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Structural transformation in Africa: New technologies, resurgent entrepreneurship and the revival of manufacturing

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Structural Transformation in Africa: New Technologies, Resurgent Entrepreneurship and the Revival of Manufacturing

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Abstract

In this paper I argue that manufacturing is still important for structural transformation in Africa. Despite failing to industrialize in the past, there may be a new window of opportunity. This is due to the convergence of new technologies of the Fourth Industrial Revolution (4IR) and a resurgence of start-up entrepreneurship. In this light I (i) show why manufacturing is vital for African economies, (ii) critically analyze the nature and impact, both in terms of opportunities and risks, of the new technologies associated with the 4IR for Africa; (iii) describe the resurgence of tech start-up entrepreneurship in Africa and (iv) call for policy support in the form of complimentary investments and regulations to allow entrepreneurs to utilize opportunities and to minimize threats. The paper show that a new narrative for African structural transformation is possible.

JEL classifications: O33, O14, O55, L52, L26
Keywords: Technology, industry 4.0, entrepreneurship, development, Africa

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1 Introduction

Africa needs to industrialize to create jobs. Its population is young and growing fast, and its population, already more than a billion, is the second highest of any region after Asia. Due to rapid rural-urban migration its population in cities will triple by 2050 (Freire et al., 2014). It has been estimated that the African labor force would swell by more than 170 million people between 2010 and 2020 (Fox et al., 2013). If there are no productive jobs for these people, the fight against poverty will be lost given that the most important determinant of whether someone in Africa is in poverty, or not, is whether they have a job.

When countries in the West and in Asia experienced similar demographic pressures in their past, industrialization enabled them to create jobs and welfare simultaneously (Naudé et al., 2015). So far, however, the verdict is that African countries have not yet seen significant industrialization (Rodrik, 2015). Pessimism about the prospects for manufacturing in Africa is also deeply rooted. Recently some have even suggested that manufacturing is not important anymore and that developing countries, including those in Africa, should perhaps not even bother with manufacturing, e.g. IMF (2018). Gollin (2018) is of the opinion that developing countries should pursue 'structural adjustment without industrialization'. In this regard Newfarmer et al. (2018) argues that African countries should focus on tourism, ICT and other services that may share 'the characteristics of manufacturing'. Hallward-Driemeier and Nayyar (2018) further deepens the suspicion towards manufacturing's potential in Africa, by arguing that it has become less feasible for low-income countries such as those in Africa, to embark on manufacturing-led development.

In this paper I take a different view. More optimism may be warranted, manufacturing may be more feasible, and indeed an important pathway to structural adjustment in many African countries ('Africa' will in this paper be short for Sub-Saharan Africa). African countries face a unique opportunity to grow manufacturing. This is due to the convergence of new technologies of the Fourth Industrial Revolution (4IR) with a resurgence in start-up entrepreneurship.

While the opportunity for industrialization exist, achieving it will not be easy or automatic: while technology and entrepreneurship offer unprecedented opportunities, they are both two-edged swords. Both *basic* and *novel* approaches are required from governments and from international development organizations: *novel* approaches to regulate and promote (for instance the digital economy) and *basic* approaches to support (for instance in provision of infrastructure).

In section 2 I outline the reason why I believe that manufacturing remains a vital sector for African economies. In section 3 I critically analyze the nature and impact, both in terms of opportunities and risks, that the new technologies of the 4IR imply for Africa. In Section 4 resurgent entrepreneurship is noted. Section 5 concludes.

2 Why Manufacturing Is Important for Africa

In this section I show that, contradicting the old narrative that the continent has no prospects as far as manufacturing is concerned and should rather focus on something else, that: (i) manufacturing in fact contributes, in absolute numbers, increasingly to value added and employment; its share of GDP has been more stable in Africa than elsewhere; (ii) manufacturing

contributes to higher labour productivity growth; that (iii) the quality of jobs in manufacturing is better than those in many services and agriculture. Moreover, with the capacity of agriculture to create more jobs constrained, manufacturing may be even more important for future jobs.

2.1 Manufacturing output and employment is reviving

The current dominant narrative about African manufacturing is that it is failing and that the continent is even de-industrializing (Rodrik, 2015; Timmer et al., 2014). This is motivated with reference to falling shares of manufacturing in output and employment.

However, considering the absolute size of manufacturing in Africa, a different narrative unfolds. For instance, far from stagnating, total value added in manufacturing (in constant US$) has almost tripled since 1980, from US$ 66 billion to US$ 158 billion by 2015.

More interestingly, most of this increase has been after the year 2000: between 1980 and 2000 manufacturing still grew, but slowly at 1,2 percent per year on average; however, between 2000 and 2015 we see a revival, with manufacturing achieving an average annual growth rate of over 5 percent per year. As remarked by Signé (2018, p.4) 'manufacturing in Africa has grown 3,5 percent annually from 2005 to 2014 faster than it has in the rest of the world. Some countries, such as Nigeria and Angola, have experienced an increase in output of over 10 percent per year'.

This revival suggests an improvement in the fortunes of manufacturing, contradicting the pessimistic narrative of an unstoppable downwards slide. It counters any claim that African countries have been 'prematurely' de-industrializing.

Even when closely scrutinizing the relative shares of African manufacturing one can discern a different narrative. For instance, the relative average share of manufacturing value added declined from 8.3 percent to 7.4 percent over the period 1962 to 2007 (Lavopa and Szirmai, 2012). This is, compared to declines in other regions, relatively small. The aggregate decline reflects moreover the impact of absolute declines in the large economy of South Africa, which has more to do with its own particular political difficulties, rather than economy-wide conditions.

A new narrative is also supported from considering employment. Here the fact is that the total employment in manufacturing in 18 of the largest African economies (for which there is data[1]) increased from an estimated 9 million in 2004 to over 17 million by 2014: an increase of 83 percent in only ten years.

The only African economies where the absolute number (level) of employment in manufacturing declined between 2004 and 2014 were Mauritius and South Africa. On the other hand, outside these two countries, some, such as Ethiopia, Kenya, Nigeria and Burkina Faso experienced notable increase in manufacturing employment, for instance in Ethiopia from just over 1 million workers in 2004 to over 5,6 million workers by 2015. Adding 4 million jobs to manufacturing in less than a decade is an indication of revival, not decline.

[1] It is often lamented that lack of sufficient and reliable data makes it impossible to settle questions of whether or not African countries are industrializing or de-industrializing, or what the nature of structural change is. While data certainly can be improved, from what reliable data is available, such as the Africa Sector Database (ASD) updated by Mensah and Szirmai (2018), and the World Development Indicators (WDI), both used in this paper, fairly clear conclusions can be drawn with respect to manufacturing in Africa over the past thirty years or so. It is about the future of African manufacturing where the uncertainty exists.

Finally, even in terms of its share contribution, a different narrative should be told: although it is true that the share contribution of manufacturing to jobs in Africa is the smallest of all the regions, it has nevertheless not been declining as elsewhere. In fact, the share of workers in manufacturing for Africa as a region has increased from around 5 percent in the early 1970's to almost 10 percent by 2008.

2.2 Manufacturing is driving higher productivity growth

According to data from the Africa Sector Database (see Mensah and Szirmai (2018)), over the period 2005 to 2014 the African countries with the highest manufacturing employment growth, such as Ethiopia and Burkina Faso, also enjoyed high labour productivity growth.

In Africa labour productivity outside of agriculture is much higher than in agriculture: according to McMillan and Headey (2014) it is up to 7.7 times more productive.

Evidence has also been found that labour in manufacturing is in some countries even up to '10 times higher than in agriculture' as measured by marginal output, and that, 'income per capita could be two and a half times larger in Malawi and Kenya if physical and human capital were reallocated to the higher productivity industrial sector' (Vollrath, 2009, p.330).

Finally, where structural change in Africa by-passed the manufacturing sector, the consequence has generally been reduced productivity and economic growth. McMillan and Headey (2014, p.3) for instance found that between 1990 and 2005 that the movement of labour into services sectors, including tourism, trade and others have seen labour moving 'from high to low-productivity activities reducing Africa's growth by 1.3 percentage points per annum on average'.

2.3 The quality of jobs in manufacturing is better

Throughout the world, the quality of jobs in manufacturing tend to be better than in agriculture or even services [2] . This is also true of Africa where for instance, only 5.4 percent of the working poor were to be found in industry between 2002 and 2012, compared to 16,4 percent in services and 78,2 percent in agriculture(Christiaensen and Chuhan-Pole, 2015).

One reason why the jobs in manufacturing tend to be on average of better quality is that they are largely located in urban areas, where jobs are better paid and protected (de Brauw et al., 2014). Cities offer access to various amenities that improve the quality of life, and manufacturing makes it possible for people to live and work in cities.

2.4 Agricultural job growth is limited

While the manufacturing sector in Africa seems to be more robust than is thought, and in the process of reviving, it is important to ensure the continuation of this revival, given that

[2] For instance, in the USA workers in manufacturing have the highest years of tenure, the lowest employee turnover, and the highest average wages than any other sector, and moreover 75 per cent of private R&D in the USA takes place in the manufacturing sector (Deloitte, 2018).

agriculture, current the largest sector for jobs, have limited prospects for further job creation. Agriculture may in all likelihood shed jobs in future.

This is because African farms need to drastically improve productivity in order to feed the population and maintain or increase its contribution to global value chains in food production (Naudé, 2016). The experience of other regions has certainly shown that gains in agricultural productivity will be accompanied by reduced employment growth. The regions in the world where agriculture is most productive are also the regions where the share of jobs in agriculture is small.

Second, agricultural jobs may actually more at risk from automation than jobs in manufacturing. Hauge (2018) cites research from McKinsey that found that many occupations in agriculture can already be 100 percent automated.

The conclusion is that sustaining the revival of manufacturing in Africa may be important for creation of quality jobs, boosting productivity growth, and facilitating urbanization.

3 The 4IR and Africa

Much hype surrounds the idea of a 4IR. The term itself, popularized by Schwab (2016) and the World Economic Forum (WEF) is itself contentious. Marsh (2012) prefers to call it a 'New Industrial Revolution' and Brynjolfsson and McAfee (2016) refer to a 'Second Machine Age'. Sometimes it is confused with the term 'Industry 4.0'[3].

Whatever the term (for purposes of this paper I will stick to 4IR) it is the case that manufacturing faces technological disruption. The key technologies and their nature are explained in the remainder of this section (3.1), including opportunities, (3.2) and threats (3.3).

3.1 Key 4IR technologies

The 4IR is the result of progress in the integration of physical and digital production and consumption. It not just about digitization (that was the 3rd industrial revolution), but about the integration of digitization with physical production tools. It is driven by a convergence of advances in sensors, advanced materials and robotics with digital platforms, artificial intelligence and big data analytics, linked by the Internet of Things. It leads to mass customization and hyper-personalization of consumption through additive manufacturing (3D-printing), production-as-a-service through digitization, and new business models (e.g. the sharing and on-demand economies). Cost reductions in computing power, data storage and bandwidth, which accelerates connectivity and machine learning, are facilitating this convergence (Deloitte, 2018).

In manufacturing these technologies are democratizing and dematerializing production (Diamandis and Kotler, 2012). The democratization is reflected in the rise of the maker movement, a growing share of small and micro-enterprises making use of 3D-printing and online e-commerce platforms such as *Etsy* or *Amazon Web Services* (AWS) to design and deliver

[3] Industry 4.0 (Industrie 4.0) refers to a particular strategy of the German government towards the digitization of German manufacturing, launched in 2011 (Economist, 2015).

personalized products to their customers. This allows mass customization (Anderson, 2012) also termed Localized-Additive-Manufacturing-on-Demand (LAMD) (Graham, 2018).

The dematerialization of manufacturing is facilitated by digital manufacturing through use of AI (e.g. in predictive maintenance or design) and advanced materials such as nanomaterials and carbon fiber composites. The dematerialization of manufacturing means less stock needs to be kept, products use fewer physical inputs, lasts longer and allow shared use, and reduces the need for long production runs.

An important, and often still not fully recognized implication is that this actually makes manufacturing easier, cheaper and more sustainable. To emphasize this point, consider that when digital and physical systems of production merge, the accompanying software systems makes 'complexity invisible'. This is aptly described by Friedman (2016, p.65) quoting former Microsoft researcher Craig Mundie, 'Software is this magical thing that takes each emerging form of complexity and abstracts it away'.

On the physical side, additive manufacturing allows both the complexity and hardness required to for molds that are essential for the manufacturing of parts and machinery to become 'free', as McAfee and Brynjolfsson (2017, p.104-105) explains. In their words (p.105) 'Extremely hard metals like titanium can be difficult and expensive to machine, but they're just about as easy as softer ones like aluminum to build up one layer at a time'. African countries are already making use of these advantages: at the time of writing, the world's largest 3D-printer was in Africa, using titanium to 3D-print aircraft parts [4].

With the technologies of the 4IR simplifying manufacturing, it allows countries and entrepreneurs to focus on the business side. More than ever it will be the demands of the consumer that will determine Africa's industrialization. And here there are signs of progress: the middle class is rising (Bhorat et al., 2017) demanding more and more consumer goods; and the entrepreneurial start-up scene is booming (Lalunde, 2017) (as I will discuss further in section 4). The latter signifies that the opportunities offered by the 4IR may be realized, if adequate support for entrepreneurial ecosystems to further develop and mature, are forthcoming.

3.2 Opportunities

To illustrate some of the opportunities of the 4IR for Africa consider food and beverages, currently the largest manufacturing sub-sector in Africa[5] . Given the rise of a middle class demanding more and better-quality processed food and beverages, there is a significant opportunity for manufacturing in agro-processing and related downstream and upstream industries. The latter includes the manufacturing of machinery used in processing, including electrical and electronic equipment (e.g. sensors, energy storage), in transportation and communication (e.g. smart vehicles, drones, advanced materials, computers), storage equipment as well as in supporting customer services (quality assurance, product tracking, timeous delivery, individualized design). Africa's imports of these goods are significant signalling the availability of a large domestic market[6] .

[4] See https://bit.ly/2O6iT1P

[5] This section draws on a contribution I wrote for the 2018 World Trade Organisation's *World Trade Report*, see: https://www.wto.org/english/res_e/publications_e/world_trade_report18_e.pdf

[6] According to UNECA (2015) Africa's largest imports in 2013 included US$ 69.3 billion of machinery, US$ 48.8 billion in vehicles and transport equipment, and US$ 47.7 billion in electrical and electronic equipment.

Artificial intelligence (AI) applications can strengthen and help expand agri-business by helping to tracking products along the supply chain, as for instance is now being done in Ethiopia in coffee production and exports[7] ; by improving the efficiency of food processing and packaging, and by reducing food waste as a start-up in South Africa recently proposed [8].

Additive manufacturing can, as has been mentioned, make it easier indigenous small businesses to start manufacturing. 3D-printers and less intensive in use of energy and transportation (Juma, 2015). Many examples of entrepreneurship starting to utilize 3D-printing in Africa abound, see some are discussed in Naudé (2017).

Renewable energy technologies (e.g. solar panels and batteries) may be expected to improve the competitiveness of African manufacturing. Diamandis and Kotler (2012, p.157) pointed out that 'Africa has nine times the solar potential of Europe and an annual equivalent to one hundred million tons of oil'. This suggests that the costs of electricity, critical for manufacturing, ought to decline significantly in future. Providing tools and equipment for the renewable energy sector could provide a further opportunity, see for instance UNEP (2013).

The Industrial Internet of Things (IIoT) can help to make African manufacturing more efficient. Efficiency improvements from implementation of the IIOT globally has been put at a potential US$ 15 trillion (Accenture, 2015).

There are many more examples of opportunities; the point rather is that each of the technologies characterizing the 4IR has particular relevance for Africa, where manufacturing growth was hindered in the past due to large geographic distances, lack of economies of scale in local production, lack of cheap energy and weak public-sector capacity - all constraints that can be lessened by the 4IR (Naudé, 2017).

3.3 Threats

The threats from the 4IR are threefold: first, despite the opportunities, African countries may not be able to absorb and utilize key technologies; second, mass unemployment may follow due to automation and reshoring; and third, new technologies may lead to more cybercrime, increased vulnerability to global shocks, and intrusive state surveillance among others.

3.3.1 Will the 4IR by-pass Africa due to lack of skills?

The first threat is that the 4IR will by-pass Africa because African countries do not have enough adequate skills and (ICT) infrastructure to make use of these technologies. For firms to identify and adopt new technology requires a fairly high level of skills. The 4IR in particular requires cognitive skills, specifically technological skills.

These are in short supply in Africa. Tertiary enrolment rates averaged 7,5 percent over the period 2003 to 2012 the lowest of any region in the world. And only 25 percent of these are in STEM areas (UNECA, 2015), which are critical skills for the 4IR (Frey et al., 2016). The

[7] See https://www.howwemadeitinafrica.com/rise-artificial-intelligence-africa/59770/

[8] See the example of *JustNow*, a proposed application to reduce food waste in South Africa, at https://startup.info/justnow/

percentage of firms that indicate facing a skills shortage, and a shortage of 'digital skills' have tended to increase in many African countries (Banga and te Velde, 2018).

Overcoming this potential bottleneck is one of the major policy challenges. A discussion of how to overcome it falls outside the scope of this paper, suffice to mention that a comprehensive approach towards human skill development is needed, which if successful would imply an 'educational revolution' in Africa.

It can however be mentioned here that low hanging fruits can to be obtained by promoting and protecting the labour force participation of women. In Africa women are more likely to be unemployed, to be in vulnerable jobs, and to be less educated. Promoting the entry of women into STEM-skill jobs, for instance by removing legal obstacles, is therefore necessary. A positive sign is that, just as manufacturing employment in Africa is expanding, more and more women in Africa are qualifying themselves in science, technology and engineering fields with 'Female representation in engineering is fairly high in Africa in comparison to other regions' (Huyer, 2015, p.97). Also, in terms of internet penetration rates per gender, the 'digital gender gap' in Africa at 6,3 per cent was less than that in Europe (6,6 per cent) in 2017 (Badran, 2018). In the new narrative for African manufacturing, women clearly play a central role, a fact that is still largely neglected in the current debate on structural change and skill development for the future in Africa.

Attracting more skilled labour and facilitating the education of STEM-skilled workers and firms that employ these workers to Africa will also necessitate that the infrastructural digital gap be closed. The gap is still significant: internet use in Africa is at 22 individuals per 100 inhabitants the lowest in the world, at about a quarter of the internet use in Europe; the same applies to active mobile-broadband subscriptions, at 26 individuals per 100 inhabitants. In terms of global digital knowledge production, African countries are faring even worse, by contributing less than 1 per cent to worldwide digital knowledge production as measure by collaborative coding and domain registrations (Graham et al., 2017). Deloitte (cited by Mehta et al. (2018) has calculated that if African countries can expand internet use to the same rate as that in high-income countries, they could create 140 million new jobs and add **US$ 2,2 trillion** to GDP.

African countries are working to reduce the digital gap. Average annual growth in households with internet access at home has been growing faster in Africa than in any other region, at 122 percent between 2005- 2017. Africa is also the region experiencing the fastest growth in mobile-cellular telephone subscriptions (41 percent over 2005-2017) and in mobile-broadband subscriptions (170 percent over 2005-2017). Investment in digital infrastructure is rising: as a result, Ericsson predicts that by 2022 around 80 per cent of mobile phone subscriptions in Africa will be WCDMA/HSPA, LTE and 5G and moreover that mobile data traffic will continue to grow by 55 percent per year until then (Mamabolo, 2017).

3.3.2 Will new technology cause mass unemployment?

A second threat of the 4IR is that it would lead to technological unemployment as jobs are automated. For the USA and Europe estimates range from 47 to 54 percent of jobs (Frey and Osborne, 2013, 2017; Bowles, 2017) and for developing countries around 66 percent (Frey et al., 2016).

These predictions are fortunately unlikely to materialize. Recent analytic work has suggested

that the negative impact of automation may be greatly overestimated (**??**). Even where job losses may occur, say in jobs with largely routine tasks, the net impact on employment is likely to be positive, as new opportunities are created elsewhere (Dauth et al., 2017; Berriman and Hawksworth, 2017).

Bessen (2018, p.14,17) illustrates that new technologies will be more likely to lead to net job creation in an industry if 'the technology is addressing large unmet needs affecting people with diverse preferences and uses for the technology' and if technology introduces 'entirely new products and services that tap into otherwise unmet needs and wantsthere may be new and unanticipated sources of employment growth'. These are precisely the conditions that characterizes the Africas growing middle class.

3.3.3 Will the 4IR bring new forms of insecurity and crime?

Finally, the technologies of the 4IR can have potential adverse impacts on broader society such as more cybercrime, increased vulnerability to global shocks, intrusive state surveillance and other social pathologies (Townsend, 2016). These are real threats, not just for African countries, but for global society, and as such ultimate solutions will need to be found through global collaboration.

A prerequisite for this is however that African societies start their own vigorous and open debates and investigations into these threats so as to determine and defend their priorities. They should also desist from curbing and limiting access to the internet and internet censorship. There are plenty of concerns in this regard. Uganda for example has introduced a tax on social media use. And according to the *Freedom on Net* in 2017 report, only Kenya and South Africa allows free internet use. After China, Ethiopia was ranked as the most abusive country towards internet freedom.

Given the huge immediate and long-term gains to be had for African economies participating more in the digital economy, such policies come with a significant price tag.

4 An African Tech-Entrepreneurial Revolution?

The brilliant technologies and their opportunities and threats for Africa, as discussed in the previous section comes at a time when there are encouraging signs that start-up entrepreneurship on the continent is blooming (Lalunde, 2017). Take just two indicators: the growth in venture capital (VC) to African tech start-ups, and the growth in the tech start-up ecosystem, as reflected in the number of start-up accelerators and incubators spreading across the continent.

Firstly, VC: between 2012 and 2018 there was a ten-fold increase in the amount of VC flowing into African tech start-ups, from a low of US$ 40 million in 2012 to US$ 608 million in 2012 (Bright, 2016).

Second, the tech start-up ecosystem in Africa has been developing rapidly since 2007, when M-Pesa was launched in Kenya (Bright, 2016). At the time of writing there more than 314 'tech hubs' and at least 60 specialized start-up tech accelerators on the continent[9] . Examples of the

[9] See `https://bit.ly/2vlTcCt` and `https://www.galidata.org`

latter include *iHub* in Kenya, *blueMoon* in Ethiopa, *BongoHive* in Zambia and *Startpreneurs* in Nigeria. The latter is an accelerator focusing on artificial intelligence, machine learning, virtual reality, blockchain, and data science. The *GrowthAfrica* accelerator that is active in Kenya, Uganda and Ethiopia reported assisting 289 new entrepreneurs and creating 25,000 jobs since 2002[10] .

Moreover, more and more global tech giants are joining this local resurgence of entrepreneurship by investing in Africa's tech entrepreneurs and tech talent: in July 2018 *Google* announced that it will establish an Artificial Intelligence Lab in Ghana and in August 2018 it was announced that *Google* and *Facebook* will be funding a new master's program in Machine Intelligence with Rwanda's African Institute for Mathematical Sciences.

In order to support the momentum of Africa's entrepreneurship start-up scene, governments and the international community should focus on enlarging the pool of finance for new high-tech ventures, particularly in manufacturing. Although the trend in VC is promising, it shows growth from a small base, and in relative context total venture capital in Africa is miniscule in global context. So far, crowdfunding, which is playing an increasing role in supporting tech start-ups in the USA, is still to become significant in Africa, and seems to be hampered in some countries, such as Nigeria, by legislative hurdles (Moed, 2018).

It should also be kept in mind that high-tech start-ups typically require more risk-tolerant, 'patient' finance than non-tech start-ups; entrepreneurs in high-tech, especially digital high-tech often have less collateral because their businesses tend to be based on intangible assets.

In such conditions, the personal managerial and entrepreneurial competencies of the lead entrepreneur in a firm is important to financiers, whether venture capitalist, or angel financiers or crowdfunders (Naudé, 2010a). Thus, the development of managerial and entrepreneurial skills within Africa's emerging tech hotspots and entrepreneurial ecosystems should be a priority for governments and international donors.

Finally, governments need to underpin investments in their entrepreneurial ecosystems with strengthening the regulatory environment for digital business (read: better cybersecurity and data protection) as well as improved social protection. These are crucial given the uncertainties that accompany the spread of new disruptive technologies (Nagler and Naudé, 2017).

As I argued elsewhere (Naudé, 2017) although some European countries are considering a Universal Basic Income (UBI) grant for citizens, administrative capacity and financial resources in Africa precludes this. These may however become less of a constraint in the future given advances in Fintech (Naudé, 2017). To fund such improvements in social security, African governments could in coordinated fashion, following the example set by the European Union's proposal for a 'equilization tax', consider taxing giant digital platform companies based on the revenue that they earn in a particular country[11].

5 Concluding Remarks

The 4IR is making a new narrative for African structural transformation possible. In this paper I have argued that the current narrative of an Africa that is de-industrializing, with little success

[10] See https://growthafrica.com/about/entrepreneurial_impact/
[11] See http://europa.eu/rapid/press-release_MEMO-17-3341_en.htm

or prospects in manufacturing, and that should look to other types of activities such as tourism or ICT, or only to a limited number of manufacturing sub-sectors such as food processing, is neither taking into account *reality* nor *potential*.

In *reality*, manufacturing is an important sector for Africa, and moreover a sector wherein the continent has achieved actually more than it is often given credit for. I showed in this paper that manufacturing contributes, in absolute numbers, increasingly to value added and employment; that manufacturing's share in GDP has been more stable in Africa; that manufacturing is associated with higher labour productivity growth; that the quality of jobs in manufacturing tend to be better than those elsewhere.

In *potential*, the key technologies of the 4IR furthers the democratization and dematerialization of manufacturing which means manufacturing becomes less complex and easier for indigenous small businesses to enter - potentially decolonializing African manufacturing. The largest manufacturing subsector in Africa, food and beverages, and its downstream and upstream related industries, in particular may benefit from 4IR technologies.

The 4IR does however bring risks with it. African countries may not be able to absorb and utilize key technologies; mass unemployment may follow due to automation and reshoring; and new technologies may lead to more cybercrime, increased vulnerability to global shocks, and intrusive state surveillance among others.

Dealing with these risks should be a priority of governments, both by focusing on basic and novel policies. I have showed in this paper that there are encouraging signs of progress in terms of skill development, infrastructure roll-out, and moreover that start-up entrepreneurship for high-tech firms is in resurgence. Governments should focus on building entrepreneurial and management skills, supporting growth in venture capital finance; regulate the digital economy and ensure data protection; protect and respect internet access and freedom, and finally expand social security and insurance.

The coordination that this will require implies that appropriate industrial policies will be unavoidable, even though industrial policy is often contentious due to its being subject to rent-seeking, political capture and government failure (Naudé, 2010b). All other regions of the world are however basing their participation in the 4IR on industrial policies, from China with its 'Made in China 2025', Germany with its 'Industrie 4.0' Platform, the USA with its 'Strategy for American Innovation' and the UK with its 'Building our Industrial Strategy' to name but a few. It is time that African countries, in coordinated regional manner, respond with their own strategies. As countries are heterogeneous, and as there are many types of manufacturing, of course there will be much heterogeneity in terms of the content of such strategies and in eventual outcomes. Not all African countries will perform similarly, and not all manufacturing subsectors will be equally important in all contexts. Whatever course is taken however, it can be underpinned by a new narrative for structural transformation.

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