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The economic potential of generative AI

The next productivity frontier

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Authors

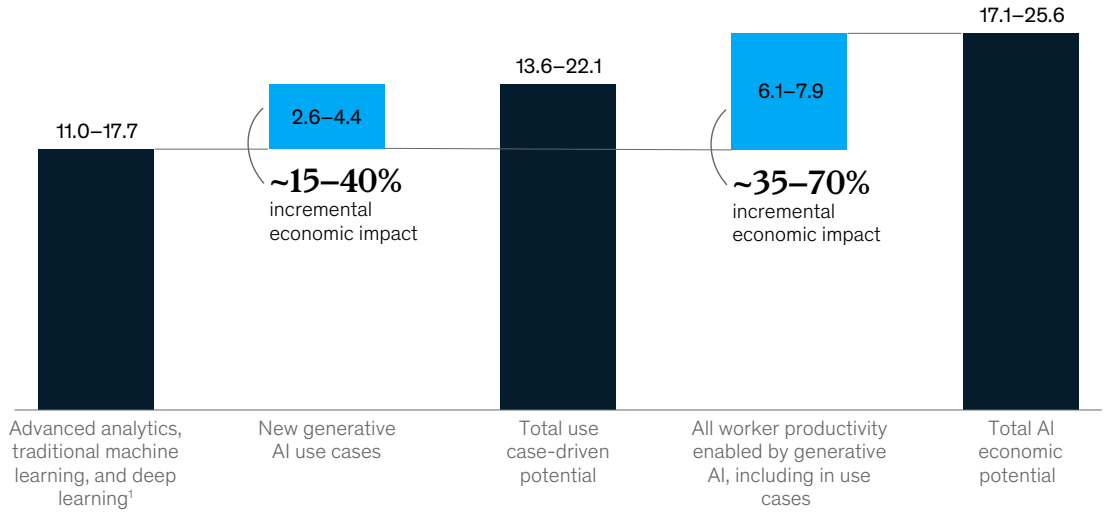
Michael Chui
Eric Hazan
Roger Roberts
Alex Singla
Kate Smaje
Alex Sukharevsky
Lareina Yee
Rodney Zemmel

Some of this impact will overlap with cost reductions in the use case analysis described above, which we assume are the result of improved labor productivity. Netting out this overlap, the total economic benefits of generative AI—including the major use cases we explored and the myriad increases in productivity that are likely to materialize when the technology is applied across knowledge workers' activities—amounts to $6.1 trillion to $7.9 trillion annually (Exhibit 2).

Exhibit 2

Generative AI could create additional value potential above what could be unlocked by other AI and analytics.

AI's potential impact on the global economy, $ trillion



[1]Updated use case estimates from "Notes from the AI frontier: Applications and value of deep learning," McKinsey Global Institute, April 17, 2018.

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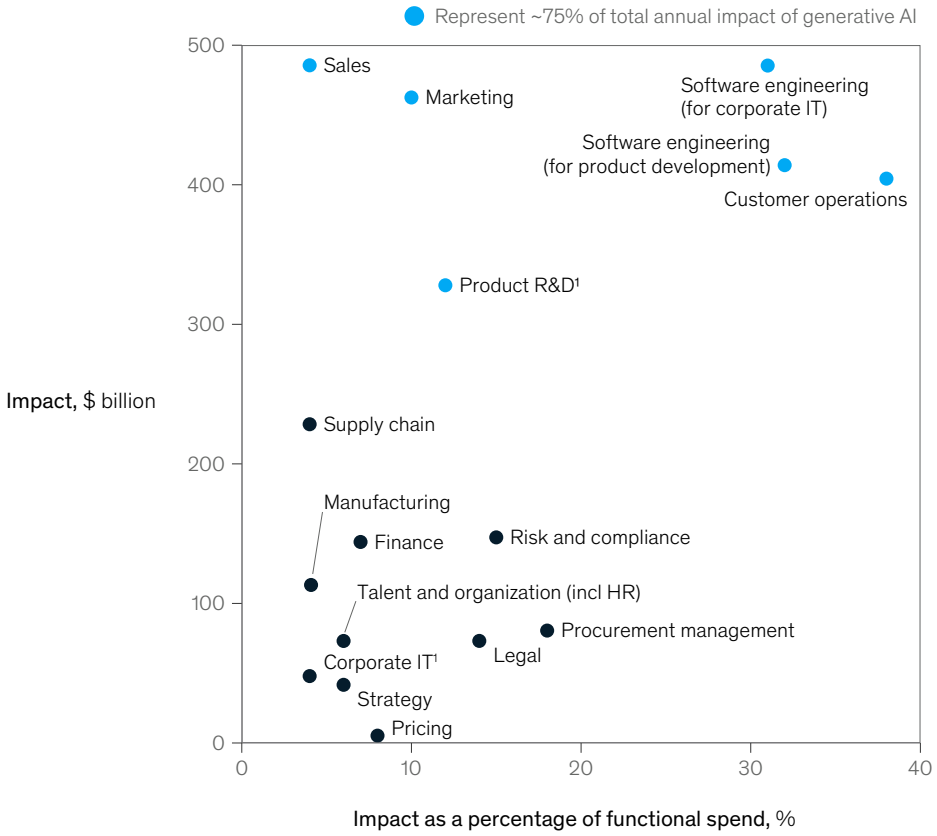
Value potential by function

While generative AI could have an impact on most business functions, a few stand out when measured by the technology's impact as a share of functional cost (Exhibit 3). Our analysis of 16 business functions identified just four—customer operations, marketing and sales, software engineering, and research and development—that could account for approximately 75 percent of the total annual value from generative AI use cases.

Exhibit 3

Using generative AI in just a few functions could drive most of the technology's impact across potential corporate use cases.



Note: Impact is averaged.
[1]Excluding software engineering.
Source: Comparative Industry Service (CIS), IHS Markit; Oxford Economics; McKinsey Corporate and Business Functions database; McKinsey Manufacturing and Supply Chain 360; McKinsey Sales Navigator; Ignite, a McKinsey database; McKinsey analysis

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Notably, the potential value of using generative AI for several functions that were prominent in our previous sizing of AI use cases, including manufacturing and supply chain functions, is now much lower.[7] This is largely explained by the nature of generative AI use cases, which exclude most of the numerical and optimization applications that were the main value drivers for previous applications of AI.

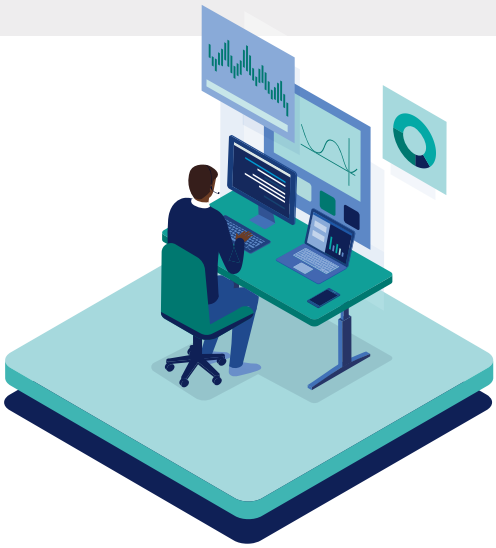
How customer operations could be transformed

Customer self-service interactions

Customer interacts with a humanlike chatbot that delivers immediate, personalized responses to complex inquiries, ensuring a consistent brand voice regardless of customer language or location.

Customer–agent interactions

Human agent uses AI-developed call scripts and receives real-time assistance and suggestions for responses during phone conversations, instantly accessing relevant customer data for tailored and real-time information delivery.



Agent self-improvement

Agent receives a summarization of the conversation in a few succinct points to create a record of customer complaints and actions taken.

Agent uses automated, personalized insights generated by AI, including tailored follow-up messages or personalized coaching suggestions.

How marketing and sales could be transformed

Strategization

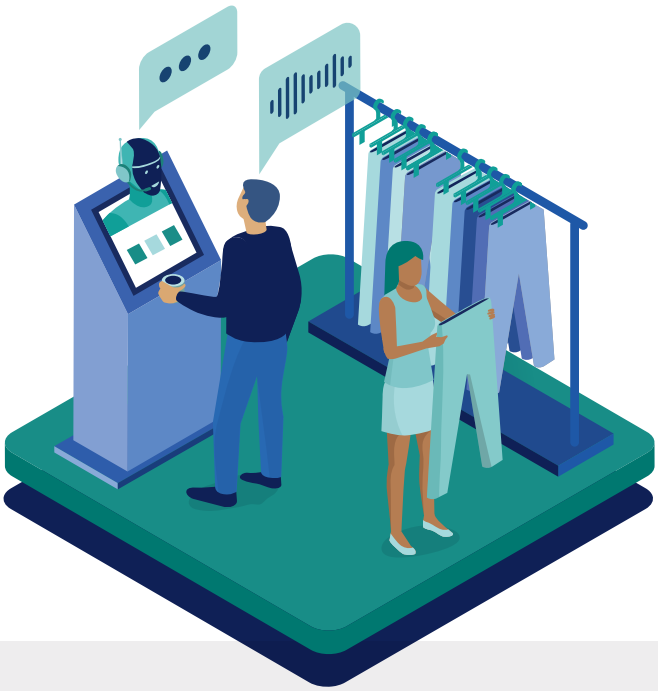
Sales and marketing professionals efficiently gather market trends and customer information from unstructured data sources (for example, social media, news, research, product information, and customer feedback) and draft effective marketing and sales communications.

Awareness

Customers see campaigns tailored to their segment, language, and demographic.

Consideration

Customers can access comprehensive information, comparisons, and dynamic recommendations, such as personal “try ons.”



Conversion

Virtual sales representatives enabled by generative AI emulate humanlike qualities—such as empathy, personalized communication, and natural language processing—to build trust and rapport with customers.

Retention

Customers are more likely to be retained with customized messages and rewards, and they can interact with AI-powered customer-support chatbots that manage the relationship proactively, with fewer escalations to human agents.

Marketing and sales

Generative AI has taken hold rapidly in marketing and sales functions, in which text-based communications and personalization at scale are driving forces. The technology can create personalized messages tailored to individual customer interests, preferences, and behaviors, as well as do tasks such as producing first drafts of brand advertising, headlines, slogans, social media posts, and product descriptions.

However, introducing generative AI to marketing functions requires careful consideration. For one thing, mathematical models trained on publicly available data without sufficient safeguards against plagiarism, copyright violations, and branding recognition risks infringing on intellectual property rights. A virtual try-on application may produce biased representations of certain demographics because of limited or biased training data. Thus, significant human oversight is required for conceptual and strategic thinking specific to each company's needs.

How software engineering could be transformed

Inception and planning

Software engineers and product managers use generative AI to assist in analyzing, cleaning, and labeling large volumes of data, such as user feedback, market trends, and existing system logs.

System design

Engineers use generative AI to create multiple IT architecture designs and iterate on the potential configurations, accelerating system design, and allowing faster time to market.

Coding

Engineers are assisted by AI tools that can code, reducing development time by assisting with drafts, rapidly finding prompts, and serving as an easily navigable knowledge base.

Testing

Engineers employ algorithms that can enhance functional and performance testing to ensure quality and can generate test cases and test data automatically.

Maintenance

Engineers use AI insights on system logs, user feedback, and performance data to help diagnose issues, suggest fixes, and predict other high-priority areas of improvement.

Software engineering

Treating computer languages as just another language opens new possibilities for software engineering. Software engineers can use generative AI in pair programming and to do augmented coding and train LLMs to develop applications that generate code when given a natural-language prompt describing what that code should do.

Software engineering is a significant function in most companies, and it continues to grow as all large companies, not just tech titans, embed software in a wide array of products and services. For example, much of the value of new vehicles comes from digital features such as adaptive cruise control, parking assistance, and IoT connectivity.

According to our analysis, the direct impact of AI on the productivity of software engineering could range from 20 to 45 percent of current annual spending on the function. This value would arise primarily from reducing time spent on certain activities, such as generating initial code drafts, code correction and refactoring, root-cause analysis, and generating new system designs. By accelerating the coding process, generative AI could push the skill sets and capabilities needed in software engineering toward code and architecture design. One study found that software developers using Microsoft's GitHub Copilot completed tasks 56 percent faster than those not using the tool.[9] An internal McKinsey empirical study of software engineering teams found those who were trained to use generative AI tools rapidly reduced the time needed to generate and refactor code—and engineers also reported a better work experience, citing improvements in happiness, flow, and fulfillment.

Our analysis did not account for the increase in application quality and the resulting boost in productivity that generative AI could bring by improving code or enhancing IT architecture—which can improve productivity across the IT value chain. However, the quality of IT architecture still largely depends on software architects, rather than on initial drafts that generative AI's current capabilities allow it to produce.

Large technology companies are already selling generative AI for software engineering, including GitHub Copilot, which is now integrated with OpenAI's GPT-4, and Replit, used by more than 20 million coders.[10]

How product R&D could be transformed

Early research analysis

Researchers use generative AI to enhance market reporting, ideation, and product or solution drafting.

Virtual design

Researchers use generative AI to generate prompt-based drafts and designs, allowing them to iterate quickly with more design options.

Virtual simulations

Researchers accelerate and optimize the virtual simulation phase if combined with new deep learning generative design techniques.

Physical test planning

Researchers optimize test cases for more efficient testing, reducing the time required for physical build and testing.

Product R&D

Generative AI's potential in R&D is perhaps less well recognized than its potential in other business functions. Still, our research indicates the technology could deliver productivity with a value ranging from 10 to 15 percent of overall R&D costs.

For example, the life sciences and chemical industries have begun using generative AI foundation models in their R&D for what is known as generative design. Foundation models can generate candidate molecules, accelerating the process of developing new drugs and materials. Entos, a biotech pharmaceutical company, has paired generative AI with automated synthetic development tools to design small-molecule therapeutics. But the same principles can be applied to the design of many other products, including larger-scale physical products and electrical circuits, among others.

Exhibit 4

Generative AI use cases will have different impacts on business functions across industries.

Note: Figures may not sum to 100%, because of rounding.
[1]Excludes implementation costs (eg, training, licenses).
[2]Excluding software engineering.
[3]Includes aerospace, defense, and auto manufacturing.
[4]Including auto retail.
Source: Comparative Industry Service (CIS), IHS Markit; Oxford Economics; McKinsey Corporate and Business Functions database; McKinsey Manufacturing and Supply Chain 360; McKinsey Sales Navigator; Ignite, a McKinsey database; McKinsey analysis

For example, our analysis estimates generative AI could contribute roughly $310 billion in additional value for the retail industry (including auto dealerships) by boosting performance in functions such as marketing and customer interactions. By comparison, the bulk of potential value in high tech comes from generative AI's ability to increase the speed and efficiency of software development (Exhibit 5).

Exhibit 5

Generative AI could deliver significant value when deployed in some use cases across a selection of top industries.

Selected examples of key use cases for main functional value drivers (nonexhaustive)

Value potential of function for the industry – High – Low

	Total value potential per industry, $ billion (% of industry revenue)	Value potential, as % of operating profits[1]	Product R&D, software engineering	Customer operations	Marketing and sales	Other functions
Banking	200–340 (3–5%)	9–15	**Legacy code conversion** Optimize migration of legacy frameworks with natural-language translation capabilities	**Customer emergency interactive voice response (IVR)** Partially automate, accelerate, and enhance resolution rate of customer emergencies through generative AI–enhanced IVR interactions (eg, for credit card losses)	**Custom retail banking offers** Push personalized marketing and sales content tailored for each client of the bank based on profile and history (eg, personalized nudges), and generate alternatives for A/B testing	**Risk model documentation** Create model documentation, and scan for missing documentation and relevant regulatory updates
Retail and consumer packaged goods[2]	400–660 (1–2%)	27–44	**Consumer research** Accelerate consumer research by testing scenarios, and enhance customer targeting by creating "synthetic customers" to practice with	**Augmented reality–assisted customer support** Rapidly inform the workforce in real time about the status of products and consumer preferences	**Assist copy writing for marketing content creation** Accelerate writing of copy for marketing content and advertising scripts	**Procurement suppliers process enhancement** Draft playbooks for negotiating with suppliers
Pharma and medical products	60–110 (3–5%)	15–25	**Research and drug discovery** Accelerate the selection of proteins and molecules best suited as candidates for new drug formulation	**Customer documentation generation** Draft medication instructions and risk notices for drug resale	**Generate content for commercial representatives** Prepare scripts for interactions with physicians	**Contract generation** Draft legal documents incorporating specific regulatory requirements

[1]Operating profit based on average profitability of selected industries in the 2020–22 period.
[2]Includes auto retail.

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In the banking industry, generative AI has the potential to improve on efficiencies already delivered by artificial intelligence by taking on lower-value tasks in risk management, such as required reporting, monitoring regulatory developments, and collecting data. In the life sciences industry, generative AI is poised to make significant contributions to drug discovery and development.

We share our detailed analysis of these industries in the following industry spotlights.

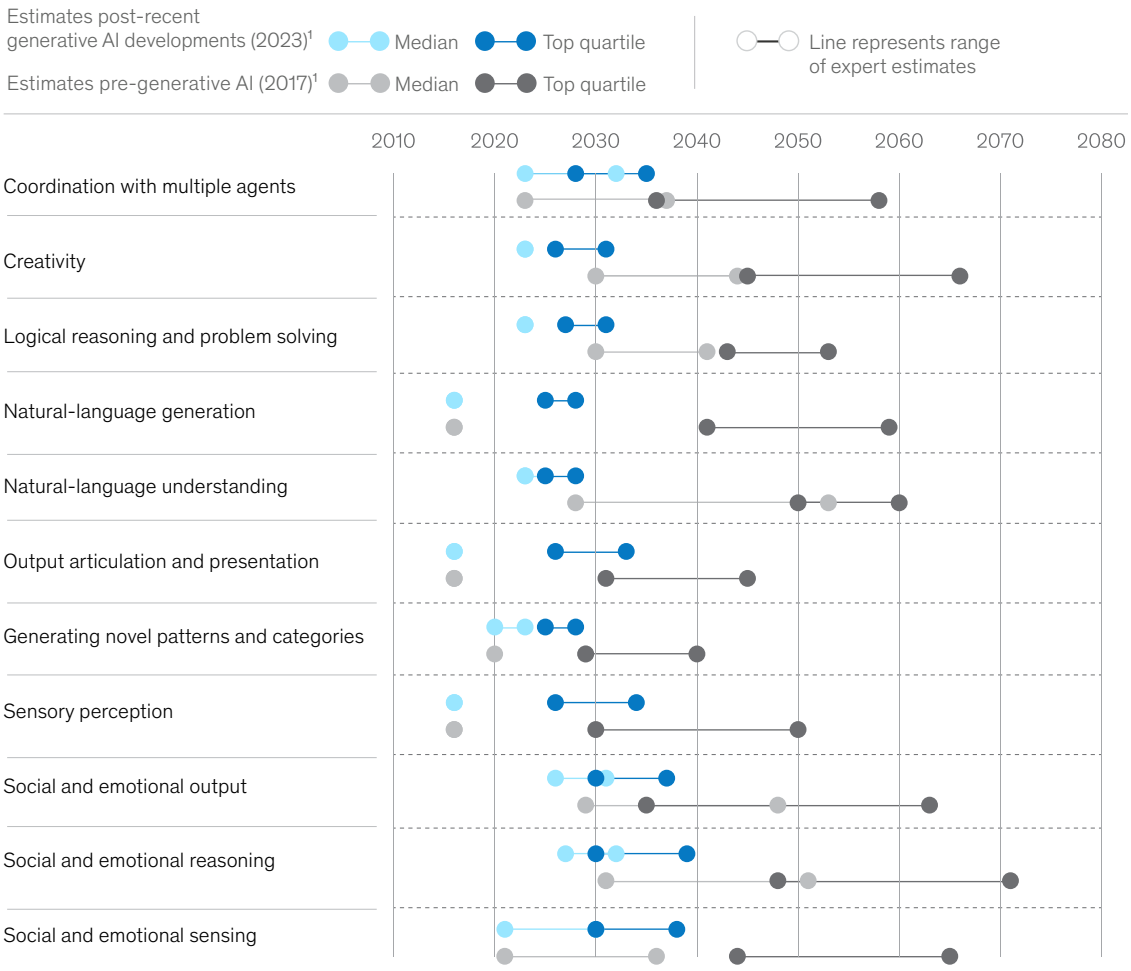
Accelerating the technical potential to transform knowledge work

Based on developments in generative AI, technology performance is now expected to match median human performance and reach top quartile human performance earlier than previously estimated across a wide range of capabilities (Exhibit 6). For example, MGI previously identified 2027 as the earliest year when median human performance for natural-language understanding might be achieved in technology, but in this new analysis, the corresponding point is 2023.

Exhibit 6

As a result of generative AI, experts assess that technology could achieve human-level performance in some technical capabilities sooner than previously thought.

Technical capabilities, level of human performance achievable by technology



[1]Comparison made on the business-related tasks required from human workers. Please refer to technical appendix for detailed view of performance rating methodology.
Source: McKinsey Global Institute occupation database; McKinsey analysis

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Generative AI's potential impact on knowledge work

Previous generations of automation technology were particularly effective at automating data management tasks related to collecting and processing data. Generative AI's natural-language capabilities increase the automation potential of these types of activities somewhat. But its impact on more physical work activities shifted much less, which isn't surprising because its capabilities are fundamentally engineered to do cognitive tasks.

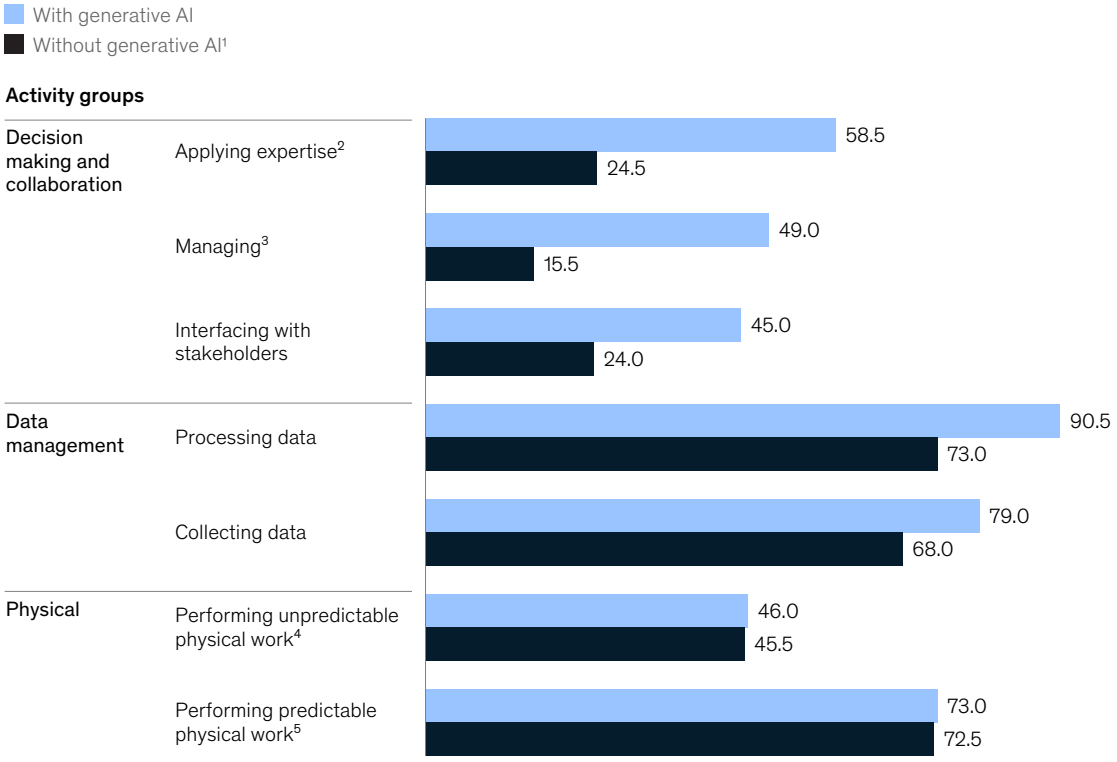
As a result, generative AI is likely to have the biggest impact on knowledge work, particularly activities involving decision making and collaboration, which previously had the lowest potential for automation (Exhibit 10). Our estimate of the technical potential to automate the application of expertise jumped 34 percentage points, while the potential to automate management and develop talent increased from 16 percent in 2017 to 49 percent in 2023.

Generative AI's ability to understand and use natural language for a variety of activities and tasks largely explains why automation potential has risen so steeply. Some 40 percent of the activities that workers perform in the economy require at least a median level of human understanding of natural language.

Exhibit 10

Generative AI could have the biggest impact on collaboration and the application of expertise, activities that previously had a lower potential for automation.

Overall technical automation potential, comparison in midpoint scenarios, % in 2023



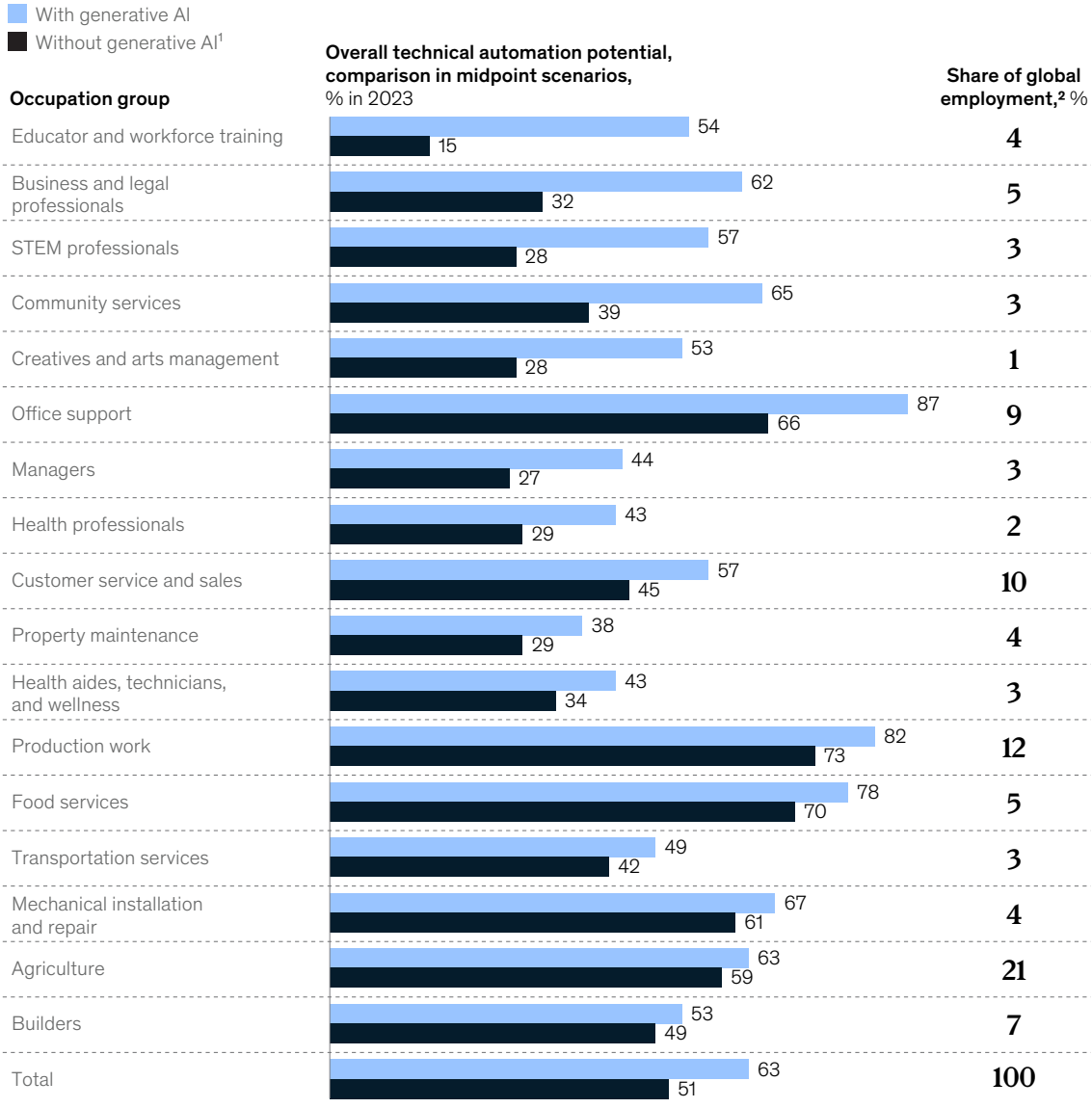
Note: Figures may not sum, because of rounding.
[1]Previous assessment of work automation before the rise of generative AI.
[2]Applying expertise to decision making, planning, and creative tasks.
[3]Managing and developing people.
[4]Performing physical activities and operating machinery in unpredictable environments.
[5]Performing physical activities and operating machinery in predictable environments.
Source: McKinsey Global Institute analysis

As a result, many of the work activities that involve communication, supervision, documentation, and interacting with people in general have the potential to be automated by generative AI, accelerating the transformation of work in occupations such as education and technology, for which automation potential was previously expected to emerge later (Exhibit 11).

Exhibit 11

Advances in technical capabilities could have the most impact on activities performed by educators, professionals, and creatives.

Impact of generative AI on technical automation potential in midpoint scenario, 2023



Note: Figures may not sum, because of rounding.
[1]Previous assessment of work automation before the rise of generative AI.
[2]Includes data from 47 countries, representing about 80% of employment across the world.
Source: McKinsey Global Institute analysis

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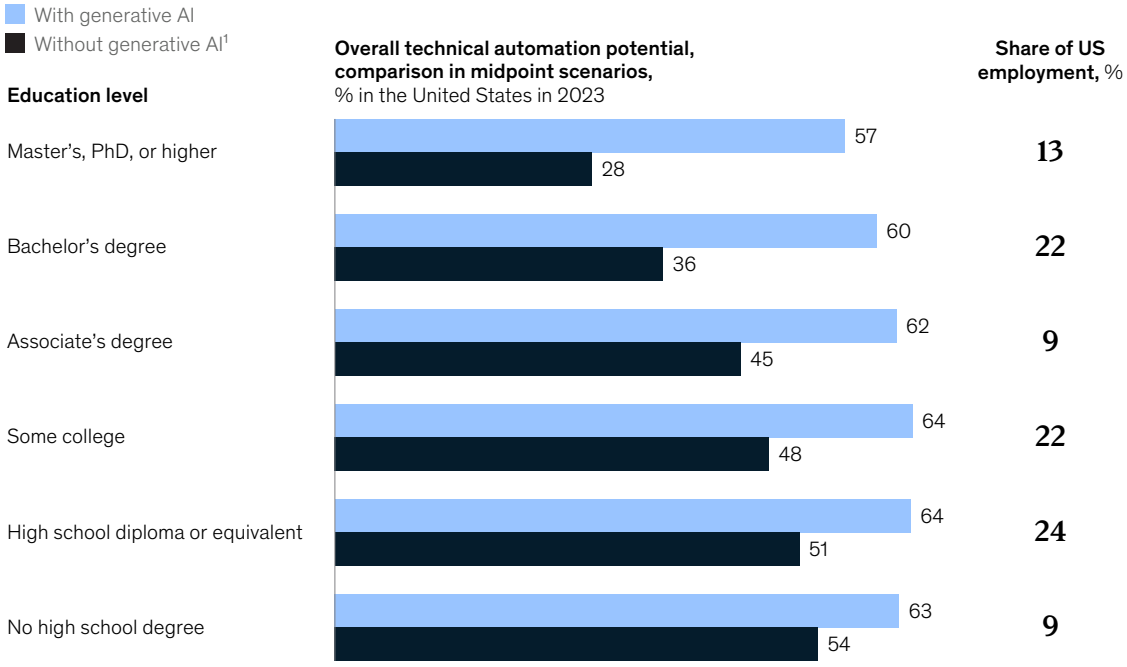
Labor economists have often noted that the deployment of automation technologies tends to have the most impact on workers with the lowest skill levels, as measured by educational attainment, or what is called skill biased. We find that generative AI has the opposite pattern—it is likely to have the most incremental impact through automating some of the activities of more-educated workers (Exhibit 12).

Exhibit 12

Generative AI increases the potential for technical automation most in occupations requiring higher levels of educational attainment.

Impact of generative AI on technical automation potential in midpoint scenario, 2023



[1]Previous assessment of work automation before the rise of generative AI.
Source: McKinsey Global Institute analysis

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Another way to interpret this result is that generative AI will challenge the attainment of multiyear degree credentials as an indicator of skills, and others have advocated for taking a more skills-based approach to workforce development in order to create more equitable, efficient workforce training and matching systems.[14] Generative AI could still be described as skill-biased technological change, but with a different, perhaps more granular, description of skills that are more likely to be replaced than complemented by the activities that machines can do.

Previous generations of automation technology often had the most impact on occupations with wages falling in the middle of the income distribution. For lower-wage occupations, making a case for work automation is more difficult because the potential benefits of automation compete against a lower cost of human labor. Additionally, some of the tasks performed in lower-wage occupations are technically difficult to automate—for example, manipulating fabric or picking delicate fruits. Some labor economists have observed a

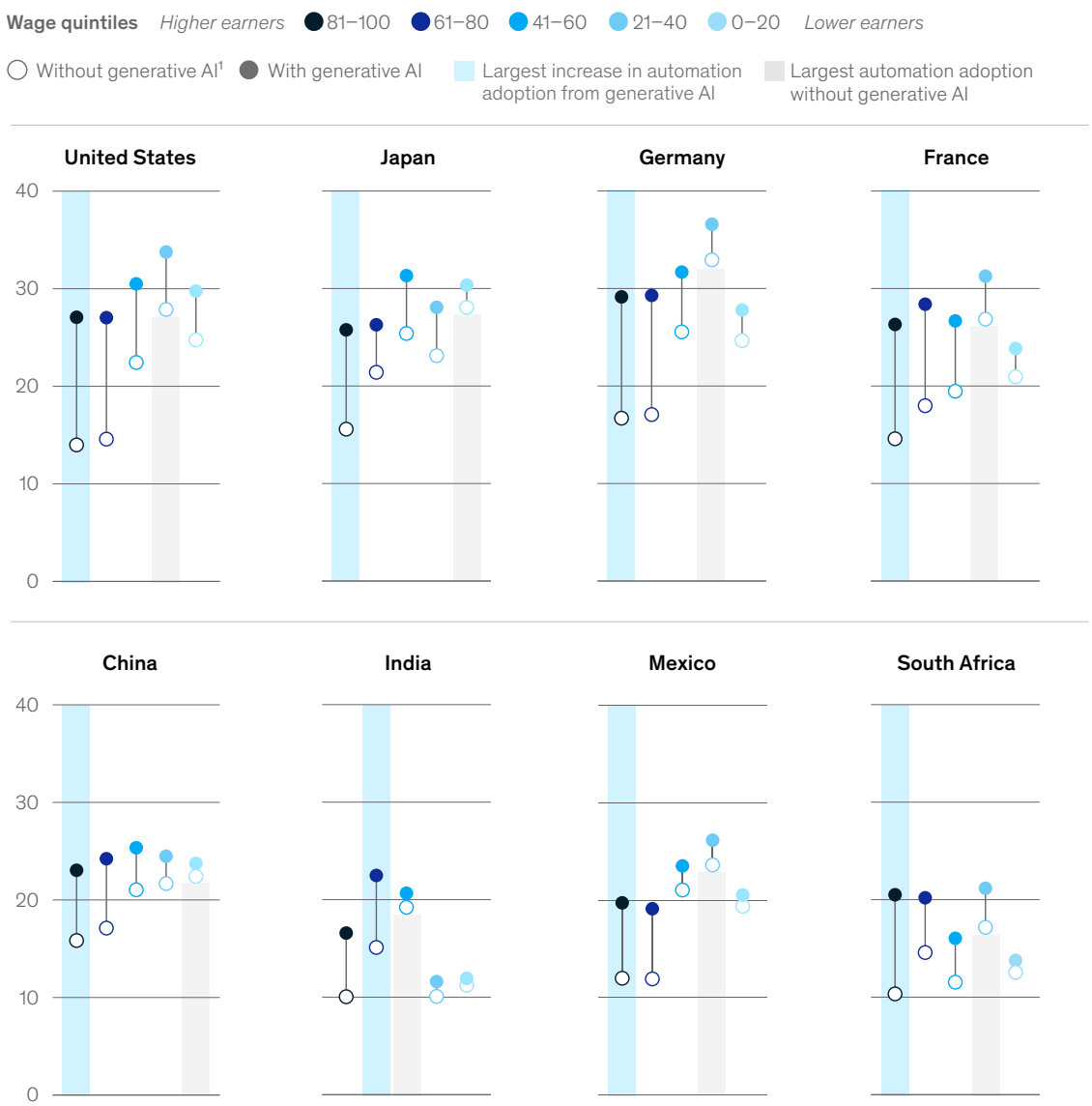
"hollowing out of the middle," and our previous models have suggested that work automation would likely have the biggest midterm impact on lower-middle-income quintiles.

However, generative AI's impact is likely to most transform the work of higher-wage knowledge workers because of advances in the technical automation potential of their activities, which were previously considered to be relatively immune from automation (Exhibit 13).

Exhibit 13

Generative AI could have the biggest impact on activities in high-wage jobs; previously, automation's impact was highest in lower-middle-income quintiles.

Automation adoption per wage quintile, % in 2030, midpoint scenario



[1]Previous assessment of work automation before the rise of generative AI.
Source: McKinsey Global Institute analysis