BlackRock

Investment perspectives
November 2024

AI's big questions

Artificial intelligence (AI) offers great promise and has spurred heavy investment. But how could the economy change? Over what timeframe? And who will reap the rewards? We look at these questions and more – and explore what it all means for investors.

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Summary

- AI has captured investor attention. We don't think this is short-lived hype: we believe AI could radically reshape economies and markets.
- Yet no one knows exactly how AI will evolve. It raises many big questions, not all of which have answers now. We use our three-phase framework — buildout, adoption, transformation — to track progress and help us adjust portfolios along the way. We take an active investment approach to capture AI's opportunities.

The macro implications

- Estimates of AI's contribution to broad economic growth range from modest to substantial, underscoring high uncertainty around how AI will evolve.
- In the near term, AI may yield modest productivity gains by helping workers be more efficient. Longer term, AI's potential to drive innovation in innovation itself could be transformational, expanding knowledge and supply capacity, possibly easing inflation and boosting growth.
- We're in phase 1 now: the buildout. As AI models become exponentially more complex, annual investment into AI data centers and their chips could surpass U.S. $700 billion by 2030 – equivalent to 2% of annual U.S. GDP. Investment on this scale creates a vital role for capital markets and a compelling opportunity for investors, in our view.
- Such spending could add to inflation, including via higher near-term energy costs: AI's massive power needs could strain energy grids in the near term, potentially slowing AI's progress. Efficiency gains may later offset some of the initial spike in energy demand.
- In phase 2, we see AI rolling out unevenly across sectors, potentially redefining production, work and consumption. This could create new jobs and evolve existing ones, but the labor market will need time to adapt.

The investment implications

- We believe AI will generate new revenue streams, though it's uncertain who will capture the most value – the providers of AI infrastructure or the developers leveraging it to create innovative AI-powered apps.
- Investment opportunities span the "tech stack", from cloud infrastructure and chips to applications, with significant potential now in foundational layers where expertise and capital are concentrated. We spotlight how one of our tech portfolio managers is navigating AI on pages 8 and 9.
- In our view, parallels to the dot-com bubble fall short: tech earnings quality and capital efficiency are stronger today, according to analysis from our Systematic Active Equity team. And unlike the dot-com era, robust earnings support today's mega-cap valuations.
- Equity market concentration today reflects a "winner-takes-all" feature of AI, we think. If market concentration is driven by underlying transformation, it does not need to imply market fragility, in our view.
- We think questions around AI overinvestment are valid, but the payoff likely lies years ahead. Big tech's capex levels appear sustainable to us, with expected revenues likely to offset these investments far faster than in the dot-com era. In our view, overinvestment should be assessed in aggregate, given AI's potential to unlock new revenue streams across the whole economy.
- Private markets may offer exposure to early-stage growth companies driving AI adoption in non-traditional sectors. An active investment approach with strong technical knowledge is, in our view, crucial to identifying future winners across industries, including utilities, industrials and real estate.

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Roadmap to track the AI evolution

AI burst into global consciousness two years ago, propelled by breakthroughs that have taken a once-niche technology mainstream. This could mark the dawn of a new intelligence age, perhaps more profound than the first industrial revolution (steam engine), the second (electricity), or the information revolution (internet).

What sets AI apart from past technological shifts is its potential to mimic, or even enhance, human intelligence. See page 8. It could reshape the economy, accelerating scientific breakthroughs and creating entirely new industries. As AI advances, it could even change the nature of work itself by enabling innovation in how we innovate. That massive potential is driving the current wave of heavy investment in AI-related infrastructure.

AI models have been scaling exponentially – their capabilities have grown with more data, processing power and improved algorithms. That's key to how rapidly they can keep advancing toward their full potential. The parameters in a model are like the building blocks of AI – more parameters mean more complex and capable models that can handle increasingly sophisticated tasks. In the mid-1950s the typical AI model had 10 parameters. Sixty years later it had 10 million. Less than 10 years later it had 10 billion. See the chart below. But scaling comes with challenges, such as the difficulty in achieving continued breakthroughs via increasingly complex algorithms, as well as the need for greater computing power, ever-greater volumes of data and sufficient energy supply. These escalating demands are why today's capital investment needs are so large – more complex models require much more resources to sustain their growth.

The timeline and scale of AI's impact on broad economic growth are still uncertain. In our view, the extent of this impact depends on two factors: how efficiently AI can transform specific tasks and how broadly it can be applied across industries. AI's potential goes beyond tech. AlphaFold, an AI tool that earned its creators a Nobel Prize in 2024, highlights how AI could speed up scientific breakthroughs, from drug discovery to new materials.

We anchor our framework to track the AI evolution around three key phases:

Phase 1 - Buildout: The first phase is the race to build the infrastructure AI needs. It's happening now, with tech giants driving record levels of capital expenditure (capex) into data centers, AI models and the power systems that support them. We see big cloud providers and chip producers benefiting, along with companies in the utilities, energy, industrials, materials and real estate sectors that provide key inputs for this buildout.

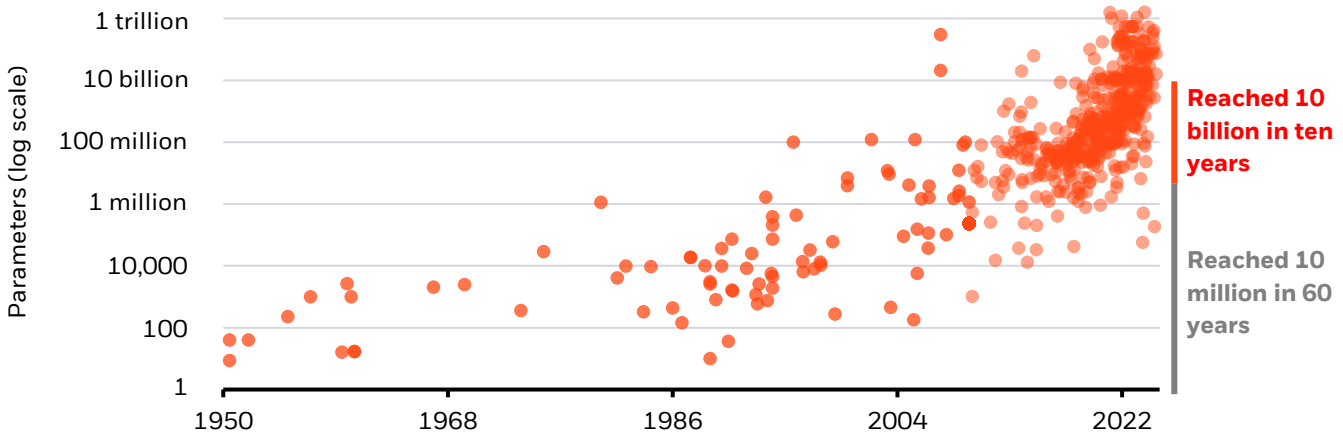
Phase 2 - Adoption: As infrastructure grows and AI applications mature, adoption is likely to accelerate – packaged into different apps and software. Companies are still learning how to harness AI. We think they will invest in AI to reshape operations and drive growth, with winners emerging beyond the tech sector in industries like healthcare, financials and communication services.

Phase 3 – Transformation: This phase is where companies could unlock the full value of AI adoption, as broad productivity gains and new business models and industries emerge. The magnitude and timing of these changes remain uncertain – and it's possible they don't materialize at all if adoption is not as widespread as expected. Identifying winners here is particularly challenging — some may not even exist yet.

It's unclear how big the transformation will be, and how quickly it could play out. If AI kicks research and development into high gear, it could ignite powerful growth, in our view. The future could unfold in multiple directions, shaped in part by the push and pull of technological advancements. Yet the race to build out artificial general intelligence (AGI) that thinks, learns and innovates like humans is already driving massive capital spending — a pillar of the *getting real* investment theme in our Midyear Outlook. One critical question is not whether AI will create new revenue streams – it likely will – but who will capture that value. In the following pages, we explore some of the major questions surrounding AI's evolution.

Exponential growth

Parameters in notable AI systems, 1950-2024



Source: BlackRock Investment Institute, with data from Epoch as processed by Our World in data, November 2024. Note: The chart shows the increase in parameters in notable AI systems. Parameters can be thought of as dials that are tweaked as the model learns settings to understand patterns in historical data. Each dot represents an AI system covered in the Epoch database. Data retrieved from https://ourworldindata.org/grapher/exponential-growth-of-parameters-in-notable-ai-systems and is based on Epoch AI, 'Parameter, Compute and Data Trends in Machine Learning'. Published online at epochai.org at https://epochai.org/data/epochdb/visualization

Will AI lift productivity?

Understanding AI's potential impact on economic growth is essential, as it could do more than improve efficiency. It may redefine how innovation itself unfolds. AI's impact could range from one-off boosts to worker productivity to more fundamental shifts that expand society's base of knowledge. In the short term, AI may primarily boost productivity within specific jobs and tasks. Research by Aghion et al (2017) shows that, over the long term, AI could vastly accelerate the process of generating new ideas and discoveries, with far-reaching implications for innovation and growth.

Quantifying AI's long-term economic impact remains a challenge. Predicting how AI will shape the mechanics of innovation and expand the knowledge base is difficult, especially when it comes to gauging its potential in research and development. If AI can substantially increase R&D efficiency, it could catalyze new knowledge creation in ways traditional technologies have not achieved.

Even projections of AI's near-term economic impact vary widely. For example, estimates of its impact on U.S. GDP growth range from modest gains of 0.1 percentage points annually to as much as 1.5 percentage points, depending on the scale of efficiency gains in specific tasks and on how broadly AI can be applied across industries.

AI's initial impact will likely mirror that of the ICT and internet revolutions, boosting task and job efficiency. During the late 1990s internet boom, productivity surged as sectors integrated new tech, with output per hour rising by about one percentage point over 10 years. Research suggests AI could lift productivity by 10-30% in tasks where it's applied. Yet some studies, such as Acemoglu et al (2023), anticipate that only 20% of tasks will be meaningfully impacted by AI within a decade, suggesting the resulting U.S. GDP gains in that period may be closer to the lower end of projections.

In addition, premature application of AI in areas where it isn't fully competent could initially dampen productivity gains, as suggested by 2023 research by Dell'Acqua et al. Such missteps could temporarily depress productivity gains, underscoring the need for a strategic, phased rollout.

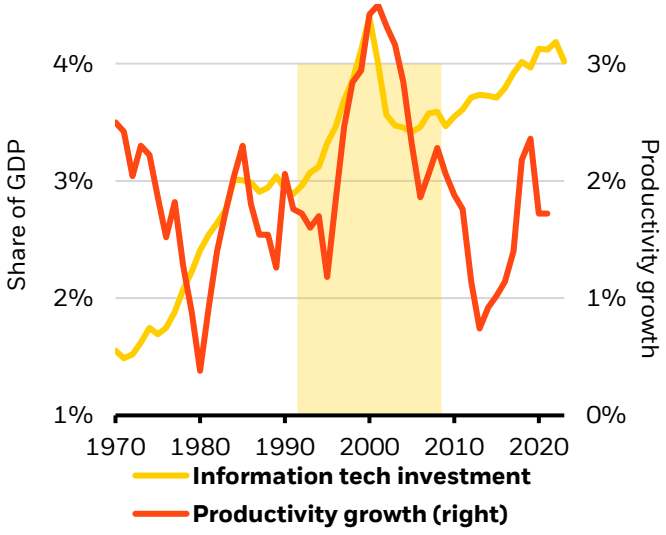
The truly transformational view is that AI, by accelerating the innovation process itself, could drive massive economic growth and advancements we cannot yet foresee. Much will depend on how rapidly AI is adopted across industries. Yet not all tasks can be automated, nor can all R&D processes be accelerated by AI. The literature suggests that ultimate growth will still be constrained by the pace at which these human-centric tasks and sectors evolve. AI's potential to drive long-term growth is vast, but exponential growth isn't guaranteed; instead, it will likely be moderated by these inherent limits.

Estimating AI's impact is one piece of the puzzle; timing is the other. History shows that broad productivity gains from breakthroughs like the steam engine and ICT can take decades to fully materialize. AI could unfold faster, but these examples temper expectations, suggesting that investors will need patience as AI's productivity benefits accumulate over time. These benefits can only come after investment – and they may also come in waves, with early adopters benefitting first as was the case through the ICT revolution. See the chart below right.

Bottom Line: Over the short term, we anticipate moderate productivity gains as AI reshapes specific tasks and industry practices. If AI can drive innovation at scale, it could expand supply capacity, ease inflation pressures, and boost economic growth more meaningfully. Yet realizing this vision will first require a large-scale infrastructure buildout across industries.

Potential reward, but with a lag

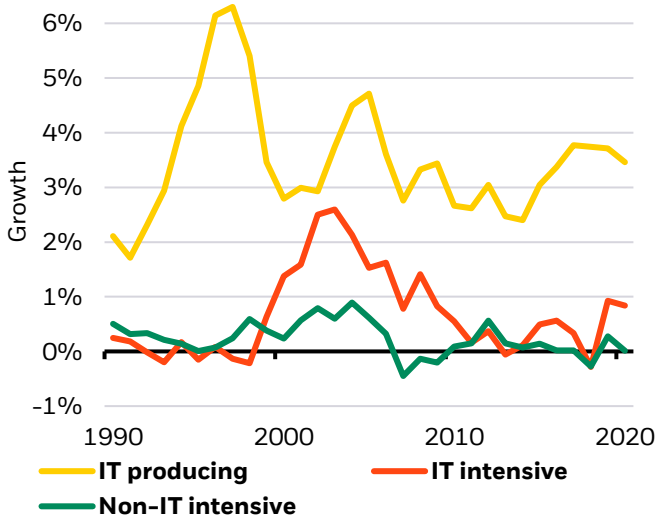
U.S. IT investment rate and trend productivity growth



Source: BlackRock Investment Institute, U.S. Bureau of Economic Analysis with data from Haver Analytics, November 2024. Note: The chart shows the five-year moving average of U.S. nonfarm business sector productivity growth and the rate of investment in information tech processing equipment and software as a share of nominal GDP.

Waves of productivity

U.S. total factor productivity growth by IT intensity



Source: BlackRock Investment Institute, BLS, November 2024. Notes: The chart shows U.S. historic average total factor productivity growth for different industry groups. Sectoral productivity indices are grouped in IT producing, IT intensive, and non-IT intensive categories as in Fernald (2015).

How big could the buildout get?

The first step toward realizing AI's transformational potential is a large-scale infrastructure buildout. Investment is pouring into infrastructure, power systems and technology – alongside investment tied to other mega forces like the low-carbon transition. That surge in capex underpins the *getting real* investment theme in our Midyear Outlook.

We see two main components to this buildout phase: *training* and *inference*. Training involves building and refining AI models. Even if only a few key models exist, training them requires immense computing resources. Yet even greater resources are needed for the inference phase, where trained AI models are continuously deployed across countless applications to interpret data, make decisions, or complete tasks. In other words, it's when AI "goes to work," applying its training to real-world applications. Both training and inference demand substantial resources and capital, driving further investment across data centers and related infrastructure.

Data centers form the backbone of this buildout, managing the vast information flows essential for AI operations. We see three primary cost drivers here: installing chips and servers, constructing data centers, and powering them. AI-focused centers command significantly higher expenses across all three areas than traditional setups. See the chart below left.

Chips represent the single largest cost factor. Procuring AI chips involves not only purchasing hardware but expanding the entire supply chain, from raw materials to specialized manufacturing processes. Some of the latest, most powerful chips cost up to U.S.$40 billion per gigawatt, compared to U.S.$10-20 billion for traditional data center chips, according to Thunder Said Energy. AI centers require advanced chips and servers, specialized cooling systems, and greater power demands.

AI-driven improvements in power efficiency may help narrow the cost gap, but the initial outlay per AI server remains considerably higher than for traditional setups. This heightened power demand is another critical element of the AI buildout. AI-specific data centers need reliable, substantial energy input – from sources like coal, gas, nuclear or renewables. This demand could soon strain existing energy grids, with utilities facing unprecedented demand levels that will require modernization to accommodate these massive new loads. See next page.

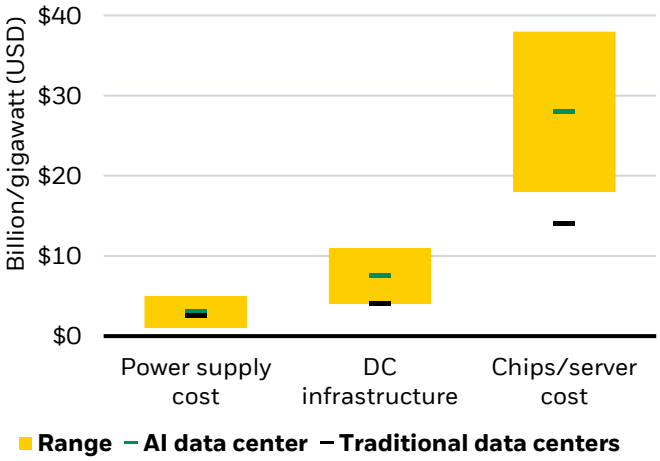
Investment across AI and traditional data centers and related power infrastructure could surpass U.S.$700 billion a year by 2030, based on the top end of projections. See the chart below right. That's equivalent to over 2% of annual U.S. GDP. It's also more than the entire U.S. private sector currently invests in information processing equipment, and on par with what the U.S. spends on research and development each year. The sheer amount of capital needed to enter this space gives mega-cap tech companies a significant competitive advantage. More broadly, the scale of AI infrastructure buildout demands significant financing, creating a critical role for capital markets to mobilize the required capital — and opportunity for investors, in our view.

Cumulatively, investment could add up to U.S.$3 trillion by 2030. Considering the spending on energy infrastructure as part of both the data center buildout and the low-carbon transition, coming investment could rival the amount seen in the industrial revolution, in our view.

Bottom line: Investment in data centers and AI chips could surpass U.S.$700 billion each year by 2030 – equivalent to over 2% of U.S. GDP. Total spending across AI and energy infrastructure could approach industrial revolution levels, though supply constraints and technological advances may impact the outcome.

Traditional vs. AI data centers

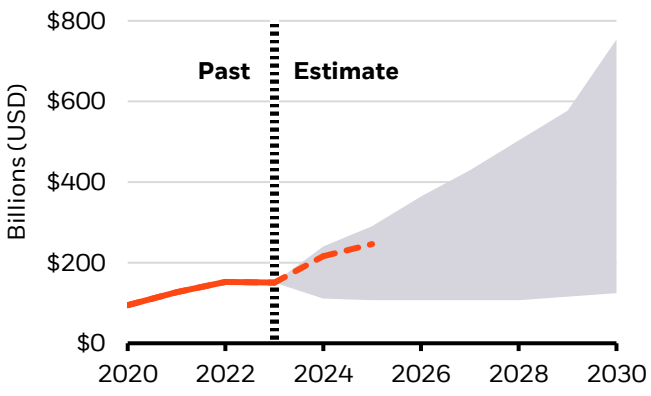
Range of estimates of data center buildout costs



Forward looking estimates may not come to pass. Source: BlackRock Investment Institute, Thunder Said Energy, November 2024. Note: The chart shows the estimated costs across three key components for data centers. Data center infrastructure relates to the full infrastructure build, excluding the cost of chips and servers. Power supply costs relate to the building of facilities needed to power data center.

Rising spending

Past and estimated capex by mega-cap tech, 2020-2030



Forward looking estimates may not come to pass. Source: BlackRock Investment Institute, Reuters, November 2024. Note: The chart shows capital expenditure by big tech on data center related projects and the estimated range of spending (shaded area) derived from industry estimates of data center power demand (see the chart on the next page), and the estimates of data center costs, including chips (see the chart on the left). "Big tech" includes: Amazon, Apple, Google, Meta, Microsoft and Oracle. The consensus projections (orange line) relate to total company capex. As no breakdown of consensus capex projections is available, we provisionally assume that 90% of this capex is on data center infrastructure.

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How will AI impact energy demand?

Much of the focus on AI's impact on the energy transition has been on its massive power demands – especially for AI training (teaching a model how to do a task) and inference (using the model). This increased power demand will come from the rapid expansion of data centers, which currently make up ~4-5% of total U.S. power demand and ~1-2% of global demand. See the chart below left. Most estimates see this doubling or, in more bullish scenarios, rising three or fourfold – though the range of projections are wide. In anticipation of this, we are already seeing some big tech companies signing multiyear contracts with energy providers as they seek to secure enough power supply for their operations.

The amount of power that data centers will ultimately need depends on several exponential trends that are still at an early stage, including demand for computational power, cooling efficiency and grid capacity. This expected surge could strain power grids and even limit AI growth, given the challenges in siting, permitting and building infrastructure.

Projections differ significantly depending on the model used. Some models assume that the expansion is constrained by the availability, or supply, of data centers or power (middle bar in the chart below right), while others focus on the power demand driven by the increasing need for chips and servers as AI models grow exponentially in complexity and capabilities. Relying solely on data center growth could underestimate the impact of rising chip demand, while focusing only on chip sales might overlook potential bottlenecks like power infrastructure, labor shortages or permitting challenges. For these reasons, the actual growth rate could fall somewhere between these two extremes.

On the flip side, AI could boost efficiency and support decarbonization, driving productivity gains in energy-intensive sectors alongside broader productivity gains, as discussed on page 4. If widely adopted, these energy-saving effects could help offset the increased energy use from AI training and operation.

We see investment opportunities across the entire energy system:

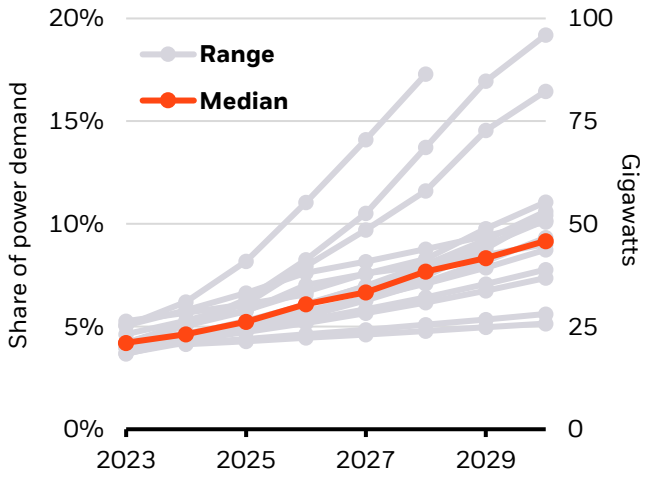
- **Power systems**: grid management, renewables integration, nuclear fusion
- **Transportation**: electric vehicles, freight algorithms, 3D-printed lightweight parts
- **Industry**: circular economy, supply chain optimization, materials innovation
- **Buildings**: smart energy systems, HVAC optimization
- **Carbon management**: carbon capture, emissions monitoring

If AI does deliver large energy efficiency gains, they can only come after widespread AI adoption. So, we think AI will first fuel energy demand before savings materialize – meaning higher near-term energy costs and inflation pressure. But when and if those efficiency gains do materialize, they would instead be deflationary.

Bottom line: AI's massive power needs could strain grids in the near term, potentially slowing the AI buildout. AI could eventually boost energy efficiency and support a low-carbon economy, yet those savings can come only after widespread adoption, meaning higher near-term energy costs and inflation pressures.

Powering the AI revolution

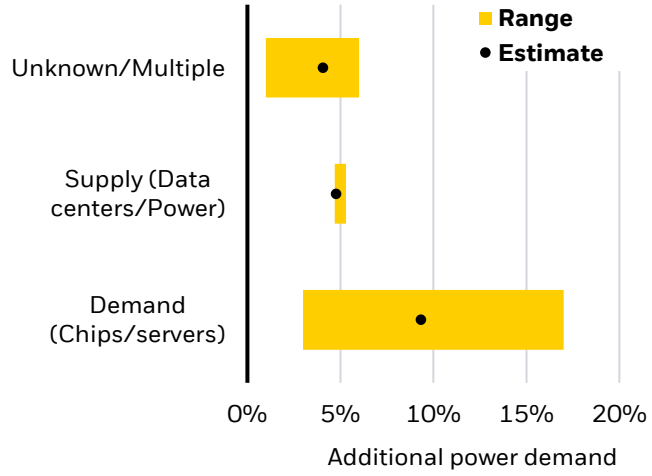
Range of estimates of data center power demand



Forward looking estimates may not come to pass. Source: BlackRock Investment Institute, IEA, Goldman Sachs, BGIF, Bank of America, Schneider, Semianalytics, Bernstein, McKinsey, BCG and BlackRock's Fundamental Equities team, November 2024. Notes: The chart shows data center power demand as a share of total U.S. power demand in 2022. It includes demand from traditional data centers and AI computing/dedicated AI data centers and excludes consumption from cryptocurrencies and data transmission networks.

The model matters

Estimated increase in data center power demand by 2030



Forward looking estimates may not come to pass. Source: BlackRock Investment Institute, with data from industry sources and brokers detailed below, November 2024. Note: The chart shows the estimated increase in data center power demand in the U.S. by 2030 vs. 2023 levels, relative to current demand, based on models that use a demand-based (SemiAnalysis, IEA, Goldman Sachs, FE Tech and WFB) or a supply-based (Bank of America, BGIF and BCG) approach. We also include selected others that use multiple approaches or do not disclose their method. These include: Bernstein, McKinsey, S&P and EPRI. Models were published between January-September 2024.

How will AI adoption alter the economy?

AI adoption could massively change how industries operate and where labor is deployed, while also creating new industries and business models. This could happen even if AI doesn't boost productivity: the same goods and services may be produced, just differently. We've seen similar shifts before. During the industrial revolution, for example, the share of agricultural workers dropped from over 50% in the 1850s to under 2% by the 1980s as manufacturing took over. See the chart below left.

The ICT revolution reshaped the workforce even more, requiring reskilling in almost every industry. Today, over 70% of workers need ICT skills, and more than half of today's jobs didn't exist in 1950. E-commerce alone created new roles in fulfillment centers, where people now work with robots.

AI adoption could reshape industries, reallocating labor and creating new business models, even without boosting productivity. Much like the industrial revolution shifted workers from agriculture to manufacturing – see chart below left – AI may transform today's workforce. The information and communication technology (ICT) revolution similarly required widespread reskilling, and AI could follow suit, or be even more transformative – this is the mass production of intelligence itself. Recent research by OpenAI researchers suggests up to 80% of workers may use AI for some tasks, and as with the ICT revolution, entirely new jobs are also likely to emerge.

Some industries will feel the impact sooner. The chart below right shows the average share of tasks across select industries where use of AI might halve the time taken for the task.

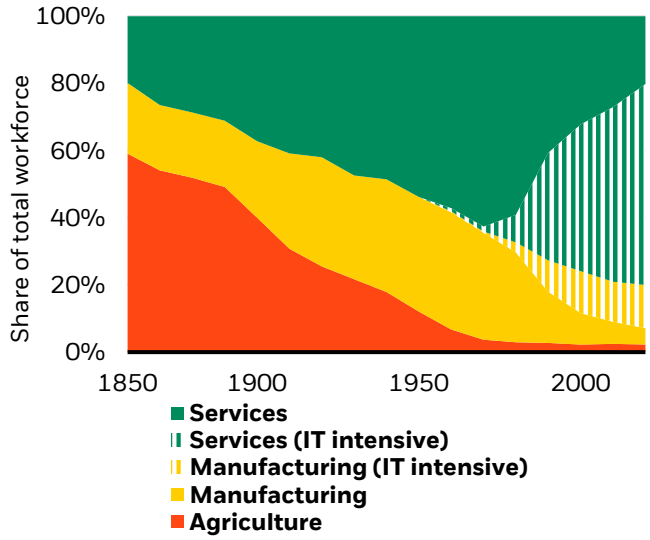
Many finance companies, including BlackRock, have been using traditional machine learning within their portfolio management processes for some time and are actively evaluating ways to deploy generative AI tools. Census Bureau surveys show only about 5% of U.S. companies are currently using AI. But we're still in the buildout phase. We expect adoption to expand rapidly, potentially faster than the four-decade ICT boom, though widespread integration will take time.

If AI is adopted very quickly, it could disrupt the economy, potentially driving inflation as demand grows faster than resources can be reallocated and workers reskilled. Further inflation may come from the investment required to adopt AI across the economy. We've written before about how we think we're now in a world where supply constraints – rather than excess demand – are driving inflation. Monetary policy faces a tougher trade-off between supporting growth and keeping inflation in check. That tradeoff may be exacerbated if labor reallocation and reskilling cause temporary worker shortages. Research by Guerrieri et al (2021) suggests that allowing some inflation, rather than aggressively fighting it, could help the economy shift more smoothly to a new equilibrium. The upshot: living with higher inflation may be part of the journey through this reallocation.

Bottom line: AI could reshape the economy by shifting labor and resources, creating new jobs and industries. Sectors like finance and IT could be early adopters. Rapid adoption may drive inflation as demand outpaces reskilling, making higher inflation part of the transition to a new economic balance.

Changing face of labor

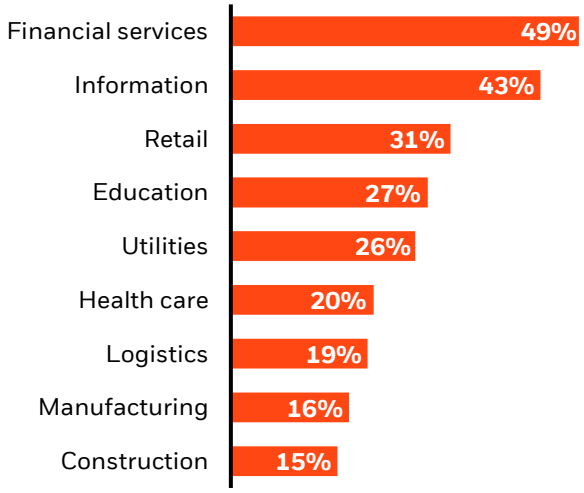
Share of workers in respective industry, 1850-2020



Source: BlackRock Investment Institute, IPUMS USA, November 2024. Notes: The chart shows the breakdown of the U.S. labor force by industry based on U.S. Census data. The grouping of services and manufacturing industries into the IT intensive category is done at the individual occupation level, using a large language model to determine which occupations required medium or high IT use, and constraining it to match 2016 results based on O*NET Database from Muro et al (2017).

Half the time

Share of tasks where use AI may halve time taken for task



Source: BlackRock Investment Institute, Eloundou et al (2023), November 2024. Note: The chart uses industry-level AI exposure measure from Eloundou et al (2023) defined as the average share of tasks where access to an LLM or LLM-powered system would reduce the time required for a human to perform a specific task by 50%. We group their results into 2-digit North American Industry Classification System industry groups and show a selection of most and least exposed industries.

A tech portfolio manager's take

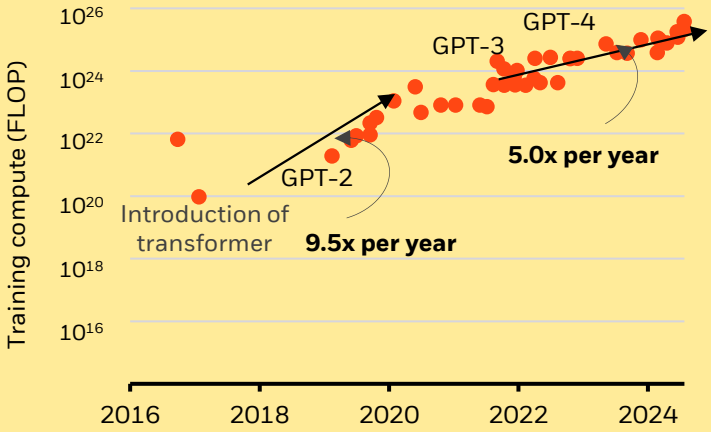
Tony Kim
Head of Global Technology Team, Fundamental Equities — BlackRock

We are at an unparalleled time in human history as we enter a new "intelligence revolution" era. Innovations in AI research have enabled the building of machine intelligence that could rival or surpass that of humans. The primary goal and the north star for the leading AI technology companies is to achieve Artificial General Intelligence (AGI). We are currently at Level 2 on the path to AGI. See table below. The implications for the economy and society are profound and this could prove to be potentially the most transformational technological wave in history.

The technology industry is now mobilized to build new "AI factories" that produce units of intelligence. A key principle is the AI scaling laws, which show that AI capabilities get unlocked with more compute, data and improved algorithms. These AI factories, however, require significant capital investment.

AI intelligence scaling

Illustration of AI's exponential growth potential



Source: BlackRock Fundamental Equities, with data from Epoch, November 2024. Note: The chart shows the increase in compute required in training notable AI systems. Each dot represents an AI frontier language system covered in the Epoch database. Data from Sevilla and Roldán (2024), "Training Compute of Frontier AI Models Grows by 4-5x per Year", retrieved from https://epoch.ai/blog/training-compute-of-frontier-ai-models-grows-by-4-5x-per-year

The path to AGI

Illustration of AI levels and capabilities

AI level	AI capability
Level 0	No AI
Level 1	Chatbots (unskilled human)
Level 2	**Reasoners (50% skilled human)**
Level 3	Agents (90% skilled human)
Level 4	Innovators (99% skilled human)
Level 5	Superhuman AGI or ASI

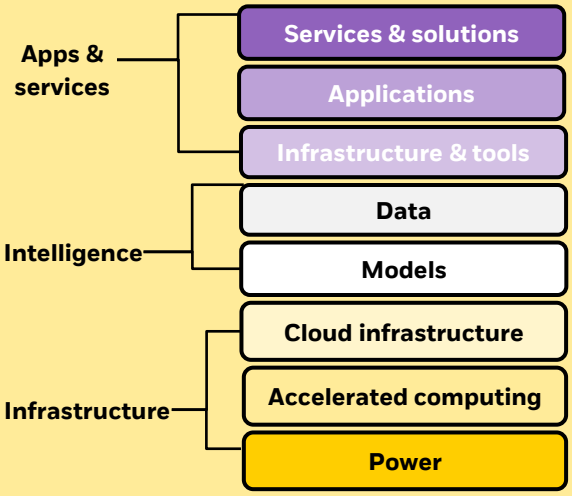
Source: BlackRock Fundamental Equities and Morris et al (2024), November 2024. Note: The table shows AI's rising intelligence levels and the extent to which it can match – or surpass – human intelligence. **For illustrative purposes only.**

The AI stack

We examine AI through the framework of a "stack" which is represented by three main layers: infrastructure, intelligence and applications.

The AI tech stack

BlackRock Fundamental Equities "blueprint" for AI investing, November 2024



Applications Layer: At the top of the stack are the software infrastructure, applications and the services that will be used in end-user use cases. AI will underpin all applications and services in both enterprise and consumer end markets.

Intelligence Layer: This layer includes AI foundation models and data. The top AI labs are driving advancements in algorithms and data scale to unlock new capabilities and more intelligent systems.

Infrastructure Layer: AI's physical infrastructure consists of cloud data centers, chips and power. These are the AI factories that are foundational to build and run the AI models.

Source: BlackRock Fundamental Equities, November 2024. Note: The schematic shows the technologies we think will be needed to develop AI applications, services and solutions. Each layer builds on the one preceding as technologies get "stacked" on top of one another enabling further innovation. The schematic is for illustrative purposes only and intended as a guide based on what we know today. As the AI ecosystem evolves some categories may be replaced by newer ones.

The AI timeline

We are also navigating AI according to an estimated timeline illustrated in the schematic below.

Source: BlackRock Fundamental Equities, November 2024. Note: The schematic shows an illustrative timeline of how AI could evolve from the ongoing infrastructure buildout to achieving artificial general intelligence. **For illustrative purposes only. Any opinions or forecasts represent an assessment of the market environment at a specific time and is not a guarantee of future results. This information should not be relied upon by the reader as research, investment advice or a recommendation.**

Build AI Infrastructure: The first stage of AI requires building AI factories. The current $1 trillion installed base of data centers must effectively be rebuilt to support AI. This started in 2023 and will likely continue at least through the end of this decade.

Enterprise adoption: Companies are starting to deploy AI agents to automate business processes and workflows. AI could underpin all enterprise software and services, driving a new wave of productivity and changing the creation of new business models.

Consumer adoption: Consumers could soon be interacting with AI personal assistants of all forms. These AI assistants could be hyper-personalized to the user. A period of rapid transformation or "Cambrian explosion" of new AI consumer services that could bring expert capabilities in nearly every domain has also begun.

Real-world AI: The embodiment of AI into physical form is the next frontier. We expect to see AI in nearly every connected physical system, including autonomous vehicles, drones (military), humanoids (robotics) and augmented reality (glasses). These systems require a different form of AI than language models, they need more quantitative and scientific models.

Scientific breakthroughs: AI could transform scientific research, driving advancements in biology, chemistry and materials science. Advanced AI could unlock breakthroughs beyond our current capabilities.

AGI: Industry experts estimate AGI (level 5) could be achieved in the next 2-10 years. If AGI is achieved, this could usher in a fundamental reshaping of our economy and society.

Investment framework for AI

The rate of change in AI has been exponential and we anticipate it will evolve at a breakneck pace. Adaptation and flexibility in investment decision-making will be critical to navigating this dynamic market. We attempt to navigate this through our view on the strategic direction of AI, the interpretation of the AI stack, and our view on the forward timeline of AI development.

Is this a dot-com redux?

Since the launch of ChatGPT in November 2022, the market value of the "Magnificent 7" U.S. mega-cap companies has more than doubled, compared with around a 50% rise in the S&P 500, according to LSEG Datastream as of November 19, 2024. That turbocharged run-up in share prices and growing market concentration around a new technology has led some investors to draw parallels between today's market and the dot-com bust.

But these comparisons fall short, in our view. Quantitative analysis conducted by our Systematic Active Equity team of hundreds of metrics reveals few similarities between now and then. The dot-com era was marked by declining earnings quality, deteriorating capital efficiency and inflated valuations. Many of these indicators had gotten considerably ahead of historical norms, signaling trouble. Today's landscape tells a different story. Earnings quality is improving, companies are more capital efficient, valuations – while elevated in some places – are far from the extremes seen in the dot-com bubble and have moved in line with solid earnings growth. See the chart below left. Earnings of U.S. tech companies are expected to grow by around 20% in 2024, compared with a little over 8% for non-tech companies, according to LSEG data.

Of course, even robust companies can disappoint if bought at inflated prices, and current valuations give some investors pause. It may be that only some of the big tech companies go on to scoop up most of the future revenues AI generates. Or the revenues could stay mainly with the users of AI rather than the builders. But the early outperformance of AI frontrunners underscores a broader insight: active, forward-looking assessment is vital as we advance through the AI buildout, scaling new layers of the AI stack.

Fears around market concentration, too, may be overdone in our view. For major players like advanced chip manufacturers, dominating the AI race may be a matter of survival. Nvidia, for example, controls the high-tech chips powering data centers and has illustrated the "winner–takes-all" dynamic over the last two years. This explains current concentration of market power – it's a feature, not a flaw. Ultimately, we see AI as an economic transformation reshaping markets. This phase of index concentration is part of this broader shift, we think. We also find that heightened concentration often precedes more dispersion, not necessarily broad underperformance.

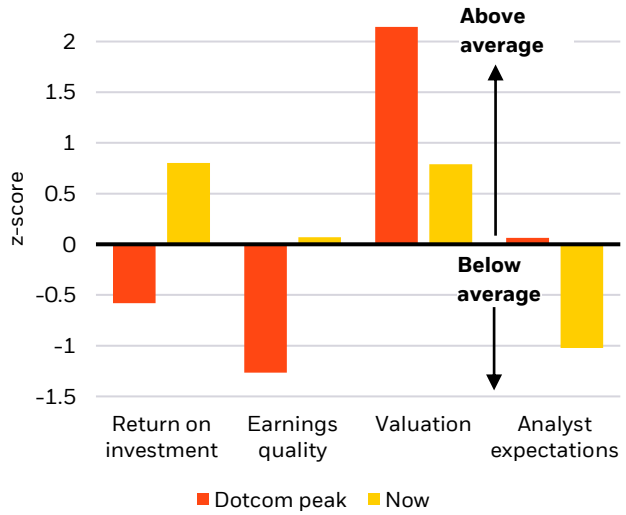
Questions around AI overinvestment are valid, but the payoff will likely come over the next decade – not in the next year or two. Metrics like capex-to-sales ratios and free cash flows suggest that, for now, mega cap tech firms are not overextended. See the chart on the right below. Some companies may overinvest in a "winner-takes-all" race, but broad sector exposure would still capture the eventual winners.

Revenues could "repay" mega cap's capex much faster than during the dot-com bubble, and the gap with the rest of the S&P 500 is less pronounced now. History shows public markets are swift to correct when investments outpace reality. Private companies may instead face greater risks of overspending. We think overinvestment must be assessed in aggregate, especially considering the new revenue streams AI could unlock across the economy.

Bottom line: We think valuations of big tech companies are far from the extremes seen during the dot-com era and current market concentration need not be a concern. But as AI evolves, so too may the opportunities.

Fundamentally different

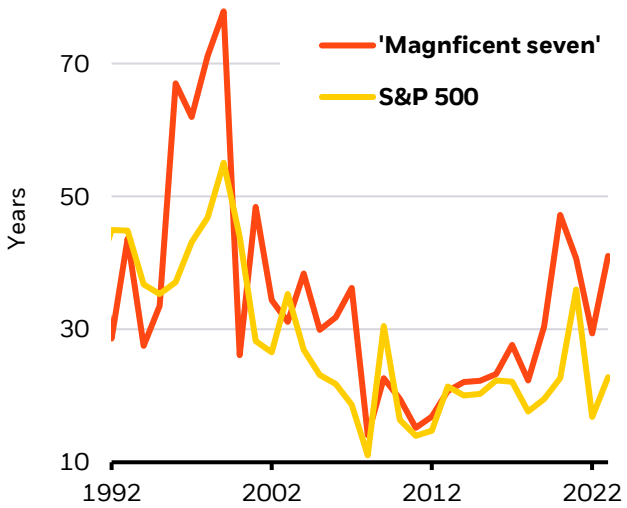
Comparison of key equity metrics, dotcom peak vs. now



Past performance is not a reliable indicator of current or future results. It is not possible to invest in an index. Index performance does not account for fees. Source: BlackRock Investment Institute with data from Capital IQ, S&P Global Market Intelligence, Alpha Factor Library. Note: The chart shows the metrics for the universe of Nasdaq 100. For each metric, we calculate a normalized z-score - the current value of each metric minus its average, divided by its standard deviation.

Cash rules

Market capitalization to free cash flow ratio, 1992-2023



It is not possible to invest directly in an index. Indexes are unmanaged and performance does not account for fees. Source: BlackRock Investment Institute, October 2024. Notes: The chart shows the ratio of market capitalization (cap) to free cash flow for the 'Magnificent seven' and the S&P 500. The number is expressed in years to show how long it would take for the free cash flow to match the market cap value. The "magnificent seven" stocks include: Alphabet, Amazon, Apple, Meta, Microsoft, Nvidia and Tesla.

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How to invest for the transformation?

We see four key investment takeaways spanning infrastructure, market leaders, private investments and future revenue streams.

The buildout beneficiaries: The infrastructure buildout phase continues to offer significant opportunities, particularly in the foundational layers of the AI tech stack presented on page 8. These include cloud infrastructure, chips and data management systems where capital and expertise are concentrated among large incumbents. Opportunities extend beyond technology to utilities, industrials, energy and real estate, all of which are critical to supporting broad AI deployment. Investment on this scale creates a vital role for capital markets and a compelling opportunity for investors, in our view.

Mega cap dominance: Mega-cap technology firms remain key beneficiaries of the buildout phase, even if some of them may ultimately lose the race to others, as discussed on the previous page. In aggregate, we believe their unmatched resources — data, talent, computational capabilities, strong balance sheets — and technological expertise enable them to innovate faster and maintain a competitive edge. This has led to market concentration for a reason, as network effects and high barriers to entry reinforce their dominance.

Private markets: We believe private markets are key to AI's investment story — not just in funding infrastructure but also in capturing potential future winners before they are publicly listed. Early-stage growth companies may drive AI adoption in non-traditional sectors. And these companies could become future acquisition targets for larger companies as AI applications integrate across industries. For investors that can tap into private markets, this may provide an opportunity to invest in potentially transformative use cases before they go public. Private markets are not suitable for all investors.

Future winners may emerge in unexpected areas: It may not be the sectors adopting AI that ultimately capture the value. For example, while the agricultural sector benefited from the industrial revolution, its economic weight declined over time, as we discussed on page 7. Similarly, AI-driven productivity gains in certain sectors may not necessarily result in those same sectors capturing a proportional share of the economic value. Signposts to watch include emerging revenue streams and cross-sector impacts.

It's hard to imagine all future AI use cases now. Some of the most disruptive companies may not exist yet, while others are in their infancy. An active investment approach could be key for navigating the complex landscape as investors with deep technical knowledge are likely better positioned to identify winners across time horizons, in our view.

Key risks we are monitoring include AI adoption disappointing expectations, power or other supply issues and regulatory pressures. Concentrated profits in new technologies have historically triggered antitrust scrutiny, as seen with railroads and telecommunications. And policymakers are becoming more hands on, with the European Union's AI Act in July 2024 marking the first comprehensive regulatory framework. Geopolitical fragmentation and global competition may shape how governments regulate AI – whether through voluntary guidelines or mandatory regulations, sectoral or economy-wide approaches, and how they balance competitiveness with human rights.

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