Adapting to the 4IR: Africa's development in the age of automation

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GOVERNANCE

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FOREWORD FROM TONY BLAIR

The Fourth Industrial Revolution (4IR) is upending the nature of work as we know it. Policymakers are struggling to grapple with this future in the West, but for African countries—and developing countries generally—the outlook appears even more bleak.

The rate of technological change is the defining characteristic of our generation. Its impact on work, labour, how people live, our social and political interactions, have all been and are being transformed by the digital revolution.

This change is likely to be a net good for the world. But progress is not always smooth.

In the developed world this tension is playing out in the debate on automation. New technologies have provided a wider array of goods, at a lower cost. They have also helped spur new industries, creating new jobs and opportunities.

But there have also been downsides. Employment in some industries has been eroded, often to the detriment of whole communities. From the American rust-belt to British ports and industrial-towns, automation has transformed the manufacturing process, making it far more advanced and technologically driven

and far less labour intensive. The cost has been the livelihoods of many people, which has often been underappreciated when looking at progress as a whole.

The impact of this revolution on Africa and other developing countries is likely to be even more seismic. Rapidly evolving technologies and the astronomical proliferation of smartphones across Africa have already changed lives on the continent and increased aspirations, but they are also altering the development pathways available to these countries.

Historically, manufacturing has been the development escalator for poor countries. Now, the labour-substitution effect of automation threatens African economies' ability to leverage manufacturing for job creation, as the emerging Asian economies did in the second half of the twentieth century.

This will drastically change the process of development, although how is anyone's guess. Only one thing is for certain: success will be premised on how African governments and their economies adapt to technological change.

This new policy framework published by my Institute helps African governments navigate this. It sets out the wide plethora of policy choices available to governments to leapfrog into the digital era: from investments in AI-powered personalised education platforms to address the severe gap in learning outcomes, to the application of advanced technology to transform the continent's agricultural productivity.

It also offers a means by which to navigate the opportunities and political considerations inherent in making such hard and contentious policy decisions. Faced with multiple priorities, the tendency of governments is to try and do too much, often to the detriment of the truly urgent issues.

But no government can implement everything; hard policy choices and trade-offs have to be made. And if understanding this is essential, so too is the need to be adaptive. Expectations are often stratospheric for leaders first coming in to office. Yet these often come into conflict with a government's capacity to deliver.

This was true for me coming into office, and it is perhaps even more so for the leaders we work with today. The challenges they face are far more complex, and nowhere is this more acute than in Africa.

Not only is government delivery hard in a low-capacity environment, but the policy choices to be made are no longer clear. The 'rule-book' for manufacturing-led development is becoming obsolete.

Being adaptive doesn't mean leaving development pathways to chance; governments must create the policy space to allow innovation to flourish. They must be clear on their goals for inclusive growth, and then step back to allow actors across the economy to innovate, creating a learning ecosystem through which they can identify successes and be prepared to shore up investment to back emergent 'winners' across the economy.

A digital framework to identify and open up these opportunities will be an essential first step.

Furthermore, African economies on their own are by and large not big enough to attract significant investment, as compared to the markets of China, India or the US. As such, African countries should unite to create a digital single market in which to generate the opportunities entrepreneurs and investors need to stimulate innovation.

Such a big hurdle, however, cannot be grappled by Africa alone.

All the opportunities that the digital revolution represents are premised on super-fast, reliable and affordable connectivity. African economies cannot shoulder this investment by themselves. It requires the financial heft of the multilateral investment community in collaboration with the leading global tech innovators to find viable solutions to connect the bottom three billion, many of whom are in Africa, by 2025.

This does not necessarily mean laying fibre optics everywhere to the last mile. To start, we need dialogue between multilateral investors and Big Tech to work out how those still unconnected can be best served, drawing on frontier models of financing with the most innovative forms of connectivity.

Kenya's Minister of Information, Communications and Technology, Joe Mucheru, sets out some of the challenges and questions that many African governments are asking today around this question in his foreword to this report. As he writes, a growing youth population has different aspirations today – and as Africa's population is likely to double by 2050, dwarfing Europe 3.5 times over, these desires are almost certain to increase with it.

His government and many others we work with, including those of Ethiopia, Rwanda, Ghana and Togo, are pressing on with reforms to make their countries prosper in the digital era. Yet it is for all of us – African governments, multilateral investment actors and the international tech community – to ensure that the fruits of this are shared. My Institute's recommendations are the first steps towards that goal.

FOREWORD FROM JOE MUCHERU

Africa is characterized by a fast-growing, youthful, rapidly urbanizing and extremely well-connected population whose aspirations and expectations have been set by their wide exposure to global media.

Our people expect technology to improve the quality of their lives and their economic participation, and it already is. Mobile money transfers have revolutionized the banking sector; farmers can now get more and better produce because of farming and weather apps while children are having their curriculum delivered through digital devices.

However, every indication and fear has been that as technology moves into the job space and automation of blue-collar work becomes mainstreamed, that low-skill repetitive jobs will become extinct and the very nature of work will be transformed.

What are the changes to expect? Are these expectations well-founded? What are their scope and scale? How do we prepare our countries for this emerging revolution? What does it mean for developing economy countries and how can we change our lot? Is winter coming?

Crystal gazing is a notoriously parlous, uncertain and error-prone profession. In this insightful monograph, Kartik and Georgina give a reasoned prognostication of the future and the options to shape it. They anticipate how some of the changes may play out and what it means for Africa.

The changes that are anticipated require a whole-of-society response - the government can set policy direction and control, to some extent, the incentives that drive the private sector, but each player in the national ecosystem needs to understand the parameters. The traditional economic factors - money, machines, manpower, materials, and markets all need to adapt to the new environment.

The fact that change is coming, cannot be gainsaid - it always has and always will - how we react to change determines the fate of our peoples and nations. if Africa is to participate meaningfully in the global economy of the future, outside of its traditional role as a resource extraction continent and market, then governments and corporations need to re-assess the priority of their investments. This analysis of the factors, nature, and levers in the hands of governments and corporations is worth a close and thoughtful look.

The confluence of climate change and the fourth industrial revolution mean that the geographic, economic, technical and social environments are transforming simultaneously. This is either a boon or a bane for developing countries.

The rapid transformation of so much, all at once, can lead to analysis paralysis. It is necessary to skillfully, knowledgeably and carefully navigate this new emergent terrain.

The seismic changes that portend on the horizon due to the rapid evolution of the technical environment cause forward-thinking policymakers concern. The advance of artificial intelligence and machine learning, the adoption of blockchain, and the manifest automation of jobs, the advent of 3D printing and additive manufacturing, nanotechnology, and the logistical impact of self-driving cars mean that the very structure of society will change.

This paper provides a preliminary framework for thinking through these challenges.

Hon. Joe Mucheru, EGH
Cabinet Secretary
Ministry of Information, Communications and Technology
KENYA

EXECUTIVE SUMMARY

The Fourth Industrial Revolution (4IR) is upending the nature of work as we know it. Policymakers are struggling to grapple with this future in the West, but for African countries—and developing countries generally—the outlook appears even more bleak.

Advancing technology will narrow the traditional route to economic transformation through manufacturing. This is a matter of when, not if—many of these jobs as we know them will be displaced.

Yet tech will transform Africa too, offering new avenues to leapfrog the old systems of the West. To achieve this, African governments, the international community and the tech community must come together to harness the power of the 4IR. If this does not happen now, a new tech inequality will further entrench the gap between the developed and developing world.

KEY FINDINGS

- **Automation in manufacturing presents a threat to labour.** The nature of manufacturing is changing in ways that may diminish opportunities to move low-capacity, low-productivity labour into more productive sectors and activities at scale. Automation is not only reshaping the structure of Western economies, but is also threatening Africa's ability to emulate the development pathway of earlier industrialisers.
- **Automation's impact on Africa poses a challenge to the West.** Africa's development and population trajectory could blow Europe's current migration crisis out of the water. If migration continues to be thwarted without many productive jobs emerging in Africa, increased insecurity and instability are likely to prevail across the region. The threats that automation poses to inclusive growth in Africa must be understood in this context, to see why the West has as much of a stake in promoting economic prosperity in Africa as Africans themselves.
- **Automation will offer opportunities for development, too.** Despite the impact of automation on manufacturing, 4IR technologies will offer diverse ways to overcome social

challenges and fuel economic growth. The use of sensors, big data and machine learning could transform Africa's agricultural productivity, releasing labour for more productive use. Artificial intelligence applied to personalised learning platforms could transform literacy and numeracy outcomes, which have been plagued by poor learning outcomes despite increases in enrolment.

POLICY OPTIONS AND RECOMMENDATIONS

Embracing vs Managing Automation

African governments face two sets of policy choices:

- **Governments can embrace automation and the opportunities of 4IR technologies.** If they do, a plethora of policy opportunities are available, from health and education to more decentralised models of advanced manufacturing and technologically enhanced service-sector development. Governments can also make complementary investments to prepare for the future economy, such as reorienting education around high-end cognitive and non-cognitive skills.
- **Alternatively, governments can manage the impact of automation by focusing on traditional pathways for development, specifically manufacturing.** For countries with the right endowments—such as abundant cheap labour and low-cost inputs that can rival Asian markets—this policy choice may be the optimum one for the near future. However, countries on this industrialisation path should not ignore the opportunities that the future economy will offer, and should simultaneously invest in alternative pathways for growth and development.

These policy choices are not mutually exclusive. Each country must make its own choices based on its unique economic, demographic and political conditions and development plans.

An Adaptive Policy Environment

As the pathways to economic transformation are currently unknown, experimentation will be key. This will require a shift in government: adaptability will be king, and governments must become directors of improvisation and innovation. To do this, African governments should:

- **Set a clear overarching policy goal.** Based on a shared vision of inclusive growth which all actors—firms, entrepreneurs, local government, bureaucrats and civil society—can support.
- **Encourage variation and not be constrained by planning.** All actors in the system must understand the parameters of reform and be encouraged to experiment in pursuit of the overarching policy goal. Where policies are reversible (and most are), governments should be biased towards action, making a range of policy decisions so that successes can balance failures, and provide political cover for them.
- **Establish a learning ecosystem**. As innovation occurs, governments must be able to identify successes in response to policy goals. Current investments in detailed policy design and planning should be redirected into a learning ecosystem that fosters experimentation and empowers actors to solve problems from the bottom up.

A Call to Arms: Investment in the Foundations for Technological Innovation

All opportunities to embrace automation require super-fast, reliable and affordable connectivity, available to the bottom three billion, many of whom reside in Africa. African governments – and governments of other low income countries – cannot shoulder this investment alone. The urgency of this investment cannot be stressed enough if Africa is not to be left behind. The international community must stand and invest together—traditional donors and global tech giants alike. To do so, they should jointly:

- **Explore innovative financing arrangements, and experiment with emergent technology.** This could take the form of a global commitment to ensure the bottom three billion have reliable and fast access to the internet by 2025, overcoming Africa's fundamental barrier to future prosperity.

The 4IR era will require African governments to apply a digital lens to their socio-economic development strategies. Without this, low-income countries may find themselves unprepared for the challenges that 4IR poses to traditional structural transformation strategies and miss the key opportunities it offers. African governments should:

- **Develop their own digital framework to support development plans.** This framework should ensure that digitally enabled opportunities are not just accounted for, but underpin all economic development strategies.

African markets on their own are not big enough to attract significant investment away from larger markets such as India, the US or China. Consequently, African governments should:

- **Unite to create a digital single market.** Whether championed by one government or tabled at the African Union, a digital single market will offer more attractive opportunities for domestic and international entrepreneurs and investors than individual countries alone.

Appropriate External Support

Adaptive policymaking requires a new type of external support. External actors must understand where they can be most impactful and avoid areas where they are not.

Tech firms, entrepreneurial corporates and impact funds should:

- **Engage in policies that require experimentation.** Organisations with 'fail-fast' mindsets and innovation in their DNA are best placed to tackle challenges with no proven solutions, especially where technology is part of the proposed solution.

Traditional donors should:

- **Engage in policies requiring systemic change if they can commit for long periods of time.** This includes policies that

require change across an entire system involving many actors, such as teachers across a school network. Traditional donors with experience of engaging with developing country governments, and with reporting cycles that allow long-term engagement, should focus their efforts here.

- **Be astute and cautious when engaging in politically complex policy areas.** External engagement in policies that are politically contentious should be avoided until an opening for change emerges domestically. This applies to all external actors, but traditional donors, with strong links to local actors on the ground, may be best placed to advise when this is the case. If anything, traditional donors can offer political cover for domestic reformers in these policy areas.

The 4IR does not mean the end of development. It means a more innovative and experimental journey for policymakers and governments, who will have to let go of detailed planning and be prepared to try things, learn and adapt. The path to the future economy is there, but governments will have to take that first step.

INTRODUCTION

Automation and emerging digital technologies—what is termed the Fourth Industrial Revolution, or 4IR—are set to destroy developing countries' traditional pathways for growth. It is not a question of if, but when manufacturing-led development will no longer be the viable escalator it has always been. As advanced technologies for robotics, 3D printing, artificial intelligence (AI) and other 4IR technologies outsmart and undercut labour, the opportunity for poor countries to use abundant cheap labour to their productive advantage becomes slimmer.

On top of that, African economies already face high unemployment, underemployment and poverty. Africa's youth population is expected to double by 2050, becoming 3.5 times the size of Europe's. By 2100, it is expected to quadruple to reach almost 4.5 billion. A ballooning underemployed youth population on Europe's doorstep could become a significant challenge for the West too, blowing the current migration problem out of the water.

But 4IR does not have to be a story of peril. While some[1] point to the challenges of 'premature deindustrialisation', driven in large part by 'labour-saving technological progress',[2] there is some emerging literature that seeks to offer a more balanced and hopeful reading of what 4IR may hold for developing economies.[3]

This report explores the opportunities that 4IR can offer for alternative pathways for growth, as well as the opportunities that new digital technologies will offer for improved public-service delivery. More importantly, it is a framework which can help African

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1 Such as World Bank Development Report (2016) Digital Dividends; Mary Hallward-Driemeier, Gaurav Nayyar (2017) Trouble in the Making? The Future of Manufacturing Led Development, World Bank

2 http://drodrik.scholar.harvard.edu/files/dani-rodrik/files/premature_deindustrialization_revised2.pdf

3 Pathways for Prosperity Commission, Oxford (2018a), Charting Pathways for Inclusive Growth: From Paralysis to Preparation; World Bank Development Report (2019), The Changing Nature of Work; Hernan Galperin, Andrea Alarcon (eds) (2018) The Future of Work in the Global South, International Development Research Centre (IDRC) | Centre de recherches pour le développement international (CRDI); Karishma Banga and Dirk Willem te Velde, 2018, Digitalisation and the Future of Manufacturing in Africa, SET Discussion Paper

governments navigate the policy choices available to them in the automated age. This is merely a first step in helping governments appreciate the types and range of policy options they will face. As the once-proven model of manufacturing-led development begins to fade, developing-country governments will have to be innovative and learn to adapt more than ever. Hence, this report also builds on recent frameworks on adaptive government and describes how African governments can apply them in practice.

Finally, the report explores how external actors—donors, philanthropists and private investors—can engage most effectively to support developing countries. A high-level model helps evaluate where an external actor can best engage, based on its risk appetite and inclination or capacity for short- vs long-term partnership with a country and, crucially, which policy areas require governments to be the first movers.

In this environment of sensationalist fearmongering or fanatical enthusiasm for 4IR, this report seeks to provide grounded direction and policy advice on how governments of developing economies can pursue their own development path, and how external actors can support them in uncharted territory.

THE CHALLENGES OF AUTOMATION FOR DEVELOPMENT

The Fourth Industrial Revolution will bring a number of significant challenges to manufacturing-led development.

The Shifting Role of Manufacturing

Export-led manufacturing was behind almost all the growth miracles of the past 50 years.[4] Manufacturing allowed developing countries to take advantage of the rapidly expanding global demand for goods in the second half of last century, which in turn fostered a learning-by-doing approach to development. From this process, additional technology spillovers and technical and business know-how were transferred into other industries. The taxation of exported goods enabled governments to raise revenues, which could then be reinvested in the human capital and infrastructure essential for long-term development.

Manufacturing also provided much-needed employment, encouraging citizens to move out of agriculture into urban areas and benefit from higher wages. Countries that pursued export-led manufacturing not only grew their economies but transformed them: moving people from lower- to higher-productivity sectors, from farms into cities and into learning-based economies for human-capital growth. This is how China was able to lift half a billion people out of poverty in an unprecedented span of just 30 years.[5]

But not all developing countries benefited from export-led manufacturing growth, and nowhere is this truer than sub-Saharan Africa. Now, 4IR is foreclosing export-led manufacturing as the model for economic development, and governments of low-income economies must become far more innovative and adaptive in this rapidly changing global environment.

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4 For a discussion of the East Asian export-led manufacturing growth model, see Wade (1990), Amundsen (1989), Johnson (1982). For a review of the literature, see Kyle (2017).

5 Manufacturing's unique properties as compared to the other major sectors of the economy, namely agriculture and services, have been empirically documented.

A THREAT TO LABOUR

The challenge now is that the nature of manufacturing is changing in ways that may diminish opportunities to move low-capacity, low-productivity labour into more productive sectors and activities at scale. Automation is not only reshaping the structure of Western economies but also threatening Africa's ability to emulate the development pathway of earlier industrialisers.

There are two essential caveats in this discussion. First, the impacts of automation will unfold fully only if these technologies are adopted widely. Second, these technologies will be adopted to different degrees across different sub-sectors, depending on the cost of the technology relative to wages, and the feasibility of applying it.

There are broadly three categories of automation that have a bearing on the way manufacturing is organised and carried out: robotisation, smart factories and 3D printing.[6]

Robotisation

Robotisation is currently well suited to routine, low-dexterity tasks—the kind executed along assembly lines by low-capacity labour. While robots are yet to have any significant effect on total employment, anecdotal evidence indicates they have already begun displacing low-skilled labour in China and Bangladesh.

As the cost of robots falls and their efficacy increases, the economic and political arguments for reshoring production closer to demand—back to Europe, the United States and even China—will increase. Not only may robotisation reduce the total number of manufacturing jobs globally, but these jobs may be even less likely to come to Africa.

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6 We borrow this categorization from Hallward-Driemeier and Nayyar (2017) Our Explainer: Why was manufacturing-led development so important and why is it at a juncture? describes adoption trends and effects of these technologies in further detail.

Companies which champion robotisation include the electronics manufacturer Foxconn and Tianyuan Garments, both with extensive operations across China, the US and beyond.[7]

Smart Factories and the Internet of Things (IoT)

Smart technologies that can collect, interpret and analyse data, using it to communicate functions to other technologies without the use of human-to-human or human-to-computer interactions – otherwise known as the Internet of Things (IoT) – are set to revolutionise manufacturing. A smart factory is premised on IoT, and employs physical-to-digital technology in machines that sense, monitor and control, with real-time communication between different parts of the value chain to serve as the basis for self-optimisation.

The effect of smart factories on manufacturing will be twofold. First, there will be improvements to operational performance, including efficiencies in labour. Second, physical-to-digital technologies will rely on advanced services to make optimal use of the data generated. This implies that manufacturing will probably become less reliant on low-skilled (mass) labour, and more dependent on engineers, programmers and other analytics-based professions to optimise these new technologies.

Firms with smart factories include Germany's Siemens, auto parts manufacturer Hirotec America and US appliances manufacturer Whirlpool.

3D Printing

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7 For example, Foxconn (Hon Hai Precision Industry), ranked 24 on Fortune Global 500 replaced 60,000 workers in one factory with robots. In 2012 Foxconn had 1.3m workers but this fell to 870,000 by 2016. See "Robots, not humans: official policy in China," Jenny Chan, 1 November 2017, New Internationalist, https://newint.org/features/2017/11/01/industrial-robots-china See also "A new t-shirt sewing robot can make as many shirts per hour as 17 factory workers", Marc Bain, 30 August 2017, Quartz, https://qz.com/1064679/a-new-t-shirt-sewing-robot-can-make-as-many-shirts-per-hour-as-17-factory-workers/ and "The Robots Are Coming for Garment Workers. That's Good for the U.S., Bad for Poor", Jon Emont, 16 February 2018, The Wall Street Journal, https://www.wsj.com/articles/the-robots-are-coming-for-garment-workers-thats-good-for-the-u-s-bad-for-poor-countries-1518797631

Three-dimensional (3D) printing is currently used across sectors such as jewellery, toys and cars. As costs come down and the technologies' sophistication increases, 3D printing's attributes of speedy delivery, customisation and responsiveness to consumer preferences have strong potential to trump traditional methods of production.

By driving down the fixed cost of manufacturing, 3D printing can democratise manufacturing by fragmenting the sector and allowing companies in Africa to engage in manufacturing without the heavy investment once required. However, hubs of 3D activities may emerge closer to demand in high-income countries. The need for highly-skilled, design-related labour will increase, while low-skilled labour employed in production and assembly will diminish, jeopardising the opportunities that light manufacturing once offered to low-skilled workers.

Examples include US car manufacturer Ford, which uses 3D printing for auto part prototypes, and General Electric, which uses 3D printing to manufacture its turbine parts.

Variable Impact

The impact of these technologies on different sub-sectors will be vastly different, and affected by different production and export concentration factors. In a World Bank report, Mary Hallward-Driemeier and Gaurav Nayyar provide an in-depth discussion on the differential impacts of automation.[8] They observe that some sub-sectors, such as electronics, pharmaceuticals and transport equipment, are more susceptible to automation, while others such as textiles and apparel, construction materials, wood products and food processing are probably be less automatable. However, as anecdotal evidence suggests, all sub-sectors could quickly become more susceptible to automation with advances in technology and greater cost competitiveness of technology vis-à-vis labour.

That said, despite historic adoption trends, it is impossible to predict how automation will affect these sub-sectors in the future, due to the many factors that influence how technology diffuses and the speed at which it does so.[9]
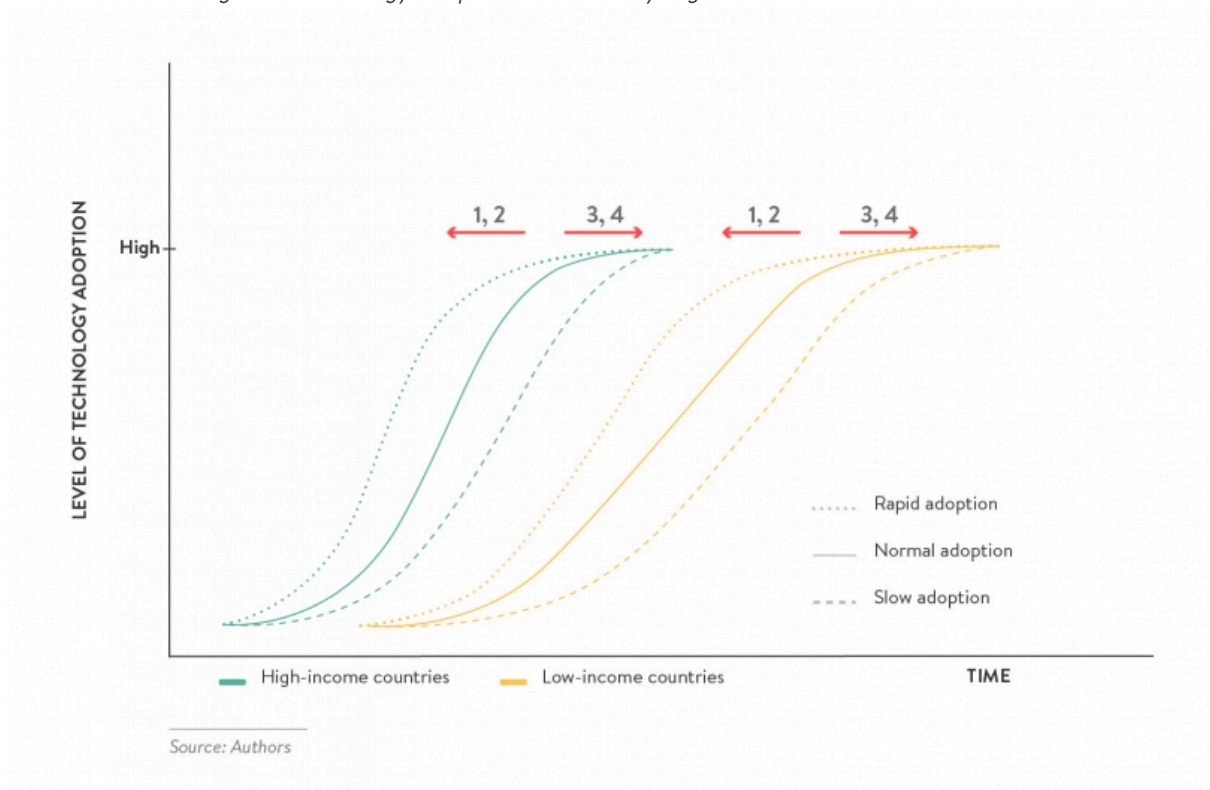
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8 See Chapter 4 in Hallward-Driemeier and Nayyar (2017).
9 See UNCTAD TDR 2017 and Banga and te Velde (2018).

These factors also vary between high- and low-income countries (see figure 1):

Figure 1: Technology Adoption Over Time by High- and Low-Income Countries

Source: Authors

The location of the curve and its inflection point are influenced by:

1. The point at which operating costs of technology (amortized fixed costs + variable costs) fall below labour costs
2. Improvements in the new technology after its introduction to the market
3. Improvements in old technology to compete with the new technology
4. The level of competition (or, the stability of the customer base)

- The quicker (1) happens, the further to the left the curve
- The quicker and more effectively (2) happens, the further to the left of the curve
- The quicker and more effectively (3) happens, the further to the right the curve
- The higher (4) is, the further to the right the curve

The steepness of the adoption curves is influenced by:

1. The rate at which countries develop skills and inputs that are complementary to the technology
2. The extent to which producers of the technology promote complementary skills and inputs

The higher both of these are, the steeper the curve.

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The following three examples illustrate this point. First, low-income countries are unlikely to have as many technology-friendly skills and inputs as high-income countries. This implies that low-income countries' adoption of 4IR technologies is likely to occur more gradually. Even if these countries do adopt these technologies, the absence of requisite skills and inputs may limit the technology's use. However, if tech producers help low-income countries to acquire these skills, it would counterbalance the slower rate of adoption.

Second, the light manufacturing sectors that low-income countries seek to enter are more likely to be competitive and thus have less stable customer bases—and more uncertain future profits—than the more complex manufacturing sectors that high-income countries dominate.[10] This may suggest that it is too risky for firms in low-income countries to invest heavily in 4IR technologies, because it is uncertain whether they can recoup high upfront investment costs, which could slow down adoption in low-income countries vis-à-vis high-income ones.

Third, improvements to 4IR technologies over time may accelerate adoption in high- and low-income countries alike—especially in areas such as textiles and apparel where key production tasks are difficult to automate. These may, in turn, trigger improvements to older technologies, which will serve as a countervailing force and delay adoption.

One should not expect a complete transformation in goods production in the next few decades. Adoption of 4IR technologies will happen in fits and starts. In addition, the positive effects these technologies can have on productivity may well foster the economic catch-up for poor countries that manufacturing has historically enabled – just not necessarily through the same process.

The major challenge will be whether productivity growth in manufacturing will emerge alongside job creation on a mass scale, as it has in the past. Importantly, this challenge will persist even if the aforementioned technologies do not achieve widespread adoption in African manufacturing. Adoption of these technologies

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10 We infer this from the fact that less complex products, such as those common in light manufacturing, are produced by a greater number of countries than more complex products. See Hausmann and Hidalgo (2010).

is already happening more quickly in existing manufacturing hubs, such as China and Germany.

Unlike past decades, when light manufacturers physically moved operations in search of lower production costs, automation will enable firms to reduce costs while remaining where they are. For instance, a 2017 report by the Center for New Structural Economics, a Chinese think tank, found that in a survey of Chinese light manufacturing firms, 54 per cent would choose to upgrade technology in response to rising wages in the country. In contrast, only 10 per cent would choose to relocate their operations, either within or outside mainland China.[11] Hence, fewer manufacturing jobs will migrate to African countries, irrespective of technology adoption trends on the continent.

This is the crux of the automation challenge. Productive, less skill-intensive jobs created through industrialisation—rather than industrial output—have historically been the lynchpin for inclusive growth and development.[12]

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11 See Jiajun Xu, Stephen Gelb, Jiewei Li and Zuoxiang Zhao, 2017, 'Adjusting to Rising Costs in Chinese Light Manufacturing: What opportunities for developing countries?'

12 Felipe et. al. (2014).

A SURGE IN AFRICA'S POPULATION GROWTH

African countries face the imminent challenge of employing a large, low-skilled labour force in more productive activities, in a continent whose population is expected to balloon (see figure 2). It is estimated that Africa's population will double from 1.26 billion in 2017 to 2.53 billion by 2050. By 2100, it will almost quadruple by to 4.47 billion, and include a significant youth bulge. Europe, Japan and China, meanwhile, are anticipated to shrink in population size by 3, 15 and 2 per cent respectively by 2050; and by 12, 34 and 27 per cent by 2100. Of the developed regions, only North America, driven by the US, is projected to grow in population size—by 22 per cent by 2050, and 40 per cent by 2100.[13]

Figure 2: Forecast Population Growth in Key Regions and Countries, 2015–2100
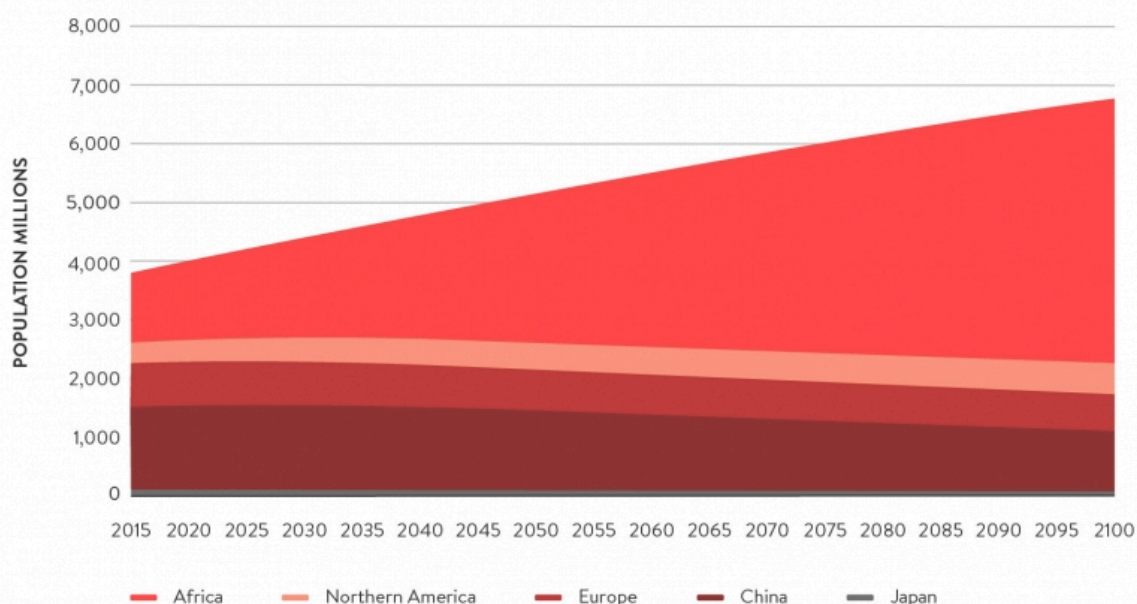
Source: "World Population Prospects: The 2017 Revision", United Nations

Source: 'World Population Prospects: The 2017 Revision', United Nations

Africa today accounts for 17 per cent of the world's population; by 2050 it will be 26 per cent, and by 2100 it will be 40 per cent. It will be 3.5 times the size of Europe by 2050, and 6.8 times its size

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13 Analysis based on Medium Fertility Variant Projections, 2015-2100. United Nations, World Population Prospects: The 2017 Revision.

by 2100. Nigeria's population alone will be over half the size of Europe's by 2050, and 1.2 times its size by 2100. To date, Africa has relied on migration to, and remittances from, Europe and the US to diffuse the economic tensions presented by a burgeoning underemployed youth population.

A CHALLENGE FOR THE WEST

Massive population growth across Africa comes at a time of rising populism in the West, making Western countries less hospitable to migration. Many people in developed economies have blamed stagnating living standards on globalisation, fearing that global trade is damaging domestic industries and that immigration is depressing wages.

There is mounting evidence that while trade has benefited all economies, benefits have not been evenly distributed within developed countries. Workers displaced in shrinking industries have not migrated into emerging ones as quickly as trade theorists anticipated, resulting in depressed wages and low labour-force participation for a decade or more after traditional industries have left developed economies.[14] This has manifested itself in the challenge of aggravated inequality within developed countries. Since the 2008 financial crisis, deteriorating real wages, rising underemployment and job insecurity have meant living standards have barely risen in over a decade.

This has affected developing economies in two significant ways. First, suppressed wages in the West have held back global import demand, limiting the opportunity for developing economies to produce goods for Western markets (including intermediate goods: parts of a complete good), which was one of the critical factors of China's success.

Second, the migration of many domestic industries in the West, which has contributed to the disappearance of vocations and

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14 Autor, David, David Dorn, and Gordon Hanson. (2016) 'The China Shock: Learning from Labor-Market Adjustment to Large Changes in Trade.' Annual Review of Economics 8: 205-240. For summary interview with Autor, see Zeeshan Aleem, 20 March 2017, Vox, "Another kick in the teeth': a top economist on how trade with China helped elect Trump'

increased economic insecurity, has manifested itself as a disillusion of purpose and identity among many citizens. Populism has been driven as much by the anxieties of those whose identities have become unmoored from their vocations (such as communities of miners, textile workers, etc.) as by uncertain, and specifically unstable, employment futures (often characterised by impermanent 'gig' work in services). Coupled with a desire for security and agency, these anxieties take on economic and cultural dimensions.[15] Migrants have become the easy scapegoat for these often acute socio-economic and cultural ills.

However, the demographic patterns across Europe and Japan—and, to a lesser extent, North America—would suggest that the migration argument is still to be won politically. A rapidly ageing and contracting European population will increasingly rely on the economic and social contributions that migrants can make. Migrants will be required to uphold the tax base necessary for Europe's social safety net, and fill the rising demand for labour in the health and care services (regardless of improvements in technology in these sectors). Yet despite the economic rationale, the political argument must be won. This will require strong leaders who can embark on a public discourse on the twin evils of the hollowing-out of the middle class[16] and the entrenched stigma attached to migration, with radical practical policies to address both issues.

Africa's development and population trajectory has the potential to blow Europe's current migration crisis out of the water. The sheer scale of Africa's population growth means that even if Europe's political position on migrants became favourable, Europe would still not have the demand or capacity to absorb that volume of labour. And if migration continues to be thwarted without many productive jobs emerging in Africa, increased insecurity and instability are likely to prevail across the region. The threats that automation poses to inclusive growth in Africa must be understood in the context of these broader demographic and migration trends,

15 For an extensive review of the types of anxieties fuelling populism, and how the centre left can manage and allay these, see Martin Eiermann, 2018, 'Confronting Populist Anxieties: How the Centre-Left Can Quell the Far-Right Surge', a Tony Blair Institute for Global Change report

16 Autor and Dorn, 2013

to see why the West has as much of a stake in promoting economic prosperity in Africa as African countries themselves.

Developed countries cognisant of future challenges must find the political and policy space to support African countries in their pursuit for inclusive growth. Doing so will be mutually beneficial, as Africa could offer a huge market for exports from Europe and the developed world in the coming decades. This is the primary opportunity that Africa's demographic dividend has to offer.

HOW AUTOMATION CAN OFFER OPPORTUNITIES FOR DEVELOPMENT

All is not lost. This age of automation and digitalisation, coupled with a profound shift in what and how people consume, will throw up a variety of opportunities for alternative development pathways. There is significant scope for Africa to take advantage of these changes, particularly because African countries are less encumbered by legacy infrastructure or institutions. The continent should invest not only in emergent technologies to boost productivity but also, and more broadly, in those that can offer citizens better social outcomes.

4IR TECHNOLOGIES FOR MANUFACTURING

The productivity gains delivered through 4th IR technologies should in theory offer two positive impacts on labour in manufacturing:

1. Lowering the cost of production, thus reducing the price of manufactured goods. This should stimulate demand, and therefore jobs, in the sector.
2. Generating new jobs in manufacturing, both within the firm through increased volumes of production, and outside the firm for sectors producing the new technology and machinery.

Labour gains experienced through improvements in automation are likely to be felt at the more skilled end of the global value chain. That would probably place Africa at a disadvantage given its relatively low-capacity labour. However, Karishma Banga and Dirk Willem te Velde offer an example from a Tanzanian factory to illustrate how adopting more advanced technologies can usher in an increase in productivity and migration of workers towards more skilled activities in Africa. The introduction of a laser fabric-cutting machine reduced the number of people required to cut the fabric from 25–35 to 17. But greater efficiencies led to an increase in overall cut fabric, leading to a higher demand for stitching—a more skilled area—which contributed an additional 300 jobs.[17]

This was a vertically integrated operation, so productivity gains translated into labour gains within the factory, albeit higher up the value chain. This would not be the case for more fragmented, particularly globally fragmented, value chains. If anything, trends back towards vertical integration are likely to be felt as greater onshoring closer to demand—that is, to the West—facilitated by 4IR technology. It is a catch 22, but until Africa can stimulate enough growth to encourage demand at home for higher-value goods, and so provide a market for vertically integrated operations, such labour gains experienced in manufacturing value chains may not be realised in Africa itself.

However, while automation looks set to displace labour, particularly low-skilled and repetitive tasks, 4IR technologies that are appropriately harnessed and disseminated should not weaken Africa's manufacturing prospects. Indeed, many emerging 4IR technologies would enable smaller African businesses and entrepreneurs to participate in manufacturing in ways once unique to large, state-backed enterprises and the political elite. New technologies such as 3D printing should begin to democratise manufacturing and help shift the story of development away from the 'big factory' model that relied on state-directed investment and widely available cheap labour towards smaller, niche and customer-responsive production.

One common challenge to manufacturing in African countries has been an inability to replace machine parts. Manufacturers in Africa often find it difficult to source spare parts from foreign suppliers, resulting in out-of-service machines lying idle. The problem could be solved by 3D printing, which offers a way for African manufacturers to produce parts on their own at low cost and on demand.[18]

For example, in Lagos, Nigeria, General Electric's 'garage' programme provided skills training in advanced manufacturing technologies and promoted local entrepreneurship. The 3D start-up

17 See Karishma Banga and Dirk Willem te Velde, 2018, Digitalisation and the Future of Manufacturing in Africa, SET Discussion Paper, p.20

18 This is an example of how 4IR technologies may create opportunities in manufacturing that have typically been too complex for African countries to engage in, e.g. manufacturing of machines that are used in the manufacturing of final goods.

Elephab, which prototypes and prints local replacement parts for various industries, emerged from this programme. Elephab subsequently received investment from US venture-capital funds.[19] Africa should expect and support a greater proliferation of smaller manufacturing businesses as an alternative development pathway for inclusive growth: one that is fostered by an entrepreneurial ecosystem heavily bolstered and propelled by 4IR technologies.

4IR TECHNOLOGIES FOR OTHER ECONOMIC ACTIVITIES

4IR technologies can also help Africa increase productivity and create jobs in parts of the economy outside manufacturing. Precision agriculture offers a huge opportunity for the continent to improve agricultural productivity (and food security), which was the cornerstone of Southeast Asia's development.

The use of lasers, satellites and big data collected on farms can measure changes in crop- and, increasingly, livestock-production capacities. Coupled with AI, robots and drones, these technologies can respond in real time to fluctuations in fertiliser, nutrients, irrigation or pests, transforming the efficiency of food production. Although Africa is rapidly urbanising, 70 per cent of its labour is still employed in agriculture. Africa's resource base, if more intensively farmed, could easily produce another 100 million tonnes of grain equivalents each year, comparable with the US corn belt's contribution to global supply.[20]

In the past, mechanisation and technology adoption in sub-Saharan Africa's agricultural sector has been poor, and sceptics doubt whether 4IR will do much to change this.[21] However, new information and communication technologies (ICTs) are offering cheaper avenues and greater reach to support smallholder farmers to make better decisions. The falling price of smartphones, as well as smart technologies adapted to analogue systems, is helping farmers to better evaluate which fertilisers and irrigation are most appropriate, to secure better access to prices as seen with Uganda's

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19 https://infomineo.com/additive-manufacturing-africa-middle-east/

20 AGRA, 2017, 'Africa Agriculture Status Report 2017 The Business of Smallholder Agriculture in Sub Saharan Africa' https://agra.org/wp-content/uploads/2017/09/Final-AASR-2017-Aug-28.pdf

21 World Development Report, 2019

TruTrade platforms, or receive accurate crop insurance cover such as that developed by Kenya's Kilimo Salama app.[22] AI in particular offers significant opportunities as it is often embedded in relatively cheap hardware, and as mobile-phone diffusion increases across the developing world, the barriers to adopting these smart technologies in agriculture will reduce.[23]

Results of the impact of ICT-based interventions on farm inputs on productivity have already emerged as remarkably positive. Some empirical studies on ICT-enabled market information services, such as better information about market prices, found little to no positive impact, but these studies also assess the problems as surmountable.[24] Many current interventions are digital solutions to analogue problems, but as the technology develops, most experts expect that the returns on agricultural productivity in poor countries will be seismic.

One study at least has suggested that ICT-enhanced farm productivity reduces the need for farm-based labour.[25] This finding would point to a broader structural transformation of an economy, which is to be expected from increased agricultural productivity and has in the past released labour from the task of food production to move into more productive areas of the economy. But unlike the past, when workers migrated from the land to mass assembly lines, this time labour will need to navigate a more diversified and unknown range of productive activities. Workers will need to be more entrepreneurial than they have ever been in the past. This is a separate challenge and the focus of this report. Regardless, increased agricultural productivity, which releases farm labour to work in other more productive markets, is essential for Africa's structural transformation, and 4IR technologies can go a long way to foster this.

New technologies also offer Africa significant opportunities to overcome its human-capital challenges. Low human-development

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22 Ibid

23 Ekkehard Ernst, Rossana Merola, Daniel Samaan 2018, ILO future of work research paper series: The economics of artificial intelligence: Implications for the future of work

24 For a literature review of the impact of ICTs on farm productivity, see Elvis Melia (2019) 'The impact of ICTs on jobs in Africa: A literature review

25 Ibid

outcomes in education, health and broader social welfare will hold back productivity at the individual and country levels, and 4IR technologies can play a helpful role in addressing these challenges. For example, AI is being applied to a range of health challenges in Africa, responding to the continent's lack of doctors and poor infrastructure (such as unreliable energy, which fails to power medical equipment).

One Nigerian start-up has created Ubenwa (meaning 'baby's cry'), a machine-learning system which uses AI to detect child-birth asphyxiation, the third-highest cause of under-five mortality in the world. This product's success is due not only to the AI technology itself, which has a 95 per cent detection rate and can be applied before birth, but also to its user-friendliness: because it operates as an Android app, it can be administered by parents and caregivers, so does not rely on a doctor or constant electricity.

In the past, expertise and infrastructure have been the building blocks for tackling stubborn social and human-development challenges across the continent. With the emergence of 4IR technologies, plus broader technological developments such as continent-wide Internet connectivity, Africa may be able to solve some of these problems by leapfrogging the traditional development challenges of insufficient doctors, or basic infrastructure. Healthier and better-educated citizens, in turn, should become more economically productive.

DIGITAL EXCLUSION

While the opportunities that 4IR technologies offer may seem vast, Africa and other low-income countries (LICs) are hamstrung by their digital realities. Despite rapidly expanding broadband coverage in LICs—with coverage available for 80 per cent of the population across these countries— use of digital services remains extremely low at 12 per cent of the population.

Not only is the relative price of mobile broadband as a percentage of gross national income per capita far higher for LICs (at 14.1 per cent in 2016) than for the wider developing world (6 per cent) and, of course, for the developed world (0.7 per cent), but

Internet tariffs are also higher in African countries than in Asia. While mobile-phone penetration has spread faster than previous technologies, use of the Internet has been comparatively slow, particularly for firms in informal sectors.

To take advantage of digital technologies, firms must have access to affordable and reliable Internet, and must be empowered to use it. Even in Kenya, at the frontier of employing digital technologies across sub-Saharan Africa, there is still a 40–50 per cent difference between firms using the Internet and those actively engaging with it, such as having a web presence or buying and selling online.

Furthermore, the price of capital in Africa is inflated across the board, both relative to labour and in absolute terms. The same is true of 4IR technologies. Despite the promise 3D printing holds for the democratisation of manufacturing, current investment in the technology is weak in Africa. North America, Asia Pacific and Europe make up 95 per cent of global investments in 3D printing, while all the other regions, including Africa, make up less than 5 per cent. The price of 3D printers is falling dramatically, with quality machines now available for under $500, but obtaining printers at these prices on the continent is far more challenging.

Robotics sales are often used as a proxy for the penetration of smart machines. The International Federation of Robotics measures annual sales of robots from leading suppliers to countries. Robot penetration is dominated by the automotive (33 per cent), electronics (32 per cent), and metals and machinery (12 per cent) sectors—industries that make up a far smaller share of sub-Saharan Africa's manufacturing capabilities than other developing regions.

As expected, Africa's investment in robotics is low. The continent's share of global robotics imports in 2017 was 23 times lower than its share of gross domestic product (GDP) (see figure 3). In contrast, the Asia-Australia region's share of robotics imports was almost double its share of global GDP, driven by China, whose robotics share was 2.4 times its share of global GDP. India, whose share of GDP in 2017 was broadly comparable with Africa's (at about 3 per cent), had a global share of robotics imports only three times lower than that of its GDP. The forecast does not look much better for Africa.

Figure 3: Key Regions' and Countries' Shares of Robots and GDP, 2017 and 2021
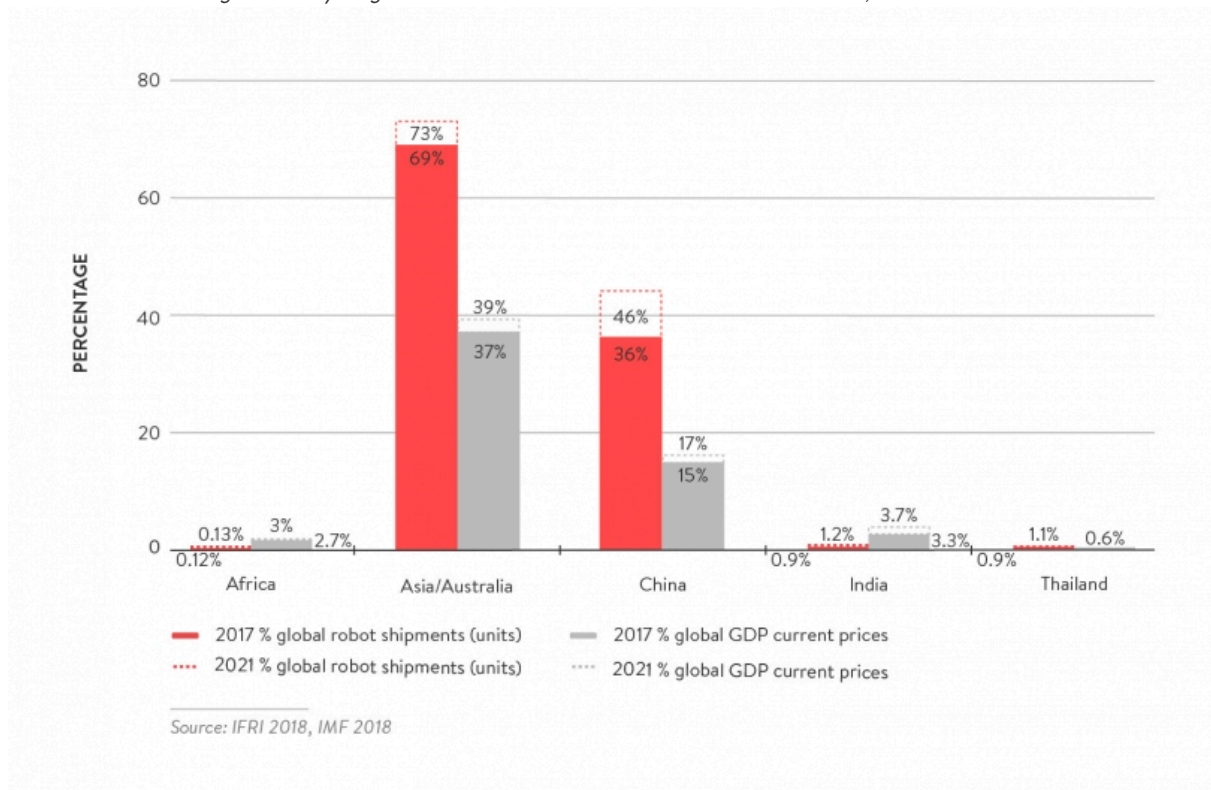
If African countries are to seize the productivity opportunities that 4IR can offer, the continent's governments and the donor community must pay serious heed to Africa's digital infrastructure needs. They must also provide the right policy and regulatory environment to ensure Africa's adoption of 4IR technology keeps pace with other frontier developing economies.

NEW PATHWAYS FOR GROWTH

Broader digital and technological developments, as well as shifting patterns in global consumption and trade, will reshape how different economic sectors can (or cannot) promote economic catch-up and job creation.

Previously, manufacturing's exportability and formality were relatively unique: exported manufactured goods would generate both foreign currency and taxes that could be reinvested into more technologically advanced capital and foreign know-how, which

boosted productivity further. In contrast, services which absorbed much urban labour in Africa, such as domestic services, markets and driving, remained relatively informal and were not exportable, hence offering few opportunities to improve a country's productivity. Now, with the Internet, digital platforms and emergent 4IR technologies, many higher-productivity, value-adding services can be exported and formalised.

Traditional professional services such as insurance, accounting, financial support and other business-process outsourcing services can now be more readily exported through the Internet and paid for by digital payments.[26] But it is the emergence of the sharing economy that is offering the most exciting opportunities for structural transformation through services exports.[27] One estimate indicates the market for online work is worth $5 billion and is supported by 48 million workers, many of whom are in the developing world.[28]

Through the digital economy, discreet low-capacity tasks such as cleaning data, processing photos, or transcribing audio or video can now be traded through online platforms such as Amazon's Mechanical Turk, a crowd-sourcing marketplace. More specialised service providers like web developers, content writers or marketing agents—as advertised on the global freelancing platform Upwork—can offer projects to freelancers anywhere in the world.[29]

More advanced activities for highly skilled, high-value services such as graphic design and coding are now opening up in Africa. Andela is an exemplary model. The firm sources the continent's most talented software developers, trains them in tech campuses across Nigeria, Kenya, Uganda and Rwanda, then employs them as

26 Bernard Hoekman (2017) 'Trade in services: Opening markets to create opportunities' a UNU-Wider Working Paper publication

27 Graham and Anwar (2018) Towards a fairer sharing economy, in Davidson et al., (eds) The Cambridge handbook of the law of the sharing economy, Cambridge University Press, Cambridge, pp.328-340

28 Siou Chew Kuek et al (2015) The Global Opportunity in Online Outsourcing

29 Both MTurk and Upwork offer opportunities for a range of skilled services. Upwork's website for examples markets its scope of work available from its pool of workers as 'Short-term tasks'; 'Recurring Projects'; and 'Full-time contract work'. See https://www.upwork.com/ and https://www.mturk.com/

full-time engineers to support leading companies and start-ups around the world. In 2019, Andela received a $100 million investment in a round led by former US Vice President Al Gore's Generation Investment Management, representing one of the largest capital raises by a tech company on the African continent.[30]

The formalisation of services in developing economies has occurred through the advent of mobile money plus digital platforms as the go-to-market route. Formalisation is beginning to occur both in domestic sectors such as transport and ride-sharing (like Uber) and in export services via e-commerce platforms (such as Alibaba and eBay). Digital platforms connect parts of the informal economy to more formalised areas, such as artisanal workers to foreign buyers, but have also begun to link informal workers (like taxi drivers) to the taxation system and other forms of social protection.[31] In developing countries, this digitisation of work can lead to greater formalisation and security across a number of sectors.[32]

However, such work has also emerged as highly commoditised, with tasks often small while the oversupply of labour is huge. Consequently, these gig workers find themselves replaceable, with limited bargaining rights and no formal access to employment benefits—a challenge facing the developed as much as the developing world.[33] If the digital-services economy is to become inclusive as well as structurally transformative for poor countries, governments must tread a fine line: promoting labour rights without over-regulating and driving the online economy away.

Policies that experiment with platform cooperatives, which are run by workers instead of private firms and shareholders, or internal advocacy campaigns to model fair-work principles based on the Fair Trade movement for commodities, could start to replicate some of the protection mechanisms that unions used to offer.[34] But given how underdeveloped labour rights already are across the developing world, governments must ensure their online workers

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30 See https://www.ft.com/content/dbe61434-1e41-11e9-b126-46fc3ad87c65 and https://andela.com/about/ for more on its model

31 Pathways for Prosperity Commission, Oxford (2018a),

32 Ibid

33 Graham and Anwar (2018) Towards a fairer sharing economy

34 Ibid

are not exploited if they are to meaningfully pursue inclusive growth.

Technology aside, the general trend in global consumption and trade has also made some services more structurally transformative and viable as complementary pathways for development.[35] Tourism and the creative industries, for example, offer such scope.[36]

Tourism globally generated $7.6 trillion in indirect revenue in 2014, contributing to 9.8 per cent of global GDP. Its direct effect on global GDP was 3.1 per cent, comparable with banking (3.2 per cent) and education (3.4 per cent), and well ahead of automotive (1.2 per cent) or chemical manufacturing (2.1 per cent).[37] Tourism plays to Africa's natural endowments (safari, sun, sea and surf) and has the capacity to employ low-skilled labour in significant numbers, for example as cleaning staff and attendants. Moreover, it provides the opportunity for skills development (for example, for managers or luxury tour guides) as well as markets for more enterprising, tech-inspired services that are increasingly formalised through digital search and pay platforms (such as Airbnb) and 4IR technologies (such as virtual tourism).

The creative industries offer similar opportunities for inclusive growth in Africa. There is an increasing democratisation of film and television production, spurred by greater connectivity, cheaper and more user-friendly production technology, and a new digital medium for accessing markets and film consumption. African countries have distinct and unique cultures that in the crudest sense are prime for marketing and consumption. And the opportunity for job creation is significant.

In Nigeria it is estimated that Nollywood generates between $500 million and $800 million annually for the Nigerian economy.[38] That makes it the country's second-biggest export, after oil, and the world's third-largest film market by revenue after

35 Ghani and O'Connell (2014).

36 For an overview of other opportunities, such as within horticulture as well as tourism, see John Page (2019) 'How industries without smokestacks can address Africa's youth employment crisis', part of Brookings Foresight Africa 2019

37 Jack Daly and Gary Gereffi, 2017, Tourism global value chains and Africa

38 Aubrey Hruby, 2018, 'Tab creative industries to boost Africa's economic growth,' Financial Times

Hollywood and Bollywood.[39] Moreover, Nollywood's growth has been surprisingly inclusive, with an estimated 1 million people currently employed in the industry—the second-largest employer in Nigeria.[40]

Jobs and growth in the creative industries have demonstrated significant resilience to economic shocks, unlike many other sectors.[41] Furthermore, creative work and African design exported through online platforms also offer great promise. Upwork, for example, offers 'designers and creatives' as a specific category of experts, and opportunities to export Africa's unique creative industry could be both promoted by its expanding international film production and facilitated by the expanding plethora of Upwork-type platforms.

These are just some of the alternative models for structural transformation. They are unlikely to be transformative in isolation: countries will have to pursue many strategies at once, and each country's development pathway will be different. What is clear, however, is that governments will need to be adaptive to respond to the changing global trends in technology, as well as opportunities emerging through shifting global consumption and trade patterns.

39 Yuen Yuen Ang, 2016, How China Escaped the Poverty Trap, and Funke Osae-Brown, 'Nollywood: No longer living in bondage', NewAfrican, October 2018

40 Erick Oh, 2014, 'Nigeria's Film Industry: Nollywood looks to expand globally', United States International Trade Commission (USITC)

41 Hruby, 2018

A POLICY FRAMEWORK FOR AFRICAN GOVERNMENTS

Economic transformation will not emerge from market forces alone. In part, this is due to the prevalence of market failures: individual rationality does not always allocate resources in ways that would maximise social welfare in the long run. Large-scale, targeted, government policies will be needed to overcome the widespread coordination and collective action problems that will prevail as countries face the economy of the future.

Specifically, industrial policy[42] is needed when 'large investments are required simultaneously across firms and when the risk of investment is high due to imperfect markets in land, labour, and capital,' conditions that will surely prevail in the 4IR.[43] In a rapidly changing technological environment, firms may lose money until they have learned how to adopt and adapt new technologies, and use them efficiently. Industrial policy can help to ensure that firms have the time to learn and adapt without losing their foothold.

Industrial policy is just one pillar in the overall policy framework that African governments need to prepare for the future. Governments must develop workforces of the future with skills that complement automation. This will involve not only major investments in education, but a major reform of the primary, secondary, and tertiary educational systems, and a reimagination of lifelong learning.[44]

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42 Industrial policy is a range of government measures, such as tariffs, subsidies or other incentives, infrastructure investment, etc, 'aimed at improving the competitiveness and capabilities of domestic firms and promoting structural transformation' (Unido, Unctad, 2011, 'Economic Development In Africa Report 2011' https://unctad.org/en/docs/aldcafrica2011_en.pdf). It is considered the means to address market failures by encouraging the growth of specific growth sectors, and is often 'considered at the core of what development economists study' (Dani Rodrik, 2008, 'Industrial Policy: Don't ask why, ask how,' https://drodrik.scholar.harvard.edu/files/dani-rodrik/files/industrial-policy-dont-ask-why-ask-how.pdf). Traditionally, Industrial policy focused on manufacturing sectors but this model can be applied to any sector.

43 Whitfield et al. 2015: pg. 288.

44 Our report, 'A New Deal for Big Tech: Next-Generation Regulation Fit for the Internet Age,' Chris Yiu, 2018, explores how government must and can invest in education to prepare for the digital age, and our 'Technology for the Many: A Public Policy Platform for a Better, Fairer Future', Chris Yiu, 2018, offers policy advice for lifelong learning, with a call to fund the up-front costs

If the new economy requires more adaptability to transition between jobs, a robust social safety net is necessary to allow workers to transport benefits between jobs and reduce income volatility between employment spells. Infrastructure is another crucial pillar: technology can hardly transform the agricultural, service, health, manufacturing, and education sectors, among others, in the absence of facilitating infrastructural investments.

FAST AND RELIABLE CONNECTIVITY

Critical to all policy options available to government will be the investment in super-fast, reliable and affordable connectivity, which, if it is to promote inclusive growth, must be to the 'last mile'.[45] In particular, all the policy options outlined within the 'Embrace Automation' policy choice below are premised on the nationwide availability of fast broadband, without which no 4IR technologies are possible.

Even 4IR applications that are adapted to the African environment—such as the text-based— still rely on some degree of connectivity. For the full developmental opportunities of 4IR to be realised, widespread fast and reliable technology will be essential.

Connectivity with high bandwidth is not being built by commercial providers in over half of the world. Some governments are taking this seriously by investing their own resources in infrastructure fit for the digital age. The Government of India is one example. But most governments across the developing world have not been acting with the same urgency, or do not have the political or economic space to redistribute investments towards connectivity.

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of education or training for anyone that needs it, at any point in their life, with greater repayments from those who go on to earn the most. Both refer to the West, but are as essential and applicable to the Global South.

45 The 'Last Mile' in telecommunications and the internet industries refers to the final stretch of infrastructure that delivers telecoms services to end-users. In this context it refers to the last set of infrastructure investments necessary to connect those that still do not have access to reliable internet. Despite referring to distance, it does not necessarily mean laying traditional wire infrastructure such as the fibre optic cable to this group of people

Without investment, the following policy recommendations will be meaningless. Multilateral institutions and the global tech community could give their support to developing country governments, helping them invest in basic infrastructure.[46]

POLICY OPTIONS AVAILABLE TO AFRICAN GOVERNMENTS

In light of the threats and opportunities that automation presents for traditional development models, African governments face two sets of policy choices. One, embrace automation and the opportunities that 4IR technologies bring. Two, manage the impact of automation by favouring traditional pathways for development in the remaining window of opportunity, which can lead to the acquisition of relevant and transferable capabilities (see figure 4).[47]

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46 With thanks to Sarah Hunter, Director of Public Policy for Google X, for her insights on the underpinning connectivity challenge.

47 We draw on Schlogl and Sumner (2018) for elements of this diagram but offer a different categorisation and take a broader view, to include how governments can use automation to promote structural transformation, productivity growth and greater social welfare.

Figure 4: Policy Responses to Automation
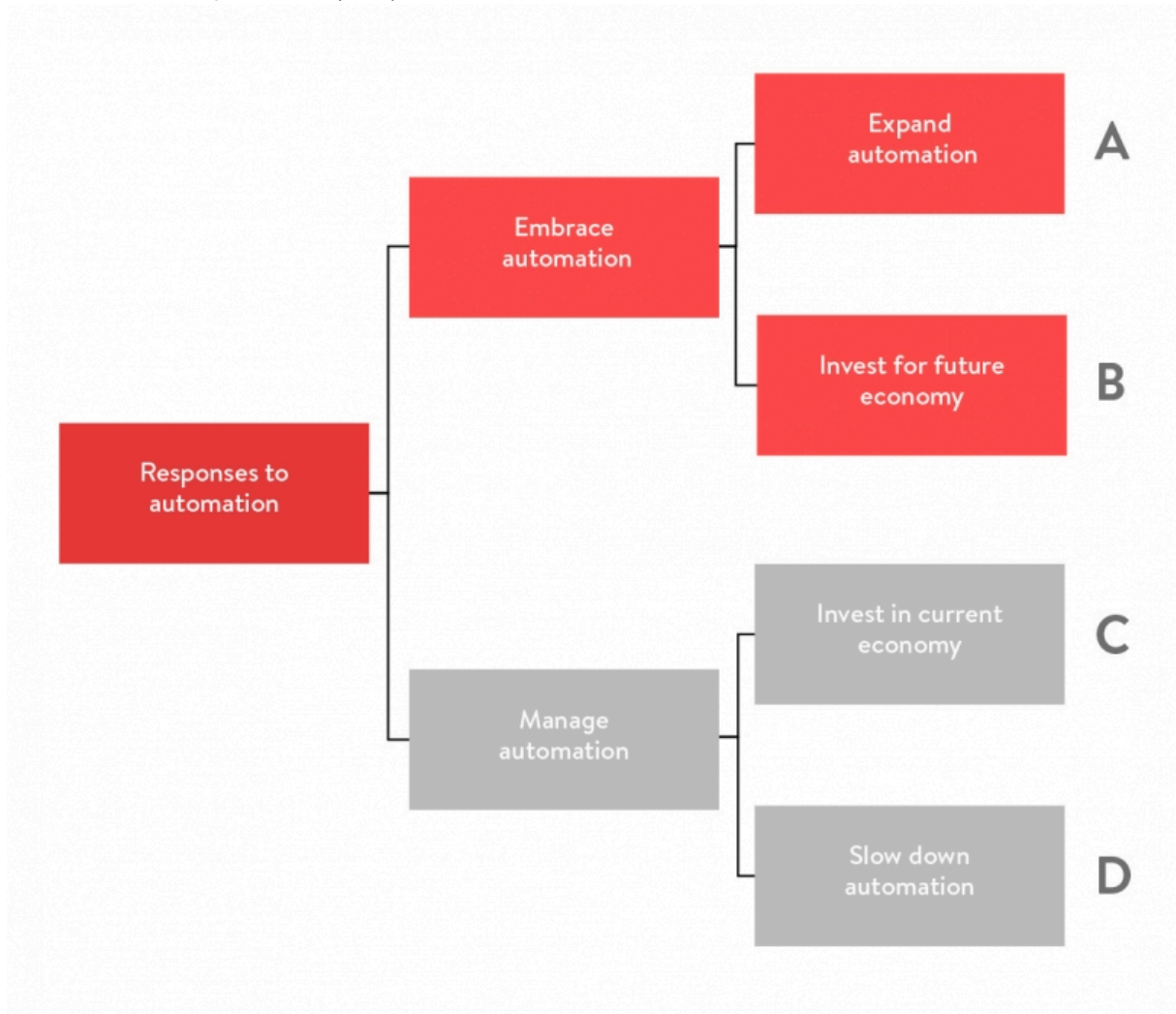
Policies can be individually selected, depending on local contexts and local capabilities. The policy framework is also holistic: investing in the current and future economy simultaneously may be the most desirable pathway of all. Both within and across each category ('Expand automation' to 'Invest in current economy'), many of the investments are complementary.

Embracing Automation

Expand Automation

A1 Tech for agricultural productivity: The application of 4IR technology (including AI, blockchain, robotics, big data, and sensors) to improve agricultural productivity. Policy responses could include incentives for foreign investors to introduce these

technologies; access to financing for local tech entrepreneurs; technology transfer through extension services to smallholder farmers.

A2 Tech for manufacturing: The development and distribution of 4IR technology (robotics, IoT, 3D printing), which is reshaping global manufacturing. Policy responses could include incentives for foreign investors to introduce these technologies; financing for local firms who adopt them; technology transfer, for example, through tech centres.

A3 Tech for services: The development and distribution of 4IR technology (AI, big data, blockchain) to reshape and increase the productivity of services and facilitate their export. Policy responses could include incentives for foreign investors to introduce these technologies; regulatory and trade facilitation initiatives; facilitating the use of these technologies, for example, via mobile money and e-commerce.

A4 Tech for education: The application of 4IR technology, particularly AI, to improve learning outcomes through personalised adaptive learning platforms, distance learning and greater availability of content; platforms to enhance collaborative learning; and the dissemination of advanced pedagogies. Policy responses could include investment in personalised learning technologies and their deployment in schools, with a focus on literacy and numeracy; incentives to support the out-of-school use of EdTech; creating enabling environments, for example, innovation hubs to develop personalised learning systems within school networks.

A5 Tech for healthcare: The application of 4IR technology (3D printing, drones, AI) to overcome capacity challenges in the health system, including lack of doctors and insufficient equipment (such as detection machines and labs). Policy responses could include incentives for foreign investors to introduce these technologies; innovation hubs next to medical centres, and the piloting of locally developed technologies; deploying mobile-based detection and advice for nurses, carers and parents.

A6 Tech for urbanisation: The application of 4IR technology (big data, AI, real-time surveillance) to make cities 'smarter', to become more sustainable, resource-efficient and responsive to citizen

needs. Policy responses could include incentives for foreign experimentation with new technologies in urban environments; greenfield sites for smart cities; regulation to facilitate the collection and appropriate use of citizen data.

Invest for the Future Economy

B1 Modern industrial policy for services: Employing modern industrial policy for the development of the services sector. This includes a focus on sectors with high competitive potential and job creation, such as online work, tourism and the creative industries; interventions to resolve sector-specific constraints; in-built mechanisms for public-private coordination and learning. Policy responses could include the promotion of foreign direct investment (FDI) in service sectors; interventions to strengthen firms' capabilities; interventions to support a more mobile labour force; mechanisms to foster dialogue between public and private actors. All interventions rely on foundational infrastructure investment, including internet connectivity, energy, transportation infrastructure and logistics.

B2 Develop an entrepreneurial ecosystem: Developing an environment and industrial policies conducive to an entrepreneurial economy ecosystem. Policy responses may include investment in innovation hubs or research parks (for example, at leading universities) to foster collaboration between researchers and private-sector firms; the support of start-up financing (for example, fund-matching); the regulation of 4IR intellectual property so that entrepreneurs can adapt these technologies.

B3 Investment in high-end skills: The development of skills that complement the future economy, specifically technical skills (including STEM) and soft skills related to creativity, social and emotional intelligence, critical thinking and problem-solving. Policy responses may include future-ready curriculum reform, including an emphasis on 'learning how to learn'; development and professionalisation of a fit-for-purpose teaching workforce; linking students with the workplace earlier and more often; promotion of basic and advanced ICT skills.

B4 Safety net 2.0: A social safety net fit for the age of automation which leverages digital technologies and payment

systems to achieve two primary goals. One: setting a floor for poverty, and two, establishing robust social insurance programmes that help workers during economic transition. Policy responses may include Universal Basic Income; informal workers' access to health insurance and pensions; a single digital identity that workers can passport across social insurance platforms and gigs; unemployment insurance to allow firms to formalise employment more easily whilst providing a cushion for individual workers during periods of unemployment.

Managing Automation

Invest in the Current Economy

C1 Modern industrial policy for manufacturing: Export-led industrialisation. Not all African countries will be able to develop large, highly productive manufacturing sectors due to their insufficient market size, unfavourable cost structure and other issues, irrespective of automation. But for those with the right endowments, a focus on labour-intensive manufacturing sectors in the next 15 to 30-year window could be advantageous.

Manufacturing is a tried and tested method of developing technological, human and business capabilities. It is still a relevant option for countries that have made some headway in industrialisation, as their political economy will already be geared towards the distributional implications of this path. However, for countries still slow to pursue manufacturing, governments should think twice given the closing window of opportunity, plus the political economy failures that such industrial policy often entails, which can be hard to reverse.

Policy responses may include Special Economic Zones (SEZs) and corresponding incentives; FDI promotion in priority sectors; interventions to strengthen business capabilities; and export facilitation measures. All interventions rely on investment in basic infrastructure, including energy, transportation infrastructure and logistics, and internet connectivity.

C2 Public works programmes: Public works programmes can offer large-scale, low-skill employment for poor and vulnerable populations and are often used to build public infrastructure. Policy

responses can include traditional public works programmes (such as road and irrigation system building); programmes focused on the needs of the new economy, from hard digital infrastructure (laying fibre optic cables) to supporting greater female participation in the formal sector (through childcare and elderly care). Although included in 'Manage automation', these interventions could also promote inclusivity and support a transition of labour towards the future economy.

C3 Reduce the cost of labour (tax, subsidies, lower minimum wage): Reducing the cost of labour to encourage foreign firms to remain and/or relocate to the country. This measure only works in the short term, as, over time, labour costs will comprise a decreasing share of manufacturing costs. Labour cost policy over the longer term should focus less on reducing the costs of full-time formal workers and more on reducing the costs of bringing informal workers into the formal sector.

Policies could include lowering the minimum wage; easing restrictions on letting go of workers; subsidies to firms employing certain types of local labour; increasing protection for workers to organise, using digital technologies to monitor working conditions; easing restrictions on registering formal businesses and on the definition of 'employees'. Although included in 'Manage Automation' as policies for traditional pathways for growth, these interventions could promote a transition of labour towards industries of the future economy, too.

Slow Down Automation

D1 Increase the cost of automation: Increase the cost for firms adopting 4IR technologies. Policies could include taxes on 4IR technologies; regulation that makes the adoption of automation more difficult and costlier; tariffs on imported inputs with automation-produced content.

Mutually Compatible Options

A government will not have the capacity to prioritise and implement all these policy choices, nor should it want to. Nonetheless, these policy choices are not mutually exclusive. A government could pursue manufacturing-led industrialisation (C1)

and increase the cost of automation (D1) to boost labour productivity in the short term, while simultaneously pursuing investments in 4IR technology to boost education outcomes (A4) and investing in high-end skills (B3), which would have longer payback times (such as 15+ years).

Nonetheless, these policy choices respond to the rise in automation in very different ways. Many of the policy responses geared toward managing automation will have short- to medium-term effects (10, 20, perhaps 30 years), with their scope and impact diminishing as global value chains for manufactured goods become increasingly automated.

Advice for African Governments

CALL TO ARMS #1: A digital framework to underpin all development plans.

While each government will develop its own unique prioritisation of policy choices to underpin its development plans, one thing is clear: technology, let alone the 4IR, will affect the opportunities and implications of all those policy choices, and governments must prepare for this.

Whether a government chooses to embrace automation by prioritising A1 Tech for Agricultural Productivity, or chooses to manage automation by enforcing in the short-term D1 Increase the Cost of Automation (a government could, indeed, do both of these things) such policy choices must be underpinned by a digital framework that can support these competing imperatives.

The 4IR era requires all governments to apply a digital lens to their socio-economic development strategies. Without taking a holistic approach to the technological and digital revolution, not only will low-income countries miss out on the opportunities these digital technologies present, but they will be blindsided by the challenges that 4IR will pose to traditional structural transformation strategies. Low-income countries will be left behind if they do not embrace the technological revolution now.

To prepare for the revolution that is already underway, African governments should develop their own **digital framework** through which to ground all their existing and future development plans.

Such a framework should ensure that digitally enabled opportunities are not only accounted for, but underpin all their socio-economic development strategies. It should not be treated as a 'bolt-on' to existing plans, but as foundational to the change their national strategies seek to pursue. A digital framework will not only help to re-evaluate existing development plans, but offer a means to identify opportunities that digitally enabled technologies can offer to rocket-boost structural transformation strategies.

If anything, a digital framework to underpin all other national strategies will be far more critical for developing nations than it is for developed ones. Not only are African governments preparing their citizens for the changing nature of work, but they will have to manage the huge ramifications that 4IR presents to traditional pathways for economic transformation. Without a digital framework that holistically informs all other development plans, national-level strategies are at high risk of becoming obsolete in the 4IR.

A digital framework must also inform the development of a new regulatory environment that can guide how digital and tech providers and investors operate in the country, both safeguarding businesses and citizens that use the technology, and promoting innovation and an entrepreneurial ecosystem.

This framework must also steer the fundamental investments required to ensure all citizens and businesses have access to fast, reliable internet (see recommendation on page 74). It should describe how to prepare citizens to use connectivity, and the broader economic opportunities and public services that digital will facilitate, especially in policy areas that the government has prioritised (such as digital education for rural communities in areas like AgTech, possibly beyond the traditional remit of agricultural extension services).

The world is becoming more digital. No matter what development strategies a government chooses to employ, to be successful, these plans must be grounded in emergent digital realities.

DIFFERENT DEMANDS ON GOVERNMENT

It is easy to say that policies should be implemented: in practice this can be extremely hard to do. Although many advanced economies have laid out a policy agenda to prepare for the future of work (such as reforming educational systems to focus on skills that complement automation), few have taken the initial first step to put the policy agenda into action. Expecting lower-income countries to undertake reforms of a similar magnitude—with fewer resources and lower government capacity— is unrealistic, but no less necessary.

We have classified policy responses based on how difficult they are to implement (their 'complexity'), in order to estimate what African governments may face when pursuing a particular policy response. Each policy area is evaluated against three factors to give governments and policymakers an indication of its complexity.

Within each policy area there is, of course, significant variation in the complexity of any given measure. For example, within the A1 Tech for agricultural productivity area, it may be relatively straightforward to attract foreign investors in AgTech into a country, but far more difficult to transfer that technology down to smallholders. Therefore, our evaluation of complexity serves only as a high-level typology through which governments can understand a policy area. The details of a particular policy measure and the context in which it is to be implemented must ultimately guide a government's consideration of its feasibility to implement.

The three factors that characterise the complexity of a policy response are its transaction intensity, informational complexity and political resistance.[48]

Transaction Intensity

How many actors must be involved to implement a policy successfully? Can implementation of the policy withstand free-riding by those involved (i.e. by those that can use the common resource without paying for it), or do all implementing actors need

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48 We draw upon Andrews, Pritchett, and Woolcock, 'Building State Capability' and Kyle, 'Perspectives on the Role of the State' for these criteria.

to participate? Are a large number of interactions between actors required to implement a policy or deliver a service?

Policies that require more actors and more transactions to execute tend to be more difficult to implement. Overcoming transactional problems requires that the actors involved know each other's interests and preferences and can make commit to complying with an agreed-upon policy. It also requires that actors have the information and capability to monitor each other's performance.

Where more actors are involved, the potential for deviation in the execution of a policy increases— through other competing incentives to deviate (including corruption); weak incentives to cooperate (for example, due to high monitoring costs and thus less robust monitoring); and through the wilful misinterpretation or adaptation of a policy's implementation. This may have negative implications, but equally it can result in positive impacts on implementation— for example, implementing agents may adapt a policy to better suit the local context. Either way, if a policy relies on the discretion of a larger number of actors, it is more complex to implement than a policy that does not.

Informational Complexity

Is there a clear policy solution to the challenge, or do policymakers need to analyse and synthesise large amounts of information to develop one? How much technical knowledge is required to formulate a policy? Has this policy been executed successfully elsewhere, or is it virgin territory?

Many of the problems presented by automation are so difficult precisely because there is no clear agreement on the appropriate policy response(s) to them. Many of the opportunities that automation presents, both in terms of technological applications and the opportunities spinning off from them (such as opportunities for the export of services), are nascent or simply unknown. Gathering the information needed to develop solutions requires a high degree of technical knowledge and capacity.

It may also require more time and experimentation to understand how an intervention or technology adopted from elsewhere can be

adapted to suit the context. The 'what' and 'how' to implement or adapt a policy or technology can be far more informationally complex for some interventions than others. For example, interventions to diagnose malaria are likely to be less informationally complex (because human bodies are relatively homogenous) than interventions to address weak skills in low-capacity environments (because human behaviour is far more heterogeneous, even within the same context).

Political Resistance

What are the distributional implications of a policy, such as who stands to gain and who stands to lose from implementation? How politically powerful are the potential losers? How quickly are gains and losses experienced, both perceptually and in reality, by different political factions?

Where the political and economic incumbents perceive that a policy may threaten the status quo (which rewards them), they are likely to resist its implementation unless concessions are made to compensate their losses. However, if a policy is introduced that is perceived to have minimal bearing on the incumbents' sphere of influence, they may allow the policy to be executed with little interference. If the policy actually rewards political and economic incumbents, they are likely to facilitate its implementation. Therefore, growth-inducing policies that reinforce political and economic incumbents' influence can be extremely successful, and far easier to implement than those that appear to threaten them.

Classification of Policy Areas According to Complexity

Based on these descriptions, we have rated each of the policy responses 'high' or 'low' across each criteria (acknowledging that, in practice, the ratings vary within policy areas and across country contexts). We then grouped the policy areas that rated the same across criteria. Against each of these groupings we have identified the role that government needs to play to implement a certain policy area response given its complexity (see table 5 and the following descriptions). These are intended only as a typology through which government and policymakers can begin to evaluate different policy choices in their specific contexts, and the trade-offs they face relating to the difficulty of implementation.

Table 5: Classification of Policy Areas According to Complexity, and Government Role Needed

Transactional Complexity	Informational Complexity	Political Complexity	Role of Government Based on Complexity of Policy
High	Low	Low	Logistician
Low	High	Low	Scientist-curator
Low	Low	High	Politician
High	Low	High	Enforcer
High	High	Low	Service provider
Low	High	High	Scientist-politician
High	High	High	Innovator

Logistician: Government must focus on building the capacity of the system to implement a policy across many places, as it relies on a large number of actors across the government to do so (e.g. running a nationwide vaccination campaign). Policy response: none above.

Scientist-curator: The role of government is to develop the best policy solution for a challenging problem, requiring it to find and curate solutions: adapting, testing and tailoring them to their context. Policy responses: A2 Tech for manufacturing, A3 Tech for services.

Politician: The main role of government is to build the political capital to pass and implement a politically challenging policy. Policy response: D1 Increase cost of automation.

Enforcer: Government must have the influence and enforcement mechanisms to win over political elites and drive change through an entire delivery system. Policy responses: C2 Public works programmes, C3 Reduce cost of labour, B4 Safety net 2.0.

Service provider: This is a challenging role for a large number of public-service deliverables such as education and health. The challenge is that the system for delivery is huge with many actors, and often the solutions (particularly given the resources available) are not obvious and require significant skill and ingenuity to identify and apply. Policy responses: A1 Tech for agricultural productivity, A4 Tech for education, A5 Tech for healthcare, B3 Investment in high-end skills.

Scientist-politician: Government needs to balance the hard task of identifying the right policy solutions to a complex challenge, while simultaneously managing and influencing vested political interests in an environment where both challenge and policy response are complex and in flux. Policy responses: B1 Modern industrial policy for services, C1 Modern industrial policy for manufacturing.

Innovator: The hardest role for government to play. It has to be agile, resourceful and politically astute while retaining an informed view and strong influence over the system to respond to challenges that are complex in every way. Policy responses: A6 Tech for urbanisation, B2 Develop an entrepreneurial ecosystem.

EVALUATION OF POLICY AREAS

In addition to complexity, governments will also need to make an assessment of the impact that a policy may have on inclusive economic growth. We have made a relative assessment of this impact for each policy area, and mapped this against how complex a policy is to implement (see figure 6).

Figure 6: Map of Policy Areas by Impact and Complexity

Policies that are...

Less complex | More complex

IMPACT ON INCLUSIVE ECONOMIC GROWTH (High / Low)

LEVEL OF GOVERNMENT CAPABILITY REQUIRED TO IMPLEMENT (Low / High)

— Embrace automation   — Manage automation

A1 Tech for agricultural productivity
A2 Tech for manufacturing
A3 Tech for services
A4 Tech for education
A5 Tech for health care
A6 Tech for urbanisation
B1 Modern industrial policy for services

B2 Develop an entrepreneurial ecosystem
B3 Investment in high-end skills
B4 Saftey net 2.0
C1 Modern industrial policy for manufacturing
C2 Public works programmes
C3 Reduce cost of labour
D1 Increase cost of automation

Source: Authors

Policies that have only one of the three complexity factors ranked as high are considered less complex, whereas those with two or more high-ranking factors are considered more complex. We consider the majority of the 14 policy areas complex. Those areas that require governments to be innovators (high across all three factors) are considered the most challenging to execute successfully. The next most challenging set of policy areas are those requiring government to act as:

- a scientist-politician: requiring expertise, information collection and synthesis, and substantial political capital to execute successfully

- a service provider: requiring numerous person-to-person transactions as well as collection, management, and utilisation of large amounts of information
- an enforcer: requiring numerous person-to-person transactions and an ability to face up to potentially strong political resistance

This mapping exercise is not a science. Some policy areas may be so complex to deliver along one of the criteria that their overall assessment of complexity increases. A clear example here is investment in high-end skills which is technically challenging and to a degree unknown, and so transaction-intensive that its complexity levels are akin to policy areas where governments have to be innovators.

That said, we can draw a few important observations from this mapping. First, it indicates that the highest-impact policies on inclusive economic growth are precisely the ones that are most difficult to implement well. Second, most of the policy responses that we have considered are relatively more complex to carry out. Learning and adaptation by governments will be essential if they are to engage with—and harness—the growing complexity that faces them.

It is important to reiterate that this exercise does not help governments decide which policies to opt for. This will depend on their economic, demographic, political and human-development circumstances, as well as the specific conditions of their government, civil service and political economy (which enable them to execute in certain policy areas more than others) as well as the country's broader strategy for growth and development.

Therefore, countries may well choose to implement policies that contribute to other development goals (such as meeting SDGs or maternal health), which will have a low (direct) impact on economic growth but improve inclusion significantly. Depending on a government and bureaucracy's specific conditions and political configuration, a mix of policies spanning levels of complexity will suit certain countries but be impossible for others to implement.

To help governments understand what combination of policy areas they can adopt in response to automation, we have evaluated

the policy options that particular types of African countries may choose given their unique circumstances. These countries —Ethiopia, Kenya, Malawi, Mozambique and Nigeria—have been selected as archetypes because their economies, endowments, demography and political conditions, as well as their existing development plans, lend themselves to different policy choices that can be informative for other governments across Africa and the wider developing world.

Assessing Inclusive Growth Impacts

Policy areas are evaluated in relation to each other, and their mapping is meant to be indicative of their potential impact on inclusive economic growth, and their complexity.

To assess their impact on inclusive growth, we qualitatively judged the potential of each policy area to promote those properties that export-led industrialisation has traditionally exhibited: continuous productivity growth, large-scale job creation, and tradability. These are the characteristics that have best enabled countries to sustain rapid and inclusive economic growth for extended periods of time.

Our assessment of a policy's impact on inclusive growth can certainly be challenged. We did not attempt to analyse policy areas in fine detail, based on rigorous quantitative evidence (partly because economic growth literature does not provide such fine-grained impact estimates). Rather, our intention is to illustrate that different policy responses will have different effects on inclusive growth, and to provide one possible arrangement of these responses based on what we believe to be critical levers for growth in the coming years.

Likewise, this mapping is not meant to indicate if one policy response is better than another. Non-economic policy responses (in, for example, health) may be just as important and suitable for a particular country, given a multitude of other factors including demographics, political demands and national security. This exercise is simply meant to illustrate the trade-offs that governments face in focusing on one policy area over another, as it relates to pursuing promising pathways for inclusive growth that at the same time are implementable given a specific country's governance capabilities.

AFRICAN CASE STUDIES

We identify what certain archetype African countries may choose to prioritise in order to respond to automation. These archetypes span countries that have made strides in pursuing the traditional industrialisation model (Ethiopia) and those that are already making significant investments in the future economy and what technology can bring (Kenya). It compares countries with huge markets (Nigeria, population of 190 million and growing) that make manufacturing in the near term still attractive against smaller countries (Malawi, population of 18 million) whose current endowments (such as being landlocked) may make traditional development pathways less promising, but where 4IR technologies offer an exciting opportunity to embrace alternative development models and public services. It also includes resource-based economies, which offer both opportunity (in terms of revenue) as well as challenges (such as governance and Dutch disease) to existing and future development pathways, and how such a government may manage that in response to automation (Mozambique).

For each country, we provide primary and secondary priority policy choices. The most attractive policy responses lie in the upper left of the chart—policies that are less complex to deliver but have high impacts on inclusive growth. However, our mapping suggests that these low-hanging fruit are scarce.

The question is how to select and prioritise policy responses. Based on our Institute's experience working in most of the countries considered below, we have made qualitative judgements about which combinations of policy responses make most sense for each country, considering the following criteria:

- **Current economic growth strategy of the country's government:** We align with a country's economic growth strategy (to the extent it was clear and reasonable). For example, for a country actively pursuing export-oriented light manufacturing, we are more likely to suggest priorities linked to this approach.
- **Existing or emerging strengths of the country's economy**: Some countries have already made substantial strides in some of the

policy areas under consideration here, in which case we identify priorities that could build upon progress already made. For example, for a country that has already developed a burgeoning tech ecosystem, we are more likely to prioritise policy responses that are enabled by this ecosystem or could strengthen it further. (Similarly, we deprioritise policy responses that we feel are not aligned with a country's comparative advantages.)

- **Implementation capability of the country's government:** The more developed a government's capabilities are (in our estimation), the more likely we are to prioritise more complex policy responses.

- **Potential to directly contribute to inclusive growth outcomes, such as job creation:** We place more emphasis on policy responses that directly contribute to productivity growth and job creation over shorter time horizons (as has been the case for manufacturing). Hence: 1) we favour economic policy responses in comparison to social welfare policy responses (such as health); and 2) we favour policy responses rated more highly on their impacts on inclusive growth, even if they are considered slightly more complex to implement than others.

We also indicate when impact from these interventions can be expected to take effect: over the short term (the next few years), medium term (10–25 years) or long term (25+ years). Across all countries, we aim to prioritise policy responses with varying timelines for impact. We have done so because complementary policy responses, by their nature, may bear fruit over different timescales, and because short-term gains are vital to enable governments to generate the political space and public legitimacy required for longer-term policy interventions.

These country examples shed light on some emerging hypotheses. A1 Tech for agriculture features highly as a policy option for all countries: this could be considered low-hanging fruit for all countries as food productivity is essential to any development strategy. B1 Modern industrial policy for services is also a priority for all countries, illustrating how fundamental and ubiquitous the service economy will be for all countries in the world of increasing automation.

B4 Safety net 2.0 also features in all case studies evaluated here: these economies, like all economies, are moving towards a future whereby there may not be enough jobs for all the labour in the market, and redistribution will be essential to support those who are increasingly marginalised. Finally, B2 Develop an entrepreneurial ecosystem also features in all case studies: it is considered essential to any industrial policy intervention, regardless of its focus on manufacturing, services or, indeed, agriculture.

ETHIOPIA: PURSUING A TRADITIONAL INDUSTRIALISATION MODEL

Ethiopia has made strides in pursuing the traditional industrialisation model, and can take measures that both harness and work around automation to further this pursuit. Some of these measures can also stand on their own to make growth more inclusive and to enhance social welfare outcomes. Ethiopia's policy priorities are illustrated in figure 7 and explored below.

Figure 7: Map of Policy Areas by Impact and Complexity: Ethiopia

Policies that are...

High — Impact on inclusive economic growth — Low

Less complex | More complex

Low — Level of government capability required to implement — High

Legend:
- ● Embrace automation
- ● Manage automation
- ○ Priority policy
- ○ Second priority policy

A1 Tech for agricultural productivity
A2 Tech for manufacturing
A3 Tech for services
A4 Tech for education
A5 Tech for health care
A6 Tech for urbanisation
B1 Modern industrial policy for services

B2 Develop an entrepreneurial ecosystem
B3 Investment in high-end skills
B4 Saftey net 2.0
C1 Modern industrial policy for manufacturing
C2 Public works programmes
C3 Reduce cost of labour
D1 Increase cost of automation

Source: Authors

Primary Policy Priorities

A1 Tech for agricultural productivity: The economy is still heavily dependent on agriculture, both in terms of contribution to GDP and share of employment. In order to facilitate a structural change towards industry, increasing productivity (including through advanced technology) will be essential. Impact timeframe: short term.

B1 Modern industrial policy for services: Due to the growing role of (modern) services in manufacturing, using industrial policy to

improve productivity in services (such as logistics or finance) can facilitate manufacturing growth. Even if Ethiopia maximises its benefits from the traditional industrialisation model—particularly in terms of employment—it is still likely to face a jobs shortfall due to its rapidly growing population. Developing job-creating service sectors would help to address this employment challenge. Impact timeframe: medium term.

B4 Safety net 2.0: Ethiopia has a longstanding social safety net (the Productive Safety Net Programme, or PSNP), so building on this foundation would enable the government to support: 1) people who are not directly participating (through employment) in the country's industrialisation push; and 2) people who, in the future, may miss out on the benefits the country generates through its industrialisation push, for example, due to the window of opportunity for manufacturing closing. Impact timeframe: short term.

C1 Modern industrial policy for manufacturing: Given Ethiopia's drive to achieve structural transformation and the investments it has already made in this direction, an industrial policy that develops priority manufacturing sectors will be the major component of the country's growth strategy. Impact timeframe: medium term.

Secondary Policy Priorities

A4 Tech for education: Basic education is weak, with the country's literacy rate at only 40–50 per cent. Basic skills are a prerequisite for advanced skills, service-sector development, entrepreneurship, and many other policy areas that are connected to economic transformation and job creation. Impact timeframe: medium term.

B2 Develop an entrepreneurial ecosystem: Building up an ecosystem that facilitates entrepreneurship will be critical for Ethiopia for these reasons:

- The economy will capture most of the benefits that industrialisation offers only if domestic firms actively participate in the country's industrialisation process
- A large swathe of the population will likely turn to entrepreneurship as their major economic activity, due to

economic reforms the government will undertake in coming years and growing opportunities to serve the large domestic market
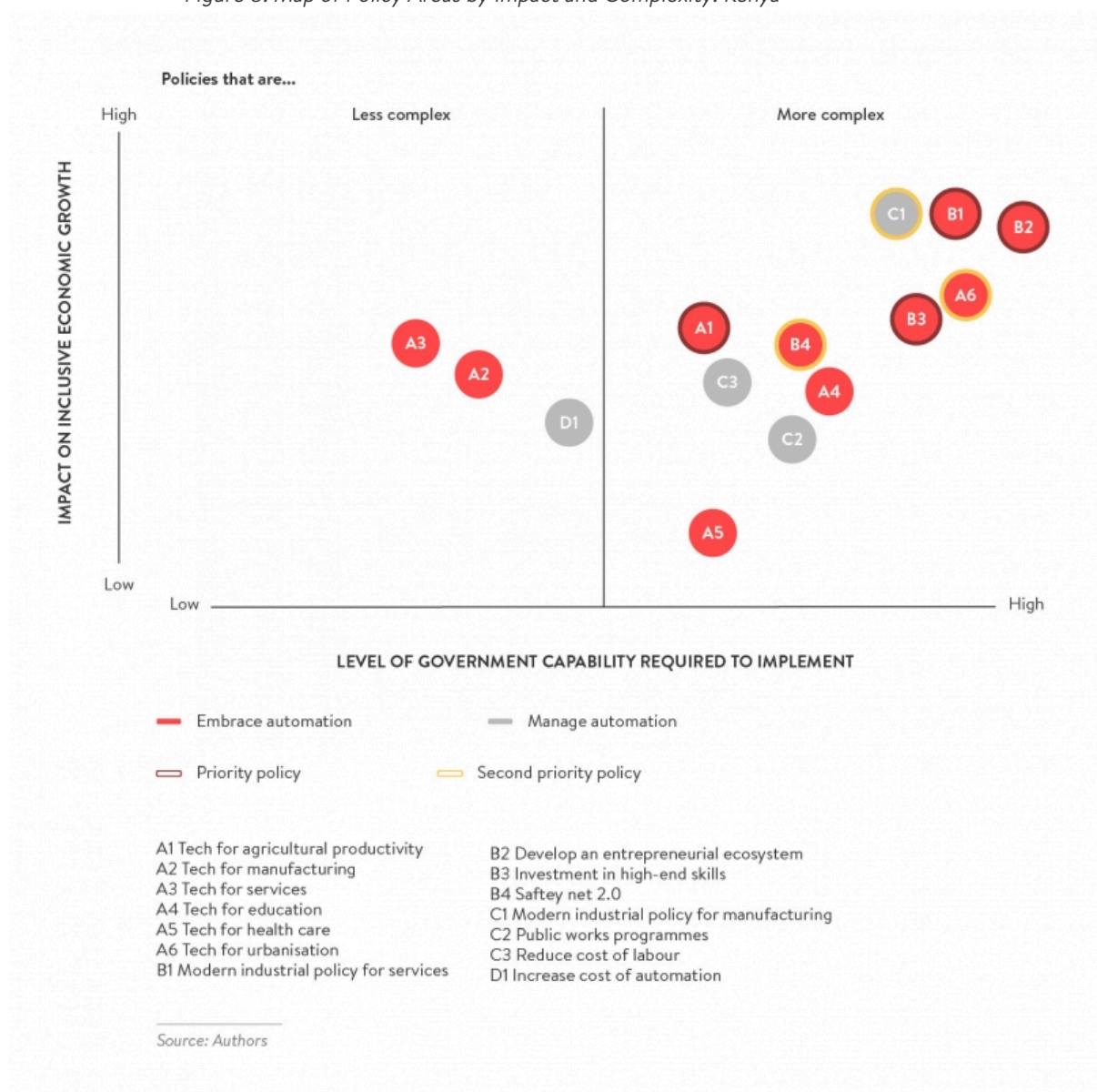
- Domestic entrepreneurship—and the jobs it creates—will have to supplement jobs created through the country's FDI-led industrialisation push to meet demand for employment among the population. Impact timeframe: long term.

D1 Increase the cost of automation: There may be select cases in the near future where it is reasonable for the government to delay the adoption of automation (perhaps for a particular sector) so that its progress on manufacturing growth and job creation is not stunted midstream. Impact timeframe: short term.

KENYA: A TECHNOLOGY-ORIENTED ECONOMY

Kenya is one of the most advanced African economies in terms of orientation toward modern technology, so it can employ a variety of measures to capitalize on this and further prepare itself for the opportunities that the 4IR will offer. Kenya's policy priorities are illustrated in figure 8 and explored below.

Figure 8: Map of Policy Areas by Impact and Complexity: Kenya

Policies that are...

High

Less complex   More complex

IMPACT ON INCLUSIVE ECONOMIC GROWTH

Low

Low   High

LEVEL OF GOVERNMENT CAPABILITY REQUIRED TO IMPLEMENT

— Embrace automation   — Manage automation

▭ Priority policy   ▭ Second priority policy

A1 Tech for agricultural productivity
A2 Tech for manufacturing
A3 Tech for services
A4 Tech for education
A5 Tech for health care
A6 Tech for urbanisation
B1 Modern industrial policy for services

B2 Develop an entrepreneurial ecosystem
B3 Investment in high-end skills
B4 Saftey net 2.0
C1 Modern industrial policy for manufacturing
C2 Public works programmes
C3 Reduce cost of labour
D1 Increase cost of automation

Source: Authors

Primary Policy Priorities

A1 Tech for agricultural productivity: Except for a few urban centres, the economy is still heavily dependent on agriculture—both in terms of contribution to GDP and share of employment. Before Kenya can fully move into higher-productivity activities, it needs to increase its agricultural productivity. It would benefit from capitalising on its current orientation towards, and capabilities in, technology. Impact timeframe: short term.

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B1 Modern industrial policy for services: Kenya has already established a strong foothold in modern services compared to other countries in the region. Doubling down on this progress by sharpening its industrial policy could bear substantial fruit in terms of productivity growth (and jobs, depending on the sector). Impact timeframe: medium term.

B2 Develop an entrepreneurial ecosystem: The country has already earned the moniker 'Silicon Savannah' for its success in creating a technology ecosystem. This ecosystem could be expanded to promote innovation in the wider future economy, so that entrepreneurism thrives in all sectors, not just technology. Impact timeframe: short term.

B3 Investment in high-end skills: Fostering the development of 21st-century skills across the population will enable Kenya to build upon its successes in modern services and entrepreneurship. Impact timeframe: medium term.

Secondary Policy Priorities

A6 Tech for urbanisation: Kenya has already created urban centres that facilitate innovation, such as Nairobi. The country can leverage its technology orientation to drive urbanisation in other large cities, and address pressing urban challenges such as housing, congestion and waste management. Impact timeframe: medium term.

B4 Safety net 2.0: Kenya's evolving economy will require widespread gains in skills and productivity among the labour force in order for Kenyans across the country to participate in the country's transformation process. This will take time and is unlikely to reach everyone. Hence, a strong social safety net that uses technology to increase the efficiency and effectiveness of state support can make a modern economy in Kenya more inclusive. Impact timeframe: short term.

C1 Modern industrial policy for manufacturing: As Kenya has excelled in technology and related services, its homegrown manufacturing sector has outperformed that of many other countries in the region. Building on this foundation, the government could employ a targeted industrial policy to produce even greater
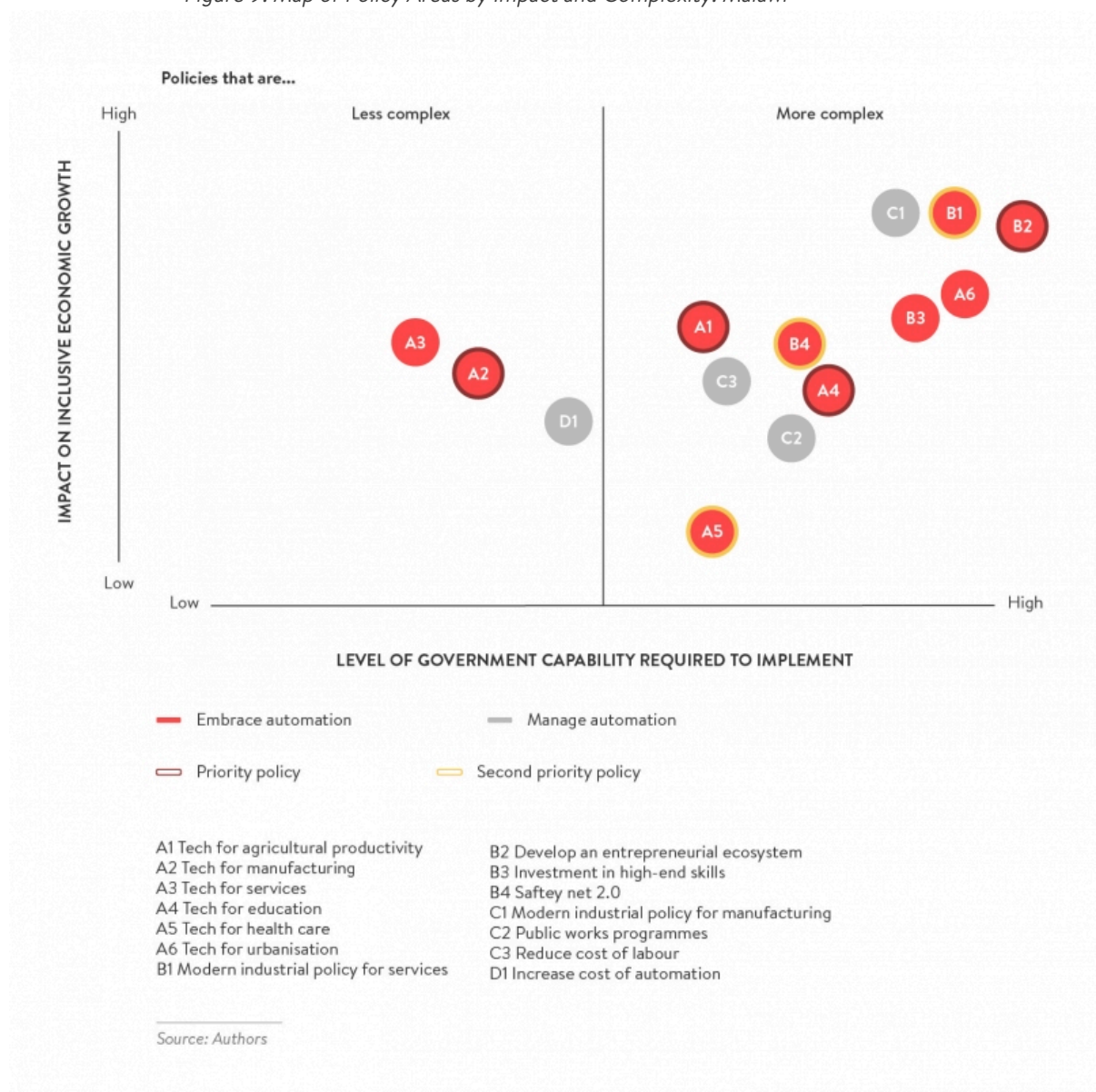
benefits in productivity, jobs and exports. To diversify its economy, Kenya could promote its labour-intensive manufacturing sector—and, given its current and hoped-for skills base—more complex and knowledge-intensive manufacturing sector. Impact timeframe: medium term.

MALAWI: A SMALL, AGRICULTURE-BASED ECONOMY

The traditional export-led manufacturing model was always going to be difficult for Malawi to fully emulate, due to its small size, geography, and agriculture-heavy economy. As a result, the country may need to focus its growth initiatives on other areas that will become prominent in the 4IR, as well as leverage technology for specific economic activities and to shore up lagging social welfare indicators. Malawi's policy priorities are illustrated in figure 9 and explored below.

Policies that are...

Less complex | More complex

IMPACT ON INCLUSIVE ECONOMIC GROWTH

High
Low

C1 B1 B2
A6
A1 B3
B4
A3
A2 C3 A4
D1 C2

A5

Low — LEVEL OF GOVERNMENT CAPABILITY REQUIRED TO IMPLEMENT — High

━━ Embrace automation   ━━ Manage automation

▱ Priority policy   ▱ Second priority policy

A1 Tech for agricultural productivity
A2 Tech for manufacturing
A3 Tech for services
A4 Tech for education
A5 Tech for health care
A6 Tech for urbanisation
B1 Modern industrial policy for services

B2 Develop an entrepreneurial ecosystem
B3 Investment in high-end skills
B4 Saftey net 2.0
C1 Modern industrial policy for manufacturing
C2 Public works programmes
C3 Reduce cost of labour
D1 Increase cost of automation

Source: Authors

Primary Policy Priorities

A1 Tech for agricultural productivity: Given Malawi's dependence on agriculture and the sector's low yields and productivity, technology solutions would push the sector forward and simultaneously support a large chunk of the population. Impact timeframe: short term.

A2 Tech for manufacturing: Being a small, landlocked country, Malawi is limited in its ability to compete in manufacturing (due to market size, transport costs). For this reason, we have not included

C1 as a priority policy. However, new technologies in manufacturing, such as 3D printing, may enable the country to develop the sector in a decentralised way that primarily targets the domestic market, but also offers opportunities for innovation and regional export. Impact timeframe: medium term.

A4 Tech for education: Educational outcomes in Malawi are poor, and technology could boost them. This would enable more Malawians to engage in economic activities outside agriculture, which aligns with the country's economic ambitions. Impact timeframe: medium term.

B2 Develop an entrepreneurial ecosystem: The country's market size hinders its ability to attract or develop large firms, so SMEs will continue to play an important role in the economy. For SMEs to become more productive and create more jobs, the government will need to relieve constraints on entrepreneurship. There are already examples of initiatives that are pursuing this goal, so the government (and development partners) can build on this foundation. Impact timeframe: long term.

Secondary Policy Priorities

A5 Tech for healthcare: Malawi has one of the highest health expenditures as a percentage of GDP in the world (in 2018, ninth highest globally after France, Sweden, Switzerland and the US). Despite this, its health outcomes are still extremely low, with one of the highest rates for HIV and deaths, and the fifth lowest physician density in the world. Given the political capital in this sector (based on public expenditure in health), building investment in health technologies would be politically attractive, and highly inclusive too. Impact timeframe: short term.
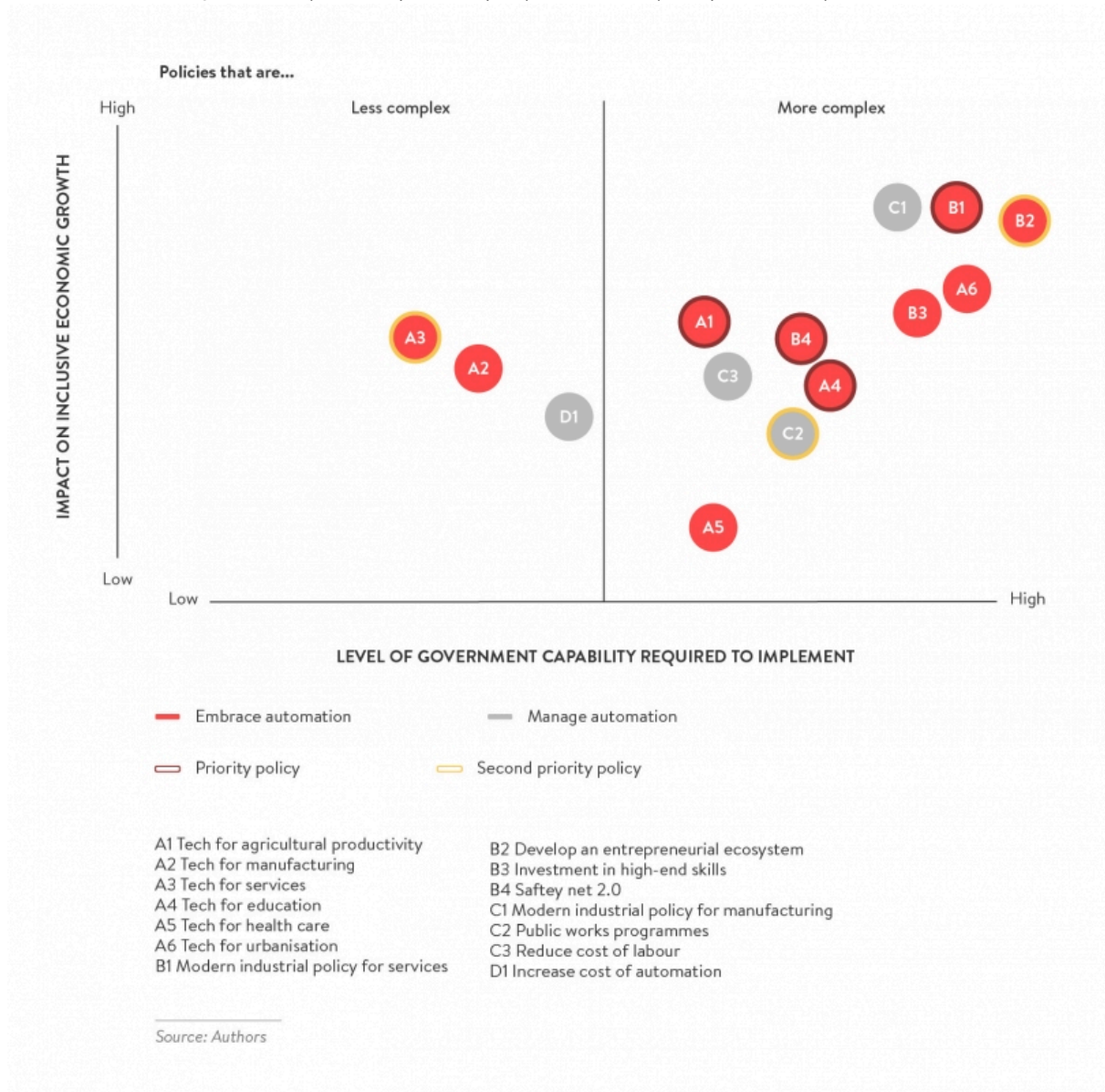
B1 Modern industrial policy for services: Some services, such as finance, telecommunications, and renewable energy, can reduce transaction costs that are particularly acute in promising manufacturing sectors in Malawi. These and others, including tourism and digital services, have scope for growth in their own right. Modern industrial policy can help the government to prioritise and tackle challenges in areas that hold back growth. Impact timeframe: medium term.

B4 Safety net 2.0: The rural, agriculture-dependent nature of Malawi's economy hints at the importance of a robust social safety net—including but not limited to cash transfers—that can help a large chunk of the population climb out of extreme poverty. It can serve as an inclusive complement to some of the policies mentioned above. Impact timeframe: short term.

MOZAMBIQUE: A NATURAL RESOURCE-RICH ECONOMY

Recent natural gas discoveries play a major role in Mozambique's economy, but the country is agriculture-driven and seeks to move into other economic activities. Hence, it will need to manage natural resource wealth for broad-based benefits and simultaneously make policy geared toward future opportunities (some of which may be linked to its resource wealth). Technology can be useful in some cases, as it can for the country's stubbornly low human capital and social protection performance. Mozambique's policy priorities are illustrated in figure 10 and explored below.

Figure 10: Map of Policy Areas by Impact and Complexity: Mozambique

Policies that are...

Less complex / More complex

IMPACT ON INCLUSIVE ECONOMIC GROWTH — High / Low

LEVEL OF GOVERNMENT CAPABILITY REQUIRED TO IMPLEMENT — Low / High

— Embrace automation   — Manage automation

⬭ Priority policy   ⬭ Second priority policy

A1 Tech for agricultural productivity
A2 Tech for manufacturing
A3 Tech for services
A4 Tech for education
A5 Tech for health care
A6 Tech for urbanisation
B1 Modern industrial policy for services

B2 Develop an entrepreneurial ecosystem
B3 Investment in high-end skills
B4 Saftey net 2.0
C1 Modern industrial policy for manufacturing
C2 Public works programmes
C3 Reduce cost of labour
D1 Increase cost of automation

Source: Authors

Primary Policy Priorities

A1 Tech for agricultural productivity: Subsistence agriculture is the primary economic activity of the vast majority of Mozambican households, but it accounts for a small fraction of the economy. AgTech could be an important tool in increasing productivity, which would in turn help to address the country's food security challenges. Impact timeframe: short term.

A4 Tech for education: Mozambique's basic education outcomes are weak. If the potential benefits of the country's resource

revenues are to fully materialise (for example, in terms of human capital investments by households), these outcomes must improve. Technology can play an important role here. Impact timeframe: medium term.

B1 Modern industrial policy for services: If Mozambique is to achieve its industrialisation ambition, it will need to develop key service sectors that serve as enablers for manufacturing. It should use modern industrial policy to explore service sectors that have links with both manufacturing and the country's natural gas sector. In addition, and over the longer term, services in their own right (such as tourism, ICT services, online work) can contribute far more to Mozambique's economy if they are effectively supported. Impact timeframe: medium term.

B4 Safety net 2.0: High levels of poverty and participation in low-productivity economic activities suggest that Mozambique should reinforce its social safety net in order to include the bulk of the population in the country's economic gains. Mozambique could use its natural gas reserves to employ a 'gas to cash' (as in 'oil to cash') programme for its (poor) population, mitigating a potential resource curse while bolstering its social protection system. Impact timeframe: short term.

Secondary Policy Priorities

A3 Tech for services: Given that (informal) services are on the rise, employing new technologies in this space can increase access to economic opportunities for a range of workers (for example, through gig economy platforms), especially those in urban areas, thus bringing more of the workforce into the formal sector. Impact timeframe: medium term.
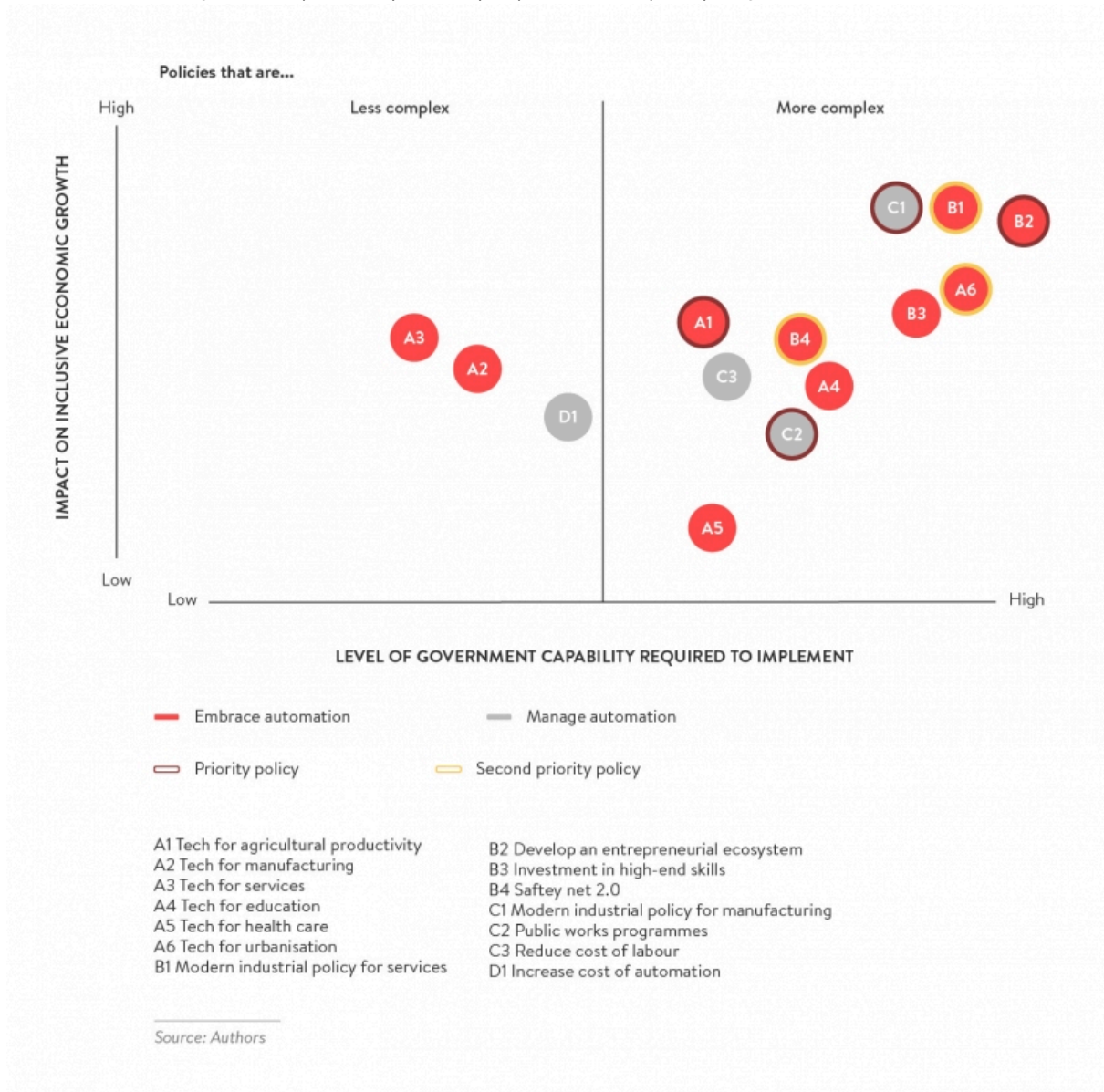
B2 Develop an entrepreneurial ecosystem: Entrepreneurship can address the gaps in services and manufacturing mentioned above, but this calls for as much or more attention from the government as the natural gas sector. Putting in place the building blocks for entrepreneurs to thrive will be particularly critical for a country like Mozambique, which may lose some growth/job creation in productive sectors (like manufacturing) due to the effects of Dutch disease—on top of similar effects arising from automation. Impact timeframe: long term.

C2 Public works programmes: Mozambique already has public works programmes to combat food insecurity, primarily in rural areas. If jobs do not materialise to the necessary extent in manufacturing and services, these programmes could be scaled up to form a pillar of the country's social safety net. This strategy would be aimed primarily at inclusion as opposed to maximizing economic growth. Impact timeframe: short term.

NIGERIA: AFRICA'S LARGEST ECONOMY

As Africa's largest country and economy, Nigeria has options available to it that many other countries on the continent do not. Yet its size also makes the challenge of creating enough jobs that much bigger. This means that the country will have to pursue policy responses on multiple fronts: address blockages to the growth of non-oil sectors; actively support activities and actors that are building up the country's burgeoning tech space; and bolster social protection systems that serve those at the bottom of the income ladder. Nigeria's policy priorities are illustrated in figure 11 and explored below.

Figure 11: Map of Policy Areas by Impact and Complexity: Nigeria

Policies that are...

High — Less complex | More complex

IMPACT ON INCLUSIVE ECONOMIC GROWTH

Low — Low — High

LEVEL OF GOVERNMENT CAPABILITY REQUIRED TO IMPLEMENT

— Embrace automation   — Manage automation

▭ Priority policy   ▭ Second priority policy

A1 Tech for agricultural productivity
A2 Tech for manufacturing
A3 Tech for services
A4 Tech for education
A5 Tech for health care
A6 Tech for urbanisation
B1 Modern industrial policy for services

B2 Develop an entrepreneurial ecosystem
B3 Investment in high-end skills
B4 Saftey net 2.0
C1 Modern industrial policy for manufacturing
C2 Public works programmes
C3 Reduce cost of labour
D1 Increase cost of automation

Source: Authors

Primary Policy Priorities

A1 Tech for agricultural productivity: Although oil accounts for a large share of the Nigerian economy, agriculture remains a key pillar: half of working Nigerians are in smallholder farming, and they make up a substantial segment of the poor. AgTech can be a boon for the Nigerian agriculture sector, both by supporting market access and productivity improvements for farmers and expanding the reach of the country's emerging technology ecosystem. Impact timeframe: short term.

B2 Develop an entrepreneurial ecosystem: The country has already seen organic growth in the entrepreneurship space, but the government could be more proactive in developing an ecosystem conducive to entrepreneurs establishing and growing their businesses. Nigeria's reliance on oil, combined with its inability so far to move into high-productivity activities, suggest that entrepreneurship will be critical going forward, both in terms of altering the country's economic structure and in creating jobs for its large population. Impact timeframe: short term.

C1 Modern industrial policy for manufacturing: Manufacturing holds great potential for the country to increase/diversify exports and create jobs, and although it has shown some progress, the services sector has outpaced it. Given Nigeria's large market and abundant labour, manufacturing could thrive in the coming years, before automation becomes viable. Employing modern industrial policy effectively can play a major role in whether or not this happens. Impact timeframe: medium term.

C2 Public works programmes: Establishing a formal public works programme may be more suitable for Nigeria than for other countries, given the size of the country's employment and infrastructure challenges. It can create jobs for people far away from economic centres and support infrastructure development in areas disconnected from markets. (Alternatively, it can be geared toward other challenges that hinder the development of these areas, such as violent extremism.) Impact timeframe: short term.

Secondary Policy Priorities

A6 Tech for urbanisation: There are already dynamic urban centres in Nigeria (as in Lagos) that generate innovative economic activity. Leveraging the country's growing technology orientation, these urban areas can spur economic growth by addressing challenges that will only become more prominent in the coming years as the country urbanises further (such as congestion, housing and basic services). Impact timeframe: medium term.

B1 Modern industrial policy for services: Recent growth has been driven by services as well as extractives. The creative industry in particular has evolved with little support from the Nigerian government: its film industry Nollywood is now the second largest

employer after agriculture, the biggest export after oil (with £800m revenue) and is the third biggest film industry in revenue after Hollywood and Bollywood (and second largest by production). The government could play a more active and facilitative role identifying and resolving constraints for service sectors that are burgeoning of their own accord.[49] Impact timeframe: medium term.

B4 Safety net 2.0: Even if Nigeria employs effective growth-enhancing policies and programmes, the scale of the job challenge renders it difficult to solve. A useful complementary strategy would be a social protection system to support households not reaping the benefits of the country's growth, such as employment. This can make Nigeria's economic path more inclusive. Impact timeframe: short term.

49 YY Ang's book, book How China Escaped the Poverty Trap, 2016 provides an excellent case study on Nollywood's growth (see the Conclusion), and the broader lessons that can be gleaned for adaptive government.

UNDERPINNING EXECUTION

This plethora of policy choice is not new to governments when it comes to promoting inclusive growth. Both early and late industrialisers had policy choices to make, few of which were obvious and easy to implement. A key difference between what they faced and what African countries face today is that the former could focus their energies on a proven model for inclusive growth: export-led industrialisation.

As the potential of this model is fading due in large part to automation and the shifting global trade environment, African governments will be forced to explore multiple avenues simultaneously to generate sustained inclusive growth. This may be advantageous for government: as there will no longer be one trusted pathway for economic transformation, governments may have no choice but to take a step back and see which sectors and firms emerge as game changers.

At the same time, unexpected 'winners' across sectors will require different types of support at the same time, which will require government to be nimble. The number of roles that government must play will grow, and they will have to rapidly improve the quality of their support in some areas to capitalise on certain windows of opportunity (manufacturing).

ADAPTIVE GOVERNMENT

All of this adds up to a complex endeavour for governments. The policy mapping above illustrates that the policy responses to automation at governments' disposal are, for the most part, complex to carry out. African governments, in turn, cannot purely imitate the approaches of past industrialisers. Given the uncertainty of their current context, they will instead have to start with what they already have, experiment and learn from multiple policy responses, and promote the measures that most effectively foster inclusive growth over time. In other words, they will have to be adaptive.

What exactly does it mean for government to be adaptive? Our intention is to contribute to the wider discussion around this question, rather than provide a full answer. Recently, there have been calls to promote adaptation in countries' development processes—under the banners of problem-driven iterative adaptation (PDIA), or 'good-enough' governance—but gaps remain in terms of what constitutes adaptive government and how governments leverage adaptive mechanisms.

In her book How China Escaped the Poverty Trap, Yuen Yuen Ang builds on these frameworks, borrowing key elements from complexity science to sketch out what she terms 'meta-institutions' for adaptation.[50] Her discussion adds useful colour to the idea of adaptive government, so we use it as a starting point here.

Variation vs Selection

Adaptation requires variation or selection. In the context of development policymaking, we can define these in the following way:

- Variation: generating alternative policy measures or implementation strategies in a given policy domain
- Selection: identifying policies or strategies that are most effective in achieving a defined policy goal

Variation is important because the decline of a dominant model for inclusive growth necessarily implies that governments will have to try various alternative development strategies to achieve the same results as past industrialisers. Selection is important because there is no use implementing a range of policy ideas if governments cannot distinguish between those that are effective and those that are not.

Each of the aforementioned policy areas are a bundle of specific measures which each require a different level and type of government involvement in policy formulation and implementation. Hence, when we speak about variation and selection in the policymaking process, these functions cannot be carried out by central governments alone; actors 'below' central governments—

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50 Yuen Yuen Ang, How China Escaped the Poverty Trap, 2016.

whether subnational governments, individual bureaucrats, firms, entrepreneurs or civil society—must contribute from the bottom up to complement the top-down role of the centre (see figure 12). This is what Ang terms 'directed improvisation'.[51]

Figure 12: Measures That Stimulate Variation and Selection in Adaptive Government Processes

Source: Authors
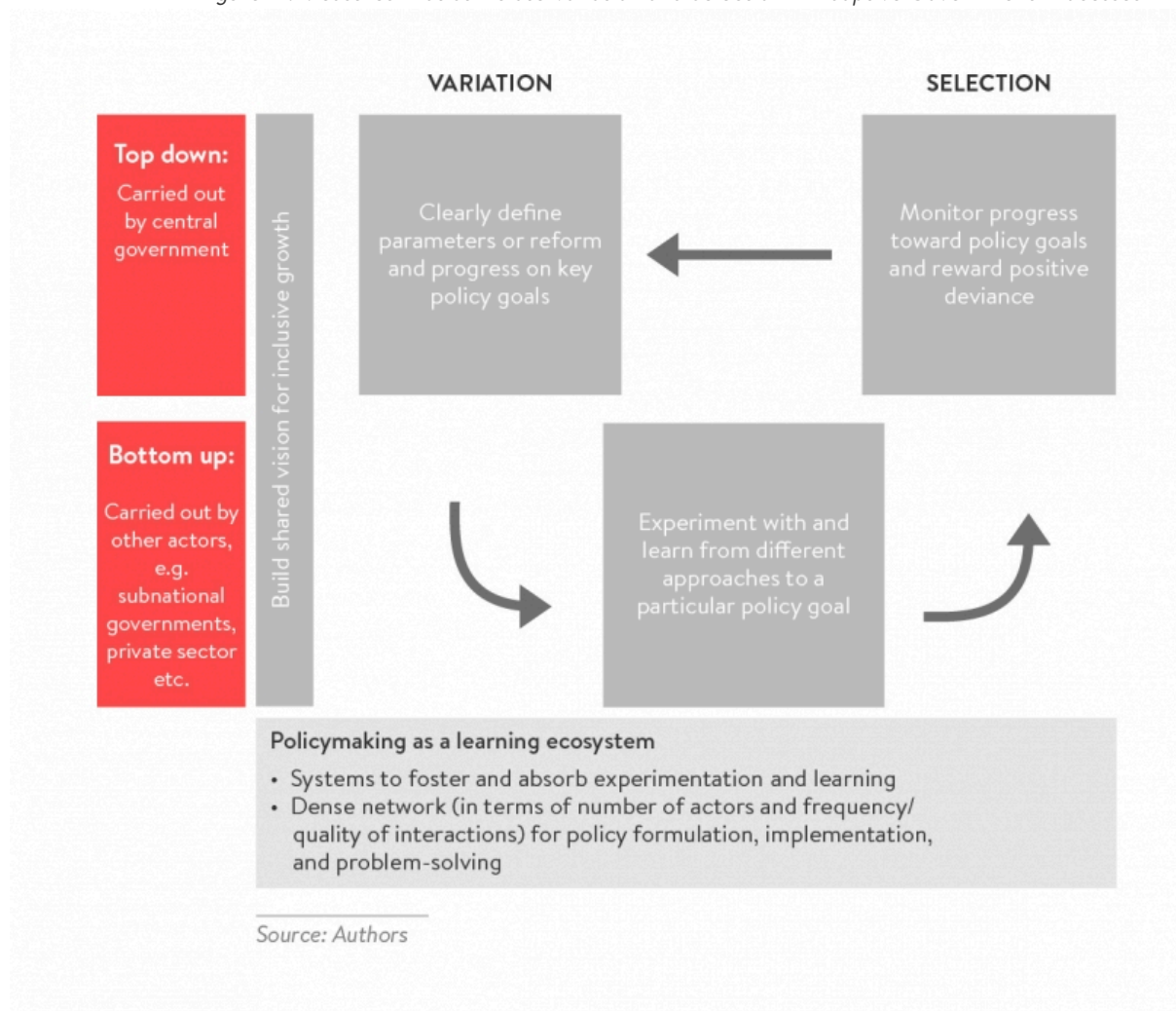
Bringing variation and selection to life can manifest in these ways:

- **Building a shared vision for inclusive growth** (top down and bottom up): Given the scale of the challenge that automation poses, key actors in the economy, both government and otherwise, must co-create a vision for inclusive growth that they can all support. This requires genuine commitment from all parties to work towards the same goal.

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51 Ibid.

- **Clearly defining the parameters of reform and progress on key policy goals** (top down): Defining policy goals which promote inclusive growth can be challenging. Each policy area can be employed for multiple, sometimes conflicting, purposes. It is nonetheless important that government knows what type of reform it seeks and the corresponding policy goals, which should be clear and specific. This is essential to properly guide and incentivise the behaviour of policymakers, firms, implementers and others in the system.
- **Monitoring progress towards policy goals and rewarding positive deviance** (top down): As alternatives are trialled in a particular policy area, the government should track how they fare against one another.[52] Those that perform best against the policy goal (positively deviating from the status quo or average) should be formally adopted, and the actors instrumental in this success should be rewarded accordingly.
- **Experimenting with and learning from different approaches to a policy goal** (bottom up): Different actors in the system will have different ideas about how to accomplish a particular policy goal. They should test these ideas, and existing or new efforts to implement them, to understand their potential.

In carrying out these functions, there are important considerations that governments and other actors should note. On the issue of variation, it is essential to strike a balance between too much and too little variation in the design and implementation of a policy measure. In complexity science, this is referred to as the exploitation (of existing and proven policy initiatives) versus exploration (of new policy alternatives to solve a problem) trade-off.

Some policy areas may not require a huge amount of exploration —the trialling of alternatives —because an existing policy measure has generated positive outcomes. For instance, every African country already has some sort of basic social protection programme

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52 Nearly always, alternative approaches in any given policy area are already being carried out, even if government has not formally authorized variation in the way a policy goal should be pursued. Part of government's role then is to seek out cases where this deviance results in more-positive-than-usual outcomes.

in place, which is typically benefiting at least some of the poor and vulnerable (if imperfectly).[53] This is a policy area in which it will make sense for governments to largely exploit what they have already established and, to a lesser extent, explore incremental improvements, for example, those that incorporate technological advancements in personal identification, or the delivery of benefits.

Other policy areas may not be familiar to a country, requiring an open approach to engagement and the willingness to learn what works best. For example, leveraging 4IR technologies for urbanisation is new to developed and developing countries alike, so African governments interested in the idea would be wise to explore a range of policies aimed at different urban challenges.

Second, the value of promoting variation depends on whether a specific policy measure is of the one-shot variety (not easily reversible or adjustable) or can be amended over time (easily reversible or adjustable). In the former case, the difficulty of remedying mistakes and the resulting political consequences means governments should put substantial time and resources into policy design, including the analysis on which it is based. There may only be one chance to get such a policy right. In the latter case, mistakes are less costly and can be rectified more easily, which gives governments the space to try out different options and learn from the experience.

In other words, the best approach in this scenario would be to 'probe, sense, and respond'[54]: to try multiple policy alternatives to probe the policy domain of interest; sense how actors within that domain react to these alternatives; and respond to these reactions based on learning accrued through experience. Used iteratively, this approach will eventually lead governments to the policy measure that works best to solve a given problem.

This discussion implies that promoting variation is more feasible and useful for reversible policy measures than it is for irreversible policy measures. Governments, however, often pay

53 Beegle et al., 'Realizing the Full Potential of Social Safety Nets in Africa', http://documents.worldbank.org/curated/en/657581531930611436/Realizing-the-Full-Potential-of-Social-Safety-Nets-in-Africa.

54 David Snowden, Cynefin framework, https://hbr.org/2007/11/a-leaders-framework-for-decision-making.

disproportionately more attention to policy design and disproportionately less attention to policy implementation, regardless of the reversibility of the policy measure in question. This stems from their aversion to criticism about not doing enough preparation or planning; from their misplaced desire to control outcomes that are inherently uncontrollable by one central entity; and from the incentives they face to focus on how a policy is designed even if its success is just as dependent on how it is implemented.[55] They should instead take the opposite approach in many policy areas: make twice as many policy decisions with half as much precision.[56] Variation is fundamental to this type of experimental approach.

> **Variation in Action: Partnership Schools for Liberia**
> One recent example in which an African government explicitly pursued variation in policy design was the Partnership Schools for Liberia (PSL) programme. Although not as a response to automation threats, the initiative targeted a major constraint to inclusive growth in Liberia: low-quality basic education. Liberia has had abysmal education outcomes, both in terms of access and quality, so the government experimented with new ways of addressing the problem. It outsourced the management of 93 public schools to eight different operators (including NGOs and for-profit providers), and commissioned a rigorous study to understand the effects of each operator's approach compared to one another and other public schools not included in the programme. (Some of the providers' approaches were technology-based, in line with our policy area A4.)
>
> Although further trialling is required determine the best operators, we already know that the PSL programme exemplifies important elements of adaptive government. First, government, from the top down, set an objective to improve learning outcomes and defined the parameters for how this would be

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55 Many have pointed out the folly of over-emphasizing plans and control. The nineteenth-century German field marshal Helmuth Karl Bernhard Graf von Moltke advocated for the idea that 'no plan survives contact with the enemy', while former world heavyweight boxing champion Mike Tyson stated that 'everyone has a plan until they get punched in the mouth'.

56 Patrick Collison interview, The Knowledge Project podcast, May 2, 2018, https://fs.blog/2018/05/patrick-collison/.

gauged. Second, it created the space for a number of actors, from the bottom up, to simultaneously trial different ways of tackling the problem. This was particularly useful because the operational decisions in this domain are reversible: tools and techniques that fall short can always be discarded the following school year.

Figuring out which operators delivered the best results is the next challenge. This is not as simple as it seems, as there are many outcomes in addition to learning (cost, willingness to cooperate with government, openness to serving a diverse set of students) that government needs to weigh up. Achieving scale will be another challenge. Less than 5 per cent of all public primary schools in Liberia were included in the PSL programme, and those that were included had many favourable characteristics compared to those left out. Experimenting with a range of operational models at greater scale with a more representative sample of schools could be a fruitful next step in identifying how to improve learning outcomes across Liberia.

On the issue of selection, the task of formulating a significant, clear standard for success is more difficult than first appears. For one, success in a policy domain is multifaceted, and all measures of success may not go together. A public works programme, for example, may provide many jobs for poor people unable to access formal labour markets, but it may also fund the construction of local infrastructure with negligible economic impacts.

Not only does this situation exhibit mixed indicators of success, but different actors will view the success of the programme differently, depending on its benefit to them. Once governments state that they will use a particular standard or metric to gauge the performance of those implementing the policy, agents in the system will face strong incentives to find ways of leveraging the standard to their own benefit. This calls into question the quality and value of the standard in the first instance.[57]

The ability of governments to effectively grapple with these considerations hinges on whether they have critical elements in place to navigate this complexity. In the adaptation mechanism

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57 This is known as Goodhart's law.

shown in figure 12, the gears enable governments to set clear policy goals, try different approaches and adopt those that achieve the most progress against goals. These gears ground policymaking in a learning ecosystem:[58]

- **Systems to foster and absorb experimentation and learning:** Key to empowering different actors in the policymaking ecosystem to try to solve problems from the bottom up, and incorporate learnings from these efforts in order to scale promising policy measures and adjust policy goals over time.
- **A dense network for policy formulation, implementation, and problem-solving:** Government is not the only actor that has a stake in policymaking; a host of others are affected by and thus interested in shaping policy goals and measures. As different actors have different ideas on, information about, and incentives regarding the suite of inclusive growth policy domains, progress in these domains relies heavily on a form of networked policymaking. Interactions between government and other actors should be dense— frequent and information-rich—so that the economic vision and policy goals have buy-in from all stakeholders.

We acknowledge that it is easier to suggest building blocks than put them in place. This is partly due to the political difficulties governments face creating space for failed policy initiatives, and the high costs they incur by regularly engaging with a wide range of economic actors. This is where a third component of adaptive government comes in: diffusion.

Diffusion addresses how a particular policy solution can be scaled to address a challenge fully rather than one element of it. Problem Driven Iterative Adaptation (PDIA) advocates achieving scale by diffusing contextually relevant, best-fit ideas and practices through teams and networks (which may be within government or other sectors). This represents a bottom-up approach to spreading locally proven policy measures throughout a system.

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58 Here we adapt some of the principles of a 'learning organization', as pioneered by Peter Senge, but expand their scope to apply to the overall policymaking space. This space involves many different actors and organisations, which is why we use the term 'learning ecosystem'.

Ang describes a complementary, top-down approach to achieving scale (see Figure 13), in which government pursues incremental but wide reforms: many policy measures at a large scale simultaneously, but with each aiming to produce relatively small changes. One benefit of this approach is that it positions policy reform to start at scale, rather than having to shepherd narrow reforms through the arduous and uncertain process of achieving scale. Hence, it circumvents the risk of 'effervescent innovation': policy ideas that prove effective on a small scale in a particular context (often outside the government) but fail to reshape system-wide performance.[59]

Another benefit of this approach is that it provides an avenue through which complementary policy measures can be carried out alongside one another. Some policies can combine to be greater than the sum of their parts but would be far less potent if implemented alone. Export incentives and trade infrastructure are an example: without the necessary physical and digital infrastructure, export incentives have limited effect because firms are physically unable to get their goods or services across borders.

At the same time, without measures to encourage and support firms to export, trade infrastructure may generate fewer benefits than expected, as exporting is difficult to learn and costly for firms, especially in competitive sectors with thin margins. This is why pursuing multiple policy changes at once is often central to successful reform.

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59 Pritchett and de Weijer, 'Fragile States: Stuck in a Capability Trap?'

TYPE OF POLICY REFORM

Source: Authors
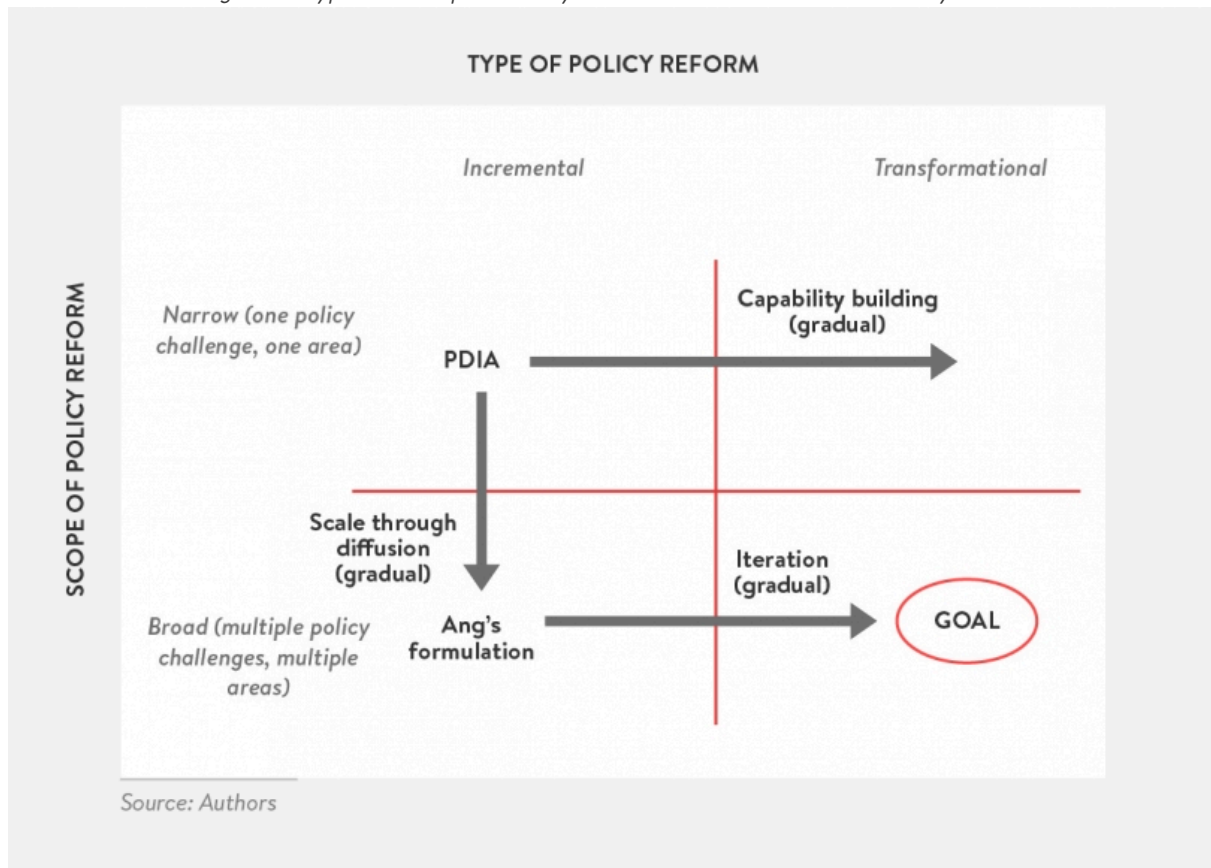
Of course, it is difficult for governments—any organisation, for that matter—to pursue reform in one complex policy domain, let alone multiple reforms in multiple complex policy domains at the same time. To keep reform feasible while attending to how policies complement each other, governments can take a staggered approach to reform, rather like the circus act of plate spinning. The goal is to get many plates (policies) spinning at once (implemented simultaneously). The performer starts with one plate, guides it into a stable spinning pattern, then moves to the next one, and so on. Likewise, governments need to establish 'tiered priorities', focusing first on the policy changes that are most critical and complementary to other critical measures, then proceeding from there.

A final benefit of Ang's formulation is that it can provide valuable political cover. Not all policy reforms end up successful, even if governments put intense focus on and resources towards a narrow, small-scale change. Failure in policymaking is inevitable, but difficult

to cope with politically. Incremental but broad reforms can ease government capability requirements because the policy changes are incremental and not transformational. They can also increase the chances that successes come along with the failures, because policy changes target many different challenges and thus may give rise to (intentionally or otherwise) effective solutions to at least some of these challenges.[60] Combining this idea with the one above, we can characterise the top-down mechanism for scaling selected variants of different policies as a 'staggered portfolio approach to reform'.

Portfolio Approach to Policy: Industrial Parks in Ethiopia

Ethiopia's industrialisation push contains elements of a portfolio approach to policy reform. Several years ago, the government sought to establish a series of industrial parks as the lynchpin of its vision to become a manufacturing hub in Africa. These parks would contain all the hard infrastructure (reliable power, water) and soft infrastructure (one-stop-shop services, fiscal incentives) necessary for foreign manufacturers to invest and operate effectively in the country. The government started the park development process at scale, with 11 parks tabled to be completed by 2020—just three years after the completion of the flagship Hawassa Industrial Park. These parks are located across a number of regions in the country.

Making all the parks a success will be no mean feat, but the government's approach allows for adaptation. By developing many parks in a short period of time and in different regions, the government has managed political opposition to them in two key ways. One, by ensuring that many different regionally based political interests can share in the potential benefits of the initiative; and two) avoiding the scenario of underperforming parks, which would instigate calls to cut short the initiative. The likelihood of at least one of the parks underperforming is high due to the

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60 This is akin to the aphorism 'don't put all your eggs in one basket'. Silicon Valley learned this lesson long ago, where we see investors building portfolios of investments in a range of companies across many different sectors. They are acutely aware that many of their investments will not pay back – a failure at the individual investment level. And whether an investment will succeed or fail is highly unpredictable (just as is the case for any given policy that government wants to implement). Hence, they pursue and evaluate their investments at the portfolio level, with the expectation that the investments that succeed will make up for those that do not (in financial terms). This is the same idea that underlies portfolio investing in the personal finance space.

difficulty of successfully developing them and attracting the right type and amount of investment. Hence, the initiative is a 'portfolio' of parks, with the expectation that some may not live up to their promise.

Furthermore, establishing a series of parks roughly at once means that many investors will pressure the government to increase support measures to enable investor success. Fewer parks would mean a smaller number of investors demanding government support, which may not be enough external pressure for forward-thinking policymakers to mobilise resources and navigate political roadblocks to investor problems. More parks equals more investors, and as more investors clamour for the same things (such as better logistics facilitation), they may provide the political cover necessary for progressive policymakers to commit the government to making these things happen, even in the face of staunch opposition by powerful interest groups.

Ethiopia's industrial park initiative is not without risk. The debt burden the parks pose has many development partners concerned, and the government's attention. If development had been more staggered, it would have reduced government borrowing. It would also have given the government more time to put in place a mechanism to learn about the strengths and weaknesses of policies informed by a wide range of actors, from civil society to investors, and guide subsequent park development.

Advice for African Governments

Policy experimentation will be key, because there are no obvious pathways for poor countries to develop. As Ang rightly pointed out, 'the lessons to be learned from China's capitalist revolution are not particular solutions, which were improvised at certain times or in certain parts of the country, but rather lessons on strategies of directing improvisation.'[61] The takeaway from China's meteoric development under Deng Xiaoping is not to doggedly pursue manufacturing or a dictatorial practice of industrial policy, but rather for government to play a directive role to foster an adaptive policy environment.

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61 Ang 2016, p.223

Contrary to many simplistic readings of China's growth, China under Deng started to create space for policy innovation to emerge from the bottom up—a lesson that is particularly relevant for governments today. Government must become nimble, with the ability to identify winners as they emerge across the economy, and the capacity to respond swiftly to their demands. Three critical steps can help governments become more adaptive and create an environment where policy innovation can flourish.

First, governments should set a clear overarching policy goal. Central government must be clear on its overarching policy goal, which must be built from a shared vision of inclusive growth from across the economy that all actors can support. One such policy goal could be literacy and numeracy skills equivalent to Grade 12 (US system) for all pupils leaving school.'

Second, governments should encourage variation and not be constrained by planning. Actors in the system— local government, individual bureaucrats, firms, entrepreneurs, civil society—must clearly understand the parameters of reform and be encouraged to experiment in pursuit of the overarching policy goal. As Deng so aptly said, 'It doesn't matter whether it is a black or white cat, as long as it catches mice.'[62] This means bottom-up innovation in pursuit of the goal as defined by central government, or what Ang calls 'directed improvisation'. To date, developing country governments have been criticised for not planning enough, but in this new world of unknown policy choices, experimentation is key. Most policy measures are reversible, so governments must be biased toward action, making many policy decisions and preparing for many to fail in pursuit of success.

Third, governments should establish a learning ecosystem. For variation and innovation to be effective, governments must be able to identify the experiments that have worked best. This is a complex task which requires a learning ecosystem. Instead of the investments governments currently make in detailed policy design and planning, they should redirect time, effort and financial investment into building a learning ecosystem, including systems that promote experimentation and networks that have strong links

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62 Ibid, p.79

across a wide range of actors, both within and outside of government.

THE RIGHT EXTERNAL ENGAGEMENT

Some policies will be more amenable to—and would benefit from—greater external engagement by development partners and wider external actors. Others are much harder for external actors to progress. Below is an evaluation of where external engagement can be most and least effective, based on the factors that we used to characterise policy complexity.

Informational Complexity

When the main factor of complexity for a policy area is informational, external investment and engagement can be highly effective. Investments in R&D and technology transfer, technical advice, and promoting private-sector investment can be extremely helpful. This is even more applicable for policies that directly try to harness the opportunities that 4IR technologies present, precisely because this is uncharted territory (such as technology for agricultural productivity).

Experimentation and piloting will be key, and governments would do well to create policy spaces and enabling environments in which external and local actors can experiment. External actors should also be prepared to take a higher-risk approach to engagement, akin to an investment portfolio approach, in the knowledge that many interventions will fail in the pursuit of breakthrough ones that can transform how a country responds to challenges (i.e. leapfrogging technology, as in the case of mobile telephony on the continent that leap-frogged investments in landlines and telephone cables).

Example policies include:

- **Development of AI-powered technology for agriculture:** External actors could invest in the development of agriculture apps which suit the African context and also address a specific need (such as overcoming human capacity constraints). One example could be a text-based app that helps smallholder

farmers manage procurement and distribution of inputs (fertilisers, pesticides, irrigation) based on predictive weather and pest patterns. The technology would need to be adapted to use satellite and publicly available data, with minimal to no sensor-related data generated from the farm or region, except for that collected by the smallholder's phone (such as GPS location). Part of the A1 Tech for agricultural productivity policy area.

- **UBI in a highly resource-constrained environment:** There is evidence that cash-based transfers are effective at improving economic and human development outcomes.[63] However, interventions are still nascent, and there are no examples of similar cash transfer systems. External actors could support pilots of UBI in resource-constrained environments and measure their efficacy against other forms of human capital investment. Moreover, they could also evaluate their mitigating impact on the challenges of a rapidly evolving labour environment, with potential lessons for both developed and developing worlds. Part of the B4 Safety net 2.0 policy area.

- **Regulatory strengthening to facilitate exports:** To export, manufacturers must meet destination market regulatory requirements and produce goods at a competitive price, but they often do not understand what these requirements are. External actors could consolidate and disseminate this information, and could link up regulatory experts from destination markets with firms/regulatory bodies in the exporting country. Part of the C1 Modern industrial policy for manufacturing policy area.

UBI and the Global Tech Community

Silicon Valley and the tech community are among the most vocal advocates for UBI, but its trials to date in advanced economies have been less than promising.[64] However, Africa and other

63 ODI, Bastagli et al (2016) 'Cash transfer: what does the evidence say? A rigorous review of programme impact and the role of design and implementation failures'; Haushofer and Shapiro (2016) 'The short-term impact of unconditional cash transfers to the poor: experimental evidence from Kenya'

64 Most notably, Finland (see Economist, April 2018, 'The lapsing of Finland's universal basic income trial') and private UBI experiments in the US

developing countries may offer fertile grounds for experimentation.

First, the majority of Africa's population live in absolute poverty, which makes UBI's universality advantageous.[65] Second, there are very few existing legacy welfare and redistribution systems to challenge the application of UBI as an alternative across Africa. And third, the simplicity of UBI's design make it well suited to the low-capacity bureaucracies common across Africa.

This type of external intervention could garner significant interest from actors already eager to pilot UBI, especially those with capital willing to invest in such a trial, including the leading advocates in Silicon Valley. Their partnership with credible international development evaluators would build up the evidence base for UBI and inform its application across the developing world and beyond. The potential for sizeable returns on human development, livelihoods and productivity across Africa could be seismic, and it would present an opportunity for the global winners of 4IR (such as the super-tech companies) to 'give back' and transform the lives of the most marginalised globally.

Transactional Complexity

Where the main factor of complexity is transactional, development partners should be committed to long-term partnerships with governments if they expect to see results. This could be better suited to philanthropic engagement or other donors that are not beholden to budgetary or electoral cycles. This is because changing the behaviours and capacity of many actors takes a very long time. If a policy area is significantly beholden to a large number of actors, external actors must acknowledge that they

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(see WIRED, August 2018, 'Y Combinator learns Basic Income is not so basic after all')

65 As defined by the World Bank: extreme poverty for those living in low-income countries (much of Africa) at <$1.90 p/day, and the poverty line in lower-middle income countries (including some economies of Africa) at <$3.20 p/day). See http://blogs.worldbank.org/developmenttalk/richer-array-international-poverty-lines

are unlikely to see results over the traditional annual budgetary and monitoring and evaluation (M&E) cycles.

Example policies include:

- **Disseminating AgTech to smallholder farmers.** If AgTech is still to be delivered through agriculture extension services (highly likely if connectivity remains patchy across swathes of rural Africa), investment in these extension services will be essential. This requires training a large number of actors, many of whom may be new to the technology and have longstanding institutional memories, including entrenched processes and traditions for engaging smallholder farmers, that can take time to change. External actors will need to engage for the long term (three-plus years) and be prepared to support the government in addressing the whole system of agriculture extension services if transformational change is to occur. Part of the A1 Tech for agricultural productivity policy area.
- **Delivery of social insurance programmes.** Advancing digital technologies and payment systems in Africa should reduce the transactional intensity of distributing social insurance programmes. However, the reality is that large parts of the population currently remain unconnected or have limited internet access, which curtails any meaningful data collection and subsequent distribution of social insurance. Delivery of a social insurance programme now would require many actors to collect information on recipients and distribute the benefits: processes liable to corruption given the scale and nature of the transactions. External actors seeking to support this engagement would need to be prepared to train large numbers of staff over a long timeframe, and work with a wider system of incentive structures to dissuade actors from deviating from the policy design. Part of the B4 Safety net 2.0 policy area.
- **Business development services to strengthen (management) capabilities.** Recent evidence suggests that improving management increases (manufacturing) productivity.[66] Improving management practices at a large enough scale to generate broad productivity gains involves regularly engaging with many firms over time, which would be transaction-intensive

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66 Van Reenen (2018), https://voxdev.org/topic/firms-trade/management-and-wealth-nations.

but potentially high-impact for external actors. The role of external actors could be to finance management training, or facilitate access to it. Part of the C1 Modern industrial policy for manufacturing policy area.

Political Complexity

When the main factor of complexity is political, it is very challenging for external actors to engage if timings are not right (if, for example, political elites will not support a policy's implementation). External actors should take an opportunistic approach and engage when a significant shift in the political settlement emerges that may change how economic rents are distributed—that is, when opportunities arise to break the status quo.

These moments will not come from a change of administration in the normal electoral cycle, but when a seismic political event occurs, such as the change of leadership in Ethiopia following the country's state of emergency in 2018. Apart from taking an opportunistic approach to engagement, external actors can provide cover for governments willing to make tough political choices, through international global agreements in areas such as education, health, social safety nets and climate change.

Example policies include:

- **Entrance of a new connectivity provider.** Even when applications are adapted to the African context (for example, text-based) transformational impact will only be realised when apps have good connectivity, allowing data collection for improved functionality, and maximum reach across the population. The introduction of new connectivity providers (such as Project Loon by Google X) has the potential to disrupt incumbents in the domestic telecoms market, challenging the elite status quo. External actors seeking to invest in such endeavours would only be effective where there is the political will and capacity to shift the distribution of rents to support such a transition. Applicable to all Embrace automation policy areas, A1 to A6 and B1 to B4.

- **Domestic investment in social insurance programmes.** Redistribution of wealth, particularly through the existing national tax system, is difficult to effect in both developing and developed worlds. Channelling national resources towards the most politically and economically disenfranchised is an extremely hard sell among political elites. External actors can do very little to influence this and can only effectively engage when there is the political will to do so, for example, in response to a seismic political event that threatens the elite or national security. Part of the B4 Safety net 2.0 policy area.
- **Location decision and acquisition of land for Special Economic Zone (SEZ) development.** Determining the location for an SEZ, and obtaining land in that location, is typically influenced by political considerations. External actors can carry out the appropriate analysis and advocate for the location that makes most economic sense, but should be prepared for their efforts to not carry much weight in the final decision. There may, however, be cases in which actors can leverage their financial support to governments and push them towards an economically sound location decision, thereby deflecting pressure from various interest groups away from governments. Part of the C1 Modern industrial policy for manufacturing policy area.

Advice for External Actors Working with African Governments

In this new world where experimentation and adaptive policymaking are key, a new roster of external support will be essential. Each external actor will bring its own expertise, risk appetite, DNA and methods, and will also be guided by its own internal systems and policies for engaging with African governments.

External actors must become cognisant of the types of policies where their engagement will be most impactful.

Tech firms, entrepreneurial corporates and commercial impact funds should engage in policies that require experimentation. Tech firms and more entrepreneurial parts of the private sector, as well as likeminded philanthropists and impact funds, are better at

engaging in policy areas with no known solutions, that is, policies which are 'informationally complex'. Policy areas that require experimentation and piloting—in particular, those that embrace automation and use technology as part of the solution—would benefit from partners with a fail-fast mindset that fosters innovation. This can also apply to more traditional donors whose systems are geared towards experimentation. For example, policies that apply 4IR technologies to literacy and numeracy challenges (EdTech), or irrigation optimisation (AgTech) in the African context, would benefit from engagement with natural innovators, as seen in the tech and entrepreneurial sectors.

Traditional donors should engage in policies requiring systemic change if they can commit for long periods of time. Those – such as multilateral organisations, some bilateral governments and well-established philanthropic organisations – both with experience in engaging with African governments and with internal reporting cycles of longer than four years, should engage in policy areas that require systemic change. These are policies that are 'transactionally complex', requiring a large number of actors to implement. For example, policies focused on developing high-end skills through improved pedagogies, which require the retraining of whole cohorts of secondary-school teachers, would need a donor capable of engaging with a national system over many years.

Traditional donors should also be astute and cautious when engaging in politically complex policy areas. Areas that are contentious and challenge the political-economy status quo should be avoided until an opportunity for change emerges domestically. These policies would benefit from political cover from external actors. Bilateral and multilateral donors and the international community are usually best placed to provide this (through United Nations or other multilateral agreements and equivalents). These donors should remain close to trusted local actors on the ground to understand the political-economy dynamics at play. They can then serve the wider community of interested external actors and investors when a political opening emerges in a policy area (such as industrial policy for services), bringing in far more effective external support and investment.

BEYOND NATIONAL ENGAGEMENT: THE GLOBAL DEBATE

Many of the challenges that automation presents for Africa cannot be solved at the national level. They require a global commitment. This is as much the case for advanced economies as it is for developing ones. Outlined below are leading issues that require a global response. They are entwined with the challenge of how to support developing countries in the age of digitalisation and automation, but require much more inquiry, research and piloting.

A GLOBAL APPROACH TO THE 'LAST MILE'

None of these policies can be implemented without super-fast, reliable and affordable connectivity. Financing this is a major challenge, but will be essential to avoid having new technologies exacerbate existing global inequalities, both in and between countries.

While prioritising investment in digital infrastructure will be essential for governments, this will not be enough for most low-income countries. Establishing tariffs that support broadband investment— as seen in efforts to invest in energy infrastructure—will exclude the world's poorest, who, at their current income levels, will never be able to shoulder the necessary investment.[67]

There are various initiatives underway to develop cheaper technologies to serve the most remote and marginalised communities, such as Google X's incubated Project Loon that uses high-altitude balloons to connect the world's most remote spaces, and its Free Space Optical Communications (FSOC) technology, which uses light to transmit high-speed data between two points—often more feasible than deploying fibre-optic cables in built-up areas.[68]

There is also experimentation with various business models to make digital access to the world's poorest more feasible, including

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67 See Pathways for Prosperity Commission's publication 'Digital lives: Meaningful Connections for the Next 3 Billion', 2018

68 See https://loon.co/ and https://x.company/projects/fsoc/

the more traditional blended public-private partnership investments, such as the C Squared partnership between the International Finance Corporation (IFC) and Google to finance network construction in Africa.[69] More innovative models have included cross-subsidy initiatives between customers, such as Facebook's Free Basics, Google's provision of free WiFi in India's train stations, and India's data-only network Jio, all offering free or low-cost data subsidised by tariffs in other parts of their business.[70]

But none of these initiatives are coordinated, nor is there yet a global acknowledgement that this is the fundamental barrier to prosperity for the bottom 3 billion in the future. A global commitment spearheaded by a multilateral or a global tech giant such as Google to seriously address this challenge in a pioneering and systemic way could go some distance in ensuring that everyone is equipped with the opportunity for prosperity in the 4IR era.

Advice for Global Investors and Big Tech

CALL TO ARMS #2: A global commitment to connect the next three billion.
Africa has huge untapped market potential. With the right investment, its ballooning population size could offer the next-biggest growing middle class in the world and turn around plateauing global demand. The first step to supporting Africa's growth and enabling it to find its footing in the digital era must be a major investment in connectivity right to the last mile. None of the policy choices outlined in this report that embrace what the 4IR has to offer are possible without super-fast, reliable and affordable connectivity. Whilst African governments must prioritise investment in their digital infrastructure, for most countries their efforts alone will not be enough.

Multilateral investors and big tech should have a substantive, solutions-focused global conversation about the last mile. This can and must include a range of innovation across financing arrangements (such as that seen by Facebook's Free Basics, and India's Jio network) as well as in the technology themselves (as piloted by Google X). This conversation must include both the

69 See https://ifcextapps.ifc.org/IFCExt/pressroom/IFCPressRoom.nsf/0/F6A93BAEE6BB7569852581230072D7A2
70 See Pathways for Prosperity Commission's 'Digital lives' 2018

global big tech firms and major infrastructure investors (e.g. the World Bank, the EIB and EBRD, the African Development Bank, etc). To drive such an initiative, a global commitment to ensure the bottom 3 billion have reliable access to the internet by 2025 (as very ambitious) or 2030 (as a must) is fundamental.

Whilst individual initiatives to connect the poorest have merit in and of themselves, this is not enough. It will take global leadership and courage to take this conversation forward. A global commitment to connect the bottom three billion could be spearheaded jointly by a multilateral such as the World Bank and a global tech giant such as Google, to generate the global weight and commitment akin to the UN Sustainable Development Goals, with backing from both the development and tech communities, which is fundamental to prosperity.

A REGIONAL APPROACH TO TECH INNOVATION

Accompanying the above global coordination for digital infrastructure, various regional and global initiatives supported by the tech superstars could be extremely impactful for Africa. This could take a number of paths.

A more unified digital market across Africa would boost competition and opportunities for new tech start-ups. This could draw on China's experience, where the government's protection of infant tech companies enabled emerging Chinese companies – such as Alibaba, Baidu and Tencent – to adopt tech insights from existing global companies (e.g. Google, Facebook, Amazon) and then develop these for their captive market. African countries do not have the individual market size to replicate the growth of China's tech giants, but a whole-of-continent approach could significantly stimulate the nascent tech economy, while ensuring that non-African tech companies have to play by African rules if they want to enter.

Crucially, it would offer a far more attractive pan-African market for FDI. Africa can and should draw on Europe's experience in establishing its digital single market, whose strategy is premised on three pillars:

1. Access: Better access for consumers and businesses to digital goods and services across Europe.[71]
3. Environment: Creating the right conditions and a level playing field for digital networks and innovative services to flourish.[72]
5. Economy and society: Maximising the growth potential of the digital economy.[73]

Speaking at the 2018 GovTech Summit held in Paris, Andrus Ansip, the EU Commissioner for the Digital Single Market, acknowledged that if the EU did not have a single set of rules for the free flow of data across borders, the message to entrepreneurs and tech start-ups was to either stay at home or go to the US, where there's a huge digital market. The EU General Data Protection Regulation (GDPR) could be drawn on as a global standard for Africa in providing common rules for the way data is used to enhance utility and efficacy across all sectors.

Some digital rights activists have indeed argued that Europe should export the GDPR in order to encourage rights-based legislation elsewhere – in particular to encourage the proliferation of alternatives to US deregulation and China's digital authoritarianism. Renata Avila, executive director of the Smart Citizenship Foundation, sees this as a response to 'Digital Colonialism,' coined to describe how big tech companies 'see the unconnected populations of the world as raw material to feed AI systems.'[74]

As Africa begins to seriously consider the connectivity investment it needs to make to leapfrog into the digital era, the time would be ripe to construct a digital single market alongside investment that works for Africa. This would create the opportunity for the continent to chart its own path and technological agency in

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71 https://ec.europa.eu/digital-single-market/en/better-access-consumers-and-business-online-goods
72 https://ec.europa.eu/digital-single-market/en/right-environment-digital-networks-and-services
73 See https://ec.europa.eu/digital-single-market/en/policies/shaping-digital-single-market
74 See https://twitter.com/iam_internet/status/1109068355942711299 and https://twitter.com/iam_internet/status/1109064957054853120

this highly unknown sphere - which Europe may well be keen to support.

The growth of EdTech is exemplary here. Its biggest markets are China, India and the US, all of which have large domestic markets with a widespread language of instruction, plus a large or growing middle class with high demand for education. Over $3 billion has been invested in EdTech unicorns[75] in these three dominant markets alone, and whilst the US still presents the biggest market, the fastest growing markets are Asian, with the online education market in India alone set to quadruple over the next 4 years to almost $2 billion.[76] A unified digital market in Africa could go some way in attracting investment into emerging technologies and digital markets that are sector specific and catalytic to Africa's growth and development (such as the A1 to A6 policy choices outlined in 3.1, from agricultural productivity through to urbanisation).[77]

A pan-African tech regulator could manage and monitor deal acquisitions and regulate when and how global tech companies acquire emerging, competitive African ones. This could go some way to ensuring that the benefits and profits generated by African tech firms are not siphoned back to the parent company outside the continent, with the public and productivity benefits disappearing with them.

A pledge of support from global tech superstars to promote a thriving entrepreneurial environment in Africa could spur the development of technologies tailored to the continent. The pledge - and the possible measures listed below - must be developed in partnership with national governments, or even better, regional bodies or the African Union. Consultation with non-government actors would be essential, including local entrepreneurs and firms as well as civil society and citizens, to ensure that Africa is driving their

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75 A startup company, privately held, which is valued at over $1 billion. See https://www.holoniq.com/edtech-unicorns

76 https://www.thetechedvocate.org/which-country-is-leading-the-edtech-movement/

77 Off the record conversations with investors and development finance institutions have indicated that the size of individual African markets are simply too small, and consequentially uncommercial, for private investors in frontier sectors such as EdTech, in stark contrast to India.

investment in a tech ecosystem that serves the continent and its citizens first.

The types of measures to respond to this pledge could include creating a platform for open source hardware and projects with incentives for entrepreneurs to 'play'[78]; investing in STEM, entrepreneur-focused higher education and tech schools of excellence in Africa, with incentives for graduates to remain in-country whilst working for the big tech firms; Challenge Funds or other venture capital vehicles to promote home-grown digital solutions.

The range of possible measures is vast, and would be complementary to an African digital single market. In the absence of strong institutions in Africa, particularly at the national level, the big tech firms' capacity to promote nascent digital start-ups could be an effective and more realistic intervention than focusing on existing institutions in African countries. However, this pledge to foster a dynamic tech ecosystem must be seen as complementary to, and even a stepping stone towards, developing a digital single market, and not be considered a substitute.

Advice for African Governments

An adaptive policy environment at the national level will not be enough. Sub-Saharan African markets alone are not big enough for significant investment and thus cannot be viewed as commercially viable, as compared to India (a comparable developing market), and certainly not compared to China.

African governments should unite to create a digital single market. This may require one government champion to spearhead such an initiative, or it could be tabled at the pan-African level through the African Union. At the very least, this should be prioritised at the regional trading bloc level (e.g. the East African Community), which currently focuses on the trade of goods but will need to address services trade. A longer-term commitment to unite with other regional digital single markets across the continent should be a priority.

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78 Ekkehard Ernst, Rossana Merola, Daniel Samaan, 2018, 'The economics of artificial intelligence: Implications for the future of work', ILO future of work: Research paper series

The African digital single market could be modelled on the European strategy, which focuses on better access for consumers and businesses to digital goods and services across the continent; creating the right conditions for digital networks and innovation; and maximising the growth potential of the digital economy. A digital single market would offer far more attractive market opportunities for domestic and international entrepreneurs and investors, which individual countries in Africa simply can't offer. It would have the hallmarks of far larger, more attractive, markets such as India or even China, and would foster innovation tailored to the African market, with the potential to transform its economy and overcome its social challenges.

MAKING MIGRATION WORK FOR ALL

The elephant in the room in addressing how developed countries can support developing ones is migration. The issue has substantial political resistance not only in developed countries but also among multilateral organisations focused on poverty alleviation. The paradox is that demand for migration opportunities will remain high, and international migration has proven benefits for migrants and their receiving and often sending countries as well. The difficulty is navigating the political realities to capture these benefits.

Two of the major concerns about migration in developed countries include: 1) the possibility that migrants fundamentally change the social fabric of the communities where they live, which many see as a threat to their local (or even national) identities; and 2) insufficient ability of countries to choose the migrants that they want or need, based on their skills.

On the first major concern regarding migration, some developed countries including Canada, New Zealand, and Spain, have found a means of separating the economic role migrants play from the social protection and integration challenges that migrant sceptics pose:[79] guest worker programs.[80] These programs grant permits to

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79 Thanks to Lant Pritchett for this useful framing.

80 This idea is described in depth in Clemens et al., 'Migration is What You Make It: Seven Policy Decisions That Turned Challenges Into Opportunities', 2018, https://www.cgdev.org/sites/default/files/migration-what-you-make-it-seven-policy-decisions-turned-challenges-opportunities.pdf and Michael

foreign, low-skilled workers to engage in seasonal work in the receiving country, often for specific employers, and sound design choices can make it easy for migrants to go home and return for future work to achieve low rates of overstay.[81] The time-bound nature of the migration and the programs' incentives for workers to return home diminish the fiscal and social obligations that host countries and communities must attend to regarding migrants.

On the second concern, developed countries want to select migrants that fit their skill needs whilst the sending countries want to mitigate against a mass brain drain that impedes their own development. One response could be a global skills partnership. This is a bilateral agreement wherein receiving country employers and governments offer vocational training in the sending country and job placement in the receiving country to migrants of their choice, but also train other workers who remain in the sending country.[82] This approach enables receiving countries to select and train the migrants their labour markets need, whilst addressing the concerns that sending countries would have of 'brain drain' through the training of natives that stay.

These proposals are complementary: the first facilitates the migration of low-skilled workers—those most at risk of being replaced by automation—and the second, the migration of high-skilled workers, which developed countries are more likely to accept

Clemens and Lant Pritchett, 'Temporary Work Visas: A Four-Way Win for the Middle Class, Low Skill Workers, Border Security, and Migrants', 2013, https://www.cgdev.org/sites/default/files/time-bound-labor-access.pdf.

81 Ibid.; in the first six years of its program, New Zealand had an overstay rate of less than one percent.

82 Clemens provides a concrete example: if we consider a nursing school in Banjul, The Gambia, the EU and European employers could provide support to the school's training of both nurse assistants to work in the EU and nurses to work in The Gambia. Migrants would thus obtain the precise set of skills they need to contribute effectively as nurse assistants in the EU. Importantly, the EU needs these nurse assistants, and would be able to get them more cheaply due to lower training costs in The Gambia. Meanwhile, The Gambia would end up with more nurses, which would motivate Gambian youth to maximize their education and skills because they may have concrete, quality job opportunities available when they enter the labour market. For more detail, see Clemens, 'Cultivating a New Bargain on Migration: Three Recommendations for the Global Compact', 2018, https://www.cgdev.org/blog/cultivating-new-bargain-migration-three-recommendations-global-compact.

on a permanent basis. Given the win-win nature of these ideas, other developed countries should take heed and craft their own versions.

In our report 'Balanced Migration: A Progressive Approach,' we offer a more extensive and holistic framework for migration based around the objectives of meaningful control, maximum economic benefits and solidarity, in line with our two proposals above.[83] A global champion could catalyse this new approach to migration to tackle the very real fears citizens have across the developed world.

TACKLING GLOBAL TAX INEQUALITIES AND ILLICIT FINANCIAL FLOWS

Many of the recommendations we make in Section 3 require significant investment from African governments. But developing countries are impaired by the permissive environment for illicit financial flows and the imbalanced global taxation system that hampers their capacity to raise revenues. Plagued by poor institutions and weak policy implementation, African resources are funnelled out of their countries by individuals and corporations both legally and illegally, at the expense of much needed public investment. If African governments are to meaningfully invest in their digital infrastructure and harness policies to support the growth of their future economies, a serious review of the global parameters for domestic resource mobilisation in the world's poorest and most disadvantaged countries is essential.

Legal tax avoidance, or 'base erosion and profit shifting' (BEPS) are legal activities that are not conducted in 'the spirit of the law.'[84] This includes transfer pricing, involving the trade of goods and services between companies within multinational corporations (MNCs) and under-pricing for the purpose of tax, as well as global tax havens.

Illicit financial flows (IFFs) by contrast, is the criminal activity involving 'dirty money' that crosses international borders, including tax fraud, tax evasion and trade misinvoicing; corruption and theft

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83 Harvey Redgrave, 2018, 'Balanced Migration: A Progressive Approach'

84 https://www.cgdev.org/blog/idea-counting-dollars-illicit-financial-flows-undermining-action-where-it-counts

of state assets; laundering of crime proceeds; and other market and regulatory abuses under cover of anonymity.[85] Some estimates indicate that IFFs out of Africa could be as much as $50 billion per annum.[86]

There is a host of initiatives that could be championed and initiated by visionary national governments to take on these two challenges. London is a leading money laundering centre and the UK Government could take a global stand to drive the IFF agenda. Starting with the City of London, it could build on the opportunities that its new Unexplained Wealth Orders (UWOs) affords by helping developing countries build up their own financial disclosure systems through which to identify politically-exposed persons. This would not only support the repatriation of corruption gains but could prove a deterrent for future administrations.[87]

But there are some international tax challenges that require a global, multilateral approach. Transfer pricing, for example, because of its technically legal position, requires the address by multilateral institutions at the regional and global level – such as through the OECD/G20 BEPS Project, or through the UN and the SDGs – if it is to be meaningfully addressed.[88] There is often an imbalance of power between multinational-corporations (MNCs) and low-income governments that rely heavily on corporate tax as a proportion of their domestic revenue. Developed countries must appreciate how their existing tax rules, treaties, and permissive environments that reinforce the conduct of their MNCs will undermine tax collection in developing countries.

85 https://www.cgdev.org/blog/proposed-sdg-indicator-illicit-financial-flows-risks-conflating-ordinary-business-dirty-money

86 High Level Panel on Illicit Financial Flows, UN Economic Commission for Africa https://www.uneca.org/iff

87 For an overview of recommendations from leading IFF experts, see https://www.cgdev.org/blog/what-advice-would-you-give-penny-mordaunt-combating-illicit-financial-flows. See also UK Gov on Unexplained Wealth Orders, https://www.gov.uk/government/publications/circular-0032018-criminal-finances-act-unexplained-wealth-orders/circular-0032018-unexplained-wealth-orders

88 For further review of this, see https://www.cgdev.org/blog/idea-counting-dollars-illicit-financial-flows-undermining-action-where-it-counts and https://www.cgdev.org/blog/proposed-sdg-indicator-illicit-financial-flows-risks-conflating-ordinary-business-dirty-money

To ensure that no one is left behind, a more comprehensive international tax overhaul will be essential. Our Institute's November 2018 report 'A New Deal for Big Tech: Next-Generation Regulation Fit for the Internet Age' recommended a transatlantic regulatory approach to encourage tech companies to take their responsibilities seriously, to ensure consumers understand the technology in their lives, and to rewrite obsolete rules for the Internet age.[89] In the absence of comprehensive international tax reform, our report recommended an alternative corporate-tax regime for large tech giants[90] to allocate profits geographically in proportion to active users. A step further could be to direct a significant portion of those tax revenues into the developing world to assist those most economically marginalised and technologically left behind. Without significant support now to help these countries adopt 4IR technologies for developmental good, the opportunity for economic catch-up for the world's poorest will be missed.

89 https://institute.global/insight/renewing-centre/new-deal-big-tech

90 Our report suggests defining these tech superstars as 'firms with more than 50 million monthly active users, annual revenues of more than $1 billion or a market capitalisation of more than $25 billion', such as Google, Amazon and Facebook. See A New Deal for Big Tech: Next-Generation Regulation Fit for the Internet Age

CONCLUSION

Development has always been hard, but now it will be much, much harder. There are no obvious avenues for wide-scale, inclusive growth to transform the economies of the world's poorest countries. In the age of automation, all governments must become nimbler and more adaptive to respond to the challenges and opportunities that the 4IR presents to both labour and citizens.

Governments must be prepared to create the policy space and ecosystem for innovation to flourish; to try out a bunch of different policies towards a common goal and be prepared to double down on the successes and kill those experiments that bear no fruit – and cultivate the political space to do so! This is hard for governments of the most advanced, established economies, let alone for those of underdeveloped ones. Government innovation and adaptability will be all the more key in severely resource- and capacity-constrained environments.

External actors can and should be prepared to support poor countries as they prepare for the 4IR. And by external actors, we mean beyond traditional donor actors that have historically been the mainstay of international development. Much of the policy choices that governments will have to navigate will require experimentation and innovation, with no obvious intervention or technological solution available. These 'informationally complex' policy choices are prime for external engagement, and particularly from those actors that have an innovative mindset and a fail-fast approach, and moderate-to-high risk appetite.

International tech companies, some multinational corporations and the global private sector, as well as impact investors, innovation funds and other types of non-traditional actors whose current business models and DNA are built on experimentation and innovation would be best positioned to shore in that support. Perhaps more appealing for these kinds of actors, engagements of this type can start to demonstrate results in relatively shorter timeframes than other policy areas.

The traditional donor community - including bilateral, multilateral and philanthropic organisations - are best positioned, assuming their own political economy allows, to engage in policy areas where the

challenges are more systemic, where a policy's implementation requires engagement across a large number of actors. Such engagements often take a long time to show sustainable results, but it is here that such actors can and will make the most difference. It is time to be bold and challenge the imperatives for short-term, results-based frameworks if meaningful, sustainable and systemic change is to occur.

Unless new seeds are sown now to construct alternative pathways for inclusive growth – which will take a myriad of directions and configurations into unknown sectors and unforeseeable labour and work characteristics – the international community will face a far more unequal, unstable and insecure world in the near future. Africa's population in 2017 was 1.26 billion; by 2050 it will be 2.5 billion and by 2100 4.5 billion. That means its population will balloon from 17 per cent of the world's population to 26 per cent by 2050, and 40 per cent by 2100. And with no seismic shift in development, that's a booming population of underemployed youth.

These population statistics do not need to be alarmist. If the right investments are made now in Africa's digital infrastructure, with the right external engagement to foster innovation and support for their government's adaptability in responding to emerging sectors, Africa could leapfrog into the 4IR the way that China leapfrogged into the twenty-first century. Africa presents the last untapped and growing market. The continent can and should be viewed as an opportunity to be seized and cultivated by the international and global corporate community.

ACKNOWLEDGEMENTS

The Fourth Industrial Revolution (4IR) is upending the nature of work as we know it. Policymakers are struggling to grapple with this future in the West, but for African countries—and developing countries generally—the outlook appears even more bleak.

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