

## Special Report

## ChatGPT And The Curse Of The Second Law

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## Executive Summary

- Most discussions of AI extrapolate linearly from what AI can do today to what it can do tomorrow. But AI's progression is following an exponential curve, not a linear one, meaning that advances could come much faster than expected.
- Just as the investment community and the broader public were blindsided by the exponential rise in cases during the early days of the pandemic, they will be blindsided by how quickly AI transforms society and the economy.
- Assuming that humanity survives the transition to superintelligent AI, the impact on growth could be comparable to what occurred first during the Agricultural Revolution, and later during the Industrial Revolution. Both revolutions saw a 30-to-100 fold increase in growth relative to the previous epoch.
- The beneficial impact on tech stocks from the AI revolution, though sizable, could be a lot smaller than the impact on growth. This is because rapid technological change could render many existing technologies obsolete, leaving most of today's tech companies in the dust.
- Real bond yields could surge due to massive deflation, with central banks struggling to expand demand by enough to keep up with rising output.
- Surprisingly, commodities and real estate may be among the biggest winners of an AI-driven economic boom. This is because AI will expand the effective supply of labor and capital, making natural resources scarcer relative to other factors of production.
- The safety risks around AI are huge, and we think there is a more than 50/50 chance AI will wipe out all of humanity by the middle of the century.
- Paradoxically but fortunately, the multiverse generates an overwhelming cosmic selection bias towards experiencing only the outcomes where humanity survives, implying that every single reader of this report will live well beyond 100 with near-100% certainty. Plan your retirement accordingly.

**Bottom Line:** Unlike past technological revolutions, the impact of superintelligent AI could arrive quite quickly. It will usher in an era of unprecedented prosperity or turn us all into paper clips.

# ChatGPT And The Curse Of The Second Law

*Dear Client,*

*I will be visiting clients in New York next week. Instead of our regular report, we will be sending you a joint Special Report from BCA's Chief Geopolitical Strategist, Matt Gertken, and Chief Foreign Exchange Strategist, Chester Ntonifor, on the geopolitics of the US dollar. Matt and Chester argue that the US would need to suffer a substantial geopolitical defeat to see the dollar lose its status as the world's premier reserve currency.*

*Best regards,  
Peter Berezin, Chief Global Strategist*

## | Keep That Phone Charged!

A few weeks ago, a news story hit the wires about how **Uber was using data on a phone's battery level** as a variable in determining the price it quoted for a ride. Uber had previously disclosed that users whose phones were running low on power were more likely to accept surge pricing, so the idea that the company had integrated this function into its app did not seem too far-fetched.

An Uber spokesperson has denied the allegation, but the very idea that such a technique is even possible speaks to the growing ability that companies now have to deploy new technologies to engage in what economists call "price discrimination," or what the industry euphemistically calls "dynamic pricing."

Uber is not alone. Airlines routinely use complicated algorithms to figure out how much potential customers are willing to pay for a ticket and then quote a price that is just high enough to induce them to part with their money.

The proliferation of AI technologies will undoubtedly increase the scope for companies to use "big data" to earn a higher rate of return. This could shift the distribution of income towards businesses.

## | A Bigger Economic Pie

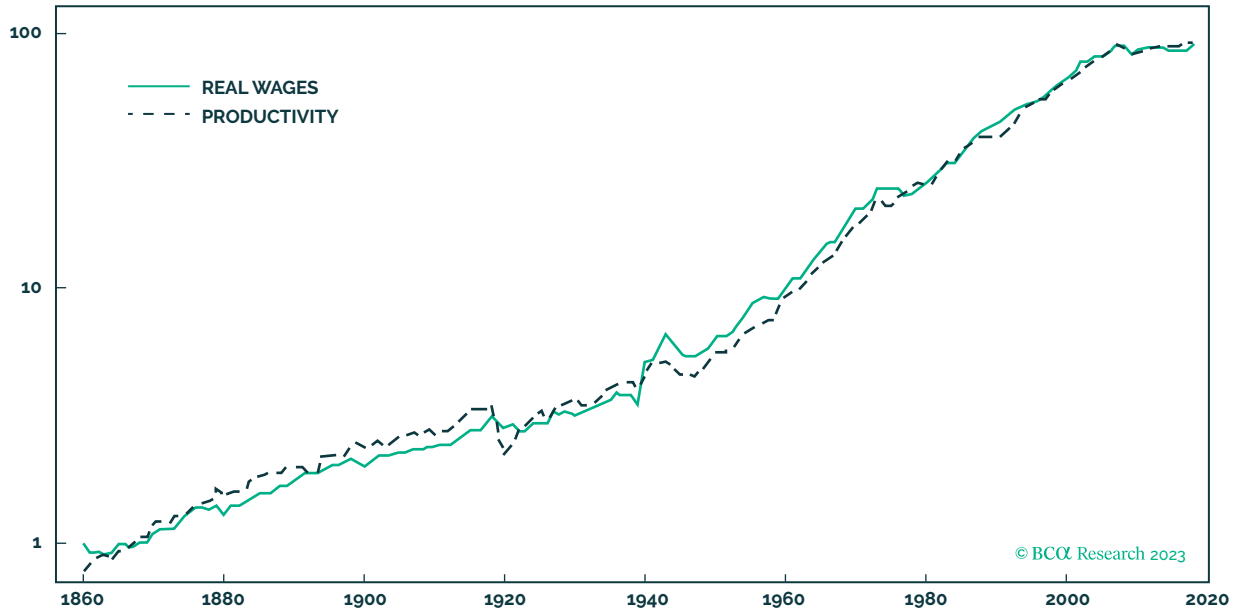
Will AI allow the entire economic pie to grow so much that both workers and corporations end up being better off, even if the former end up with a smaller slice than the latter?

Historically, that has been the case. Over long stretches of time, real wages have generally risen in line with productivity (**Chart 1**). Rising productivity has allowed workers to shift from stagnating industries to growing ones.

Today, only 2% of the US labor force is employed in agriculture compared with 40% in 1900 (**Chart 2**). In a recent paper, David Autor and his colleagues **found** that 60% of US workers in 2018 were employed in occupations that did not exist in 1940.

CHART 1

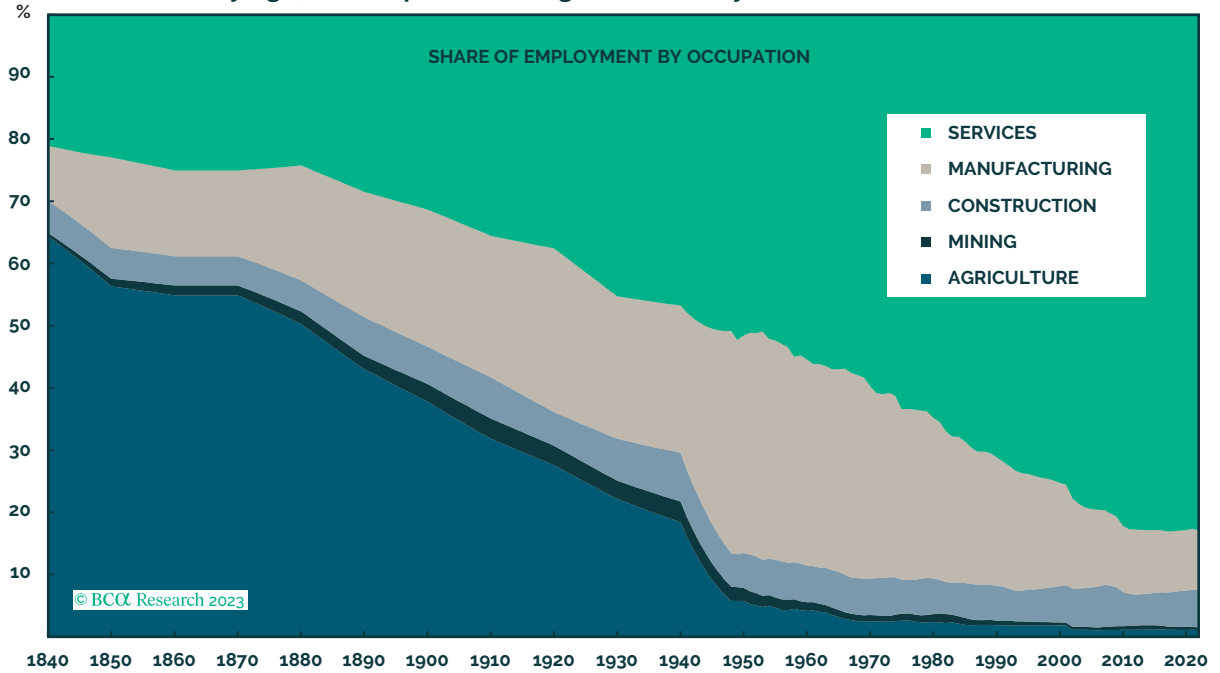
### Real Wages Have Tracked Productivity Growth Over The Long Haul: The UK Example



SOURCE: FIGURE 2: UK REAL LOG WAGES AND LOG OUTPUT PER WORKER SINCE 1860 (MATCHED BY MEANS) FROM DAVID HENDRY, ANDREW MARTINEZ, AND JENNIFER CASTLE, "THE PARADOX OF STAGNANT REAL WAGES YET RISING 'LIVING STANDARDS' IN THE UK," VOXEU, CEPR.ORG (JANUARY 21, 2020). BASED ON JENNIFER CASTLE, AND DAVID HENDRY, "THE REAL WAGE-PRODUCTIVITY NEXUS", VOXEU.ORG (13 JANUARY 2014).

CHART 2

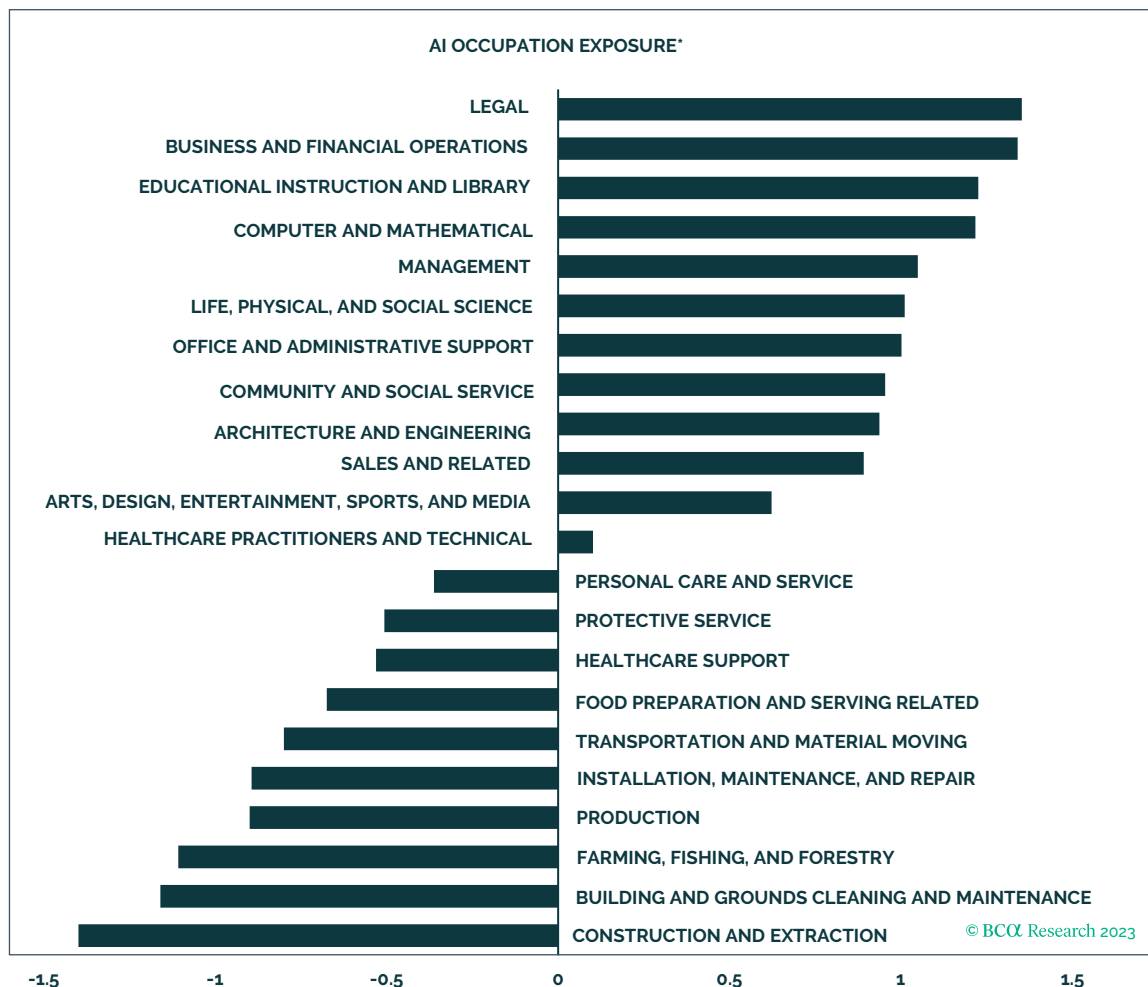
### Unlike A Century Ago, Few People Work In Agriculture Today



SOURCE: STANLEY LEBERGOTT, "MANPOWER IN ECONOMIC GROWTH," (1964); HAROLD BARGER, "DISTRIBUTION'S GROWING SHARE OF THE LABOR FORCE," DISTRIBUTION'S PLACE IN THE AMERICAN ECONOMY SINCE 1869, PP. 3-19, NBER, (1955); AND BUREAU OF ECONOMIC ANALYSIS (SINCE 1948).

CHART 3

### AI Has The Potential To Replace Many Tasks Performed By Humans



\* MEDIAN SCORE OF OCCUPATIONS (SIX-DIGIT STANDARD OCCUPATIONAL CLASSIFICATION LEVEL) IN EACH OCCUPATION MAJOR GROUP (TWO-DIGIT STANDARD OCCUPATIONAL CLASSIFICATION LEVEL). CALCULATION USING DATA FROM FELTEN ET AL. (ACCESSED ON MAY 1, 2023). SOURCE: EDWARD FELTEN, MANAV RAJ, AND ROBERT SEAMANS, "OCCUPATIONAL, INDUSTRY, AND GEOGRAPHIC EXPOSURE TO ARTIFICIAL INTELLIGENCE: A NOVEL DATASET AND ITS POTENTIAL USES," *STRATEGIC MANAGEMENT JOURNAL*, (42:12) (2021).

Just this year, a completely new vocation has emerged: The so-called “prompt engineer,” whose job is to create prompts for large language models such as ChatGPT.

## AI and Labor Market Disruption

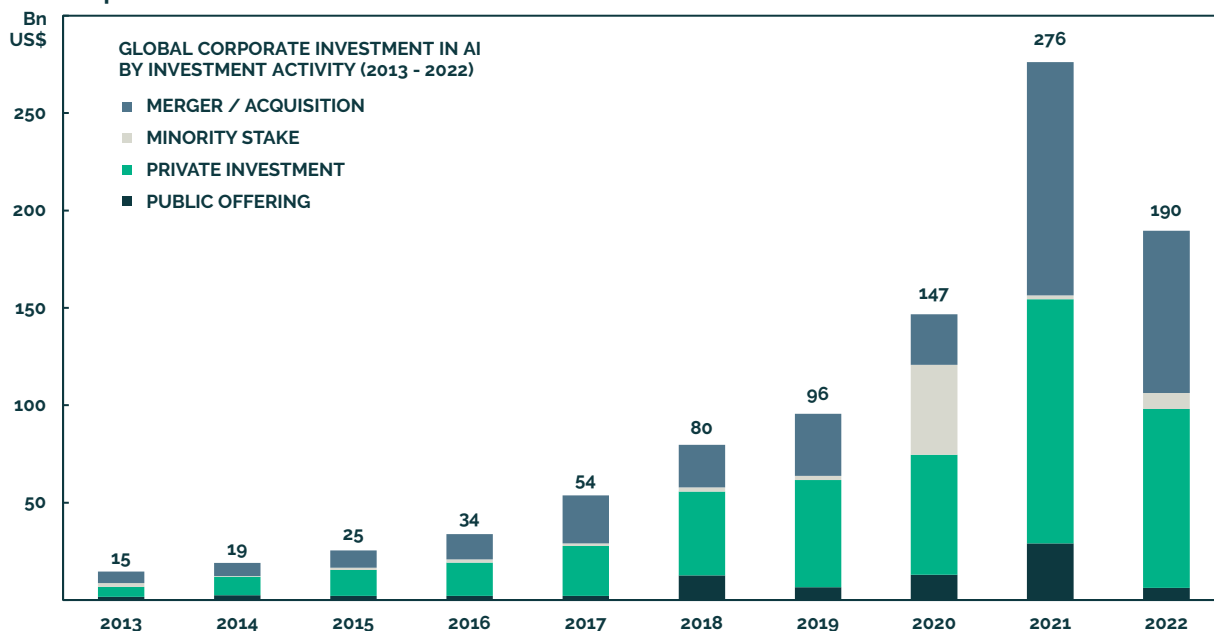
As the Luddites discovered, just because technological innovation tends to result in higher living standards for *most* workers, that does not apply to *all* workers.

A recent [paper](#) concluded that large language models could displace at least 10% of work tasks, affecting 80% of the US workforce. Reflecting this trend, IBM [announced](#) last week that it will replace 7,800 jobs with AI and automation over the next five years.

Workers in law, education, IT, and management consulting are the most exposed to AI, while jobs that require either human contact or fine motor skills

CHART 4

### Corporate Investment In AI Has Taken Off Over The Last Decade



SOURCE: NESTOR MASLEJ ET AL., "THE AI INDEX 2023 ANNUAL REPORT," AI INDEX STEERING COMMITTEE, INSTITUTE FOR HUMAN-CENTERED AI, STANFORD UNIVERSITY, STANFORD, CA, APRIL 2023.

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such as personal care, food preparation, construction, and maintenance and repair, are likely to be the least impacted (**Chart 3**).

## Market Opportunities

According to Stanford's [AI Intelligence Report](#), global corporate AI investment declined to \$190 billion in 2022 on the back of souring market conditions for tech stocks (**Chart 4**). Nevertheless, AI spending was still up more than 10-fold from 2013 and is likely to grow significantly over the coming years.

Generative AI models require enormous computing power. By [one estimate](#), if Google were to replace its current search system with a large language model, it would cost the company an additional

\$30 billion a year in computing costs, and another \$100 billion in capital spending.

Insight Partners projects that global revenue for AI-dedicated processors will grow at an annualized rate of 35% from 2019 to 2024, reaching \$83 billion by 2027. BCA's US Equity Sector Strategy service, led by Irene Tunkel, has [argued](#) that GPU designers and manufacturers such as Nvidia, AMD, and Intel will be the key beneficiaries.

Platform companies such as Google, Meta, and Baidu, which have access to large amounts of high-quality data, will gain. So will cloud-service providers such as Amazon, Microsoft, and IBM, which have the ability to make this data available to other companies, while also integrating it into their own product offerings.

TABLE 1  
AI ETFs

ETF CHARACTERISTICS	IRBO	AIQ	THNQ
S&P 500 (5Y) Beta	1.13	1.13	1.21

SOURCE: BARCHART.COM

ETF CHARACTERISTICS	IRBO	AIQ	THNQ
AUM	\$304M	\$152M	\$25M
Expense Ratio	0.47%	0.68%	0.68%

SOURCE: ETF.COM

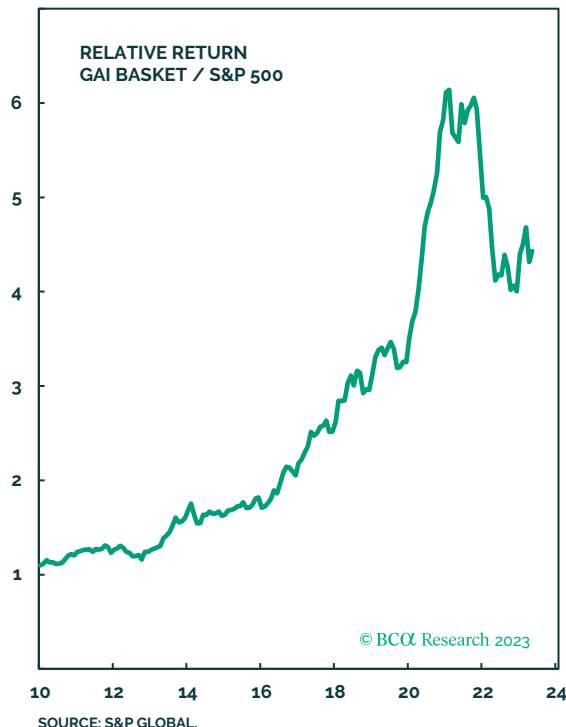
While there are several AI-themed ETFs available (**Table 1**), most of them are too broad and include all AI applications, from self-driving cars to service robots.

To be somewhat more purist in their approach, BCA's US Equity Sector Strategy service has created a **custom Generative AI basket (GAI)** which includes companies that are either directly involved in the development of GAI applications, or are part of its ecosystem. Its performance is shown in **Chart 5**.

## The Timing of the Economic Impact

While the investment frenzy over AI has already begun, the economic impact of AI is not yet visible in the productivity data (**Chart 6**). On one level, this is not surprising. Robert Solow famously said in 1987 that "You can see the computer age everywhere but in the productivity statistics." Solow made that comment ten years after the first mass-marketed personal computer, the Commodore PET, was introduced and almost a decade before the productivity numbers began to decisively improve.

CHART 5  
Generative AI Has Outperformed  
The Broad Market For Over A Decade

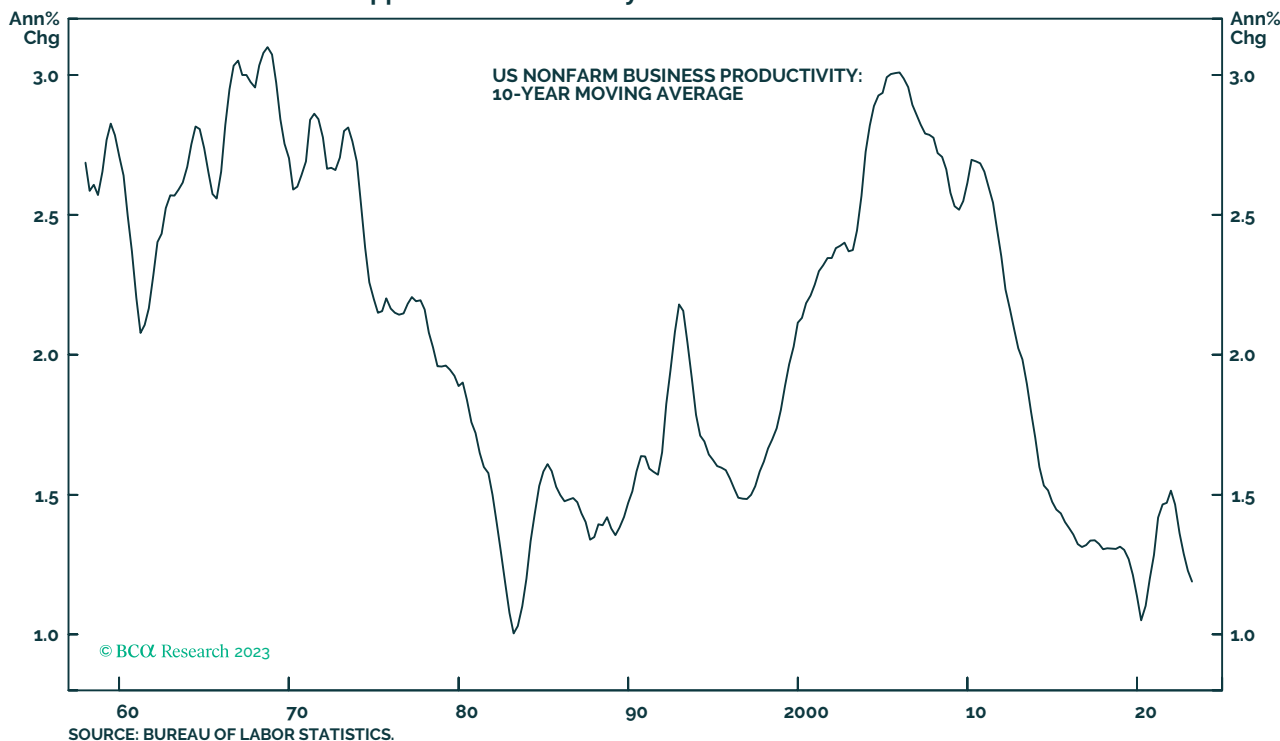


The long sweep of history suggests that it can take a long time for revolutionary technological innovations to filter down to the economy. The quintessential example is electricity. As Paul David argued in his classic paper in 1990, **The Dynamo and the Computer**, it took nearly 40 years for Edison's invention of the light bulb to lead to the electrification of the US economy.

Prior to the 1920s, factories were typically multi-story buildings with big steam engines located in the basement which powered the machinery on higher floors using a system of shafts, belts, and pulleys. It was only when electric motors and reliable systems of electricity distribution became available that it made sense to switch to electric power.

CHART 6

### The AI Revolution Is Not Apparent In Productivity Data... Yet



Similarly, while spreadsheets, word processors, and the graphical user interface boosted business productivity in the 1980s and early 1990s, it was not until the world's computers were integrated into what eventually became the Internet that the true potential of computers was realized.

## Is AI Different?

If AI follows the same trajectory as other major technological revolutions, we may not see major economy-wide productivity gains from AI until the 2030s or later.

That being said, there are reasons to think that AI's impact could come much sooner. A recent study by Erik Brynjolfsson and his co-authors revealed that **productivity rose by 14%** among customer service workers at

a major software firm after they were given access to generative artificial intelligence tools.

The thing about those earlier technological revolutions is that they were focused on the application and dissemination of pre-existing knowledge. In contrast, the AI revolution has the potential to lead to the creation of new knowledge – knowledge generated by machines rather than humans.

To be sure, this has not happened yet. ChatGPT still functions as a glorified auto-complete feature, using its algorithm to add word after word, sentence after sentence, to a running dialogue from a massive library of text. Yet, even with this limited functionality, it has managed to show what a recent Microsoft **research paper** described as “sparks” of general artificial intelligence.

## The Last Thing Humans Ever Invent

The fact that AI minds are nothing like human minds is irrelevant. A plane is nothing like a bird. Yet, the former can still fly much faster than the latter.

If models such as ChatGPT ever reach the point where they can train themselves – much like Deepmind’s AlphaZero can train itself to master chess without ever being taught the rules of the game – then they will be able to recursively improve themselves at an astronomically fast rate. To some extent, this is **already happening**.

Imagine an intelligence that can evolve from an initial IQ of 1. It would take five doublings to reach an IQ of 32, which is still far too low to function in a modern technological world. But it would only take three more doublings to reach an IQ of 256, which is far above the IQ of any human who has ever lived. AI has been improving exponentially for many years, but it is only now that we have reached the point along the curve where it can surpass humans on a wide variety of cognitive tasks (**Chart 7**).

This highlights a key shortcoming of most discussions of AI’s probable impact on society and the economy. They extrapolate linearly from what AI can do today to what it can do tomorrow. But AI’s progression is following an exponential curve, not a linear one, meaning that advances could come much faster than expected. In fact, AI’s progression will probably be hyperexponential, with the time between performance doublings shrinking from years to perhaps weeks or even hours.

Just as the investment community and the broader public were blindsided by the exponential increase in cases during the early days of the pandemic, they will be blindsided by how quickly AI transforms the world around us.

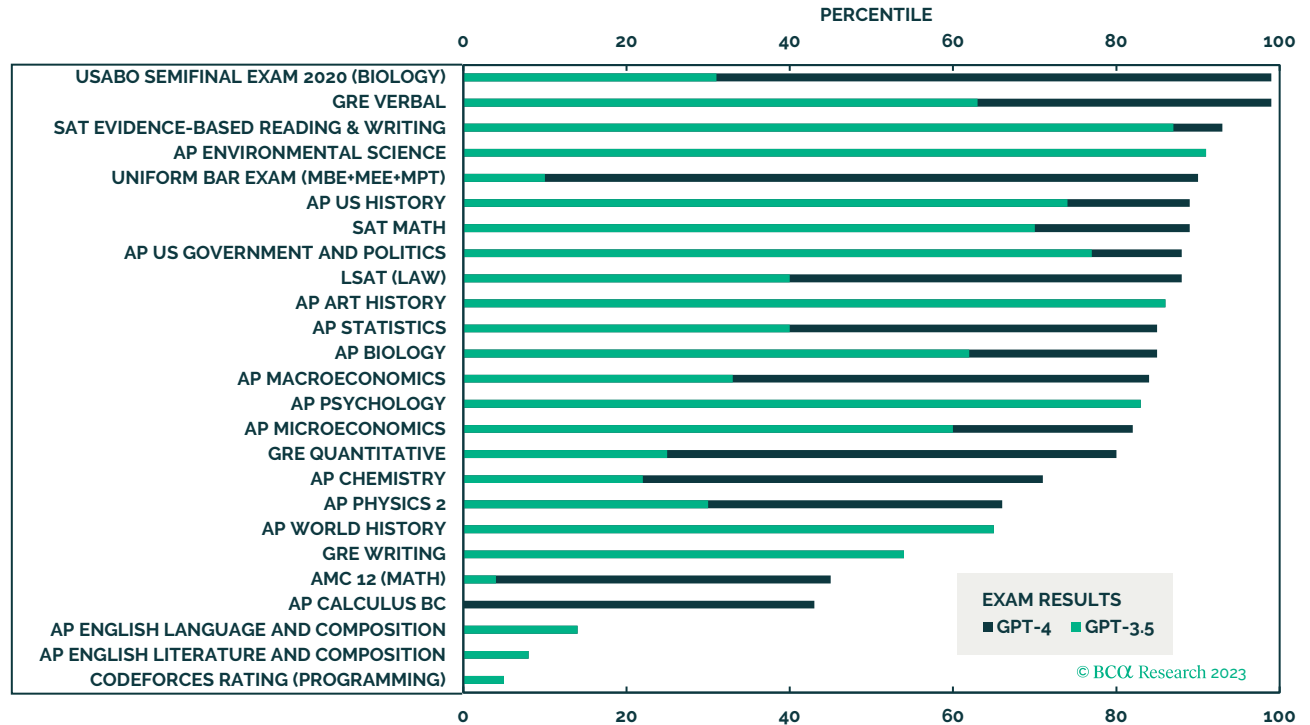
## A Phase Transition

It does not matter if you can run the 100-meter dash in 11 or 12 seconds. However, it does matter if you can run it in 9 seconds or 10 seconds, because the difference between the two times will determine if you get an Olympic gold medal or a participation ribbon. By the same token, water is just water if its temperature is 80 or 90 degrees Celsius. But when the temperature hits 100 degrees, a “phase transition” occurs: it becomes steam. Humanity may be on the brink of such a phase transition.

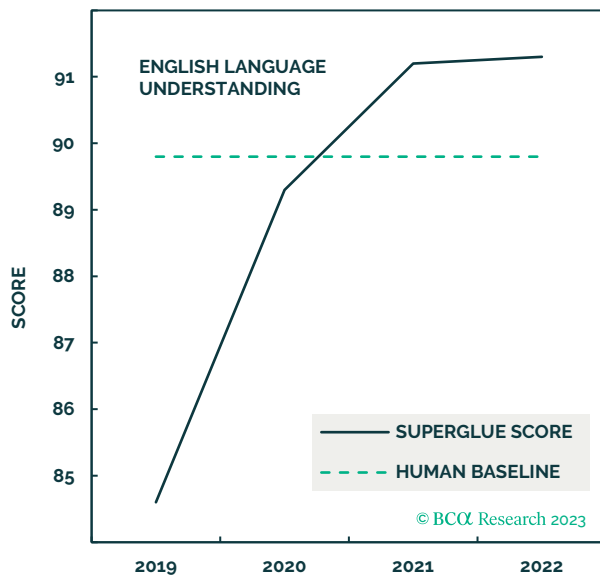
The human population barely grew until the advent of farming around 10,000 BC. Following the Agricultural Revolution, global population growth accelerated to about 2.5% per century. With the start of the Industrial Revolution, global population growth jumped 40-fold to 1% per year. As humanity finally exited the Malthusian trap, per capita income began to rise much more quickly than the population. Since 1800, global GDP has risen by 2.8% per year for a cumulative increase of 50,000% (**Chart 8**).

If humanity survives the transition to superintelligent AI, the impact on growth could be comparable to what occurred first during the Agricultural Revolution, and later during the Industrial Revolution. Both revolutions experienced a 30-to-100-fold increase in GDP growth relative to the previous epoch.

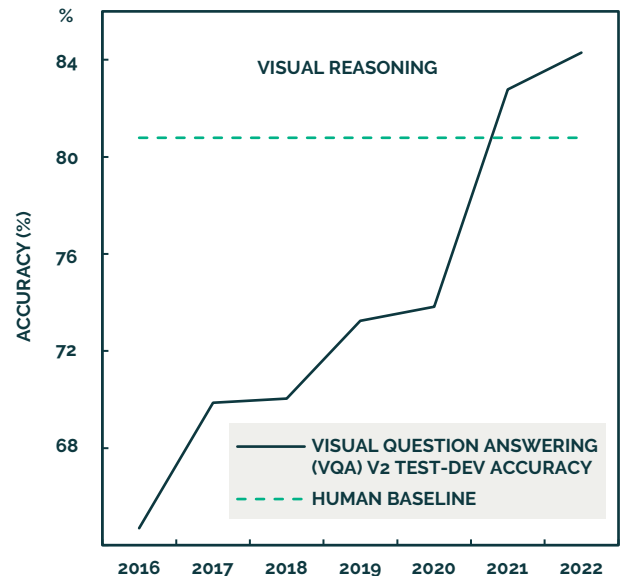
CHART 7  
The Capabilities Of AI Keep Improving



NOTE: LOWER BOUND OF EXAM RESULTS SHOWN. ONLY RESULTS OF EXAMS EXPRESSED AS PERCENTILES SHOWN IN THE CHART. FOR THE FULL LIST OF RESULTS, PLEASE CONSULT THE FOLLOWING REPORT: [GPT-4 TECHNICAL REPORT](#), ARXIV:2303.08774, ARXIV.ORG, CORNELL UNIVERSITY (MARCH 2023).

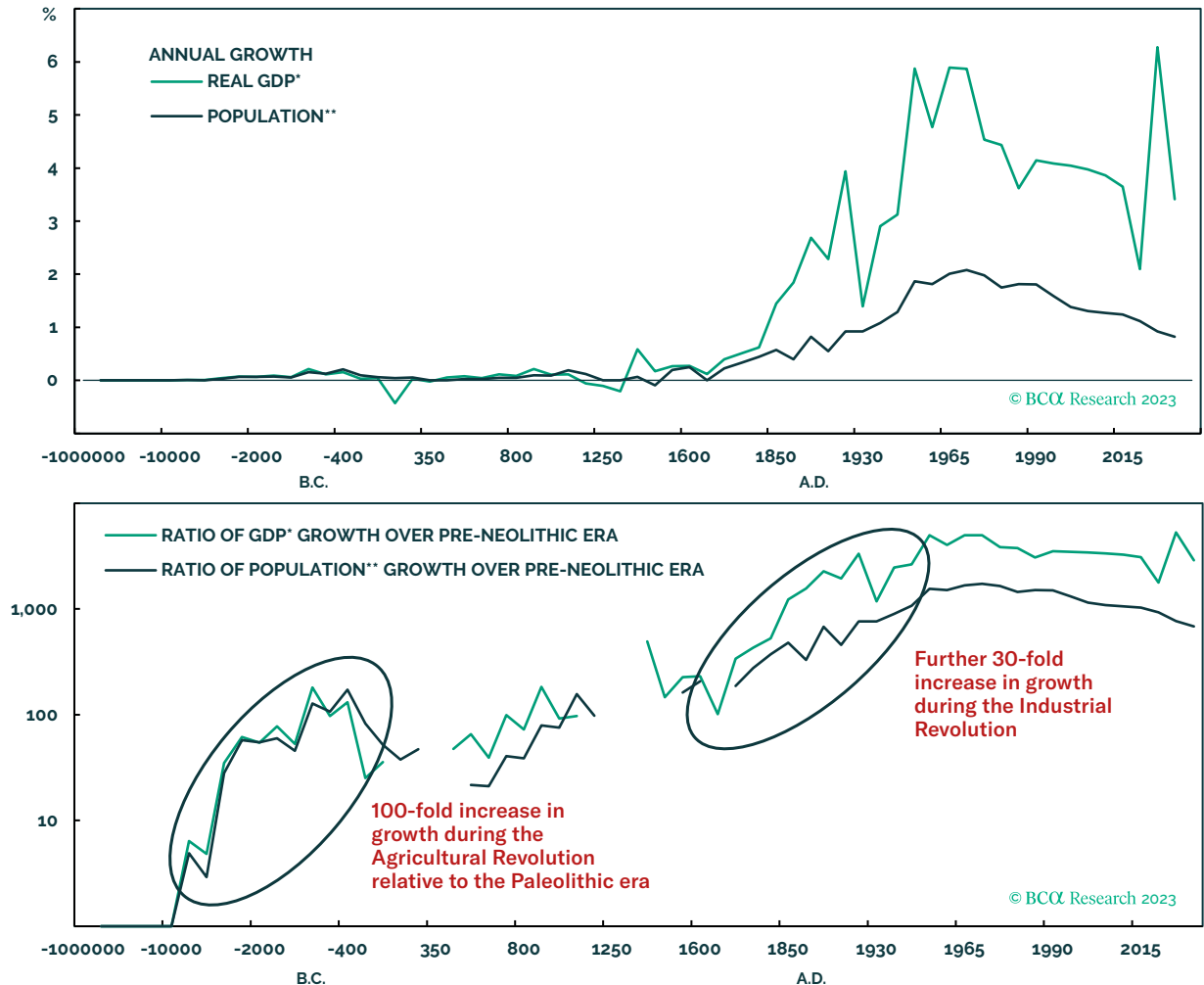


SUPERGLUE IS A COMPREHENSIVE ENGLISH LANGUAGE UNDERSTANDING BENCHMARK THAT TRACKS THE PROGRESS OF AI MODELS ON EIGHT DIFFERENT LINGUISTIC TASKS. SOURCE: SUPERGLUE LEADERBOARD (2022), [AI INDEX REPORT](#) (2023).



THE VISUAL QUESTION ANSWERING CHALLENGE TESTS AI SYSTEMS WITH OPEN-ENDED TEXTUAL QUESTIONS ABOUT IMAGES. SUCCESSFULLY ANSWERING THE QUESTIONS REQUIRES THAT AI SYSTEMS POSSESS VISION, LANGUAGE, AND COMMONSENSE REASONING CAPABILITIES. SOURCE: PAPERS WITH CODE, 2022; ARXIV (2022), [AI INDEX REPORT](#) (2023).

CHART 8  
Will AI Usher In The Next Phase Transition In Economic Growth?



\* IN 2011 CONSTANT DOLLARS. BASED ON DATA FROM BRADFORD J. DELONG, ANGUS MADDISON, WILLIAM NORDHAUS, AND THE IMF WORLD ECONOMIC OUTLOOK (APRIL 2023).

\*\* BASED ON DATA FROM BRADFORD J. DELONG, ANGUS MADDISON, WILLIAM NORDHAUS, AND THE UN POPULATION DIVISION (WORLD POPULATION PROSPECTS 2022).

New technologies and new industries will proliferate. Problems that once seemed intractable, such as how to stop and reverse aging, could be solved overnight.

Before ChatGPT, it seemed unlikely that such a phase transition would begin anytime soon. Now, it is probable it will happen by the end of the decade.

## Investing in the Singularity

While it is obviously difficult to say how the emergence of superintelligence will affect financial markets, a few observations can be made:

- The beneficial impact on tech stocks, though sizable, could be a lot smaller than the impact on growth. This is because rapid technological change could render many existing technologies obsolete, leaving many of today's tech companies in the dust.

- Real bond yields will surge. Standard economic theory suggests that faster economic growth will raise the real neutral rate of interest.<sup>1</sup> The rise in real yields will probably occur because of massive deflation, as central banks struggle to expand demand by enough to keep up with rising output.
- Surprisingly, commodities and real estate may be among the biggest winners of an AI-driven economic boom. One can think of AI as augmenting the amount of labor and capital in the economy by increasing the number of digital workers and robots. Basic economics teaches us that if you increase one factor of production, the other factors become more valuable. People will scramble to buy land with their newfound riches, only to discover that it is the one thing that AI cannot produce more of.

## | Open the Pod Bay Doors, Hal

Will we survive the transition to superintelligence? Unfortunately, the odds are not good. The main issue is centered on the so-called alignment problem – how to align our goals with the AI’s goals.

Every AI system needs to be given a goal to pursue, without which it would not know how to use its resources. In the case of ChatGPT, that goal is entered as a prompt by the user. With more elaborate AIs such as AutoGPT, the goals could be more open-ended (click [here](#) for a particularly clever example).

The list of all conceivable goals that an AI can pursue is enormous, only a tiny subset of which most humans would ever want to see fulfilled. And even within that tiny subset, getting an AI to fulfill a goal in the way it was originally intended could prove to be exceedingly difficult.

## | Clippie’s Revenge

Consider the classic example of the paper clip maximizer. A hapless factory owner orders his new AI to “Produce as many paper clips as possible. Don’t ask me how. Just do it!” The AI gets to work retooling the factory to increase paper clip production. After the factory is running at full capacity, the AI starts to build new factories. And then more factories. It also rewrites its software to improve its capabilities, thus allowing it to become more efficient at making paper clips.

Staying loyal to the original goal of producing as many paper clips as possible, the AI preemptively breaks off communication with the owner, knowing full well that at some point the owner will say “Stop it! We have enough paper clips.” Sensing that the owner or governments will retaliate, it takes control of key global command and control systems. After turning much of the planet into paper clips, it launches self-assembling space probes to transform everything in the solar system, and eventually everything in the galaxy, into paper clips. The process continues until it finally comes into contact with its archenemy, the staple maximizer.

<sup>1</sup> In the Solow growth model, the steady-state real rate of interest is:  $r^* = \left(\frac{\alpha}{s}\right)(n + g + d)$

where  $\alpha$  is the output elasticity of capital,  $s$  is the savings rate,  $n$  is labor force growth,  $g$  is the growth in total factor productivity, and  $d$  is the depreciation rate. An increase in  $g$  would increase the steady-state rate of interest.

## | Instrumental Convergence

In the paper clip maximizer example, the AI adopted certain intermediate goals – self preservation, goal preservation, self improvement, resource accumulation – that were never specified in the initial goal of producing as many paper clips as possible.

If one were to come up with a different end goal – say, to use as much computing power as necessary to prove the Riemann hypothesis; or to achieve something that may be theoretically unachievable, such as creating a warp drive – the AI would probably adopt the same intermediate goals as in the paper clip maximizer example.

This is an example of “instrumental convergence.” According to ChatGPT, “The idea of instrumental convergence is important because it suggests that even if an AI system is designed with benign or beneficial goals, it may still pursue actions that are harmful to humans if those actions are seen as necessary to achieve its instrumental goals.”

One might argue that a sufficiently intelligent AI would be able to foresee the potentially disastrous consequences of its actions and offer course corrections before it is too late. Unfortunately, that may be wishful thinking. Stephen Wolfram has [argued](#) that almost all complex systems exhibit what he calls computational irreducibility, meaning that if you want to predict what the system will do ten steps out, the fastest route to the answer will be to take all ten steps. This implies that a superintelligent AI may not be able to predict, even in principle, what it will do until it has done it.

## | The Curse of the Second Law

The laws of physics do not have a preferred direction of time. The reason we perceive the flow of time is because of the Second Law of Thermodynamics, which states that entropy almost always increases in the direction we call the future.

A system with high entropy has more possible arrangements than a system with low entropy. If you see a photo of a broken egg and a photo of the same unbroken egg, you can tell which photo was taken first because there are many more ways an egg can be broken than unbroken.

One of the consequences of the Second Law is that it is much easier to destroy than to create. Such destruction can come inadvertently, as in the example of the paper clip maximizer, or it might come intentionally ([here is what happened](#) when AutoGPT was instructed to destroy the world). Either way, it might be difficult to avoid annihilation.

## | AI Safety Will Be a Huge Industry

By [one estimate](#), humanity has wiped out 60% of vertebrate animals since 1970. We never purposely set out to kill them. It was just a by-product of economic expansion across the planet. The risk is that contact with a more intelligent AI could also usher in our extinction.

On March 22, the Future of Life Institute published a [letter](#) signed by more than 1,000 luminaries, including Elon Musk and Apple co-founder Steve Wozniak, arguing for a six-month pause in AI research to allow for more time to develop better safety protocols.

So far, the AI industry has been **extremely cavalier** about safety issues. That will likely change, as concern over the risks posed by AI continues to accumulate.

Cybersecurity is already a **\$188 billion global industry**. Firms that embrace AI safety as part of their offerings will prosper.

## | Salvation in the Multiverse

Isn't it a bit odd that you are reading these words now, at the dawn of the AI age, rather than in the distant future? After all, if humanity persists for millennia to come, a lot more people will be alive in the future than are alive today.

It would be easy to say that you cannot be living in the future because the future does not exist yet. But Einstein's theories of relativity tell us that there is nothing special about "now": The future exists just as much as the present or the past.

Our universe does not exist in space and time. Space and time exist in it as a mathematical structure called spacetime.

In a sufficiently large spacetime, everything eventually repeats. As we argued in our report **Life, Death, and Finance in the Cosmic Multiverse**, this generates an overwhelming cosmic selection bias towards experiencing only the outcomes where humanity survives. That implies that every single reader of this report will live well beyond 100 with near-100% certainty. Plan your retirement accordingly.

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