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IMPACT SERIES

AI revolution: productivity boom and beyond

Barclays Research partners with the IBM Institute for Business Value to explore how recent breakthroughs in Artificial Intelligence could provide a boost to productivity, similar to past periods of revolutionary technology change.

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Foreword

Welcome to the twelfth Impact Series report from our Research team, authored in partnership with the IBM Institute for Business Value, which explores the impact of Artificial Intelligence on productivity across industry sectors and the wider economy.

11 January 2024

As new tools such as ChatGPT have emerged, much has been written about the explosive growth of generative AI and how it could transform our world.

Yet less analysis has been done to assess how AI may unlock meaningful gains in labour productivity. We've published this report to help companies, investors and society better understand how AI's twin advantages – ease of access and versatility – could lead to tangible improvements in output-per-hour worked across a range of industries.

We use real case studies, drawn from the experiences of a car insurer in Gurgaon, India, and a food-flavourings giant in Baltimore, to show how the integration of AI has already led to significant gains in productivity. We also look forward, showing how broad adoption of AI could help to tackle some of the longer-term challenges facing the global economy, offsetting the effects of ageing workforces in developed markets, while supporting real-income growth in developing economies.

Importantly, we discuss some of the guardrails that need to be in place, to manage the cost to society from the rapid growth of AI. Capitalising on this ground-breaking technology in an intelligent, sensitive way is likely to require a very human response: a collaborative effort from industries and regulators.

We hope you find our analysis thought-provoking.

C.S. Venkatakrishnan
Group Chief Executive Officer
Barclays

The steam engine; the invention of electricity; the personal computer. In each case, a breakthrough in technology led to an era of rapid economic expansion. Boundaries were pushed and great riches accrued not just to the pioneers, but to generations that followed. Could the growth of Artificial Intelligence do something similar?

For much of 2023, it seemed like it could. Excitement mounted over so-called "generative" AI – which uses powerful computer models to produce high-quality content, based on the data they are trained on. Stocks linked to AI were among the year's best performers. "Word of the year" lists were dominated by terms such as "authentic" and "hallucinate."

Some of that buzz may well fade this year. But there are good reasons to believe recent advances in AI are likely to bring a boost in productivity that the world has not seen for a while.

For one thing, the technology is accessible to a very wide audience, on infrastructure that is already in place. Any user can issue basic instructions to a tool such as ChatGPT, the bot developed by OpenAI and launched in November 2022, without having to learn any special programming language. Software providers, for their part, can roll out AI capabilities by bundling them into pre-existing search engines, office suites or even incorporate launchpads into user hardware.

Moreover, these tools are not confined to any particular task, function, problem or sector. This makes them usable across different disciplines. Once a Large Language Model (LLM) is trained on a body of text, for example, it can summarise a legal document as well as it can a medical document or an insurance document. Such tools are not limited to words, either: GenAI systems can combine text and images with video and audio and even robotic functions.

For the US economy, where information and knowledge work dominates, recent research[1] finds that around 80% of the workforce could have their tasks affected by LLMs in some way. As Jerry Kaplan, a Stanford academic, put it several years ago: "automation is blind to the colour of your collar."

Those two core attributes – accessibility and versatility – suggest that a broad rollout of GenAI could encounter fewer obstacles than previous advances in technology, and thus provide a genuine boost to the production of goods and services. However, ensuring that we unlock the full potential of AI technology and limit its negative effects will require the right policy mix, both from a regulatory standpoint and at the enterprise level.

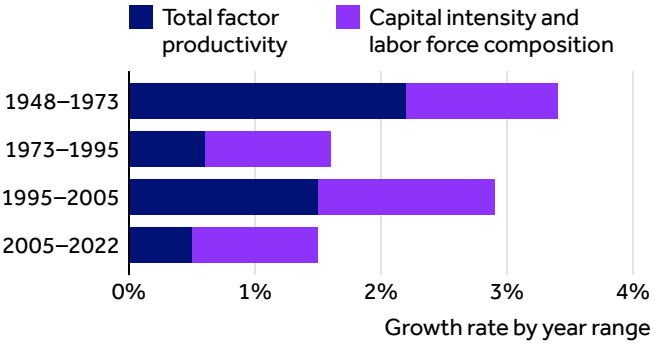
Two of the big, longer-term challenges for the global economy are, on the one hand, ageing workforces in developed countries and, on the other, low per-capita output in developing countries. AI could help in both respects.

Plenty of companies are already using AI and reporting positive experiences. Barclays' partner in this report, the IBM Institute for Business Value, has been involved in a series of innovative projects. We highlight two of them here and add insights from a broad survey of top executives' attitudes to AI.

For developed economies, the implications of an AI-led boom would be significant. Put simply, economic growth can be driven by how much labour you put in and/or how productive it is. If economies can get more out of their pools of labour, raising output-per-hour-worked, they can offset a loss of capacity due to ageing.

FIGURE 1

Labour productivity and working age population growth



Source: Martin Neil Baily, Erik Brynjolfsson, and Anton Korinek, "Machines of mind: The case for an AI-powered productivity boom" Brookings, May 2023

To illustrate the potential benefits, we select two reference points: the period between 2015 and 2019, and the 1990s. 2015-2019 is a benchmark for what was considered the pre-pandemic "new normal": the immediate shocks of the Global Financial Crisis and the Euro-area sovereign debt crisis had receded, but their aftermath of prolonged private and public balance sheet repair was weighing heavily on economic growth. The 1990s, meanwhile, were a period of generally high growth in labour productivity and in working-age populations. Both factors combined to produce strong growth in GDP.

1 Cornell University

The productivity puzzle

Why didn't smartphones make us smarter? It's a question that has bothered economists the world over, as they survey sluggish growth in labour productivity since the early 2000s (in the wake of a revival in the 1990s).

Productivity represents our ability to produce more goods and services through a better combination of inputs, using new ideas, technological innovation and superior business models. This makes growth in productivity – or output-per-hour-worked – the main source of durable growth in per-capita income.

"Productivity isn't everything, but in the long run it is almost everything," wrote Paul Krugman in his 1990 book, *The Age of Diminished Expectations*.

So why the sluggish performance in a period in which the digitisation of the world economy progressed rapidly and consumers gained access to vast, handheld computing power?

One explanation could be the typically long lag between the invention of new technologies and the point when they materialise in macroeconomic gains. In the case of the steam engine, for example, it took as much as a whole century between James Watt's patent in the 1760s and the peak of the subsequent growth in productivity.

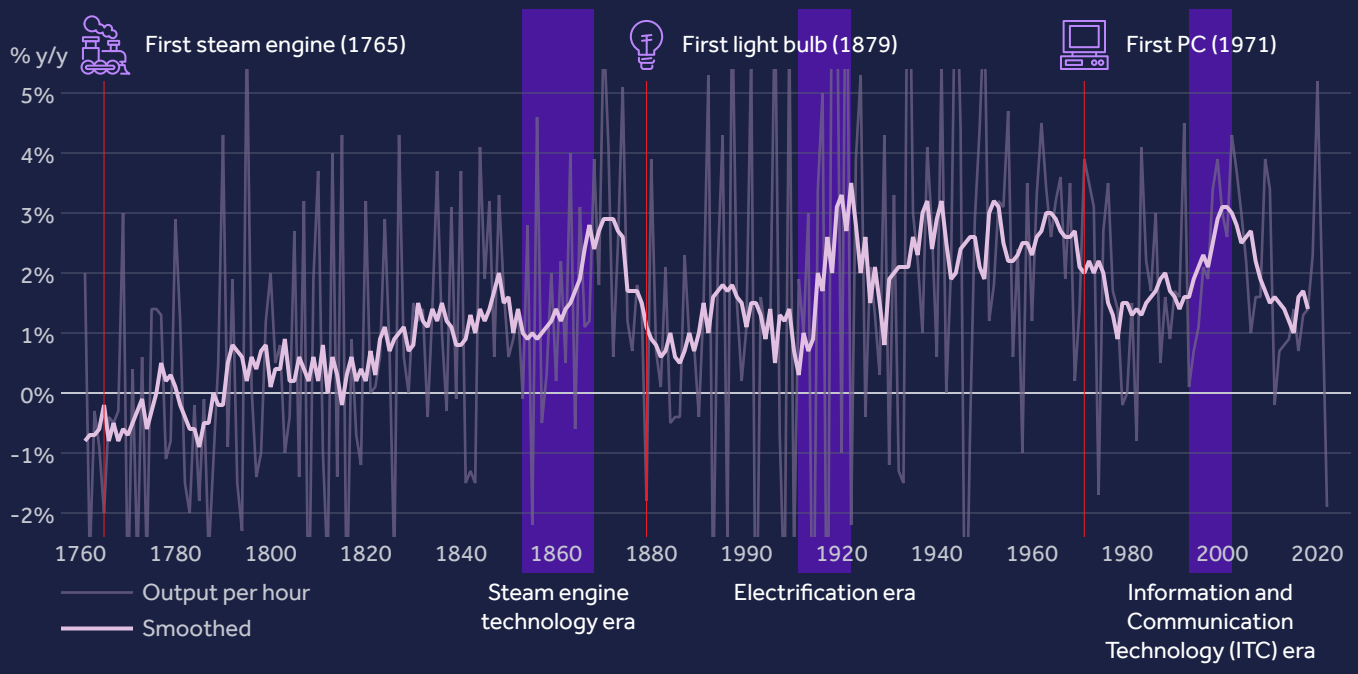
Another – more pessimistic – interpretation is that digitisation and portable devices do not measure up to the big productivity revolutions of the past. Unrestrained access to social media and other entertainment apps may have made large impressions on the consumer, but simply do not generate the kind of productivity improvement associated with, say, the automobile, intercontinental flight or air conditioning.

It is also possible that what we are seeing are measurement errors: that the output produced in a digital world is not adequately captured by traditional GDP statistics. Many digital products have zero marginal costs and are often provided free of charge. They therefore do not show up as an increase in output – even though they provide some value to the consumer.

The truth may lie in a combination of all three. But for us, the more pressing question is whether AI has the power to supply that much-anticipated surge in productivity. We are optimistic that it does.

FIGURE 2

The effect of technological advances on labour productivity

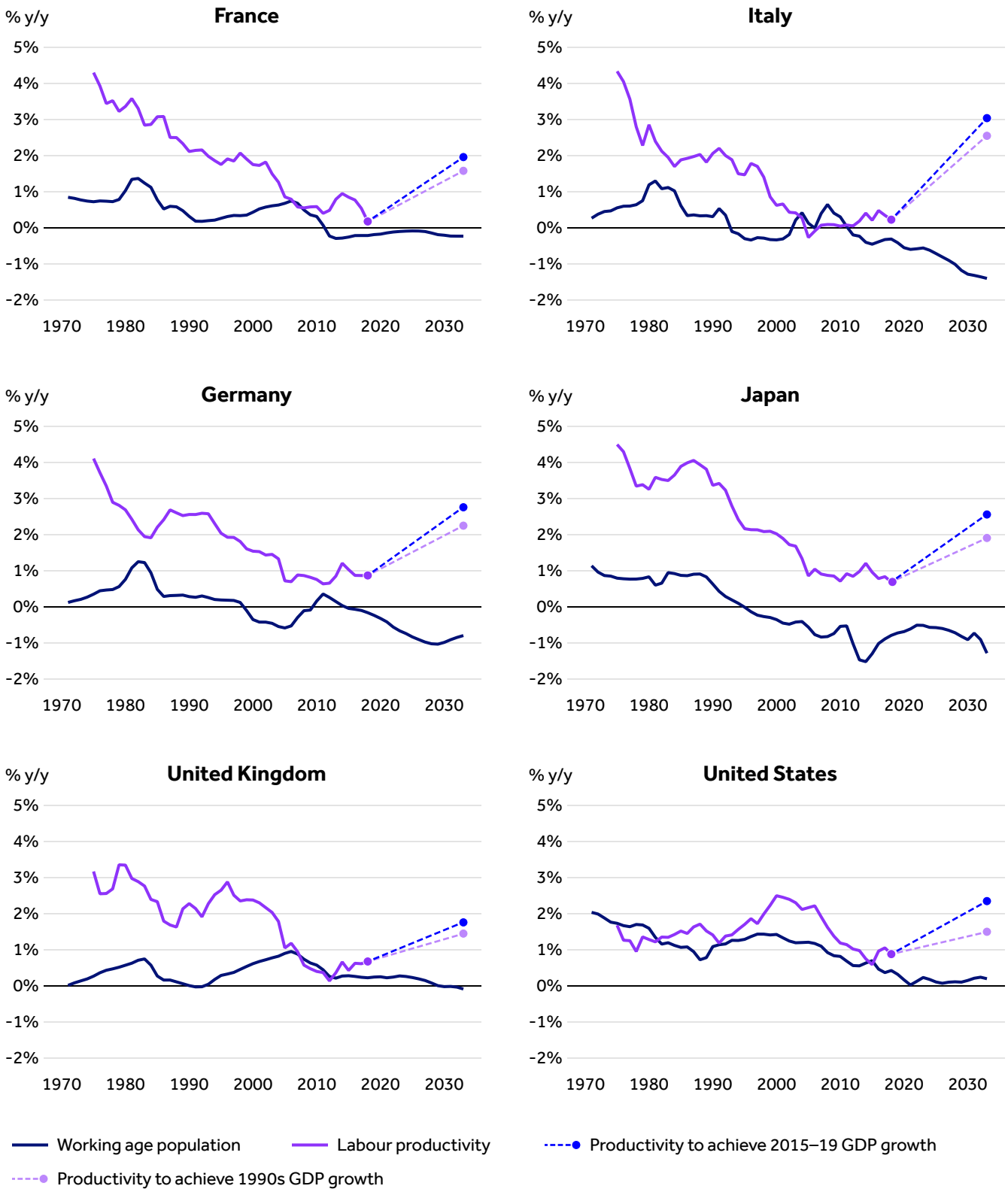


Source: Kendrick (1961), Syverson (2013), BLS, BoE, Barclays Research

Note: Smoothed series is a 9-year centered moving average

FIGURE 3

Labour productivity and working age population growth



Source: OECD, Barclays Research

In Figure 3, we show the level of productivity growth that would be required in 2033, for growth in that year to equal the average from 2015-2019 or that from the 1990s. Our assumptions rely on projections for working-age populations from the United Nations.

For the most rapidly ageing countries, the boost to the annual rate of labour productivity growth that is required just to maintain the pre-COVID level of growth is substantial: just below a 1-1.25 percentage point increase in Germany and Japan, and an almost 2.5pp increase in Italy. (Such an increase in Italy would lift the country's productivity to a level significantly higher than in any five-year period since 1990.) Even more slowly ageing countries, such as the UK, the US and France, would require significant boosts to productivity to maintain the rate of growth achieved between 2015 and 2019.

Yet big leaps forward are not without precedent. As our charts show, to reclaim the average pre-COVID rates of growth by 2033, most countries would have to achieve similar levels of growth in labour productivity that they achieved in the early 1990s. It is conceivable, therefore, that AI could help advanced economies overcome drags from demographics. Doing so would, however, require AI to deliver substantial gains in productivity in relatively short order.

When it comes to emerging economies, the picture is different: working-age populations are still expanding, on the whole, and in some cases very rapidly. But skills and education levels tend to be limited, on average, compared to advanced economies, which manifests in low GDP-per-hour-worked.

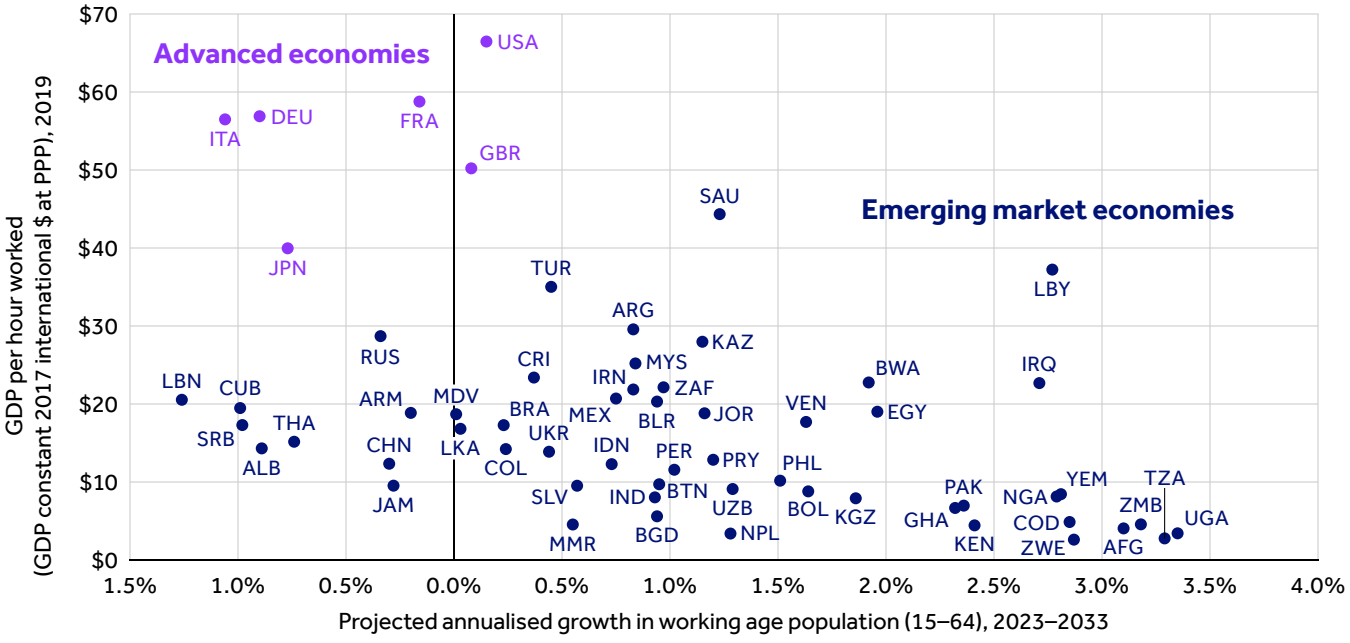
What's more, economists are observing what some have described as a "premature de-industrialisation", in which developing nations no longer experience the industrialisation that typically resulted in large productivity – and real income – gains, as workers moved from agriculture into manufacturing. With AI, however, such a productivity-boosting effect may now be possible, if such workers shift into AI-aided services industries. "Service-isation" could take on the role that industrialisation played in the past.

However, it is also worth considering whether the widespread adoption of AI could disadvantage developing economies, to the extent that it introduces the ability to automate simple services – such as call centres – that are often provided from cheaper locations. Initially, at least, the effects might be detrimental.

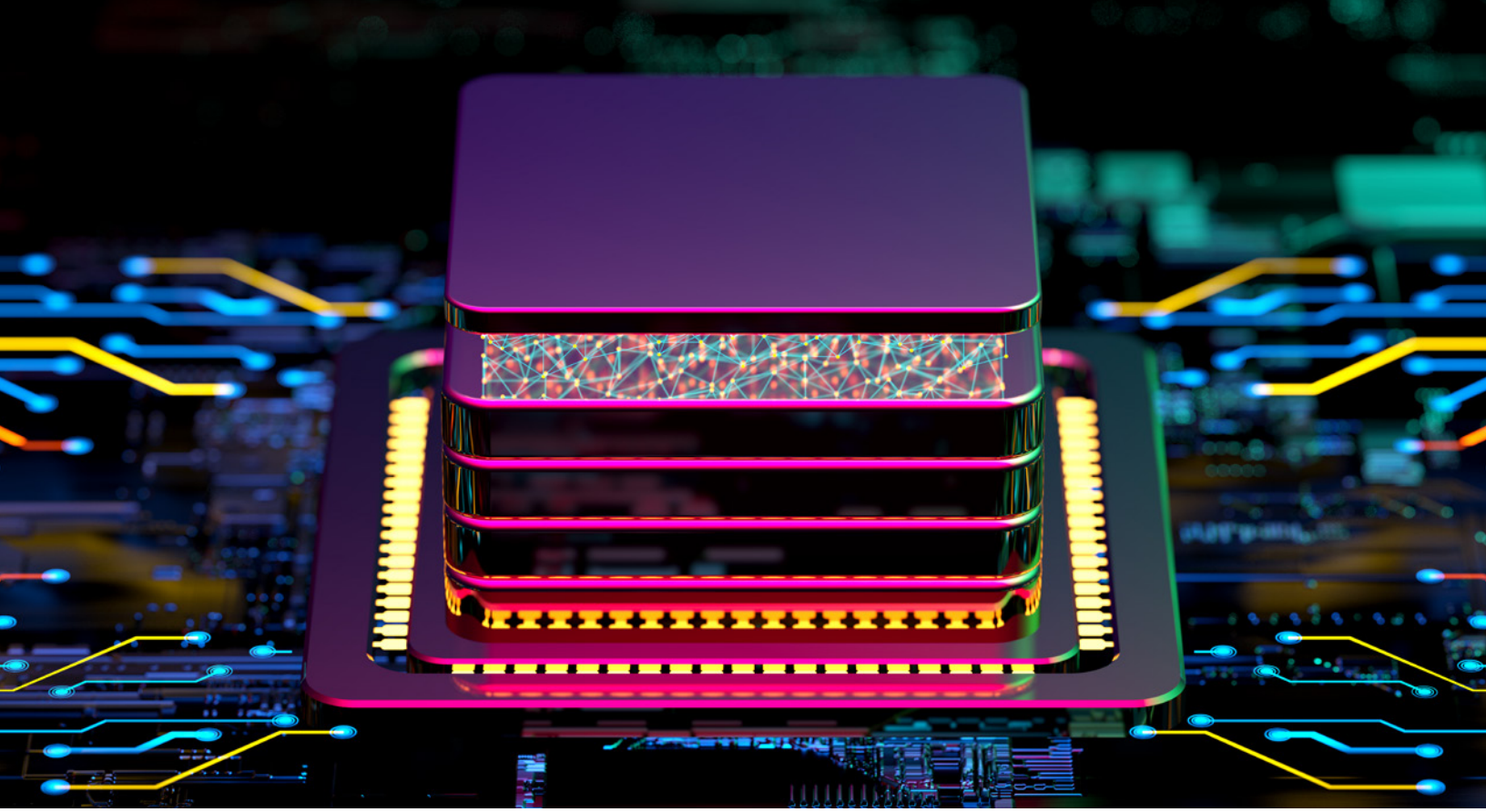
Even with these caveats, however, AI could have a significant role to play in giving developing economies a leg-up. There is evidence that AI has the greatest positive impact on people with foundational skills that the technology can take a lot further. If greater adoption of AI does indeed lead to job augmentation, it could create more productive and thus better paid jobs.

FIGURE 4

Labour productivity vs. working age population



Source: OurWorldData, UN, Barclays research



There are a lot of variables at play, of course.

The policies adopted by companies, industries and regulators will have a large bearing on the delivery of the promised benefits of AI, and how those benefits will be shared.

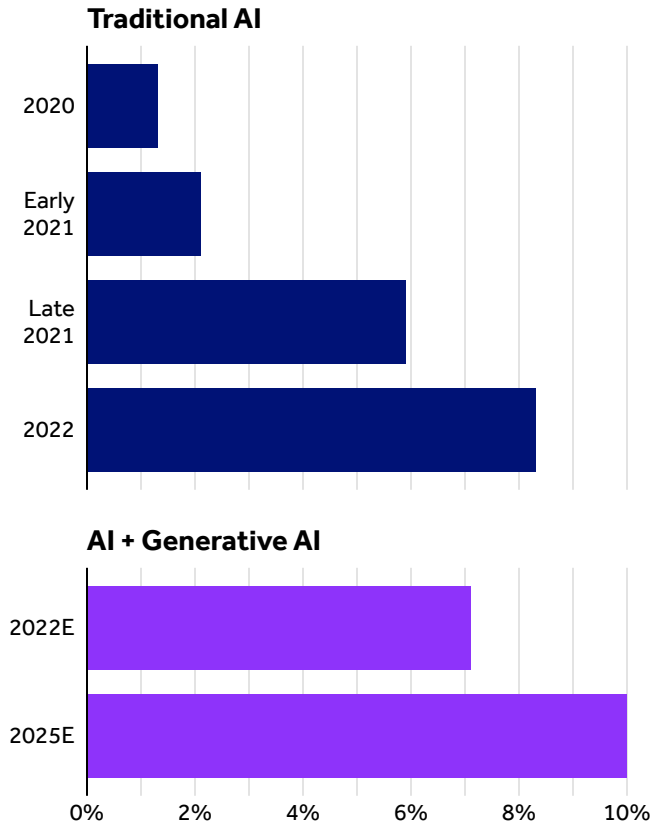
Within companies, for example, the distribution of knowledge and talent does not always line up neatly with the ability of organisations to absorb insights and skills. Institutional barriers can get in the way, as can rigid management that resists the discomfort that change can bring.

Cost will be a critical factor too, as the acquisition of data and computing capacity (and the energy it requires) is not cheap. Tools developed by tech-industry consortia, and made widely available, could be important to capture opportunities that are uneconomical at the individual enterprise level.

Evidence suggests that the returns on AI investments are low, at least in the early years, as teams work out the kinks. So far, few companies have been able to generate returns in the double digits: average ROI climbed from about 1% in early 2020 to about 6% by the end of 2021, according to estimates gathered by the IBM Institute for Business Value. A successful adoption of AI is likely to follow the "J-curve" pattern typical for transformative technologies, with a slow start but an exponential rise beyond a certain threshold.

FIGURE 5

Returns on investment from AI



Source: IBM Institute for Business Value, Barclays Research

Two guiding principles seem especially crucial to us in the development of AI. The first is that the technology be used as a complement to labour, rather than as a substitute for it.

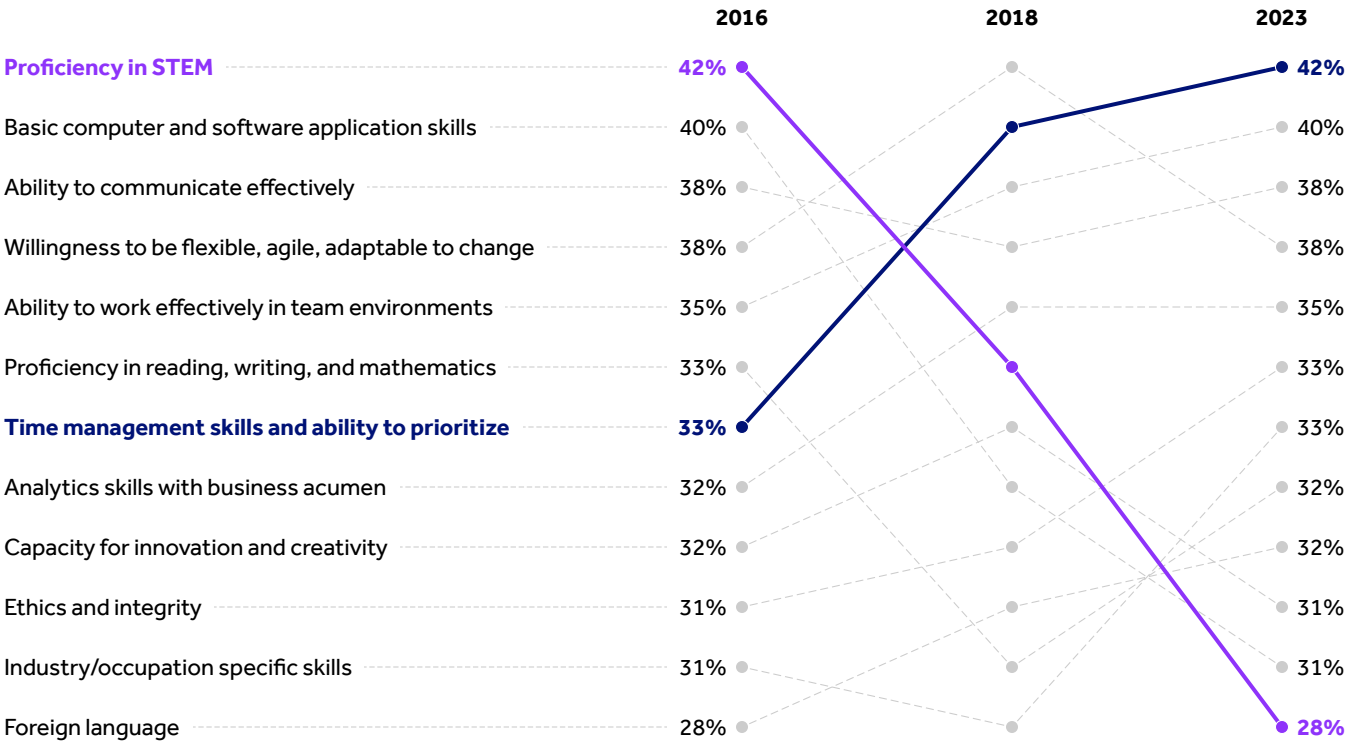
To some extent we are seeing this already, with executives focusing primarily on augmentation rather than total automation. As a recent survey from the IBM Institute for Business Value indicates (see page 11, "Me, myself and AI: How the world of work could be changing"), companies' overriding aim is to allow a sharpened focus on uniquely human talents such as creativity, social and interpersonal skills, and empathy. In that context, critical skills required of a workforce include time management, the ability to prioritise and an affinity for working in teams.

That is not to say that traditional Science, Technology, Engineering and Mathematics (STEM) skills will be any less important. But increasing use of AI is likely to change the ways in which those "hard" skills are used within companies and may attach a premium to employees who are able to offer a combination of hard and "soft" skills. AI, after all, can complement a person's particular blend of attributes but can hardly replace them.

Second, it is vital that policies should encourage the spread of AI across the economy. Regulation around accessing data to train models or to deploy specialist technology is likely to play a critical role.

FIGURE 6

Most critical skills required of the workforce



Source: IBM Institute for Business Value, Barclays research

Recent surveys of firms suggest that some of the key barriers to the effective use of generative AI are in issues related to security, privacy and ethics. Accordingly, policies need to focus on creating a sustainable governance framework.

The precise areas where policies need to focus remain unclear – and necessarily so in those instances where AI's true reach and its implications are simply not yet understood. But in that context, we are encouraged by initiatives such as the AI Alliance, a global network of technology firms, universities, non-profits and government groups that has come together to, in its words, "responsibly maximise benefits to people and society everywhere."

The recent advancements in Artificial Intelligence significantly expanded the breadth of capabilities of the technology. While the precise impact on productivity is yet to be realised, early signs indicate the potential for this to be a game changer. Yet fully exploiting the benefits is likely to require a very human response: a collaborative effort from industries and regulators, and a wholesale reimagining of business models and workflows.

Me, myself and AI: How the world of work could be changing

Will robots take your job? Probably not – but they might just make it more rewarding.

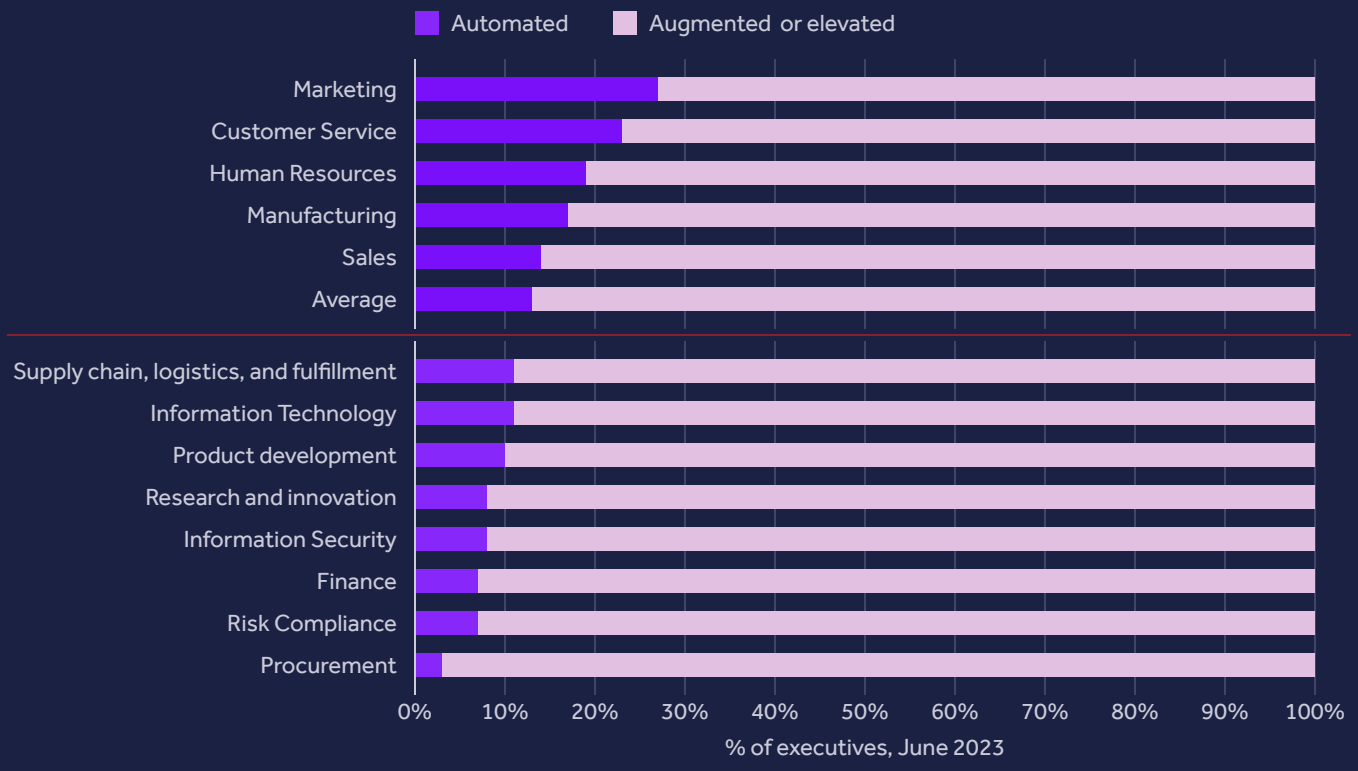
The IBM Institute for Business Value has found widespread enthusiasm among business leaders to use AI as a complement to human labour, rather than as a substitute for it. In an August 2023 survey of 3,000 C-suite executives across 20 industries and 28 countries, 87% of respondents said they believed employees were more likely to be augmented than replaced by generative AI.

That proportion varied across functions – 97% of executives thought staff in procurement were more likely to be augmented than replaced, compared to 95% for employees in risk and compliance, 93% in finance, 77% in customer service and 73% for marketing.

"AI has the potential to transform the employee experience," says Jill Goldstein, managing partner in IBM's Talent Transformation Consulting group. "It can automate repetitive tasks, letting people focus on what they are passionate about, freeing up their time for skills development or work-life balance, and potentially create exciting new job roles and career paths."

FIGURE 7

The effect of technological advances on labour productivity



Source: IBM Institute for Business Value, Barclays research

The AI alliance

Adding to a rich set of industry-academic partnerships in AI, 'The AI Alliance' was founded in 2023 by a number of international technology firms, universities, non-profits, and research and government organisations10 focused on open source foundation models and practices.

Together, these institutions formulated the following objectives:

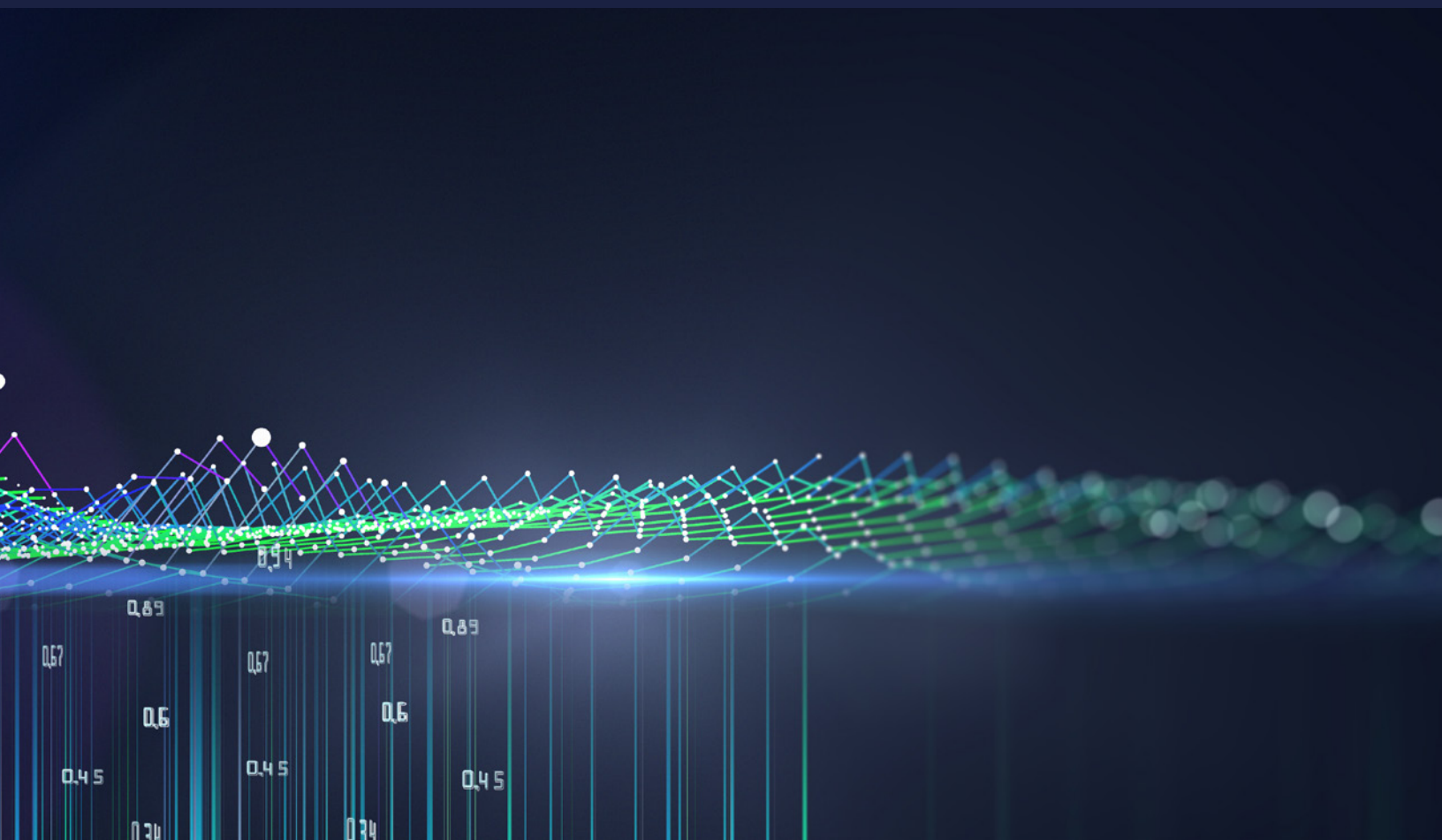
- Develop and deploy benchmarks and evaluation standards, tools, and other resources that enable the responsible development and use of AI systems at global scale, including the creation of a catalog of vetted safety, security and trust tools. Support the advocacy and enablement of these tools with the developer community for model and application development.
- Responsibly advance the ecosystem of open foundation models with diverse modalities, including highly capable multilingual, multi-modal, and science models that can help address society-wide challenges in climate, education, and beyond.
- Foster a vibrant AI hardware accelerator ecosystem by boosting contributions and adoption of essential enabling software technology.
- Support global AI skills building and exploratory research. Engage the academic community to support researchers and students to learn and contribute to essential AI model and tool research projects.
- Develop educational content and resources to inform the public discourse and policymakers on benefits, risks, solutions and precision regulation for AI.
- Launch initiatives that encourage open development of AI in safe and beneficial ways, and host events to explore AI use cases and showcase how Alliance members are using open technology in AI responsibly and for good.

AI alliance founders include: Meta, AMD, CERN, Cleveland Clinic, Cornell University, Dartmouth, Dell Technologies, EPFL, ETH, Hugging Face, IBM, Imperial College London, Intel, Linux Foundation, MOC Alliance operated by Boston University and Harvard University, NASA, NSF, Oracle, Partnership on AI, Red Hat, ServiceNow, Sony Group, University of California Berkeley, University of Illinois, University of Notre Dame, The University of Tokyo, Yale University and others

Augmenting human intelligence

IBM's Institute for Business Value observes the following best practices for achieving the principle of augmenting human intelligence into practice:

1. Use AI to augment human intelligence, rather than operating independently of, or replacing it.
2. In a human-AI interaction, notify individuals that they are interacting with an AI system, and not a human being.
3. Design human-AI interactions to include and balance human oversight across the AI lifecycle. Address biases and promote human accountability and agency over outcomes of an AI systems.
4. Develop policies and practices to foster inclusive and equitable access to AI technology, enabling a broad range of individuals to participate in the AI-driven economy.
5. Provide comprehensive employee training and reskilling programs to foster a diverse workforce that can adapt to the use of AI and share in the advantages of AI-driven innovations. Collaborate with HR to augment each employee's scope of work.



Case Study

McCormick: Sauce Code

In 1889, Willoughby M. McCormick started mixing fruit syrups and root beer in his basement in Baltimore. Today, the firm he founded – McCormick & Company – is among the world's biggest manufacturers of spices and condiments, home to brands including Schwartz seasonings, French's mustard and Frank's RedHot sauce.

A few years ago, the company partnered with IBM to build SAGE – an AI system trained on hundreds of millions of data points on flavour palettes, sensory science and consumer preferences. It works by accepting a seed formula (such as a flavour profile for Korean BBQ) and a set of constraints ("must have mango," for example). SAGE then generates formulas with varying amounts of deviation from those inputs, depending on the desired degree of novelty.

The result? A significant reduction in the number of trials required to produce flavours that could be submitted to a client. Food scientists with just a few years of experience were able to achieve performance similar to much more senior colleagues.

"The system allows us to layer on an additional level of creativity to our job and allows us to explore different flavour territories," said AuBrei Weigand, a product developer at McCormick, speaking to a video team. The combination of McCormick's taste data and IBM's technology produced suggestions for "new formulas that maybe we wouldn't come up with on our own."

Case Study

IFFCO-Tokio: Body of proof

It does not take long for a visitor to India to appreciate that the country has a road culture unlike almost anywhere else. Collisions are frequent and so are claims for damages. That presents a challenge to insurers such as IFFCO-Tokio, a joint venture established in 2000 between Indian Farmers Fertiliser Co-operative Limited and Japan's Tokio Marine Group.

To improve its claims-handling process, the company developed an app to allow policyholders to upload images of scratches and dents and, in return, receive quotes for repairs. But turnaround was slow, with much time lost to poor-quality snapshots. So the company teamed up with IBM to develop a system that made much quicker assessments of the cost of repair or replacement by adjusting for glare, reflections or dim lighting. Before long, customers could submit photos of damaged vehicles, find out which parts were repairable or replaceable and get an estimate – all within about half an hour.

IFFCO-Tokio also saw settlement prices fall by about 40%, and its acceptance ratio more than double, to 65%. Most significant was that the company could link the new system to increased customer satisfaction, retention and even acquisition. AI was a driver not just of increased efficiency, but also top-line growth.

Success factors for AI business integration

Adoption of AI alone is unlikely to yield significant benefits. To generate significant measurable value, adoption of AI needs to be combined with new ways of working, reskilling of staff and embracing cultures of innovation and experimentation. For example, recent analysis from the IBM Institute for Business Value suggests that AI adopters that also outperform on reskilling staff see a 36% revenue growth rate premium over other AI adopters.

We learned that best-in-class AI performers build capabilities across six key areas, in a holistic, integrated way—with trust at the core: i) vision and strategy; ii) AI operating model; iii) AI engineering and operations; iv) Data and technology; v) Talent and skills; and vi) Culture and adoption. Best-in-class companies that have developed all six mature capabilities reported average ROI of 13% on AI projects.

Even beyond the microcosm of AI capabilities, other technologies and factors play a role in value realisation. For instance, AI needs to be integrated into intelligent workflows that harness data and other technologies in secure environments. Moreover, AI needs to be ethically managed and governed. And we find that taken together, these different complementary levers amplify the value impact of AI by up to 17 times compared to AI in itself.

About the authors

Barclays Research

Christian Keller is Head of Economics Research at Barclays, leading a global team covering both developed and emerging markets. He is based in London and joined Barclays in 2007 from the International Monetary Fund (IMF), where he had worked on programs with emerging market economies in Europe, Latin America and Asia. He graduated with a PhD in Economics from University of Köln, Germany, and holds a joined-MA in Economics and Finance from University of Köln and HEC, Paris.

Mark Cus Babic is an economist at Barclays, based in London. He focuses on global and euro area economics, including inflation and thematic macroeconomic research. He joined the bank in 2020. Mark holds an MA Hons in Economics from the University of Edinburgh.

Akash Utsav is an analyst in the Global Economics Research team at Barclays. He joined the bank in 2017 and contributes to global macroeconomic thematic notes, as well as to quarterly publications. He holds an MSc Economics degree from University College London (UCL), London, UK, and completed his undergraduate from Loyola College, Chennai, India.

IBM

Ana Paula de Jesus Assis is the Chair and General Manager for IBM Europe, Middle East and Africa (EMEA), responsible for IBM's overall business and relationship with the European Union and other public institutions. Previously, she was GM of the Client Transition Office, IBM GM in Latin America and held multiple positions in the USA and China.

Brian Goehring is an Associate Partner in the IBM Institute for Business Value, where he leads the AI business research agenda, collaborating with academics, clients, and other experts to develop data-driven thought leadership. He brings over 20 years of experience in strategy consulting with senior-level clients across most industries and business functions. He received an AB in Philosophy from Princeton University with certificates in Cognitive Studies and German.

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