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Africa's Emergent Tech Sector: Its Characteristics and Impact on Development and Labour Markets

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Abstract

This study investigates the characteristics of Africa's tech sector, its digital services, and its impact on economic development, specifically on labour markets. Our literature review and new analyses based on a database of African startups shows that Africa's emergent tech sector is adapting to the continent's constraints on development and, sometimes, contributes to overcoming them. A case in point is the credit constraints that numerous startups have overcome to attract very significant amounts of capital. Tech startups tend to be concentrated in financial services in the "Big Four": Egypt, Kenya, South Africa, and Nigeria. We show, first, that "home-grown" African platform businesses do not simply connect demand and supply, but also invest in logistics and infrastructure; second, that many tech firms offer multiple products that complement the original service; and third, that business models often rely on large networks of agents. We conclude that more evidence on the impact of digital technologies is needed.

Keywords: Africa, digitalisation, startups, development, labour markets, ICT

JEL classification: N27, O30, M13, O10, J40, L86

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Jann Lay and Tevin Tafese

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- 3 Africa's tech sector: Challenges and characteristics
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1 Introduction

In recent years, several African economies have experienced a rapid expansion of their technology sectors.¹ Across the continent, one can observe increased adoption of digital technologies in different sectors, including in finance, transport, retail, and agriculture – potentially

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yielding significant development gains. Many of these home-grown innovative digital products and services (Tafese, 2022) have been carefully adapted to the local context in which they were created and, in some cases, have spread from there to the rest of the continent or even the world. The most prominent example of an African home-grown digital technology has been the invention of mobile money in Kenya, which has since spread to almost every single African country, as well as dozens of low- and middle-income countries (LMIC) outside of Africa.

Because this new wave of African startups is growth-oriented, unlike the small and mostly informal businesses typical of Africa, they have significant investment needs even in the early stages. Local and international investors – primarily venture capital firms, but also big tech and development finance institutions – have recognised the potential of African startups and massively increased their early-stage investment in recent years, making the African tech ecosystem one of the fastest-growing startup ecosystems in the world and attracting investment in a considerable order of magnitude. At the time of writing, eight African tech startups have already achieved “unicorn” status, meaning a valuation of more than USD 1 billion, and tech or tech-enabled startups are among the fastest-growing companies in Africa (Financial Times, 2022).

Although still in its infancy, it is very likely that Africa's tech sector will have an impact far beyond the information and communications technology (ICT) sector. The digital services and products developed by the sector are already fundamentally changing the way Africans work and how businesses operate across all sectors. These services and products are adapted to and partly address the obstacles and constraints to economic development on the continent, including but going well beyond credit constraints and other market imperfections. Through complementary investments, tech firms also tackle “harder” constraints, for example the lack of physical infrastructure. Digital services and platforms have the potential to increase employment and productivity – hence wages and, ultimately, living standards. However, the effects of digitalisation may at times be ambiguous, as increased competition – think of the effect of the arrival of ride-hailing apps on traditional taxi drivers – may also create losers. Further, digitalisation itself has yet to produce decent pay and good working conditions.

Because Africa's tech sector is developing so rapidly and because the market and the digital services it offers are in constant flux, the sector's characteristics are not well documented. Further, with the notable exception of mobile money, there is little conceptual work or empirical evidence on the development and labour market impacts of home-grown digital technologies. In this article, we seek to close these gaps by (a) examining Africa's connectivity (gaps), (b) taking stock of Africa's tech sector and its characteristics, partly drawing on a new dataset of African startups, and (c) providing a brief review of the scarce findings on the tech sector's development and labour market impacts.

This paper is structured as follows: Following this introduction, Section 2 provides a brief assessment of Africa's connectivity and digital infrastructure. Section 3 then introduces Africa's emergent tech sector, based on a unique database of African tech firms, and describes the key characteristics of African startups and the (mostly) digital services and products they have developed and are offering. Section 4 reviews the available evidence on the development and labour market impacts of the African tech sector and its products. Finally, Section 5 concludes and lays out policy implications.

2 Africa's growing connectivity and remaining gaps

Over the past two decades, Africa has become increasingly connected as more and more Africans have gained access to the internet and mobile phones. This can mainly be attributed to investments by the major telecom companies ("telcos") operating in Africa – notably MTN, Orange, Vodacom/Vodafone, and Airtel – which have rolled out their broadband networks across the continent. These investments, particularly in mobile broadband, have led to significant improvements in internet access and mobile phone adoption in Africa over the last two decades. As of 2020, a total of 30 per cent of sub-Saharan Africans used the internet, compared to only 6 per cent in 2010 and 1 per cent in 2000 (World Bank, 2022b). Over the same period, the number of mobile cellular subscriptions per 100 people increased from 2 in 2000 to 45 in 2010 to 83 in 2020. Despite these increases, Africa still lags far behind the global average of 85 per cent internet use and 106 mobile phone subscriptions per 100 people.

At the same time, there are significant digital divides between and within African countries, reflected in significant variance in internet usage and mobile phone adoption across the continent. For example, internet usage is as high as 58 per cent in Ghana but only 14 per cent in the Democratic Republic of the Congo (DRC), and the number of mobile cellular subscriptions (per 100 people) for the same two countries is 130 and 46, respectively. Much of this difference in connectivity comes down to the geographic location of African countries: subsea internet cable landings and data centres naturally favour countries on the coast, and there is a lack of terrestrial cables connecting landlocked countries to those subsea cable networks. The difficulty of extending internet cables inland to offer "last-mile" connectivity to households and businesses has also led to digital divides within countries, as metropolitan areas often have much better access to the internet than secondary cities and rural areas.

In addition to patchy internet coverage, high costs of accessing the internet still prevent many Africans from joining the digital economy. While 81 per cent of sub-Saharan Africans live within the footprint of a mobile broadband network (GSMA, 2021), only 30 per cent use the internet. One major factor contributing to the internet usage gap are high prices of mobile data in Africa compared to Africans' average income. Across Africa, the average cost for 1GB data is around 7.2 per cent of the average monthly salary, compared to 1.5 per cent and 2.7 per cent in Asia and the Americas, respectively. Again, however, there is significant heterogeneity

in the costs of 1GB data between African countries, comprising around 2 per cent of the average monthly salary in Ghana and 30 per cent in the DRC (ITU, 2020).² To complicate matters further, Africa's rapid population growth and increasing urbanisation, along with the associated growing internet user base, has already put stress on the existing digital infrastructure. Without major additional investments in its digital infrastructure, connectivity gaps between Africa and the rest of the world and across African countries may even grow in the future.

In the last few years, some of the world's tech giants ("Big Tech") have identified Africa's existing connectivity gaps and its need for additional investments as a huge business opportunity. Two prominent examples are Google's and Meta's respective investments in the Equiano and 2Africa subsea cables, which aim to cut the costs of access to their services and content in a largely untapped African market. Google's Equiano subsea internet cable, named after the Nigerian-born writer and abolitionist, is set to run from Portugal to South Africa along Africa's West Coast and go live by the end of 2022. Google (2022) estimates that the cable will increase internet speed by a factor of anywhere from three to five times, cut internet prices by approximately one fifth, and increase internet penetration by up to 9 per cent in the countries where the cable lands. The 2Africa subsea cable, funded by the 2Africa consortium, which besides Meta includes some of Africa's largest telcos, is expected to be the longest subsea cable system ever deployed, connecting Europe, the Middle East, and Africa. Meta (2021) projects that once it is operational in 2024 the cable will provide nearly three times the total network capacity of all the subsea cables serving Africa today.

Importantly, there is a growing body of rigorous evidence that Africa's improved digital infrastructure is already having a positive impact on its people and economies. A recent report by GSMA (2021), the biggest industry organisation of mobile network operators, estimates that mobile technologies and services generated 8 per cent of GDP in sub-Saharan Africa (SSA) in 2021, with indirect productivity benefits in non-ICT sectors accounting for 5 per cent. More rigorous evidence supports this view. For example, Hjort & Poulsen (2019), document large increases in employment rates and average incomes in several African countries as a consequence of greater and cheaper access to the Internet, which occurred due to a mix of factors including greater firm entry, productivity, and exporting. A cross-country study of the service sector of 45 sub-Saharan African countries by Ndubuisi, Otioma, & Tetteh (2021) find moderate increases in employment following improvements in digital infrastructure, including internet usage, fixed telephone subscription, and mobile cellular subscription. Finally, another cross-country study by the International Telecommunication Union (ITU, 2019) found for a sample of 34 African countries that an increase of 10 per cent in mobile broadband penetration yields an increase in 2.5 per cent in GDP per capita, which is higher than 2 per cent in a sample of low-income countries outside of Africa. While some of the results of these mentioned studies

2 The big telcos on the continent earn good profits and have become critical taxpayers and thereby main sources income for governments in Africa. MTN is the biggest taxpayer in Nigeria; in Kenya it is Safaricom.

need to be taken with a grain of salt, as the causal direction between Africa's digital infrastructure and (socio-economic) development is not always entirely clear, there is fairly strong evidence overall of the positive impacts improvements in Africa's digital infrastructure have had on Africa's economies and people.

3 Africa's tech sector: Challenges and characteristics

Connectivity is an important pre-condition for digital technologies to be developed and applied. Further, there are additional features of (most) African economies that, on the one hand, pose specific challenges to African tech firms – for example, difficult access to credit or limited market sizes. On the other hand, the response of the tech sector to these challenges may lead to innovation and change to overcome (some of) these challenges and ultimately contribute to economic development. These challenges include but are not limited to (1) credit market failures and relatively low levels of both local, (2) low income levels as well as fragmented markets, (3) lack of digital skills, (4) weak infrastructure (electricity, roads), along with high transport and logistics costs, and (5) high levels of (under)employment in subsistence agriculture and low-productivity urban informal (often retail) activities – as both cause and consequence of (1) to (4).

First, investment rates in Africa remain below the average of other so-called “developing” regions, in particular in Asia. This has to do with both low domestic savings and low foreign capital inflows, which probably reflect the lack of profitable investment projects. While this situation started to improve in the late 2010s, including through international efforts (e.g. “G20 Compact with Africa”), the pandemic and the current difficult macroeconomic environment with price pressures and higher interest rates have worsened the conditions for investment to pick up. As we will show below, despite the difficult pandemic conditions, Africa's tech sector has still managed to offer so-called “bankable” projects, which have received very significant amounts of capital, including from within Africa. Further, through improving the availability and efficiency of financial services, the tech sector is likely to contribute more broadly to the mobilisation of savings and the financial sector's capacity to channel resources into productive projects.

Second, most African consumers have low disposable incomes, most of which is spent on food, and consumer purchasing power is concentrated in the top 10 per cent, who spend more than USD 5 per day (Kendall, 2021). Low income levels therefore naturally limit what is called the total addressable market (TAM) for African startups, especially consumer-facing ones, making it difficult for them to sell their products and services at the scale on which business models often critically depend for profitability. As a result, most startup activity is concentrated in the urban hubs of a few large economies, as many smaller African countries struggle

to support growth-oriented, venture-backed³ startups. Low incomes and small markets are also key reasons why it is not uncommon for African startups to seek international expansion at a young age, in order to reach higher-income digital consumers in the capitals of other countries and thus expand their TAM. However, international expansion comes with its own challenges, as regulation often varies widely across African markets, as they are not unified under a common regulatory framework.⁴

Third, digital and programming skills are essential ingredients for Africa's tech sector to create home-grown innovation and inclusive digitalisation. However, a major challenge facing local businesses and digital startups is the shortage of professional software developers on the continent. Despite recent advances, Africa has only slightly more developers than California, with a total of nearly 700,000 in the former compared to 630,000 developers in the latter, half of whom come from a handful of countries (Google & IFC, 2020). Outdated and overly theoretical public tertiary education systems are often blamed for the shortage of African developers. The lack of tech talent is also one of the main reasons why tech giants such as Google and startups such as Andela have started training African software developers on a large scale using private-led certification of IT-related skills – for instance, AWS and Microsoft certification (World Bank & IFC, 2021). In addition, and more fundamentally, deficient basic education still poses a major problem in Africa due to low-quality primary and secondary education.⁵

Fourth, sub-Saharan Africa has a very significant infrastructure deficit despite the progress in digital infrastructure outlined above (Holtz & Heitzig, 2021). According to estimates by the African Development Bank, Africa faces an annual infrastructure financing gap of between USD 68 and 108 billion (Punch, 2022). In particular, often dysfunctional and poorly maintained road networks are major constraints for the transportation and logistics sector in Africa (Kuteyi & Winkler, 2022). In addition, more than 500 million people in Africa still do not have access to electricity, with very low access rates concentrated in Central Africa. Even in the Sahel and East Africa – with Kenya as a notable exception – access rates are often well below 50 per cent (International Energy Agency, 2021). These infrastructural deficits can make it difficult for tech firms to succeed, as a well-functioning infrastructure and stable energy are a prerequisite for

3 Venture capital, unlike public market investment, tends to have binary outcomes, where startups either win big and go to scale or lose everything and go out of business. Returns in public markets are normally distributed but in VC, they are power-law distributed.

4 Jumia, Africa's first tech unicorn, is a good example of a company whose early geographic expansion in Africa was probably too ambitious, causing its valuation to plummet and it to exit many of the countries it had expanded into.

5 Educational technology (edtech) is often hailed as a solution to many of the ills that afflict African schools, and recent evidence suggests that edtech, in particular technology that leverages self-led learning and improves instruction, can be very effective in improving learning outcomes (Rodriguez-Segura, 2022). Yet, the adoption of edtech has remained low in Africa, despite students mostly working from home because of school closures during the COVID-19 pandemic. According to the database EdTech Hub, just 19 million out of over 450 million children in Africa are using EdTech (Crawford, 2020).

African individuals and businesses to access their (often digital or digitally mediated) services and products through their mobile devices. Overcoming such infrastructure challenges is key to opening up previously underserved markets.

Fifth, the rise of the tech ecosystem in Africa is taking place in an economic environment still dominated by small-scale activities in agriculture and services. More than 75 per cent of sub-Saharan Africa's workforce is self-employed, mainly in small-scale subsistence agriculture in rural areas and informal trade and petty services in urban areas (World Bank, 2022b). According to estimates by the ILO (2019), 80 per cent of total SSA employment occurs in enterprises with fewer than ten employees, and 87 per cent of employees work in informal businesses – that is, those that are not registered with relevant national authorities such as the tax office. Informal firms' dominance in key service sectors targeted by startups often requires locally adapted business models.

Africa's tech sector adapts to and sometimes contributes to overcoming some of these challenges. In the following we therefore examine (1) how the tech sectors attracts capital and (2) the type of business that tech firms engage in and their business models, highlighting the roles played by (a) platform businesses, (b) embedded services and products, and (c) agent-based models. Subsequently, we look at how these different features of the emerging tech firms play out in different sectors: fintech, e-commerce and retail, agritech, and transport.⁶

3.1 The tech sector attracts capital

Enabled by enhanced connectivity and the growing availability of venture funding in Africa over the past decade, and at an accelerating pace since 2015, a new wave of fast-growing, digital tech companies has emerged in many African countries. This process has come with a particular spatial and sectoral distribution that we document here.

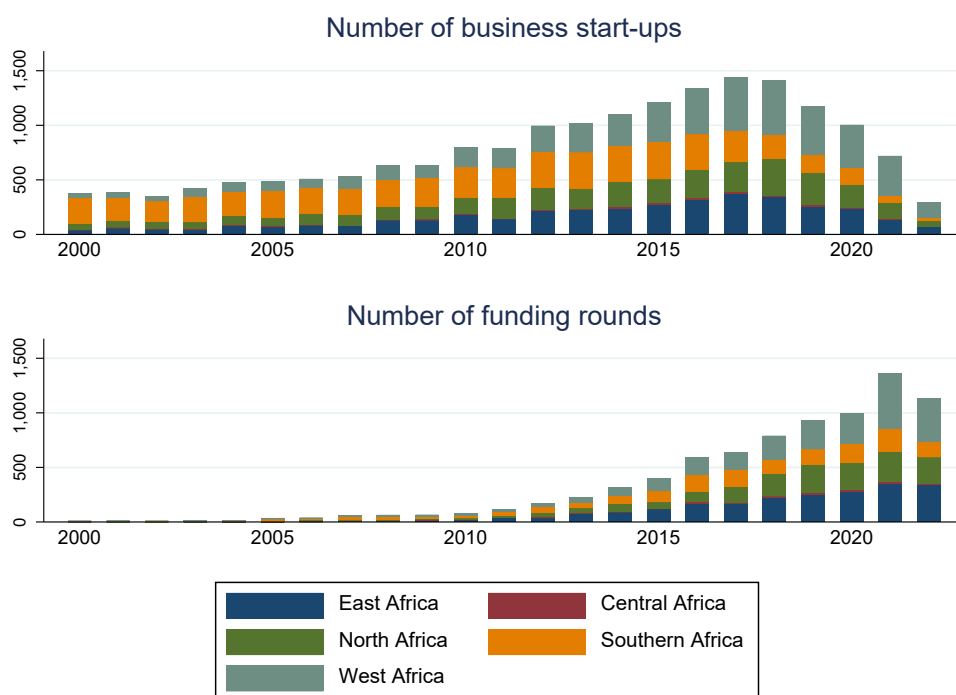
3.1.1 Regional and time trends

Some tech startups are among the fastest-growing startups in Africa (Financial Times, 2022) and are increasingly reaching market sizes and valuations similar to the incumbents in the sectors in which they operate. Just last year, for example, Nigerian fintech Flutterwave was valued at USD 3 billion, making it Africa's most valuable startup. By comparison, Nigeria's Access Bank, Africa's largest bank by number of customers, had a market capitalisation of nearly USD 1 billion and an asset value of USD 28 billion in 2021 (Statista, 2021b; Trading Economics, 2021). At the same time, African startups are increasingly becoming takeover targets of multinationals. For example, it was recently announced that BioNTech, the German biotech company behind one mRNA COVID-19 vaccine, will acquire the Tunisian AI and machine-learning company InstaDeep for USD 682 million, making it the largest acquisition of an

6 Despite their potential to address major deficiencies in public service delivery, we do not cover health and education tech here. This is partly because these firms and their services have yet to gain traction.

African startup. This compares to an annual net FDI inflow into Tunisia of about USD 500 million in 2021.

Figure 1. Business Startups and Funding across African Regions, 2000–2022



Source: Authors' own construction from data from Crunchbase.

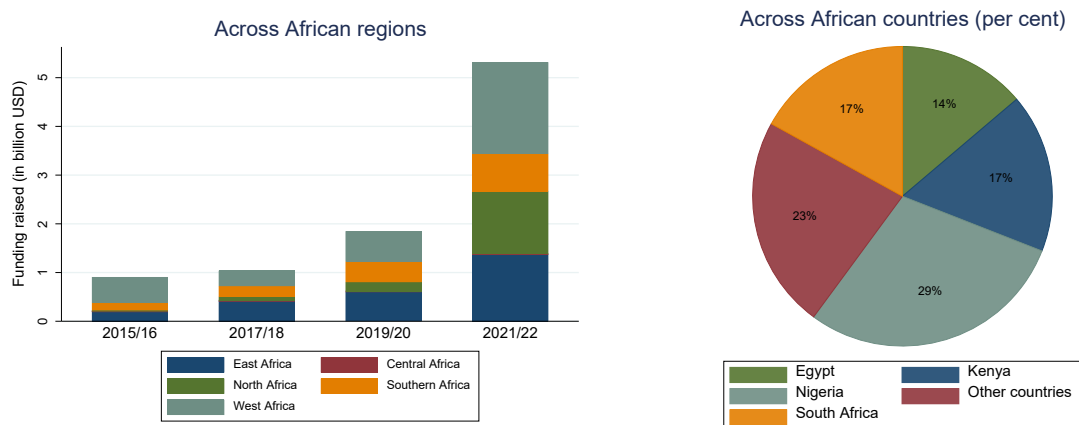
Note: Funding rounds include all types of investments, including venture capital, private equity, (post-)IPO financing, debt, grants, and non-equity assistance.

The increasing dynamism of the African tech ecosystem is reflected in an increasing number of business start-ups – that is, newly founded businesses – and funding rounds, as shown in Figure 1 using data from Crunchbase on technology companies in Africa (see Appendix A1 for details on Crunchbase). In the first decade of the century, the number of business start-ups increased only marginally, hovering around 500, and the number of funding rounds was negligible. However, this changed dramatically in the second decade, when the number of both business start-ups and funding rounds increased rapidly. While the number of business start-ups peaked at nearly 1,500 in 2017 and has since declined, despite the outbreak of the COVID-19 pandemic in 2020 the number of funding rounds continued to rise, exceeding 1,000 for the first time in 2021. This increase has also occurred despite the recent decline in the number of startups, as many of the companies founded in the peak years of 2016–2018 are only now entering the typical venture funding phase with its Series A, Series B, Series C rounds, and so on. These venture rounds usually take place after a startup has been operating for several years and has received initial business start-up financing from a so-called angel investor in the “seed funding” round. In fact, startups, which we define as those tech companies founded after 2010, account for approximately 80 per cent of all funding rounds. Figure 1 also shows that of the

five regions, West Africa has experienced the strongest growth in the number of business startups and funding rounds, especially in recent years, closely followed by East and North Africa. Southern Africa, on the other hand, saw a larger increase in earlier years but has recently stagnated, while the numbers in Central Africa have remained negligible.

Consistent with the overall increase in the number of funding rounds over the past decade, the left bar graph of Figure 2 shows that the amount of funding raised by startups has also increased significantly, especially very recently after the 2020 pandemic outbreak. In West, North, and East Africa, funding volumes raised over two years are well above USD 1 billion. These include domestically raised funding and foreign investment from within and outside Africa (Michael, 2022). To put these figures into perspective, note that net FDI inflows into Nigeria were USD 3.3 billion in 2021 and about USD 500 million in Kenya, compared to around USD 980 million and USD 200 million in funding respectively raised by Nigerian and Kenyan startups in 2021. Startups from West Africa are clearly in the lead, having attracted the lion’s share of funding, followed by East African startups, which are roughly on par with their West African counterparts. Similarly, North African startups in particular increased their funding by several orders of magnitude in 2021/22, while funding for Southern African startups increased more moderately and remained negligible for Central African startups.

Figure 2. Funding Raised by African Startups, 2015–2022



Source: Authors’ own construction from data from Crunchbase.

Note: Only venture capital, grants, and non-equity assistance received by companies founded in 2010 or later are considered.

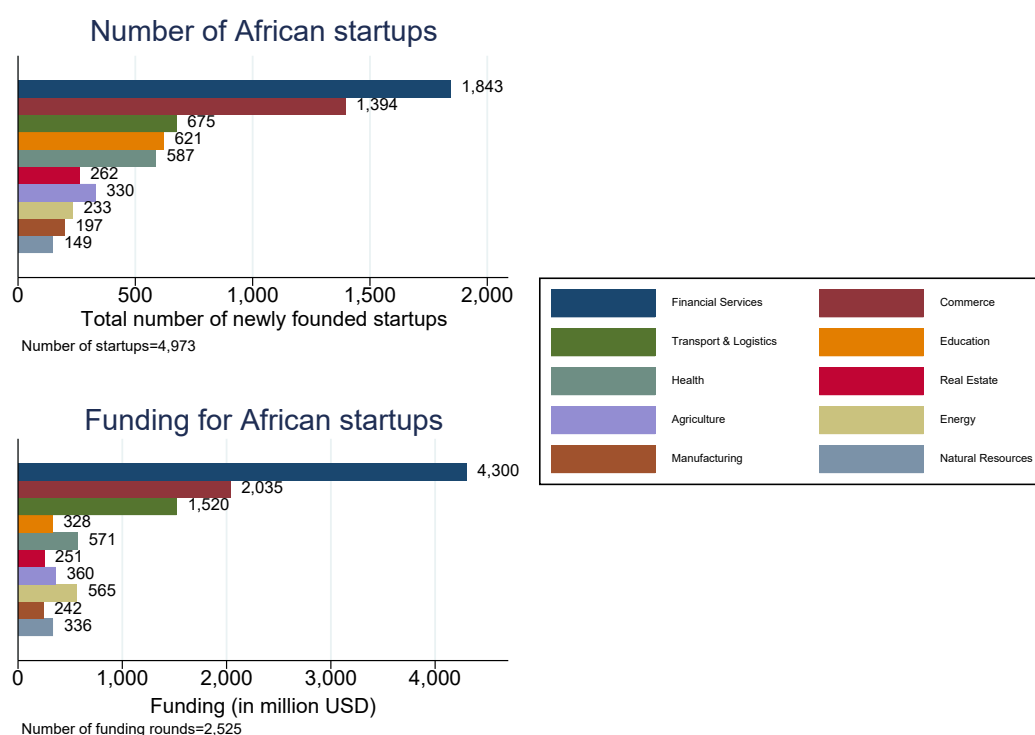
However, in each of the four regions where funding increased, a single country accounted for the vast majority of funding: Egypt in North Africa, Kenya in East Africa, South Africa in Southern Africa, and Nigeria in West Africa. Because of their dominance in Africa’s tech ecosystem, these four countries are often referred to as the “Big Four.” In fact, the Big Four have attracted more than 75 per cent of the total funding for startups in Africa between 2015 and 2022, as shown in the right pie chart in Figure 2. Within the Big Four, funding is highly concentrated, with most of it going to startups based in the urban centres of Lagos (Nigeria), Nairobi (Kenya), Cairo (Egypt), and Cape Town and Johannesburg (South Africa), which are also

the most developed startup ecosystems on the continent according to a 2022 ranking from StartupBlink (2022).

3.1.2 Main activities of African startups

Many of Africa's tech firms can be found in sectors that remain underdeveloped and that have often been identified as obstacles to economic development. This includes first and foremost the financial sector, but also trade and commerce, as well as the transport sector. Financial services startups clearly lead the way in terms of both their number and the funding they attracted between 2015 and 2022.

Figure 3. Number and Funding of African Startups for Top 10 Sectors, 2015–2022



Source: Authors' own construction from data from Crunchbase.

Note: Only the top 10 sectors in terms of number of African startups are included. Sectors are not exclusive, so the same startup/funding round can belong to several sectors. In addition, in the bottom panel only venture capital, grants, and non-equity assistance received by companies founded in 2010 or later are considered.

With more than 1,840 new startups created (top panel, Figure 3) and more than USD 4 billion in funding attracted (bottom panel, Figure 3), financial services startups have clearly outpaced startups in all other sectors. Most startups in the financial services sector are fintechs, which use technology to deliver financial services such as mobile applications, application programming interfaces (APIs), artificial intelligence, blockchain and cryptocurrency, and data analytics. Using such technologies has allowed some of them to grow rapidly. Of the current seven

African unicorns, six are fintech startups. One of the main reasons for the dominance of fintech is that most startups in the sector pursue asset-light business models, which theoretically allow them to scale and become profitable more quickly, making them attractive for venture capital firms to fund.⁷

After financial services, the most popular sector for investment in African tech was the commerce sector, with more than 2,000 new startups created since 2015 (top panel, Figure 3) and USD 2 billion in funding raised (bottom panel, Figure 3). Most startups in this sector use e-commerce business models, which have at their core a platform that connects buyers and sellers and, to varying degrees, also organise the logistics between the demand and supply sides. Other startups in the sector offer technology-based management solutions for businesses, such as app-based bookkeeping, as well as customer, store, and sales management tools.

Apart from startups in the financial services and commerce sector, only startups in transport and logistics were able to raise more than USD 1 billion. Startups in this sector include urban ride-hailing startups, which cater to individuals in African cities, and end-to-end logistics startups, which organise and implement the logistics and warehousing of goods for businesses. The remaining sectors in Africa's top 10 in terms of startup activity are more nascent and have not yet reached the same levels of startup funding and digital technology penetration.

3.2 The business models of Africa's tech firms

Startups in Africa's tech sector can be broadly divided into those that primarily serve individuals (B2C) and those that primarily serve businesses (B2B) with their products and services. Both types of models can be found in Africa. While this is typical for businesses elsewhere, we will now focus on specific aspects of startup business models that are particularly relevant in the African context.

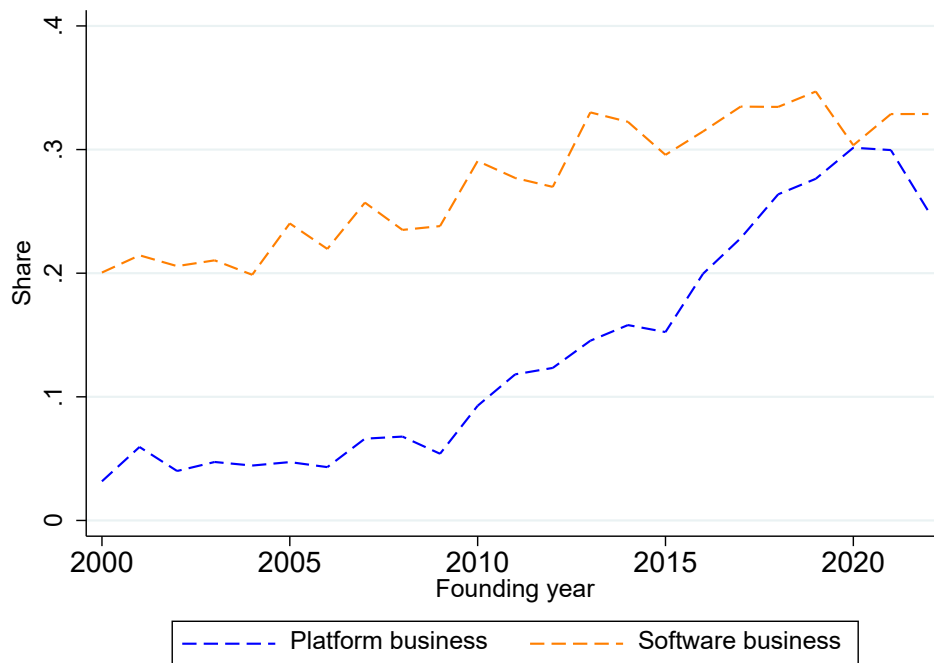
3.2.1 Platform businesses

Over the past decade, digital platforms that bring together different market actors in order to distribute or exchange products, services, and information have become ubiquitous around the world (ILO, 2021). The rapid proliferation of platforms has also reached Africa, with the share of African startups in platform businesses increasing over the past two decades from less than 5 per cent in 2000 to around 25 per cent in 2022, as shown by the dashed blue line in Figure 4. Similarly, by the end of 2022, the share of venture funding attracted by platform businesses had risen to more than a quarter. The expansion of platform businesses in Africa has been driven by increases in all major sectors, but particularly by the proliferation of plat-

⁷ On the other hand, low fixed operating costs make them more vulnerable to competition.

form businesses in the commerce and transport and logistics sector, where they have accounted for between 40 and 60 per cent of newly founded businesses in recent years (Figure Appendix A2). More generally, Figure 4 also shows that over the same period, the share of African software business startups has also increased from around 20 per cent to around 30 per cent.

Figure 4. Share of African Platform and Software Businesses Startups, 2000–2022



Source: Authors' own construction from data from Crunchbase.

Note: We categorise as platform businesses those startups that have the keywords "platform," "market place," "ride-sharing" in their industry classification or company description. We follow the same procedure to categorise startups as software businesses.

The rapid expansion of platform businesses in Africa coincides with, and has been mainly driven by, the increasing availability of venture capital for growth-oriented startups (Figures 1 and 2), as well as the expansion of mobile networks and the proliferation of mobile phones – both basic feature phones and smartphones (Section 2). The popularity of platform business models, particularly among venture capital firms, stems from their growth potential due to network effects and their "asset-light" nature, meaning that they typically require little or no investment in traditional capital assets such as cars, machinery, or buildings and warehouses, as the key function is to connect the supply and demand sides on the platform, who make the investments themselves.⁸ Interestingly, while many African startups start out as pure asset-

⁸ For the sake of this study, it is not necessary to further classify platform business into different types, although we are aware that it is common in the literature. For example, Koskinen, Bonina, & Eaton (2019) classify platform businesses into different types based on their main purpose – transaction, innovation, and integration – and the ILO (2021) based on what they mediate – for example, services and goods or work.

light platform businesses that simply connect the demand and supply sides, after a while many realise that they need to invest in other parts of the value chain to improve their service or product. As a result, they often end up making substantial investments along the value chain, such as in trucks and cars for transportation or warehouses for storage, and thus become asset-heavy companies. Twiga in agriculture, Wasoko in the retail, M-Pharma in healthcare, and U-Lesson in education are all prominent examples of this.

3.2.2 Embedded services and products

Another key characteristic of Africa's tech sector is that many startups offer products or services in more than just one sector, thus exhibiting a multi-product market structure (World Bank, 2022a). It is not uncommon for African startups that have built a relationship with their customers around a core product/service in one area to leverage the existing relationship with customers, including data on them, to offer additional complementary products/services. As a result, customers, who may be individuals or businesses, may be able to access products/services that they would not otherwise have access to.

In particular, financial services such as payments, lending, and insurance, which are traditionally offered by banks and other financial institutions, are often embedded by non-fintech startups in their non-financial apps and platforms. For example, the platforms Wasoko, mPharma, and Twiga Foods all offer their customers – retailers in the case of Wasoko, individuals in the case of mPharma, and smallholder farmers in the case of Twiga Foods – short-term financing through “buy now pay later” services, in addition to simply connecting them to the other side of the marketplace. In order to monetise their existing customer relationships, several startups such as Safeboda, Opay, MNT-Halen, and Yassir are even developing into so-called “super-apps” that offer or facilitate a wide range of products and services to customers (Mastercard, 2021).

3.2.3 Agent-led business models

A particular challenge for many businesses in Africa is serving the so-called “last-mile” – individuals, smallholders or retailers who are difficult to reach through traditional distribution and advertising channels, for example because they live in remote rural areas or informal settlements, and/or are not online. To overcome this, many startups rely on large networks of agents who are well known and well trusted in their local communities to onboard new customers and provide them with products and services.

Agent-led business models have been at the heart of many of the African tech success stories, including the mobile money revolution in Africa. Africa's most famous mobile money platform, M-Pesa, for example, relies on a network of more than 600,000 mobile money agents in both rural and urban areas to enable customers to easily deposit into and withdraw money from their mobile money wallets wherever they live. More recently, fintech startups such as Wave and Kuda Bank have built huge agent networks, often comprising thousands of people,

to deliver their mobile money and other fintech services to customers. However, agent-led business models are not limited to the consumer fintech sector, as startups in other sectors such as retailtech and agritech have similarly used large networks of thousands of agents to bring new smallholder farmers and retailers/vendors onto their platform and offer various products and services through them. Crucially, anecdotal evidence from across these different sectors suggests that locally adapted agent-led business models appear to be more successful in achieving product-market fit than conventional “lift and shift” models, which take a known business model from another, typically West, context and apply it to the African context – we will discuss this in more detail for e-commerce below.

3.3 Insights into selected African tech sectors

We will now delve deeper into the characteristics and evolution of Africa's three most dynamic tech sectors, namely fintech, e-commerce and retailtech, and transporttech, as well as agritech, due to their importance for development, presenting selected startups and how they have transformed – or may transform – their sectors through digital solutions.⁹

3.3.1 *Fintech*

Over the past decade, technology-enabled financial services have spread across the African continent like no other technology or service. The proliferation of fintech has its origins in the fact that a large proportion of African individuals and businesses have been underserved or unserved by the formal financial system. As a result, fintech solutions that integrate these individuals and businesses into the financial system have an enormous disruptive potential. In the following, we will distinguish between consumer fintech solutions offered to individuals (B2C) and business fintech solutions offered to businesses (B2B).

Consumer fintech

In 2011, when the African fintech sector was still in its infancy, only approximately 23 per cent of African individuals had a bank account at a financial institution or with a mobile money service provider (World Bank, 2022b), excluding the vast majority of Africans from the formal financial system. However, with the expansion of mobile money services across SSA over the past decade, this has changed dramatically. Account ownership increased to 34 per cent in 2014 and 55 per cent in 2021 as the share of mobile money account holders increased from 10 per cent in 2014 to 33 per cent in 2021. At 33 per cent, the share of mobile money account holders in SSA is more than three times the global average of 10 per cent, and in 11 SSA economies, the share mobile account holders is even higher than the share of holders of an account at a bank or other financial institution.

9 For more information on each of the startups mentioned in this sub-section, see Appendix A3.

The spread of mobile money across Africa started with M-Pesa, Africa's first and best-known fintech success story, which has grown over the past decade to become Africa's largest mobile money financial platform. Launched in 2007 by Safaricom, Kenya's largest telco (so not by a startup), the platform allows individuals to make cashless payments through accounts on their mobile phones and deposit money via agents found ubiquitously in urban areas. Since its founding in Kenya, M-Pesa has expanded to six other African countries, with more than 50 million users across Africa, and many of the other major telcos operating in Africa have developed their own mobile money networks for their local markets.

While the expansion of mobile money was initially driven by telecom operators such as Safaricom in Kenya and Orange in French West Africa, in recent years fintech startups such as ChipperCash, Wave, and Kuda Bank have played a leading role in facilitating affordable mobile payments between individuals within and across borders. In addition, these and other startups are offering higher value-added financial services, such as savings and loans, to previously underserved or unserved customers through their app-based platforms.

Notwithstanding the expansion of digital financial services in Africa, appropriately regulating this process without hindering innovation is a challenge. One specific challenge, which is not limited to Africa's fintech services, is that – in most countries and for good reasons – only banks can hold deposits. One way to address this has been to allow telcos to provide mobile money through banking subsidiaries or partner banks. More and better regulation may also be required to protect consumers. This is particularly relevant as low-income individuals who were excluded from the formal financial system may be at high risk of over-indebtedness due to predatory lending, gambling, and data breaches.

Business fintech

The rise of mobile money and consumer fintech services was only the starting point for Africa's fintech boom, as an influx of funding since around 2015 has propelled several B2B fintech startups across the continent. In particular, a recent wave of startups focused on digital payment processing, predominantly from Nigeria, including Paystack and Flutterwave, have become major players in Africa's financial services system. By developing application programming interfaces (APIs) that allow web developers to integrate payment processing into their websites and mobile applications, these startups have allowed thousands of African businesses that traditionally had no choice but to run their businesses solely with cash to accept digital payments through different types of payment methods, including bank transfers, local and international cards, and mobile money wallets.

In enabling digital payments for businesses, African startups have played a key role in making business transactions in selected African countries increasingly digital. Nonetheless, digital transactions still make up only about 10 per cent of all transactions in Africa, and many African businesses, particularly SMEs, are still excluded from more advanced financial services such as credit and insurance (McKinsey & Company, 2022). Therefore, there is still plenty

of room left for fintechs to deliver broad social and economic benefits by targeting these still underserved businesses.

3.3.2 *E-commerce and retailtech*

The products and services of Africa's second-largest tech sector, retailtech, have not yet achieved the same level of market penetration as fintech startups. Yet, as indicated above, this sector has recently also raised large amounts of funding. It is not clear how e-commerce or other digital solutions for retail will influence retail markets in Africa. At present, the share of online purchases in Africa, meaning, e-commerce retail, is still low and does not come close to other regions. Even among the Big Four, e-commerce retail in 2021 accounted for only 4 per cent in South Africa, Kenya, and Egypt and 7 per cent in Nigeria, compared with 24.5 per cent in China and 14.7 per cent in the United States (Statista, 2021a). However, given the rapid growth of several e-commerce platforms across the continent in recent years, the share of African e-commerce is likely to increase in the coming years. At the same time, it seems that several retailtech startups in Africa appear to be targeting informal retailers (or producers) rather than selling directly to consumers (The Economist, 2022).

E-commerce platforms

Most of the early African e-commerce startups such as Jumia and Konga have relied on an Amazon-style "lift and shift" platform business models. However, this has largely failed to gain traction with customers and achieve profitability, resulting in massive losses, devaluations, and job cuts (Kazeem, 2018; Rest of the world, 2023). In contrast, a second generation of e-commerce startups such as Copia in Kenya and Brimore in Egypt, have made significant progress by enabling customers to place orders through the large agent networks they have built up. In general, therefore, the biggest challenge for startups in Africa is often not a competitor, but to devise a business model that can reach a sufficiently large number of customers within the circumstances of specific markets.

Digital retail solutions for SMEs

At the same time, other startups have identified a business opportunity digitising the often sub-optimal sourcing, distribution, and management practices of informal retailers (The Africa Report, 2022). Some startups, such as Kenya's Wasoko – Africa's fastest-growing company between 2017 and 2020 (in terms of revenue) (Financial Times, 2022) – or Nigeria's TradeDepot, for example, use platform business models and their own distribution chain (from warehousing to logistics) to connect retailers with manufacturers, thereby improving access to capital and supplies for small, predominantly informal retailers. Specifically, retailers can order goods from local and multinational suppliers via SMS or mobile applications for same-day delivery to their stores, and obtain short-term financing through "buy now pay later" services.

Still other retailtech startups provide small businesses with app-based bookkeeping as well as customer, store, and sales management tools. For example, Nigeria's Bumpa and Kippa and Egypt's Sabi allow retailers to efficiently and seamlessly organise, manage, and monitor transactions, customers, cash flows, and debt on their mobile phones.

3.3.3 *Transporttech*

Ride-hailing platforms

Digital ride-hailing apps have become ubiquitous across Africa. The business is typically dominated by companies based outside Africa, such as Uber, Bolt, or Yango, but there are also several African startups that have ventured into this sector, including Kenya's Little Ride, Algeria's Yassir, or Egypt's MNT-Halan. In some cases, these African startups focus on "non-taxi" transport modes that are common in the countries in which they operate. This includes Safe-Boda from Uganda and Gokada from Nigeria, which offer ride-hailing via moto-taxis and provide other delivery services in urban areas for food and parcels. All these startups have at their core a platform that algorithmically matches individual passengers with drivers, calculates the fastest route to the specified destination, and transparently estimates the fare for the ride.

End-to-end logistics platforms

While the aforementioned ride-hailing platform startups have transformed passenger transport in many African cities, end-to-end logistics startups are trying to do the same for the movement of goods across the continent. By connecting manufacturers and trading houses with transport service providers and individual truckers, and digitally tracking the cargo through their platform, startups such as Nigeria's Kobo360 or Kenya's Lori Systems are reducing coordination costs and information asymmetries on both sides of the market. Some startups, such as Sendy and Kobo360, have also integrated advanced financing services into their platform.

3.3.4 *Agritech*

Digital technologies in agriculture hold great promise, but many of them have yet to be adopted at scale. Scaling has proven difficult for many innovations in agriculture (Deichmann et al., 2016), but some digital solutions are taking off. Since African agriculture is dominated by smallholder farmers, agritech startups primarily focus on their needs. The most prominent example is Twiga Foods, an online B2B marketplace for agricultural produce. This startup has become one of the largest agricultural wholesalers in Kenya (TechCrunch, 2021). Since its founding in 2014, Twiga has raised more than USD 100 million to build its own distribution chain – it now connects over 100,000 farmers and vendors through its platform. According to Twiga, farmers benefit from higher prices, guaranteed market access, and reduced post-harvest loss, while vendors benefit from fresher and better-quality food.

Marketplace platforms are not the only digital solution offered by agritech startups for smallholders, however. Others have focused, for example, on enhancing access to extension services through peer-to-peer knowledge-sharing platforms (WeFarm) or capital-intensive equipment and machinery such as tractors (Hello Tractor of Nigeria and Trotro Tractor of Ghana), or solar-powered water-pumping systems (SunCulture) and crop-processing technology (Releaf).

4 Development and employment impacts of Africa's tech sector

The above account of the characteristics of Africa's tech firms and the digital products and services they provide are a testament to the sector's potential to hugely impact economic development and people's livelihoods. As in the cases of mobile phones – with many users never having possessed a fixed-line phone – and digital wallets and mobile money – with many customers never having opened a traditional bank account – Africa may leapfrog certain “stages of technological development.” This not only means that people now have access to mobile phones and bank accounts; it can also facilitate African economies becoming much more productive and providing more productive employment, higher incomes, and higher living standards – and probably much more rapidly than would have been the case without digital technologies.¹⁰

As we have seen above, there is some empirical evidence that suggests that connectivity leads to higher incomes, but the role of startups and the digital services they offer in explaining these gains is poorly understood. In principle, digital services and products by private startups have the potential to fix some (but not all!) market and government failures, make more efficient use of resources, and improve economic outcomes at the individual, sectoral, and economy-wide level.¹¹

For example, mobile money and other digital finance solutions have clearly expanded access to credit and other financial services by considerably lowering transaction costs. This can enable individuals and firms to invest in productive capital. The potential downsides (e.g.

10 Despite the historical emphasis on manufacturing as an engine of economic development, today's developed economies are characterised by standardised and mass-produced services that have become a key source of productivity growth, and thereby overall growth, over the past few decades (Gollin, 2018). The role of manufacturing as a driver of development is often attributed to the modularity and standardisation of manufactured goods. Such products have great scope for economies of scale and encourage innovation through codified scientific and technical knowledge, leading to increases in productivity and economic growth. If digital technologies can facilitate the formalisation, modularisation, and standardisation of Africa's predominantly small-scale and informal service and agricultural activities, this could bring about the much-needed scale and innovation to enable substantial increases in productivity and growth.

11 We focus here on the private sector and the labour market. We thus do not cover the public sector and the potential of digital technologies to address some of its shortcomings, which are, rightfully, often flagged as a key obstacle to economic development in sub-Saharan Africa.

over-indebtedness) are most likely smaller than the upsides of improved access. Generally, many of the aforementioned apps and platforms address information failures and asymmetries by revealing critical information on transactions and the involved parties to both buyers and sellers. Better information can lead to more efficient outcomes, including the better use and allocation of resources. For example, through a tractor-sharing app, tractors, which have considerable fixed costs, can now be booked and used by many more farmers, making the investment into tractors worthwhile and potentially increasing the overall supply of tractors.

When digital solutions create digital marketplaces, they often lead to more competition and competitive prices. Effects on prices can be large when this happens in regulated sectors, such as the taxi industry. When prices fall, this is good for consumers but may hurt producers, i.e. traditional or “analogue” taxi drivers in said example. Competitive pressure may also come from startups entering oligopolistic and monopolistic markets. A case in point is the French-speaking West African mobile money market that tended to be dominated by telecom giant Orange. The startup Wave conquered this market with much lower prices for the same service.

Typically, more efficient markets and lower prices will lead to increased consumption and more people being able to consume/have access to certain services. In principle, larger markets/higher demand may also generate more employment opportunities. As we show below, it is especially the agent-based business models that directly generate non-negligible employment. Yet, impacts of digital technologies on labour markets are ambiguous, as illustrated by the case of taxi drivers, whose incomes may be depressed when “digital” competition emerges. In economic environments where average labour productivity is low and labour supply (at least for a certain type of task or service) is relatively abundant – as is typically the case in urban sub-Saharan Africa – many service-sector jobs with low entry barriers, which are created through platforms, may neither pay well nor offer (much) better than average working conditions (Mastercard Foundation, 2019).

Better working conditions may, however, result from the rise of digital services if the potential of digitalisation for formalisation is harnessed. Employment through a digital platform implies that the related economic transactions leave a digital trace that could be used to integrate workers and (smaller) firms into the formal economy (Lakemann & Lay, 2019). Ride-hailing apps, for example, could only allow drivers to operate on their platforms if they have obtained certain licences, or are registered with the tax authorities or possess the relevant social protection.

All these are plausible transmission channels through which digital technologies and services may eventually affect development and labour market outcomes. Yet, for many of those there is anecdotal evidence at best. In fact, the only digital technology whose impact in Africa has been under scientific scrutiny is that of mobile money. We review the corresponding studies below. Some technologies have been studied in other geographical contexts. The impacts of e-commerce have, for example, been studied for the Chinese case, with studies suggesting that higher prices for sellers on online platforms are partly (if not entirely) eaten up by higher

marketing costs (Liu et al., 2021). Couture et al. (2018) examine the effects of a Chinese policy that connected rural villages to e-commerce and find positive average income effects that tend to be concentrated among younger and richer households. Before we turn to the evidence on the effects of mobile money, we will present some figures on the direct employment effects of parts of the digital economy.

4.1 Employment effects

Africa's startups and the services they develop impact the labour market through different channels. We distinguish between first-, second-, third-, and fourth-order effects. First-order effects refer to direct employment generation in the tech sector. Overall, this direct contribution to employment generation is negligible, but selected firms can quickly reach a significant size. For example, Jumia has between 5,001 and 10,000 employees, according to Crunchbase, which includes customer service representatives, warehouse workers, and delivery drivers. Twiga, the B2B marketplace for agricultural produce, has more than 1,800 employees, and Wasoko, the startup that connects retailers with wholesalers and producers, has more than 1,000.

The rise of platforms in Africa has led to important changes in the business landscape and, importantly, the boundaries of firms, with an army of agents and delivery workers in between wage employment and self-employment. This includes the jobs that we categorise under second-order job creation. These workers are typically active on the supply side of platforms, but not directly employed by the firm behind it. This includes, for example, around 18,000 drivers on SafeBoda, more than 50,000 retailers/vendors using Wasoko, and 140,000 retailers/vendors and more than 1,000 farmers using the Twiga platform.

In addition to these "platform customers," there is third-order job creation, which encompasses agents who facilitate the transaction on platforms. The numbers of such agents can be relatively large. M-Pesa, for example, has around 600,000 mobile money M-Pesa agents. Copia uses around 40,000 agents (small shop owners) to reach rural customers. M-Kopa, which offers financial services, relies on 10,000 salespeople.

The challenge is that many of these newly created jobs on and through platforms are characterised by irregular and low pay and are outside the scope of protection in the event of unemployment or accidents at work, as most platform workers, especially in the second and third tiers, are classified as independent contractors. In fact, in almost all cases, the number of such "semi-formal" platform-related jobs far exceeds the standard formal employment in platform businesses.

Finally, there is fourth-order job creation, which refers to the wider indirect employment effects through increased efficiency/lower prices and/or new products/services. These effects need further analysis and quantification through studies similar to those on M-Pesa.

4.2 The effects of mobile money

Early evidence by Suri & Jack (2016) suggests that M-Pesa's impact in Kenya, where the platform has more than 30 million active users (The East African, 2022), has been enormous, lifting approximately 2 per cent of Kenyan households out of poverty. According to the authors, the platform achieved this by formalising the financial arrangements of previously unbanked household and integrating them into the formal financial system. Specifically, M-Pesa has increased household's financial resilience and savings, and improved labour market outcomes for individuals, particularly women, by enabling them to transition from agricultural to non-agriculture employment. A review by Aron (2018) concludes that there is robust evidence that mobile money fosters risk-sharing. She argues that the evidence on the positive welfare impacts, including higher labour market incomes and higher savings, is less convincing (Aron, 2018). Accordingly, Suri & Jack's (2016) findings on M-Pesa's impact in Kenya have been challenged more recently due to important omissions and errors in their analysis (Bateman, Duvendack, & Loubere, 2019). Yet, overall, there is growing evidence of the positive socio-economic impacts of mobile money in African countries where it is present (Ahmad, Green, & Jiang, 2020; Nan, Zhu, & Markus, 2020).

5 Conclusion and policy implications

Digitalisation is gaining momentum in Africa as significant improvements in Africa's digital infrastructure and a vibrant startup ecosystem transform large parts of African economies. The analyses of this study show that digital technologies, and in particular digital platforms, are increasingly being deployed at scale in key African sectors in a growing number of African economies. Africa has become increasingly connected, an important pre-condition for digital technologies to spread and get adopted. While coverage is improving – 81 per cent of sub-Saharan Africans live within the reach of a mobile broadband network (GSMA, 2021) – internet use remains low, at only 30 per cent. Further, both coverage and use differ very considerably across but also within countries.

So far, anecdotal accounts suggest that home-grown digital technologies can have transformative impacts on the individuals, businesses, and farms that adopt them. Overall, however, with the notable exception of mobile money, there is almost no rigorous empirical evidence on the economic impact of these digital technologies – be it on productivity, employment, or living standards. At the same time, very little is known about the contribution of African startups to growth in Africa, while we know from other places such as the United States, for example, that a few high-growth startups – so-called “gazelles” – contribute disproportionately to job creation, output, and productivity growth (Haltiwanger, 2017). This study is only a moderate first step in expanding our knowledge about the characteristics of Africa's tech

sector, the digital services it develops, and its impact on economic development, specifically on labour markets.

We have shown that Africa's emergent tech sector manages to adapt to and, at times, to address some of the continent's constraints to development. Startups continue to attract very significant amounts of capital. The worth of some startups is the same as, or even more than, the annual FDI inflows to the countries in which they are based. Investment into startups – from both domestic and international sources – is, however, concentrated in a few countries. The “Big Four” – Egypt, Kenya, South Africa, and Nigeria – have attracted approximately 75 per cent of all startup funding in Africa between 2015 and 2022. There is also sectoral bias, as most of the funding goes to tech firms in financial services. E-commerce, retailtech, and transporttech also receive important amounts of investment.

Our review of business models and digital services shows how tech firms adjust their services and business models to the African context. For example, the dominance of financial services among tech firms is no coincidence but also a result of the underdeveloped finance sector that fails to reach a vast majority of Africans. For many of these firms, a key challenge is to develop a product or service that can be profitably scaled in a low-income environment. Home-grown African digital solutions differ – to some extent – from solutions elsewhere in three important respects: First, platform businesses, which continue to gain importance in Africa, cannot only function by simply connecting demand and supply, as platforms do in other markets. This is because other obstacles, for example in transport and logistics, but also on the producer side, prevent the platform from establishing a functioning market. As a result, platform businesses need to address some of these obstacles, for example by investing in storage facilities or in trucks and cars for transportation. Second, and responding to the challenge of relatively poor customers that may be difficult to reach, many tech firms offer multiple products that complement the original service. Some kind of financial service, in particular “buy now pay later,” is offered on many platforms. Third, many tech firms, including M-Pesa and Copia in Kenya, rely on large networks of agents that are anchored in their local communities to gain new customers and provide them with products and services. Our examples from different tech sectors forcefully illustrate how these principles play out in specific cases that are often too recent to be judged as sustained success. However, the fast growth of selected e-commerce platforms (e.g. Wasoko), transport and delivery services (e.g. Gokada), and agritech services (e.g. Twiga and Hello Tractor) can be taken as signs of the transformative potential of these context-adapted tech services.

It will be important to understand whether and how this transformative potential will materialise. As our brief review of the literature suggests, our knowledge on the impact of digital technologies is very limited, in terms of both sectors and regional and country coverage. The only case that has been thoroughly studied is mobile money in Kenya, and the literature suggests significant but moderate positive impacts on people's livelihoods. Our brief recap of the direct and indirect employment impacts of tech firms is suggestive of transformative impacts

that can go beyond the specific tech firm. More empirical evidence is urgently needed; not only to take stock and understand “digital development,” but also to analyse the reasons why certain technologies are adopted and achieve scale and impact in some places, but not in others. Such knowledge is obviously very policy-relevant, as it may allow us to identify policies and development interventions that can leverage the development potential of startups and digital services.

From the present review, we can draw three general policy recommendations, which rest on the general assumption – supported by this review – that home-grown digital solutions hold very significant development potential. It is difficult to predict which innovations and adaptations to the African contexts will make a difference in the end. Even less predictable is which firms will eventually develop a sustainable and scalable business model. Yet, as Africa's digitalisation accelerates, it will become increasingly important for African governments and their partners to develop policies that capitalise on and leverage the benefits of emerging technologies, while simultaneously ensuring that digitally backward African countries and parts of society do not fall further behind in terms of their digital development and socio-economic development in a broader sense.

First, to promote local entrepreneurship and technological innovation, antitrust regulation will not suffice. In many African countries entrepreneurs still find it difficult to start and scale their businesses due to a burdensome regulatory environment, as SSA remains the region with the least ease of doing business (World Bank, 2020). To improve the status quo, several African countries have either signed national startup laws (Tunisia and Senegal) or approved them in their respective parliaments (Kenya, Ethiopia, and Nigeria) (TechCabal, 2022). Startup legislation aims to make starting, operating, and scaling businesses easier by clarifying investment standards, subsidising entrepreneurs' salaries, and providing tax breaks, government loans, and credit guarantees for young companies. Alongside such tangible benefits, they aim to bridge the engagement gap between startups and regulators, ensuring that regulation is sensible and does not stand in the way of innovation. In Nigeria, for example, prior to the passage of the national startup bill, the Central Bank of Nigeria had banned all types of cryptocurrency transactions. Similarly, Lagos State had banned bike-hailing services in Nigeria's most populous city. Such bans make it practically impossible for startups in these sectors to compete with incumbents, and technological innovation is thus prevented. This is not to say that new technologies should be left unregulated. Potentially harmful impacts must be anticipated and prevented. In Kenya, for example, several fintech startups entered the market and ended up trapping people in debt under high-interest loans (Bloomberg, 2020). In fact, startup bills can be an important tool for governments to strike a balance between draconian measures such as outright bans and the unregulated use of new technologies.

Second, international and multinational partners of African governments can play a crucial role in supporting entrepreneurship and innovation in Africa, particularly by empowering underrepresented groups such as African-born and African-educated entrepreneurs, particularly

women, who are severely underrepresented in Africa's tech sector (Cuvellier, 2022a, 2022b). One way to do this can be, for example, through financial and technical support to startup incubators and accelerators that specifically target these underrepresented groups. When it comes to investing in local startups, partners, particularly development banks, can play an important role by contributing with their financial resources to investment funds managed by experienced venture investors. Good examples of this include KfW's EUR 45 million and IFC's USD 26 million investment in the "Partech Africa II" fund, which targets African tech startups (KfW, 2022; IFC, 2022). Investments from partners can be particularly valuable when they target startups in sectors with potentially positive development impacts like e-health and edtech, which have received comparatively little attention from venture capital firms because these sectors are not easy to monetise.

Third, while private efforts to equip Africans with programming skills are commendable, they are unlikely to be sufficient to make up for the shortcomings of the African public tertiary education system. Close cooperation between the private sector and African universities is imperative here in order to design state-of-the-art and practice-oriented university programmes in a rapidly changing digital world. Expanding the pool of tech talent in Africa will also require instilling digital skills from an early age. Encouragingly, more and more African governments are recognising this need in their national digitalisation plans. For example, the Kenyan government recently included coding as a subject within the official curriculum for primary and secondary schools, and the Rwandan government will expand its "Smart Classroom" programme across the entire country, equipping primary and secondary schools with an IT infrastructure.

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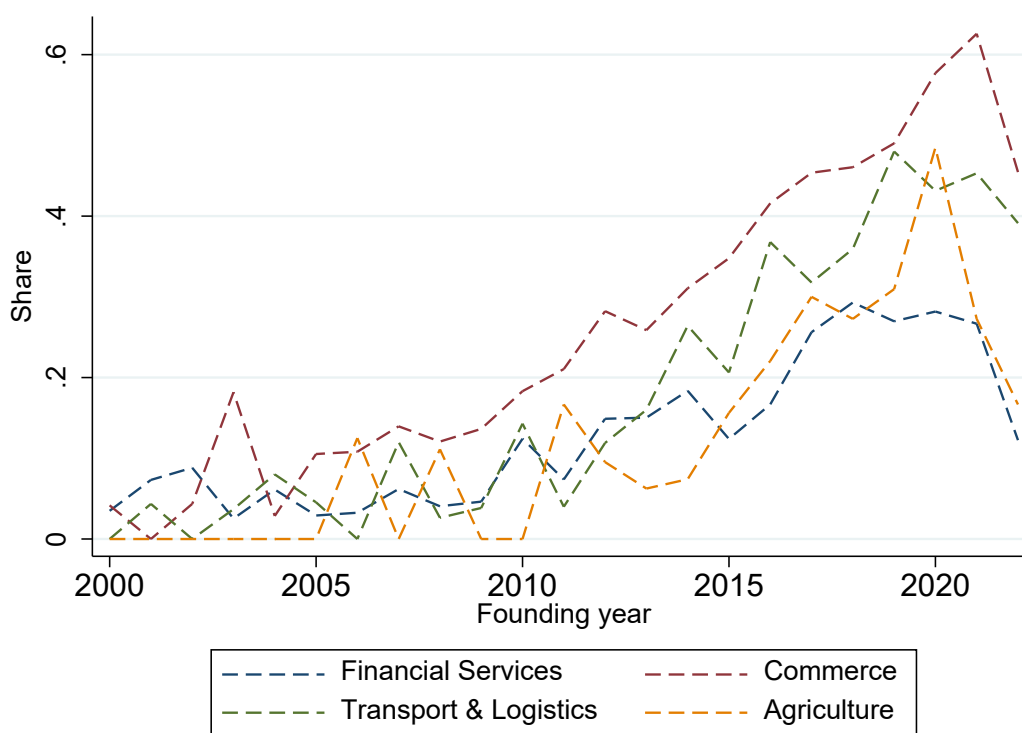
Appendix

A1. Crunchbase database

Launched in 2007, Crunchbase is a relatively new commercial database on innovative, often venture-backed, companies from around the world. Company information in the database is compiled and curated from four main channels: (i) a large investor network of more than 4,000 investment firms that submit monthly portfolio updates; (ii) community contributors such as executives, entrepreneurs, and investors who contribute to company profile pages; (iii) AI and machine-learning (ML) algorithms that validate the data and flag anomalies; (iv) an internal team of data analysts that manually validate and curate the company information.

Crunchbase's crowd-sourced and AI/ML-driven approach to data collection represent important innovations compared to other commercial and public data sources, making the database unique in terms of its timeliness and scope. The database has therefore become, if not the single-most, one of the most widely used databases in the venture capital industry. Researchers and scholars are also increasingly using the database to analyse the tech/startup world – according to (Dalle et al. 2017), more than 90 scientific articles have already been published using the Crunchbase database as of 2018.

A2. Share of African Platform Businesses Startups by Sector, 2000–2022



A3. Key Characteristics of Startups (either mentioned in the text or with major funding raised, according to Crunchbase)

Fintech

Company name	Founding	Focus area; Business model	Focus market(s)	Funding raised, in million USD	Funding type
M-Pesa	2007	Mobile payments; B2C	Kenya	N/A	N/A
Opay	2018	Mobile payments; B2C	Nigeria	570	Equity
Wave	2018	Mobile payments; B2C	Senegal	291.5	Equity
Sendwave	2014	International payments; B2C	Pan-African	500	Acquisition by WorldRemit
Chipper Cash	2018	Intra-African payments; B2C	Pan-African	302.2	Equity
Interswitch	2002	Online payments integration/API; B2B	Nigeria	320.5	Equity
Flutterwave	2016	Online payments integration/API; B2B	Nigeria	474.5	Equity
Paystack	2015	Online payments integration/API; B2B	Nigeria	200	Acquisition by Paystack
Fawry	2008	Mobile payments; B2C	Egypt	122	Equity (IPO)
Paga	2009	Banking; B2C	Nigeria	36.7	Equity
Kuda	2019	Banking; B2C	Nigeria	91.6	Equity
M-Kopa	2011	Lending; B2C	Kenya	263.6	Equity, Debt
FairMoney	2017	Lending; B2C	Nigeria	67.4	Equity

E-commerce and retailtech

Company name	Founding	Focus area; Business model	Focus countries	Funding raised, in million USD	Funding type
Jumia	2012	E-commerce marketplace and logistics; B2B/B2C	Nigeria	1,200	Equity (IPO)
Konga	2012	E-commerce marketplace and logistics; B2B/B2C	Nigeria	79.5	Equity
Copia Global	2012	E-commerce marketplace for low and middle income; B2C	Kenya	103	Equity
Brimore	2017	Social commerce platform			
Wasoko	2013	Marketplace and logistics for consumer goods; B2B	Kenya	143.6	Equity
TradeDepot	2016	Marketplace and logistics for consumer goods; B2B	Nigeria	123	Equity
MaxAB	2018	Marketplace and logistics for consumer goods; B2B	Egypt	101.2	Equity
Allerzo	2019	Marketplace and logistics for consumer goods; B2B	Nigeria	16	Equity
Jabu	2020	Marketplace and logistics for consumer goods; B2B	Namibia	18.2	Equity
Kippa	2021	App-based bookkeeping for SMEs; B2B	Nigeria	11.6	Equity

Transporttech

Company name	Founding	Focus area; Business model	Focus countries	Funding raised, in million USD	Funding type
SafeBoda	2015	Urban motorbike ride-hailing platform; B2C	Uganda	1.3	Equity
Gokada	2018	Urban motorbike ride-hailing platform; B2C	Nigeria	12.4	Equity
MAX	2015	Urban motorbike ride-hailing; last-mile delivery and online retail; B2C	Nigeria	64.4	Equity, Debt
MNT-Halan	2017	Ride-hailing; B2C	Tunisia	530	Equity, Debt
Yassir	2017	Ride-hailing; B2C	Algeria	217.6	Equity
Moove	2020	Revenue-based vehicle financing; B2B	Nigeria	200.1	Equity, Debt
Tugende	2013	Motorbike-financing; B2B	Uganda	61.1	Equity, Debt, Grant
KOBO360	2017	End-to-end logistics platform; B2B	Nigeria	36.3	Equity, Debt
Lori Systems	2016	End-to-end logistics platform; B2B	Kenya	38.2	Equity, Debt
Sendy	2014	End-to-end logistics platform; B2B	Kenya	26.5	Equity

Agritech

Company name	Founding	Focus area; Business model	Focus countries	Funding raised, in million USD	Funding type
Twiga Foods	2013	Marketplace and logistics for fresh produce; B2B	Kenya	157.1	Equity, Debt, Grant
Apollo Agriculture	2016	Access to financing, inputs, insurance, and advice; B2B	Kenya	61.7	Equity, Debt, Grant
Wefarm	2015	Peer-to-peer knowledge-sharing network for smallholders; B2B	Pan-Africa	32	Equity, Grant
ThriveAgric	2016	Access to financing, inputs, insurance, and advice; B2B	Nigeria	58.5	Equity, Debt, Grant

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