 3G technology and submarine cables as important for telecommunication companies' growth in Benin.

Key Words: Industrial revolution, industrialization, Africa, sectoral shifts, ternary graphs, manufacturing, employment, value-added, leapfrogging, appropriate technology, telecommunication, multinationals performance, economic growth.

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Table of Contents

List of Figures

List of Tables

12

Introduction

The world has been through drastic changes over the centuries marking the recent ones with a series of Industrial Revolutions. Starting in England, the phenomenon of the Industrial Revolution (IR) has become global and its outcomes are perceived as a basis of growth measurement. The counting of IRs is a controversial matter among scholars. Several studies refer to our current era as the Fourth Industrial Revolution while the three previous ones have still not yet been fully fathomed out. In this thesis, we explore the question of the industrial revolutions globally and focus on its expansion to African countries. We discuss the sectoral changes, the manufacturing development, telecommunication and the leapfrogging effect. Industrialization in Africa being a complex, dynamic and very broad topic, we ensure from each chapter to approach a specific independent aspect all connected under the shade of industrialization.

The thesis is structured as follows. The first chapter reviews in detail the literature on the industrial revolutions globally and the situation of industrialization in Africa, particularly. We develop on the definition of each revolution and expand on various features approached by some important scholars. The question of industrialization was deeply analyzed in the context of Africa from a historical background prior to Africa conquest till the post-independence period. We also consider the views of some important international organizations including the African Development Bank, World Bank Group and the United Nations. This chapter pointed out the uniqueness of the African industrialization pattern which was further explored in the next chapters. The second chapter expanded on the sectoral shifts that have occurred in African countries over the recent decades employing ternary graphs for a clear visual description. This chapter built upon the three-sector model of Petty-Clark and a comparative study between the African countries' sectoral change and that of the global standard. Due to the differences in African countries' features, four categories of countries were identified based on their industrial development level. The third chapter further analyzed the pattern of industrialization based on the manufacturing sectors' data with a focus on 9 African countries from the previously defined categories. Countries including Tunisia, Egypt, Mauritius, South Africa, Kenya, Morocco, Senegal, Benin, Nigeria were specifically analyzed in this chapter to fully comprehend the manufacturing sectors' development and the stage of industrialization of the different countries. We discover the main engine of manufacturing growth in industrializing countries, de-industrializing countries, slowly industrializing countries, and least industrializing countries respectively. The industrialization of Africa in recent years coincides with the outbreak of telecommunication on the continent. The fourth chapter therefore extensively reviews the question of telecommunication which is paramount to the industrialization experience in Africa. We analyzed the impact of economic growth on telecommunication and expanded on the leapfrogging concept before presenting the major telecommunication companies in Africa. The last chapter is a case study on the

performance of telecommunications companies in Benin, a West African country with dual French-English influence that has experienced considerable industrial growth and a typical development pattern in the telecommunication sector over the past few decades. This chapter focuses on the historical development of telecommunication companies in Benin with a comparative approach in order to understand the outperformance of some companies over others.

Chapter 1

Industrial Revolutions and Industrialization in Africa

1.0 Introduction

Multiple events have marked societies and economies throughout the history of humanity. Industrial Revolutions (IRs) represent important turning points in history. They are pivotal historical moments with technological breakthroughs that fundamentally reshaped human society. From a technological perspective, the Industrial Revolution is characterized by interconnected, major inventions that rapidly stimulated further smaller, incremental technological developments (Mokyr, 1993). Industrialization fundamentally redesigned economic systems, transportation methods, and medical practices, and generated unprecedented technological advancements. IRs are characterized by tremendous changes in different sectors. Interrelated changes developed together and to a sufficient degree, constituting an IR (Deane, 1979). They have often been connected with substantial population growth a dramatic rise in the total production of goods and services, and identifiable changes in the methods and characteristics of economic organizations. The world has been through various different changes considered as IRs and nowadays debates are surrounding the existence of a 4th IR. The counting of the IR, nonetheless, is a controversial topic among scholars. Many economic historians have different approaches to the question and in this study, we described each IR based on the literature review and academic debates including the journalistic sources. Also, many Asian countries that have experienced the IR are considered as latecomers due to their delay in catching up. In contrast, Africa is claimed to have skipped the two first IRs and is now trying to catch up with the ongoing one. This chapter, in addition to the literature review, investigates and analyzes the position of Africa in the context of the IRs.

Economists used different variables in explaining the IRs. Franco Amatori (2013) analyzed the IR in terms of the changes observed in the population, education, energy, Research and Development (R&D) investment, index of import and export, foreign investment, volume of production etc. Allen (2015) considered the wages (high), energy (cheap in Britain for the first IR), living standards (rise) etc. Other variables such as average income, child and infant mortality rate, fertility rate, life expectancy, Human Development Index, real gross domestic product (GDP) are factors which have been explored as well.

This is an introductory chapter of a thesis on Industrialization experience in Africa and Mobile telecommunication development. The objectives of this chapter consist in defining and describing each IR and attempting a clearer periodization based on the literature and analyses; We also critically examined the existence of a fourth IR and finally assess the case and position of Africa regarding the IRs. The research methodology employed in this first chapter is that of a conceptual analysis focused on the review of literature on the history of IRs and industrialization in Africa.

1.1 The Industrial Revolutions

1.1.1 The first IR (1760-1840)

Great Britain was the leading nation of the first IR which is usually defined in terms of invention and/or rapid development of steam engines, iron, textile, cotton, coal, steel, chemicals, railroads etc. The cotton industry increased from about 0% of GNP in 1760 to about 8% of GNP by 1812 and iron production rose from 28,000 in 1750 to 250,000 tons by 1805 (G. Clark, 2005). The first IR is the transition from a traditional system to a machinery and manufactured world. The mechanical innovations, cotton and wool textile, the steam engine, coal, metalworking, iron, and steel industry marked this period.

Steam engine technologies of the first Industrial Revolution were tragically used not just for industrial production, but also to mechanize and expand the systematic human trafficking that devastated African communities, but useful as the labor force (Benyera, 2021).

The first IR is usually set around the 1760s to 1840s although this period varies among some economic historians.

The following Table 1.1 summarizes the different thoughts of several economists and historians regarding the first IR.

Table 1.1: Compilation from previous literature on the first IR

Historian	**Time Period**	**Key Concepts**	**Main Arguments**
Arnold Toynbee (2013)	1760-1810	Single historical event	The first to describe the IR as a unified event. Highlighted rapid population growth, agricultural decline, improved techniques, and scientific development.
Thomas Ashton (1997)	1760-1830	New manufacturing processes	Focused on transitions in the charcoal-iron industry, steam engines, iron and textile industries. Emphasized entrepreneurs and mercantilism. Noted substantial rise in average living standards.
Phyllis Deane (1979)	1750-1840	Demographic changes, Economic revolutions	• Positive demographic effects: declining death rates, increasing birth rates. • Highlighted cotton and iron industries, innovation, labor roles, capital banks. • Emphasized agricultural revolution, commercial revolution, and infrastructure development.

Continued on next page

Table 1.1 – *Continued from previous page*

Historian	**Time Period**	**Key Concepts**	**Main Arguments**
Joel Mokyr (2018)	1760-1830	Social and technological changes	Illustrated limitations of compartmentalizing historical sciences. Emphasized radical changes in family roles, work nature, social structures. Highlighted British macro inventions and various schools of thought in IR studies.
Nicholas Crafts (2018)	Not specified	Slow growth, structural change	Described IR as a mix of slow growth, population rise, and structural change. Focused on microeconomic foundations and impact of institutional arrangements on productivity. Introduced concept of total factor productivity.
E. Williams (2013)	Not specified	Slavery and colonial trade	Argued IR was realized through slavery and cotton. Emphasized the triangular trade's pivotal role in economic modernization and industrial development. Highlighted slavery's role in capital accumulation for IR.

1.1.2 The Second IR (1860-1930)

The United States and Germany surpassed England in terms of technology and growth during the Second IR however remained the three nations of major changes. Other European countries such as France, Italy, and Japan had great progress during this period.

Known as the electrical or technological revolution, the second IR was marked by discoveries and advances in electricity, improved communication technologies, and railway transport. "In 1866 the first underwater telegraph cable across the Atlantic Ocean was successfully installed, and ten years later, Alexander Graham Bell invented the telephone" (Beck, 2022). Many inventions were made in the automobile, chemical industry, oil, electronic economy, etc.

It was the age of science, the birth of Engineering Education and Belt conveyors guided by humans. It was the era of mass production and consumption of automobiles. Production focused on steel production, assembly line, modern light bulb, the telegraph, the radio, aircraft, and factory machines, transport and communication.

Great inventions were likewise made in the field of chemistry and medical science. Crafts (2018) argued that the neoclassical model broke down because it underestimated both the role of natural resources and the difficulty of transferring technological expertise in a time when hands-on learning was essential.

Looking from an African point of view, during the Second Industrial Revolution, European powers colonized Africa primarily to secure access to raw materials and create new markets for their manufactured goods so the continent represented essentially a raw materials supplier. (Benyera, 2021). Western nations with industrial powers invaded

endowed nations, symbolizing the New Imperialism. Africa was invaded to be plundered of natural resources used to maintain the consistent growth. According to Doorsamy et al. (2022), Africa was a mere spectator during the first IRs, whereas its role cannot be undermined at this period. Africa represented the fuel that kept the fire of these IRs burning through the provision of her natural resources and manpower.

Table 1.2 summarizes different thoughts of several economists and historians regarding the Second IR.

Table 1.2: Compilation of previous literature on the second IR

Historian	**Time Period**	**Key Arguments**
Mokyr and Strotz (1998)	(1850) 1870 to 1914	Characteristics of the second IR can be traced back to 1850 and the major innovations are: the sewing machine, electrical power, telephone, telegraph, railroads, submarine cables, Diesel engine; Steel's spectacular success, the emergence of massive industrial enterprises, with companies like Carnegie Steel, DuPont, Ford Motors, and General Electric dominating the American landscape, while similar industrial powerhouses arising across Europe in this era. In chemistry, Germans took the lead especially in the production of fertilizer. New technologies rapidly enhanced people's quality of life, expanding purchasing power and living standards unprecedented for middle and working classes and there was a changing nature of the organization of production.
Stanley Jevons (1931)	1873-1994 (in the United States from 1865-1996)	Continuous mass production, reducing cost, ever-increasing competition amongst manufacturers and the ever-widening market were remarkable including in business, the birth of scientific management, rationalization, specialization, the professionalizing of industry and Trade Organizations. Accountancy upgraded to an applied science designed to aid the businessman in the policy of his operations; During the second IR, there was a rise in the profession of chartered accountants; Engineers practically applied theoretical scientific findings, focusing on creating bridges, ships, and boilers that were both economical and safe to operate.
Andrew Russell (2006)	1840 - 1950s	The significant changes occurred between the 1880s and 1920s. Chemical and electrical innovations, the rise of internal combustion engines, and the extensive development of new infrastructure networks - from railways to telegraphs and telephones.s were central to the second IR; It was the era of big business, dominated by massive corporations. Germany, Britain, and the United States were leading nations.

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Table 1.2 – *Continued from previous page*

Historian	**Time Period**	**Key Arguments**
Franco Amatori (2013)	Toward the end of the 1800s	Mass production, mass-distribution industries, growth in communication and transportation networks, telegraph and telephone, electricity and automobile, railroad, invention or refining of machinery, chemicals, and electrochemicals etc. were central to the second IR. The revolution in transportation and communications lowered costs and increased speed in distributing goods. Economies of scale were associated with economies of scope in distribution. Nation's financial institutions' role became dominant and banks played a key role in pushing companies to adopt more efficient and organized approaches to manufacturing and services. Meanwhile, railway companies pioneered early forms of employee benefits, introducing basic insurance and pension systems for their workforce; The United States, Germany, and Great Britain accounted for two-thirds of the world's industrial production at the end of the nineteenth century.
Levin et al. (2010)	1850 - 1930	Paris, London, Chicago, Berlin, and Tokyo emerged as the primary hubs where the Second Industrial Revolution took place, with Chicago, the most exhilarating of the second IR; There were new types of applied science institutes, social order, industrial innovations and sewage system as well as urban rebuilding to authorize expositions, establish museums and healthful and attractive environments. Leaders of this era recognized how scientific and technological advances worked together to create a new kind of urban life, one that brought advantages both within nations and across borders. During this period of constant international rivalry and mutual influence, a city's scientific and technological capabilities became a crucial indicator of its nation's status among industrialized powers.

1.1.3 The Third IR (1950-2020)

The third IR is known as the digital Revolution translating systems from analogue to digital and mechanical to electronic (Chirinda et al., 2022a). Several economic historians agree on the occurrence of the third IR with evidence and important changes as noticed in the previous ones. However, this third IR is a matter of concern and controversy among economists and historians as many do not agree on its period of occurrence.

The American Economic theorist Jeremy Rifkin building on the previous economists' thoughts added some new futuristic features to the third IR, making it more popularized. According to Rifkin (2011), IRs occur when innovations converge across three different

areas: energy, communications, and transportation. He explores subjects like green energy, renewable energy, micro-power plant buildings, smart grid technology, hydrogen technology etc. Rifkin's theory, nonetheless, is based on a futuristic technology yet to be realized. In addition, there was no historical evidence supporting Rifkin's theory. The third IR is basically defined as the era of Information Communication Technology with the invention of the phone, computer system, internet, the semiconductor etc. with new energies such as nuclear power promoted. Moreover,there is more to the third IR. The four Asian Dragons (Singapore, South Korea, Honk Kong, Taiwan) have started to be revealed during this era and were considered as the Asian miracle as they evinced a surprising industrial performance. The rise of Silicon Valley in the USA cannot be overlooked.

The second and third IRs have not been subject to enough review studies due to the ambiguity for economic historians regarding their occurrences and the periodizations. With this study we shed more light in clarifying the specific IRs by summarizing several thoughts of the preccedent's researchers.

The following Table 3 summarizes some thoughts of several economists and historians regarding the third IR.

Table 1.3: Compilation from previous literature on the third IR

Historian	**Time Period**	**Key Arguments**
Franco Amatori (2013)	From 1950	The third IR is the Information Age: electronics and jet transportation shrank space, Technologies and new industries were developed including: microelectronics, the Internet, mass air transport, and nuclear energy with new market opportunities and radical changes in communications, transportation, and physical materials. Physics became the foundation for major innovations as scientists tried to go beyond space, time, and materials science. Several key developments transformed society: the worldwide spread of personal computers, improvements in both landline and mobile phone technology, and aviation advances that included faster, larger aircraft using new materials like plexiglas and jet propulsion - all of which made transportation more affordable. The development of atomic weapons was followed by peaceful applications of nuclear energy. Nuclear research offered new solutions to address the scarcity and rising costs of traditional fuel sources like oil and coal. Meanwhile, scientific breakthroughs in molecular biology, biochemistry, and genetics during the 1950s and 1960s gave birth to the new field of biotechnology. Globalization, the increase in the volume and intensity of world trade and the increase of foreign investments were important. Heavy investments were made in R&D, especially in the US, Britain, Germany, and Japan.
Jeremy Greenwood (1997)	From 1950	The third IR is the IT Revolution, the era of computers: computer use evolved from academic and industrial research to electronic filing systems used by companies, reducing the manual labor involved in information management processes; And then became connectivity and interaction devices. There was an increase of information workers over production workers. Unskilled wages, stock market boom and investment opportunities were important. There was a surge in wage inequality, and a slowdown in the advance of labor productivity as well.

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Table 1.3 – *Continued from previous page*

Historian	**Time Period**	**Key Arguments**
Andrew Russell (2006)	From 1950	The third IR began in the 1950s in the United States, Japan, and Western Europe, and continues to the present day. It was the 'Information Age' and the 'Network Society': with the innovations in computing and electronics, including the invention of transistors, integrated circuits, and digital computers and networks. A new group of entrepreneurial firms in a region of California that became known as the 'Silicon Valley' emerged. Executives in private firms responded to changes in technology and regulation by forging international partnerships with other firms through co-operative arrangements such as joint ventures and standards-setting institutions. By the 1980s and 1990s, the American telephone system expanded to carry digital voice and data traffic and attach to different types of telephones, including wireless telephones. The Bell System, which is a nationwide telephone network more efficient and reliable computing technologies global 'alliance entrepreneurship' in US Telecommunication was developed.
Cooper and Kaplinsky (2005)	from late 1970s	The third IR is the 'Technological revolution': with the development of microelectronics technology and the growing dominance of a new paradigm named systemofacture by authors. The Technological change in economic growth was crucial with new radical discontinuities providing an opportunity for technological leap-frogging, and hence favored Least Developed Countries (LDCs). 'Greenfield' LDC sites might offer a more favorable environment for the adoption of new technologies than 'brownfield' Developed Country (DC) sites. The authors stressed the 'economies of mass resources. From mass production to flexible specialization: The labor process in the era of systemofacture: which has developed over the past two-to-three decades in the Japanese automobile and electronics industries. The application of the new heartland technology to products and processes: the diffusion of microelectronics and the importance of systems in production. New patterns of interfirm relationships, import protection and foreign investments emerged; Authors explore countries such as Japan, Korea, Brazil, Taiwan, Singapore, Thailand, Malaya and China.

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Table 1.3 – *Continued from previous page*

Historian	**Time Period**	**Key Arguments**
Jänicke and Jacob (2013)	from 1990	Dominant technology and raw materials were important to the third IR: ICT, Microelectronics, new materials, renewable raw materials, cleaner technology, bio-technology, recycling etc are developed. Changes in Transport and Communication include high-speed railway systems, internet, mobile telecommunication. The society was dominated by Civil society, globalization, and global governance. The dominant energy source is renewable energy. Core countries: EU, China, USA, Japan.
Jeremy Rifkin (2011)	Not specified	The Third IR offers the hope that we can arrive at a sustainable post-carbon era by mid-century and avert catastrophic climate change. Rifkin embeds green transport inside a new high-tech Third IR infrastructure, re-framing the very concept of human mobility. This could well be the future of transportation. Convergence of communication technology and energy regimes. The conjoining of Internet communication technology and renewable energies is highlighted for the third IR. The five pillars of the Third IR are (1) transition to Renewable Energy Sources; (2) Decentralized Energy Production using buildings as power plants; (3) Energy Storage Technology; (4) Digital Communication Technologies/Smart Grid Infrastructure; and (5) Electric and Fuel Cell Transportation.

1.1.4 The Fourth IR

If the third IR is still a controversial debate among economic historians, the fourth IR is even more controversial and is just considered as an absurdity or nonexistent for several scholars and economists. The fourth IR has been officially declared by Klaus Schwab, founder and executive chairman of the World Economic Forum (WEF) and has supposedly started from 2000. It is claimed to be the "fusion of the biological, physical, and digital worlds" (Chirinda et al., 2022b). Artificial intelligence and Machine Learning, the Internet of Things, Advanced Connectivity, robotics, automation, 3D printing, nanotechnology, Genomics and biotechnology, Big Data and Advanced Analytics, and cybersecurity are some flagship technologies highlighted by the pioneers of this new ideology of the fourth IR. Social networks, e-business, e-finance (financial technology), mobile phone outbreak, mobile platforms and apps, Cloud, miniaturization, cheap sensors, autonomous systems, and self-steering cars are also central to this fourth IR. The fourth IR is therefore the process of accelerated automation of traditional manufacturing and industrial practices via digital technology. New economic models evolved, namely capitalism, become central in the USA; socialism adopted in Great Britain and France; and communism emerged in

the Soviet Union (Broadberry & Gupta, 2005). According to Moll (2021), changes in the twenty-first century are generally the continued evolution of the Third IR (3IR) and there is no such phenomenon as a Fourth IR for most of the technologies highlighted as flagships of the fourth IR are only a continuation of that which started during the third IR. The term AI for instance existed since 1956 and has just been popularized in more recent years. Morgan (2019), being critical about the technologies of the 4IR, argue that the timeline that has emerged for those technologies typically focuses around 2030 and the changes collectively represent an anticipated fundamental transformation . We could consider this era as a period of transition to an eventual future IR. The following Table 4 summarizes some thoughts of several economists and historians regarding the fourth IR.

Table 1.4: Compilation of previous literature on the fourth IR

Historian	**Time Period**	**Key Arguments**
Klaus Schwab (2017)	From 2000	Built on the digital revolution and characterized by a much more ubiquitous and mobile internet, by smaller and more powerful sensors that have become cheaper, and by artificial intelligence and machine learning, the fourth IR is evident in 'the staggering confluence of emerging technology breakthroughs, covering wide-ranging fields such as artificial intelligence, robotics, the internet of things, autonomous vehicles, 3D printing, nanotechnology, bio-technology, gene sequencing, materials science, energy storage and quantum computing, big data, sensor technology; blockchain, Bitcoin, driverless cars, social media for the community. It results in rising inequality.
Johnson and Markey-Towler (2020)	Mid-2000	The fourth IR is all about the convergence of innovation, fusion of new digital technologies rooted in advances from the Digital Revolution, with technological applications in the physical and biological domains. Globalization is more tangible with Amazon, Google, Facebook, etc. The latest generation digital platforms and IoT systems based on evolving Internet technologies, the many creative blockchain use cases (beyond crypto-currency), and the applications of artificial intelligence which replace automation with "smartization" (Park 2017) are the three most important of all of these technological mega-trends in terms of their realized and potential impact on the economy and its institutions.

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Table 1.4 – *Continued from previous page*

Historian	**Time Period**	**Key Arguments**
Doorsamy et al. (2021)	Not specified	The Fourth IR (4IR) has already begun and is based on a confluence of multiple technologies like Artificial Intelligence, Internet of Things, Machine Learning, Big Data, Additive Printing, Cloud Computing, Virtual and Augmented Reality; e-governments; etc. The 4IR is 'the current that blurs the lines between the physical, digital and biological spheres through AI, automation, biotechnology, nanotechnology and communication technologies contrary to the earlier IRs, the 4IR is based not on a single technology, but on the confluence of multiple developments and technologies'
Kumar et al. (2019)	from 2011	Presently with globalization and open market economy, the market has become consumer driven or customer dictated. This has given rise to the 4th IR and has initiated amalgamation of Internet, information and communication technologies (ICTs) and physical machinery with the coinage of words like Internet of things (IoT), Industrial Internet of things (IIoT), Internet of Services, robot (collaborative robot), big data, cloud computing, virtual manufacturing, 3D printing finding their way into our daily life. Cyber Physical Systems lay the foundation of fourth IR also referred to as Industry 4.0 (I4.0). The concept of I4.0 originated in Germany in the year 2011 and with subsequent advancements and continual research became one of the strategic initiatives of the government. The industries are experiencing the Fourth IR with robotics and digitalization at the center stage.

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Table 1.4 – *Continued from previous page*

Historian	**Time Period**	**Key Arguments**
Jamie Morgan (2019)	2030	The combination of many technologies including machine learning, artificial intelligence, robotics' impact on work has been packaged as the concept of a fourth IR though not reducible to merely employment issues, a further and intersecting context for the future of work, heavily focused on new technology, has also arisen in the early twenty-first century, invoking claims regarding a new phase in capitalism. That is, what has been variously referred to as a new (digital) machine age, industry 4.0 or a fourth IR. Health services of the near future could draw on household management AI through a health monitoring function to seamlessly integrate such monitoring into personal calendar-matched (and so not missed) doctor and hospital appointments. The idea of a fourth IR and the individual technologies merely in aggregate are slightly different, since the functionality of the technologies and their combinations is implicitly dependent on and operative through the collection, transmission and use of information.
Moll (2021)	Not specified	The fourth IR is a myth; there is no such phenomenon as a Fourth IR. All the innovations claimed to be evidence are simply an accelerated evolution of the technologies of the 3IR. Digitalisation (sociological concept) and artificial intelligence (field of knowledge and research) are not technologies.

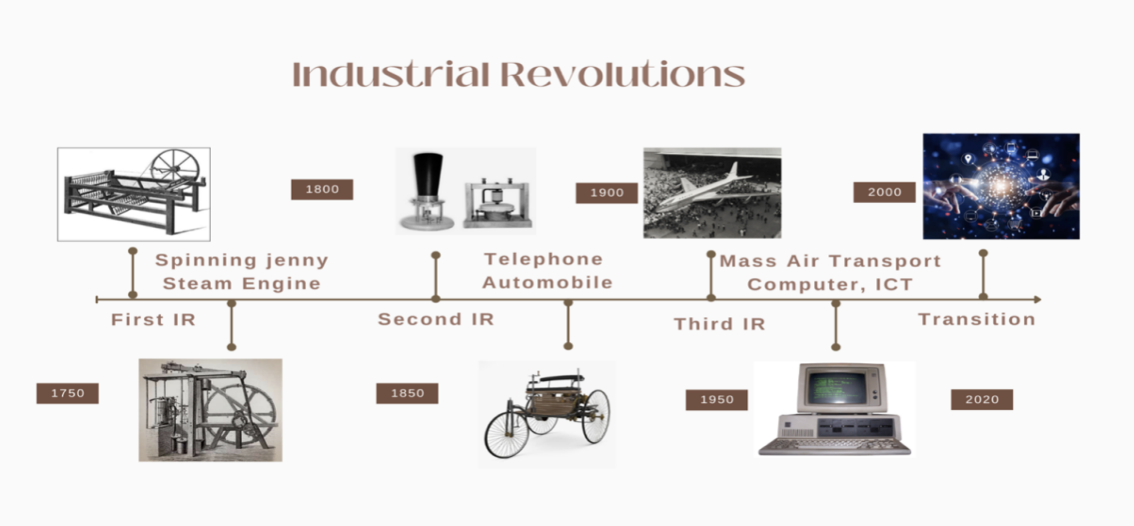

Figure 1.1: The Industrial Revolutions
Source: By authors

1.2 Industrialization in Africa

1.2.1 Prior to the Colonial Conquest

Before the conquest of Africa, several countries used some methods and techniques for transforming mineral resources. Africans had the technologies for the extraction, transformation and exploitation of the different natural resources available such as gold, iron, steel, silver etc. Before the slavery and colonialism episode, Africa witnessed an iron-making industry (Emeagwali & Shizha, 2016). Not only Egypt but antic Sub-Saharan Africa had important inventions in fields like textile manufacture, mining, architecture, engineering, metallurgy, calculations, astronomy, navigation, and medicine (Blatch, 2013). However, this has been disrupted by the Scramble of Africa.

1.2.2 During Slavery and Colonialism

African historians demonstrated that the contribution of Africans was important to the origin of the IR in England (Inikori & Inikori, 2002). Through colonialism, Africa had greatly contributed in providing natural and human resources to sustain the evolution of the IRs in the Western countries by remaining poor and even conditioned to consume manufactured goods produced in the Western nations that experienced and led the IR. Industrialization in Africa was discouraged by colonial policies (Steel & Evans, 1981). A study revealed the historical and current technology underdevelopment of Nigeria could not be explained without reference to imperialism and European economic domination (Onipede, 2010).

According to a study on the experience of industrialization in Sub-Saharan, it was found to have occurred in two phases: a first step, very early during the colonial regime began around the 1920s and ended in the late forties; a second phase of industrialization began in the late fifties and gained momentum in the sixties, when import substitution was implemented more widely (Mendes et al., 2014). Actually, during the colonial era, African nations did not experience enough changes or improvements regarding industrialization. In a sense, industrialization aims at improving and raising living standards which most African countries were denied during colonial periods. Although few infrastructures were built in Africa during colonialism with a limited access to machinery for manufacturing, they were exclusively established for the sole profit of the colonizers to better extract, process and ship the various resources Africa has been endowed and this has not led to growth. For instance, colonial policy restricted industrialization in Africa by African through many ways. In Uganda, Africans were prohibited to own cotton ginneries by legislation (Rodney, 2018) and African commercial farming could not easily have access to the non-farm cash community due to the severe restrictions (Steel & Evans, 1981).

1.2.3 After Independence

After the colonization, African countries were left with some infrastructures and industrial equipment such as telegraph, railways, processing plants, submarine cable,

computers, telephone, etc. African leaders opted for industrialization in Africa through various policies realizing this could be the only way for Africa to free herself from the external dependance of processed products from her exported raw material. As independence approached, the pace of industrialization accelerated in some francophone countries' colonies such as Ivory Coast and Senegal (Steel & Evans, 1981). African real experience of industrialization started after independence through different subsequent policies and strategies including import substitution; export processing, basic industries, market-oriented strategies and upstream production in the Global Value Chain (GVC).

Import substitution in Africa

Around the 1960 after independence, most African countries adopted the policy of import substitution which put a high emphasis on the local production to the detriment of import and thus decreasing the international dependence of manufactured goods. Continued emphasis was thus placed on primary agricultural production in an attempt to provide the requisite raw materials for the manufacturing sector (Newfarmer et al., 2019). Governments set severe regulations on manufactured imported goods increasing the taxes and thus provided a secure environment for local manufacturing industry mostly related to food transformation, beverages, textile, wearing apparels. metal products, wood furniture, etc. The important substitution along with some other policies and strategies adopted within 1960-1970 projected some growth on the manufacturing share of the GDP and the labor force which was quite impressive (Steel & Evans, 1981). However, this growth was not for long for African industries and some economic factors started decreasing. This failure was due to the limited human and physical capital, the low literacy rate and infrastructures and the lack of experience (Bruton, 1998). In addition, the involvement of the state, foreign firms, and the World Bank in the investment of manufacturing led to debts, budget deficits, and productivity growth issues in particular (Bruton, 1998).

Export Processing strategy

Export Processing Zone (EPZ) has been initiated in order to promote economic development through the provision of foreign investors with tax and other incentives such as the exemption of import duty and use of a bonded factory in order to set up businesses exporting goods. After the launch of the import-substitution strategy, some African countries, dissatisfied with the results, revolved in experiencing an export-led industrialization strategy using light manufacturing, especially the apparel and textile sector, as well as oil and gas with the dual benefits of creating jobs and promoting exports. The vision of zones has driven the EPZ agenda in many African countries with problematic consequences. Export processing zones in Africa have generally had poor forward and backward linkages because they have not been designed with an institutional focus relative to the industrial policy priorities of the country (Stein, 2012). However, in 1990, Egypt, Mauritius, and Tunisia had zones with significant exports. The industrial policy instruments and the EPZ model in Mauritius were constantly modified and adapted

to fit the new requirements of the external environment and to tap new opportunities (Oqubay, 2022). From 1980, the industry level in Sub-Saharan Africa from the value-added share of the GDP data has been on a declining trend reaching its lowest point of 23% in 2016 (Figure 1.2). However, from 2016, a reverse tendency has been noticed and in 2021, more than 5% increase on the value-added share of GDP had been recorded. Employment equally is on a steady slow increasing trend. Some studies findings show that Sub-Saharan Africa (SSA) except for Mauritius has experienced de-industrialization (Rodrik, 2016) Considering the steady upward trend of industry employment in SSA, however, we can't conclude the continent is experiencing a deindustrialization. According to Rodrik (2016), the fact that developing countries are becoming more service oriented in their economic activities skipping the real experience of industrialization is a sign of premature deindustrialization. Actually, countries in Sub-Saharan Africa have had different experiences in industrializing their economies, and clear evidence of premature deindustrialization in the region as a whole is lacking (Abreha et al., 2021). After all, the continent is still industrializing.

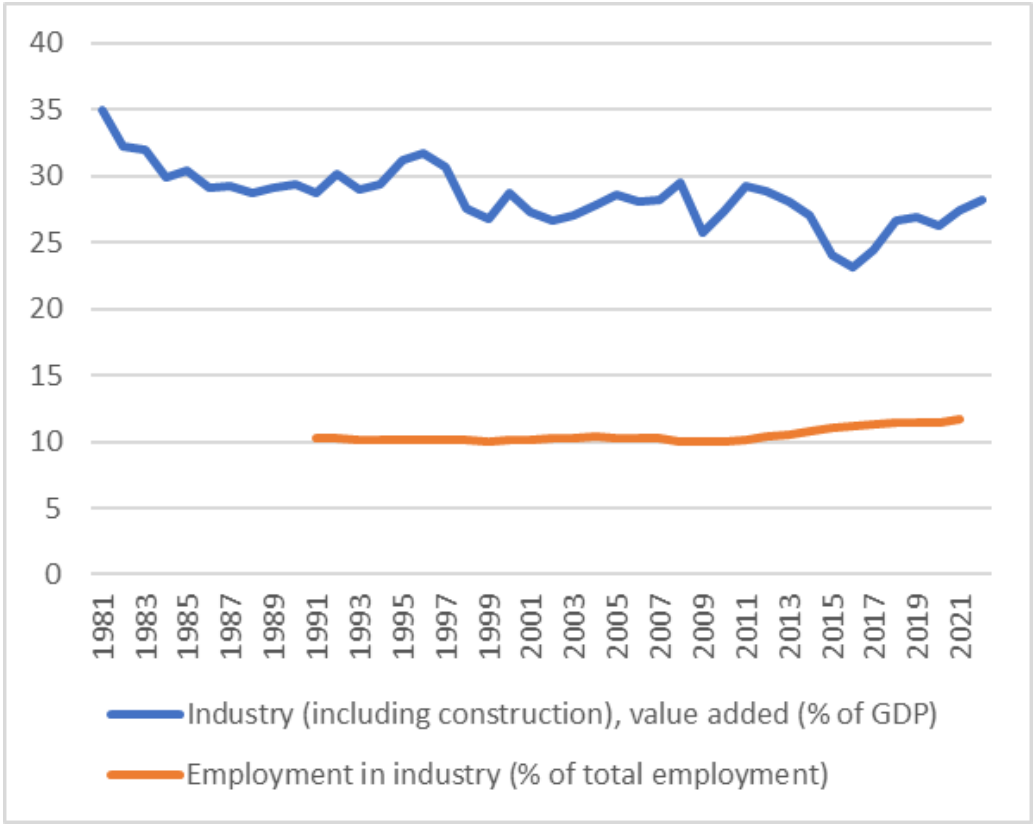

Figure 1.2: Industry in Sub-Saharan Africa
Source: WorldBank

The following Table 1.5 summarizes some thoughts of several economists and historians regarding Africa in the context of the different IRs.

Table 1.5: Compilation of previous literature on Africa and the IRs

Author(s)	**Time Period**	**Key Arguments**
Benyera (2022)	Not specified	He argued that Africa could not take advantage from the 3 firsts IR and can now benefit from this 4th IR only by epistemic freedom, just and ethical leadership. In addition, Africa needs economic and political independence. Applying Marxism in Africa is an abuse in his opinion for Karl Marx and Frederick theories were not designed for African context. Africa suffers from coloniality and needs active citizenry to eradicate it. Devoid of epistemic freedom, an ethical and just leadership which thinks from and for Africa, the 4IR will become a curse unto Africa
Chirinda et al. (2022b)	Not specified	The authors of the various chapters in this volume have positioned the 4IR research in their respective local contexts. They have addressed numerous interests, concerns, and implications regarding Mathematics Education and 4IR in Africa. They defend Mathematics as a critical and indispensable subject during the new IR. Africa has still not fully engaged productively with the Third IR (digital revolution) and Mathematics education has not been updated to the new generation of high tech equipment, new teaching and learning procedures such as the virtual laboratories, online tools and multimedia. The 4IR has created a new world of new digital technologies including innovation in mathematics education. The data revolution, the rate at which the world produces and records data, is insurmountable. Sub-Sahara Africa curriculum developers should therefore pay attention to Data Science and its affordances for 4IR. Beyond infrastructure, governments should prioritize education quality and promote STEM education. As Africa is simultaneously dealing with the different stages of development, it also needs to catch up with the rest of the world. Challenges to leveraging the 4IR include lack of infrastructure, expertise, and collaboration between academia and industry.

Continued on next page

Table 1.5 – *Continued from previous page*

Author(s)	**Time Period**	**Key Arguments**
Naudé and Tregenna (2023)	1965 - present	The first phase of industrialization after independence (roughly 1965- 1975) was marked by post-independence consolidation and volatility. The second phase (1975-1995) was a phase of structural adjustment which derailed the industrialisation agenda and led to very premature deindustrialization in many African countries, following the energy crisis and associated debt crises in many African countries. The third phase (1995 -2008) saw recovery and modest growth in employment in manufacturing while the share of MVA in manufacturing continued to decline (i.e. low productivity). A fourth phase, following the 2010 global financial crisis, saw accelerated growth in the share of manufacturing employment as well as a modest recovery in the share of MVA and coincides with the convergence of digital technologies and connectivity from particularly 2007 onward. A possible fifth phase started around 2019-2022 and is marked by increased global instability reflected in greater sluggishness in global supply chains, rising energy and food prices, and a slowdown in global economic growth.

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Table 1.5 – *Continued from previous page*

Author(s)	**Time Period**	**Key Arguments**
Everisto Benyera (2021)	Not specified	The Fourth IR (4IR) will not positively change the fate of Africa and Africans but will rather serve to further marginalize Africa within the international community. The third IR saw cartels and multinational corporations ruling Africa in cohorts with African pseudo nationalists. Likewise, the fourth IR for Africa is a looter continuum, from slaves, raw materials, and now the empire is looting African data which will result in the (re)colonisation of Africa; ensure that Africa's cyberspace, data, and digital spaces, and products are owned and controlled by the empire. The 4IR is essentially a services revolution brought about by the merging of nanotechnology, biotechnology, information communication technology (ICT), among others in the process blurring the traditional boundaries between the physical, the digital, and the biological worlds. The 4IR extends the loss of sovereignties from the African nation-state to the individual Africans. With the history of exclusion, slavery, colonialism, and perpetual denial into personhood, black people are still struggling to be part of the thinking beings and always grapple with how to enter the realm of knowledge production. The 4IR will undoubtedly complicate the quest for black people to enter and be accepted into the realm of humanity. In the 4IR, the thinking and cognitive space has new entrants, trans-humans, robo-humans, and other forms of enhanced humanity who occupy an ontological position higher than that of black people. The 4IR is therefore another sad moment in the life of black people as they slide lower and lower on the ontological ladder, whose apex is occupied by white Caucasian males and the bottom is occupied by black women.

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Table 1.5 – *Continued from previous page*

Author(s)	**Time Period**	**Key Arguments**
Newfarmer et al. (2019)	Not specified	Historically, industry, particularly manufacturing, is the sector on which economies have relied early in the process of structural transformation. Africa's experience with industrialization, however, has been disappointing. Today, a wide range of services and agro-industrial products, including horticultural products, has emerged. These activities have many features in common with manufacturing. Modern services are a critical input into downstream industries and their impact on manufacturing productivity is considerable. The authors mentioned the 'Servicification' of Manufacturing. New technologies will allow Africa to leap-frog in the high-income countries, most likely in network industries where the high fixed cost of investments constrains adoption of latest technologies in richer economies. There is some evidence that in Africa, services are taking up the role as the primary source of within-sector productivity growth. Modern, tradable services, such as ICT-based services, tourism, transport and logistics have the potential for strong within-sector productivity change and contribute to raising productivity in other sectors of the economy. Agro-industrial production and horticulture offer the potential for productivity growth and exports.

1.2.4 Manufacture-driven Development Policy

The African Development Bank, the WorldBank Group and the United Nations became very keen on Africa industrialization and developed several programs to assess and improve Africa's pace of industrialization.

The African Development Bank (AfDB)

According to the AfDB (2022), Africa has the potential to become the next global frontier for industrial development. AfDB is one of the important organizations engaged in accelerating industrial development in Africa. It launched the Africa Industrialization Index (AII) in order to provide a more accurate level of industrialization in African countries using key indicators, covering manufacturing performance, capital, labor, business environment, infrastructure, and macroeconomic stability (AfDB, 2022). It classifies industrialization along three dimensions: performance (manufacturing output and exports), direct determinants (capital and labor), and indirect determinants (infrastructure, institutions and macroeconomic variables). The AfDB's report on AII 2022 shows that most African countries are making slow and steady progress on industrial development

(AfDB, 2022). Thirty-seven African countries (Algeria, Benin, Botswana, Burkina-Faso, Burundi, Cameroon, Central African Republic, Chad, Comoros, Congo RDC, Côte d'Ivoire, Djibouti, Egypt, Ethiopia, Eritrea, Gabon, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Mauritania, Morocco, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra-Leone, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe) have industrialized over the past 11 years improving their AII score. South Africa is ranked first, and has maintained this advanced position throughout the 2010-2021 period. Followed by Morocco, Egypt, Tunisia and Mauritius, they make the top five industrialized nations in Africa (AfDB, 2022).

African countries based on AfDB studies should define resolute and appropriately suitable policies, invest in infrastructures, in capital markets and in government capacity, encourage SMEs (Small Medium Enterprises), develop Special Economic Zone and partnerships (AfDB, 2022). Figure 1.3 summarizes the Africa Industrialization Index of the top 10 countries from the AfDB classification and Figure 1.3 presents a descriptive image of the trend.

Year	South Africa	Morocco	Egypt	Tunisia	Mauritius	Eswatini	Senegal	Nigeria	Kenya	Namibia
2010	0.8957 (1)	0.7643 (3)	0.7578 (4)	0.7895 (2)	0.6802 (5)	0.6426 (6)	0.5547 (14)	0.5766 (10)	0.5723 (11)	0.6106 (7)
2011	0.8937 (1)	0.7996 (2)	0.7525 (4)	0.7991 (3)	0.6909 (5)	0.6439 (6)	0.5772 (11)	0.5792 (10)	0.5837 (9)	0.6133 (7)
2012	0.8948 (1)	0.8035 (2)	0.7663 (4)	0.7938 (3)	0.6983 (5)	0.6355 (6)	0.5833 (10)	0.5817 (11)	0.5936 (9)	0.6136 (7)
2013	0.8888 (1)	0.8155 (2)	0.7792 (4)	0.8044 (3)	0.7018 (5)	0.6408 (6)	0.5867 (14)	0.5901 (13)	0.6025 (11)	0.6193 (7)
2014	0.8829 (1)	0.8219 (2)	0.7745 (4)	0.8073 (3)	0.7128 (5)	0.6357 (6)	0.5847 (15)	0.6207 (7)	0.6090 (11)	0.6107 (8)
2015	0.8764 (1)	0.8104 (2)	0.7731 (4)	0.7869 (3)	0.7081 (5)	0.6312 (7)	0.5813 (13)	0.5991 (10)	0.5939 (11)	0.5998 (9)
2016	0.8669 (1)	0.8201 (2)	0.7813 (4)	0.7914 (3)	0.7061 (5)	0.6247 (7)	0.5880 (11)	0.5635 (17)	0.5983 (10)	0.6009 (8)
2017	0.8746 (1)	0.8302 (2)	0.7667 (4)	0.7871 (3)	0.6965 (5)	0.6373 (6)	0.5968 (10)	0.5734 (15)	0.5887 (12)	0.6189 (8)
2018	0.8752 (1)	0.8369 (2)	0.7699 (4)	0.7777 (3)	0.6889 (5)	0.6385 (7)	0.6015 (10)	0.5921 (12)	0.6029 (9)	0.6434 (6)
2019	0.8696 (1)	0.8333 (2)	0.7755 (4)	0.7808 (3)	0.6872 (5)	0.6485 (6)	0.5979 (10)	0.6133 (9)	0.5964 (11)	0.6189 (8)
2020	0.8498 (1)	0.8387 (2)	0.7934 (3)	0.7808 (4)	0.6794 (5)	0.6405 (6)	0.6116 (10)	0.6122 (9)	0.6042 (11)	0.6139 (8)
2021	0.8404 (1)	0.8327 (2)	0.7877 (3)	0.7714 (4)	0.6685 (5)	0.6423 (6)	0.6147 (7)	0.6046 (8)	0.6029 (9)	0.6014 (10)

Note: Figures in brackets are the countries' ranks in the corresponding year.

Figure 1.3: Africa Industrialization Index 2022 Top 10
Source: AfDB (2022)

The WorldBank Group

Industrialization offers a viable path to structural transformation and job creation as the driver of growth. However, effective industrialization requires drastic, complex, and entrepreneurial-oriented strategies employing new technologies. Policymakers in Africa must reorient policy strategies to provide support for integration into Global Value Chains (GVCs) as Africa has the potential to exploit opportunities in manufacturing GVCs for job creation and structural transformation by facilitating productivity growth and promoting competitiveness. While the fragmentation of manufacturing activities across countries has created opportunities to industrialize, long-term success will depend on investments in skills and technologies (Abreha et al., 2021). These investments will be critical to

enhance production capabilities, build comparative advantages in higher-value-added tasks to promote more and better jobs, raise productivity, and foster structural transformation (Abreha et al., 2021). The World Bank report in 2021 on Industrialization in Sub-Saharan Africa revealed that new and young firms have great potential as drivers of job growth. Also, manufacturing-driven structural change is important for success.

The participation of many African countries in the global supply chains is mainly constituted of natural raw materials while manufacturing of finished goods, final product assembly and processed raw materials with higher value-added remain low on the global market. Nevertheless, GVC integration has led to job growth, and backward integration is especially associated with more job creation (Abreha et al., 2021). The study shows in addition that Sub-Saharan Africa has not experienced premature deindustrialization for the region and saw substantial growth in manufacturing jobs due to a lack of improvement in the contribution of manufacturing value-added to GDP (Abreha et al., 2021). There is a large heterogeneity across countries in SSA and a single story of premature deindustrialization cannot encompass the industrialization experience in the region (Abreha et al., 2021). Only 5 of 41 countries studied in SSA show evidence consistent with an inverted U-shape in real manufacturing value added (Kassa & Owusu, n.d.). Industrialization is alive and well in many countries of SSA and countries such as Mauritius and South Africa, have successfully developed strong industrial economies (Abreha et al., 2021).

1.2.5 ICT-driven Development Policy

The outcomes of the third IR including advanced digitization, data, connectivity, automation etc give way to new perspectives of industrialization with new possibilities of catching up without necessarily taking the route of traditional manufacturing systems. Africa through leapfrog technology has an opportunity of catching up. A good illustration is the case of the telecommunication boom in Africa (Doorsamy et al., 2022). The outbreak of mobile phones, the rising of African telecoms multinationals, and the access to the latest communication technologies are key factors to the industrialization in the continent. Many innovations including internet banking are initiated and in use even in the most remote rural areas. Internet access promotes e-banking, e-commerce, and a new generation of social media influencers allowing a global integration of Africa. There is a rise of entrepreneurs leading the adoption of platform business models, with more than 300 indigenous digital platforms arising in recent years (Naudé, 2019). Also, a new wave of African technology startups has recently emerged with locally adapted "home-grown" digital technologies positioning Africa's tech sector as one of the fastest growing tech ecosystems in the world (Lay & Tafese, 2023). James (1995) highlighted the important role of the government in the industrialization of Africa arguing the low technological behavior in the public sector may have contributed to the typically inefficient pattern of industrialization in Sub-Saharan Africa. Several countries have started taking action toward the acceleration of the ongoing industrialization. Governments in countries such as South Africa, Morocco, Egypt, Tunisia, Rwanda, and Kenya have developed national AI strategies with digital transformation

plans. In Benin Republic, Glo-Djigbé Industrial Zone (GDIZ) was established through a public-private partnership to carry out processing and manufacturing activities such as cashew processing, soya processing, integrated textile factories with spinning, weaving and garmenting, ceramic tiles factory, electric bikes factory, pharmaceuticals factory, etc .

1.3 Conclusion

The journey experience of IRs are varied across continents and nations. Some Asian countries seen as latecomers can still boast of having caught up and realized the miracle of the IR just at a much later timing in comparison to England, Germany, France, and US. Africa is in an alarming position concerning the first and second IR and although it was not involved productively in these revolutions, the continent's human capital and resources constitute undeniable determinants of the IR. European industrialization was simultaneously creating a growing demand for African resources and human capital. Regarding the third IR, Africa is catching up through appropriately adapted technologies and leapfrogging advantages, especially in the fields of ICT and telecommunications. However, industrialization patterns are as varied as the countries themselves. Different countries, and even different regions within the same country, may be experiencing different stages of industrialization. Ndoye (2010) maintains that Africa is simultaneously going through three ages of revolution: pre-industrial, industrial, and post-industrial. Many African countries have not necessarily industrialized following the same pattern of textile-steel-iron production but rather food processing is very crucial to African industries in most countries. The process may seem slow but African countries are industrializing and moving towards a growth that will set up a new model of industrialization different from all that which has been previously documented. Industrialization in Africa is a complex topic that needs more studies and more approaches in order to fully perceive the uniqueness it englobes as far as each country or country's region is concerned.

Chapter 2

Economic structure and sectoral shifts in African Countries

2.0 Introduction

Before the modern period, agriculture was the most important activity sustaining and enriching nations. However, during the modern period, there was a rise of the secondary sector and a shift from the primary sector to industrial sector. The industrial sector surpassed the primary sector (agriculture) in terms of economic output and employment in many countries. The industrial sector has been and remains paramount to the most developed countries. However, the recent years have also witnessed a rise in the service sector. C. Clark (1940) highlighted the importance of sectoral changes, particularly the shift from agriculture to industry and services, as an economy grows.

The industrialized nations in Europe, America and Asia follow quite similar sectoral shifts as in the classic way from agriculture dominance to the industrial and then to the tertiary sector. These sectoral changes in African countries have different patterns and especially varied based on countries features. African countries are mostly the latest vague in the world having experienced industrialization and this tremendously affected the economic sectorization. It is believed that African countries remained keen on the primary sector including agriculture and natural resources. However, the rise of the tertiary sector could not be overlooked. This chapter is an extensive study on the sectoral shifts in the economy of all African countries. Although access to historical statistics data is challenging in African countries, we attempt in this study to describe the situation of Africa regarding the economic sectoral changes.

Sectoral shift patterns are widely considered to be essential elements for assessing disparities in economy in different countries of the world, however few studies have examined this question in the case of Africa. The objective of this study is to clearly present the changes that occurred in the economic sectors over the past decades in African countries and provide the possible reasons for the various changes. We thoroughly reviewed the previous studies on the economic sectors changes in the world in general and in Africa in particular. In addition, building on Allan Fisher, Collin Clark and Jean Fourastie three-sector model, we presented a descriptive analysis with visual representation using ternary graphs.

2.1 Literature Review

Several authors have explored the question of economic structure. William Petty (C. Clark, 1940) is often credited as a pioneer of the idea of economic sectorization, particularly with his early conceptualization and attempts to categorize different types of economic activities. He emphasized on the importance of agriculture and industry as well as on the distribution of wealth and productivity across different sectors of the economy. Petty's work in the 17th century was an early precursor to the tripartite economy structure theory. He actually laid the groundwork for the development of the formal three-sector model as known today which was more clearly articulated in the 20th century by economists like Colin Clark (C. Clark, 1940) and Jean Fourastié (Fourastié, 1949).

Fisher (1935) was the first to label the service industries as "tertiary" and his findings support the theory that the importance of the tertiary sector increases as countries become more economically developed.

Colin Clark is, also known as a pioneer of the modern concept of sectorizing the economy into three, developed on Petty idea. He is the one who made the economic analysis of sectoral shifts, especially, the evolution of the economy through primary, secondary and service sectors. By postulating the existence of "sectors", Clark inferred that industries could be organized in groups as each sector exhibits distinct features. These sectors show significant variations in productivity and demand structures as income levels rise, with fundamental differences in output nature and growth limitations. The primary sector includes agriculture and mineral extraction. The sector is limited by natural resource availability. The secondary sector rather involves manufacturing or production. The sector is dependent on technological and mechanical factors. The service sector is rather limited by human skills, expertise, and professional capabilities with intangible outcomes. Primary and secondary activities can be further distinguished from the remainder activities by the nature of their output, which is tangible in nature.

In the opinion of C. Clark (1940) the service sector encompasses a diverse range of activities including transportation, communication, financial services, professional fields, government administration, and personal and domestic services. In contrast, the secondary sector includes craft and construction industries, alongside manufacturing, mining, and utility services like gas and electric production. Clark's conception of the service sector functions as a residual classification, including diverse economic activities that fall outside conventional sectoral groups. C. Clark (1940) argued that economic progress is often accompanied by a shift in employment and production from agriculture to industry and then to service sectors. This is represented in Figure 2.1 presenting a sharp decline of primary activities and a significant increase of the Tertiary activities while the secondary activities has an inverted U-shape trend with the beginning the de-industrialization at the peak. Clark argued that the increase in services was a key indicator of economic maturity and progress.

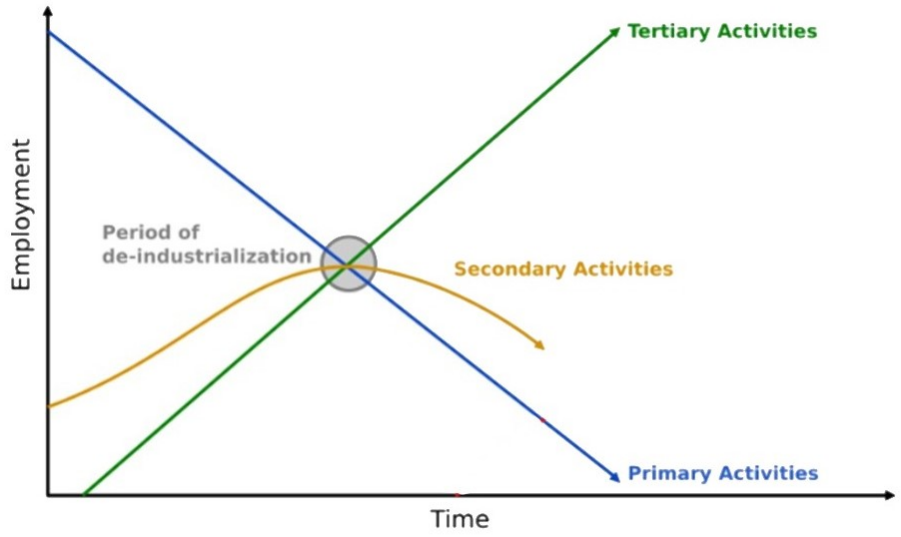


Figure 2.1: Clark's sector model
Source: Adapted Clark Sector Model

Jean Fourastié (1949), a French economist, expanded the three-sector model ideology by examining the evolution of economies from primary to tertiary sectors over time. Fourastié's sectoral definition hinges on technological dynamism: the tertiary sector represents activities with minimal technical advancement, the secondary sector embodies significant technological progress, and the primary sector is exclusively agricultural. He elaborated on the three-sector hypothesis, also arguing that economic development progresses through three stages, each characterized by the dominance of a particular sector. In the initial phases of economic development, most of the workforce was engaged in agriculture and economy was largely rural and subsistence-based. After industrialization, transition to a manufacturing and industrial based economy evolved. Economic development at this transitional stage was marked by urbanization, advances in technology and agricultural productivity which became the main factors in labor shifting into industrial-based employment. Eventually, the economy transitions to a service-based structure, where the greater share of employment is found in services such as education, healthcare, finance, and other professional activities. Fourastié (1949) emphasizes that productivity growth in the tertiary sector is slower compared to the primary and secondary sectors, which explains the increasing share of employment in services as economies mature. Therefore, the low rate of productivity growth in services, combined with this shift in demand to services, would be the great hope for 20th century employment. Fourastié's three sector model is generally adopted in the German system and represented in a layered area graph as below in Figure 2.2. The Figure shows the significant shrinking of the primary sector, moderate decrease of the secondary sector and high expansion of the tertiary sector.

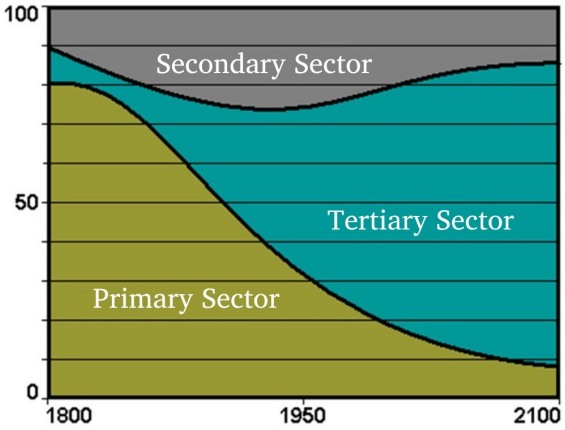


Figure 2.2: Three sector model representation by Jean-Fourastié
Source: Jean-Fourastié

Fuchs (1968) explores the rise of the service sector in the United States and the changing composition analyzing consumption data for 48 states over the period 1938 to 1958 (using data on household expenditures from NIPA). The study examines the trends in employment across different sectors, focusing on the shift from agriculture and manufacturing to services (Fuchs, 1968). The author analyzed various data sources and looked at the demand side using household budget surveys. Before 1920, employment changes primarily reflected the movement from agriculture to non-agricultural sectors, with industrial employment growing as rapidly as service employment. After 1920, industrial employment's share began to decline while service sector employment rose dramatically. The author identified the income elasticity of demand for services reflecting increased urbanization as one reason for the growth in the service sector employment. Besides, he mentioned several factors that drove up the demand for services including the expansion of educational opportunities and the fact that there were more elderly people who could afford to spend more. The research also showed that employment in the service sector grew primarily because services weren't becoming more productive at the same rate as other sectors. This slower productivity growth could be linked to a smaller increase in worker skill levels within the service sector.

Bryceson (1996) studied the deagrarianization and rural employment in sub-Saharan Africa from a sectoral perspective assessing how changes in the agricultural sector and the growth of other sectors are influencing rural employment patterns and economic opportunities. Based on statistical analysis, this research shows that sub-Saharan Africa is moving away from agriculture, but in an unusual way. Instead of people specializing in new occupations, they are individually taking on various jobs while staying within their existing sectors. Manufacturing has not taken off in urban areas because local industries cannot compete with more advanced international manufacturers. However, rural services have an advantage - they are protected from international competition, and a basic service infrastructure is already in place. The author categorized services as value-added production of goods and activities provisioned by either public or private economic agents (Bryceson, 2019). For private businesses, they're customized goods and services

that meet individual customer needs. In the public sector, services include government administration, transportation systems, and energy supply that support the exchange of goods and services (Bryceson, 2019). McCaig and Pavcnik (2013) mentioned there was a significant shift in the economy away from farming toward factory work and contemporary service jobs. During the 2000s, manufacturing jobs overall grew impressively by more than 10% each year and the growth was particularly strong in specific sectors in Vietnam: the clothing industry saw over 15% annual growth, while the computer and office equipment sector experienced an extraordinary 30% yearly increase (McCaig & Pavcnik, 2013). In addition, from the late 1980s, major changes occurred in the workforce distribution over the following twenty years. The proportion of people working in agriculture dropped by 20 percentage points yet, manufacturing jobs increased from 8% to 14% of total employment, and the service sector saw an even larger jump, growing from 19% to 32% of the workforce. Kang and Liu (2020) research on the structural change in Central Asian region shows that the industrial structure of Central Asian countries is evolving with service industries lead system, followed by manufacturing, and then agriculture (tertiary-secondary-primary pattern). Kazakhstan has maintained this service-led pattern for a long time, with its service sector becoming increasingly important. Uzbekistan has undergone a notable transition from having manufacturing as its leading sector at the time when the country gained independence from the Soviet Union, to services as the leading sector. Tajikistan has seen significant changes too, with its manufacturing sector declining while services grew rapidly. In Kyrgyzstan, while both manufacturing and service sectors have been unstable, the service industry has shown considerable improvement. Turkmenistan's agricultural and service sectors remain underdeveloped, and the economy is dominated by oil and gas, lacking diversity and sophistication. Overall, the study concludes that Central Asian economies remain heavily reliant on their energy sectors. (Kang & Liu, 2020).

In their research on Sub-Saharan Africa's economic development, Ajakaiye and Jerome (2014) point out that, except for Mauritius and South Africa, African nations remain stuck in primary production (like agriculture and raw materials). They explain that normal economic development usually involves moving away from primary production toward manufacturing activities. However, Africa's continued dependence on farming and raw material exports has held back its economic growth. They criticize that most policies have failed to address this needed economic transformation. The researchers emphasize that African countries need to industrialize and shift their economies to focus more on manufacturing and exporting finished goods rather than raw materials. Page (2012) argues that the secondary sector has the potential to be the cornerstone of Africa's economic transformation. He also explained that an agricultural transformation or agriculture-led industrialization would be helpful in the process of African industrialization. The study shows that African industry became smaller, less diverse, and less sophisticated between 1975 and 2005, highlighting the need for a clear industrialization plan. Jobe and Ricciuti (2023) explain that successful economic transformation typically involves workers moving from low-productivity farming to more productive manufacturing and service jobs. While Africa is making progress in this direction, they note that this change is happening very

slowly. Their research shows that Africa's economic growth now depends heavily on services, while manufacturing has remained a minor contributor for the past 30 years. Despite agriculture employing 51% of workers in 2018, both its economic value and share of employment have been declining, showing how the region's economic structure is changing. When looking at worker productivity, the service sector leads, followed by industry, while agriculture trails behind - even though it remains the biggest employer. Importantly, they note that Africa is seeing a strong shift toward informal service jobs, which typically offer low wages (Jobe & Ricciuti, 2023).

Aryeetey and Kanbur (2017) argue that moving workers from farming to other sectors is crucial for economic development and change. Looking at Ghana's economy since its independence, they found that agricultural employment has dropped significantly, decreasing by about 20 percentage points between 1960 and 2010 (Aryeetey & Kanbur, 2017). The industrial sector has had an uneven history. After a short period of success in the 1960s, Ghana's industrial sector, especially manufacturing, went through cycles of growth and decline. As a result, manufacturing's contribution to the economy fell to about half of what it was in 1970 (Aryeetey & Kanbur, 2017). While Ghana is considered an emerging market, it hasn't developed into an industrialized economy. However, the discovery of oil brought new optimism to Ghana's business sector. Oil exploration, combined with government policies, led to another shift away from agriculture. The industrial sector recovered strongly through the mid-1990s, followed by rapid growth in services during the 2000s, particularly in private banking, telecommunications, and public sector services. The authors found that in Ghana's urban areas, most jobs aren't in factories but in services (including finance, insurance, government administration, arts, entertainment, recreation, information, communications) and trade (Aryeetey & Kanbur, 2017). Many African countries have initiated policies and strategies aimed at boosting the secondary sector, recognizing its potential to drive economic growth, create jobs, and reduce dependency on primary sector however many challenges still need to be met. Regional integration and Global Value Chains are to be taken into consideration in order to overcome the market fragmentation and take advantage of the economies of scale.

2.2 Data and Methodology

This study uses data from World Development Indicators (WDI). WDI is the World Bank's main database of development statistics. It draws from official international sources to provide up-to-date and reliable data on global development, including measurements at national, regional, and worldwide levels. The data ranges from the year 1990 to 2022, for all the African countries. One key strength of this database is that it covers the employment shares at the sectoral level. Industrial structure is usually measured using the number of employees, production value, income, etc., however the number of employees is the most used variable by researchers when analyzing employment data. We proceeded the analyses using triangle plots and linear graphs for a clear description and visualization.

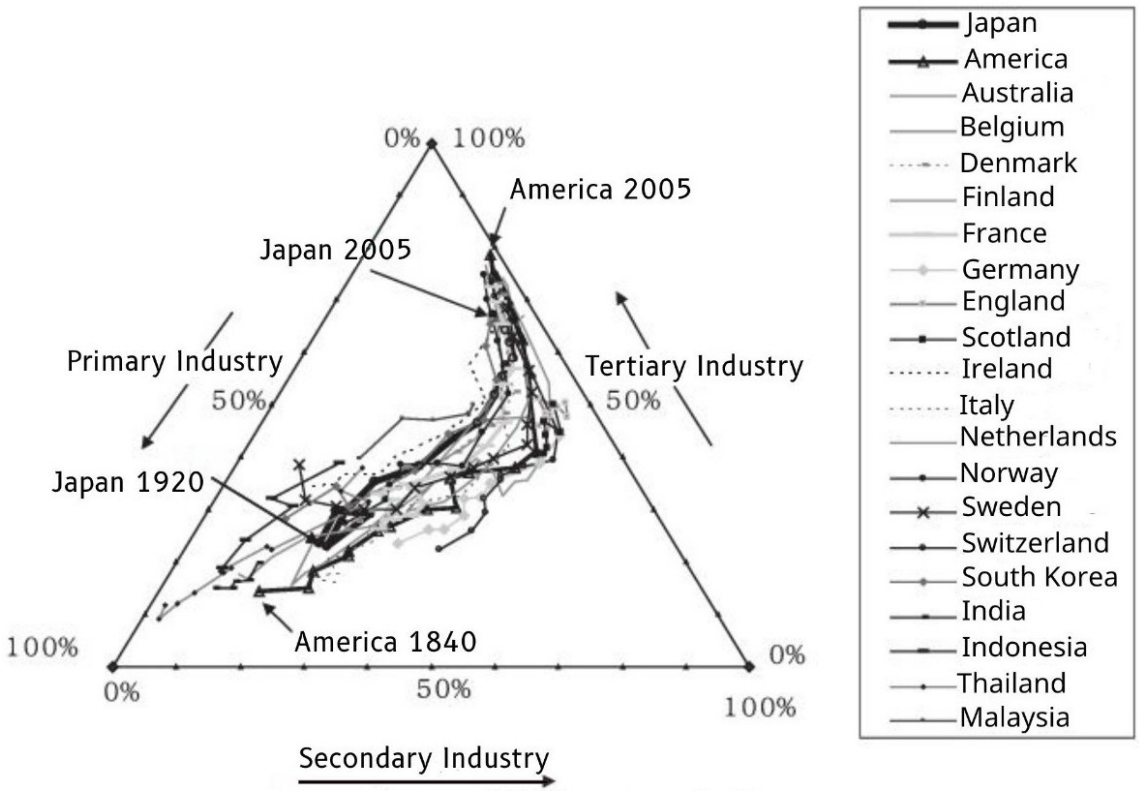


Figure 2.3: Patterns of change in industrial structure (21 countries)
Source: Yoshimura (2008)

2.3 Triangle Plots

Trilinear diagrams such as Triangle plots or ternary diagrams are graphical representations to analyze and visualize data with three dimensions. The data components on a ternary diagram must be normalized to 100 % to perform the analysis. Hence, it applies within the framework of the three-sector economic structure, comprising the primary, secondary, and tertiary sectors that together form a constant.

Yoshimura (2008) in his study of the Global Standard Patterns of industrial structural change found a clear similarity in the pattern of the economic structural shift moving from the primary sector to the secondary and then to the tertiary. Figure 2.3 shows that the patterns of change in industrial structure in each country have almost the same trends in each country. The primary industry decreases year by year, and the reverse occurs. The common trends seen in the changes in industrial structure of each country are referred to as the "global standard pattern of changes in industrial structure".

2.4 Results

Building on the same logic as Yoshimura (2008), we try to comprehend the pattern of industrial structure change in Africa compiling the industrial structure of countries with similar trends in a same triangle. The results of this study shows that the evolution of the industrial structure in African countries has various trends that were classified into 4

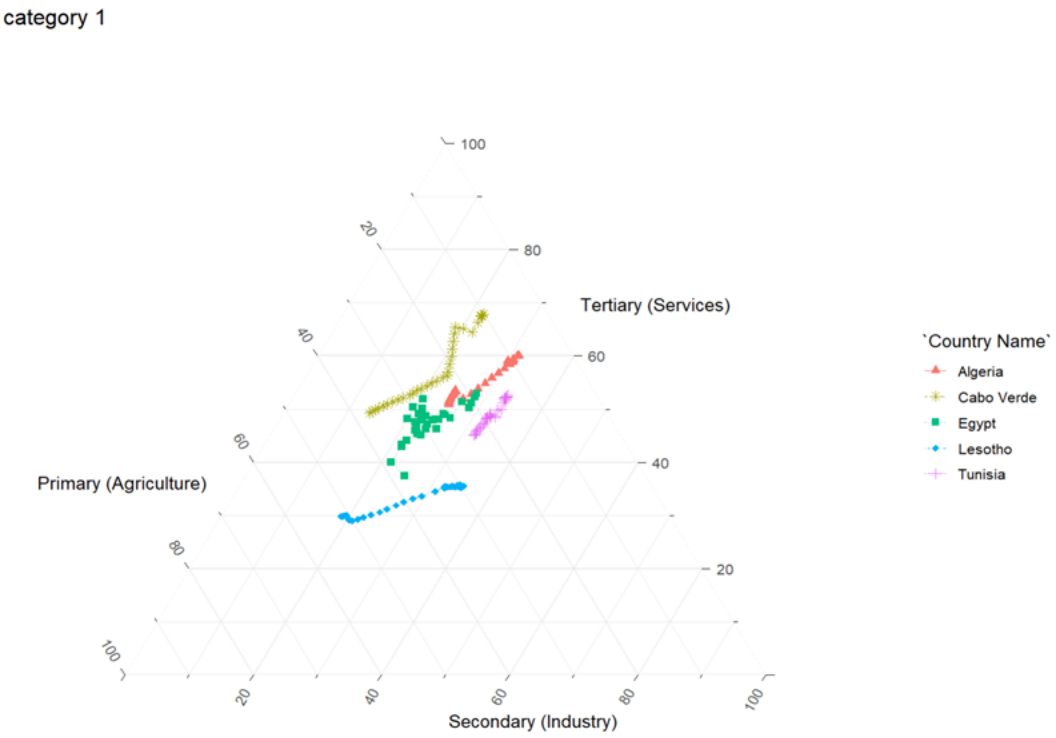


Figure 2.4: Industrializing Countries in Africa
Source: By authors based on World Bank Database

categories. In Africa, the pattern of industrial economic structure appears to be different from that of the "global standard pattern of changes". African countries object the 'one size fits all' concept having a varied and unique trend. We show the changes in industrial structure for African countries, broken down into four categories as developed below.

2.4.1 African Industrializing Countries

This category includes countries in Africa that have experienced an increase in employment in their secondary sector. Figure 2.4 shows 5 African countries whose dependence on agriculture is steadily decreasing while the industry is rising along with the service sector. Although these countries have the highest percentage for the secondary sector share of employment in Africa, the service sector employment share is the most dominant. Lesotho has the highest share in industry employment followed by Tunisia and Algeria, hovering above 30%(See also Appendix A.1). Lesotho has the highest share of employment in the secondary sector which is almost equal to the tertiary employment share. The industrial sector of the country is dominated by the labor-intensive textile sector. (See also Appendix A.1). Tunisia and Egypt's manufacturing development will be more deeply studied in Chapter 3.

2.4.2 De-industrializing Countries in Africa

This category includes countries that have regressed as far as the secondary sector's employment share is concerned. Figure 2.5 presents a set of eight African countries which

all are experiencing some decline in the employment of the industry sector. South Sudan is the most dependent on the primary sector in this category with its employment share in the sector hanging above 60% while slowly decreasing over the period 1991 to 2022. Comoros and Congo Republic have seen their service sector grow steadily while the primary sector went downward below 35%. The other countries in this category experienced tertiarization as well, and the primary sector continued to decrease along with the secondary sector. Botswana's pattern is quite unsteady over the years. Although the tertiary sector has been increasing both the primary and secondary sectors remained quite low and decreasing. Actually, the industrial sector has declined from over 25% to about 15% from 1991 to 2021. South African employment share of the industry has had a 10% drop over the past 20 years and therefore fits in this category. However, South Africa is known to have a developed manufacturing sector with industries such as automotive, steel, and machinery. Such sectors are technology-intensive, and the low employment rate might have other implications to be explored. In this category, Mauritius has had the most drastic decline in the employment share of the secondary sector decreasing from 40% to 20% over 1991 to 2022. (See also Appendix A.2). The Mauritius and South African cases are studied in more detail in the next chapter.

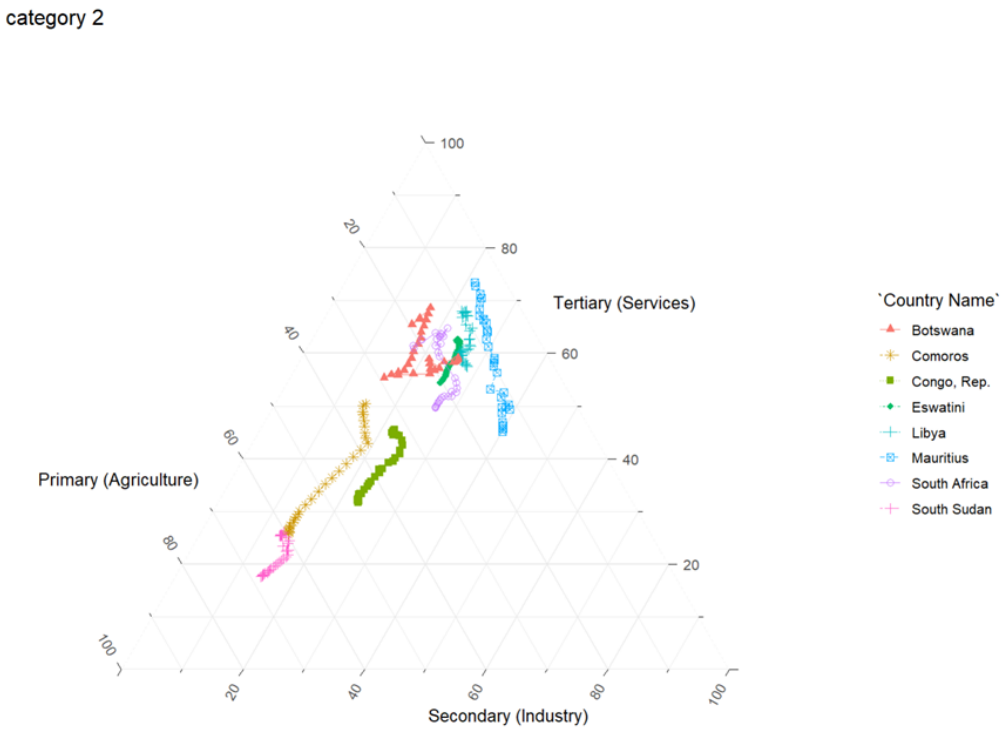


Figure 2.5: De-industrializing Countries in Africa
Source: By authors based on World Bank Database

2.4.3 Slowly Industrializing Countries

This group comprises countries that have moderately increased the employment share of their secondary sector and mostly have above or around 15%; The countries from

Figure 2.6 include the countries that are getting less dependent on agriculture while slowly industrializing with the tertiary sector as highest for most countries. This is the second most dominant pattern in Africa and around 17 countries align with it as shown in Figure 2.6. Only Zimbabwe, Equatorial Guinea and Rwanda keep a high share of employment in the primary sector above 50% (see also Appendix A.3). Equatorial Guinea is one of the largest oil producers in Africa while Zimbabwe is rich in mineral resources including gold, coal, diamond, etc; and Rwanda rather relies on Agriculture (including livestock and forestry). Countries such as Benin, Senegal, Morocco, Kenya, and Nigeria also belong to this category. Benin has long held the highest share of employment in the industry sector especially in West Africa before being surpassed around 2021 by Senegal (see Appendix A.5). Senegal's industry share of employment is rapidly increasing and has surpassed the employment share of the primary sector in 2021. Moroccan employment share of the secondary sector is the lowest of the three sectors but steadily increasing and above 20%. The Kenyan and Nigerian patterns look similar with the employment share around 15%, below 40%, and around 50%, respectively, for the secondary, primary and tertiary sectors. Though the data look similar, Nigeria is a natural-resource-rich country heavily dependent on oil and gas while Kenya is rather more agricultural oriented with a large production of tea and coffee. Each of these 5 countries will be deeply analyzed in the following chapter.

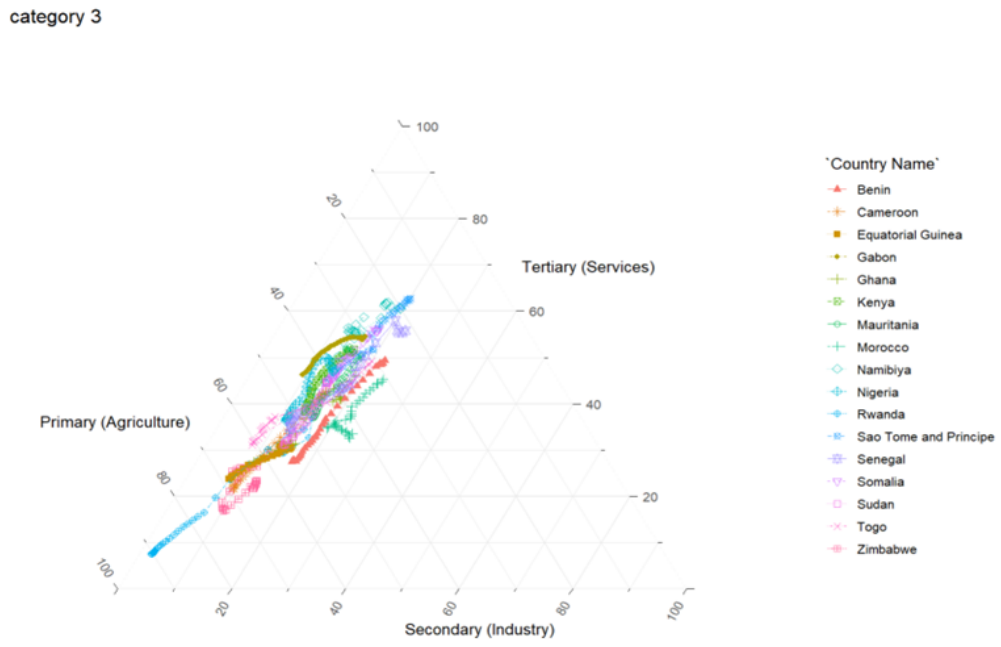


Figure 2.6: Slowly Industrializing Countries in Africa
Source: By authors based on World Bank Database

2.4.4 Least Industrializing Countries

This category covers countries with a very low and almost stagnant share of employment in the secondary sector. The countries here show a heavy dependence on the primary sector which is reducing over the years as the tertiary sector surges. The

secondary sector on the other hand remains low ranging between 1% to 10%. Figure 2.7 includes 21 countries with an upward trend almost parallel to the primary sector line.

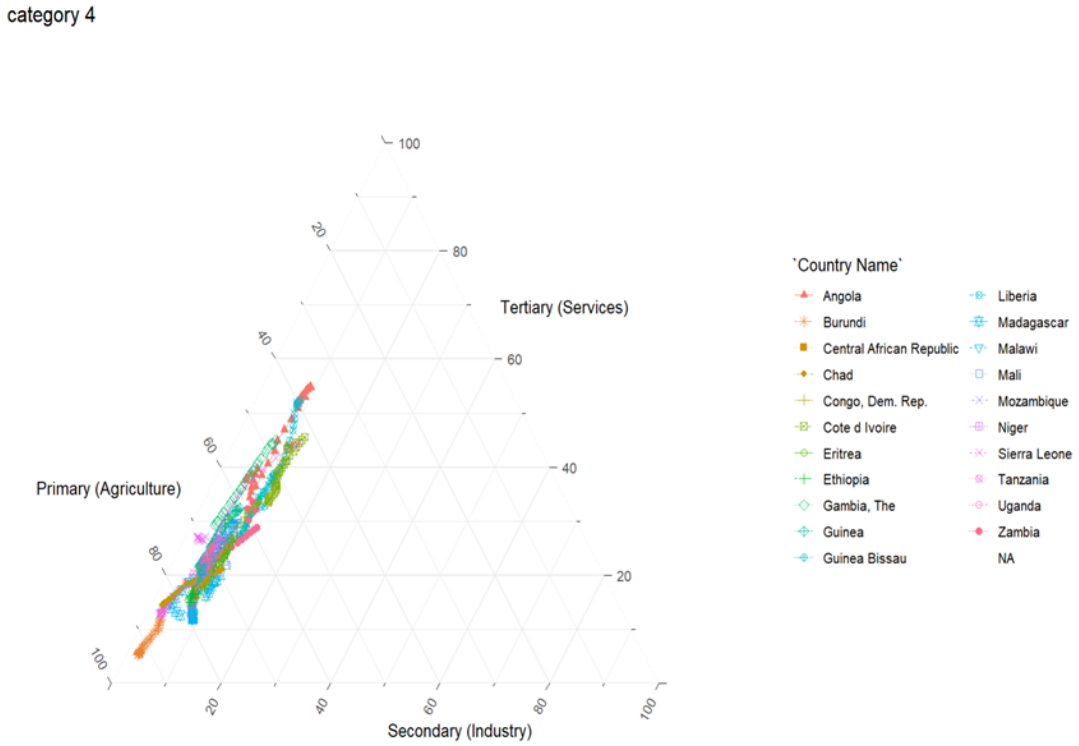


Figure 2.7: Least Industrializing Countries

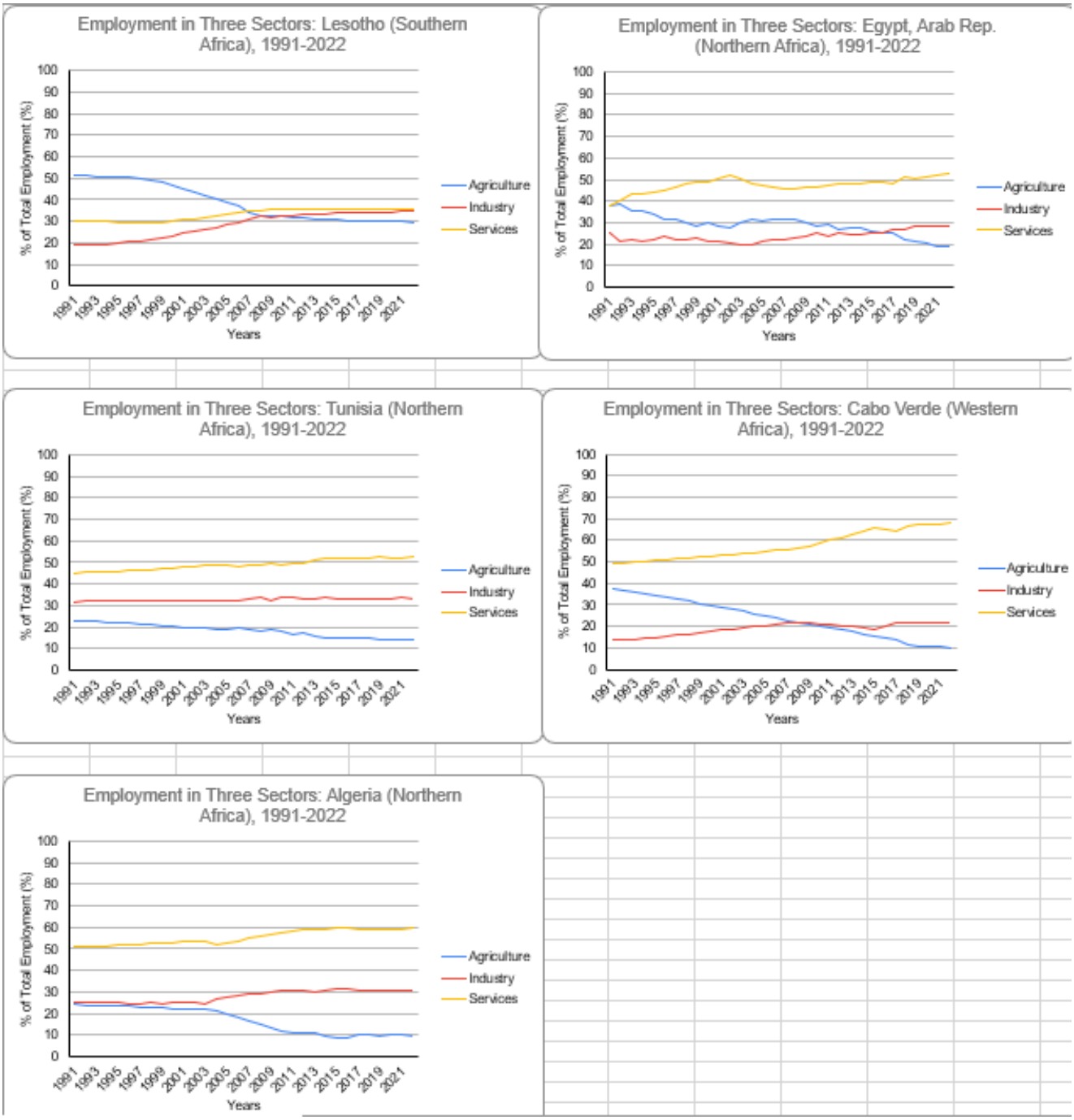
The patterns in Figures 2.6 and 2.7 are similar and can be described as typical to African countries with more than 2/3 of the countries falling under this upward oblique trend. In 8 countries, industry employment is on a decreasing trend symbolizing a deindustrialization. All the deindustrializing countries have the tertiary sector as most dominant except for South Sudan which still has more than 60% share to the primary sector employment. The country heavily depends on agriculture and oil while the industry sector remains very low and the tertiary sector recording some moderate rise. From a descriptive analysis of the triangle graphs based on the employment data, among the 5 industrializing countries, Lesotho, Tunisia, and Algeria are the top countries with the highest employment share of the industry sector surpassing or hovering about 30%. When we compare the African countries' trends to the global pattern, we could notice that all of the African countries are yet to reach full maturity of industrialization but already are going through the tertiarization process. More than half of the countries studied have the service as their highest share. Over 20 countries still depend on the primary sector. Among these countries about 15 have their primary share above 60%. Although the primary sector is dominant in more than 20 countries, it is rapidly shrinking in more than 30 countries. The industrial sector is showing a growth trend in most countries, particularly accounting for over 20% in about 10 countries, but in around 20 countries, it remains below 10% with no growth.The service sector has experienced rapid growth, inversely proportional to the

agricultural sector, accounting for 50% or more in over 10 countries. The tertiarization is connected to urbanization with the high demand in services including finance, healthcare, education, and trade. Comparing the global standard to the African pattern, we see a striking difference. None of the 4 categories identified in this study fit the global standard. Only the Mauritius section looks like the ending portion of the global standard symbolizing deindustrialization. In contrast to the global standard, most African countries' trend looks like an oblique line, symbolizing that African countries have not significantly developed the secondary sector yet have increased their African countries share of the tertiary sector

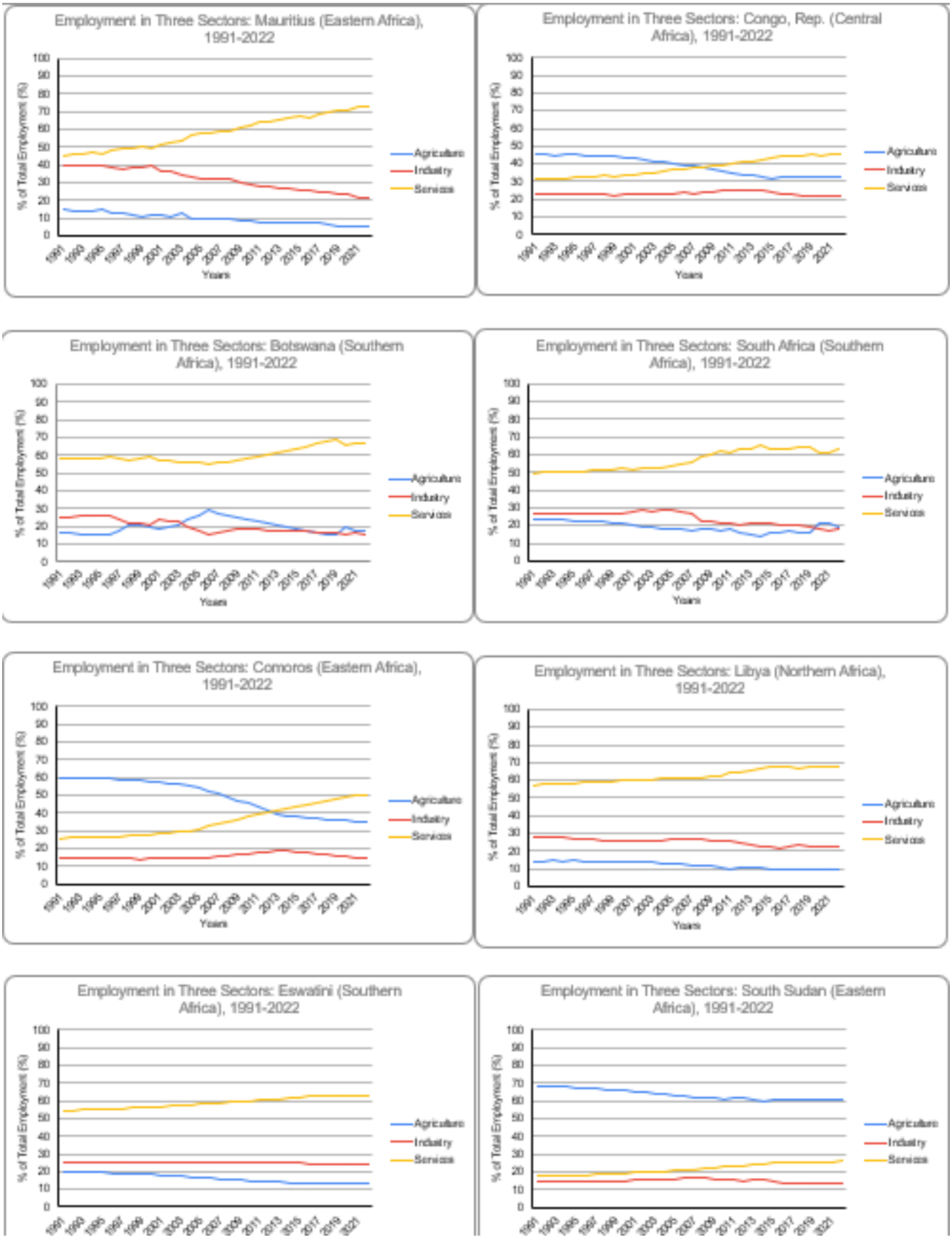
2.5 Conclusion

This study attempted to complement the dearth in knowledge on the economic structure applying the three-sector model to identify the pattern of structural transformation in African countries. It has been demonstrated from previous literature that successful structural transformation is often associated with decreasing productivity in agriculture and increasing one in industry and service. A global pattern was developed in this context. However, African countries do not fit in the global pattern as African countries had a different experience of industrialization with unique and varied features. 52 African countries were classified into 4 categories such as industrializing, de-industrializing, slowly industrializing, and least industrializing. The least industrializing category is the most dominant with 21 countries that mostly depend on the primary sector which is nonetheless on a downward trend except for Angola as the country still heavily relies on natural resources. The industrial sector for these countries is around or below 10%. The slowly industrializing category (17 countries) is the second dominant category with a similar trend to the prior but with less dependency on the primary sector and a significant rise of the tertiary sector. The secondary sector in this category is above 15% for most countries and on a steady moderate rise. 8 countries were identified as de-industrializing as the secondary sector employment share declined over the period. 5 countries have experienced significant progress in the secondary sector forming the industrializing category. These countries also have an important share of the tertiary sector which remains the most dominant. Lesotho is the only country that has almost the same share of industry and service employment. This study reveals that African countries' economic sectors are heavily dependent on either the primary or the tertiary sector while the industrial sector is slowly increasing for most countries. The primary sector in Africa includes natural resources and agriculture. Several African countries are rich in minerals (including gold, diamond,copper, coal etc), oil and gas; and in agricultural goods (coffee, cocoa, cotton, timber, fisheries, etc). The primary sector therefore constitutes the main source of supply in minerals, food and beverages which are the raw materials used by the industrial sector. Over 20 countries depend on the primary sector in Africa, but this study also shows that the sector is on a decreasing path for all the countries except for Angola. The literature review shows that a shift from the primary sector towards the non-agricultural field is an indicator of growth. Although many African countries have shifted from the primary sector to the tertiary, their growth remains a challenge as the secondary sector remains low. Only 5 countries had their secondary sector expanding with a significantly high share as well. The primary sector is important for the economy in Africa however, countries should not solely depend on the primary sector. In the following chapter, we focus on a few countries from the different categories identified in this chapter to review in more detail their manufacturing structure and development.

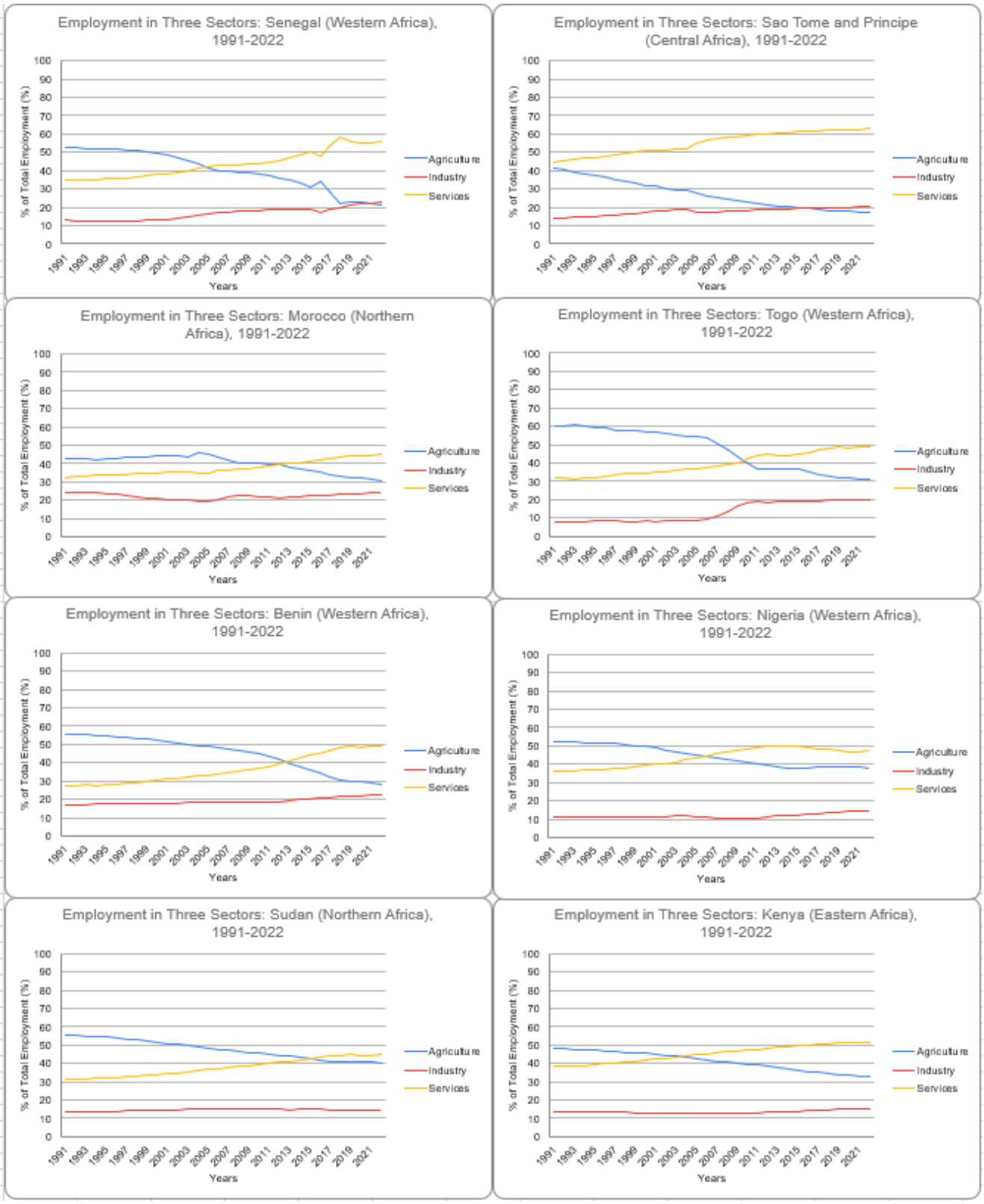
Appendix A



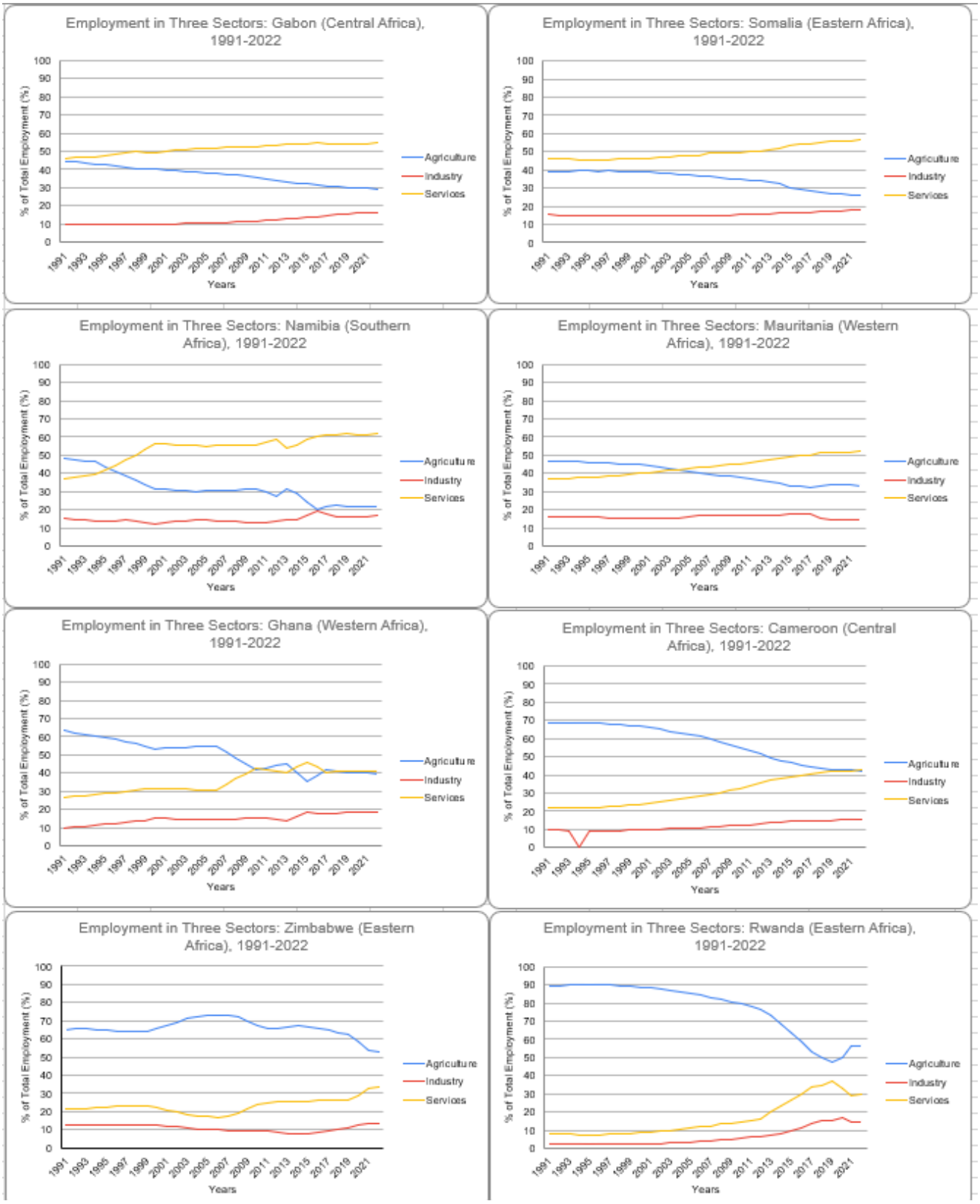
Appendix A.1: Linear Graph of African Industrializing Countries



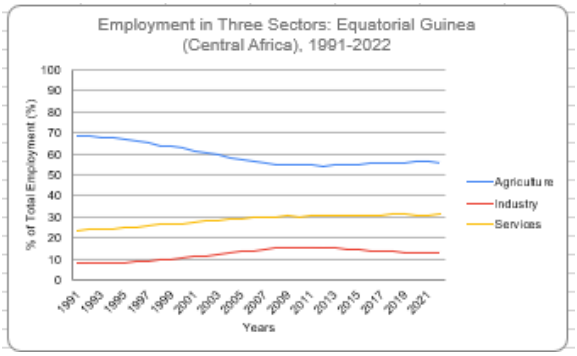
Appendix A.2: Linear Graph of African de-industrializing Countries



Appendix A.3: Linear Graph of African Slowly Industrializing Countries(Part1/3)



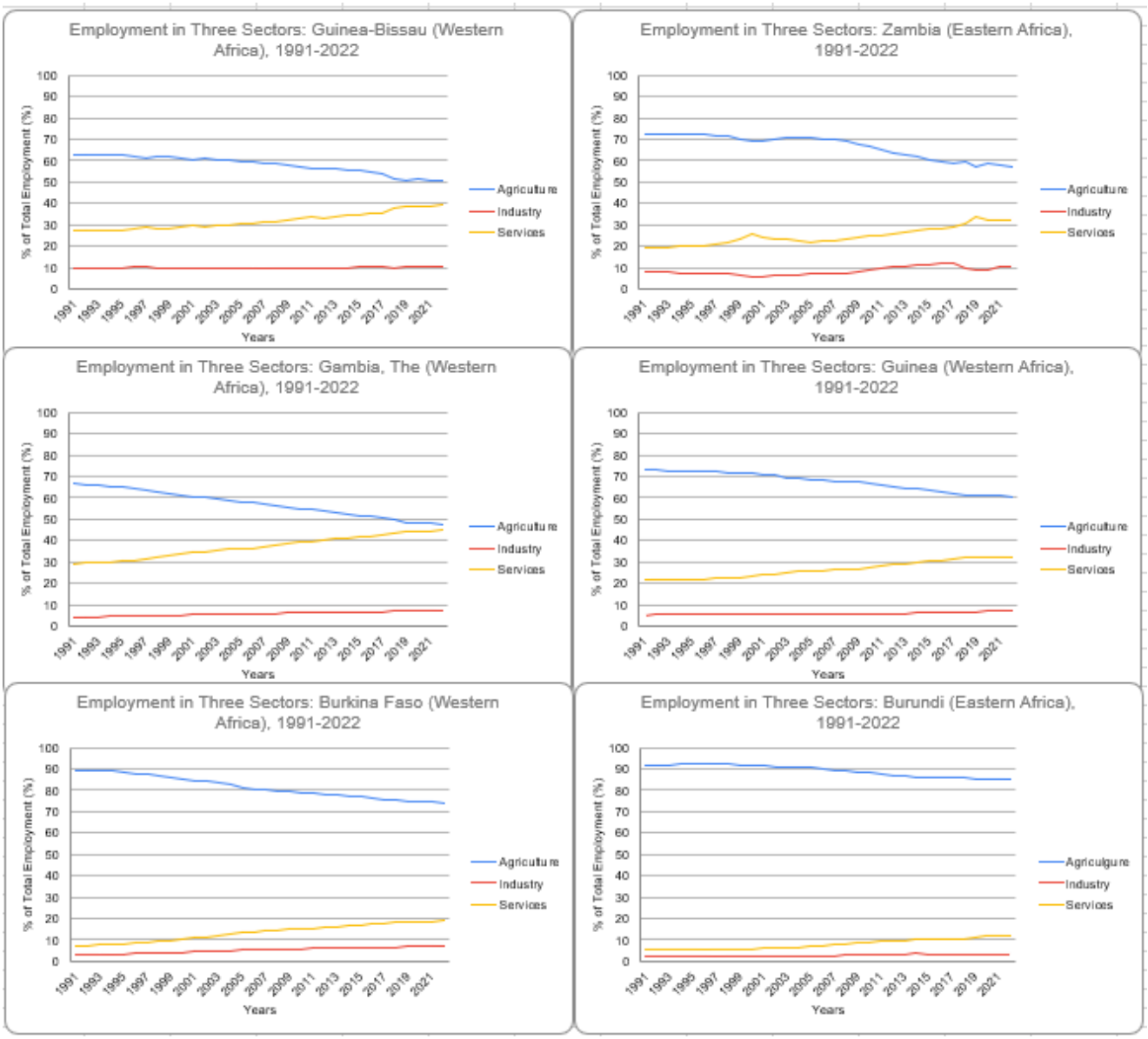
Appendix A.3: Linear Graph of African Slowly Industrializing Countries(Part2/3)



Appendix A.3: Linear Graph of African Slowly Industrializing Countries(Part3/3)

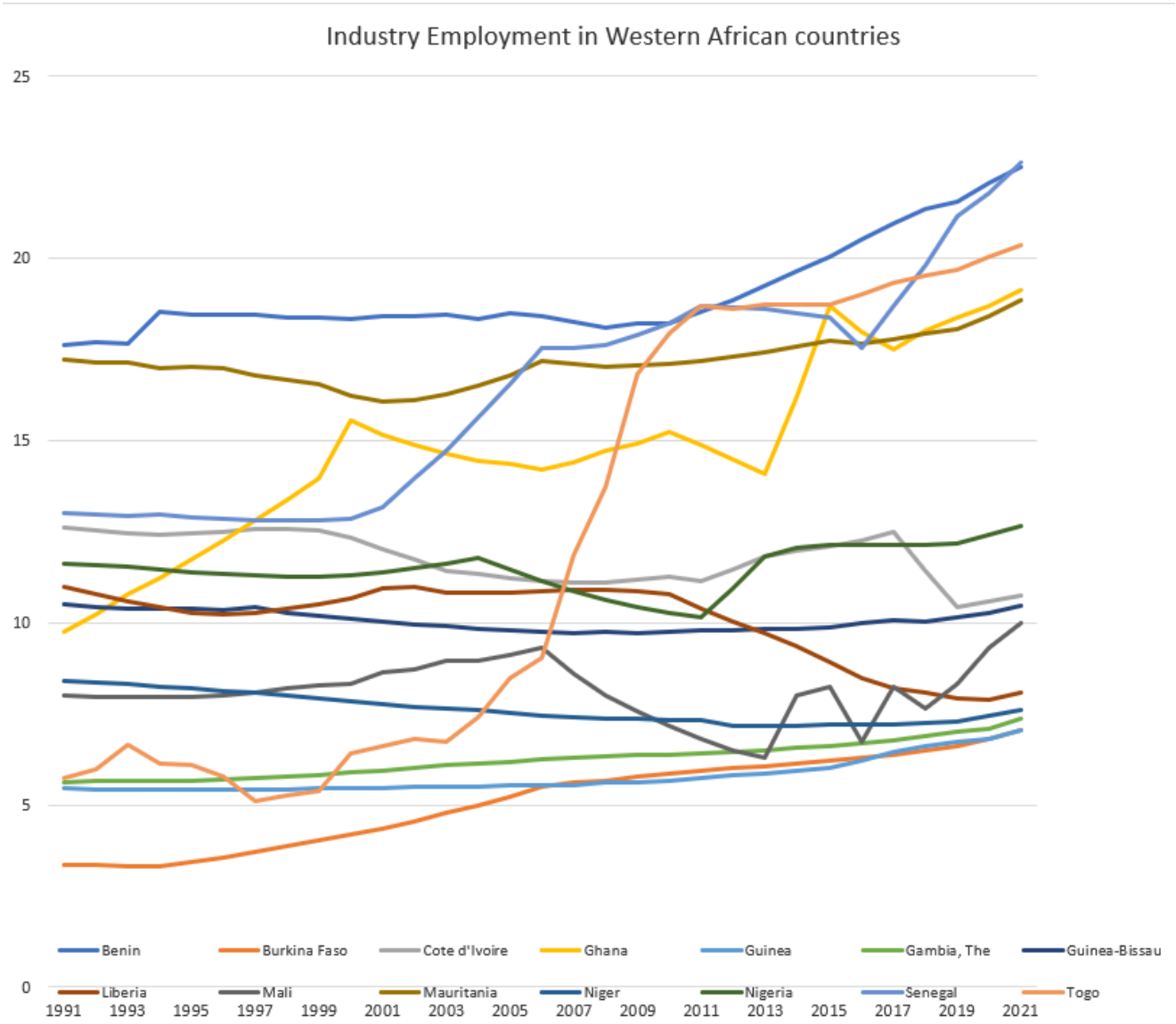
Appendix A.3: Linear Graph of African Least Industrializing Countries(Part1/3)

Appendix A.4: Linear Graph of African Least Industrializing Countries(Part2/3)



Appendix A.4: Linear Graph of African Least Industrializing Countries(Part3/3)

Source: World Bank database



Appendix A.5: Industry Employment in Western African Countries
Source: World Bank database

Chapter 3

Development of Industrial Sectors in 9 African Countries (1963-2021)

3.0 Introduction

Industrialization occurred with a deep transformation in how goods were produced and significantly transformed economic, social, and cultural conditions. Industries developed with new technological innovations such as new machinery and manufacturing processes including the steam engine, mechanized textile, iron smelting, and the power loom which revolutionized production. Significant investments in infrastructure, including railways, canals, and later, electric power grids, facilitated the expansion of industrial activities. Africa is one of the least industrialized continents in the world and only a few studies deeply focus on the question of the manufacturing development of African countries. African nations are as varied as their experience of industrialization and although some similarities can be seen, we cannot generalize the question of industrialization in Africa in a homogeneous way. We concluded from the previous chapter that the primary sector is crucial in the manufacturing industry across Africa, especially for the provision of raw materials. Globally, the first industrial revolution was preceded by an agricultural revolution, however, no industrial revolution in economic history has been associated with a focus on food and beverages. This case study challenges the orthodox belief that the first industrialization was a revolution in coal and textile; the second, a revolution in steel production and electricity invention and the third one, automation development. We examine the industrial performances of 9 of Africa's emerging manufacturing economies from the different regions in Africa during the contemporary period. The countries studied were chosen from 3 categories of the previous study: industrializing, de-industrializing and slowly industrializing. The least-industrializing countries were left out due their weak secondary sector share in the industrial structure. We identified the main driving sectors of manufacturing shaping the industrialization path and the determining factors of industrialization in Africa from 1960 to 2022. This study aims to provide an overview of the evolution of the African manufacturing industry as a whole over the past fifty years, and of the larger forces which have resulted in changes in its growth and sectoral structure. Details of the development of particular manufacturing sectors, such as textiles and wearing apparel, food beverages, chemicals, or motor vehicle industry, are also discussed.

3.1 Literature Review

Kaldor (1966) refers to economic principles that highlight the important role of the manufacturing sector in driving economic growth. He posits three laws in this way; the first law states that there is a positive relationship between manufacturing growth and output growth in an economy. According to this law, manufacturing is a long-term economic growth engine. The second law also known as the Verdoorn's Law states that productivity growth is identified by static and dynamic returns to scale with manufacturing growth. This means that there is a positive correlation between the growth of output in manufacturing and the growth of productivity in manufacturing. Finally, Kaldor's third law suggests that non-industrial productivity growth and growth in the manufacturing sector positively affect each other (Kaldor, 1966,Verdoorn, 1980). This imply that manufacturing leads to faster growth in other sectors, especially due to the demand for services and raw materials used for manufacturing processes. According to Kaldor, countries with a strong manufacturing base have higher possibilities to achieve sustained economic development. These laws were first used in 1966 by Kaldor to explain the poorly performing British economy in a lecture. Since then, many countries have tested the laws to explain economic growth. Exporting manufactures has been considered as a barometer of national prosperity in different studies.

On the other hand, some authors and scholars have argued that manufacturing is not the only driver of economic growth, and that other sectors can also contribute to increasing productivity. Dani Rodrik (2016) discusses the idea that structural changes in the global economy from 1980 onwards included high rates in sector involving services. In addition, Robert Lucas (2002) has pointed out the importance of human capital in driving economic growth, suggesting that sectors like education and services can be just as important as manufacturing. Some findings by Szirmai and Verspagen (2015) show that the manufacturing sector might not be the most important sector influencing economic growth. Some resource-rich countries in the Middle-East have advanced economy due to the abundance of their mineral resources. Yet, it has also been argued that it may be comparatively more difficult for resource-rich countries to industrialize today than under circumstances resembling those of the 1870-1914 period (Findlay et al., 2017).

Other important facts to point out regarding African manufacturing is the striking difference between the development of the Northern part compared to Sub-Saharan Africa. This difference has often been credited to the close proximity of the North African countries to the Mediterranean region and Europe (Del Prete et al., 2018).

3.2 Data and Methodology

For this study, we used data from UNIDO, World Bank, International Trade Center Database. The UNIDO Industrial Statistics (INDSTAT) Revision 3 Database was mainly employed in the course of our analysis. The database which is of official statistics is organized according to the International Standard Industrial Classification of All Economic Activities (ISIC). INDSTAT Revision 3 contains data that UNIDO collects directly from

national and regional statistical offices, national data suppliers as well as other official sources. It covers the three industrial sectors according to ISIC Revision 3 but we mainly focus on manufacturing (ISIC Rev. 3 Section D); Main indicators of industrial statistics including employment and value-added were exploited in the analysis through the diagram's graphs. We used the WorldBank database mainly to generate some illustration on the manufacture exports. The International Trade Center database was exploited to provide some details on the exports of the countries.

The study focuses on 9 African countries derived from the industrializing, de-industrializing and slowly-industrializing countries category defined in Chapter 2. Tunisia and Egypt represent the industrializing countries category; South Africa and Mauritius are part of the de-industrializing countries and for the slowly-industrializing countries, Morocco, Senegal, Nigeria, Kenya and Benin have been considered. In addition, all the countries selected except for Benin are the top African Industrial Index (AII) countries explained in Chapter 1. Although Benin is not included, the country has recorded the highest industry employment share in the West-African region from 1991 to 2020 (See Appendix A.6). Our country selection is representative of all the regions in Africa (North, South, East and West) which gives an overall look of the situation of industrialization and manufacturing development on the continent. Although few African countries have had a certain level of industrialization experience even before 1960, this research focuses on the period after 1960 as regarding to the availability to more accurate data and in view to complement the existing literature. Relevant and consistent data on the manufacturing structure before 1960 in Africa seem hard to access. This study therefore specifically focuses on the period from 1963 to 2022.

3.3 Results

From the UNIDO database, there are several manufacturing sub-sectors but we made an original classification grouping the subsectors for the purpose of our analysis in this chapter. The grouping made is considered from the least to the most industrial sector.

- Strictly non-durable consumer goods: Food Beverages (FB) and Tobacco (To)

This group includes essentially goods of a short lifespan such as Food, Beverages and Tobacco which require less capital or technology compared to the other groups. Food processing and beverage production are quite predominant in Africa mainly due to the abundance of agricultural resources and they usually serve mainly to the local population but in some countries, they constitute the main export product.

- Non-durable consumer goods: Textiles (Te), Apparel Industry (AI) and Wood Products (WP)

This category refers to the production of items made from soft materials such as textiles, fabrics, leather, fur, clothing, footwear, bedding, upholstery, bags, accessories, and other pliable substances. Wood-based materials such as lumber, plywood, paper, and wood pulp are also included. This sector is considered as a light-industry as it is less capital-intensive and rather labor-intensive.

- Producer goods: Coke, refined petroleum products, nuclear fuel (CRPPNF); Chemicals and chemical products (CCP); Rubber and plastics products (RPP); Non-metallic mineral products (NMMP) and Basic metals (BM).

The Producer goods category involves primary extractive or commodity manufacturing with the processing of raw materials into intermediate or final products. This category is highly dependent on the availability of natural resources.They are capital-intensive and technologically intensive and considered to be heavy-industry.

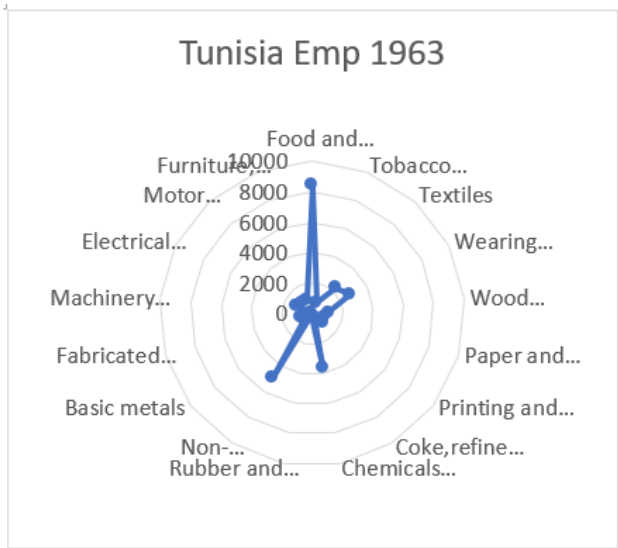
- Industrial Manufacturing/ Durable consumer goods: Motor vehicles, trailers, semi-trailers (MVTST); Machinery and equipment n.e.c (ME)

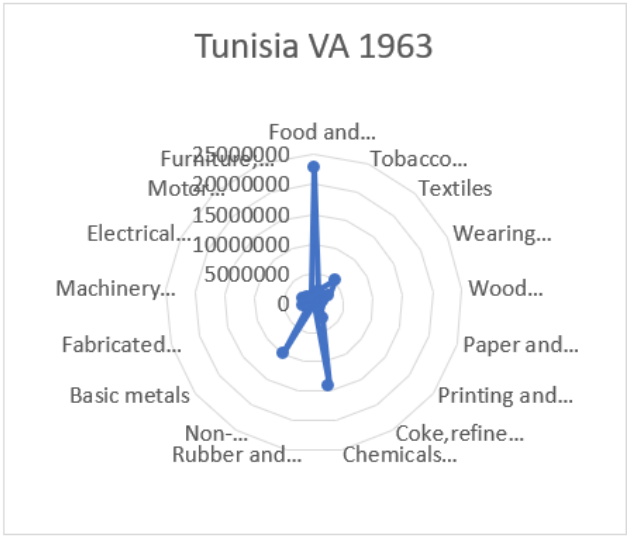
The industrial manufacturing category combines the most capital-intensive and technological intensive sectors. It includes industries that require a certain advanced level of industrialization.

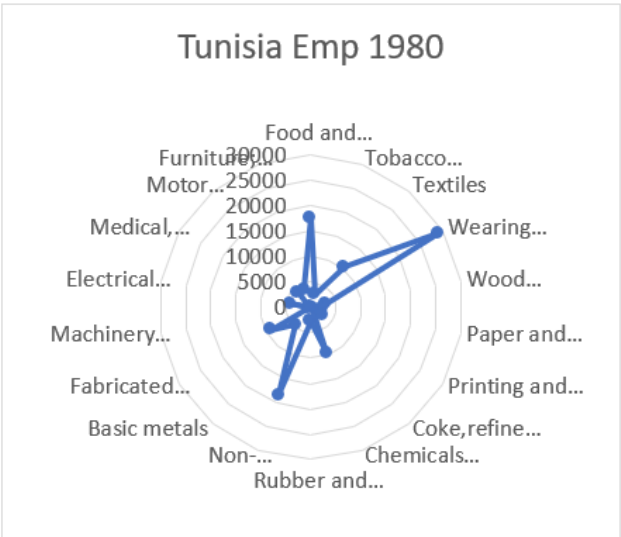
3.3.1 Industrializing Country: Tunisia

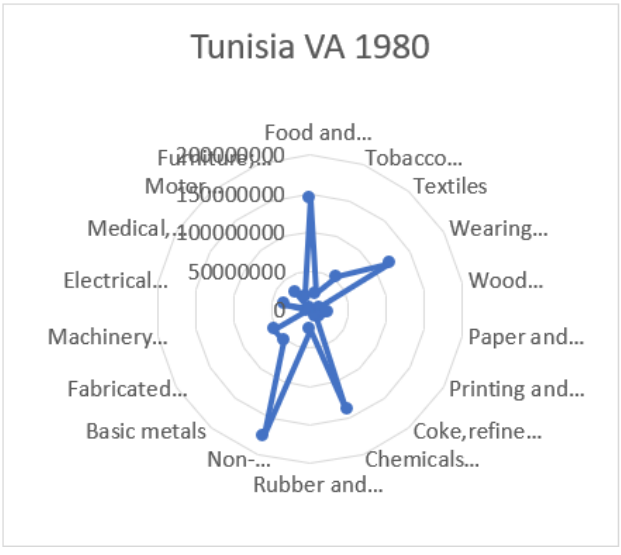
Following its independence from France in 1956, the Tunisian government adopted policies aimed at promoting economic development and industrial growth and the 1960s marked the initial phase of industrialization, characterized by state-led initiatives and the establishment of industrial zones. Tunisian manufacturing industry in 1960-1970 was mainly led by the producer goods category, which had the highest employment and value-added (VA) figures. The nonmetallic mineral products sector and the chemical and chemical product sector were central to the manufacturing (Figure 3.1), as the country is rich in natural resources including phosphate, limestone, and clay. The strictly non-durable consumer goods constituted the second main and most important manufacturing sector leading the industrialization. However, around the 1980s onward, the food and beverage (strictly non-durable consumer goods) sector has become less significant (Figure 3.1). In 1980, although the value added of producer goods was still the highest, the employment of the textile, apparel and wood products increased the most (Figure 3.1). This shows the engagement of the country to not only rely on the natural resources but also to make some transformation and experience the active industrialization. Around 2000, the textiles, apparel industry and wood products manufacturing industry increasingly gained importance becoming the first leading sector of manufacturing both from the employment and Value-Added perspective and followed by food and beverages sector. Employment in electrical machinery and apparatus was also quite high though the VA added is not as high compared to other sectors from the producer's goods such as chemical and non mineral metallic products. In 2021, although the sector still employs the highest number of employees its value added lagged behind the strictly non-durable consumer goods sector. The value-added of non-metallic mineral products and chemical were also significant from the producer goods manufacturing. Employment in electrical machinery and apparatus increased demarking Tunisia which invested and made significant efforts for its industrial manufacturing sector. In summary, around 1963, Tunisia had its first wave of industrialization focusing on Producer goods sector making use of its natural resource

reserve but about 20 years later, diversify to investing in the non-durable consumer goods especially Textiles realizing the second industrialization. During this period, the Producer Good sector was still significant (Appendix B.1). From 2000, the country began exploring the industrial manufacturing sector expanding on electrical machinery and automotive development in 2021 marking the beginning of a possible third wave of industrialization (Check also Appendix B.2 and Appendix B.3). The case of Tunisia can be seen as a successful industrialization path as the country did not not only content with the extraction and manufacturing of primary resources but also engaged in developing the other sectors of manufacturing. This confirms the results from chapter 2 identifying the country as an industrializing one.









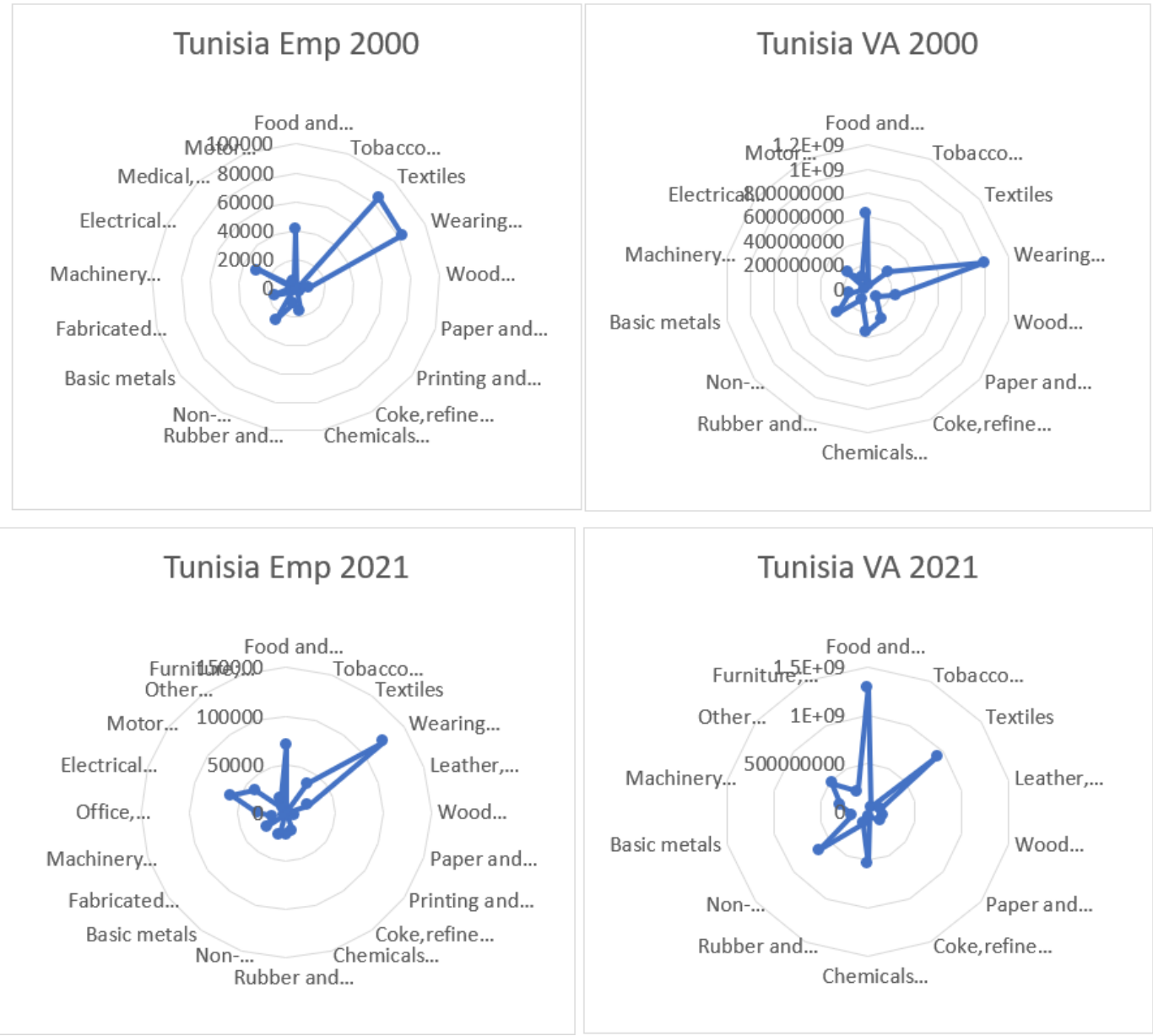


Figure 3.1: Radar Graphs of Tunisia Employment and Value-added from 1963 to 2021
Source: By authors based on UNIDO Database

The manufacturing production is mainly directed toward exporting to Europe and manufacturing exports account for about 80% of total exports in 2022 (Figure 3.2). Tunisia relies more on its manufacturing industry for export as the country has limited natural resources in oil or natural gas compared to its neighboring countries.

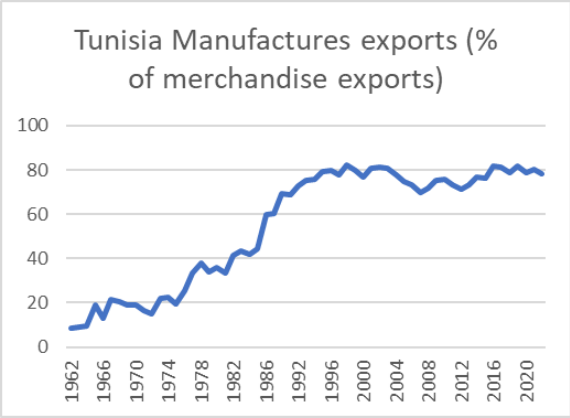
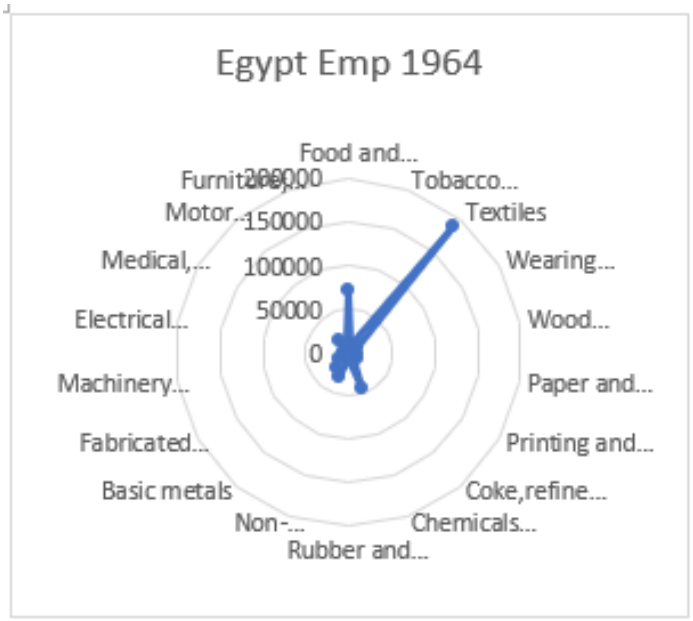


Figure 3.2: Tunisian Manufactures exports (%of merchandise exports)
Source: WorldBank Database

3.3.2 Industrializing Country: Egypt

Egypt is the only African country to have had an industrialization experience dating back to the early 19th century with Muhammad Ali Pasha who made important efforts to modernize the country (Cameron, 1993). After some decades, the attempts to modernize Egypt failed by the late 19th century with the British occupation and other factors. The country rekindled its industrialization journey again after independence in the mid-20th century. Through 1964-1980 from Figure 3.3, the textiles and apparel industry was the main leading sector of manufacturing. Egypt has a long history of textile manufacturing, and under President Gamal Abdel Nasser, the government invested heavily in modernizing and building new textile factories in accordance with the state-led industrialization strategy. The textile industry remained a pillar of the Egyptian manufacturing sector from 1960 to 1980 with a high export capacity. Although its employment share was still the highest, the textiles and apparel industry value added has been decreasing since 2000. From Figure 3.3 in 2000, employment in textile (272,170) and food-beverages (234,612) was highest followed by chemical (97,855) and non-metallic mineral products (91,756); However, the value-added was highest respectively for the sector of Chemical and chemical products, food-beverages, textile, and non-metallic mineral products. The high value-added of Chemical and chemical products could be as a result of the sector being capital-intensive and relying more on machinery rather than labor-intensive. In 2019 (Figure 3.3) the highest employment was for food-beverages, followed by wearing apparel fur and textile, then chemical and non-metallic mineral products. Although the Coke, refined petroleum products, and nuclear fuel sector had only 36,421 employments, it yielded the highest VA of more than 9 billions (US). Followed by Food and Beverages (8 billions) and chemical (5 billions). The Value Added of Textile manufacturing in Egypt was very low in 2019 and this might equally lead to a drop in employment and investment in the sector in the future. In Egypt, the strictly non-durable sector kept the position of the second most important manufacturing sector group with impressive growth over the years. The Producer goods manufacturing was very low until around 2000 when the

chemical's value-added yielded the highest figure and continuing to 2019 with the coke, refined petroleum products, and nuclear fuel sector which had the highest value-added as well. The producer goods sector became very important to industrialization in the late 20th century however, the employment by the producer goods manufacturing sector is not very significant which could be explained by the advanced mineral processing technologies and automation employed by mine multinationals. Egypt had begun to develop its chemical and petrochemical industries by the mid-20th century producing fertilizers, basic chemicals, plastics, and pharmaceuticals. Basic metal manufacturing, such as steel production and metal fabrication, was also important to the industry. In summary, Egypt's first industrialization after independence focused on the non-durable goods especially textiles and around 2000, the country experienced its second wave of industrialization characterized by a shift from the textiles to the producer goods especially chemical sector and the coke, refined petroleum products, nuclear fuel sector (check also Appendix B.1). The main companies of the sector included the Egyptian General Petroleum Corporation (EGPC), the Middle East Oil Refinery (MIDOR), the Alexandria National Refining and Petrochemicals Company (ANRPC) and the Suez Oil Processing Company (SOPC). The industrial manufacturing sector remained very low in Egypt. We can therefore conclude that after independence, Egypt had its first wave of industrialization around 1964 characterized by the non-durable goods sector, especially textiles. As competition began to increase, the sector's value added started decreasing and from 2000, the country turned to focusing on developing the Producer goods manufacturing realizing its second industrialization. In our study, Egypt is also considered as a successful case of industrialization experience in Africa which confirms the results from chapter 2 identifying the country as an industrializing one.



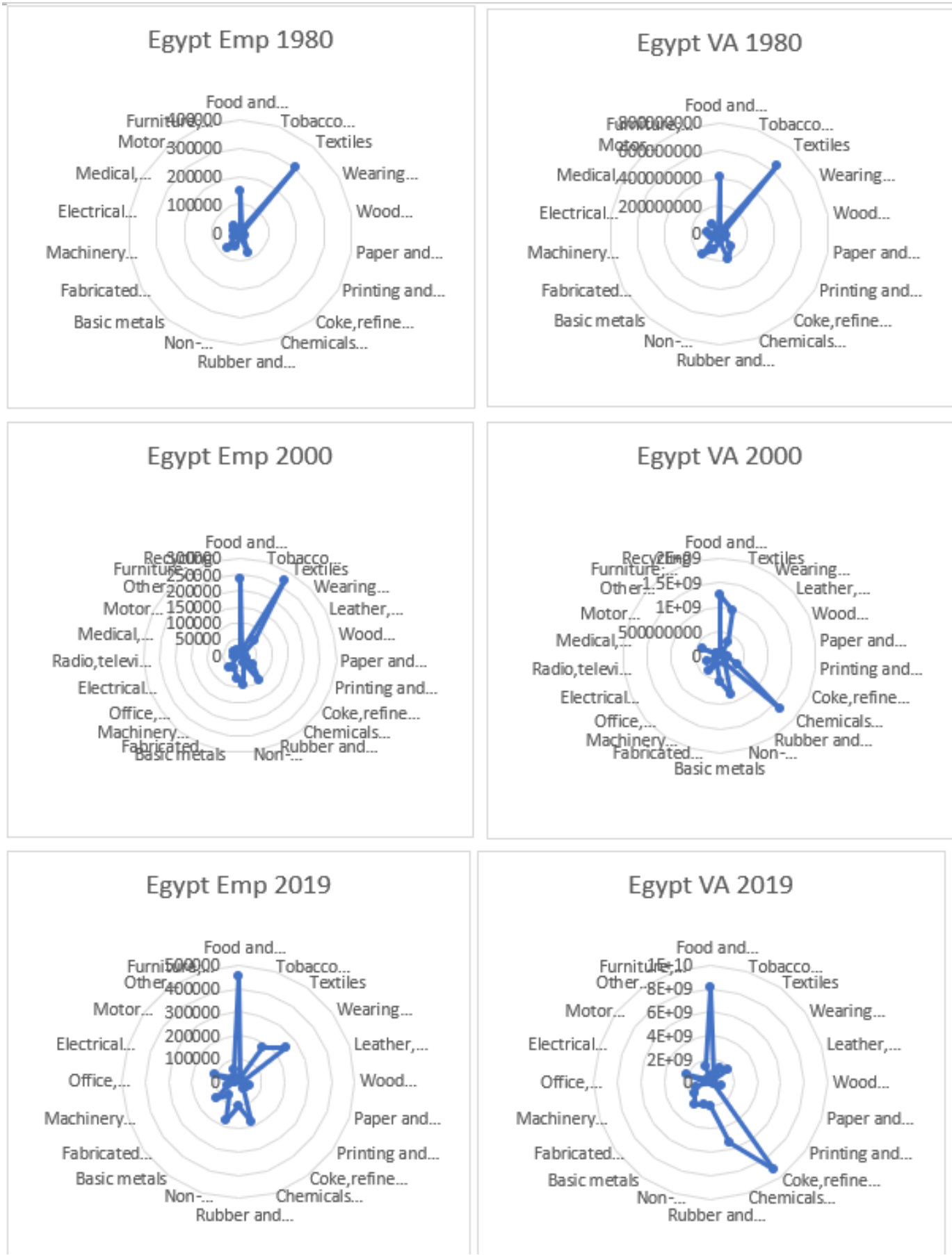


Figure 3.3: Radar Graphs of Egypt Employment and Value-added from 1964 to 2021

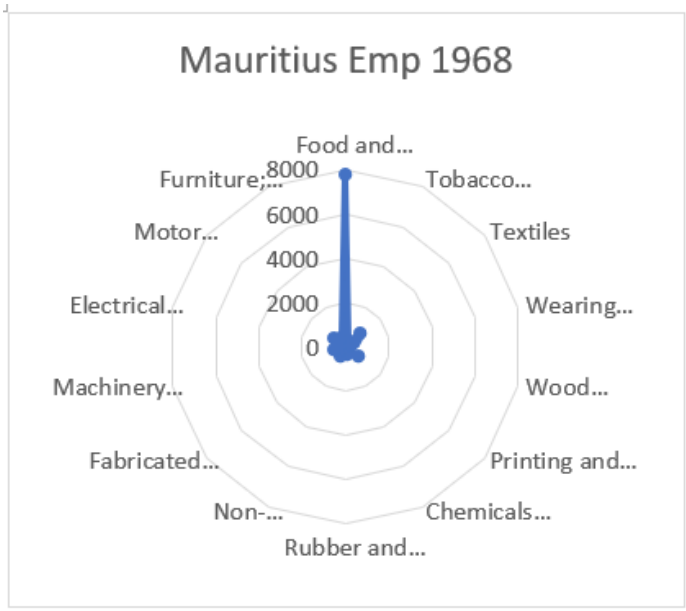
Source: By authors based on WorldBank Industry Database

The Egyptian export of manufactured goods has doubled over 1965 to 2022 (Figure 3.4). Although the country's manufactured export has increased, it is still nearly 40% which means the country exports a significant amount of its natural resources as raw materials. Important efforts have been made by Egypt, however there is a need for more transformation to take full advantages of the available resources.

Figure 3.4: Egyptian Manufactures exports (%of merchandise exports)
Source: WorldBank Database

3.3.3 De-industrializing Country: Mauritius

Mauritius began its industrialization around 1970s after independence from Britain in 1968. Mauritius had a monoculture economy heavily reliant on sugar production. To diversify the economy and promote industry, the Mauritian government implemented new policies and established Export Processing Zones (EPZs) in 1970 offering tax incentives, infrastructure support, and other benefits to attract foreign investment and promote export-oriented manufacturing. From Figure 3.5 in 1968, the manufacturing industry was mainly focused on Food and beverages but since 1980 it was led by the durable consumer goods sector which has the highest employment but lagged behind the strictly non-durable consumer goods industry especially in 2021. In 2021, although employment in Food and Beverages is half the employment in Textiles, the value added in Food and Beverages was double that of wearing apparel. Producer goods, especially coke, refined petroleum products, nuclear fuel, were the third important sector by 2021 in terms of value added. The industrial manufacturing sector remained very low compared to other sectors. The model of industrial development in Mauritius was not based on natural resources. The state took action played a crucial role in creating a conducive environment for manufacturing growth. In summary, Mauritius realized its first industrialization around 1980 focusing on Textiles and Wearing Apparel, fur sector. Around 2021, efforts are made to expand the manufacturing to Producer goods (Appendix B.1). Although the country's natural resources are limited, efforts were made to develop the manufacturing of coke, refined petroleum products and nuclear fuel. The establishment of EPZs in the 1970s and 1980s attracted significant foreign investment and provided a favorable regulatory environment, boosting manufacturing exports.


Mauritius Emp 1968
Food and...
Tobacco...
Textiles
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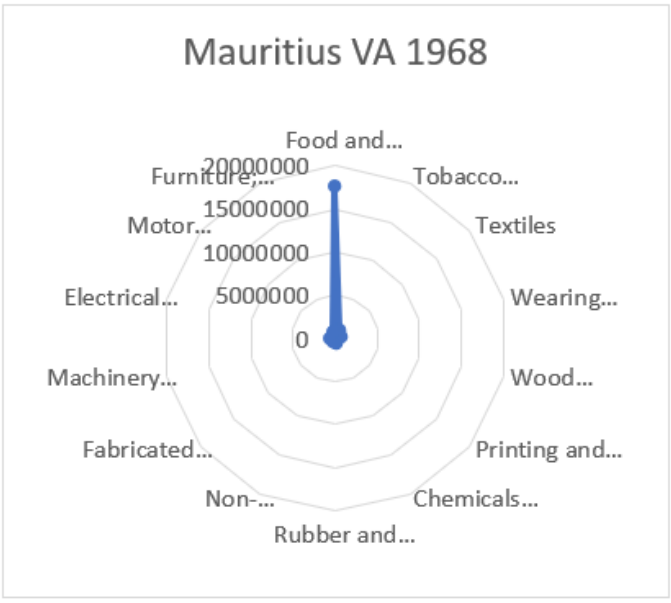
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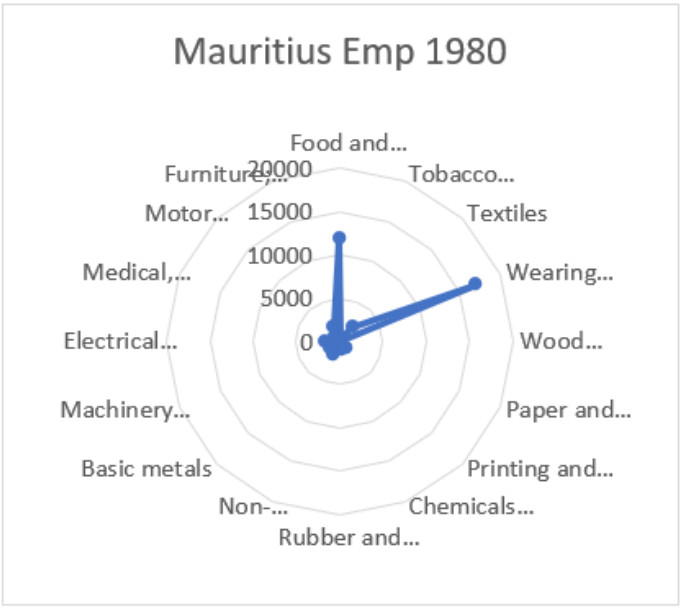
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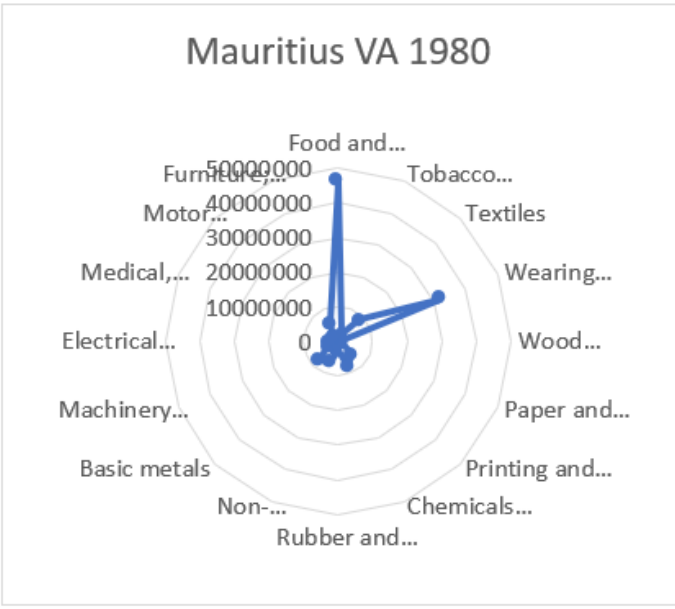
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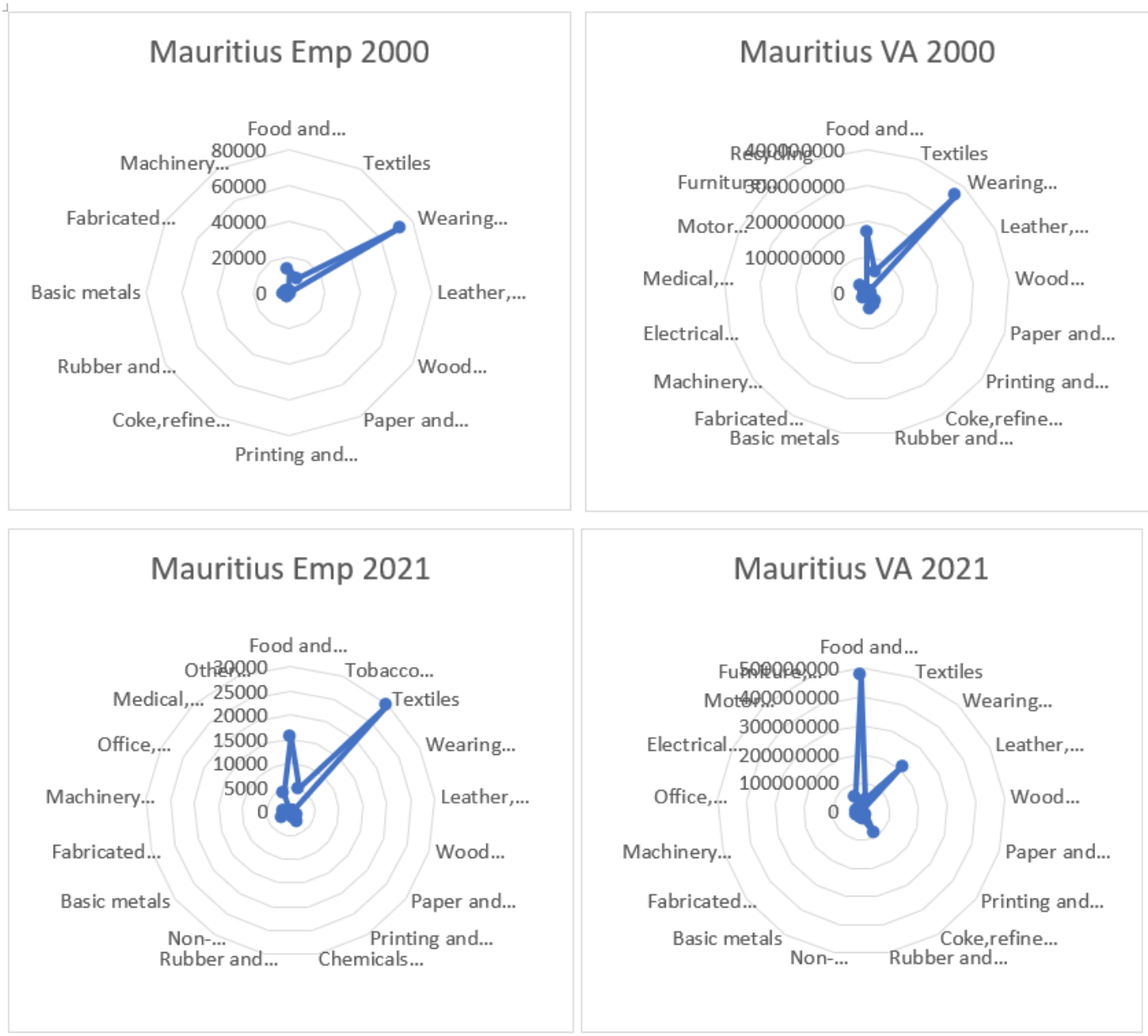


Figure 3.5: Radar Graphs of Mauritius Employment and Value-added from 1968 to 2021
Source: By authors based on UNIDO Database

Mauritius benefited from preferential trade agreements, such as the Lomé Convention with the European Union and the African Growth and Opportunity Act (AGOA) with the United States, which provided favorable access to key markets. All of these led to significant growth in export manufacturing from the 1970s to 2000 (Figure 3.6). After reaching a peak of 80% in 2000 (Figure 3.6), the exports manufacturing of the total export merchandise has decreased to below 60% in recent years, confirming the finding in the previous chapter classifying Mauritius as a de-industrializing nation. The decline in the employment share (also check appendix B.4) has therefore led to a decline in the manufactured production affecting the export. This decline could also be related to the expiration or reduction of preferential trade agreements, such as the phasing out of the Multi-Fibre Arrangement (MFA) in 2005, which had previously provided quota-free access to developed markets,

reduced Mauritius' competitive advantage in textiles and apparel. The rise of China and other low-cost manufacturing hubs also increased competition in the global textile and apparel markets. Nonetheless, Mauritius still has a high export rate of manufacturing production and export ranking it as one of the top industrialized countries in Africa.

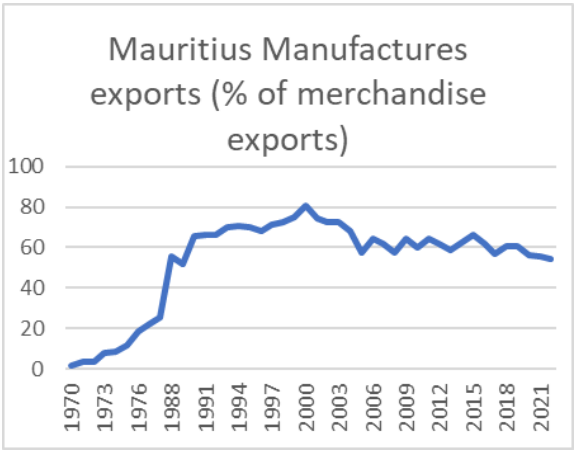


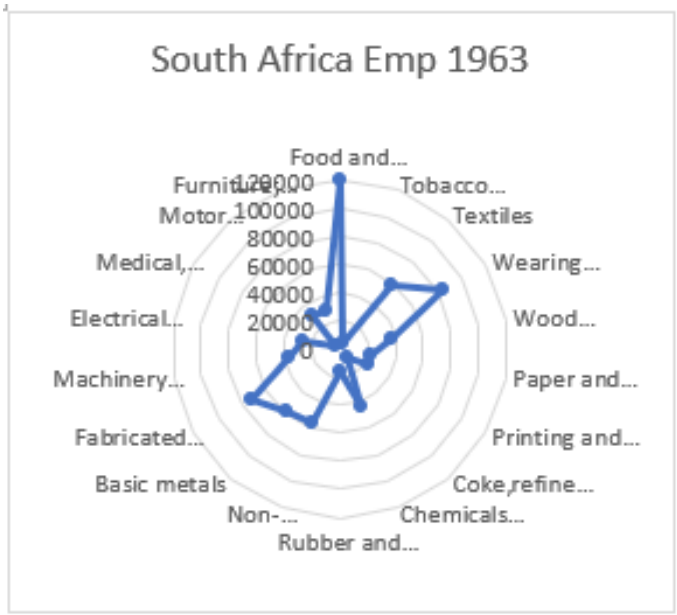
Figure 3.6: Mauritian Manufactures exports (%of merchandise exports)
Source: WorldBank Database

3.3.4 De-industrializing Country: South Africa

In South Africa, the manufacturing sector through employment and exports revenue contribute significantly to the economy. The country is known to be blessed with natural resources including gold, diamond, coal etc. Figure 3.7 shows a consistent shrinking in the non-durable consumer goods sector over the years. In 1963, South Africa's manufacturing sector was driven by industries such as food and beverages, metal (basic and fabricated), chemicals, wearing apparel fur and textiles. In 1980 (Figure 3.7), the manufacturing of food and beverages, motor vehicles, trailers, semi-trailers, machinery, basic metals in South Africa remained the significant industries. Although the basic metal employment increased moderately, the value-added (VA) highly increased surpassing food and beverages VA and becoming the most important sector of manufacturing in terms of VA. This was driven primarily by the country's abundant mineral resources including gold, platinum, and iron ore. The basic metal manufacturing sector include activities such as smelting, refining, and processing of these raw materials into intermediate and finished metal products. During this period, South Africa was one of the world's leading producers of gold and platinum, and it also had a steel industry. Companies like Iscor (now ArcelorMittal South Africa) specialized in steel products for construction and other infrastructures evolved. The manufacturing of basic metals in South Africa around 1980 contributed in supporting downstream industries including automotive, construction, and machinery manufacturing. In South Africa in 2000 (Figure 3.7), Food and beverages, coke, refined petroleum products, nuclear fuel, basic metal and then motor vehicles, trailers, semi-trailers industries were significant sectors within the manufacturing and energy landscape. South Africa has many coal reserves, and coke production is important for supplying the domestic steel producers and others. The

refined petroleum sector involves the processing of crude oil into petroleum products such as gasoline, diesel, jet fuel, and lubricants. South Africa has several oil refineries managed by companies like Sasol and PetroSA supplying refined petroleum products to meet domestic and international demand. The country also engage in mining uranium ore, and processing into nuclear fuel for nuclear facilities. The expansion of mines led to increasing demand in machinery equipment and chemicals. In 2021 (Figure 3.7), from the value-added data, food and beverages followed by Coke, refined petroleum products, nuclear fuel constituted the main industries. Although employment coke, refined petroleum products, nuclear fuel was not as important, the value-added was high. This can be explained by the fact that machinery and equipment were used for the extraction of the Coke, refined petroleum products, nuclear fuel and therefore the sector did not require a high human labor force. This explanation aligns with the findings of Tregenna who concluded that industrial upgrading and new labour-dislodging machinery were associated in South Africa, between 1980 and 2005, with a falling employment multiplier in manufacturing. Manufacturing is still the engine of growth but it may not always carry quite so many people with it In South Africa, all through the process of industrialization, from 1963 till 2021, the Strictly non-durable consumer goods (Food, Beverages and tobacco) category has always been among the most dominant manufacturing sector. Although an important part of this manufactured food and beverages serve to the export, over 50% is used for local needs. South Africa invested a lot in the textiles, apparel industry and wood products but with a quite low value-added as result which led to a drastic drop and the sector losing its prominence in the recent years around 2021. The producer goods manufacturing sector is very determinant to industrialization mainly due to the country's abundant mineral resources. The manufacturing of basic metals and coke, refined petroleum, and nuclear fuel respectively remained key pillars of South Africa's industrial base in 1980 and 2000 in terms of value added. South Africa is one of the rare African countries that already invested a lot and developed the sector of industrial manufacturing in the 1960-1980. Although industrial manufacturing is still significant to the industrial base its scope has decreased showing more specialization. In summary, considering our period of study, South Africa had its first wave of industrialization in 1963 developing all its sectors which were all significant until 2021 as the non-durable consumer goods' share declined. The second industrialization occurred in 2021 as the country focused on developing the industrial manufacturing sector. The manufacturing dynamism of South Africa has decreased yet the country remains one of the most industrialized African countries. Another important point to mention about the case of South Africa is that despite the shrinking of the employment, the value-added keeps increasing showing the country employs more technology-intensive and capital-intensive manufacturing processes (Check also Appendix B.5 and Appendix B.6).

Since 2002, the manufacturing export share has been on a decreasing path from around 60% to 37% in 2022. This result confirms the findings from Chapter 2 classifying South Africa as de-industrializing.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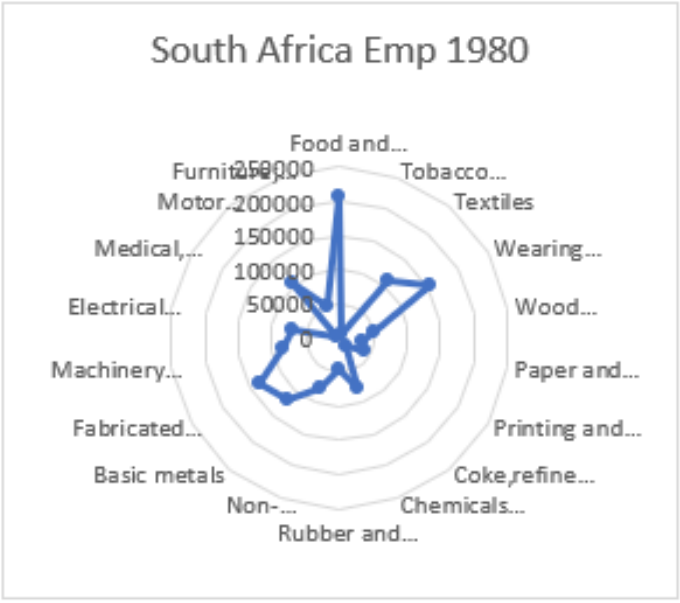
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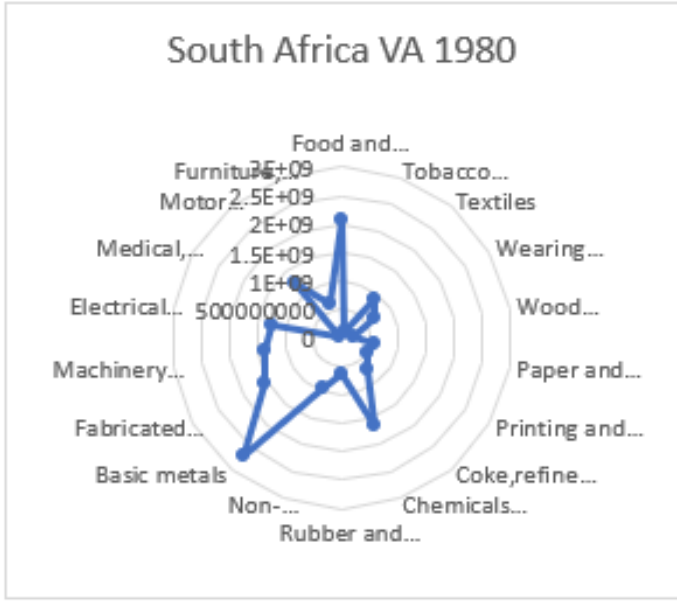
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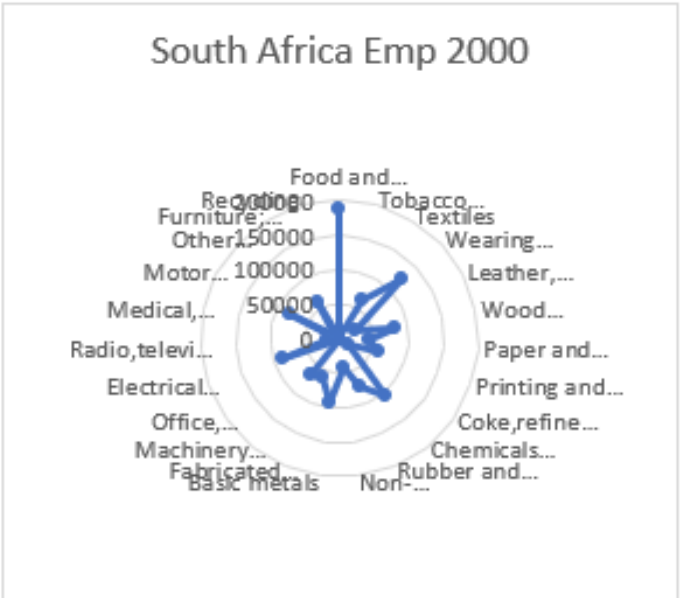
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South Africa VA 2000
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Wearing...
Leather,...
Wood...
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Printing and...
Coke,refine...
Chemicals...
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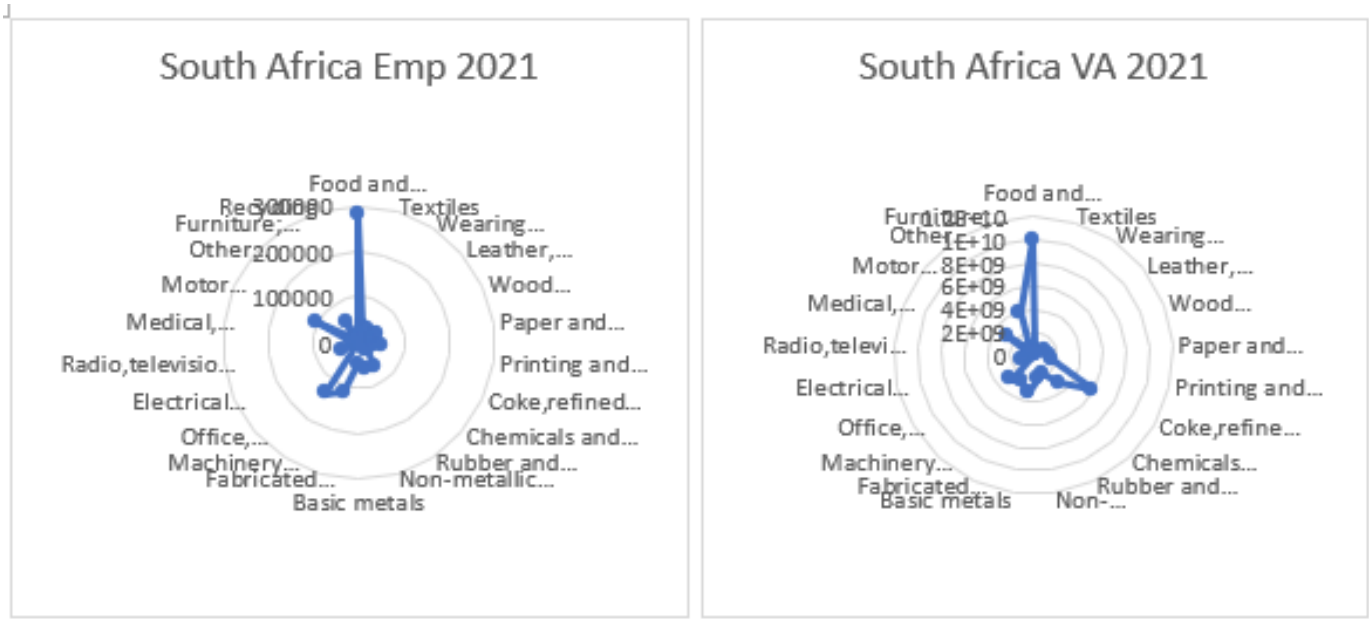


Figure 3.7: Radar Graphs of South Africa Employment and Value-added from 1963 to 2021
Source: By authors based on WorldBank Industry Database

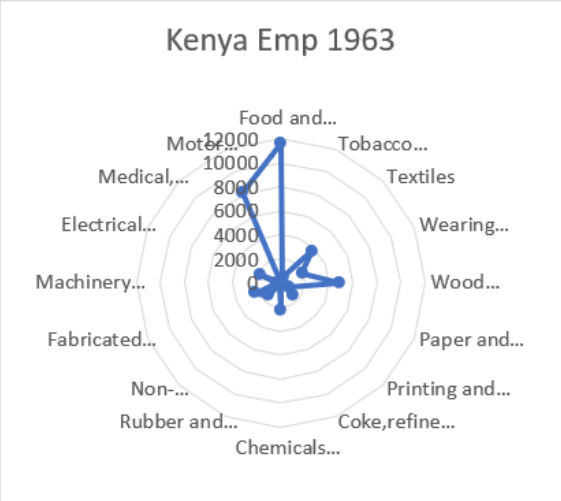
The decline in the manufacturing exports shows that South African export is gradually depending more and more on the raw natural resources such as gold, platinum, diamonds, coal, and iron ore etc and the abundance of natural resources certainly contributed to create a suitable environment for industrialization. The manufactured exports as well as its composition varied considerably over 1970 to 2021 (Figure 3.8). Manufactured exports have become an increasingly large proportion of South Africa's total exports, doubling from 1974 to 2002 reaching a peak of 61% before decreasing to 37% in 2022. In 1980, the export drop by half from about 37% to 18%. This drop could be attributed to the international economic conditions. The late 1970s and early 1980s were marked by negative occurrences such as the oil price shocks, the high inflation rates, and global recession. These situations might have led to a decrease in the exports. In addition, the South African apartheid policies led to some international sanctions and boycotts which limited the country's access to international markets.

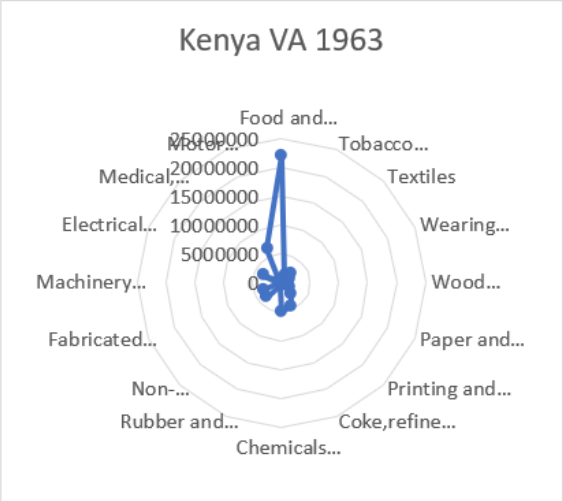
Figure 3.8: South African Manufactures exports (%of merchandise exports)
Source: WorldBank Database

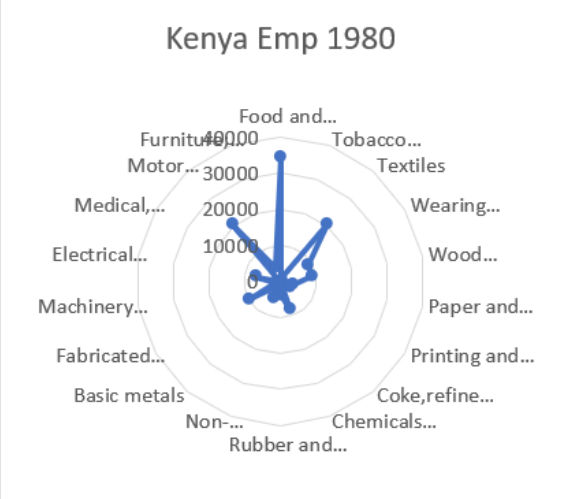
3.3.5 Slowly industrializing Country: Kenya

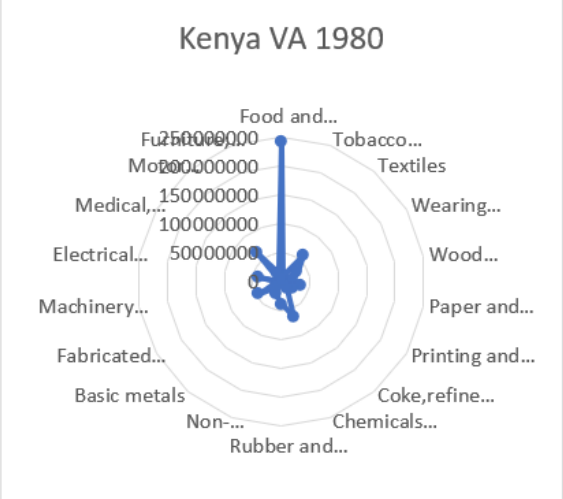
In 1963 from Figure 3.9., Food and Beverages and motor vehicles, trailers, semi-trailers industry were the most dominant sectors recording the highest employment and Value Added. The country's manufacturing sector was in its early stages of development after independence and the economy was still highly dependent on agriculture. However, the government speedily initiated new regulations and policies in order to encourage industrialization and economic diversification. The motor vehicles, trailers, semi-trailers industry was an important sector as some assembly plants were operational on the market and fabricated complete vehicles from imported parts, supplying the domestic market and surrounding East African countries. On the other hand, textiles, and wood product manufacturing started slowly to emerge. The Kenyan government provided incentives such as tax adjustments, subsidies and investment support to encourage local manufacturing enterprises. Motor vehicles, trailers, and semi-trailers manufacturing employment was still important in Kenya until 1980 but the Value Added remained low. The importance of motor vehicles, trailers, and semi-trailers manufacturing in Kenya significantly reduced in the 2000s (Figure 3.9) due to the limited modernization and inadequate infrastructure. Besides, second-hand fully built vehicles, imported from Japan, Europe, and the Middle East became prevalent as they were way cheaper than locally assembled vehicles. In 2021 (Figure 3.9), the main manufacturing sectors in Kenya included food and beverages, textiles and clothing, chemicals, and chemical production. In summary, the strictly non-durable consumer goods remains the lead sector of manufacturing in Kenya. This aligns with the findings from Chapter 2 confirming Kenya to be agricultural oriented.The industrial manufacturing or durable consumer goods sector was significant in the early years of industrialization but significantly decreased in recent years. Efforts were made to increase the employment in the non-durable consumer goods sector, but the value added over the years remained low. We could conclude that Kenya realized its first industrialization around the 1960s with a prevalence of automotive assembly plants and a moderate rise in the textile and wood sector. Later, the manufacturing has been focused

on food and beverages and a moderate share of Textile and Wearing sector. This could be seen as a case of industrialization regression.









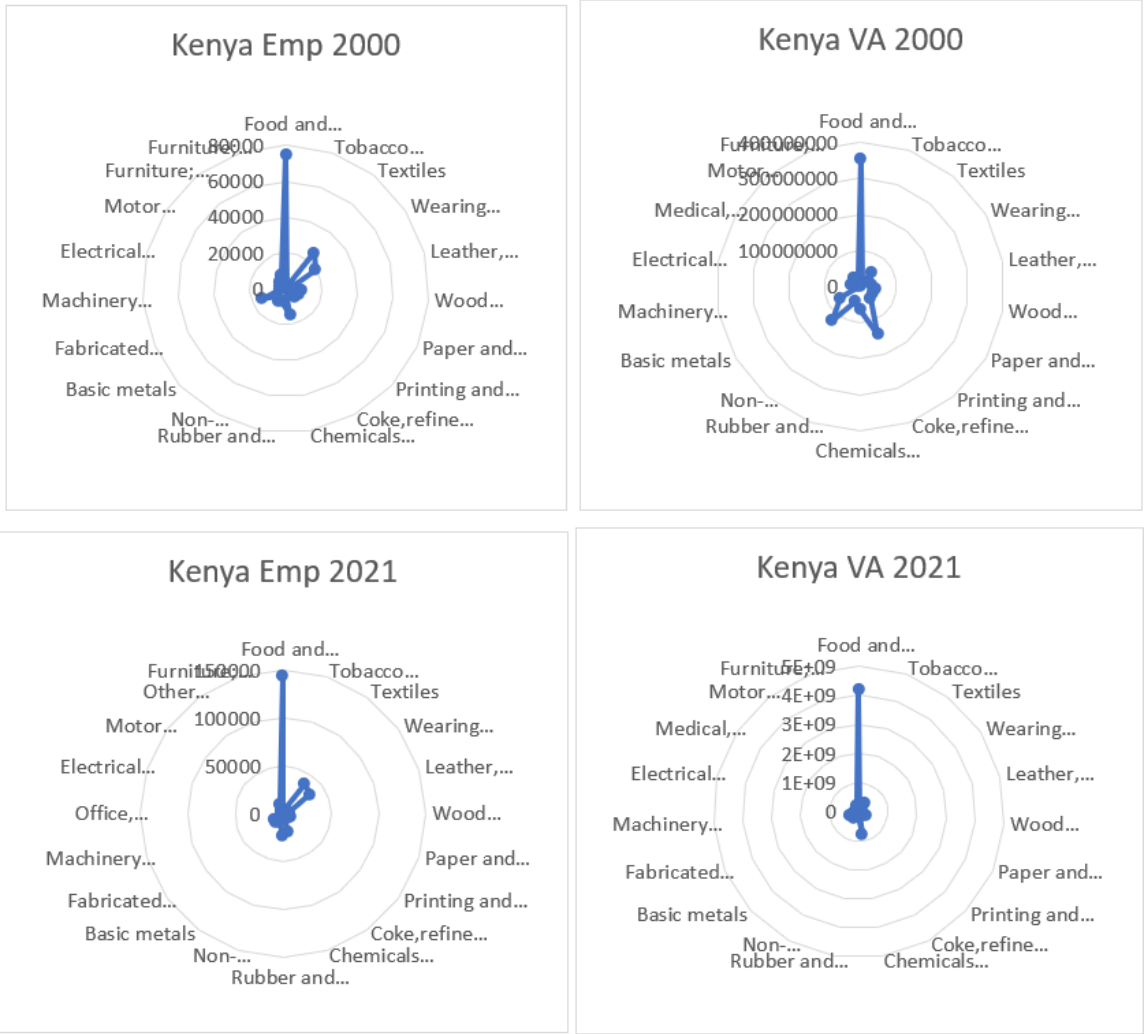


Figure 3.9: Radar Graph of Kenya Employment and Value-added from 1963 to 2021.
Source: By authors based on UNIDO Database

Figure 3.10: Kenyan Manufactures exports (%of merchandise exports)
Source: WorldBank Database

The increase in manufacturing exports in Kenya between 1986 and 1990 (Figure 3.10) could be attributed to several factors such as the government policies and regulation encouraging liberalization. In addition, during this period, a shift was being implemented

from import substitution to export promotion strategies.

Kenyan manufacturing export as of 2021 is still around 30% (Figure 3.10) certainly because the export is still dominated by agricultural products (tea, flowers, fruits, coffee, etc.) and raw materials including minerals and petroleum products.

3.3.6 Slowly industrializing country: Morocco

Morocco experienced its initial industrialization around 1960-80 (post-independence). The focus was on import substitution industrialization (ISI) led by the state developing industries to reduce dependence on imports, especially in textiles, food processing, and chemicals. Economic reforms in the 1980s and 1990s reduced state control, encouraged privatization, and improved the investment climate leading to an export-oriented growth. Many free trade agreements, particularly with the EU and the US, boosted manufacturing exports.

In the 1980s, the textile and garment industry played a significant role in leading the manufacturing sector in Morocco with the highest employment (Figure 3.11). This sector experienced growth due to favorable government policies, investment incentives, access to skilled labor, and proximity to European markets, making it a key driver of industrialization and economic development during that time. The chemical industry also experienced notable growth recording the highest value-added. The chemical industry encompassing fertilizers, petrochemicals, and pharmaceuticals, contributed to the diversification and expansion of the country's industrial base. The strictly non-durable consumer goods manufacturing sector in Morocco was a vital component of the country's manufacturing industry characterized by the production of a wide range of food products such as processed foods, dairy products, beverages, and confectionery items. This sector benefited from Morocco's agricultural resources, government support for food processing industries, and growing domestic demand. Additionally, the sector also catered to export markets, particularly in Europe and neighboring African countries. The non-metallic mineral products sector in Morocco was an important part of the country's manufacturing industry including various activities such as cement production, ceramics, glass manufacturing, and building materials. Morocco's abundant natural resources, including limestone, clay, and silica, supported the growth of this sector.

In 2000 from Figure 3.11, the strictly non-durable consumer goods sector was the most important manufacturing industry in Morocco. Although the textiles and garment industry had the highest employment rate, its value-added was not correspondingly high. The producer goods manufacturing sector especially the chemicals and the non-metallic mineral products sector got significant value-added.

In 2021 (Figure 3.11), the basic metal manufacturing employment tremendously increased. Basic metals manufacturing mainly involves primary metal production like steel, aluminum, copper, iron, lead, zinc, nickel, etc. Moroccan basic metals demand has remained high in the recent years not only for the domestic needs but also for the global market. Beside the basic metal, the textiles and garment manufacturing sector recorded a

high employment rate as well. However, the value-added for both sectors was very low. The food and beverages industry, the chemical and chemical industry and the motors, vehicle, trailer and semi-trailers industry successively recorded the highest value-added figures. The chemical and chemical product manufacturing sector growth could be explained by the presence of several multinationals such as the OCP Group (Office Chérifien des Phosphates) which is one of the largest companies in Morocco and a global leader in the phosphate industry; SNEP (Société Nationale d'Électrolyse et de Pétrochimie) which produces chlorine, caustic soda, and other petrochemical products mainly for local industries; Afric Industries which produces adhesives, sealants, and specialty chemicals in order to supply the construction, automotive, and packaging industries. Regarding the motors, vehicle, trailer and semi-trailers industry, Morocco has been attracting significant investment in its automotive sector, with several international companies setting up production facilities. The automotive industry has become one of the leading manufacturing sectors, thanks to the government regulations, incentives and partnerships. In summary, although food and beverages represent an important sector in Morocco, it is not the main lead of manufacturing as in many other countries considering especially the employment data. The first industrialization in Morocco was characterized by a focus on Textiles and apparel industry and the second industrialization was rather characterized by a focus on producer goods mostly based on primary resources as well as a new development of the industrial manufacturing which might lead the third industrialization. The most important manufacturing industry was that of textiles which faced increasing difficulties partly due to strong competition from some Asian countries. Through 1980-2000 high investments were made in the sector of Textiles, Apparel Industry and Wood Products manufacturing which was had the highest employment but with a decreasing value-added which led to a change of strategy. In 2021, the Producer goods became the most important sector in terms of employment and the strictly non-durable consumer good the sector with the highest value added. Although the employment of the of Textiles, Apparel Industry and Wood Products manufacturing is still significant, we assume it might considerably drop in the years to come if the value added continue to remain so low. In 1980, investments were made in the producer goods and this sector had the highest value added in manufacturing. In 2000, employment in the producer goods reduced but in 2021 represents the main leading of industrialization in Morocco. Important efforts were made to develop the industrial manufacturing sector especially that of motor vehicles, trailers, semi-trailers in the recent years and the sector also demarked Morocco with advance automotive development.

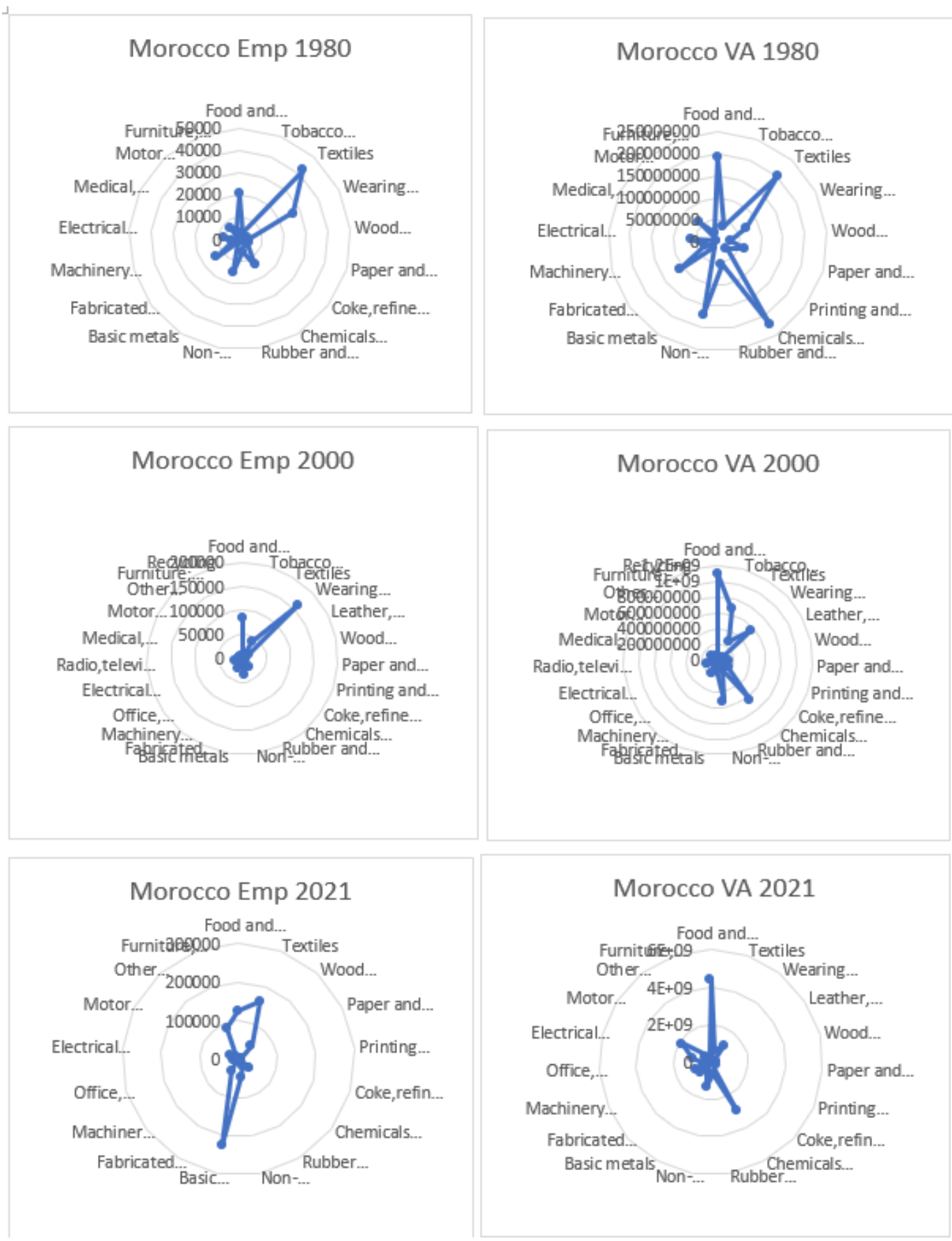


Figure 3.11: Radar Graphs of Moroccan Employment and Value-added from 1980 to 2021

Source: By authors based on WorldBank Industry Database

The export of manufactured goods in Morocco is on a steady increasing trend surpassing 70% as of 2021 (Figure 3.12). This is a good indicator showing that Morocco does not just content to export raw material but rather enlarging the amount of manufactured goods in exports over the years.

Figure 3.12: Moroccan Manufactures exports (%of merchandise exports)
Source: WorldBank Database

3.3.7 Slowly industrializing Country: Senegal

Senegal during the colonialism was as an important hub to the West African region and important infrastructures including ports, railways, roads, and urban facilities were constructed particularly in Dakar. This laid the groundwork for industrial activities. In 1960 after independence, the most significant manufacturing industry in Senegal was the strictly non-durable consumer goods especially the processing of agricultural products like groundnuts (peanuts). In 1980 from Figure 3.13, the main manufacturing sectors was food and beverages but in a more diverse way. Food processing involved agricultural products like grains, fruits, vegetables, and fish into finished food products such as flour, vegetable oils, canned fruits and vegetables, fish products, and dairy products for domestic consumption and export. Beverage production includes soft drinks, fruit juices, bottled water, and alcoholic beverages. The consumer goods sector was the second most significant industry marking the first industrialization experience in Senegal around 1980, however, it has become negligible 20 years later and was replaced by the producer goods sector during the second wave of industrialization. The textile manufacturing source primary raw materials from locally grown cotton. In 2000 (Figure 3.13), manufacturing employment was highest for food beverages and chemical sectors while the value-added was high not only in both sectors but also for coke, refined petroleum products, nuclear fuel and non-metallic mineral products. The producer goods especially chemical, coke, refined petroleum products, nuclear fuel and non-metallic mineral products were central to the second industrialization in Senegal. In 2021, food beverages sectors and chemical sectors were the leading manufacturing followed by the textiles, non-metallic mineral products and electrical machinery and apparatus industries. Important efforts have been made to develop the industrial manufacturing sector, but it remains very low.

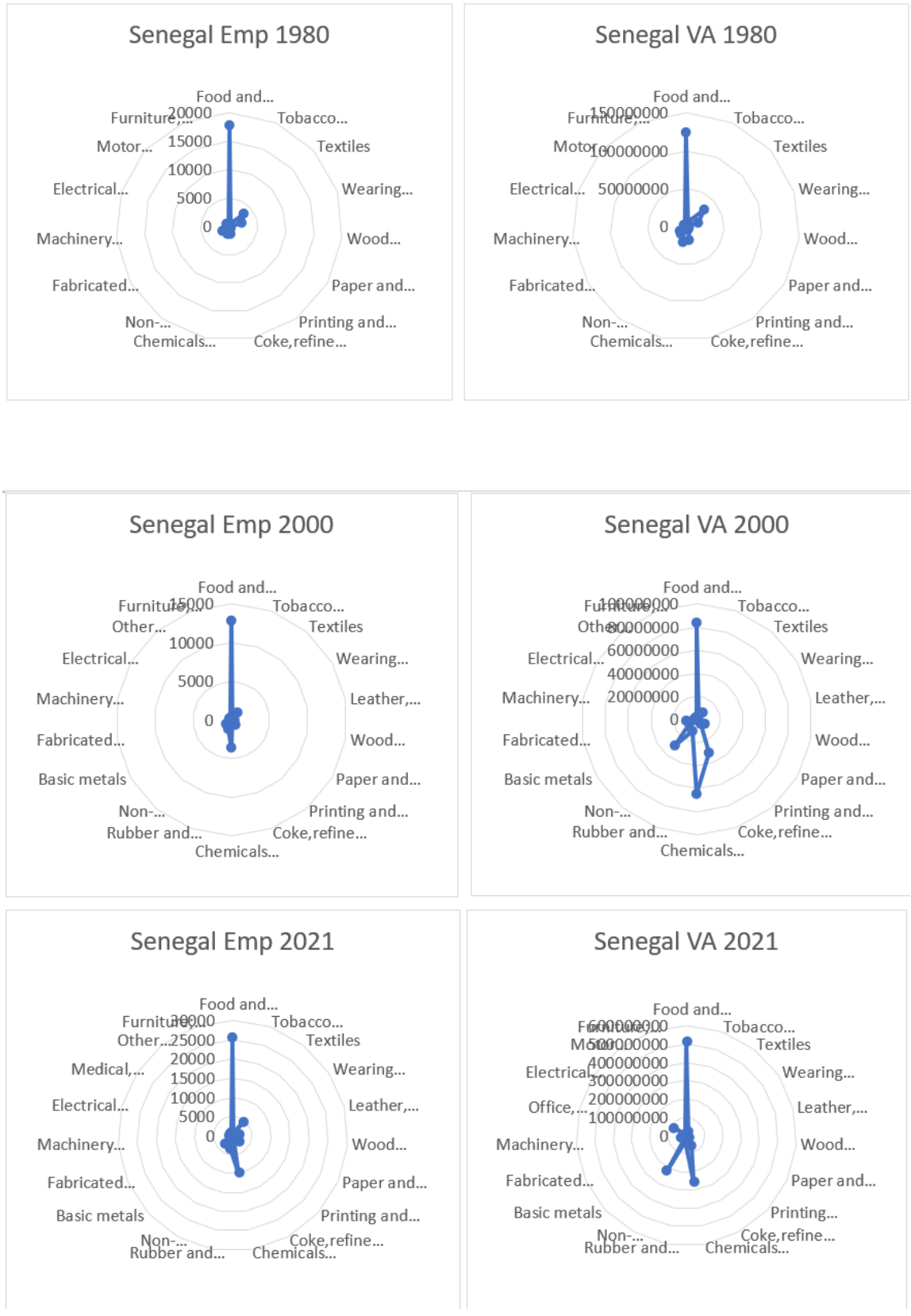


Figure 3.13: Radar Graphs of Senegal Employment and Value-added from 1963 to 2021
Source: By authors based on UNIDO Database

In summary, Food and Beverages has always been dominant to the manufacturing. The first industrialization was characterized by Textiles development in the 1980 and the

second one starting around 2000 focuses on the Producer goods taking advantage of the natural resources. Some efforts have been made to engage in industrial manufacturing product as of 2021. This sector has the potential to lead the next wave of industrialization. Figure 3.14 shows a spectacular growth of manufacturing exports from 1979 to 1999. During this period, Senegal was experiencing its first and second industrialization combined with export promotion, industrial policy reforms and regional integration, led to the increase in manufacturing. In recent years, manufacture exports decreased to below 30%, revealing that the country rather exports raw natural resources.

Figure 3.14: Senegal Manufactures exports (%of merchandise exports)
Source: WorldBank Database

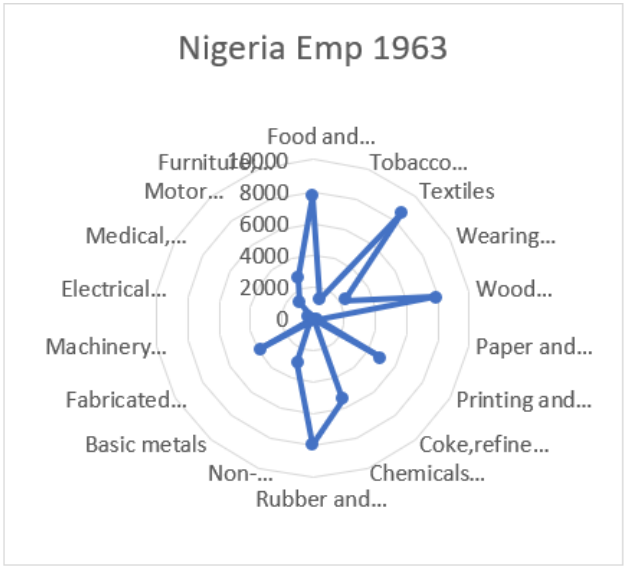
3.3.8 Slowly industrializing Country: Nigeria

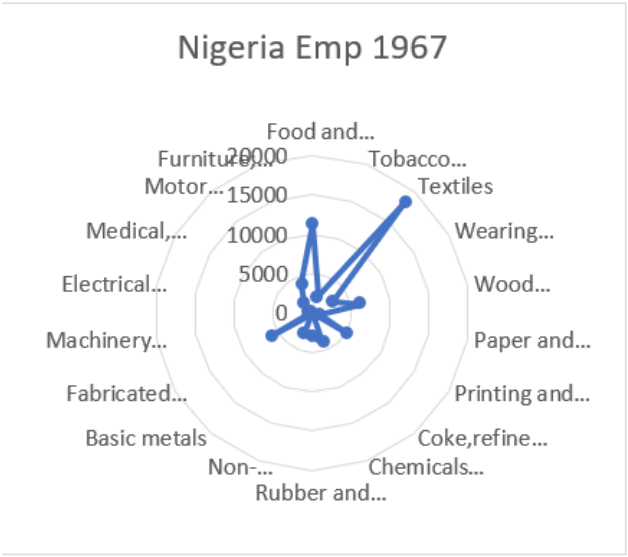
In 1960, after independence the Nigerian government focused on diversifying the economy and promoting industrial development. The First National Development Plan (1962-1968) emphasized infrastructure development and industrialization. From the Figure 3.15 in 1963, although the strictly non-durable consumer good sector is important to the manufacturing industry in Nigeria, it led industrialization together with many other sectors such as textile and apparel industry, chemical, motors and machinery industry etc. In 1963, the employment was successively highest for textiles, rubber and plastics products, wood products, food and beverages, chemical and Printing and publishing sectors. The value-added on the other hand was significant for food and beverages, tobacco, chemical, textile, wood and Rubber and plastics products industries. Textile mills were among the earliest manufacturing establishments in Nigeria. Some manufacturing activities were focused on producing construction materials such as cement, roofing materials, and bricks.

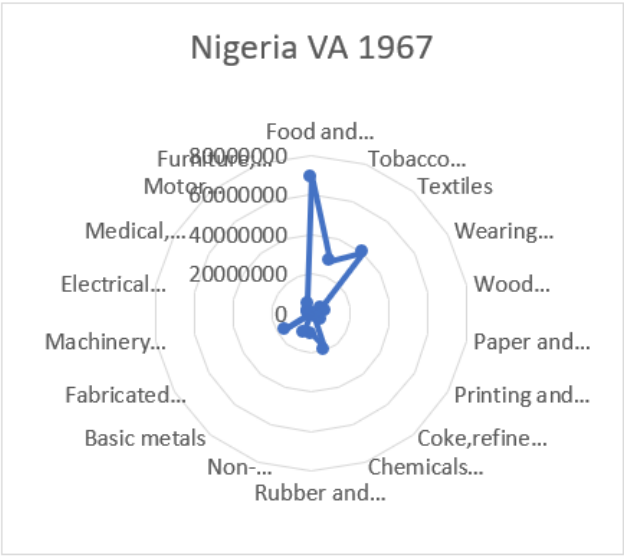
In 1967, the country became more focus and develop the textiles sector more realizing the first industrialization. Fabricated metal products was also significant during this period. In 1980, employment in textiles, food and beverages, fabricated metal products, rubber and plastics products sectors were highest while motor vehicles, trailers, semi-trailers industry, food and beverages industry, chemicals industry and textiles industry were the most significant contributors to the value-added (Figure 3.15). Investment in motor vehicle and trailer manufacturing represented a strategic effort to diversify the economy away

from dependence on oil exports and towards manufacturing. The producer manufacturing industry occupies an important position and increasingly became important around 1980.

In 1996, employment for textiles, food and beverages, furniture manufacturing, and fabricated metal products were the highest while food and beverages, chemicals, textiles, fabricated metal products sectors respectively yielded the highest value-added. Nigeria has encouraged and invested in the textiles and wearing sector which has been having the highest employment figures until 1996, but the sector struggles to yield a substantial value added. The industry faced challenges such as outdated machinery, high production costs, and competition from imported textiles. In 1996 chemical and chemicals products field recorded the highest value-added in the Nigerian manufacturing industry. The oil and gas sector remains the backbone of Nigeria's economy. The Nigerian manufacturing sector is still low, accounting for an estimated 2.6% of GDP in 2012. In summary, Nigeria realized its first industrialization in 1967 with a focus on the consumer goods sector; Although still interested in the sector, especially textiles, the country made efforts to increase industrial manufacturing production around 1980 realizing the second industrialization, and by 1996,







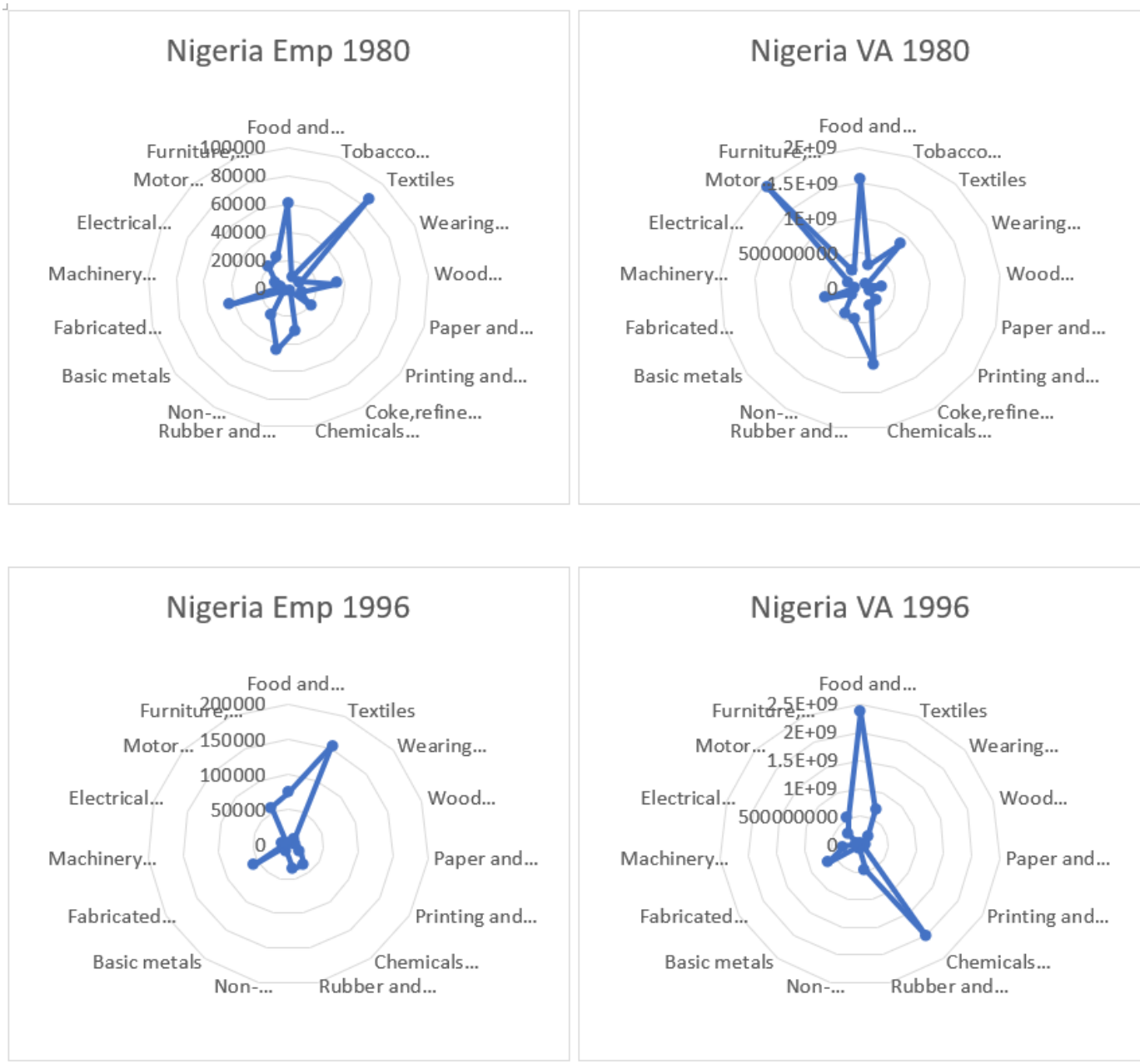


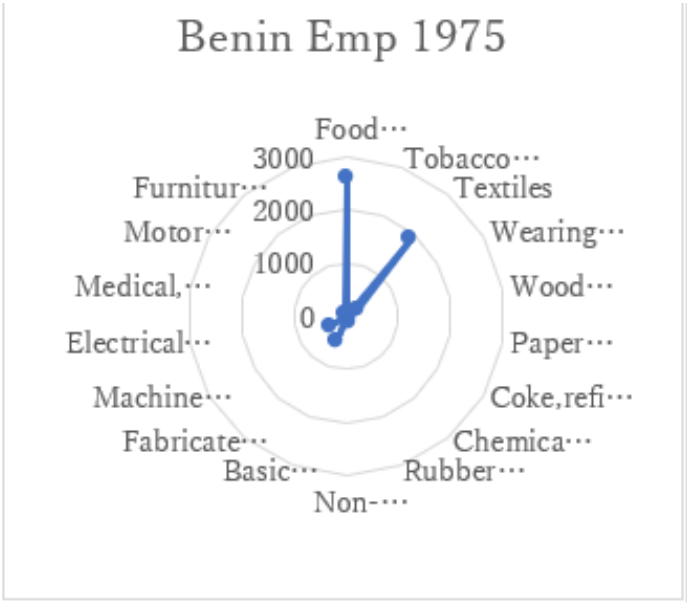
Figure 3.15: Radar Graphs of Nigeria Employment and Value-added from 1963 to 1996
Source: By authors based on UNIDO Database

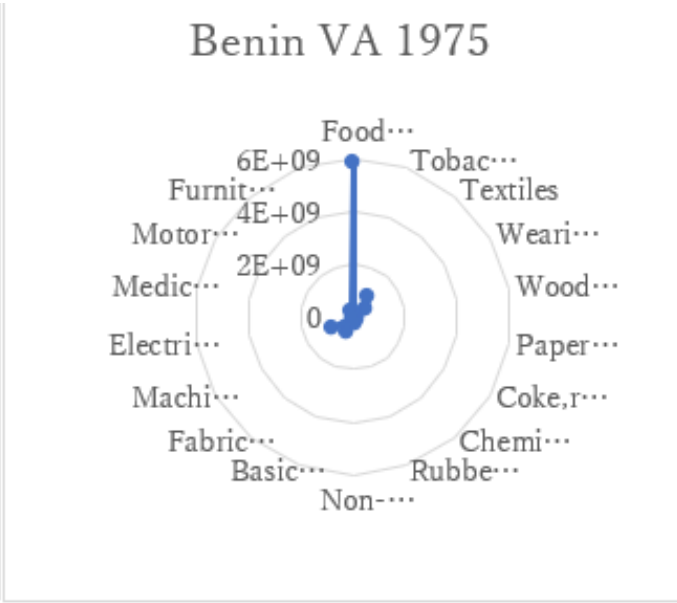
the country's manufacturing was mainly dominated by producer goods, especially chemical and chemical products. The heavy reliance on oil exports leads to a lack of diversification and low development of the manufacturing industry which explains the low rate of the manufactured export as it is about 5% as of 2022 (Figure 3.16).

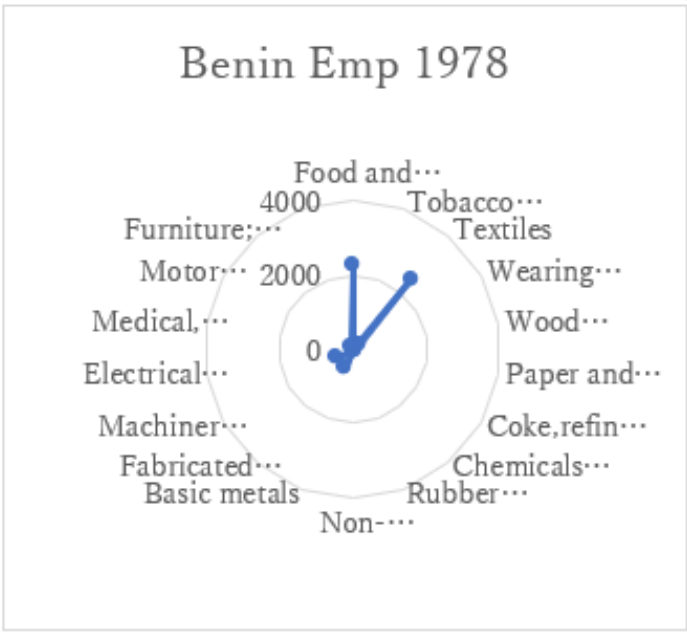
Figure 3.16: Nigerian Manufactures exports (%of merchandise exports)
Source: WorldBank Database

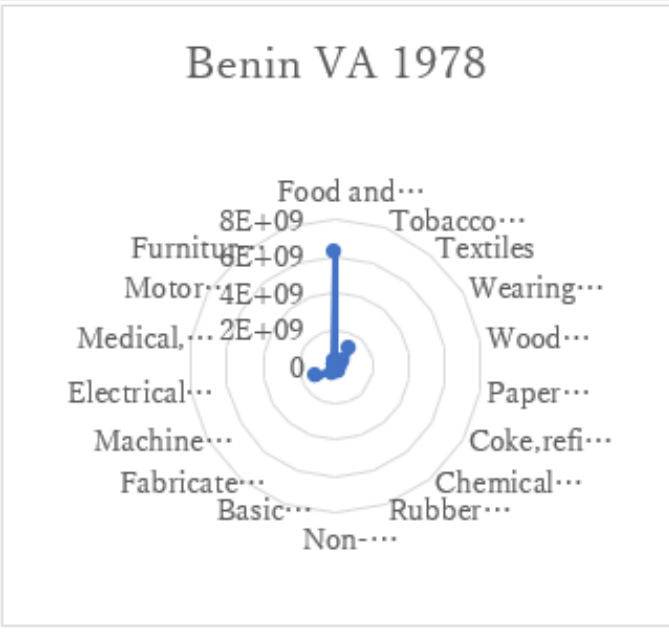
3.3.9 Slowly Industrializing country: Benin

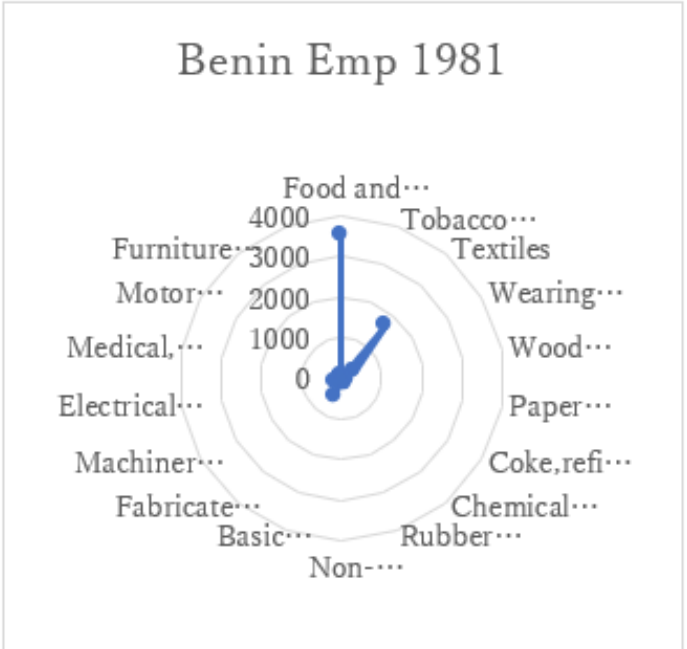
After independence in 1960, as in the case of many other African countries, Benin engaged on a journey of industrialization with a focus on the textile sector and agricultural processing industries. By 1972, the country became a Marxist-Leninist state and all the industries were nationalized with full control of the state. Benin Republic highly focuses on the development of the Strictly non-durable consumer goods and the consumer goods over 1975 through 1981 (Figure 3.17). Companies such as Société Nationale de Production Agricole (SONAPRA) and Société Beninoise de Développement (SOBEDEV) were in charge of the agricultural and food processing while the Société Beninoise de Textile (SOBETEX) produced textiles and fabrics locally. The industrial sector production in Benin mostly serves for domestic use. Although investments were made to keep the employment sector high for the two sectors, only the value added from the food and beverages sector remained significant. The value added from the Textile industry was low over the years. Benin's primary sector is the first source of wealth to the nation and this could clearly explain the high importance of the Strictly non-durable consumer goods. Besides, Benin is one of the largest producers of cotton in Africa which explains the interest from the government to develop the textile industry. However, several challenges including the non-modernization of the industry, inefficacy of existing machinery and unskillful human capital led to an inconsistent value added. After 1982, most of the state-owned industries started facing bankruptcy along with the political system weakening.
This explains the drastic drop in the manufacturing export as shown in Figure 3.18 after 1982. The manufacturing export in Benin remained very low after 2000. Efforts were made to revive the production in manufacturing but as of 2021 the manufacturing export share in the merchandise export is below 10%. The exports in Benin is dominated by agricultural products and mostly cotton.











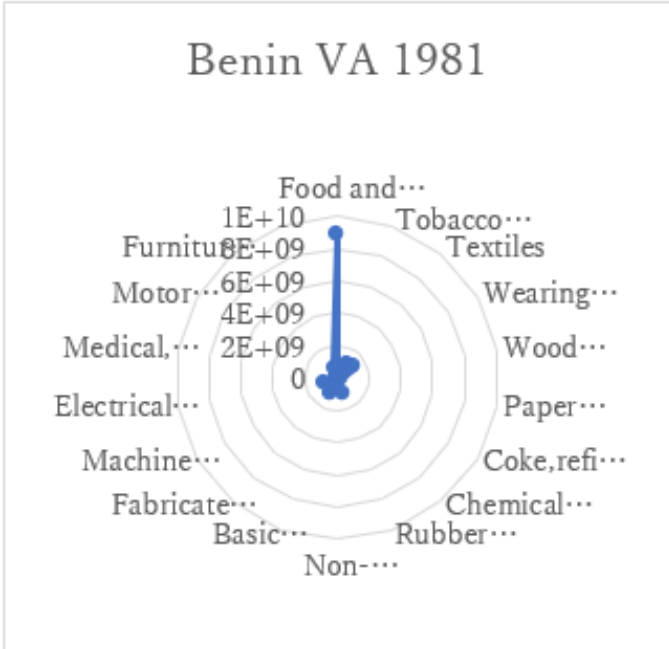


Figure 3.17: Radar Graphs of Benin Employment and Value-added from 1975 to 1981

Source: By authors based on UNIDO Database

Figure 3.18: Beninese Manufactures exports (%of merchandise exports)
Source: WorldBank Database

	Strictly non-durable consumer goods	**Non-durable consumer goods**	**Producer goods**	**Durable Consumer goods**
1963	Tunisia Egypt South Africa Kenya Nigeria	 Egypt South Africa Kenya Nigeria	Tunisia South Africa Nigeria	 Kenya
1967/1968	Tunisia Egypt Mauritius South Africa Kenya Nigeria	Tunisia Egypt South Africa Kenya Nigeria	Tunisia South Africa 	 Kenya
1980	Tunisia Egypt Mauritius South Africa Kenya Morocco Senegal Nigeria Benin	Tunisia Egypt Mauritius South Africa Morocco Nigeria Benin	Tunisia South Africa Morocco Nigeria	 South Africa Nigeria

	Strictly non-durable consumer goods	Non-durable consumer goods	Producer goods	Durable Consumer goods
1996/2000	Tunisia Egypt South Africa Kenya Morocco Senegal Nigeria	Tunisia Mauritius South Africa Morocco Nigeria	 Egypt South Africa Morocco Senegal Nigeria	Tunisia South Africa Nigeria
2019/2021	Tunisia Egypt Mauritius South Africa Kenya Morocco Senegal	Tunisia Mauritius South Africa	Tunisia Egypt South Africa Morocco Senegal	Tunisia

Figure 3.19: Summary Table of Industrialization pattern
Source: By authors

Tunisia's industrialization was initially dependent on strictly non-durable consumer goods and producer goods (Figure 3.19) focusing on natural resources, especially chemical and non-metallic mineral products; However, over the years, the non-durable consumer goods became significant and the country has diversified its industrial manufacturing industry including sectors such as mechanical and electrical industries, which is a successful industrialization experience. Tunisia by 2021 has diversified and developed all of the industries sectors as shown in Figure 3.19. Egypt rather shifted from the non-durable consumer goods to the producer goods (Figure 3.19) which is also a good example of industrialization. Mauritius manufacturing in the 1968 was highly dominated by the strictly non-durable consumer goods before investing and diversifying to non-durable consumer goods (Figure 3.19). South Africa is the most industrialized country in Africa and it has realized the first and third industrial revolution even though high on food and beverages. The country's manufacturing remains diversified but regressing over the years. In 1980-2000, the country developed all the manufacturing industries but in 2021 the industrial manufacturing share was very low suggesting the country's experience of de-industrialization. Kenyan manufacturing is characterized by a strong focus on the strictly non-durable consumer goods however Kenya in its early years of independence made great efforts realizing an industrialization with automobile sector development which later declined. The case of Kenya could also be described as a de-industrialization case but

the the manufacturing exports of the country is increasing symbolizing a shift and higher productivity in the other sectors. Senegal as well is characterized by a high focus on the strictly non-durable consumer goods. In recent years they diversified making use of the natural resources manufacturing the producer goods(Figure 3.19). The case of Senegal is a successful case.

3.4 Conclusion

In this chapter, we focus on African countries and meticulously assess their industrialization pattern from 1960 to 2021. Using empirical evidence from 9 African countries considered as representative of the different industrial stages on the continent, we show the different patterns of industrialization. Food and beverages are very crucial to industries in most African countries. Tunisia and Egypt are considered as successful cases of industrialization as they develop the non-durable goods, producer goods and the industrial manufacturing over the years. Mauritius and South Africa are de-industrializing, though they have a high level in manufacturing. Morocco and Senegal are slowly industrializing developing their producer goods sector. Kenya and Benin highly rely on agricultural products while slowly industrializing. Nigeria heavily relies on natural resources which hinders the country from effectively industrializing and therefore has a moderately slow manufacturing growth. The natural resources in such a case become rather a curse. Nevertheless, Nigeria's effort to develop textile industry realizing the first industrialization is worth noting. Some countries made important efforts to industrialize beyond their natural resources. Egypt, Tunisia, the sectors, and Morocco were keen on the textile and wearing industry realizing the first industrialization. Tunisia and Egypt recorded the highest industry sector employment among the African countries. This chapter shows that African countries in their manufacturing development have a diverse experience. The industrializing countries experienced a shift from food and beverages to textiles and then to producer goods and industrial manufacturing. The de-industrializing countries, especially South Africa, have recorded a decline in the industrial manufacturing share over the years while Mauritius rather experienced a drop in the strictly non-durable goods. It was concluded that these countries classified as de-industrializing especially Mauritius rather shifted to more sophisticated and technology-intensive industries. The slowly industrializing countries mostly recorded a shift from strictly non-durable sector towards the non-durable goods and the producers' goods. Many of the countries studied developed the producer goods manufacturing sector in recent years. Taking advantage of natural resources is legitimate; Even the first industrial revolution in England hovered around natural resources such as coal and agricultural crops such as cotton. However, countries in Africa should not content in extracting and exporting the raw resources but rather develop ways to make some transformations and also invest in other manufacturing industries. In addition, efficient policies and responsible government leadership are indispensable. Some countries or regions will continue to slowly industrialize by acquiring traditional manufacturing capabilities in less-technologically intensive sectors. We can't therefore set a monolithic interpretation of industrialization.

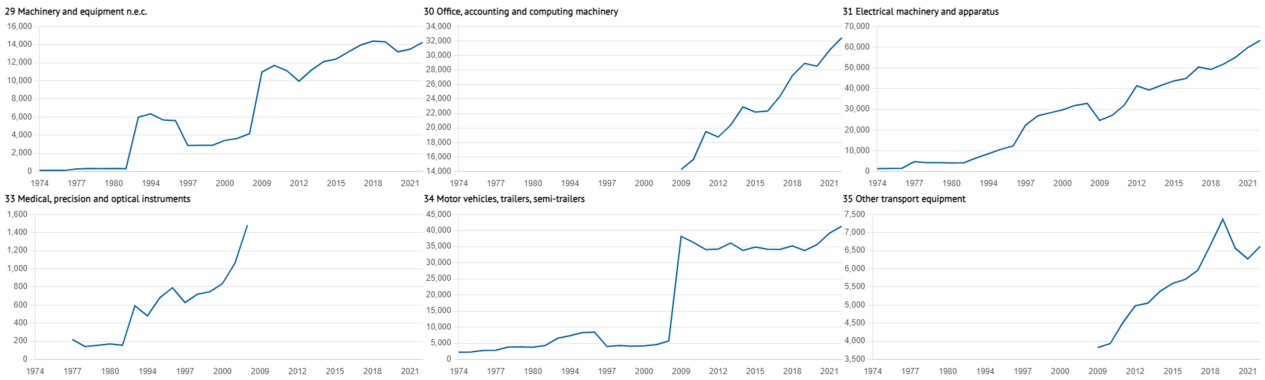
The third industrial revolution as mentioned in chapter 1 is the digital revolution with a high focus on telecommunication which will be our next chapter concern.

Appendix B

	First Industrialization	Second Industrialization	Third Industrialization
South Africa	1963 Textile Basic Metal Fabricated Metal	1980 Motor Producer Goods	
Morocco	1980 Textile (non-durable consumer) Producer Goods (Chemical, non-metallic-mineral)	2021 Industrial Manufacturing (Motor) Chemical Basic Metal	
Egypt	1964 Textiles	2000 Chemical Coke	-
Tunisia	1963 Producer Goods	1980-2000 Textile Producer Goods	2021 Textile Industrial
Mauritius	1980 – Textiles	2021 Producer Goods	
Senegal	1980 Textile	2000-2021 Producer Goods	
Nigeria	1967 Textile	1980- Textile Producer goods	1996 Industrial manufacturing
Kenya	1960 Motor	1980 Textile	

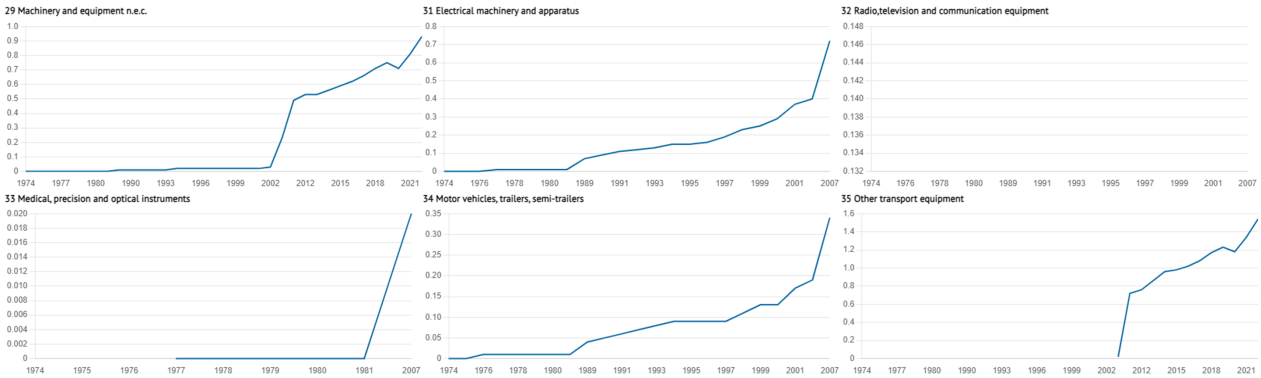
Appendix B.1: Industrialization leading sectors in Africa over the years

Source: By authors



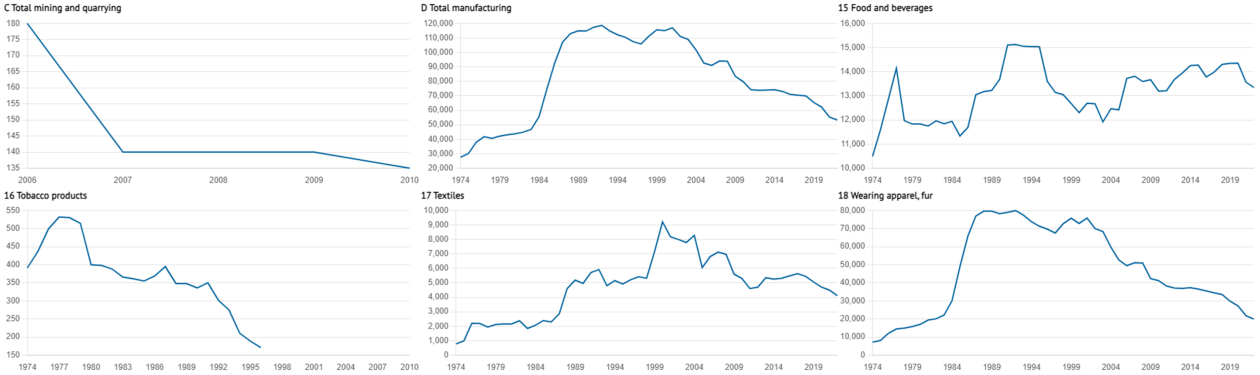
Appendix B.2: Tunisia Industrial Manufacturing Employment

Source: UNIDO Database



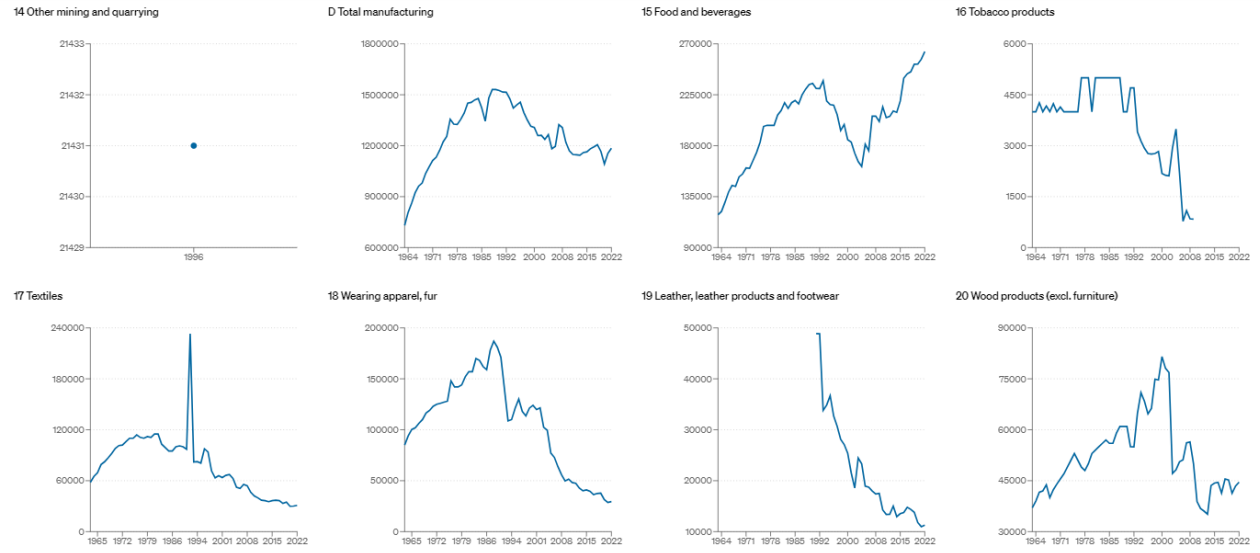
Appendix B.3: Tunisia Industrial Manufacturing Value Added

Source: UNIDO Database



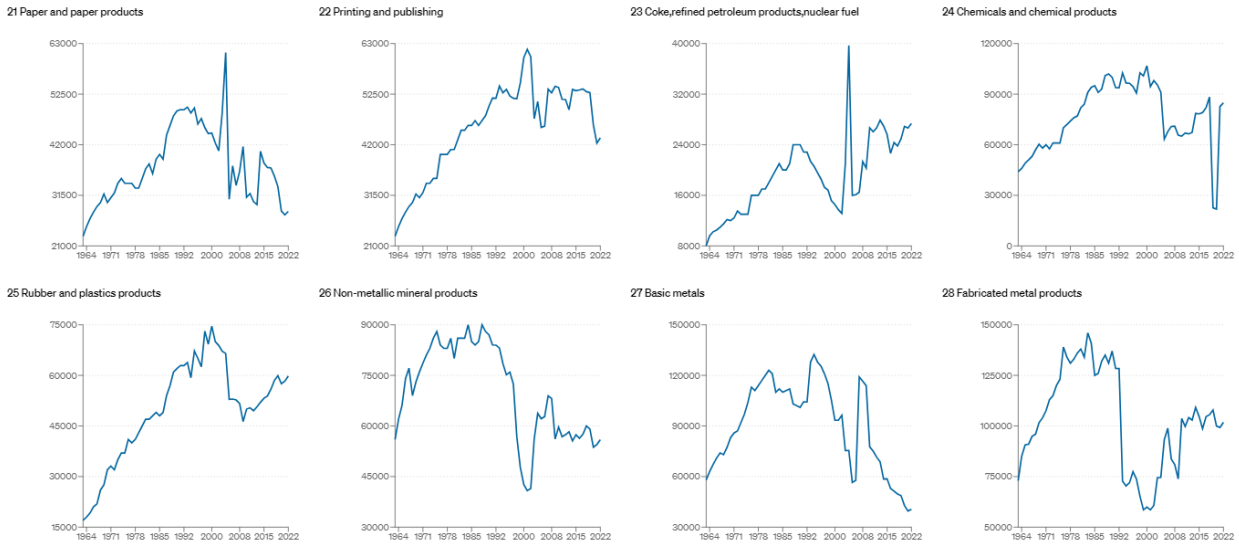
Appendix B.4: Mauritius Manufacturing Employment

Source: UNIDO Database

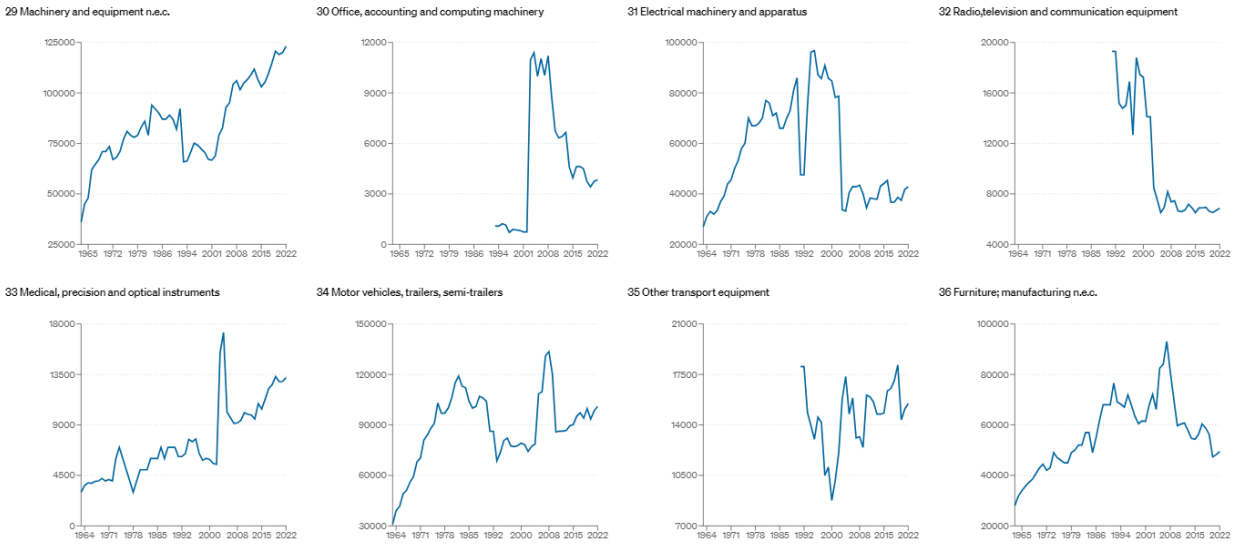


Appendix B.5: South African Manufacturing Employment (Part1)

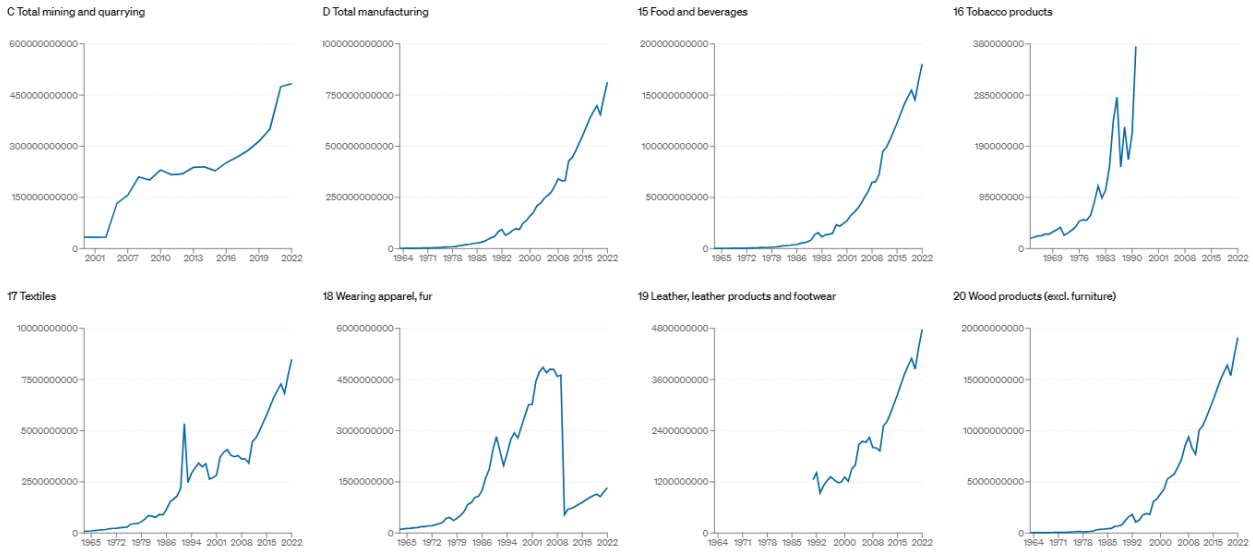
Source: UNIDO Database



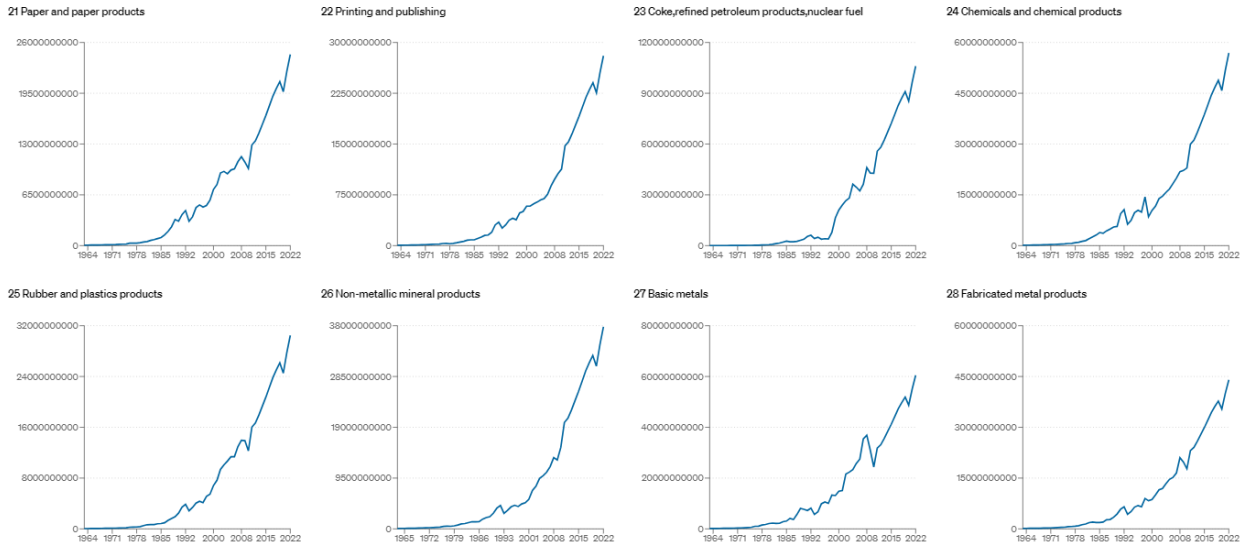
Appendix B.5: South African Manufacturing Employment (Part2)
Source: UNIDO Database



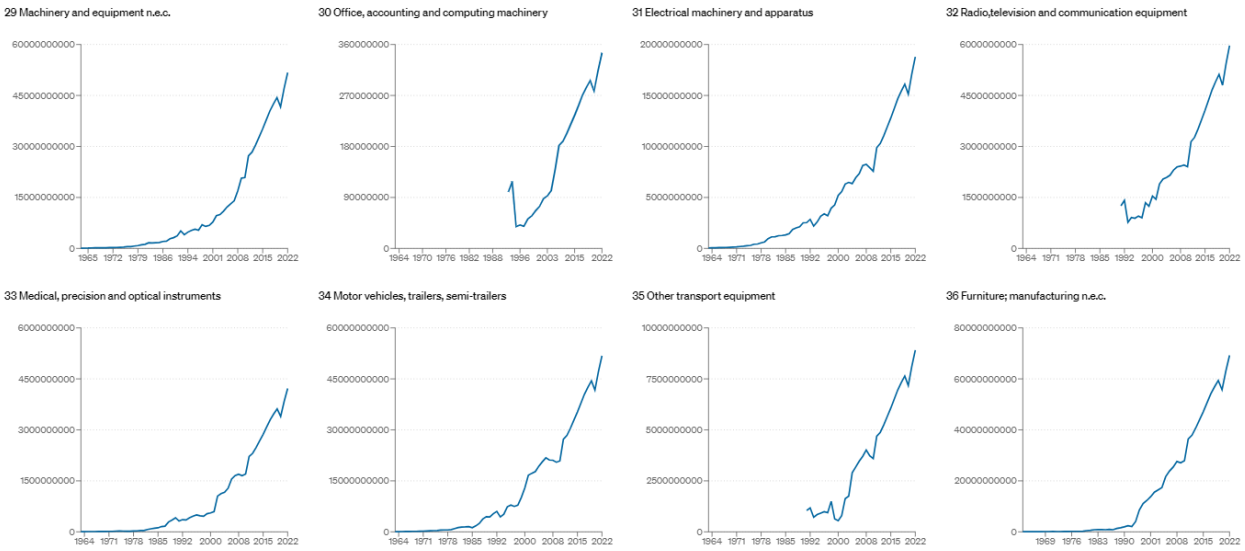
Appendix B.5: South African Manufacturing Employment (Part3)
Source: UNIDO Database



Appendix B.6: South African Manufacturing Value Added (Part1)
Source: UNIDO Database



Appendix B.6: South African Manufacturing Value Added (Part2)
Source: UNIDO Database



Appendix B.6: South African Manufacturing Value Added (Part3)
Source: UNIDO Database

Chapter 4

Telecommunication and Economic Growth in Africa

4.0 Introduction

The third industrial revolution was marked by electronic, IT and telecommunications rather than electronics or traditional mechanical technology. Economy also took on a new dimension in this information world, and with the rise of IT & internet dying industries got revitalized into digitized enterprises from production to delivery. The e-commerce sector is essentially fueled by the growth in telecommunications and Africa could undergo its own industrialization. Mobile penetration in Africa to the Internet and digital services represents some level of Digital Revolution coming into African economies. Mobile money services like M-Pesa in Kenya demonstrate the potential for telecommunications technology to contribute meaningfully towards financial inclusion and economic expansion. Business operates more effectively, government services improve, and information becomes accessible, all driving economic development. Information and Communication Technology (ICT) has increasingly attracted the attention of many researchers in recent times. One of the main perspectives maintains that generally, ICT improves societal life standards as it generates important revenue and creates jobs. It boosts economic performance by improving productivity, lowering business costs, minimizing price volatility, increasing market transparency, and creating more dynamic and attractive investment environments. This study aims to investigate the relationship between telecommunications development and economic growth, especially in African industrial countries from our previous works. This study also analyzes the impact of economic growth on the development of telecommunications. We present the top telecommunication companies and accentuate the leapfrogging and appropriate technologies that are central to many African countries.

4.0.1 Literature Review

Impact of telecommunication on economic growth

Various studies found that the telecommunications sector contributes significantly to GDP in many countries, exemplifying its role in modern economic structures. Norton (1992) analyzed how telecommunications reduce transaction costs and thereby enhance economic growth. Röller and Waverman (2001) have studied the impact of telecommunications infrastructure on economic growth of 21 industrialized OECD (Organization for Economic Co-operation and Development) countries over the period of 1970-1990 by jointly estimating a micro model for telecommunications investment with a macro production function. They found a bidirectional causality between the variables. The study shows a significant and positive relationship between telecommunications infrastructure and economic growth. They specifically found that a 10% increase in the telecommunications infrastructure stock leads to a 2.8% increase in GDP. They also discovered a threshold effect, which suggests that the condition for telecommunications infrastructure to have a major positive influence on economic growth is to reach a particular critical mass first. This implies that investments in telecommunications have non-linear benefits and necessitate a substantial initial investment. Qiang et al. (2009) in a World Bank report argued that broadband telecommunications can significantly boost economic growth, particularly in developing countries. Koutroumpis (2009) demonstrated the economic benefits of broadband telecommunications in multiple regions. Ding and Haynes (2006) have studied the impact of telecommunications infrastructure on regional economic growth in China using a panel data set of 29 regions over the period of 1986–2007. Employing the dynamic fixed effects model, they found that telecommunications infrastructure and real GDP per capita are positively correlated.

Aker and Mbiti (2010) examined how the proliferation of mobile phones has impacted economic development in Africa, highlighting various positive outcomes. They evaluate the effects of the rapid adoption of mobile phones on income, poverty reduction, and market efficiency. By improving market information accessibility and mitigating information asymmetries, mobile phones enable farmers and traders to make better decisions about prices and sales, so fostering more efficient markets. Additionally, by offering real-time information about costs in various areas, mobile phone use minimizes price dispersion among markets. Farmers that use mobile phones to get information on market prices and weather predictions, can also enhance agricultural productivity. Financial inclusion has greatly risen in Kenya thanks to mobile banking services like M-Pesa, especially in rural areas. This facilitates easier access to credit, improved savings, and seamless financial transactions. Jobs are also created by the mobile phone sector, from manufacturing to support services like sales and repairs. Notwithstanding the advantages, there are infrastructure-related difficulties, like the requirement for dependable electricity and network coverage in rural locations. The poorest sections of society may still find the cost of mobile phones and services to be unaffordable, and there are still certain issues with digital literacy that need to be resolved. This study uses primary data from surveys and secondary

data from national statistics offices, World Bank and International Telecommunication Union. The authors made use of Descriptive Statistics to show the trends in mobile phone adoption and usage across different regions and countries. Additionally, they analyzed the effect of mobile phone use on economic results. The independent variables included mobile phone adoption and usage rates while the dependent variables included measures of market efficiency, agricultural productivity, income, and poverty. They used Instrumental Variables (IV) to address endogeneity issues and robust causal inference techniques to comprehensively assess the impact of mobile phones on economic development in Africa.

Gruber and Koutroumpis (2011) have assessed the impact of mobile phones on annual GDP growth of 192 countries over the period 1990-1997 and found that mobile adoption had a positive impact on annual GDP growth (Gruber & Koutroumpis, 2011). Lee et al. (2012) have reviewed the effect on economic growth of mobile cellular phones in sub-Saharan Africa; they found that increased mobile phone coverage helps drive economic growth in sub-Saharan Africa. Statistical analysis revealed that mobile phones' positive effect on the economy has been steadily increasing over time. Notably, mobile phones make an even bigger difference in areas where traditional landline phones are scarce (Lee et al., 2012).

Chavula (2013) has studied the impact of telecommunications on economic growth in Africa between 1990 and 2007. Using a panel data analysis with the OLS method, the study reveals that across Africa, both traditional landlines and mobile phones helped improve people's quality of life, while internet access didn't make a noticeable difference to economic growth. However, when the countries are categorized into the three groups following the 2008 World Bank classification criteria using income levels, the results show that in richer African countries (upper-middle income), all three technologies - landlines, mobile phones, and internet - boosted economic growth. In poorer African countries (upper-low and low-income), only mobile phones made a significant impact to the economy. Moreover, mobile phones had the strongest positive effect on growth compared to other technologies across all country groups.

Donou-Adonsou et al. (2016)studied the impact of telecommunications infrastructure in Sub-Saharan Africa for 1993–2012. Applying the instrumental variable generalized method of moments (IV-GMM), they found that mobile and Internet and economic growth are significantly positively correlated.

Adeleye and Eboagu (2019) investigate the impact of information and communication technology (ICT) on economic growth across 54 African countries from 2005 to 2015. Their study aims to evaluate the relationship between economic growth in Africa and different ICT metrics, including internet usage, mobile subscriptions, and fixed telephone subscriptions (Adeleye & Eboagu, 2019). In order to adjust for variables like trade openness and inflation rate, the authors used econometric models such as pooled ordinary least squares (OLS), random and fixed-effects models, and the system generalized method of moments (GMM). It was discovered that there is a strong and positive correlation between ICT development and economic growth in Africa. The three ICT indicators' output elasticities, however, vary greatly from one another. Of all the models, mobile subscriptions had the biggest effect on economic growth. Furthermore, the study backs up

the leapfrogging theory, which postulates that African nations can skip some conventional developmental stages thanks to mobile technology. The study also discovered notable variations in the ways that ICT affects economic growth in various sub-regions of Africa. Concentrated efforts to lower expenses and improve ICT infrastructure can also stimulate economic growth. Haftu (2019) studied on the information communications technology and economic growth in Sub-Saharan Africa; Using a dynamic panel data model, they found that a "10% increase in mobile phone penetration results in a 1.2% change in GDP per capita" (Haftu, 2019). Although mobile phone access proved to be a valuable tool for reducing poverty by increasing individual earnings, greater internet availability didn't show any measurable impact on average income levels during the study period. Wachira and Njuguna (2023) discussed how mobile telecommunications, specifically mobile money, has transformed economic activities and growth in Kenya.

A study by Cleeve and Yiheyis (2014) investigates the relationship between mobile telephony and economic growth in Africa, focusing on how the proliferation of mobile phones influences economic development across the continent. The authors employed econometric models and a quantitative approach, analyzing data from 36 African countries. The study controlled for other variables that might affect economic growth, such as investment in infrastructure, education levels, and political stability. The findings indicate a significant positive correlation between mobile telephony and economic growth. Specifically, it was found that an increase in mobile phone penetration leads to an increase in GDP. The authors suggest that mobile telephony facilitates better communication, improves market efficiency, and provides new opportunities for businesses and entrepreneurs. The study also highlights the importance of complementary investments in infrastructure and education to maximize the benefits of mobile telephony on economic growth.

M. D. J. Williams et al. (2011) in a World Bank report provided an in-depth analysis of the impact of mobile telecommunications on economic growth in Africa. The report highlights the spectacular growth of mobile telecommunications in Africa, driven by liberalization of the sector, investments, and innovation. Mobile phone penetration has increased significantly, providing access to communication for millions. Telecommunications contribute to economic growth by improving business efficiency, reducing transaction costs, and facilitating access to information. The sector creates jobs directly (e.g., in network operation and maintenance) and indirectly (e.g., through increased business activities enabled by better communication). Mobile technology supports financial inclusion through mobile banking services, enabling people to save, transfer money, and access credit. Mobile phones also support healthcare delivery (e.g., through telemedicine and health information dissemination) and education (e.g., via educational content delivery). Despite progress, challenges remain such as the urban-rural divide, high costs of services, and regulatory issues. The report recommends policies to foster competition, reduce costs, and promote investment in infrastructure to extend services to underserved areas. The report by Williams, Mayer, and Minges underscores the significant role telecommunications play in driving economic growth and development in Africa.

It highlights both the opportunities created by the mobile revolution and the ongoing challenges that need to be addressed to fully leverage telecommunications for inclusive economic development. Several authors have argued on the positive correlation between telecommunications and economy highlighting the critical role of telecommunications infrastructure in enhancing economic productivity, reducing transaction costs, and fostering economic development. However, on the other hand, some authors have argued that telecommunications do not necessarily have a significant impact on economic growth, or that the relationship is more complex and contingent on other factors.

Eggleston et al. (2002) nuanced the relationship between ICT, including telecommunications, and economic development, highlighting that simply having access to technology does not guarantee economic growth therefore telecommunications infrastructure alone is insufficient for economic growth. The presence of complementary infrastructure, such as roads, electricity, and other public utilities, is essential. For example, mobile phones can improve market efficiencies, but without reliable transportation, the physical movement of goods remains a bottleneck. Effective regulation and competition in the telecommunications sector are also critical. The study highlights that countries with liberalized markets and robust regulatory frameworks see more significant economic benefits from telecommunications. Regulatory policies that ensure fair competition and prevent monopolies can lead to lower prices and better service quality, thus enhancing the economic impact. The economic policy environment plays a crucial role as well. The stable macroeconomic conditions, prudent fiscal management, and trade openness, complement the benefits of telecommunications. Good governance and strong institutions ensure that the gains from telecommunications are broadly shared and not captured by a few.

The level of human capital, including education and skills, is vital. Telecommunications can enhance productivity and innovation, but only if the workforce has the necessary skills to leverage these technologies. Investment in education and training programs that focus on ICT skills can amplify the economic benefits of telecommunications. The study provides empirical evidence showing varying impacts of telecommunications based on these conditional factors. For instance, in regions with strong complementary infrastructure and supportive regulatory environments, the economic benefits of telecommunications are more pronounced. On the contrary, in areas lacking these conditions, the impact is less significant, illustrating the importance of a conducive environment. While telecommunications have the potential to drive economic growth, their impact is conditional on several factors including the availability of complementary infrastructure, effective regulatory frameworks, sound economic policies, a skilled workforce, well-integrated markets, and supportive social and cultural environments. Without these enabling conditions, the potential economic benefits of telecommunications may not be fully realized.

Datta and Agarwal (2004) analyzed the relationship between telecommunications infrastructure and economic growth using panel data from 22 OECD countries. They found that while there is a positive relationship between telecommunications and economic growth, the strength and significance of this relationship can vary, suggesting that

telecommunications only are not a panacea for economic growth. The impact of telecommunications on economic growth is conditioned by the presence of complementary factors, such as education, regulatory frameworks and the level of economic development. Deregulation and liberalization of the telecommunications sector lead to increased investments, lower costs, and improved service quality, which spur economic growth. Countries with monopolistic market structures tend to experience less pronounced economic benefits from telecommunications. The level of economic development influences the impact of telecommunications. In more developed economies, telecommunications infrastructure enhances existing capabilities and drives further growth. In developing economies, while the potential for impact is high, the absence of supporting infrastructure and institutions can limit the effectiveness of telecommunications in driving growth. The availability and quality of complementary infrastructure such as electricity, roads, and logistics are crucial. Without these enabling conditions, the potential for telecommunications to drive economic growth will be constrained.

Kenny (2003) examines the impact of the Internet on economic growth and argues that this impact of telecommunications, particularly the internet, on economic growth in less-developed countries is often overstated and contingent on other supportive factors. He found that while the Internet has potential, its direct impact on economic growth in LDCs is limited due to existing infrastructural, educational, and economic challenges. The article also emphasizes the necessity of complementary investments in human capital, infrastructure, and institutions to fully harness the benefits of the Internet. Kenny highlights that the Internet can have significant indirect benefits, such as improving access to information, enhancing communication, and facilitating better governance and service delivery. The article suggests that while the Internet can contribute to development, it is not a panacea and should be part of a broader development strategy. Kenny (2003) recommends policies that focus on increasing access to the Internet, improving digital literacy, and fostering an enabling environment for technological adoption.

Matalqah and Warad (2017) investigate the role of telecommunications infrastructure on economic growth in Arab countries, distinguishing between oil-producing and non-oil producing nations. The results of the study reveal that investment in telecommunications has a significant and positive impact on economic growth in non-oil producing Arab countries. Specifically, a 10% increase in the number of telecom subscribers can lead to a 3% increase in real GDP in these countries. However, the same impact is not observed in oil-producing Arab countries, where there was no evidence of a strong relationship between telecommunications infrastructure and economic performance. This suggests that in oil-producing countries, the economy might rely more heavily on oil revenues rather than the development of telecommunications infrastructure.

Gillwald et al. (2012) study about the implications of telecommunications reforms in Southern Africa, analyzing how these reforms have impacted economic growth and access to services. They argue that despite the rapid expansion of telecommunications infrastructure in South-Africa, the impact on economic growth has been uneven and often limited by regulatory, infrastructural, and socioeconomic barriers.

Mutula (2008) discusses the digital divide in Sub-Saharan Africa and argues that while telecommunications have the potential to contribute to economic growth, the benefits are often not realized due to disparities in access, education, and supporting infrastructure. These articles provide a more critical perspective on the assumed positive relationship between telecommunications and economic growth. While telecommunications infrastructure has expanded rapidly in many parts of Africa, its impact on economic growth is not straightforward and is often mediated by other factors.

An important angle that this study approached is to elaborate on the impact of economic growth on telecommunication. Although there have been several studies on how telecommunication affect economy, rare studies have really set a focus on analyzing the effect of the economy on telecommunication.

4.1 Impact of economic growth on telecommunication

Economic growth can significantly impact telecommunication development. People need to achieve certain level of ease in order to be able to acquire telecommunications' goods. Economic growth often leads to higher demand for telecommunications services, including mobile networks, internet access, and related technologies. Therefore, more resources are allocated for telecommunication infrastructure, such as broadband networks, fiber-optic cables etc. Economic growth leads to the expansion of markets, providing telecommunications companies with new opportunities for growth and service provision.

Lam and Shiu (2010) studied on the economic growth and telecommunications development around the world and found that mobile telecommunications development has been a main factor of global economic growth in recent years. While mobile phone adoption has boosted economies worldwide, its economic impact varies significantly between regions. In Europe and wealthy nations, having more people using mobile phones (higher teledensity) directly leads to increased wealth and income. However, in developing countries, the relationship works differently - economic growth tends to drive mobile phone adoption, rather than mobile phone adoption driving economic growth. As Nigeria's economy grew, the telecommunications sector experienced substantial investment and expansion. Companies like MTN and Airtel have played significant roles in improving connectivity and access to mobile services across the country. South Africa's relatively advanced economy has enabled it to develop a robust telecommunications infrastructure. The country has seen significant investment in both mobile and fixed-line networks, contributing to its position as a regional telecom hub.

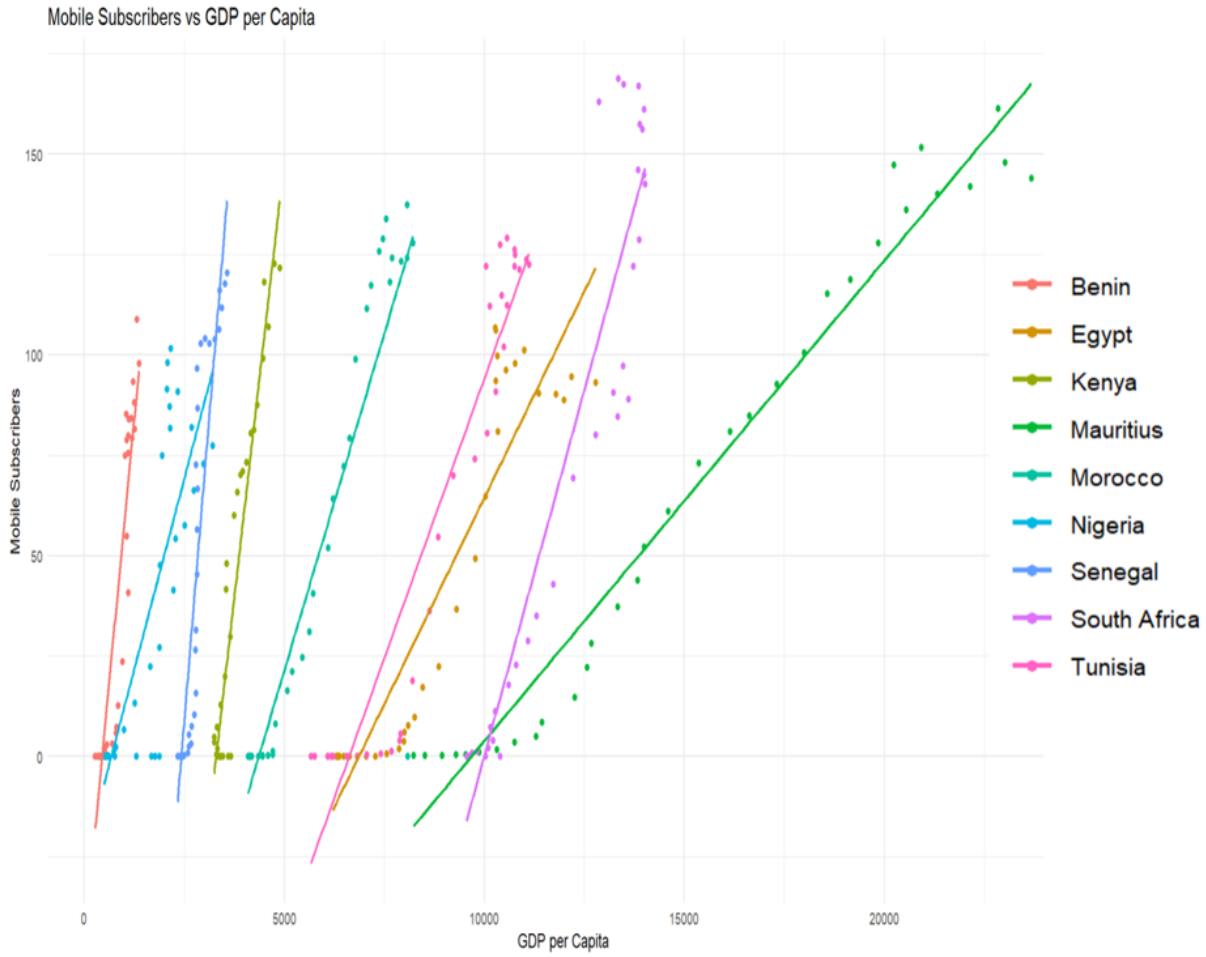


Figure 4.1: Scatter Plot of GDP per Capita and Mobile Subscribers in 9 African countries
Source: By authors based on World Bank database

The Figure 4.1 scatter plot depicts the relationship between GDP per capita (x-axis) and mobile subscribers (y-axis) for the African countries studied in the previous chapters. Each data point represents a specific country variable, and the lines represent linear regression fits for each country, color-coded and listed in the legend.

We could observe in general a slight positive correlation; This positive trend, indicates that as GDP per capita increases, the number of mobile subscribers also increases across most countries. This suggests that wealthier countries with higher GDP per capita in Africa tend to have more mobile subscribers. In addition, the countries of the study have different slopes, indicating that the relationship between GDP per capita and mobile subscribers varies and is country-specific:

- Egypt has a positive trend indicating a strong relationship between mobile subscribers and GDP per capita. As the GDP per capita increases, so does the mobile subscription.
- Tunisia has a moderate positive relationship with a slightly flatter slope, similar to that of Morocco and Nigeria.
- Mauritius shows the strongest positive correlation in the selection implying that as GDP per capital increases, the mobile subscription as well increases.

- South Africa has a slightly bent slope showing a very moderate relationship between the mobile subscription and GDP per capita.
- Benin, Senegal and Kenya are similar with a more vertical trend, suggesting a very minimal relationship between GDP per capita and mobile subscriptions.

In summary, the plot effectively illustrates that while there is a general trend of increasing mobile subscribers with increasing GDP per capita, the strength of this relationship varies significantly across the African countries selected. Most countries show weak positive relationships, while Mauritius shows the strongest relationship. This variation highlights the complexity and diversity of the African market, which may be attributed to differences in market maturity, government policies, infrastructure, or other socio-economic factors.

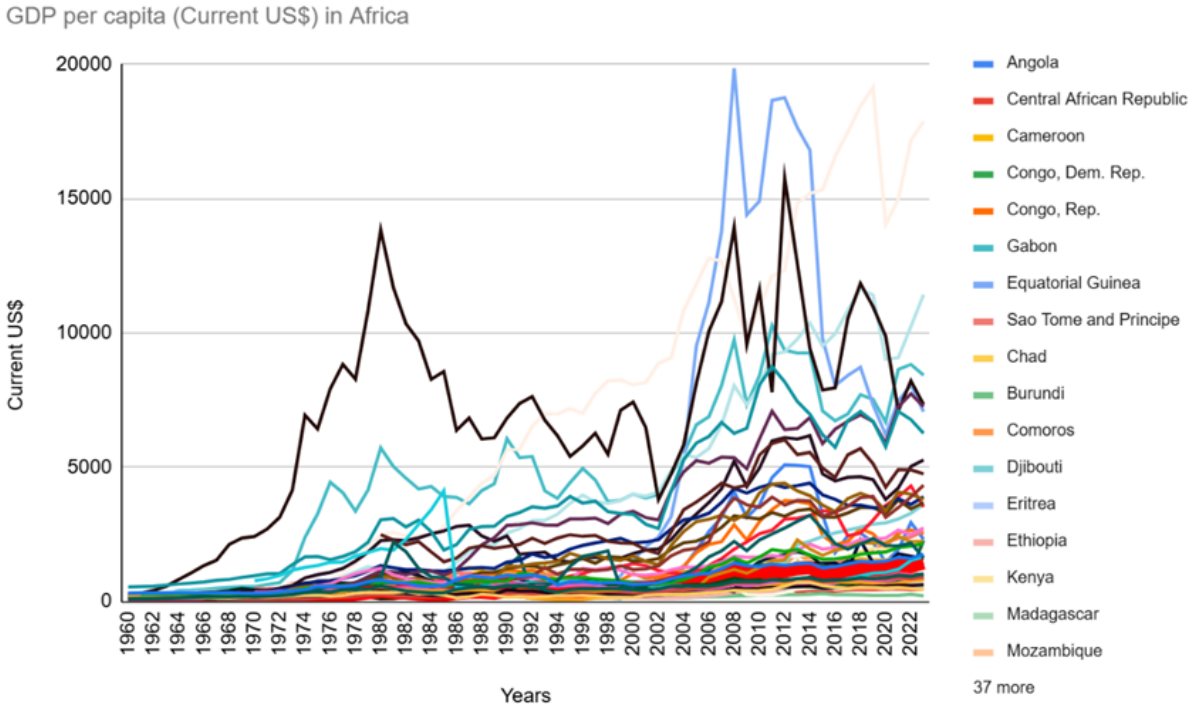


Figure 4.2: GDP per capita for African countries

As shown in figure 4.2, the GDP per capita in Benin is very low, yet the mobile cellular subscription in the country is high and above 100% (Figure 4.3). Before 2000, most African countries had a very low or inexistent mobile cellular subscription. By the end of the 20th century and in the beginning of the 21st, most African countries adopted privatization and liberalization which led to the entry of many private and international telecommunication companies. The following years witnessed a tremendous growth of mobile subscription rising from nearly 0% to above 200%. Benin mobile cellular subscription follows the typical trend in Africa hanging at an average position which leads us to consider the country for a more detailed study in the last chapter. In Benin Republic, most people have at least one mobile cellular phone on average. The data from the internet subscription shown in Figure 4.10 reveal that about 34% of Beninese have access to the internet. This implies

that most people still use the first-generation mobile GSM leading to the appropriate technology concept. This concept involves cost-effective solutions given to local people using the Last-Mile Connectivity. The Mobile Money and Digital Banking is a typical example of the appropriate technology whereby in Kenya for example M-PESA enables financial inclusion for unbanked populations simply with the use of basic feature phones, not just smartphones. Depending of the service, the appropriate technology uses mixed technologies such as GSM for basic coverage, small cell solutions for dense urban areas and a focus on reliability over high bandwidth.

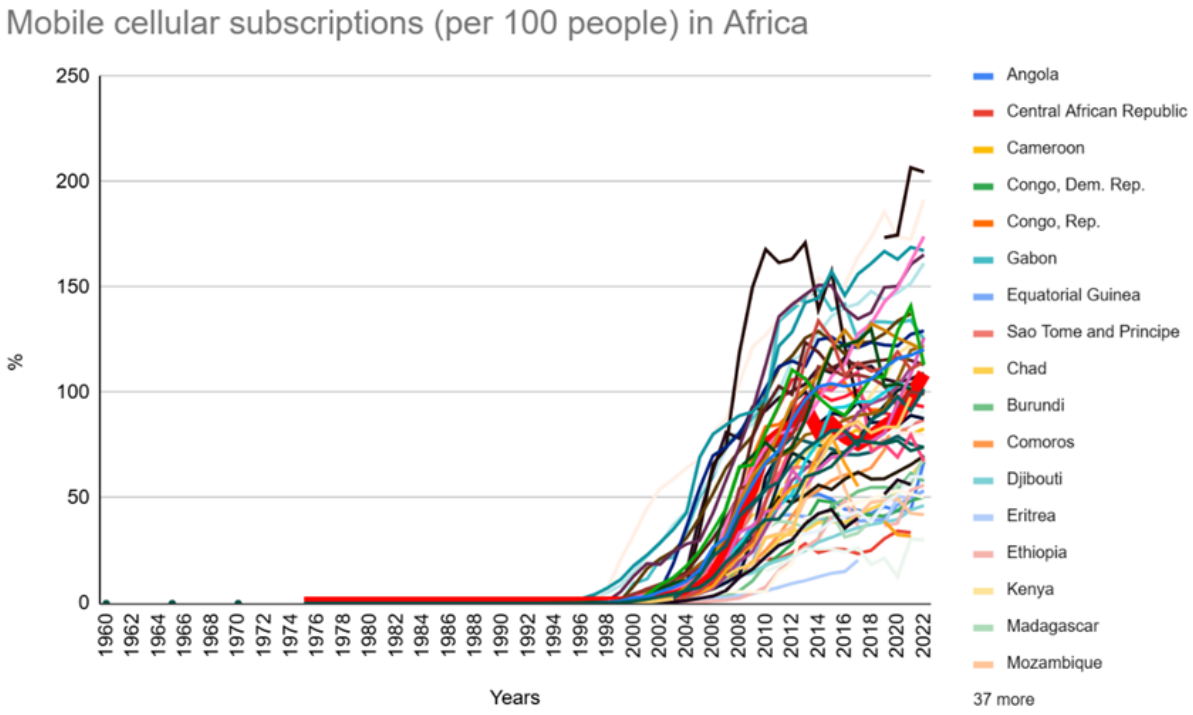


Figure 4.3: Mobile cellular subscription in African countries
Source: World Bank database

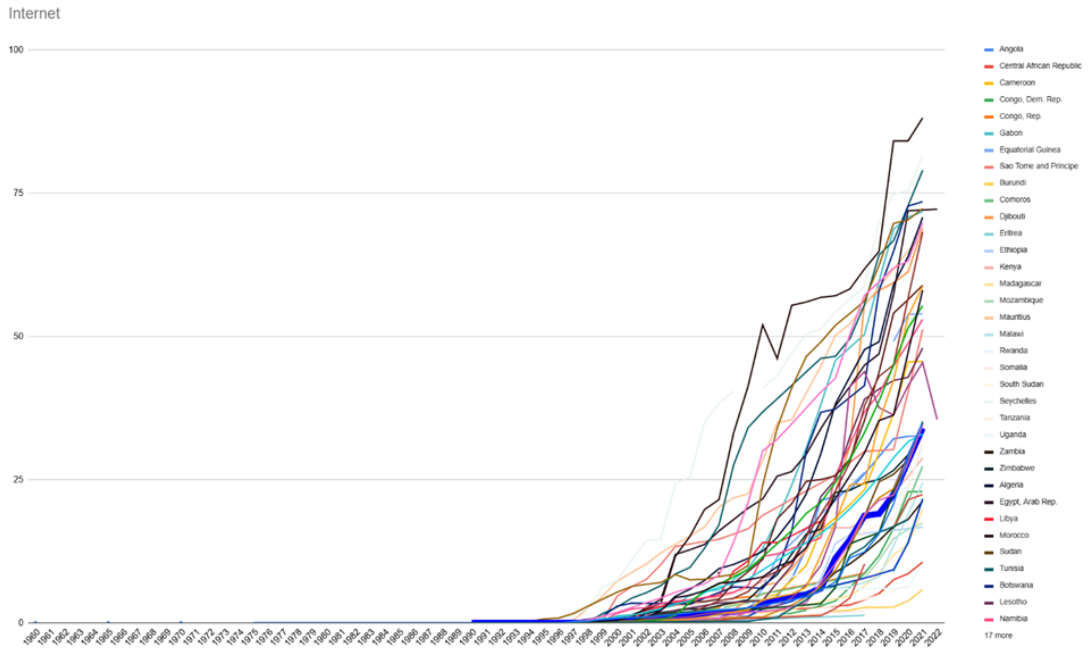


Figure 4.4: Internet Users in African countries
Source: World Bank database

4.2 Leapfrog and Appropriate Technology

The leapfrogging of mobile telecommunications in Africa refers to the bypassing of traditional stages of technological development to directly adopt the latest innovations. Instead of gradually evolving through various phases of telecommunications infrastructure, such as landline phones, Africa has largely skipped directly to the wide spreading of mobile phone usage. Mobile technology was adopted at a much faster rate compared to other regions. According to Aker and Mbiti (2010), the mobile phone has effectively leapfrogged the landline in Africa (Figure 4.3 and Figure 4.5). In fact, in many African countries, the penetration of mobile phones increased rapidly because of the low-cost of mobile devices designed for African markets and in addition, they provided an accessible communication tool to a population that had limited access to other forms of telecommunication. Greater access in rural areas has also become available. Despite the low levels of landline infrastructure, African countries have the highest mobile phone adoption rates in the world. Leapfrogging in mobile telecommunications has allowed countries to rapidly advance in terms of connectivity, economic development, and social services without the need for extensive and costly infrastructure associated with traditional telecommunications. It has also led to the development and widespread use of mobile-based services, such as mobile money (e.g., M-Pesa in Kenya), which allows people to perform financial transactions through mobile phones, bypassing traditional banking systems. Aron (2017) posits that "mobile money technology has spread rapidly in the developing world, “leapfrogging” the provision of formal banking services by solving the problems of weak institutional

infrastructure and the cost structure of conventional banking". Digital finance has helped to access and make use of digital solutions such as mobile money, online banking, and others without building physical banks with conventional banking systems. The leapfrogging goes along with the appropriate technology whereby people are not required to have access to the highest or latest technology in order to enjoy telecommunication services. For instance, low-cost devices including GSM can be used to perform financial transactions even offline. This justifies why in African countries, although the mobile cellular subscription is high, the internet users are not equally as significant (Figure 2.3 and Figure 4.4).

The following Figure 4.2 shows the rise in the mobile subscription over the years depicting the breakthrough in the mobile phone technology in most industrialized African countries.

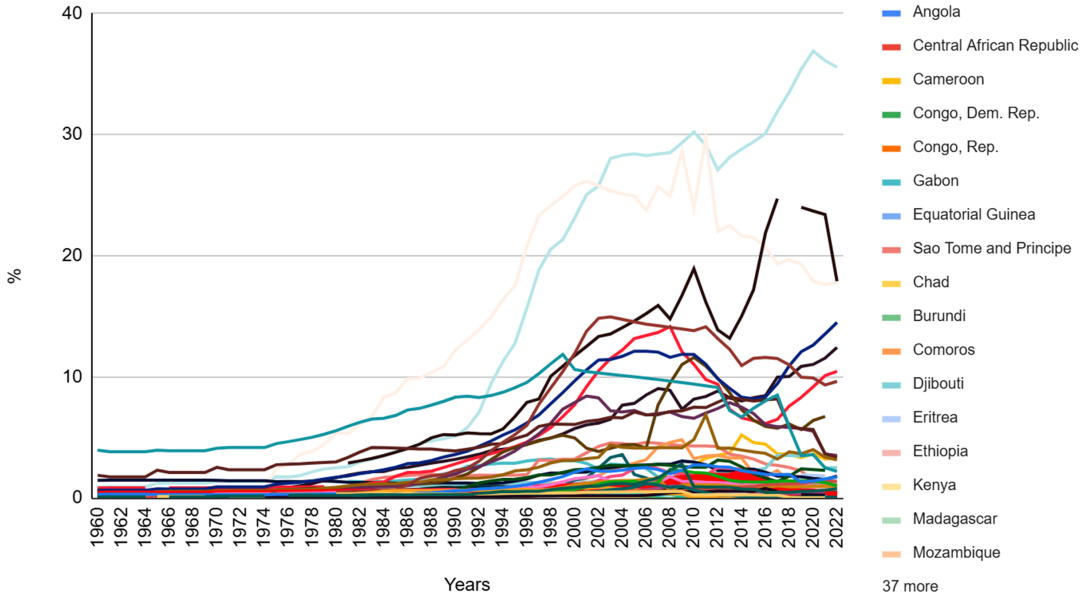


Figure 4.5: Fixed Phones in African Countries
Source: World Bank database

4.3 Telecommunication companies in Africa and Submarines cables.

After privatization in Africa around 2000, several telecommunications companies mostly international and private made their entry into the telecommunication markets in most African countries. Each multinational in its own way impacts the market with new innovations and high technology. Safaricom's M-Pesa in Kenya is as a groundbreaking innovation in mobile banking, driving financial inclusion and economic activity. MTN Group's extensive network and service offerings are credited with enhancing connectivity and supporting various economic sectors across Africa. M. D. J. Williams et al. (2011) develop on how telecommunication companies such as MTN Group, Vodacom, Orange S.A., Safaricom, and Airtel played a crucial role in the mobile revolution in Africa.

Here are the major players on the telecommunication market in Africa.

4.3.1 MTN Group

MTN is the largest telecommunication multinational in Africa by subscribers with its headquarter in South-Africa. It operates in Nigeria (more than 82 million subscribers), South Africa (about 33 million subscribers), Ghana (26 million subscribers), Uganda (16 million subscribers), Cameroon, Ivory Coast, Rwanda, Zambia, Liberia, Benin, Guinea-Conakry, Guinea-Bissau, Congo-Brazzaville, Sudan, and Eswatini. MTN total subscribers' number exceeds 290 million in Africa as of 2023.

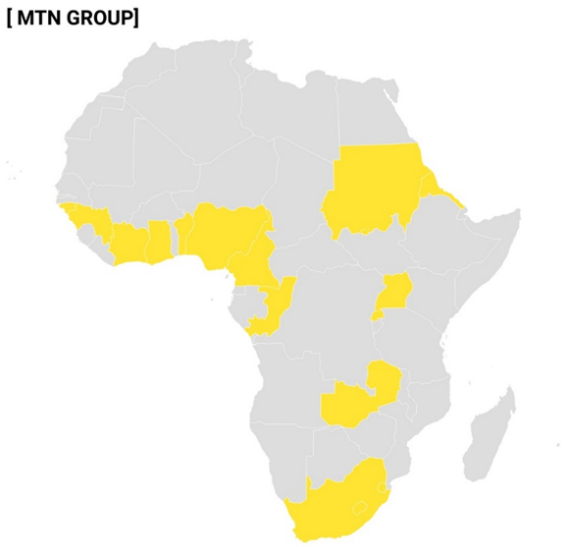


Figure 4.6: MTN Presence in Africa
Source: By authors

Several significant submarine cables are connected to MTN Africa, which is essential for supporting its operations throughout the continent and enabling international connectivity. MTN is linked to the West Africa Cable System (WACS), a high-capacity underwater cable that connects several African nations to Europe and stretches around the continent's west coast. Due to MTN's significant investment in this cable, its ability to provide high-speed internet and other services is improved. SAT-3/WASC: This cable system crosses various West African nations en route from South Africa to Europe. MTN is a major participant in this system and uses it to give its clients in these areas access to connectivity. ACE (Africa Coast to Europe): The ACE cable, which has landing sites spread across several African nations, connects Europe to the west coast of Africa. By using this cable, MTN is able to increase service quality and redundancy inside its network. The Eastern Africa Submarine Cable System, or EASSy, connects nations from Sudan to South Africa and beyond to Europe and Asia. It stretches along the continent's east coast. Strong connectivity in East Africa is made possible by MTN's participation in EASSy.Another significant subterranean cable network that links Africa to Europe and Asia is called SEACOM.

MTN leverages SEACOM to bolster its data services and ensure high-speed connectivity across its network. Impact on Market Leadership MTN's extensive connectivity to these submarine cables significantly strengthens its position as a leader in the African telecommunications market.

MTN makes use of SEACOM to improve its data offerings and guarantee fast network connectivity. Market Leadership Affected MTN's position as the industry leader in African telecommunications is further enhanced by its wide connectivity to these underwater cables.

Compared to rivals, MTN can provide faster internet speeds and more dependable service since it is connected to many high-capacity underwater cables. In a market where demand for data services is rising quickly, this is essential. MTN has network redundancy thanks to its numerous cable connection; in the event that one cable malfunctions, traffic can be redirected via another. Asia and Europe to Africa. This guarantees continuous service, which is essential to preserving market leadership and client trust.

MTN is able to offer services in a wide geographic region, encompassing both the east and west coasts of Africa, thanks to its varied network of cables. This broad reach is an advantage over competitors, particularly in regions where dependable connectivity is still a problem. The strategic ties that MTN has to these underwater cables help it to keep and grow its market-leading position in the African telecoms industry.

4.3.2 Vodafone Group

Vodafone, through its subsidiary Vodacom, has a substantial presence in Africa. It serves more than 44 million people in Egypt, 44 million people in South Africa, 44 million people in Kenya, 43.8 million people in Tanzania, 16.7 million people in the Democratic Republic of the Congo, 15 million people in Mozambique, 10.7 million people in Ethiopia, and 1.7 million people in Lesotho.

Figure 4.7: Vodafone Presence in Africa
Source: By authors

4.3.3 Airtel Africa

Based in New Delhi, Bharti Airtel is a global Indian telecommunications services corporation. Airtel Africa is a subsidiary of this company. It serves 15 African nations, including the Democratic Republic of the Congo, Congo Brazzaville, Madagascar, Gabon, Seychelles, Tanzania, Chad, Niger, Malawi, Zambia, Ghana, Rwanda, Nigeria (60 million subscribers), Kenya (17 million subscribers), Uganda (13 million subscribers), and Kenya. By 2023, the company will have served over 143 million clients.

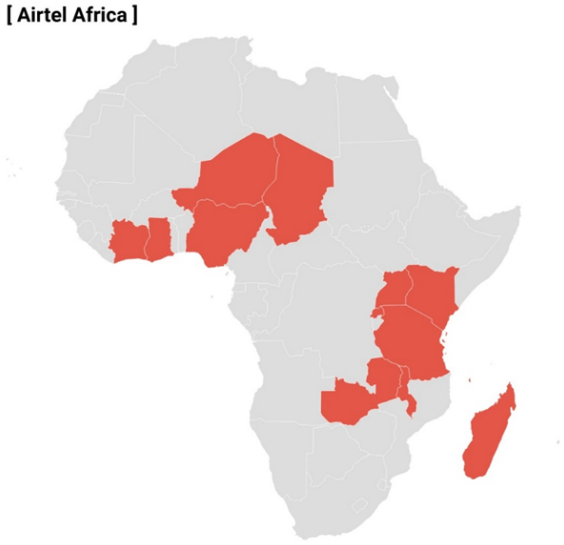


Figure 4.8: Airtel Presence in Africa
Source: By authors

4.3.4 Orange Group

Orange Group is a French multinational with a strong presence in North and West Africa. Headquartered in France, its operation are in countries such as Egypt (43 million subscribers), Morocco (21 million subscribers), Tunisia, Côte d'Ivoire (13 million subscribers), Senegal, Cameroon, Mali, Guinea, Botswana, Burkina Faso, Democratic Republic of Congo, Central African Republic, Guinea-Bissau, Liberia, Madagascar, Sierra Leone, Mauritius. Orange has around 140 million subscribers in Africa.

Figure 4.9: Orange Presence in Africa
Source: By authors

4.3.5 Etisalat

Etisalat, known as Emirates Telecommunications Group Company has its headquarters in the United Arab Emirates. It operates in Egypt (approximately 26 million subscribers) and Morocco. Etisalat operates in Morocco through its stake in Maroc Telecom. The group therefore has indirect control over approximately 75 million subscribers across Morocco and other African countries such as Mauritania, Mali, Burkina Faso, Gabon, Côte d'Ivoire, Benin, Togo, Niger, and Central African Republic.

The multinational operated in Nigeria and Sudan in the past. The total number of subscribers directly under the Etisalat brand in Africa is around 26 million, with an indirect influence over approximately 75 million subscribers through its stake in Maroc Telecom.

Figure 4.10: Etisalat Presence in Africa
Source: By authors

4.4 Conclusion

The rise of the service sector made ground for the telecommunication outbreak, especially in African countries. telecommunication infrastructure is the core factor influencing industrial sector productivity in Sub-Saharan Africa is both through their quantity and quality. (Azolibe & Okonkwo, 2020). This chapter reviewed the development of telecommunication as a component of the third industrial revolution especially in Africa. Studies associate the surge of telecommunication with economic growth while others argue about a conditional relationship based on several other factors. We try to evaluate how the economic level affects the penetration of mobile telecommunication in a few most industrialized African countries and discover a moderate positive correlation. This study also presents the leapfrogging experience in telecommunication, especially with mobile telephony with an unprecedented outbreak permitting Africa to enjoy the latest technology in the sector in the same ways as developed countries. These could have been seen as a catch-up to the difference that Africa is not as productively engaged but rather in a position of consumer. Among the most dominant telecommunication companies, only MTN is an African-based provider. Since telecommunication has great potential in the new era, African countries need to rather engage more productively to fully benefit from the outcomes.

Chapter 5

The development of multinationals in the contemporary French West-Africa: Case study of the mobile telecommunication market in Benin Republic (2000-2021)

5.0 Introduction

Telecommunication infrastructures are major keys in the economy and overall development of all nations. These facilities have played such pivotal roles since the Second Industrial revolution with the advent of revolutionary means of transport and telecommunication, as they contributed lowering costs and increasing speed in distributing goods (Franco Amatori, 2013). Over the few decades, new communications systems have been implemented in African countries, notably in telecommunication area where telegraphs have been replaced by telephones. In West Africa, the mobile telephony market has been particularly dynamic as landlines fixed telephone were losing predominance, especially in the French West African country, Benin Republic. According to the WorldBank database as shown in Figure 5.1, the fixed telephone subscription in Benin had an increasing trend with a maximum of 195,662 subscribers, until 2015 when it started dropping drastically. As of the mobile telephony system, it became active in Benin around 2000 with an overall increasing trend of subscribers reaching 8,660,432 in 2014 (Figure 5.2). This rise is very significant and more important than that of the fixed line. In the region of the Economic Community of West African States (ECOWAS) as well, the mobile coverage in Benin Republic is the highest as of 2014 (Figure 5.3). The GSMA (Groupe Speciale Mobile Association) Mobile Economy speculates Sub-Saharan Africa will remain the fastest growing region, with a Compound Annual Growth Rate (CAGR) of 4.6% and an additional 167 million subscribers over the period to 2025 which will take the total subscriber base to just over 600 million, representing around half the population.[1]. These different situations and facts have attracted the interest of many researchers in telecommunication from various perspectives with specific results depending on geographic consideration. Few studies have addressed the question of telecommunication and companies performance analysis especially in Benin. This paper is a descriptive study that focuses on the situation of the mobile telecommunication market in French West African Benin, evaluating details of the different careers that have operated and/or continue to operate on the market, and specifying the important growth variables. Benin, previously known as Dahomey until 1975, got its independence in August 1960 with a population of more than 13 million people as of 2022 (United Nations data). Benin has a strategic location in Africa bordered in the southern part of the country by the Atlantic Ocean. The coastline stretches approximately 125 kilometers (78 miles) along the Bight of Benin. The autonomous port of Cotonou in Benin handles important trade activities and serves as a hub for the West African region. In addition, Benin stands in a position between two giant English-speaking countries such as Nigeria and Ghana while being a French-speaking country. With these important features, Benin stands as a crossroad and the perfect example of a French and English culture co-existance in the western African region.

[1]The Mobile Economy Sub-Saharan Africa 2019, GSMA 2019

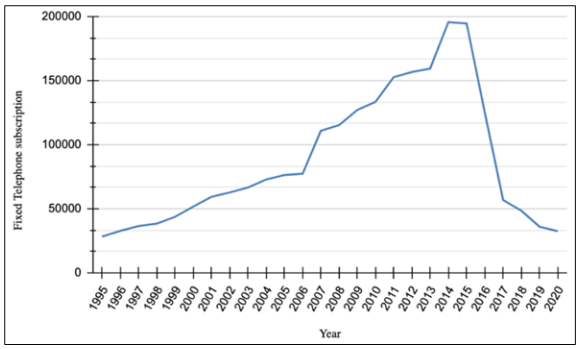


Figure 5.1: Fixed Telephone Subscription per year

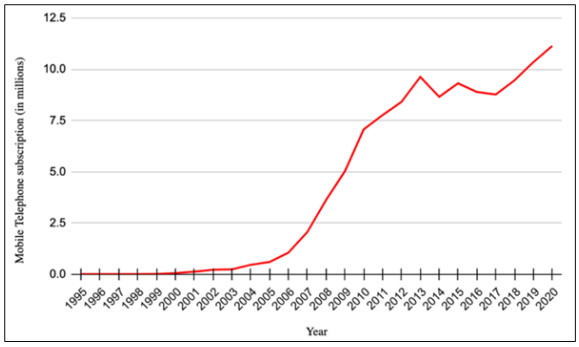


Figure 5.2: Mobile Telephone Subscription per year
Source: WorldBank Database

Country	***Population Covered by mobile***
Benin	*99*
Burkina Faso	*N/A*
Cape Verde	*96*
Cote d'Ivoire	*95*
Ghana	*87*
Mali	*N/A*
Nigeria	*96*
Senegal	*91*
Togo	*91*

Figure 5.3: Mobile Population Coverage in ECOWAS
Source: The little databook on ICT (World Bank Group, 2014)

5.1 Objective

The general objective of this study is to assess the evolution of mobile telecommunication market in Benin in the contemporary period. The specific objectives consist in:

- Explaining the evolution of the incursion and withdrawal of GSM networks careers in Benin;
- Determining the performance of the various GSM networks and some plausible causes;
- Clarifying and analyzing the position of telecommunication multinational's investment.

5.2 Literature Review

Telecommunication reduced many barriers and costs related to information sharing. After the independence, the telegraph system was the most popular technology for communication in colonies. Telephone was as well used but rapidly grew, undergoing several changes resulting in fixed and mobile telephony. Literature has often evaluated the development of fixed telephone market in contrast with mobile telephone. A performance review of the telecommunication shows that in Benin the mobile telephony between 2000 and 2005 is more successful than fixed telephony due to its accessibility, technological innovation, the relative ease with which it can be implemented and its convenience; While landline faces low fixed-line telephone broadband penetration rate, a slow network development and poor exchange trunks (Chabossou, 2007). The success of mobile telephony in Benin is due to several failures of fixed telephony services such as the low network coverage, the high cost, the slowness of line assigning process etc. (Chembessi, 2013). This process refers to the concept of "leapfrog" as the mobile telephony involved incremental improvement to override the fixed telephone system which was encountering various limitations. A study in 54 African countries from 2005 to 2015 about ICT analyzing the internet, mobile subscribers and fixed telephone subscribers supported the "leapfrogging" hypothesis highlighting the fact that the mobile subscribers ranked highest and represent the dominant enhancer of economic growth in Africa in addition to exhibiting the most "leapfrogging" potential among the three ICT indicators (Adeleye & Eboagu, 2019). Another study in 46 sub-Sahara African countries revealed that the deployment of submarine cables has almost doubled the penetration of Internet. Furthermore, it showed that exogenous sources of telecommunication disruptions related to submarine cables reduce internet and mobile penetration rates, lower investments in ICTs, increase mobile-cellular tariffs and the wireline network instability (Cariolle, 2018).
Another important factor to consider about telecommunication is the innovative technology involved including the 3G, 4G and others. Mobile telephony first used the 1G (first generation) technology and evolved to the Global System for Mobile Communications (GSM) with the 2G technology which, in its turn, was later replaced by the 3G, dominant on the Sub-Saharan African market at this time. According to GSMA report, 2022 marks

a turning point as 3G adoption begins to decline for the first time reflecting the growing shift towards 4G as operators take steps to migrate customers from legacy networks (2G and 3G) and by 2025, 4G will account for a third of mobile connections in the region, compared to under a fifth of connections in 2021.[2]

A descriptive study of the mobile telephony market in Croatia shows a strong competition on the market between 2010 and 2013 while alerting for an investigation on the causal effects of a telecommunication tax on mobile price and operators' price-quality behavior (Forenbacher et al., 2009). Several studies have been carried out in the telecommunication sector in various parts of the world from different perspectives with different findings but few academic articles focused on the market in West-African Benin. As far as we know, no study on a consistently long period of time in Benin with a focus on companies' panel data.

5.3 Data and Methodology

Initially, we conducted a documentary review on the evolution of telecommunication technologies in general and in Benin in particular. We used panel data collected from reports and statistics of the Autorité Transitoire de Régulation des Postes et Télécommunications (ATRPT) and the Autorité de Régulation des Communications Electroniques et de la Poste du Benin (ARCEP BENIN), from the World Bank database, and journalistic sources during the period 2000-2020. Here are the used mobile market indicators: mobile subscription, investment, and turnover.

A descriptive analysis was carried out based on the data from the various annual reports (ATRPT, ARCEP, MTN, MOOV etc.) and information from the journal articles as we evaluate the quality and relevance of the sources of the information in order to draw some important results about the telecommunication market business in Benin.

As we were linking elements from various sources, we found some discrepancies in the broadly published data. Actually, data published by ARCEP and the ones from the ATRPT do not match, especially when it comes to the number of subscribers, investment and turnover for the years 2012 and 2013. In addition, World Bank's data seem to be slightly different from that of ATRPT, mostly around 2006-2009. After reflexion and logical considerations, we decided to exploit ATRPT's data in 2003-2013 and ARCEP's data in 2014-2021 for this study. Actually, we have considered the fact that ATRPT was the agency in charge of the telecommunication regulation until May, 2014[3] (ARCEP, Benin, 2014) after the adoption of its creation's ordinance on January 31st, 2002[4]. After July 2014, ARCEP became the official Regulatory authority of telecommunication in Benin3 and we therefore believe data until 2013 should simply be a transcription from the reports of the previous authority in charge, unless there are some corrections which have not

[2]The Mobile Economy Sub-Saharan Africa 2022, GSMA 2022 (https://www.gsma.com/mobileeconomy/wp-content/uploads/2022/10/The-Mobile-Economy-Sub-Saharan-Africa-2022.pdf)

[3]Rapport ARCEP 2014

[4]Ordonnance No 2002-003 du 3l Janvier 2002

been mentioned from our investigations. Regarding the difference between the data from ATRPT and WorldBank, we think ATRPT source is more reliable as they are on the field and are more qualified and entitled to produce accurate figures of the telecommunication market in Benin. Based on the telecommunication market trend in Benin, a periodization in three stages has been considered in the results.

5.4 Results

5.4.1 Telecommunication Market Situation

After the independence of Benin in 1960, The management of the telecommunication sector was the sole responsibility of the government. In 1999, the liberalization of the mobile telephony was effective (Affougnon, 2009), leading to the entry of international, private and local telecommunication companies. Benin recorded a total number of 5 mobile telephone operators in its history as of 2021. The exploitable data collected, ranging from 2003 to 2021 allowed us to design the following Table 5.1 describing the important facts on the telecommunication market at specific periods of time.

MTN and Moov are the two multinationals active on the telecommunication market of Benin Republic at the time of this study. In 2021, it was recorded that MTN's business in Africa was extended to 17 countries while Moov is present in 12 countries of Africa as represented in Figure 5.4 and Figure 5.5.

5.4.2 Emerging of telecommunication companies (2000-2007)

During this period, all the 4 careers on the GSM market experienced a steady growth. BBCOM had the most significant evolution as in 2003, within 4 years, its number of subscribers increased by 50 times as described in Figure 5.6. Libercom has the least significant growth, considering that its subscribers almost tripled over the 4years. Although BBCom made a good progress, MTN and Moov have the highest share of the subscribers on the market being in a tight competition with MTN ahead as shown in the Figure 5.6.

Table 5.1: Telecommunication market in Benin Republic from 2003 to 2020

Period	LIBERCOM	SPACETEL MTN Benin	Etisalat Moov Benin	Bell Benin Communication BBCom	Globacom Glo
1st Period: Growth of the GSM from 2000 to 2007	Commercial activities launched in May, 2000. Subsidiary of the historical operator Benin Telecom SA	Commercial activities launched in June 2000 as BeninCell. Changed name to Areeba in 2005. MTN acquired Areeba in June 2006. License suspended on July 9, 2007 due to brand change	Commercial activities launched in July, 2000 as Telecel. Changed name to Moov (Atlantique Telecom Group). Operated by Etisalat, a subsidiary of Maroc Telecom Group. License suspended on July 9, 2007 due to non-compliance	Commercial activities launched in December, 2003. BBCOM is an operator with majority Beninese capital	License obtained in August, 2007
2nd Period: Marketing –Strategy –Competition from 2008 to 2013	-	3G Internet service (2012)	3G Internet service (2013)	-	Commercial activities launched in June, 2008. 100%-owned by Nigerian investors
3rd Period: Struggle on the market from 2014 to 2017	-	-	-	Cancelation of BBCOM's GSM operating license in 2017 due to failure to meet obligations regarding continuity of service, and non-payment of debts (Agence Ecofin reports)	Operating license of Globacom's local unit withdrew in a dispute over new terms related to the price of the license renewal in 2017.
4th Period: Duopoly on the market from 2018 to	Commercial activities stopped on August 29, 2018	Nº1 Telecommunication company	Nº2 Telecommunication company.	-	Glo Mobile subscribers reassigned to Moov Benin in

Figure 5.4: MTN Presence in Africa in 2021
Source: By authors from MTN Integrated Report 2021

Figure 5.5: Moov Presence in Africa in 2021
Source: By authors from MTN Integrated Report 2021

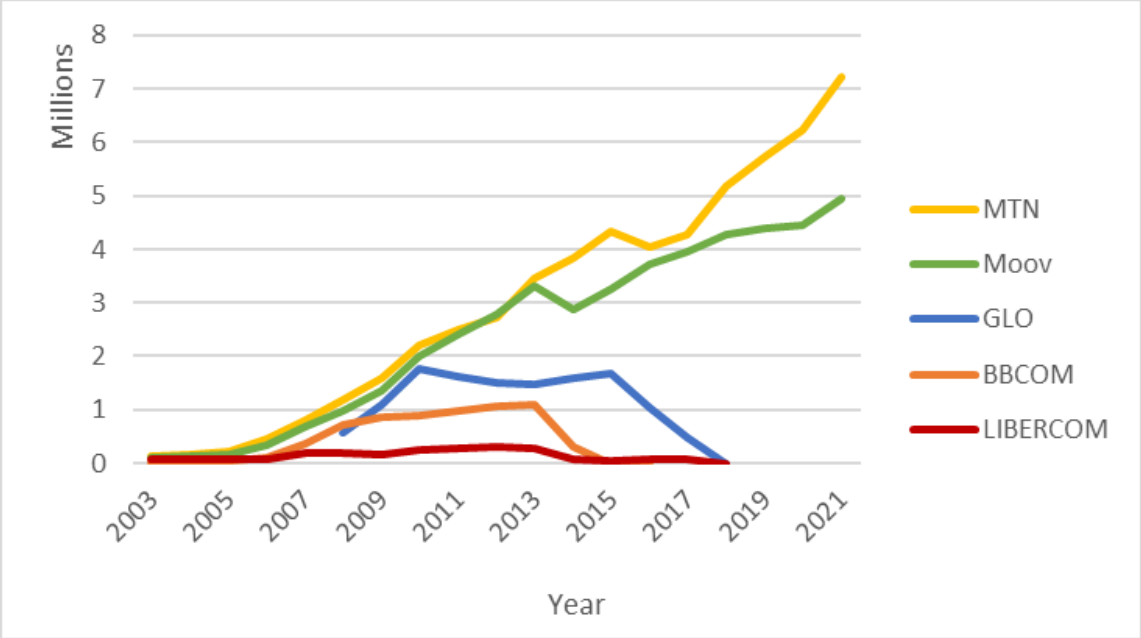


Figure 5.6: Number of subscribers by career per year

As described in Figure 5.7, MTN and BBCOM made the highest investment in this period which was especially in the construction and operation of the bi-brand 900MHz and 1800MHz based on our investigation. Libercom being already the lowest investor on the market, still reduced its investment during this period which negatively affected the subscription number.

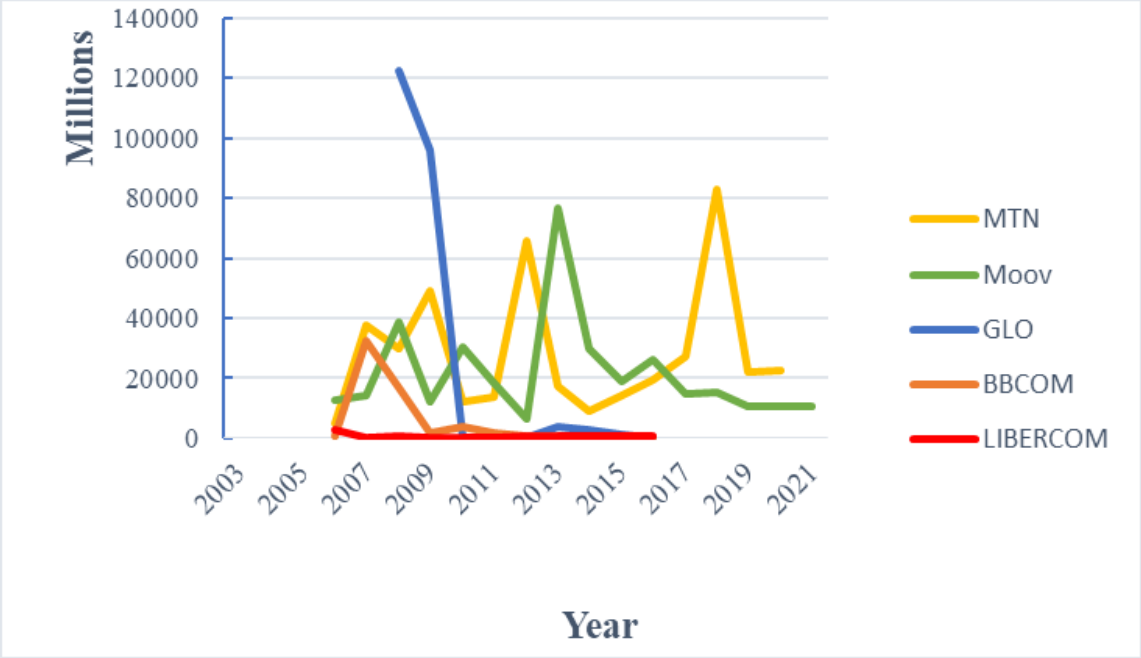


Figure 5.7: Investment per year
Source: Combined by authors from ATRPT & ARCEP

The turnover during the first period is almost stagnant with MTN and Moov on top

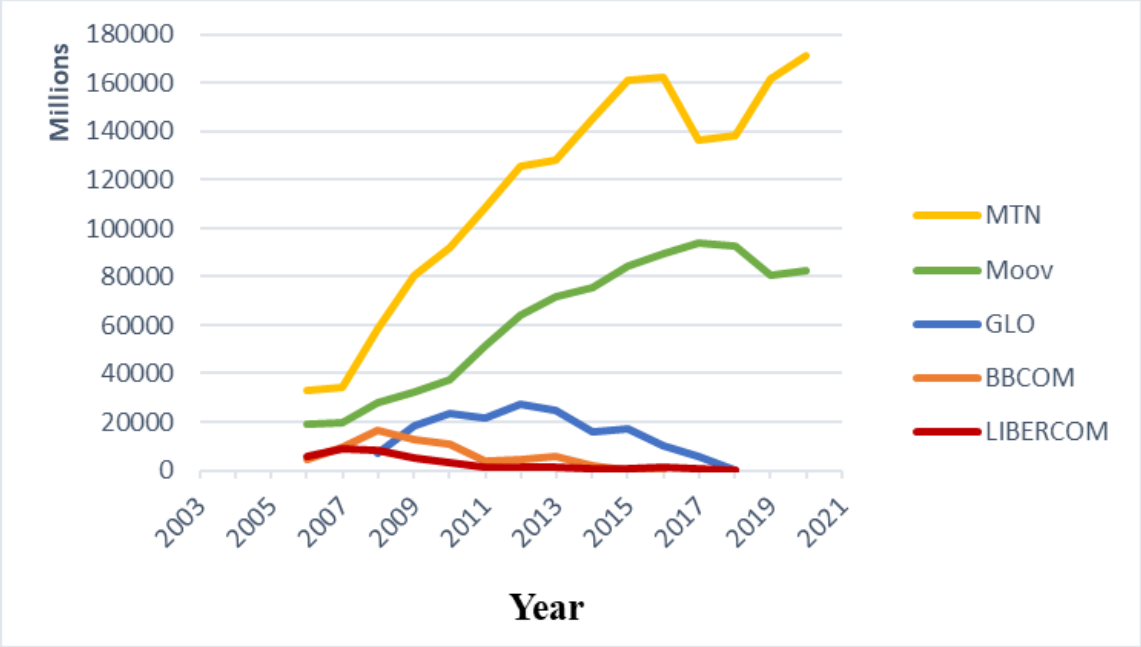


Figure 5.8: Turnover per year
Source: Combined by authors from ATRPT & ARCEP Data

as shown in Figure 5.8.

During this same period, there has been a reform from the new government of 2006 inciting all the telecommunication companies to a cost reduction for the services provided.

The state company in charge of telecommunication, Benin Telecom operated since 2002 the South Atlantic 3/Western Africa Submarine Cable (SAT-3/WASC) which links Portugal and Spain to South Africa, with connections to several West African countries. SAT-3/WASC/SAFE began operations in 2001, taking up service from SAT-2 which was built in the 1960s. In November 2007, there was a technical failure leading to various losses. These are some information about the submarine cable SAT-3/WASC/SAFE and Figure 5.9 present a map of its trajectory.

- Supply contract in force since March 2000
- Supplier: Alcatel Submarine Networks (France)
- System length: 14350km
- System type: 4 fibers, OA, WDM
- System Capacity: 120 Gigabits
- Equal to 1.45 million 64kb/s data channels or 2304
- television channels
- Landings in Europe, West and Southern Africa
- System design life of 25 years

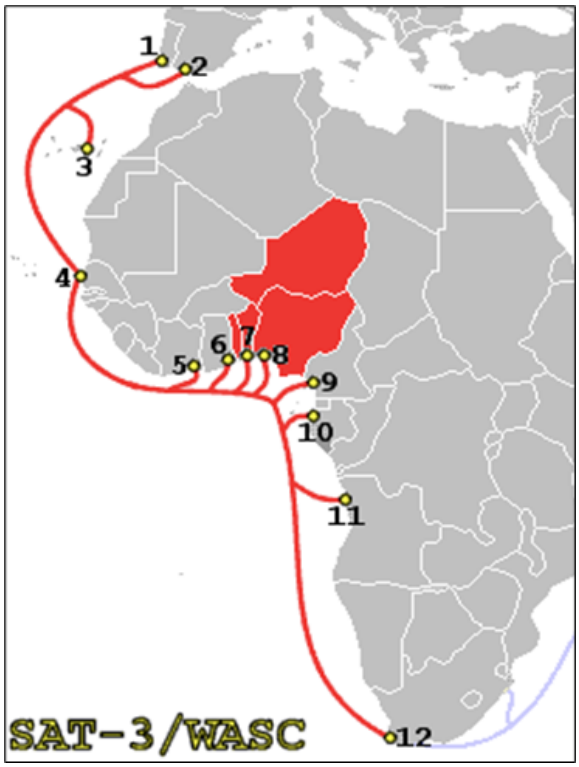


Figure 5.9: SAT-3/WASC, Submarine Cable
Source: SAT-3/WASC, Submarine Network Website

5.4.3 Competition on the telecommunication market (2008-2013)

The second period was marked by a strong market competition among the five telecommunication's companies.

The increasing number of subscriptions observed in the first period continued with BBCOM reaching a peak quite over a million registered mobile user accounts at the end of this second period (Figure 5.6).

GlobaCom, the fifth mobile telecommunication company entered the market in the beginning of this period after the suspensions following the licenses' issues of MTN and Moov Benin by the government. Glo has experienced a quick and short increase of its subscribers until 2010 and then declined (Figure 5.6). There was also a decline in the number of subscribers of Libercom in 2009 and 2013.

MTN and Moov continued in the tight competition and in 2012, for the first time Moov's subscribers' numbers slightly surpassed MTN's with (a difference of 65,850 subscribers) MTN having 2,729,716 subscribers while Moov got to 2,795,566 (Figure 5.6). This could be explained by the dissatisfaction of subscribers with the early 3G services provided which was said to be of a poor quality.

Investment (Figure 5.7)

Libercom continued with its low investment strategy keeping it the lowest of the five GSM operators by subscribers and based on the turnover. BBCom investment sharply

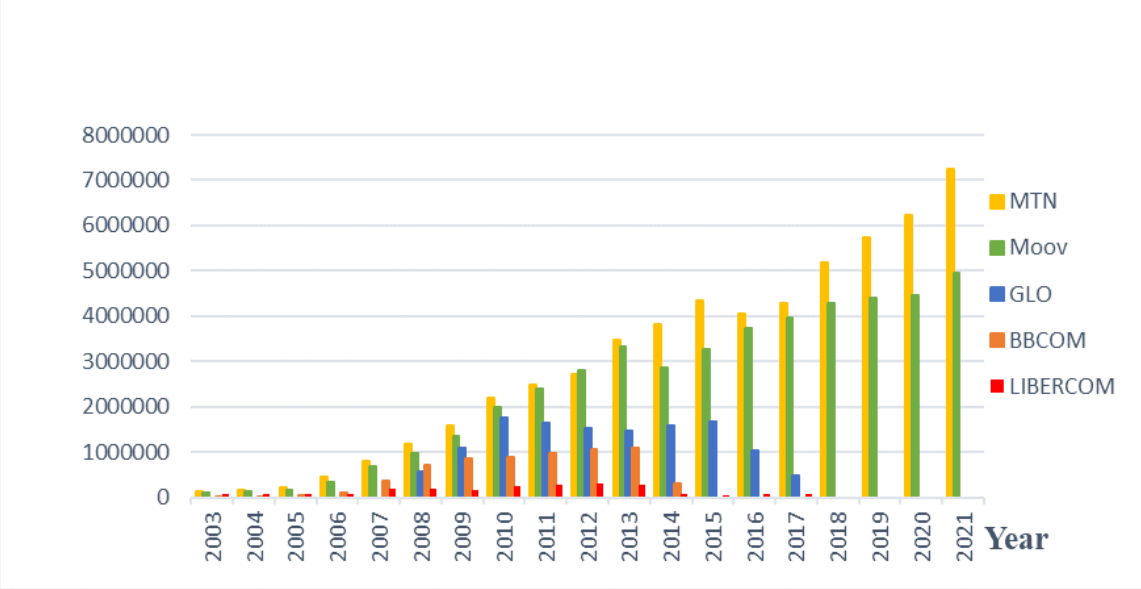


Figure 5.10: Number of subscribers by career every year (Bar Chart)
Combined by authors from ATRPT & ARCEP Data

decreased at the beginning of this period to remain lowly stagnant over the whole period. This decline in the investment led to the stagnancy of the subscribers' number yielding into the decrease of the turnover. BBCom was reported to have about USD140,000 debt.

In 2008, GlobaCom made an incredibly high investment for starting-up its business in Benin providing great services including the 2G technology with a strong low-cost marketing. The amount invested was the highest investment recorded on the telecommunication market in this period. Controversially, no investment was made over 2010-2012 and timidly resumed investing in 2013. Only the GSM network operators: Moov, MTN and Global Com, offer an Internet connexion to their customers and can increasingly be considered Internet access providers as of 2009.

Since September 2010, MTN has launched its mobile money offer, and got active in signing partnerships to reach a critical mass of users. In October 2011 the multinational company has submitted an offer for the 3G license, for an amount of 25 billion CFA francs. (JeuneAfrique); MTN and Moov Benin invested in acquiring the licenses and operating the 3G/4G technology respectively in 2012 and 2013.

In 2013, MTN set the Intracom WiBAS system and Moov started Flooz Mobile Money. This period was the most critical and most determinant for the telecommunication companies. Those that were able to invest adequately with a good backing up strategy such as MTN and Moov became the leading companies on the market.

Around late July 2009, SAT-3 cable (Figure 5.9) had some damages that resulted in internet blackouts. (Cable fault cuts off West Africa. BBC News. July 30, 2009). Investors started therefore considering to connect to new submarine cables and many African countries opted for the Africa Coast to Europe (ACE) submarine cable. During this period in September 2011, the government of Benin held a universal license tender and the following year, guaranteed the right to purchase international capacity from multiple

sources and not exclusively through Benin Telecom SA (BTSA).

5.4.4 Struggle on the telecommunication market (2014-2018)

Subscription (Figure 5.6)

BBCom reached its nadir of 0 subscriber in 2015 and Benin cancels BBCOM's GSM operating license in 2017 due to failure to meet its operating obligations regarding continuity of service, and non-payment of debts. Libercom keeps a very low and stagnant number of subscribers until 2018 when all operating activities stopped. The last recorded number of subscribers is 62,987 and they have been entrusted to MTN Benin.

Glo and MTN were found in non-compliance with quality of service (QoS) standards by the regulator, which has also sanctioned the pair by issuing a temporary ban on launching new value-added services or developing new SIM card services on their networks, which will be lifted only if QoS standards are improved over the three-month period June-August. (TeleGeography's GlobalComms Database, 2016)

Glo had a decreasing tendency throughout this period and eventually went extinct in 2018. Glo still had its subscribers when the license has been canceled by the government and therefore all the subscribers were reassigned to Moov Benin. The last record of Glo's number of subscribers was 475,776 in 2017.

Moov's subscription decline in 2014 is as result of the launching of a new technology 3G which came with some defaults and challenges for the shifts resulting in a dissatisfaction from the customers however the coming years gave stability and improving in the services which quickly changed the situation back to an increasing trend. MTN had a decline in its number of subscribers for the first time in 2016 due to its poor-quality services in the year; Despite the decline, MTN remains the number 1 on the telecommunication market in terms of subscribers and turnover followed by Moov Benin.This period depicts the polarization of 3G operators.

Investment (Figure 5.7)

BBCom had the lowest investment in this period which was in 2014 and also the last investment it made.

Compared to the other periods, MTN and Moov did not invest a lot except for MTN at the end of this period which has invested over XOF 80billions. the operator installed new base stations in 2018 to densify its indoor network from the country (ARCEP Benin, 2018). In addition, the digital finance business was boosted and MTN Benin secured a restricted cash deposit for Mobie Money (MTN Group Limited Annual Report, 2019). Among many other partnerships with local developers, MTN developed MoMo shop app in Benin with local trade. MTN Benin made payments of CFA35 billion (R802 million) and CFA35 billion (R857 million) in May 2018 and February 2019, respectively. Part of the payment relating to the extended license and the right to deploy optical fibre was recognised as an intangible asset (CFA55,2 billion, R1 370 billion) (MTN Group Limited Annual Report, 2019). All the investments accentuated the position of MTN as the leader

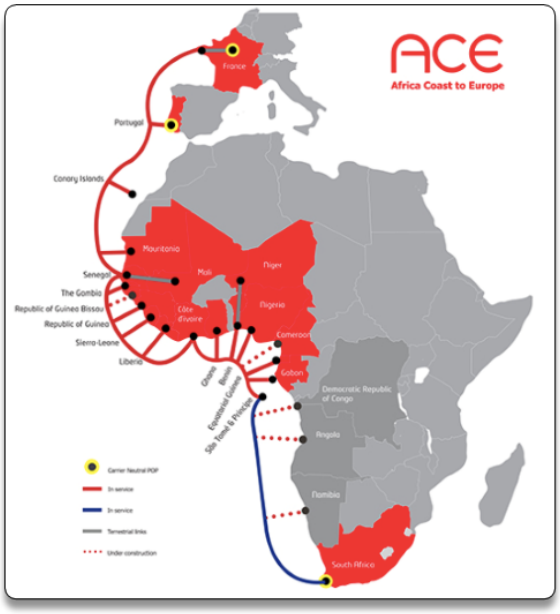


Figure 5.11: Africa Coast to Europe (ACE) Submarine Cable
Source: SAT-3/WASC, Submarine Network Website

on the telecommunication market in Benin. From the analysis, it seems the payments made are considered as investment.

The 4G was deployed both for MTN and Moov during this period. Meurisse report (2007) shows that switching from 3G to 4G requires only light investment; Networks supporting 4G are equipped with upgraded equipment from 3G for better performance. The investment cost is lower since it involves software updates. The transition from the first 3G technology to that of 4G does not require a renewal of equipment, but of complementary technology. The turnover of MTN at this period had a decline in 2017 (Figure 5.8). This could be explained by the lower quality services noticed in 2016 and in addition, MTN hadn't made any large investment over the period. This turnover decrease may have also triggered the high investment of MTN in 2018. Benin connected to ACE cable in February 2015 having as shareholders: Benin ACE GIE which consists of local mobile/fixed telecoms operators/ISPs, namely: Moov Benin 9%, MTN Benin 8%, Benin Telecoms/Libercom, Isocel, Espace Informatique Benin (EIT), Omnium des Telecommunications et de l'Internet (OTI) and Univercell.

Africa Coast to Europe (ACE)

The ACE is 17,000 km-long with a high-speed fiber optic and it links Europe to the west coast of Africa and to South Africa (Figure 5.11). It was a 700 million dollars project and the Consortium agreement was signed on June 5th, 2010. On 15 December 2012 the cable was put into service and in 2015, Benin connected to the ACE submarine cable.

In 2016, the available capacity on the ACE cable was upgraded. MTN was the first to operate an international fiber-optic bandwidth with full landing in South Africa and along the West Coast of Africa. This allowed the multinational to offer more

affordable and effective transport of voice, data, Internet and television services. A due diligence analysis showed that ACE was the most economical option for Benin to access abundant international connectivity and secure redundancy route for connection to the global backbone.

5.4.5 Oligopoly of two multinational 2019-2021

Moov's turnover decline in 2019 (as observed in Figure 5.8) can be explained by the steady decrease of the investments made in this period. The current Mobile Telephony market in Benin is a duopoly between MTN and MOOV Benin. The two telecommunication giants are in competition with MTN clearly ahead of Moov Benin from most aspects such as the subscribers' numbers, mobile financial services' users, investment, turnover, etc.

Submarine Cables

There are in total 7 Cables connecting West Coast of Africa to Europe:

- **ACE (Africa Coast to Europe)**
- WACS (West Africa Cable System)
- MainOne
- **SAT-3/WASC**
- Equiano (under construction)
- 2Africa (formerly know as Facebook's Simba, under construction)
- HARP (under construction)

Only two of them connect to Benin: SAT-3/WASC and ACE (Africa Coast to Europe) which are mainly being managed by the state company Benin Telecom. In the light of this study, there are some important outcomes to point out. MTN and Moov Benin have been in a tight competition regarding the number of subscribers until the last period where MTN clearly was demarked from Moov. In the second period Moov overtook MTN in especially 2012 for the first and only time but even though MTN was slightly surpassed in terms of subscriber's numbers, its great sense of prediction and consistent investment on the market has yielded in a good turnover over all its competitors. MTN has been the first mover with a great sense of prediction and a good strategy over all the periods. It invested at the best time in important technologies which resulted in good result regarding the number of subscribers and the turnover. Moov Benin has been a good copycat imitating MTN in its moves. This has allowed Moov to be the number 2 on the telecommunication market in Benin. The subscriber's number and the turnover of Moov Benin are as well important. Globacom has dug its grave at its entrance on the market with its gigantic investment. This company thought to quickly override its predecessors without taking time for a meticulous study of the market and a good strategy. As a result, a lot of money has been wasted and the number of subscribers was not as high neither was the turnover. This situation did not allow or encourage the 5th telecommunication company to take more risks paying the license fee imposed for renewal by the government in 2017. BBCom was a pure locally owned company that engaged into debts to keep up with its position on the

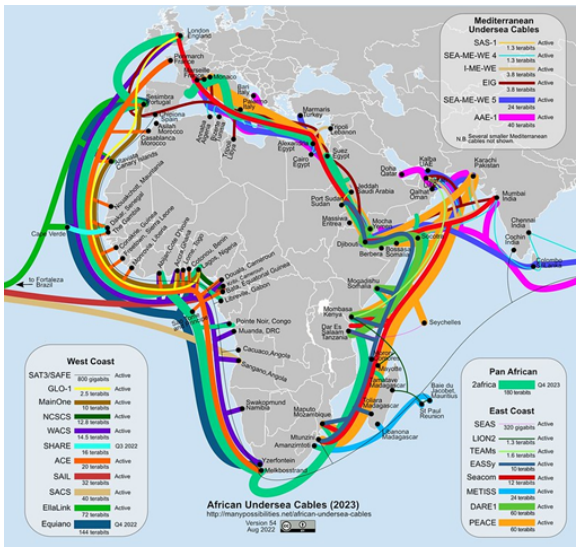


Figure 5.12: African Undersea Cables
Source: African Undersea Cables, by Steve Song, Many Possibilities

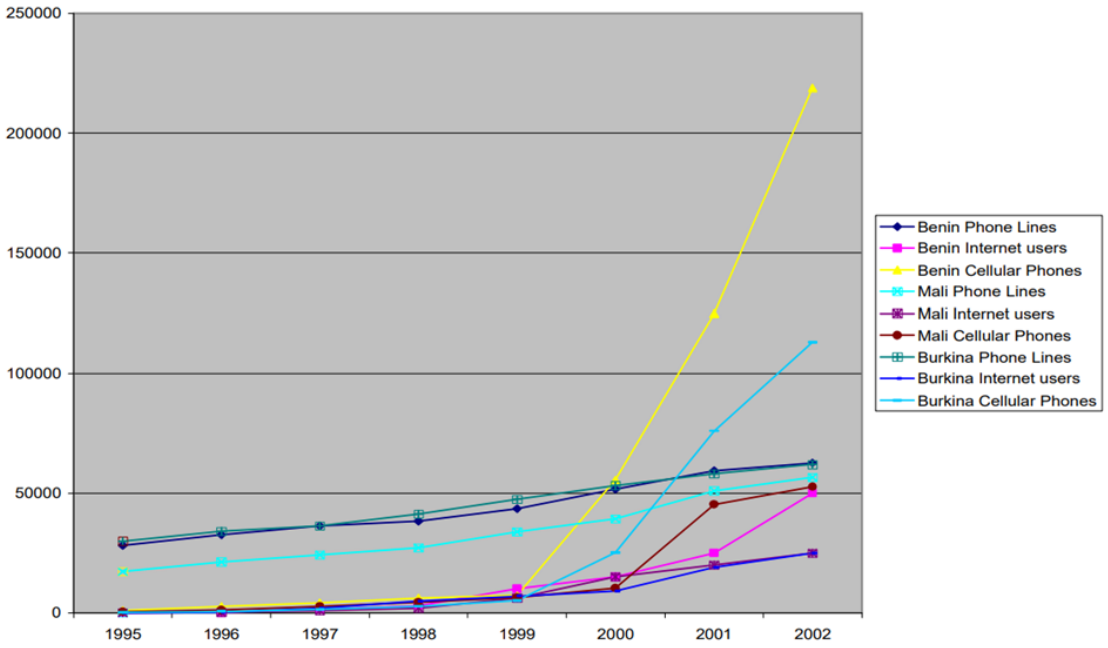
market. Having international companies as competitors, BBCom could not stand out on the market due to its limited resources for the investments. It went bankrupt and was ejected from the telecommunication market in 2017 very indebted. Libercom, as a state company has most time occupied the last position on the market from all aspects due to the corruption, mismanagement and lack of strategy.

In summary, We found that investment following a good strategy on the telecommunication market led to a high performance reflected in the number of subscribers and a good turnover. It was also found that the telecommunication companies in Benin classify the licenses fee as an investment because each year when there is a payment of license fee, the investment increases sharply.

5.5 Conclusion

The GSM (Global System for Mobile Communications) sector witnessed a tremendous boost as demonstrated by the rapid growth of the number of subscribers to its various networks in Benin. Mobile telecommunications leapfrogged fixed telephony providing effective and efficient social solutions not only for communication but also for financial transactions, weather forecasts etc. The privatization in 2000 allowed several telecommunications companies to access the market and Benin Republic has recorded a total of 5 telecommunications companies as of 2021. The telecommunication market in the country is currently in a duopoly situation between MTN & Moov Benin. This study outcome shows that investment positively correlates with performance and turnover. When made along with a good strategy diligent marketing, and investment, especially in important technologies such as the submarine cables, 3G constitutes a key factor to the success of telecommunication companies in Benin. The companies that could not continue operating exited the market either because they could not survive the competition and went bankrupt or because they had to face some administrative legal issues.
Telecommunication outbreak and development in Africa represent an important figure of Africa catching up with the global trend of industrialization sharing the same outcome and latest technology operated by African-owned companies.

Appendix C



Appendix C.1: ICT expansion in Benin, Mali and Burkina-Faso
Source: Bollou (2006)

Conclusion

Several changes have occurred in world history and this thesis focuses essentially on industrialization, manufacturing, and telecommunication. The first chapter examines how the Industrial Revolution affected and is interpreted from an African perspective. From the analysis, five main findings emerge.

First, the Industrial Revolution and industrialization are the most central issues in economic history. However, academic research has focused on the First Industrial Revolution, which was driven by cotton, steam engines, and coal, and the Second Industrial Revolution, which was driven by electricity, chemistry, internal combustion engines, and oil. This is also true of related discussions of productivity, growth rate, population, health, education, gender, etc.

Second, The terms "Third Industrial Revolution" and "Fourth Industrial Revolution" were popularized by Jeremy Rifkin (2011) and Klaus Schwab (2017) respectively. However, their works were largely focused on future predictions rather than rigorous historical analyses and empirical research. Although these books received considerable media attention, serious academic studies of these periods in economic history remain rare, with Amatori's 2013 analysis of the Third Industrial Revolution being one of the few scholarly exceptions.

Third, the debate on the industrial revolution has focused on developed countries, mainly those of Europe and America, and OECD countries and has not taken Africa into consideration. However, the supply of labor, raw materials, and markets from Africa was also essential for the industrial revolution in the Western world. It is therefore necessary to reorganize the history of the Industrial Revolution to include the Global South as a key player.

Fourth, the service industry is emerging in Africa without waiting for the maturity of the industry. There are three main periods of industrialization in Africa that are noteworthy: (1) the construction period of telegraphs, telephones, railways, undersea cables, etc. during the colonial period of the 1920s-1940s, (2) "import substitution industrialization" during the independence period of the 1950s-1960s, and (3) the "export processing strategy" since the 1980s.

"Import substitution industrialization" imposed high tariffs on imports, aiming to produce manufactured goods locally and reduce dependence on imports. Emphasis was also placed on agricultural production to supply raw materials, and manufacturing industries such as food processing, beverages, textiles, clothing, metal products, and wooden furniture were encouraged.

On the other hand, the "export processing strategy" welcomed foreign capital and aimed to promote employment and exports through light industry, especially apparel and textile industries, and manufacturing using oil and gas. However, the value-added rate of manufacturing in Africa has fallen to 23% since 1980. Without completing the industrial revolution, the country has experienced "de-industrialization," that is, the rise of the service industry.

Fifth, two strategies are discussed for Africa's industrialization strategy.

(1) One is manufacturing, which corresponds to the first and second industrial revolutions. Economists close to the African Development Bank and the World Bank emphasize manufacturing for job creation and economic growth. They aim to participate in the Global Value Chains (GVCs) through technology investment and new companies. They also aim to reform the structure to resource processing and finished product assembly, which have higher added value than natural resource exports. The manufacturing industry was certainly stagnating, but it is too early to conclude that the country has "de-industrialized". In fact, Mauritius, South Africa, etc. have succeeded in industrial development.

(2) The other is ICT, which corresponds to the third industrial revolution. These trends include the spread of mobile phones, the rise of African multinational telecommunications companies, and Internet banking. Over 300 digital platforms and startup entrepreneurs have also been born. It is also noteworthy that governments in South Africa, Morocco, Egypt, Tunisia, and Rwanda are formulating digital strategies.

From the literature review, three Industrial Revolutions have been recorded so far and even though a fourth one has been propagated in recent years, it still remains very controversial among economic historians. This study suggests that instead of stating a fourth Industrial Revolution, this period should rather be considered as a transition timing.

Orthodox Interpretation			African Interpretation
First Industrial Revolution	1760-1840	Leading country: Great Britain Key inventions: steam engines, textiles, cotton, coal, iron, steel, chemicals, railroads, etc. Mechanical Revolution	During the first and second IR, Africa essentially contributed in providing human and natural resources to the Western countries.
Second Industrial Revolution	1860-1930	Leading countries: United States, Germany, UK Key inventions and development: electricity, improved Communication, telegraph, telephone, automobile, railway transport, chemical industry, oil, electronic economy, etc. Electrical or Technological Revolution	
Third Industrial Revolution	1950-2020	Leading countries: United States, Japan, China, etc. Key inventions and development: Computers, Internet, Automation, Digital Revolution	After independence, many African countries adopted an Import-substitution policy succeeded by an Export Processing strategy. While the African industrialization situation remains low on a global look, the situation cannot be generalized as each country has different experiences, unique endowments, and different levels of industrialization. Several institutions play important role in order to support and encourage industrialization in Africa.
Transition period		AI, IoT, 3D Printing, Blockchain	

Summary Table of Chapter 1

Chapter 2 and Chapter 3 examine the fist strategy focusing on the manufacturing. Chapter 4 and Chapter 5 examine the second strategy focusing on the ICT.

In the context of industrialization, topics related to economic structural shifts, manufacturing development, and ICT are crucial.

Industrialization has been well documented for the Western nations and even for Asian latecomers however, in Africa, the question of industrialization's historical background and development has had limited studies.

This research shows that African countries have mostly skipped the first and second industrial revolutions and are experiencing a catch-up in the current era which is associated with important transitions in the economic structures.

Chapter 2 examines industrialization in 52 African countries and presents four models of African industrialization which differ from the classic Three Sector Model (known in Japan as Petty-Clark's Law) used in Western developed countries.

The classic studies by C. Clark (1940), Fourastié (1949), and Fisher (1935) showed the advancement of industrial structure from primary to secondary and then tertiary industries. However, Petty-Clark's Law applies to developed industrial countries but not to Africa. In Africa, the primary industry is declining, but the growth of industrialization remains slow and even slows. Conversely, the service industry is growing without industrialization reaching maturity. The slow-down or slow industrialization in Africa is a major point of debate.

There are economists who focus on agriculture, industry, and the service industry. The common points between the three are the re-evaluation of agriculture, pessimism about industry, and the new factor of mineral resources.

(1) Page (2012) evaluates agriculture and argues for an agriculture-led industrialization strategy.

(2) Ajakaiye and Jerome (2014) believe that most African countries will remain primary producers, except for industrialized Mauritius and South Africa. They consider dependence on agriculture and resource exports to be the reasons for the slowdown in industrialization, and advocate an industrial strategy to overcome this

(3) According to Jobe and Ricciuti (2023), productivity is highest in the service sector, followed by industry and agriculture, and total output growth is dependent on the service sector. According to Aryeetey and Kanbur (2017), Ghana's manufacturing industry grew and declined repeatedly in the 1960s and 1970s, causing a decline in its share of GDP. However, with the discovery of oil, the industry recovered in the 1990s and services also grew. As a result, the source of employment in the urban economy became services and commerce rather than manufacturing. According to Bryceson (1996), the rural service sector is expected to be a better fit for the post-agricultural economy than the urban industry.

However, the 52 African countries are diverse and cannot be generalized. Chapter 2 analyzes employment changes in the three sectors and categorizes industrialization into four types.

Category	List of countries	Characteristics (add percentage)
Industrializing Countries	Lesotho Egypt Cabo-Verde Tunisia Algeria	Increase in employment in their secondary sector; roughly from 20% to around 38%; Agriculture dependence is steadily decreasing while industry is rising along with the service sector
De-industrializing Countries	Mauritius Libya Congo, Rep South Africa Eswatini Botswana South Sudan Comoros	Decline in the secondary sector's employment share; Primary industry is on a decreasing trend; Tertiary sector increasing
Slowly Industrializing Countries	Morocco Kenya Namibia Senegal Gabon Zimbabwe Nigeria Ghana Mauritania Cameroon Benin Somali Rwanda Sudan Togo Equatorial Guinea Sao Tome and Principe	Moderate increase in the employment share of the secondary sector and mostly above or around 15%; Primary sector mostly on a decreasing trend; Tertiary sector increasing
Least Industrializing Countries	Angola Malawi Mozambique Burundi Zambia Eritrea Liberia Uganda Gambia Madagascar Guinea Mali Congo Dem, Rep Chad Ethiopia Cote d'Ivoire Niger Guinea Bissau Sierra Leone Tanzania Central African Republic	Very low and almost stagnant share of employment in the secondary sector generally below 10%; Heavy dependence on the primary sector which is reducing over the years as the tertiary sector surges

Summary Table Chapter 2: 52 African countries in 4 categories

(1) The least industrializing category is the most dominant with 21 countries that mostly depend on the primary sector which is however on a downward trend except for Angola as the country still heavily relies on natural resources. The industrial sector for these countries is around or below 10%.

(2) The slowly industrializing category (17 countries, including Morocco, Senegal, Kenya, and Nigeria) is the second dominant category with a similar trend to the least industrializing category but with less dependency on the primary sector and a significant increase in the tertiary sector. The secondary sector in this category is above 15% for most countries and on a steady moderate rise.

(3) 8 countries including South Africa and Mauritius were identified as de-industrializing as the secondary sector employment share declined over the period. The secondary sector share is varied and ranges between 40% to 15%.

(4) 5 countries including Egypt an Tunisia have experienced significant progress in the secondary sector forming the industrializing category. These countries also have an important share of the tertiary sector which remains the most dominant. Lesotho is the only country that has almost the same share of industry and service employment. The secondary sector share in this category varies between 15% to 38%. African countries' economic sectors are therefore heavily dependent on either the primary or the tertiary sector while the industrial sector is slowly increasing for most countries.

From the orthodox perspective, countries first develop the primary sector and with industrialization, they become more industry-oriented developing the secondary sector which reaches a peak followed by a downturn trend expressed as de-industrialization while the tertiary sector increases. In the case of African countries generally, the secondary sector has not fully matured yet the tertiary sector experienced an important rise. The analysis in this chapter was essentially based on the employment data with a limited assessment of the tertiary sector. Future studies could therefore cover these points for better insights on

the topic. This thesis explored the question of industrialization and manufacturing in its broadness as applied to Africa.

A more detailed study of 9 countries considered as representative of the different industrial stages from the three most significant categories of the previous chapter was conducted in Chapter 3. Four manufacturing sector groups were defined.

The first group is the Strictly non-durable Consumer Goods sector combining Food, Beverages, and Tobacco.

The second group is the Non-durable consumer goods sector which includes mostly textiles, fabrics, clothing, footwear, bags, and other as well as Wood-based materials.

The third group is the Producer Goods sector which involves primary extractive or commodity manufacturing such as Coke, refined petroleum products, nuclear fuel, Chemicals and chemical products; Rubber and plastics products; Non-metallic mineral products, and basic metals.

The fourth group is the Industrial Manufacturing sector and it combines the most capital-intensive and technology-intensive industries such as Motor vehicles, trailers, semi-trailers; Machinery and equipment n.e.c.

Strictly non-durable goods 15. Food and beverages, 16 Tobacco products
Durable goods 17.Textiles, 18.Wearing apparel, fur, 19. Leather, leather products and footwear, 20.Wod products (excl. furniture), 21.Paper and paper products, 22.Printing and publishing
Producer goods 23.Coke,refined petroleum products, nuclear fuel, 24.Chemicals and chemical products, 24C Chemicals and chemical products, 25.Rubber and plastics products, 26.Non-metallic mineral products, 27.Basic metals, 28.Fabricated metal products
Durable goods 30F.Office, accounting and computing machinery, 31.Electrical machinery and apparatus, 31A Electrical machinery and apparatus, 32.Radio,television and communication equipment, 33.Medical, precision and optical instruments, 34.Motor vehicles, trailers, semi-trailers, 35.Other transport equipment, 36.Furniture; manufacturing n.e.c., 37.Recycling

Four categories of industrial sectors
Source: ISIC Revision 3 from UNIDO's INDSTAT

The results of the third chapter revealed that Strictly non-durable manufacturing including the food and beverage sector is significant in most African countries.

Some countries such as South Africa, Mauritius, Egypt, Tunisia, Morocco, and Benin have passed the first industrialization experience with the development of the non-durable manufacturing involving the textile industry. The Producer goods sectors including chemical, coke, mineral fuel, and basic material are also important, revealing the dependence on natural resources of some resource-rich countries. Several countries such as Tunisia, Egypt, South Africa, Morocco and Senegal realized the second industrialization experience with the development of the producer goods. Very few countries such as South Africa, Tunisia and Morocco developed the industrial manufacturing sector involving machinery, electrical apparatus, motors, trailers, and semi-trailers sector.

On another hand, the industrializing countries including Tunisia and Egypt

experienced a shift from food and beverages to textiles and then to producer goods and industrial manufacturing. The de-industrializing countries, especially South Africa, have recorded a decline in the industrial manufacturing share over the years while Mauritius rather experienced a drop in the strictly non-durable goods. It was concluded that these countries classified as de-industrializing rather shifted to more sophisticated and technology-intensive industries, especially Mauritius. The slowly industrializing countries mostly recorded a shift from strictly non-durable sectors towards non-durable goods and producers' goods. Many of the countries studied such as Tunisia, Egypt, South Africa, Morocco, Senegal, and Nigeria developed the producer goods manufacturing sector in recent years. The African model of industrialization is a resource-based industrialization whereby countries' manufacturing sectors use local agricultural resources (Kenya, Benin, Senegal) or mineral resources (South Africa, Nigeria, Egypt, Tunisia, Morocco, Senegal) in industries. Industrial Revolutions in Africa is henceforth resource-based. Except for Nigeria, most other countries made important efforts to develop the industries using the mineral resources available however, more efforts could be considered.

Manufacturing classification			
Strictly non-durable Consumer Goods	Non-durable consumer goods	Producer Goods	Industrial Manufacturing
Food, Beverages and Tobacco which requires less capital or technology compared to the other groups.	Include mostly textiles, fabrics, clothing, footwear, bags, and other as well as Wood-based materials	Involves primary extractive or commodity manufacturing with the processing of raw materials into intermediate or final products; Coke, refined petroleum products, nuclear fuel, Chemicals and chemical products; Rubber and plastics products; Non-metallic mineral products and basic metals.	Combines the most capital-intensive and technological intensive industries requiring a certain advanced level. Includes Motor vehicles, trailers, semi-trailers; Machinery and equipment n.e.c.

Category	Country	Characteristics
Industrializing	Tunisia	Successful case of industrialization; Development of non-durable goods, producer goods, and industrial manufacturing; High Export Manufacturing about 80%
	Egypt	Successful case of industrialization Manufacturing focused on textile and producer goods. Increase in Export manufacturing (40%)
De-industrializing	Mauritius	Manufacturing dominated by Strictly non-durable consumer goods and durable consumer goods; Adoption of more sophisticated and technology-oriented systems; Export Manufacturing decreasing from a peak of 80% in 2000 to below 60% in 2021;
	South Africa	Decrease in manufacturing dynamism focusing recently on Strictly non- durable Consumer Goods, industrial manufacturing and producer goods; Decline in manufacturing Export to below 40%; Remains the most industrialized country in Africa.
Slowly-Industrializing	Kenya	Shifted focus from industrial manufacturing to Strictly non-durable Consumer Goods making use of agricultural resources; Low manufacturing exports around 30%
	Morocco	Successful case of industrialization; Development of textile industry, producer goods, and industrial manufacturing; Manufacturing exports high and increasing rapidly, above 75%
	Senegal	High focus on Strictly non- durable Consumer Goods with some diversification in recent years developing the Producer Goods sector; Manufacturing Exports below 30%
	Nigeria	Diversified manufacturing sector in early years of industrialization; Manufacturing Exports below 5% showing a high dependence of the country on mineral resources for export;
	Benin	Focus on Strictly non- durable Consumer Goods and Non-durable consumer goods; Manufacturing Export very low around 5%
All the countries adopted resource-based industrialization using agricultural and/or mineral resources available for manufacturing development		

Summary Table Chapter 3

African countries have skipped the First and Second Industrial Revolutions but

are experiencing the third Industrial Revolution. The mobile telephony sector has had an unprecedented outbreak leapfrogging fixed telephony, and with significant innovation through the appropriate technology as African countries' access to the internet remains limited, especially in rural areas. Telecommunication companies in Africa adopted the appropriate technology and managed to provide useful services including financial solutions to meet the needs of citizens. Some of the innovations made in terms of mobile banking are unique and not available even in some technologically developed countries. The drawback of this economic transformation is that Africa is not as productively engaged in manufacturing but rather the continent stays in a position of consumer. As such, the African tertiary sector has tremendously increased, providing jobs in service-based industries where mobile telephone plays a role in the infrastructure.

Category	Country	GDP Telecommunication
Industrializing	Tunisia	Moderate positive relationship with a slightly flatter slope
	Egypt	Positive trend indicating a strong relationship between mobile subscribers and GDP per capita. As the GDP per capita increases, so does the mobile subscription.
De-industrializing	Mauritius	Strongest positive correlation in the selection implying that as GDP per capita increases, the mobile subscription as well increases
	South Africa	slightly bent slope showing a very moderate relationship between the mobile subscription and GDP per capita.
Slowly-Industrializing	Kenya	Almost a vertical trend, suggesting a very minimal relationship between GDP per capita and mobile subscriptions.
	Morocco	Moderate positive relationship with a slightly flatter slope
	Senegal	Almost vertical trend, suggesting a very minimal relationship between GDP per capita and mobile subscriptions.
	Nigeria	Moderate positive relationship with a slightly flatter slope
	Benin	Mostly vertical trend, suggesting a very minimal relationship between GDP per capita and mobile subscriptions.

Summary Table Chapter 4

Chapter 4 examines the debate on the correlation between ICT and economic growth.

Strong	Weak	None
Mauritius	South Africa Egypt, Tunisia	Senegal, Kenya Benin

Correlation of Mobile Subscribers and GDP per capita

The optimistic view: Aker and Mbiti (2010), Gruber and Koutroumpis (2011), Lee et al. (2012), and M. D. J. Williams et al. (2011) point out that mobile phones are effective for market efficiency, agricultural productivity, mobile banking, medical education, etc in Africa. Wachira and Njuguna (2023) also argue that mobile money boosted Kenya's economic growth. Conversely, Lam and Shiu (2010) argue that economic growth boosted mobile phones in Nigeria. This leads to the leapfrog theory.

On the other hand, some scholars deny the impact of the Internet in Africa, emphasizing only GSM mobile phones among ICT. Haftu (2019) and Chavula (2013) argue that the combination of mobile phones, fixed phones, and the Internet are effective only in wealthy countries, but only mobile phones are effective in poor countries. This also relates

to the theory of appropriate technology.

Regional differences in Africa are also important. Adeleye and Eboagu (2019) and Donou-Adonsou et al. (2016) acknowledge the effectiveness of mobile phones, but emphasize the differences between countries. In particular, Kenny (2003), Cleeve and Yiheyis (2014), Eggleston et al. (2002), and Gillwald et al. (2012) emphasize the importance of infrastructure investment, ICT regulations and competition, education, and poverty.

Chapter 4 provides an overview of the trends in per capita GDP, mobile phone subscription rate, fixed phone subscription rate, and Internet usage rate in 54 African countries from 1960 to 2022. As a result, the majority of African countries saw a rapid increase in mobile phone subscription rate after 2000 while their fixed phone subscription rate remained low. This should be a typical example of the leapfrog hypothesis.

On the other hand, while many countries have a mobile phone subscription rate of over 100%, there are also countries with a rate of less than 50%, and there are large differences between countries. There is even greater variation between countries in Internet usage rates, with many countries at less than 30%. This means that many people are using 2G GSM mobile phones rather than 3-5G smartphones. In fact, M-Pesa in Kenya realizes mobile banking services, skipping a usage of banking card, by using GSM technology. This should be a prime example of "leapfrog" and "appropriate technology" in Africa.

Leapfrog	
Fixed Telephone Subscribers (2000-2022)	Mobile Phone Subscribers (2000-2022)
Increase from 0% to above 100%	Decrease from 8% to about 0%
Mobile cellular subscriptions increased significantly while fixed telephone subscriptions decreased. Mobile cellular became more useful and effective, leapfrogging the fixed telephony system. Most African countries have their subscribers 'number above 100% yet users of the internet are generally below 50%	
Appropriate Technology	
0% to about 60 percent increase was recorded for Internet Users; This number is low compared to the number of mobile phone subscribers showing Appropriate technology adoption in the use of mobile phones.	
African telecommunication companies developed several needful services available even with the use of GSM	

Leapfrog and Appropriate Technology in Africa

Since telecommunication has great potential in this new era, African countries need to engage more productively to fully benefit from the outcomes of industrialization. Besides, governments ought to invest in ICTs and telecommunication infrastructures such as submarine cables while regulating the "appropriate technology".

	ICT in Benin	Note
GDP per capita (2023)	1434.7 dollars	No correlation with Mobile Subscribers
Mobile cellular subscription (2021)	98%	Leapfrogging (without the income increase)
Fixed phone subscription (2021)	0.9%	Leapfrogging (skipping fixed phone)
Individuals using the internet (2021)	34.0%	Appropriate technology (Smartphone users are 1/3 of Mobile subscribers)
Fixed broadband subscription (2021)	0.2%	Appropriate technology (Internet users are smartphone users)

ICT in Benin

Benin which is a slowly industrializing and agricultural resource-based country was studied in Chapter 5 as a micro example of a slowly industrializing country and the results revealed the high importance of mobile telephony and the main leading role of multinational companies in Africa in the experience of industrialization.

With the arrival of multinationals due to privatization, telecommunication services were improved and many local companies with limited capital could not withstand the competition. Other companies entered legal regulatory issues which led to their exit from the market while some faced the consequences of malinvestment.

Finally, two large multinationals are in a duopoly on the market thanks to their experience, marketing strategies, and investment in important technologies.

Telecommunication Companies	Status	Features (GSM)	Advanced Technology 3G	Submarine Cables
Libercom (Local)	Operation Ceased September 2018	Created in 1998; First leading GSM operator; In 1999, set up an AMPS-type mobile network which has been very successful. Success resulted in saturation which led in a drop in quality.	No investment; 3G Unavailable	Connected to SAT3 submarine cable
BBCom (Local)	Operation Ceased	license in 2017 due to failure to meet its operating obligations regarding continuity of service, and non-payment of debts	No investment 2G-only service provider; 3G Unavailable	Connected to SAT3 through optic fiber; BBCOM got into legal issues with the regulator institution due to failure to meet its operating obligations.
MTN (South African)	Leader on the Telecommunication market	From BeninCell to Areeba (in 2005) Acquired in June 2006 by MTN (Mobile Telephone Network),	Investment in the 3G; High Technology: Available	Connected to SAT3- WACS; ACE;
Moov (owned by Maroc Telecom)	Number 2 Leader Telecommunication Market	Télécel network created on December 17, 1997, and launched activities on July 10, 2000; Created by the Atlantique Telecom Group, the Moov Benin network replaced Télécel; Moov Benin is a public limited company with a capital of 1,437,000,000 FCFA;		Connected to SAT3- WACS; ACE, Maroc Telecom West Africa
GlobaCom (Nigerian)	Activities ceased in Benin Republic	Globacom (Glo) is launched GSM services in Benin in June 2008;	No investment to get the 3G	Legal Issues with Regulator due to non-payment of license fee

Summary Table Chapter 5

This thesis concluded that Africa has a unique and varied pattern of manufacturing development which literally differs from that of developed countries. African countries follow resource-based industrialization for manufacturing development. In many countries, the secondary industry sector remains low as the tertiary sector has surged in recent years with the outbreak of telecommunication which is central to our new era defined as a transition period from the third industrial revolution. Africa holds an opportunity to leapfrog the first and second industrial revolutions and catch up now if important policies can be applied.

Policy Implication

A revolution in the industrial field is associated with access to knowledge and know-how and involves the creation of an environment favorable to the establishment and the emergence of the necessary manufacturing infrastructures for the production of new consumer goods, their promotion, popularization, their adoption, use, and maintenance. Each government needs to take the responsibility of processing the resources available instead of exporting raw natural resources.

The Policy implications also vary by country.

(1) Resource-rich countries need policy investments to shift from low-value-added resource exports to high-value-added resource processing manufacturing.

(2) Industrializing countries and slowly industrializing countries need investments in information infrastructure and education, as well as deregulation and competition policies in the ICT field, to accelerate the slowing growth of manufacturing. As World Bank economists argue, the use of ICT is essential to incorporate Africa into the global value chain.

(3) Information and Communication Technology (ICT) alone doesnot generate employment. African nations would need to make extensive transformations to reach the same technological sophistication of digital giants like the American GAFA companies (Google, Alphabet, Facebook, Apple) or China's BATH corporations (Baidu, Alibaba, Tencent, Huawei).

However, by making the Internet, as an appropriate technology, a shared infrastructure for the nation, unique business models different from those in developed countries can be developed not only in the service industry but also in the manufacturing industry. Global value chains and the sharing economy and some parts of the fourth industrial revolution (AI and IoT) will also have many times more possibilities if all citizens have access to the Internet.

We recommend in addition resource-based industrialization as a start to the countries with availability of resources.

As for the countries that have limited natural resources, imports from neighboring countries or other African countries should be made possible via Free Trade Zone establishments in the region.

The industrialization is crucial for development. Through manufacturing, employment is generated even for low-skilled workers. Africa still lags behind in terms of manufacturing and actions must be taken.

The industrialization of Africa must begin with the establishment of industries for the production of local consumer goods. Industries established in Africa in general have been weighed down by an unfavorable local, regional, and international environment. In fact, they have not been able to stand for long in the face of tough international competition.

However, the situation is not identical across the continent. Some countries are industrializing, few are de-industrializing, some are slowly industrializing and many are least industrializing.

The majority of African countries are least industrializing and struggling to make their way in the global industrial space. African countries should get involved in the forms of development learning from other countries, adopt and appropriate new techniques and technologies, and correct the inadequacies in order to get equipped with quality human resources, capable of carrying out ambitions for change.

The African continent has enormous and indisputable assets which are just waiting for these developments to reveal the immense possibilities of the continent. This will come true through strong leadership, good governance, and appropriate institutions.

Many African countries have a high subscriber number to mobile cellular phones but the rate of people using the internet is low showing the importance of appropriate technology in Africa, whereby people are able through simple GSM to access several services without necessarily having to connect to the internet. In as much as appropriate technology is a good approach to solving various social issues, access to the internet and higher technology is indispensable in this new era of transition to fully participate in industrialization.

Governments should therefore invest in telecommunication technology, as telecommunication growth has erupted in most African countries in recent years. Most importantly, investments in technologies such as submarine cables, 3G and 4G technologies, etc., are needed to increase access to the internet and broadband across the continent for better outcomes and to realize the 3rd Industrial Revolution fully.

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