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Dear Partner,

	January 2025	2025	Alkeon Growth Strategy Since Inception (Cumulative)	Alkeon Growth Strategy Since Inception (Annualized)
Alkeon Growth Partners¹	6.53%	6.53%	2357.39²	12.55%²
MSCI World	3.47%	3.47%	309.63%	5.34%
MSCI AC World	3.29%	3.29%	281.36%	5.07%

Past performance is no guarantee of future results. Investing in securities involves substantial risks. Please see Important Notes at the end of this letter.

Alkeon Growth Partners Portfolio Information (Approximate)³:

- Net Exposure (delta adjusted) 76.9%
- Gross Exposure 174%
- Number of Long Positions 83
- Number of Short Positions 100

January offered positive results to global equities. Alkeon Growth Partners, LP returned 6.53%. Our long positions had positive performance during the month, while our short positions and market hedges underperformed. Portfolio performance was positive in the US, Europe, Latin America and Asia.

As you have seen in our recent communications, we remain cautious on the broader market, but at the same time, very constructive on the opportunity for stock-picking and potential for double-alpha generation. In that direction, we were certainly very pleased to deliver double-alpha in our portfolio last year.⁴ Before dissecting further our broad macroeconomic, market and technology views, we would like to first discuss a couple of very recent developments.

First, DeepSeek. Although not everything is known, the fact that DeepSeek’s models are open-source and have been tested gives us strong confidence to comment that the models are very powerful and impressive. DeepSeek was able to intelligently “stitch together” a number of algorithmic innovations such as MoE (“Mix of Experts”), a technique that combines multiple models into a larger model, MLA (“Multi-Head Latent Attention”) that reduces the size of KV Cache (Key Value Cache, memory) needed when running the program, and MTP (Multi-Token Prediction), a technique that allows you to run multiple tokens at the same time, to create a new, very advanced model. Although most of these innovations were known, others are more novel, such as the use of Nvidia’s PTX (Parallel Thread Execution) instead of CUDA to compile some code, getting closer to assembly language, effectively compiling on bare-metal and speeding things up.*

Also, DeepSeek’s models used a lower-precision data format, Float 8-bit or FP8, compared to the 16 or 32-bit that most western labs use. Furthermore, our understanding is that DeepSeek also reconfigured H800 GPU to overcome artificially imposed connectivity limitations, which helped to accelerate training speed. During training, DeepSeek also chose to use pure RL (Reinforcement Learning) without SFT (Supervised Fine Tuning). This saved significant costs while retaining similarly strong performance. Finally, DeepSeek designed an innovative pipeline parallelism algorithm called DualPipe, which accelerates model training by overlapping forward and backward computation.

As noted, DeepSeek models also use large-scale RL, in particular the Group Relative Policy Optimization (GRPO) algorithm, instead of PPO (Proximal Policy Optimization) that most western labs use (see <https://yugeten.github.io/posts/2025/01/ppogrp/> for technical details). The use of various RL techniques is most notable in DeepSeek’s reasoning model, R1. A DeepSeek researcher describes that “2025 could be the year of Reinforcement Learning”.⁵ We believe RL will be a very important part of the post-training techniques along with synthetic data generation, as Jensen Huang described recently in his three AI scaling law theory (see the full DeepSeek paper here: https://github.com/deepseek-ai/DeepSeek-R1/blob/main/DeepSeek_R1.pdf).

Putting aside the technical jargon, there are five key takeaways from the DeepSeek development to note. First, DeepSeek was able to put together very powerful models, expertly using and beautifully combining a series of existing innovations as well as introducing some great novel techniques. The models are impressive, and so is the DeepSeek team. The history of carefully “stitching together” a series of small to medium-size innovations is not new. Last year, Sam Altman, founder of OpenAI, in a podcast with Lex Fridman (rephrasing an Ilya quote) indicated that there is not one thing OpenAI does so much better, but rather “we multiply 200 medium-sized things together into one giant thing”.⁶

Second, there is a long history of companies claiming their foundational model is better than everyone else’s. This is what AI companies do, outcompete. This part is not new. For example, in China already a couple of models are claiming to be as good as if not better than DeepSeek.⁷ Commenting on DeepSeek, Sam Altman tweeted on X, “DeepSeek’s R1 is a very impressive model... we will obviously deliver much better models... [you will] be quite amazed by the next-gen models coming”.⁸



Sam Altman

“look forward to bringing you all AGI and beyond.”
(On X, January 27th, 2025)

*PTX is an assembly language that can improve performance in certain areas, especially for repetitive tasks such as instructions to GPU to run matrix multiplications or things like loading matrix saved in files into GPU, etc. Computer programmers will sometimes use assembly languages for certain performance critical instructions. But for a computer programmer to completely replace high-level compilers with PTX, whether it is C/C++ compilers or CUDA compilers, it would be extremely cumbersome and inefficient. The main challenge with PTX is that it does not scale easily. You can use PTX for 20,000 lines of code, but not 100,000 lines of code, let alone 500,000 or one million lines of code. It is also incredibly error prone compared to high level compilers, very tedious and it is very difficult to update and maintain.

Third, DeepSeek has claimed that they were able to dramatically reduce the cost of training and inference. It is very likely that the cited cost of training of their reasoning model, R1, is not referencing total training costs, which should also account for the cost of training DeepSeek’s “master” foundational model V3, which was then used to train R1 – the classic example to understand this structure, i.e., using expert models to train a smaller reasoning model, is to think of how long it would take to understand the laws of physics observing nature vs. being taught at school. Thus, the total cost is likely understated. Again, this is not new. Alphabet last year referenced a 90% reduction in costs of AI powered search results over an 18-month period.⁹ And Nvidia has referenced a 1,000x increase in compute per chip over 8 years, implying a commensurate reduction in the cost of training, all else equal. Importantly, and considering market implications, one should also carefully consider Jevons Paradox, an economic concept that suggests how the lower cost of a particular good ultimately leads to higher aggregate total dollar demand for that good.



Satya Nadella

“Jevons paradox strikes again! As AI gets more efficient and accessible, we will see its use skyrocket, turning it into a commodity we just can’t get enough of.”
(On X, January 2025)

Fourth, DeepSeek used “distillation”, a technique that uses outputs from existing powerful AI models, including its own, to train its reasoning model R1. That naturally raises the following question. Regardless of one’s view on technology export controls, if an administration decides to control hardware, would it not also be natural for it to control software models, which ultimately provide AI? A recently proposed Framework for AI Diffusion by the Bureau of Industry and Security (BIS) on January 13th is designed to impact foreign countries’ access to advanced chips as well as frontier models.¹⁰ Under the proposal, model weights become an export-controlled item. If implemented, it will make it more difficult to distill closed-source and open-source models above certain parameters. Under the proposal, BIS would require a license to export or transfer model weights of any closed-source and open-source models above a *1e26 FLOP compute budget* to non-Tier 1 countries. Llama 3 406B, for example, is right around this limit. So non-Tier 1 countries’ access to future generations of Llama open-source models and advanced closed-source models would be effectively restricted and controlled.

Fifth, there has been a passionate debate in the industry around open-source vs. closed-source (proprietary) models. Without taking a view on this, some of the main arguments around open-source models include advancing humanity faster and imposing better safety and bias controls vs. closed-source models that are black-box and “hidden” from the public eye or criticism. On the other hand, if ultimately AI reaches a super-human level –and we believe it has that potential–, supporters of closed-source models argue that offering a super-human model to potentially very bad adversaries, for free, may not be the greatest idea. The new administration’s AI Czar, David Sachs, in an All-In Podcast, mentioned that although DeepSeek was largely celebrated in Silicon Valley, the idea that DeepSeek is advancing humanity is an oversimplification, and that “self-interest” played a part.¹¹

The second recent development that we thought was noteworthy was Elon Musk’s reference at the end of January that he is cautiously optimistic the administration can reach a \$4 billion per day deficit reduction through September of this year, effectively cutting the federal deficit by half, or \$1 trillion. The administration believes they can cut the other half through economic growth. We are carefully evaluating these developments, as we have referenced unsustainably high fiscal deficits as being one of the three main structural risks that concern us.



Elon Musk

“Reducing the federal deficit from \$2T to \$1T in FY2026 requires cutting an average of ~\$4B/day in projected 2026 spending from now to Sep 30.

That would still result in a ~\$1T deficit, but economic growth should be able to match that number, which would mean no inflation in 2026.

Super big deal.

(On X, January 30th, 2025)

“I am cautiously optimistic that we will reach the \$4B/day FY2026 reduction this weekend”

(On X, January 31st, 2025)

The third recent development was tariffs. This is a fluid and evolving set of policies, and there is of course a significant negotiating aspect to this development. As we are putting the final touches on this letter, it was already announced that both Canada and Mexico tariffs were delayed for a month, as the administration seeks to complete a deal. Both equity and bond markets reacted relatively calmly on the announcement. The effect on the economy and markets is difficult to fully and accurately assess, as many interrelated vectors have opposing effects. For example, basic economic theory suggests that tariffs in isolation are likely, in the near-term, to both slow down the economy and increase inflation (with general ranges of 30bps to 100bps and 20bps to 70bps, respectively, on the recent announcement).¹² These of course are opposing forces in the Fed's efforts to determine whether to raise or lower rates. (The Fed has said that they cannot predict the effect of tariffs on the economy and will wait to assess the data.) Consistent with this view, right after the announcement, on Monday, February 3rd, both 10-year Treasuries and 10-year Breakevens remained relatively unchanged.

But this is in isolation. In reality, one has to carefully consider the important effect of other factors (which themselves are a result of tariffs being imposed) such as US dollar appreciation (which effectively reduces the pass-through of tariffs to the end US consumer and is itself a disinflationary factor), retaliation by trade partners, the desire by foreign exporters to absorb part of the tariff increase in currency-adjusted terms (or risk losing market share), as well as the desire of importers and retailers in the US to also absorb part of announced tariff increases. And of course there are significant long-term effects. We plan to provide more details on the subject in future communications, but we emphasize that the subject is quite complex.

With these important recent developments in mind, we can now turn to discussing our broad views on the economy, markets and technological innovation.

We continue to find significant opportunities to invest in high quality growth compounders at attractive relative multiples in the current market environment. Additionally, given more recently elevated valuations for the broader equity market, particularly in the US, we are also seeking to remain highly selective in our stock picking.

Furthermore, we see elevated tail risks currently, including around increased social polarization and potential for social unrest as well as unsustainable large fiscal deficits and global geopolitical uncertainty, and therefore we believe it is more imperative than ever to *balance our high conviction long investments* in quality secular growth companies with alpha-seeking short investments as well as structured market hedges, and also to stay globally diversified, seeking to reduce concentration in any single country, currency or regional economy.

Stepping back for a moment and looking at the broader macroeconomic picture, 2023 marked the end of the most aggressive global tightening cycle in decades, which, as we show below, particularly hurt high growth stocks over this period. This dynamic began to change in 2024, in our view. As we elaborate in this letter, we currently believe the monetary backdrop is gradually and slowly shifting, changing in a way that is favorable to growth investing.

In fact, June 2024 was the first month since October 2020 in which no central bank globally raised rates.

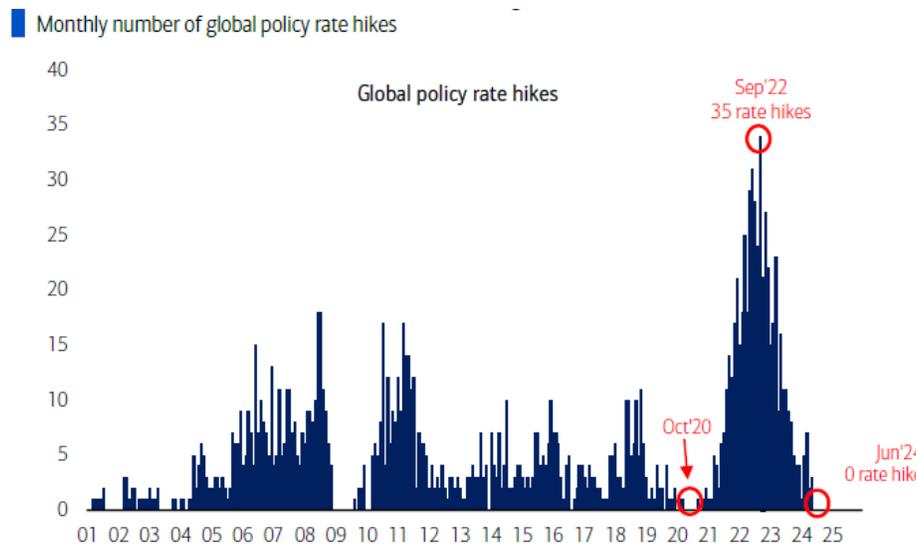


Exhibit 1. Monthly Number of Global Policy Rate Hikes, July 2024, source BofA Global Research.

Overall, central banks cut rates in 2024 at the fastest rate since the Covid crisis.

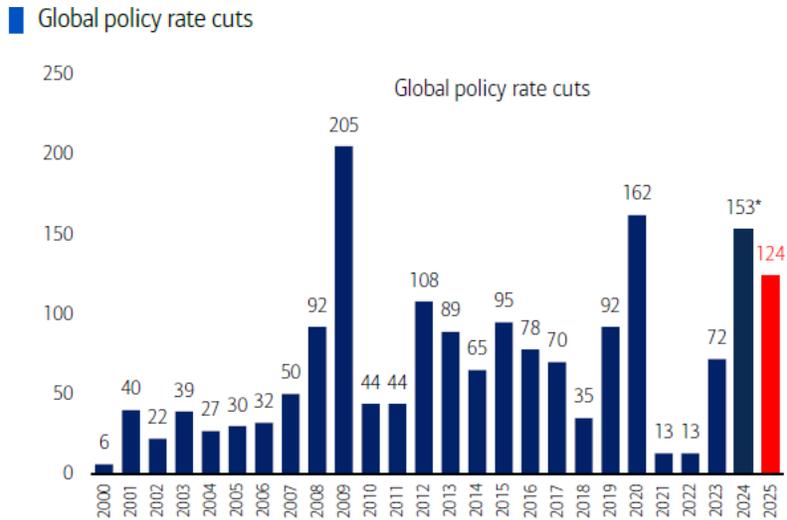


Exhibit 2. Global Central Bank Policy Rate Cuts, November 2024, source BofA Global Research.

And despite last year's positive returns, the cumulative correction in high growth stocks over the last four years has been severe. Specifically, and according to Empirical Research, the 75 fastest growing US stocks corrected more than 69% vs. the market from their early 2021 peak through their trough in early 2023, erasing all 2019 and 2020 relative gains; in fact, by early 2023 all relative gains since 2017 had been erased! This was remarkable.

Even with the market's appreciation in 2023 and in 2024, the correction in high growth stocks stands at more than 45% from the early 2021 highs.



Exhibit 3. The Big Growers Relative Growth of a Dollar (Equally Weighted), December 2024, source Empirical Research.¹³

This severe correction in high-growth stocks –since their early 2021 peak– continues to present potential significant opportunities to buy high quality, classic growth compounders at attractive relative multiples, in our view.

And we currently believe there are other broad groups where stocks have not yet recovered, and where attractive risk/reward opportunities are persisting. For example, almost half of Nasdaq stocks are still down 50% or more from their 2021 highs.

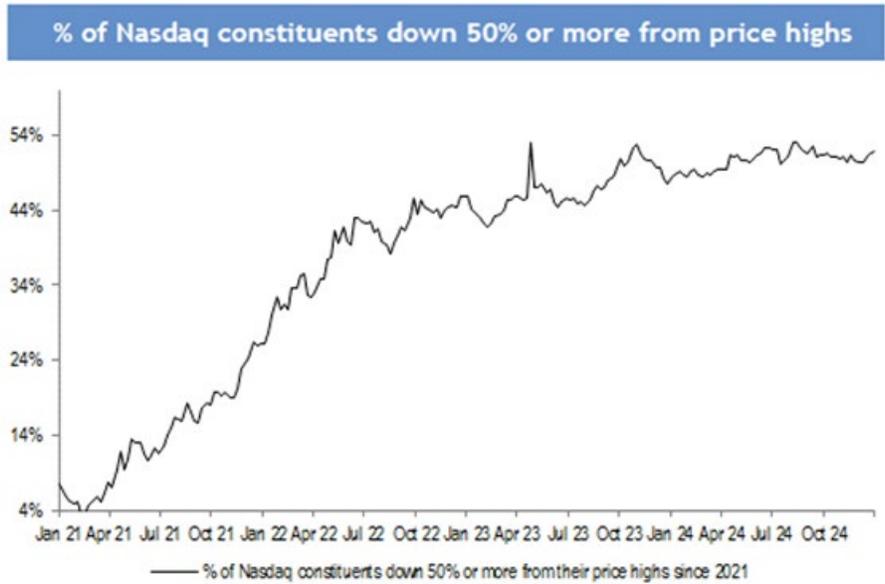


Exhibit 4. Percentage of Nasdaq Constituents Down More Than 50% Since 2021 Price Highs, January 2025, source JP Morgan.

Moreover, many high growth segments of the market have actually continued to de-rate. For example, both Fintech and non-profitable Tech are still currently trading at Price/Sales relative multiples below their historical medians, with non-profitable Tech trading close to all-time lows.

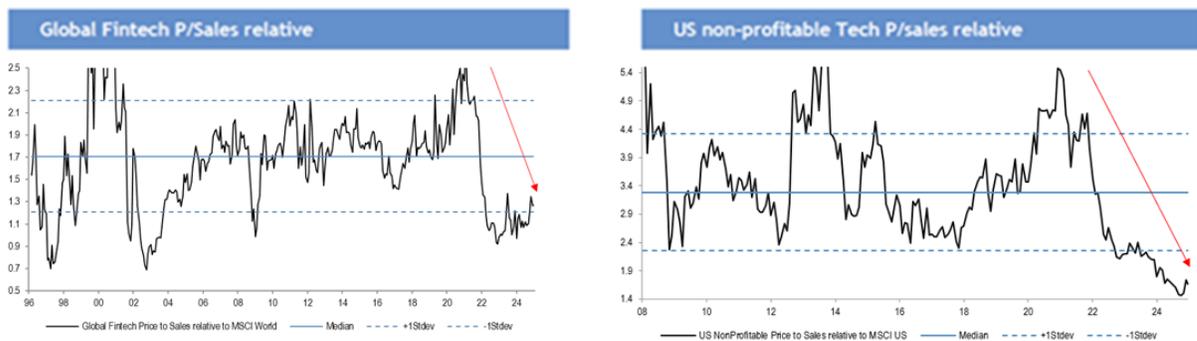


Exhibit 5. Global Fintech & Non-Profitable Tech Price/Sales, January 2025, source JP Morgan.

This may start to change as rates slowly go down, as long-duration groups, i.e., stocks expected to produce their highest cash flows in the future such as unprofitable tech, have historically been very sensitive to changes in interest rates and they tend to outperform when rates go down.

Lower rates should also help the relative profitability of small cap stocks, which, excluding financials, have been carrying a larger amount of floating rate debt vs. large cap stocks.

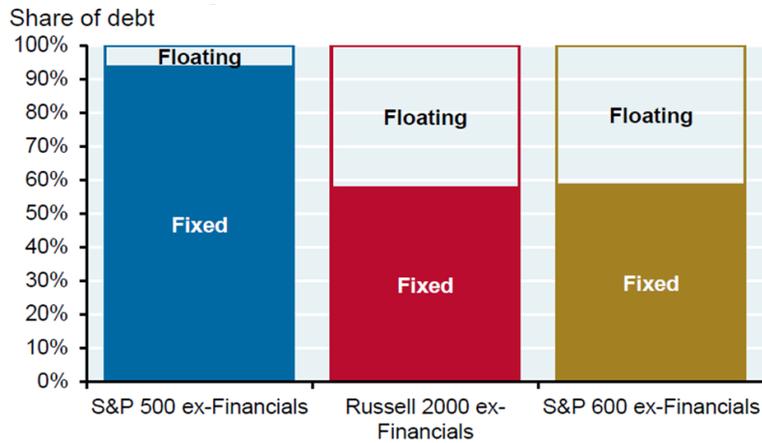


Exhibit 6. Fixed vs Floating Rate Debt, July 2024, source JP Morgan.

The challenge, however, small caps may face is the tug of war between falling rates and a structurally challenged economy. Historically, small capitalization equities tend to perform better early in the economic cycle (for example coming out of a recession), not late in the cycle. Small caps also tend to include lower quality names, with much lower free cash flow margins, significantly higher debt to cash flow ratios and a much larger percentage of unprofitable companies in aggregate, relative to large caps.

	Operating Margin T12	Net Debt/EBITDA	Earnings Growth Q4	% Constituents Reported a Loss		
				Current	Decade ago	Start of Millenium
Russell 2000	3.7%	4.6	-19.6%	43.5%	31%	22%
S&P 500	13.9%	1.5	8.8%	4.8%	4%	6%

Exhibit 7. Russell 2000 Index vs S&P 500 Index, December 2024, source Alkeon, Bloomberg and FactSet.

To offer a last example of how the correction in high growth stocks since 2021 has a long way to change course, both SaaS companies and fast-growth Internet companies are currently trading at multiples significantly below their 2021 peaks.

Tech Valuations

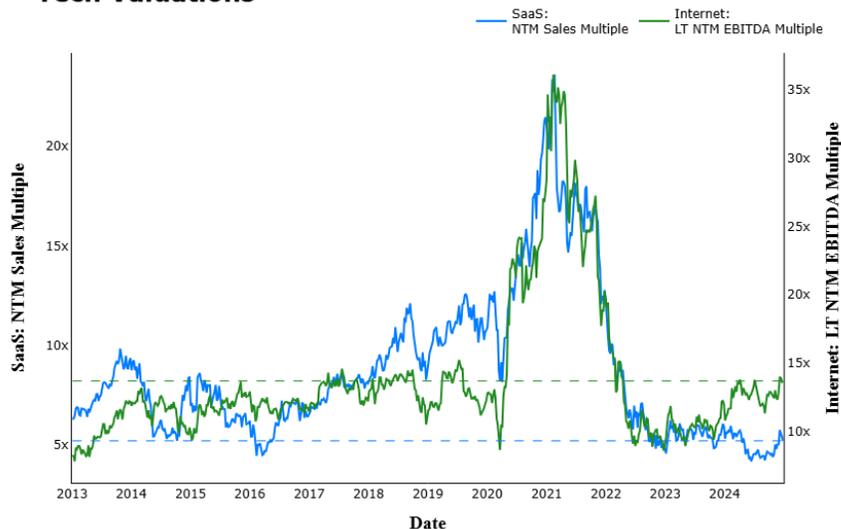


Exhibit 8. SaaS and High Growth Internet Valuations, December 2024, source FactSet and Alkeon.¹⁴

In summary, and despite this year's rally, we believe there currently do remain attractive opportunities to invest in high quality growth compounders at attractive relative multiples.

Emphatically, we believe these opportunities are select. As we will elaborate below, given high market valuations and the widening gap between winners and losers (due in part to the impact of AI), we believe stock picking and the ability to short stocks and use market hedges to mitigate risk have become increasingly important in the current market, which we characterize as unattractive in the aggregate.

Furthermore, we have continued to hedge our top portfolio investments via a combination of individual stock options and hedges embedded in index or ETF options attributable to such positions. At the end of January, approximately 17.61% of the aggregate exposure of our top five positions remained unhedged.¹⁵ Our total value at risk (i.e., the risk of total loss of capital) for our top five positions at month end was approximately 35.82% in aggregate.

Such active efforts to short stocks and hedge the portfolio have become imperative, in our view, *given the increased potential for tail risk events (such as default or currency debasement in light of unsustainably high fiscal deficits) and elevated geopolitical uncertainty, which we currently regard to be at one of the highest levels ever.*

As noted above, we are concerned about the level of valuations in the equity market, especially in the US. Last year the S&P 500 produced a total return almost three times its underlying earnings growth. On the other hand, 10-Year Treasury yields rose by 70bps in 2024 and have risen further so far this year.¹⁶ Such divergence is very alarming, in our view.

The US market, in particular, is very expensive, offering a rather unattractive risk/reward proposition in aggregate, with a forward P/E ratio that stands 39% above its historical median.

12m Fwd. P/E across key geographies			
	Current	20Y Median	Current vs Median
Italy	10.1	11.9	-15%
Spain	10.3	11.9	-14%
UK	11.4	12.4	-8%
Eurozone	13.1	12.8	2%
Japan	14.7	14.2	3%
Germany	13.0	12.4	5%
EM	12.0	11.3	6%
France	13.6	12.8	6%
Switzerland	16.5	15.1	9%
World	19.2	15.0	28%
US	21.9	15.8	39%

Exhibit 9. 12-Month Forward P/E, January 2025, source JP Morgan.

In fact, the only times the forward P/E on the S&P 500 was higher in recent decades was in early 2021 (post-Covid rally) and the Internet bubble in the late 90's.

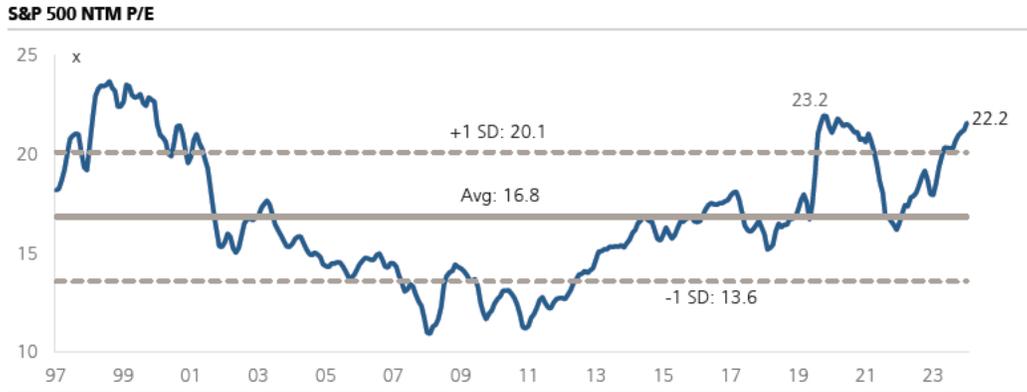


Exhibit 10. S&P 500 Index NTM P/E, December 2024, source UBS.

Not only is the US market unattractive on a standalone, absolute basis, but also it is very expensive against the rest of the world on a relative basis, trading at the biggest P/E premium in decades.

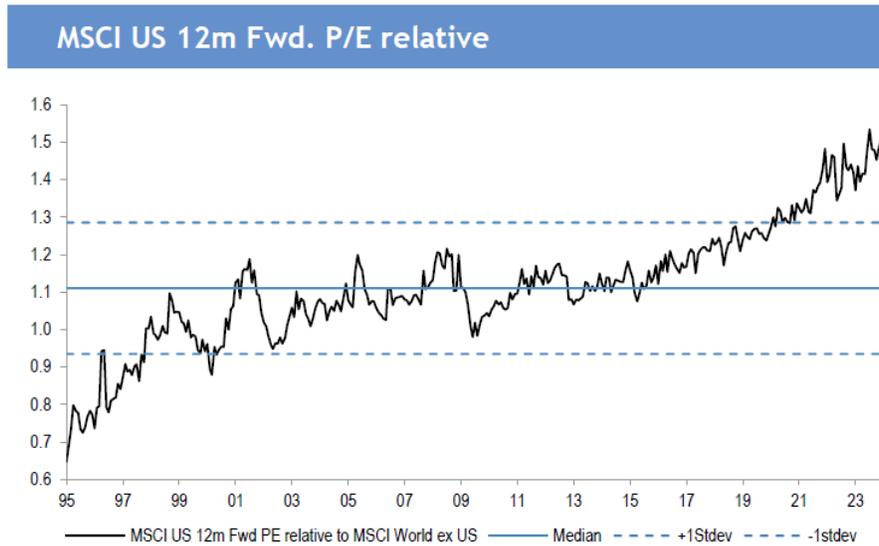


Exhibit 11. MSCI US 12M Forward P/E Relative to World ex US, January 2025, source JP Morgan.

And even the S&P 500 equally weighted P/E, which normalizes outliers, and removes concentration, shows the US market remains extended vs. real yields.

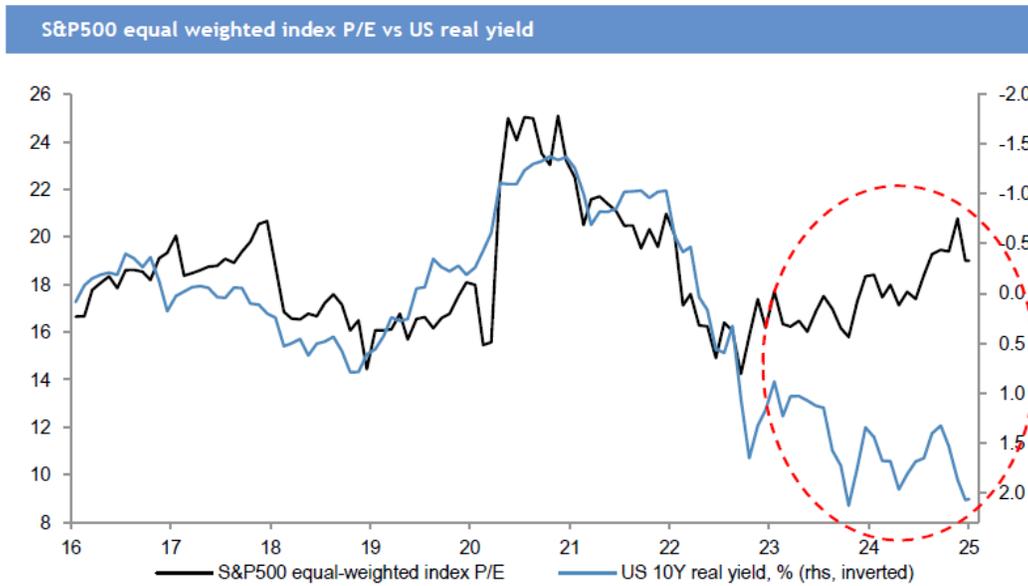


Exhibit 12. S&P 500 Equal Weighted Index P/E vs. 10-Year Treasury Yield, January 2025, source JP Morgan.

Notably, not only do broad equity market valuations remain very high, but also earnings growth and earnings revisions have been underwhelming.

Looking at the last two years, and excluding the “Magnificent Seven”,¹⁷ earnings growth for the S&P 500 (the “S&P 493”) was in fact negative in 2023.

Magnificent 7, SPX, and SPX ex Mag 7 earnings growth	
	2023 Net Income Growth
AAPL UW Equity	0%
AMZN UW Equity	307%
MSFT UW Equity	13%
NVDA UW Equity	313%
GOOGL UW Equity	22%
TSLA UW Equity	-29%
META UW Equity	50%
Magnificent 7	27%
SPX	1%
SPX ex Magnificent 7	-4%

Exhibit 13. 2023 Net Income Growth for Magnificent Seven and S&P 500 Index, January 2025, source JP Morgan.

Moreover, 2024 earnings revisions for the S&P 493 were negative.

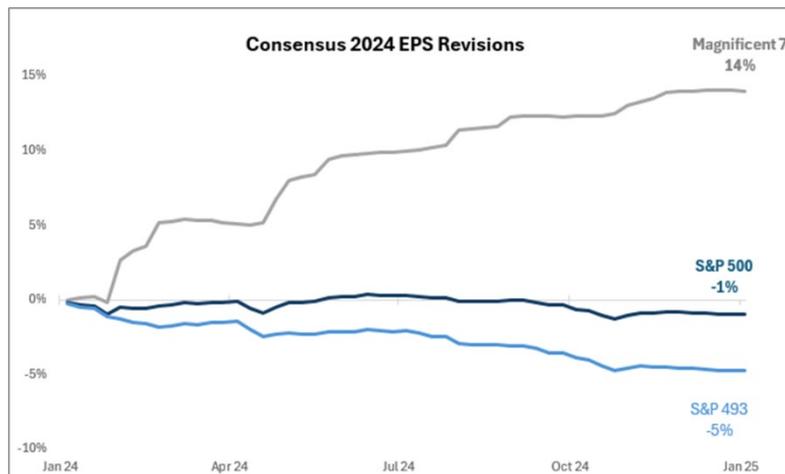


Exhibit 14. Negative Revisions for the S&P 493 and the Aggregate S&P 500 Index vs. the Magnificent Seven, December 2024, source Factset, Alkeon.

This of course begs the question, are the Magnificent Seven overvalued? Somewhat surprisingly on the surface, the actual numbers strongly suggest they are not. In particular, while we currently believe broad equity market valuations remain extended, for the five of the seven stocks in the Magnificent Seven that actually grew earnings both in 2023 and 2024, absolute cash flow valuations do remain sensible, relative to recent historical levels, in our view.

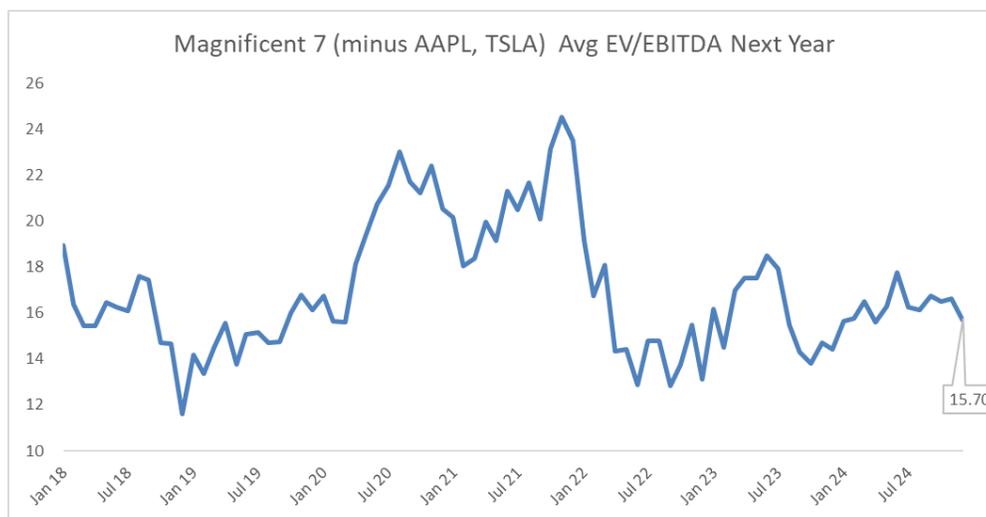


Exhibit 15. Magnificent Seven (ex AAPL, TSLA) Average Forward Year EV/EBITDA, December 2024, source Alkeon and Bloomberg.

Impressively, against the S&P 500, relative cash flow valuations for the same group of five stocks have actually come down over the last seven years!

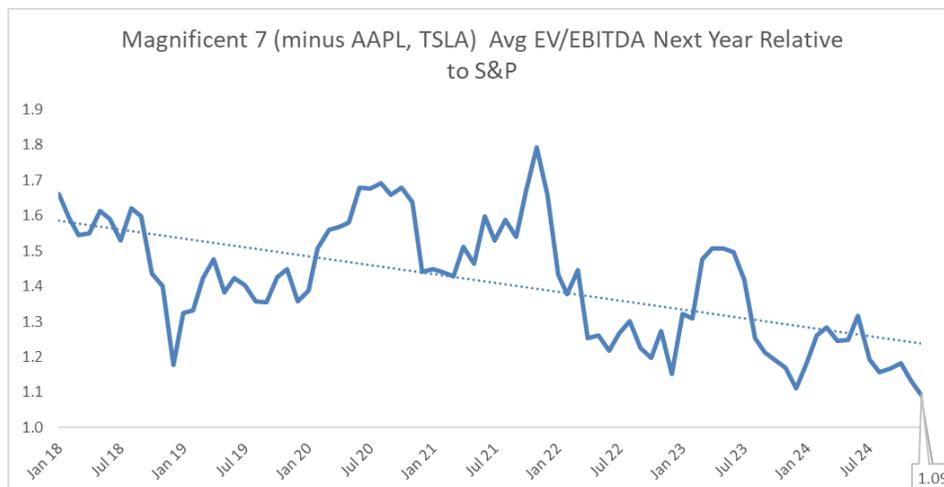
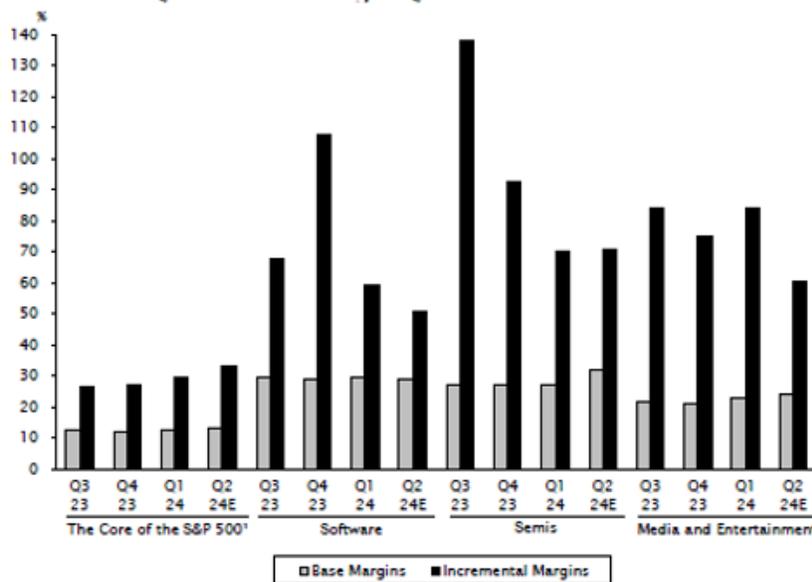


Exhibit 16. Magnificent Seven (ex AAPL, TSLA) Average Forward Year EV/EBITDA Relative to S&P 500 Index, December 2024, source Alkeon and Bloomberg.

This is not surprising, given the significant cost-cutting and price optimization initiatives commenced by a number of these and other companies in the last two years, some of which had never optimized for margins, e.g., companies like Meta and Spotify, which had never done so since IPO-ing. These recent profit optimization efforts created exceptional operating leverage, with industries such as software and semiconductors remarkably producing close to or greater than 100% incremental pre-tax profit margins on new sales in Q4 2023, and continuing to produce strong incremental margins in 2024.

**The Core and Technology-Related Stocks
Base and Incremental Pre-Tax Profit Margins²
Q3 2023 Through Q2 2024E**



Source: Empirical Research Partners Analysis.

¹ Excluding financials, REITs, utilities and energy.

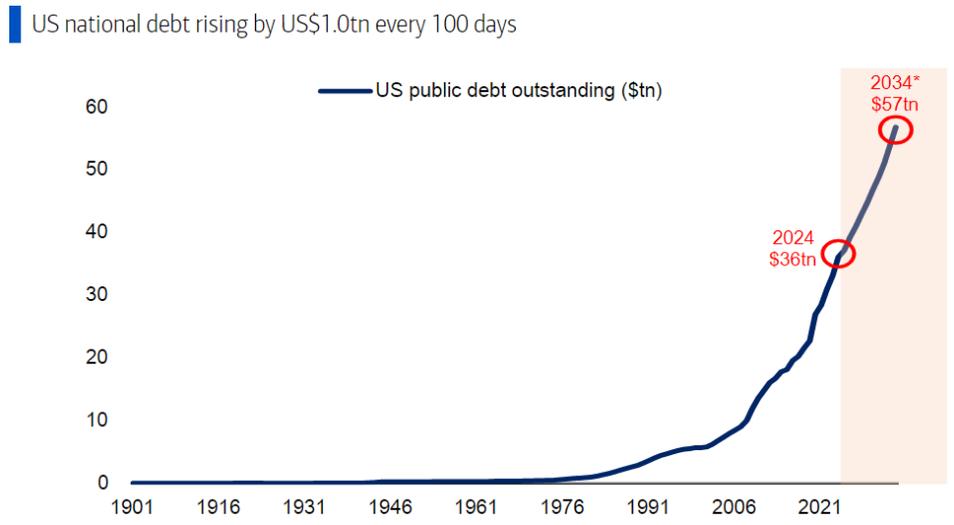
² Incremental margins are those earned on a dollar of new sales.

Exhibit 17. The Core and Technology-Related Stocks Base and Incremental Pre-Tax Margins, August 2024, source Empirical Research.

In summary, we strongly reiterate the need to be highly selective in the current market. In fact, and given the elevated tail risks we currently see, such as increased social polarization and potential for unrest, unsustainably high fiscal deficits, and global geopolitical uncertainty, we do believe it is more imperative than ever before to balance our high conviction long investments in quality secular growth companies with alpha-seeking short investments as well as structured market hedges, and to also stay globally diversified, as we seek to reduce concentration in any single country, currency or regional economy.

The US Economy is Structurally Challenged

Structurally the economy in the US remains especially vulnerable, as the three D's, Debt, Demographics and technological Disruption remain in full force and are highly disinflationary. Additionally, and of particular concern, the spike in US government debt over the last two decades is increasing bearish risk scenarios for asset prices and systemic instability, such as default, currency debasement and inflation. Against this backdrop, we believe a long/short strategy balanced with hedges that seek to mitigate tail risk can offer a suitable fit to equity investors in the current high-risk environment.



*2025 onward based on CBO forecast

Exhibit 18. US Public Debt Outstanding & CBO projections, November 2024, source BofA Global Research.

The huge surge in government debt is particularly worrisome, as historically the correlation between US unemployment and the budget deficit has been quite high.

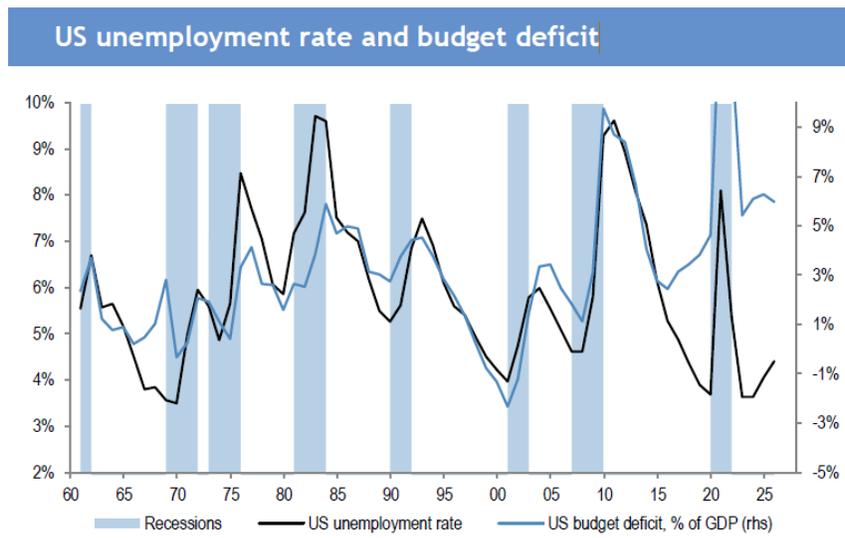


Exhibit 19. US Unemployment Rate and Budget Deficit, January 2025, source JP Morgan.

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To make things worse, the US is running the largest deficit since the Second World War.

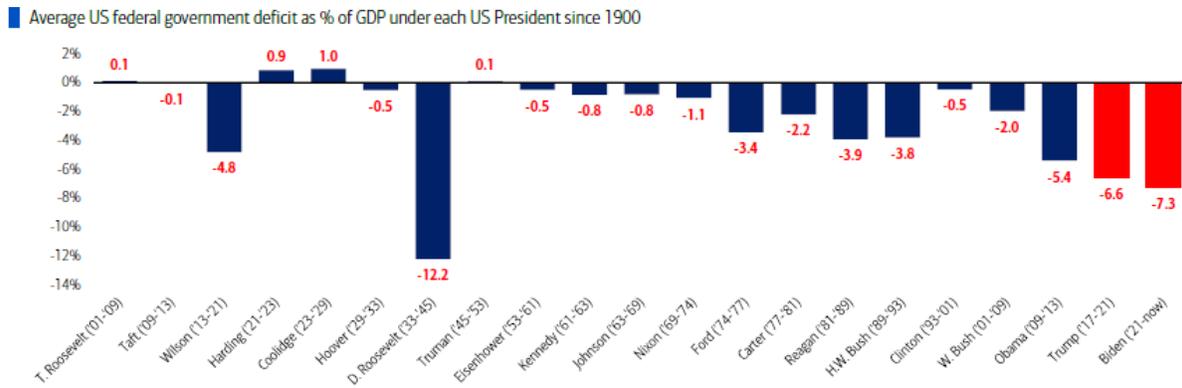


Exhibit 20. Average US Federal Government Deficit as a Percentage of GDP under Each President since 1900, source BofA Global Research.

On the consumer side, the recent economic turmoil has made the retirement crisis even worse. Half of private-sector employees do not even have an employer-sponsored retirement plan,¹⁸ and recently the US savings rate collapsed to the lowest level since the Global Financial Crisis.

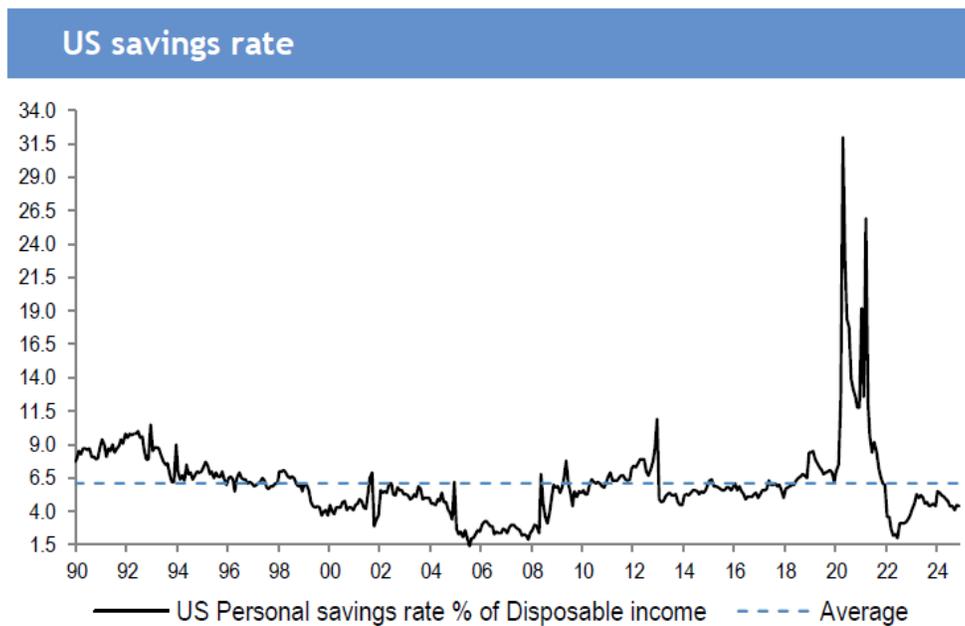


Exhibit 21. US Personal Savings Rate, January 2025, source JP Morgan.

In fact, the picture for consumers is deteriorating, especially as credit delinquencies are at the highest levels since the global financial crisis.

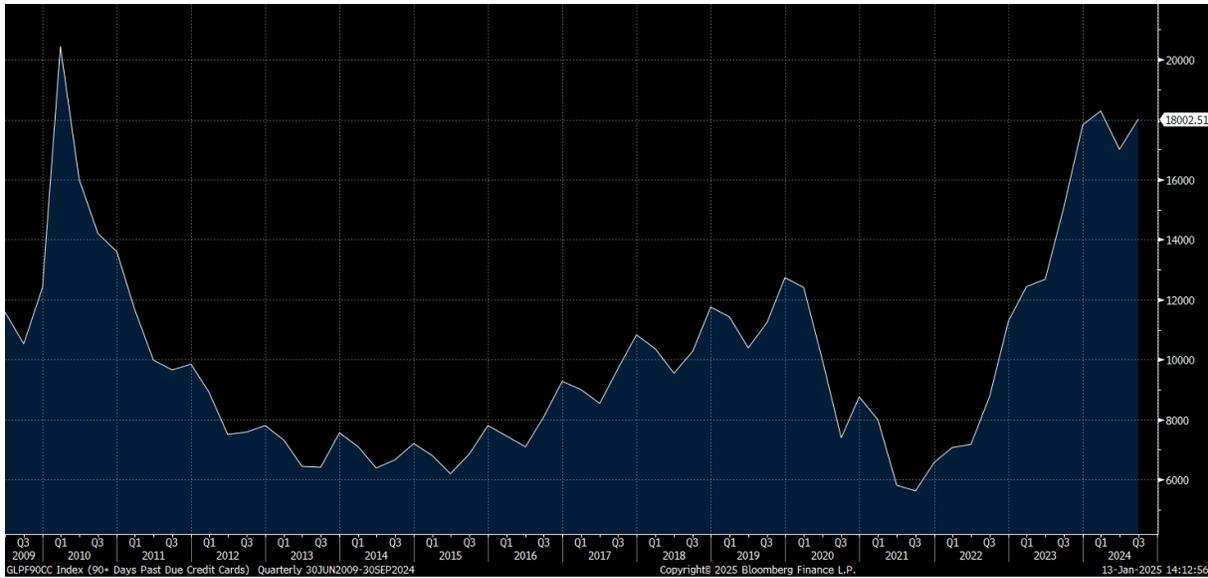
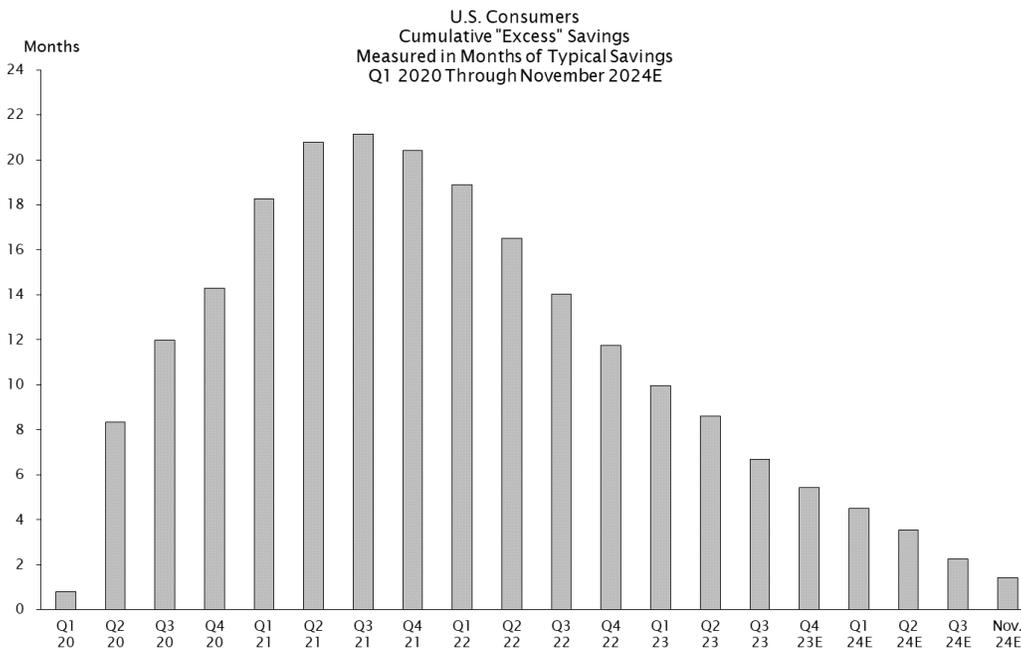


Exhibit 22. 90+ Days Past Due Credit Card Level – Highest since the Global Financial Crisis, source Bloomberg.

This is unlikely to change in a meaningful manner soon, as excess savings are being depleted and have been trending downward recently.



Barbiero, O. and Dhiren Patki, 2023. "Have US Households Depleted All the Excess Savings They Accumulated during the Pandemic?" Federal Reserve Bank of Boston Current Policy Perspectives, de Soyres, F., Moore, D. and Julio Ortiz, 2023. "An Update on Excess Savings in Selected Advanced Economies," FEDS Notes, U.S. Department of Commerce, Empirical Research Partners Analysis and Estimates.

Exhibit 23. US Consumers Cumulative "Excess" Savings Measured in Months of Typical Savings, November 2024, source Empirical Research.

Offsets to Structural Economic Challenges

While the US economy is facing structural challenges, there are positive offsets worth highlighting.

First, there is optimism that the new administration's set of policies will accelerate economic growth.



Exhibit 24. *NFIB Small Business Optimism, source Bloomberg.*

This may lead to an uptick in domestic job openings, which have been steadily declining since 2022.



Exhibit 25. *US Job Openings Total, source Bloomberg.*

In turn, this may fuel wage growth, which has slowed, ultimately reversing a downward trend in the US Quits rate.

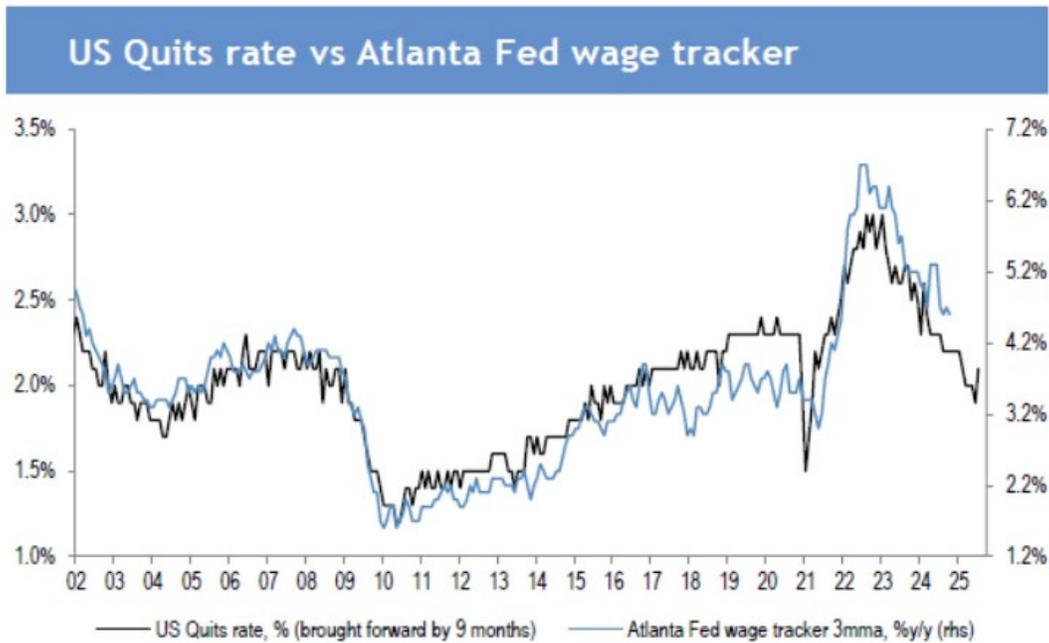


Exhibit 26. *US Quits Rate vs Atlanta Wage Tracker, source JP Morgan.*

In light of the US economy’s structural challenges and the change in administration, careful monitoring and evaluation of all new fiscal, regulatory and trade policies, and their effect on both economic growth and inflation, is critical over the next year.

The second positive offset is of course AI, and specifically its effect on productivity. As we will detail later on in this letter, increases in productivity have accounted for the majority of GDP growth in recent decades, and it is estimated that AI is likely to create a productivity boost we have only seen a few times in the past one hundred years, potentially adding a gain of 1.5% in output per year, as a base case.

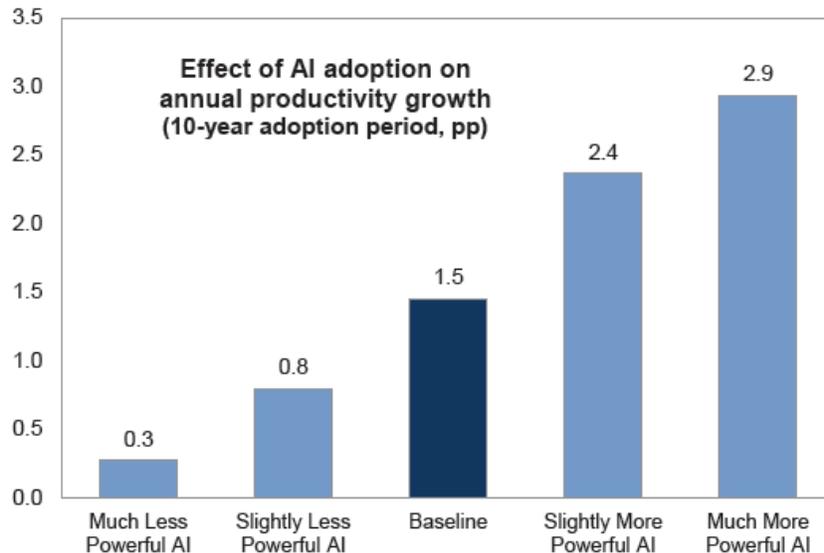


Exhibit 27. *Estimated Effect of AI Adoption on Productivity Growth, source Goldman Sachs.*

In summary, although severe long-term structural economic challenges persist, there are some near to medium-term positive tailwinds to GDP growth as well as consumer and business confidence.

At the same time, however, we do face significant tail risks and an expensive equity market. Moreover, against this very fluid macroeconomic backdrop, market complacency remains high with credit spreads standing at levels close to multi-year lows.

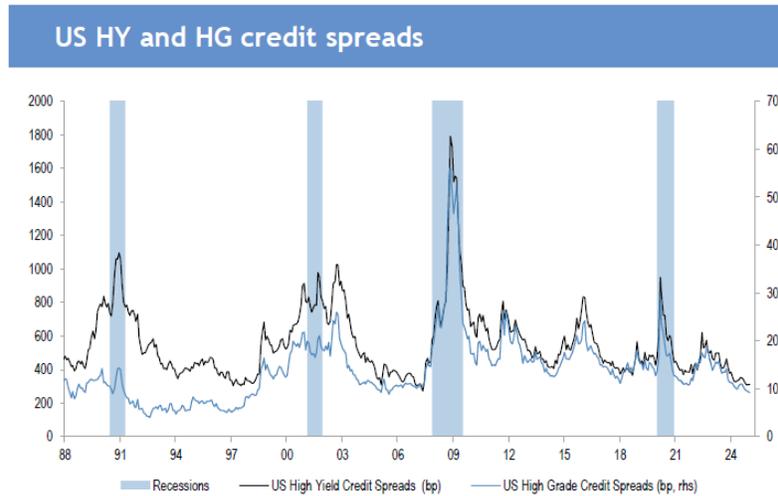


Exhibit 28. US High Yield and High-Grade Credit Spreads, January 2025, source JP Morgan.

Notably, credit spreads are currently the lowest since 2007.



Exhibit 29. US Bonds Rated B Average Spread, January 2025, source JP Morgan.

We believe the combination of a broadly unattractive market with areas of strong secular growth driven by innovation *can create a dynamic that elevates the attractiveness and scarcity value of secular growth assets with product cycles that are largely independent of the economic cycle.* This is especially true at a time when risks remain elevated, in our view.

Therefore, we believe a long/short strategy, balanced with hedges and alpha-seeking shorts, can offer a suitable fit to equity investors in the current high-risk environment. Our summary message in the current equity market is simple: **Stay Hedged, Stay Balanced with Shorts, Stay Globally Diversified.**

Broader Valuation Considerations

From a relative asset valuation perspective, we currently believe global equity valuations are elevated relative to bonds, although they appear more reasonable relative to their cost of capital, as on both a price-to-free-cash-flow basis and a price-to-return-of-capital (dividends plus buybacks) basis (see Exhibits 32 and 34 below, respectively), the market has been trading at reasonable levels relative to its long-term average.

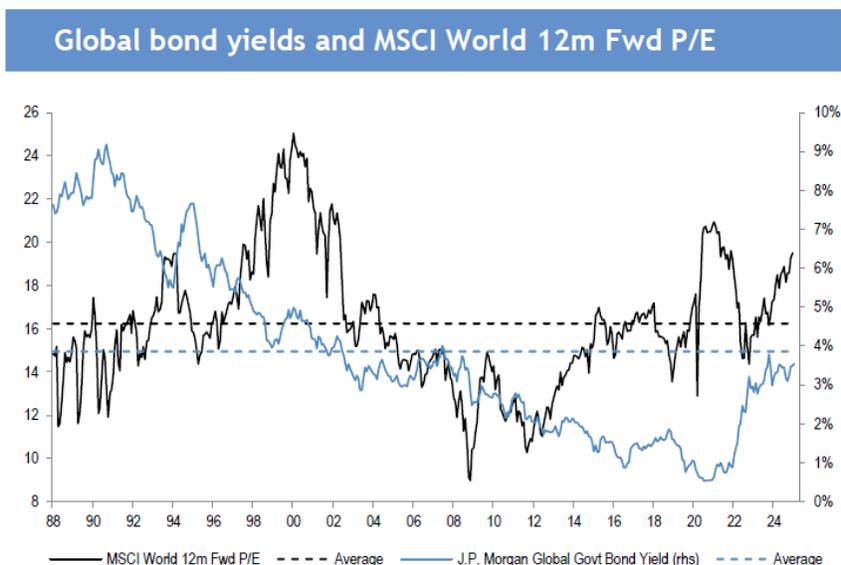


Exhibit 30. MSCI World Index P/E and Global Sovereign Bond Yields, January 2025, source JP Morgan.

Additionally, the gap between dividend yield and bond yield is unattractive, in most regions globally.

DM yield gap in the historical context					
	Dividend yield	10Y Bond yield	Dividend yield minus bond yield	Average since '00	Current vs Average (bp)
US	1.3%	4.6%	-3.3%	-1.4%	-186
Japan	2.2%	1.1%	1.1%	0.9%	21
Eurozone	3.2%	2.9%	0.4%	0.4%	-7
UK	3.8%	4.6%	-0.8%	0.5%	-135

*Current as of 01st Jan '25

Exhibit 31. Average Developed Market Yield Gap, 2024 vs. 2000, January 1, 2025, source JP Morgan.

On the other hand, cash flow generation has been very strong, enabling cash flow valuations to remain reasonable relative to average historical levels.

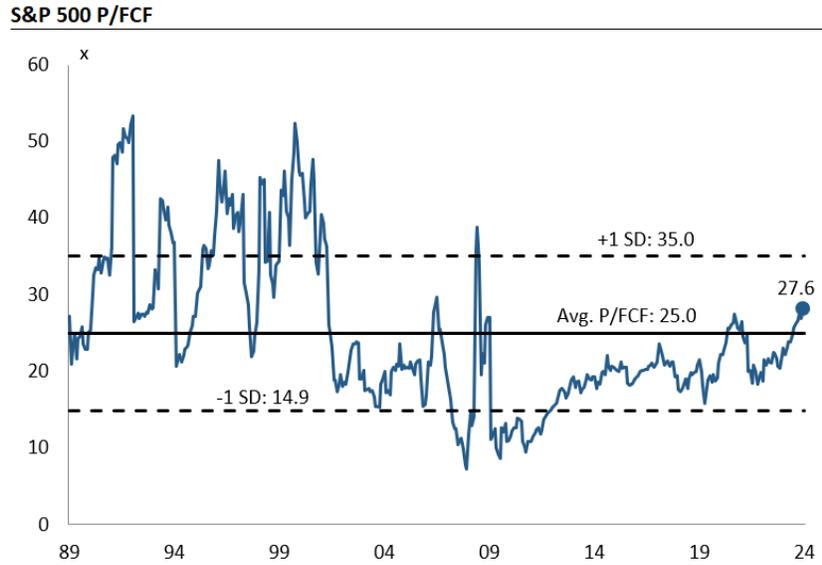


Exhibit 32. S&P 500 Index, Price/Free-Cash-Flow Ratio, December 2024, source UBS.

It is not surprising that although absolute P/Es remain elevated, P/FCF levels are more attractive. In particular, it is important to note that US companies have increasingly adopted asset-light models over the past decade. The result has been the almost doubling of free cash flow generation as a percentage of sales to above 10% in recent years.

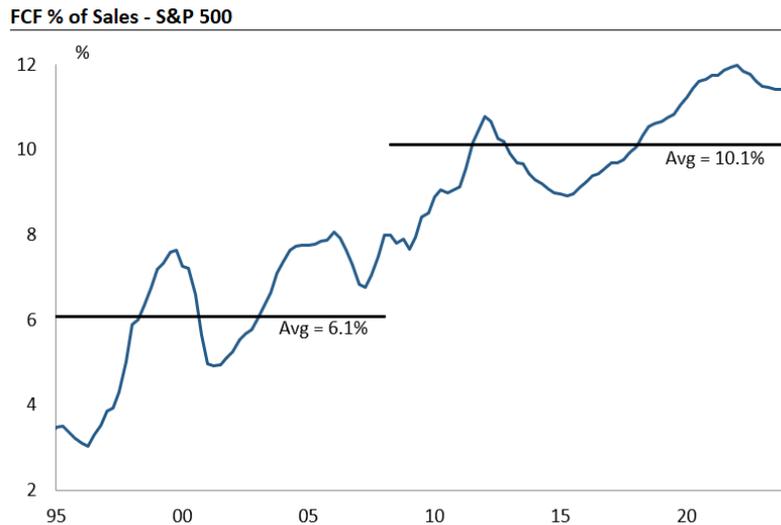


Exhibit 33. US Equities Free Cash Flow as a Percentage of Sales Since 1984, Russell 1000 Index (pre-1990) and S&P 500 Index (after 1990), December 2024, source UBS.

Furthermore, from a price to return on capital (dividends plus buybacks) standpoint, US equities have been trading at reasonable levels relative to the historical average.

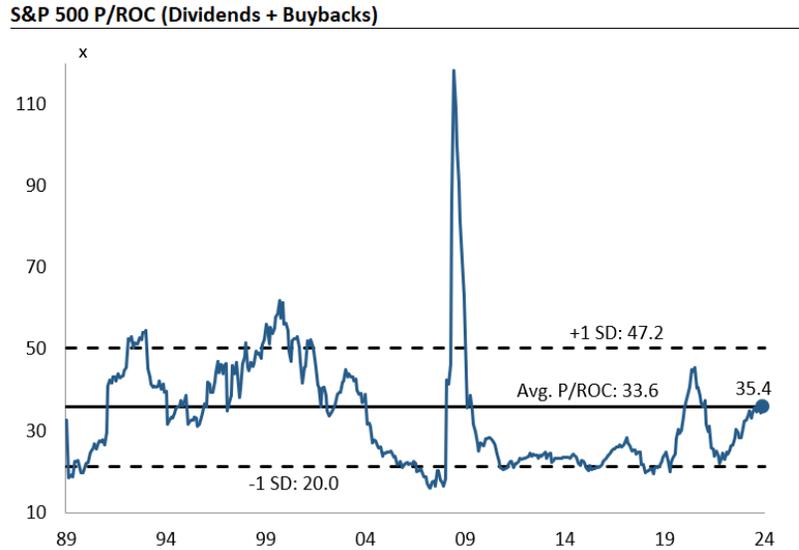


Exhibit 34. US Equities Price to Return of Capital Multiple Since 1984, Russell 1000 Index (pre-1990) and S&P 500 Index (after 1990), December 2024, source UBS.

By the end of last year, the market had generated approximately a 20% ROE¹⁹ and returned approximately three quarters of that to shareholders, negating the argument that value in stocks solely depends on future growth projections.

**Large-Capitalization Stocks
Return of Capital to Shareholders
As a Share of the Equity Base¹
1972 Through Late-December 2024**

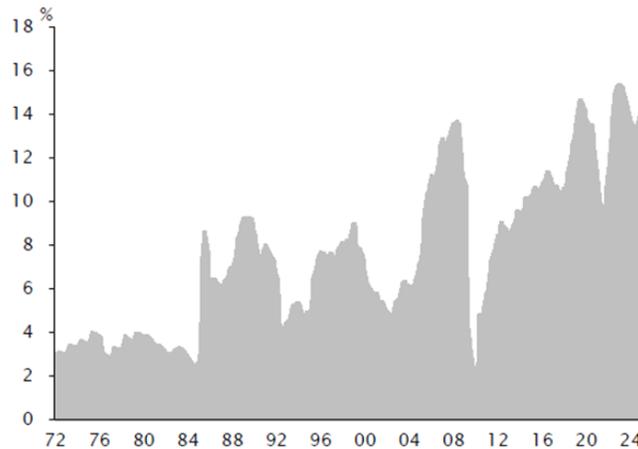


Exhibit 35. Large Cap Stocks Return of Capital to Shareholders, January 2025, source Empirical.

Against this broad backdrop, we continue to favor high quality growth sectors such as technology and communication services. We believe these sectors are supported by, one, superior fundamentals, e.g., high barriers to entry, stronger balance sheets, and higher returns on invested capital; two, strong secular growth trends; three, a broader scarcity of growth assets; and, four, supporting cash flow valuations relative to the underlying growth rates.

In particular, and as we have stated in previous investor communications, we consider technology to be not only a growth investment but also a defensive one. This is due to its cost-cutting (high ROI) and productivity-enhancing proposition to the end customer, superior balance sheet, strong cash flow conversion, low labor cost to sales, ongoing industry consolidation, and, lastly, strong underlying secular innovation trends.

To this last point, companies that innovate tend to be less correlated to the economic cycle. This is consistent with our own desire to identify secular growth stories with company-specific product cycles that are less dependent on the economic cycle.

It is noteworthy that revenue growth for technology stocks has substantially exceeded that of the broader market in the last decade. We would also add that, importantly, this was just not the case during the tech bubble, when technology revenues (and earnings) underperformed, lagging price appreciation.

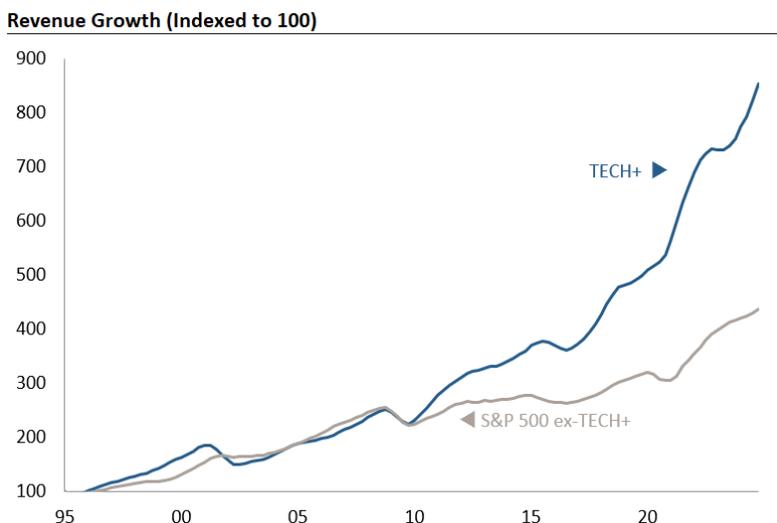


Exhibit 36. S&P 500 Index Technology Revenue Growth, December 2024, source UBS.

Lastly, during the last decade margins for technology stocks more than doubled the market level.

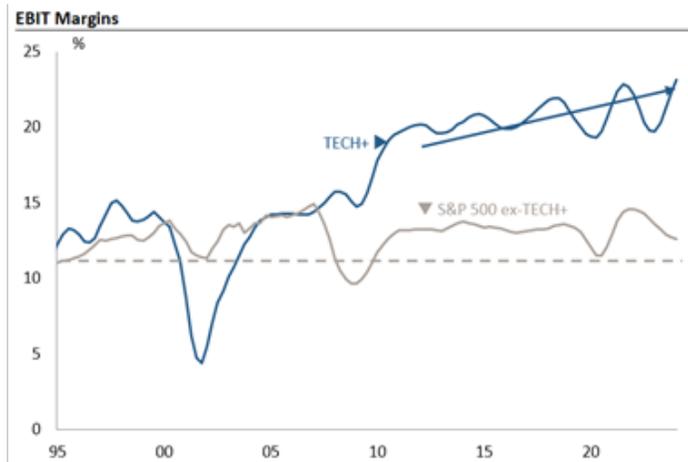


Exhibit 37. S&P 500 Index Technology EBIT Margins Growth, December 2024, source UBS.

In summary, we consider the current investment opportunity set to be attractive for a select number of high-quality growth equities on a relative basis, particularly as the market overall remains extended.

This is an environment of scarce secular growth opportunities, elevated market valuations, increased geopolitical uncertainty, and technological disruption that increases the gap between the “haves” and the “have-nots”, all of which we believe enhances the spectrum of opportunity for long-short investing currently.

Secular Opportunity for Technology

In recent communications, we have extensively detailed our outlook on the emerging wave of technological innovation and AI, and more recently modern (Generative) AI, which we expect to be wide in scope, transformative and highly disruptive. As the digital foundation of the global economy expands rapidly, it is enabling disruption in a matter of months. Businesses can now reach millions of users in the shortest time ever.

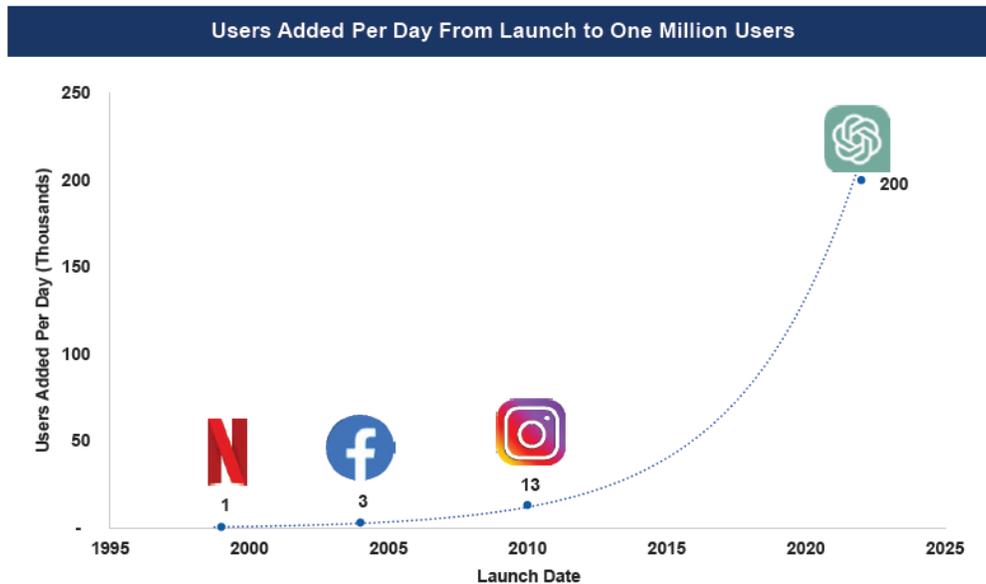


Exhibit 38. *Users Added per Day from Launch to One Million Users, source Morgan Stanley.*

The origins of this new technological revolution can be traced a few years back. In our quarterly communications, we first extensively discussed the AI revolution in 2017, the year in which Alphabet introduced their Transformer architecture, which was then split into BERT (short for Bidirectional Encoder Representations from Transformers, a machine-learning framework for natural language processing) and a series of GPT models.

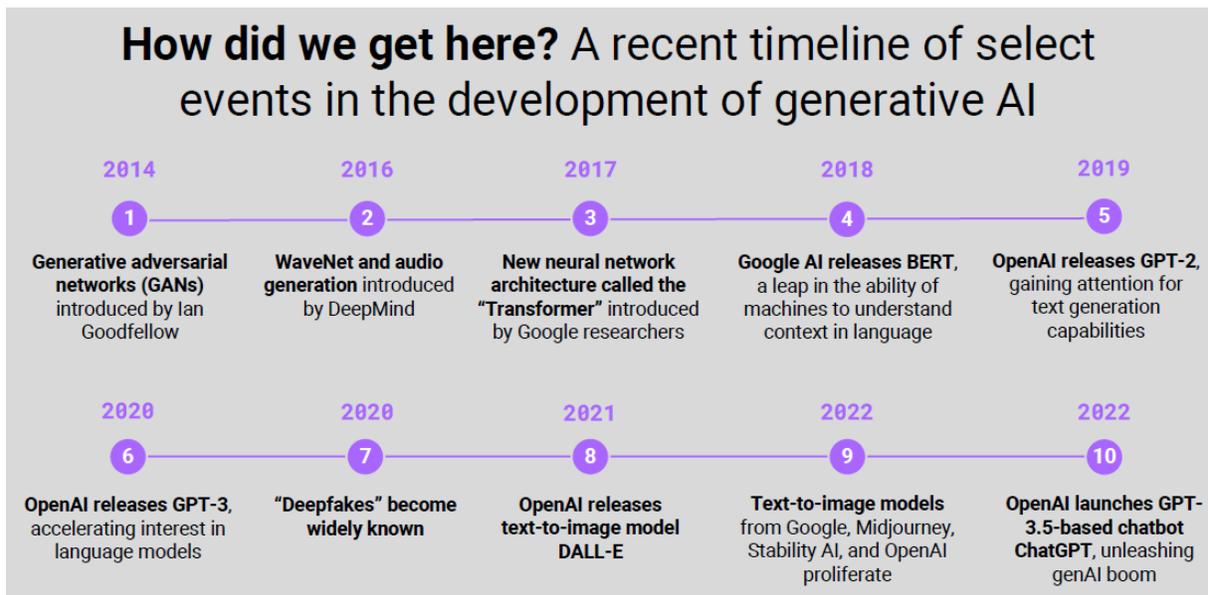


Exhibit 39. *The History of Generative AI, source CB Insights.*

The following year, 2018, marked the first year in which the amount of data generated by machines surpassed the amount of data generated by humans (see Exhibit 67). This data explosion then began to feed new large and complex AI models, which in turn needed an advanced and powerful new compute platform for model training.

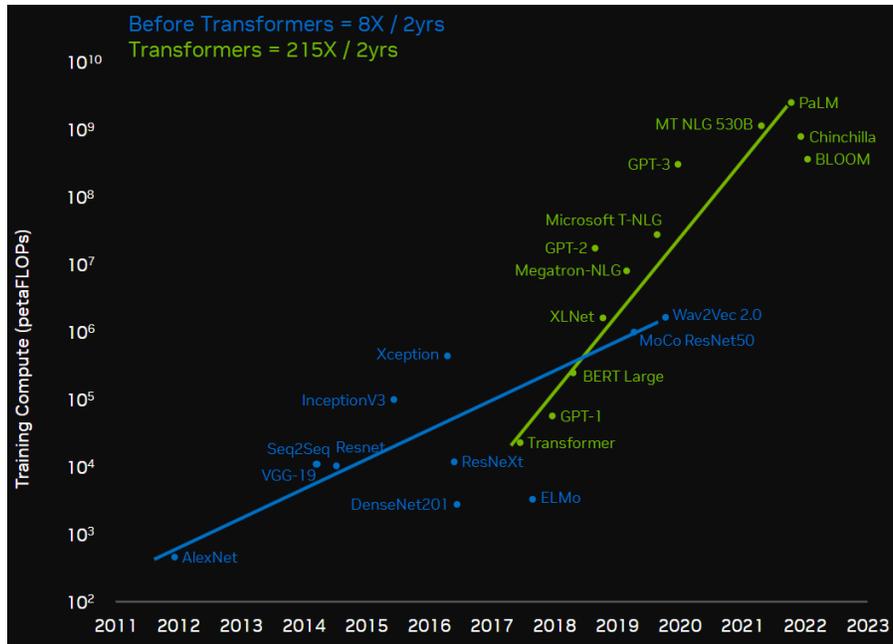


Exhibit 40. GPU Computing Powers AI Advances, source Nvidia.

The creation of a powerful compute platform that was able to accommodate and handle AI models with tremendous complexity occurred between 2020 and 2022, ultimately leading to the tipping point for modern, generative AI at the very end of 2022 (AI going mainstream with the launch of ChatGPT).

It was precisely this marriage of powerful transformer models and advanced compute hardware platforms that led to generative AI breakthroughs in recent years, bringing modern AI to the mainstream.

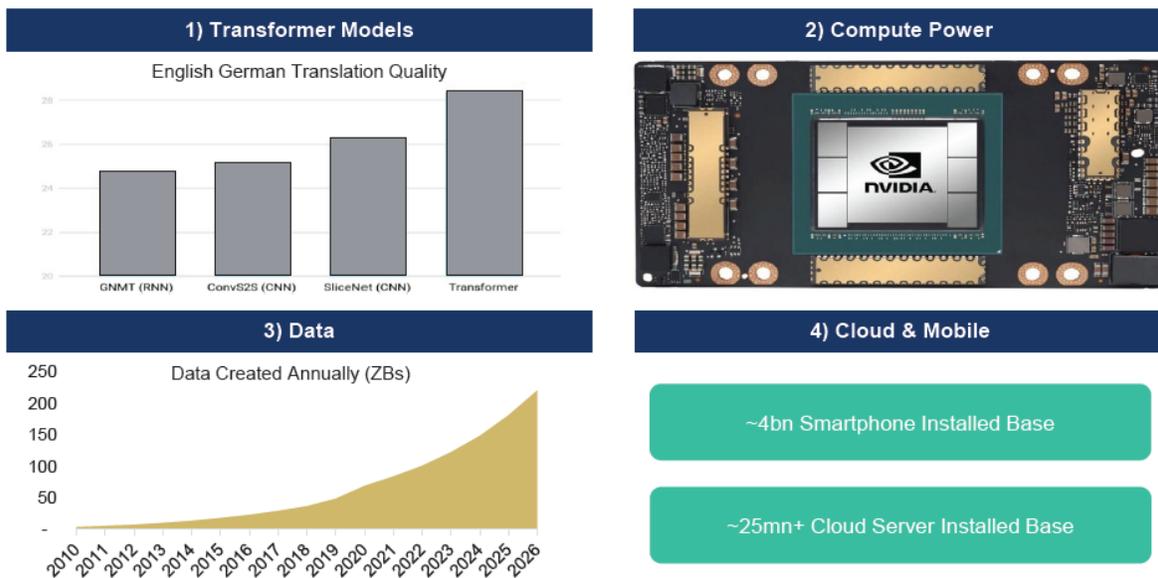


Exhibit 41. Four Key Factors That Led to The Current “AI Breakthroughs”, source Morgan Stanley.

And now, we currently believe we are about to take a further huge leap forward, with the introduction (at the end of 2024) of AI models with advanced reasoning capabilities. This marks the start of the pre-AGI phase.



Exhibit 42. *Four States of AI, source Alkeon.*

These pre-AGI phase models leverage training compute to self-reflect, consider different reasoning paths, look ahead or back-track and THINK before answering complex questions.

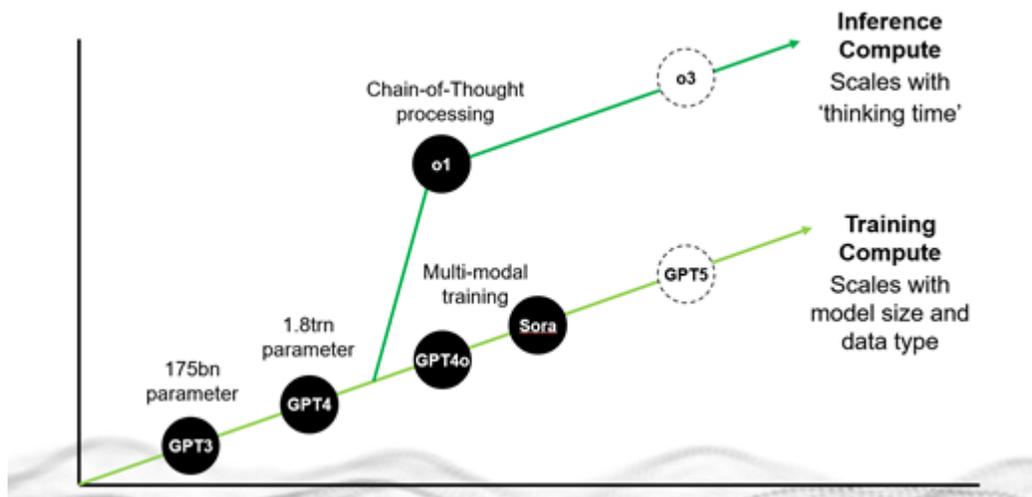


Exhibit 43. *AI Scaling Evolution – Pre-Training and Inference, source Alkeon.*

These brand new, intelligent models, alongside the emergence of multimodal, synthetic and enterprise data, are likely to power a new cycle of growth in the next few years, in our view.

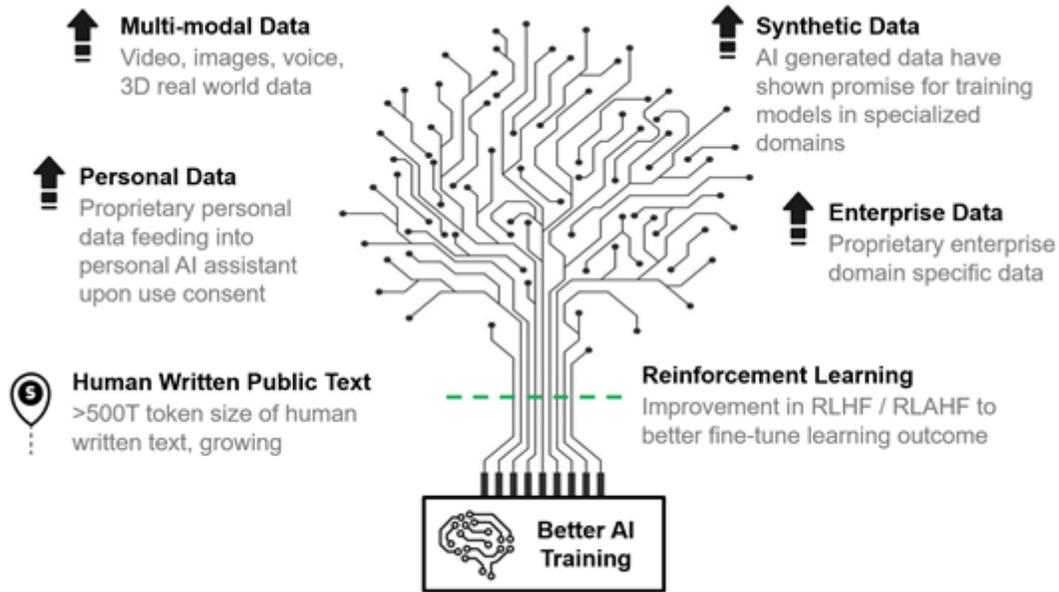


Exhibit 44. *AI Scaling Evolution – Data, source Alkeon.*

As we will discuss later, recent advanced reasoning models require a tremendous amount of compute power, particularly as scaling now occurs on two dimensions, both training and inference. Newly introduced AI chips such as Blackwell chips accelerate compute power exponentially.

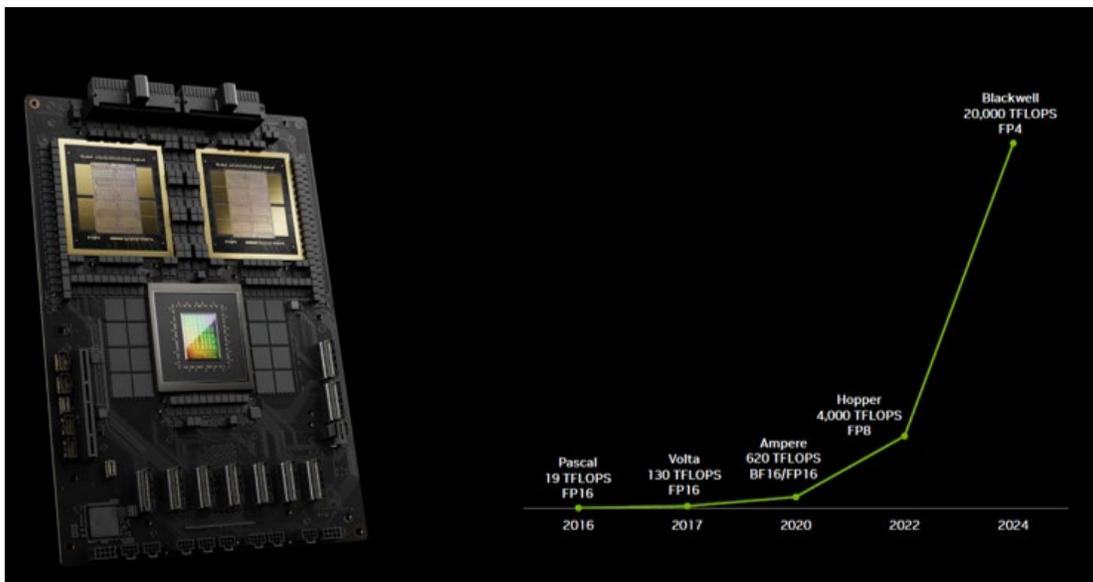


Exhibit 45. *1000x AI Compute in 8 Years, August 2024, source Nvidia.*

This elevated compute capacity is needed to accommodate advanced AI models, i.e., generalized reasoning models, which will require hundreds of thousands and eventually millions of GPUs for training and inference.

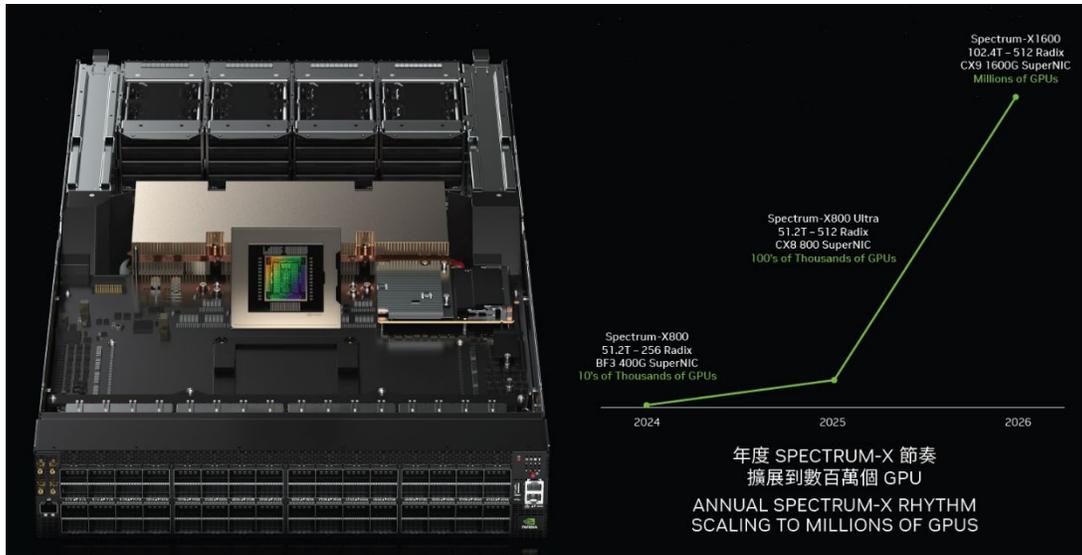


Exhibit 46. *Scaling to Millions of GPUs, June 2024, source Nvidia.*

Given these most recent advances in both model complexity and compute power, which we witnessed at the very end of 2024, we believe it is fair to say that the modern AI revolution is just beginning, and it will transform the world.

Importantly, we also believe this tectonic wave of technological innovation is likely to fuel GDP growth, as innovation and growth go hand in hand, and, like previous cycles of innovation, AI is likely to ultimately create more jobs than it destroys.

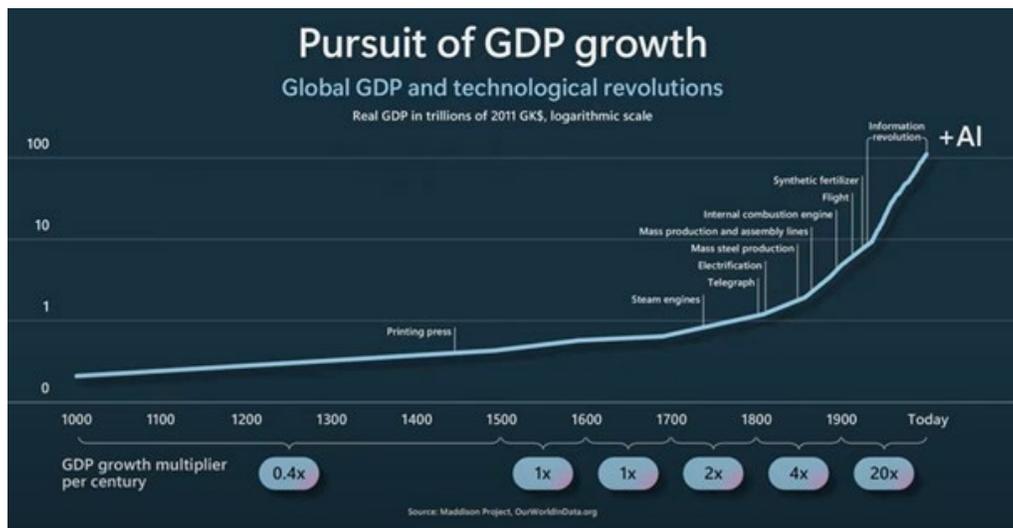


Exhibit 47. *Global GDP and Technological Revolutions, source Microsoft.*

This is partly because, one, the effect of AI on annual productivity growth can be very significant. AI is likely to create a productivity boost we have only seen a few times in the past one hundred years, potentially adding a gain of 1.5% in output per year, as a base case scenario.

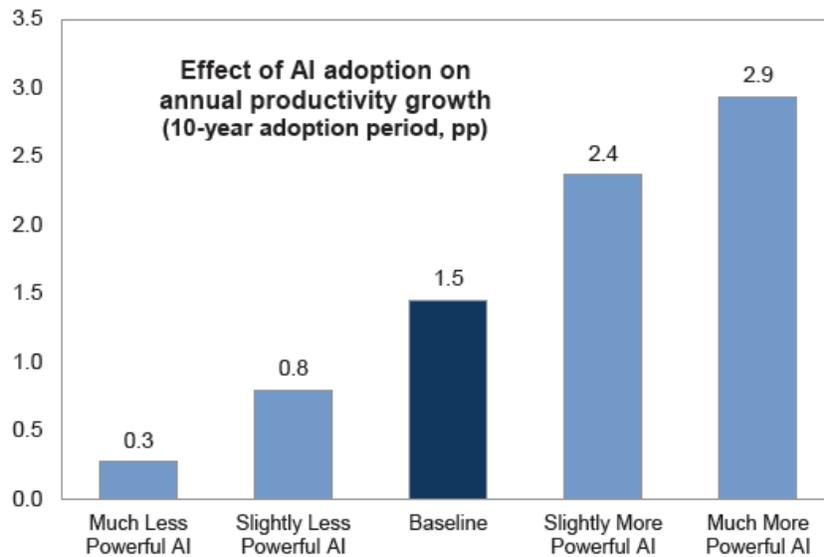


Exhibit 48. *Estimated Effect of AI Adoption on Productivity Growth, source Goldman Sachs.*

And two, which is important to here, productivity growth has been the main engine of GDP growth over the past thirty years, with the link between the two being very strong historically.

Real GDP growth contribution of employment and productivity growth, 1972–2022, global GDP growth, CAGR, %

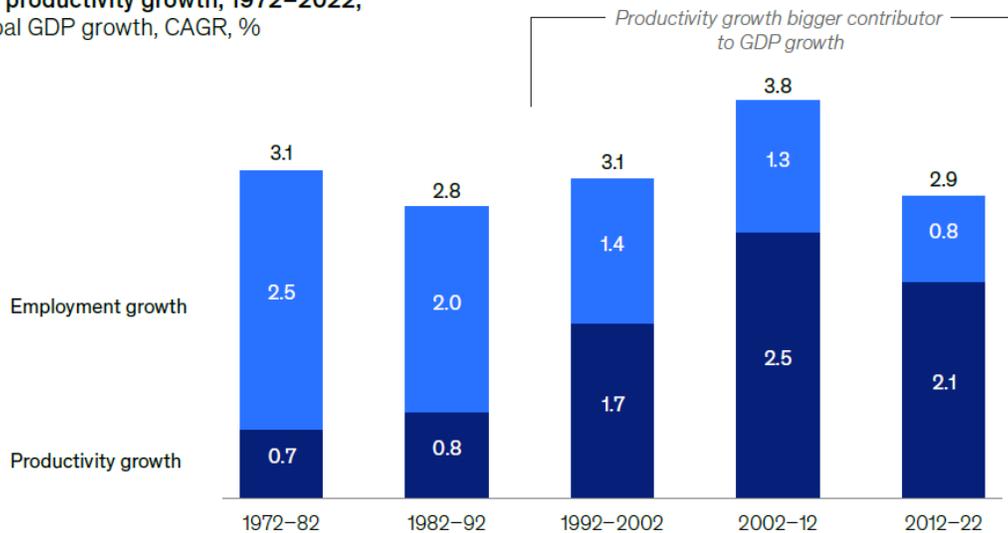
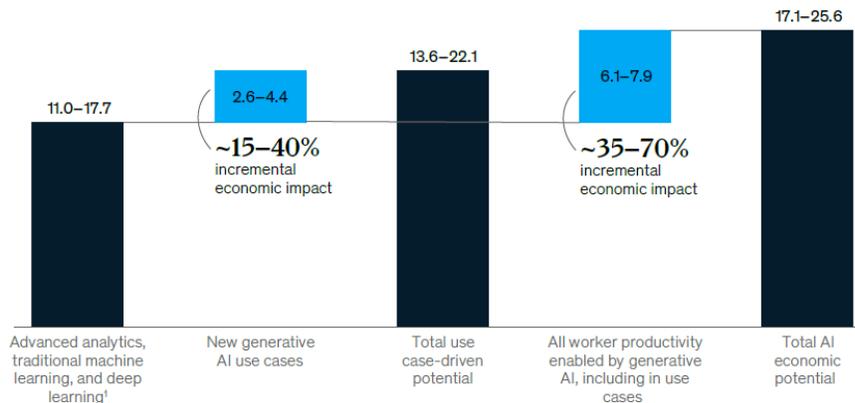


Exhibit 49. *Real GDP Growth Contribution of Employment, source McKinsey.*

Like previous major innovation cycles, there will be a transitory phase of job evolution. In particular, generative AI is expected to disrupt the labor markets in a significant manner. McKinsey & Company has estimated that 60-70% of all workloads can be impacted or eventually be automated by AI. Looking at hundreds of occupations and detailed work activities, McKinsey estimated that a total economic benefit of \$17.1 to \$25.6 trillion annually, across all industries, with the incremental Generative AI impact in the \$6.1-\$7.9 trillion range.

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



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

Exhibit 50. AI's Potential Impact on the Global Economy, \$ Trillion, source McKinsey.

There are more conservative estimates, but of the same incredible magnitude. For example, Morgan Stanley estimates that Generative AI can impact approximately 25% of labor today and 44% in three years, affecting \$2.1 trillion of labor costs associated with these jobs today and \$4.1 trillion in three years, just in the US.²⁰ Globally, the incremental software opportunity alone is estimated to reach \$150 billion in three years.

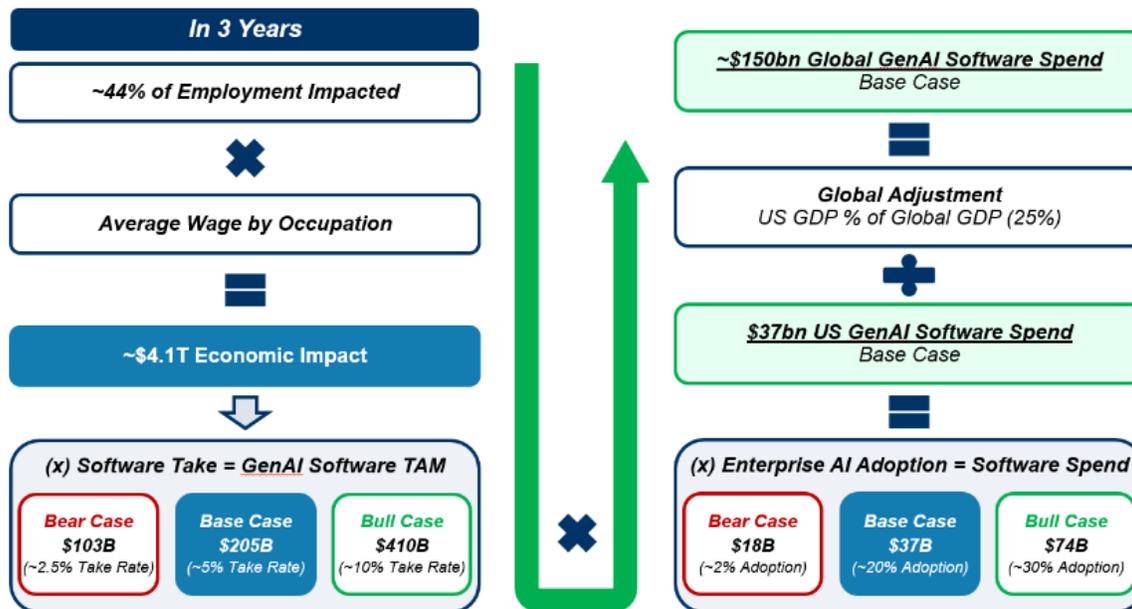


Exhibit 51. Global Generative AI Software Impact, January 2024, source Morgan Stanley.

Fundamentally, the reason behind this large-scale economic impact is simple, AI provides instant and large productivity gains.²¹



Michael Dell

"There aren't many gifts of 20% and 30% productivity that I can think of, certainly in my working lifetime, and as a result, this is a conversation in every boardroom."

(Goldman Sachs *Communacopia* + Technology Conference, September 2024)



databricks

"In just a year, Heathrow sped up forecast insights from two weeks to four hours while decreasing the margin of error from 30% to 10%, allowing the airport to become more efficient and accelerate productivity."

(Company Press Release, September 2024)

"Especially as the models get smarter, we've heard examples of senior lawyers at law firms who said, 'I just had o1 (OpenAI's reasoning model) write a legal brief for me. **That would have taken a \$1,000 an hour associate six hours. And it did it in five minutes.**' "

(December 2024)



Kevin Weil,
CPO at OpenAI

Recent earnings calls provided numerous examples of how Generative AI can save up to thousands of years of work.



"We've used multiple large language models to accurately create or improve over 850 million pieces of data in the catalog. Without the use of generative AI, this work would have required nearly 100x the current headcount to complete in the same amount of time."



"The average time to upgrade an application to Java 17 plummeted from what is typically 50 developer-days to just a few hours. We estimate this has saved us the equivalent of 4,500 developer-years of work (yes, that number is crazy, but real)."



"We had approximately, give or take, 300 people who were involved in solving employee tickets for our employees. So about 2% of our 15,000 people. We have just launched last week, what we call the internal AI employee experience that has allowed us to reduce that headcount by 50%. And we think that can go down to 80%... Some of our best developers are 40% better in coding who have used our internal coding co-pilot."



"When you look at our own deployment of Now Assist, the initial results are staggering. With better deflection, our IT help desk is saving 45 minutes per avoided case. In customer service, our colleagues are saving 30 minutes every time the computer generates the knowledge-based article for them. Our employees will save 21,000 hours with faster self-service, and our developers are completing non-complex scripts in half the time."

Exhibit 52. GenAI ROI Examples from Q2 2024 Earnings Calls, source Walmart, Amazon, Palo Alto Networks, ServiceNow.²¹

At the end of 2024, AI Agents that can process complex instructions, develop plans and complete tasks were introduced by companies like Salesforce, HubSpot, Workday and Microsoft, offering strong productivity gains and ROI to customers.²²



Exhibit 53. Productivity Gains and ROI, September 2024, source Alkeon.

This cycle of AI disruption and associated value creation carries another important implication. There is going to be a small number of companies that generate the majority of added wealth. For example, according to BofA Global Research, between 1990 and mid-2020, the global market generated approximately \$56 trillion of wealth. Yet, only 1.5% of companies accounted for all of this wealth creation, with an acceleration of this concentrated wealth creation in recent years, in our view.

Share of net wealth* generated by stocks between 1990 & mid-2020

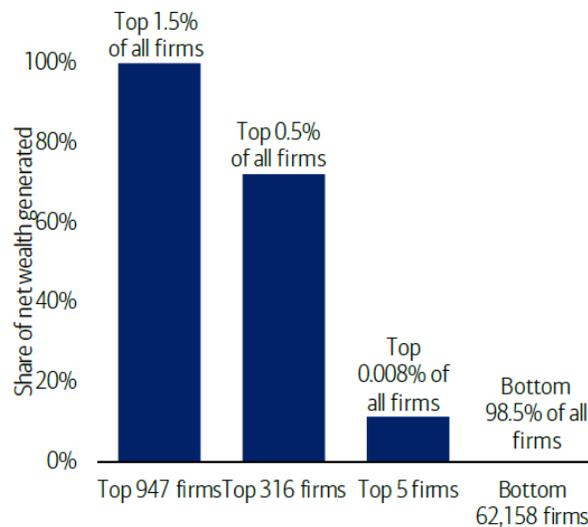


Exhibit 54. Share of Wealth Generated by Global Stocks, 1990 to mid-2020, source BofA Global Research.

In this connection, BofA Global Research has predicted that 50% of S&P 500 companies could be replaced in ten years. Specifically, the average tenure of an S&P 500 company has been forecast to contract from its high of nearly sixty-one years in 1958, thirty years in the 1980s, and twenty-four years in 1976, to approximately twelve years by 2027.

This supports our view of a highly favorable environment for stock picking, reinforcing the need for investors to remain exceedingly selective.

Average company lifespan on S&P 500 Index (year, rolling 7 year average)

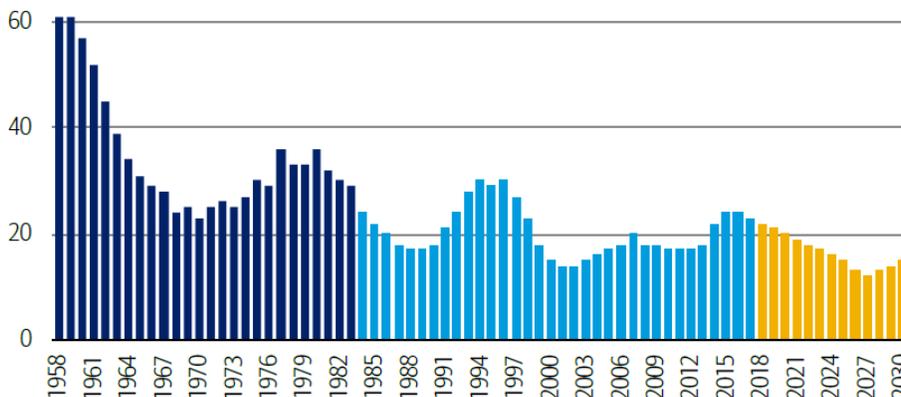


Exhibit 55. Average Lifespan of S&P 500 Index Companies on the Decline, September 2021, source BofA Global Research.

There is a fundamental reason behind this disruption, namely, the costs of innovating are high. AI is expensive, and has become increasingly so as the cost of AI training soared as models scaled up. For A model the size of GPT3, can cost more than \$10 million for a single training run, and trillion parameter models can have training costs upwards of \$50 million for a single training run.

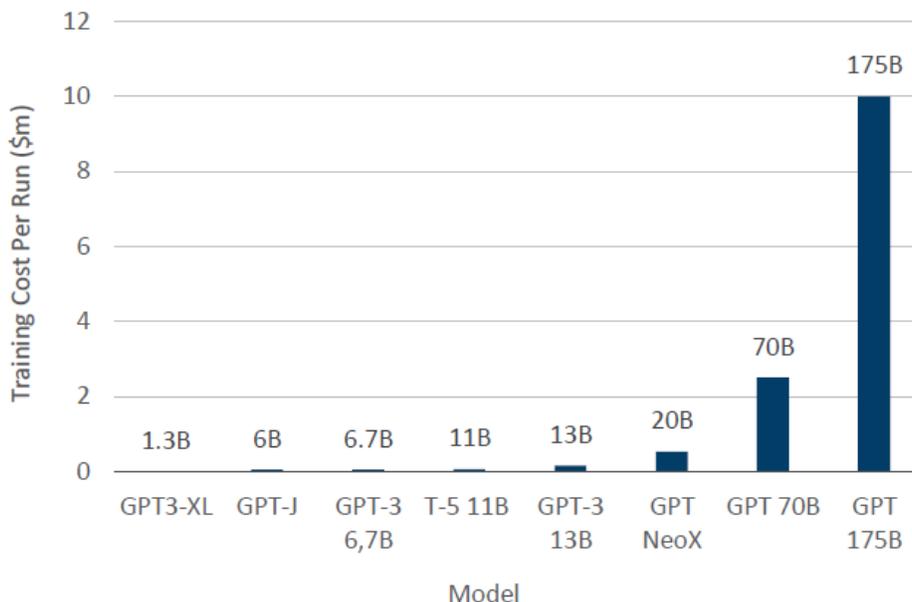


Exhibit 56. The Cost of AI Training is Soaring as Models Scale Up (Single-Run Costs), source Nvidia.

Consequently, we believe this pattern of disruption and concentration in wealth creation is likely to continue in the next decade, widening the gap between the “haves” and the “have nots”, and potentially creating an attractive backdrop for long-short equity investing.

Fundamentally, we currently believe we are at the very beginning of a secular growth path that favors a number of high-quality secular compounders with strong competitive positions.

It is important to stress that the AI revolution is at its very early stages, as only in late 2022 did AI go mainstream with the introduction of ChatGPT.

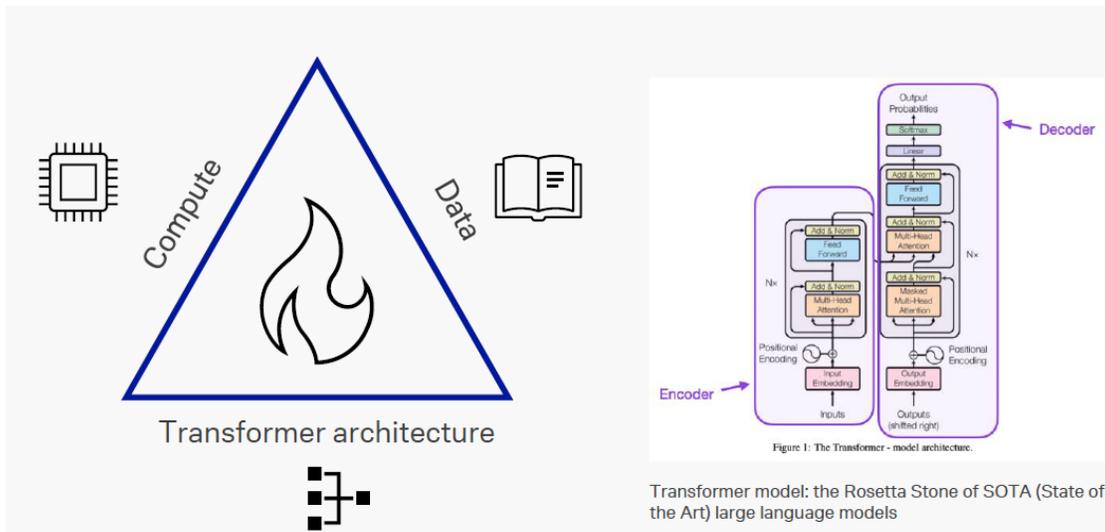


Exhibit 57. The Tipping Point for Generative AI: Massive Computing Power, Data and the Invention of the Transformer Model, source Deutsche Bank.

Modern AI, which –to the mainstream– is only two years old, represents a huge leap, a step-function improvement over traditional AI models in its ability to handle unstructured data and create new content.

For the first time, the addition of a reasoning engine at the core of the algorithm allows AI to be empathetic and imaginative, creative, generative, and inventive, as it approaches human-mind complexity and deep-path relational reasoning.

Generative AI Adds a Reasoning Engine to Software Tool Kit

By Representing the Relationships Between Words and Images in Numbers, Generative AI Enables Three Core Functions within Enterprise Software

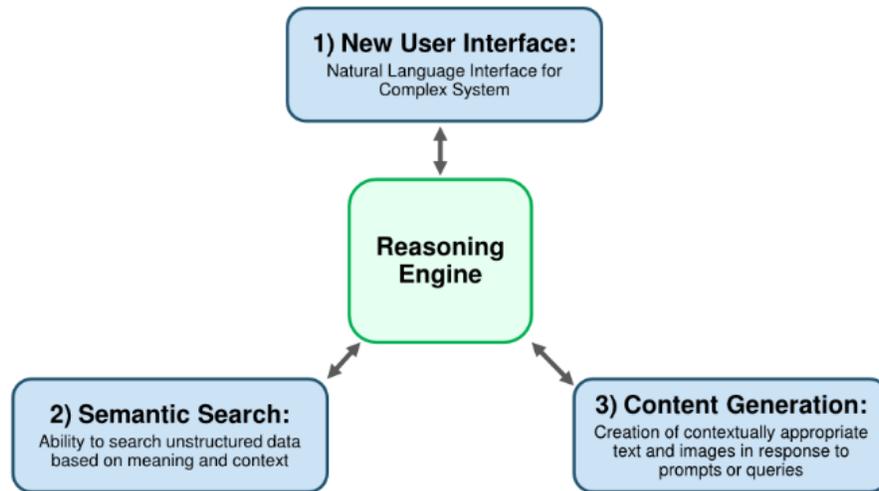


Exhibit 58. Generative AI Relational Reasoning Capabilities, source Morgan Stanley.

Another key to this important breakthrough over the last two years is the ability to draw insights from large amounts of unstructured data, including text, images and video.

Generative AI Unlocks Insights from Unstructured Data...

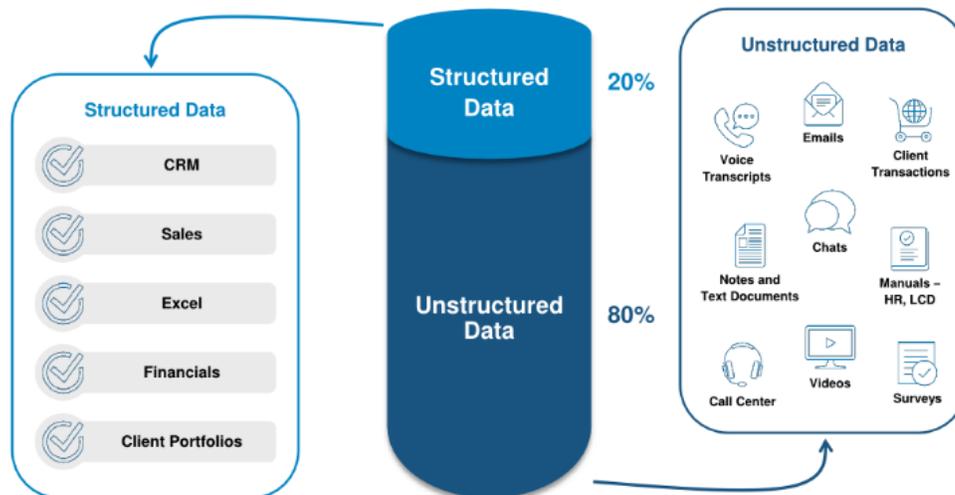


Exhibit 59. Generative AI Handling of Unstructured Data, source Morgan Stanley.

This new data paradigm is expected to significantly increase the amount of compute power needed to drive these very large datasets and complex Generative, and now Generalized Reasoning, AI models, with hundreds of billions of parameters, and now trillions of parameters over the next several years.

Early Stages of the AI Revolution

We remain relatively early in AI’s adoption across the broader economy, but we are accelerating rapidly. By the end of 2024, AI adoption among companies with more than 250 employees doubled to about 12% from 6% in the middle of 2024.

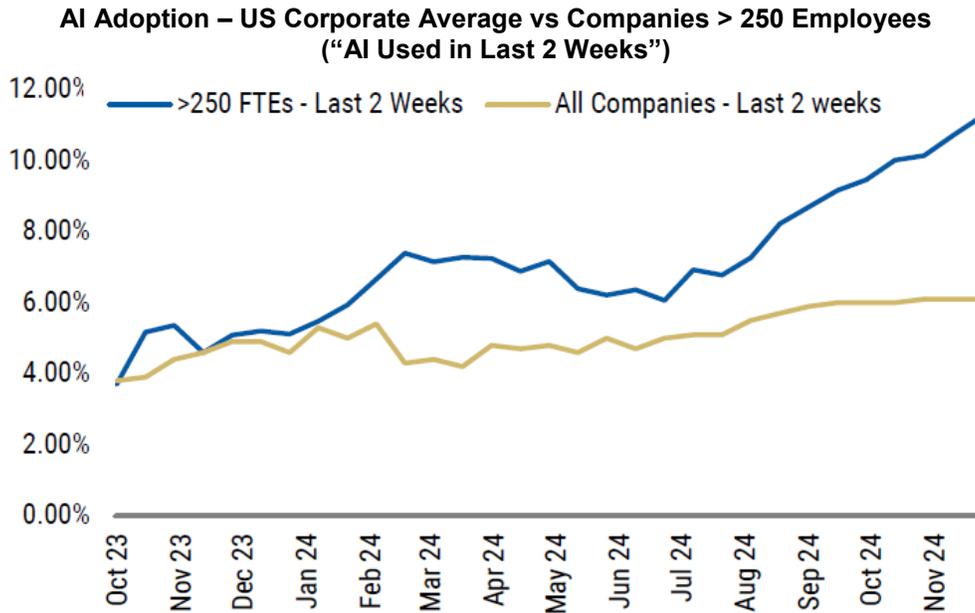


Exhibit 60. AI Adoption, source Morgan Stanley.

We also expect larger enterprises to move from proof-of-concept and experimentation phase to production in 2025, adding to three other market segments with significant 2025 tailwinds, namely the consumer, hyperscalers and sovereign segments, in our current view.

Assessing AI Demand and ROI

Consumer AI	<ul style="list-style-type: none"> Subscription-led monetization a proven model with 200mln+ WAUs on ChatGPT META AI and Apple Intelligence to ramp from 2025 Edge AI to drive major refresh cycle of PCs, smartphones and other consumer devices Autonomous driving and general robotics both large TAM opportunities in the next 10 years
Enterprise AI	<ul style="list-style-type: none"> Enterprise AI deployment going from PoC to trials to pilot. Early production ramp in 2025 and acceleration from 2026 Today, less than 1% of IT budgets is allocated to AI. This could reach >10% for G2000 corporates in three years, driving a new cycle in enterprise IT investments in servers, storage networking, software and services
Cloud AI	<ul style="list-style-type: none"> \$10bln Azure AI revenue run-rate by the end of 2024, 8 quarters after commercial launch. It took Azure Cloud Service 8 years to get there Cloud AI IaaS, database, and applications will be the fastest enterprise service monetization ever, with proven margins and payback economics
Sovereign AI	<ul style="list-style-type: none"> Global government IT spend reached \$700bln in 2023, and early AI investment exceeds \$10bln in 2024 Meaningful productivity savings and strategic national scientific investments will drive a fast and significant investment cycle in the next 3-5 years

Exhibit 61. Assessing AI Demand and ROI, September 2024, source Alkeon.

As we detail below, the AI revolution has been decades in the making. But until most recently, the compute power needed to handle AI models with tremendous complexity was simply not there.

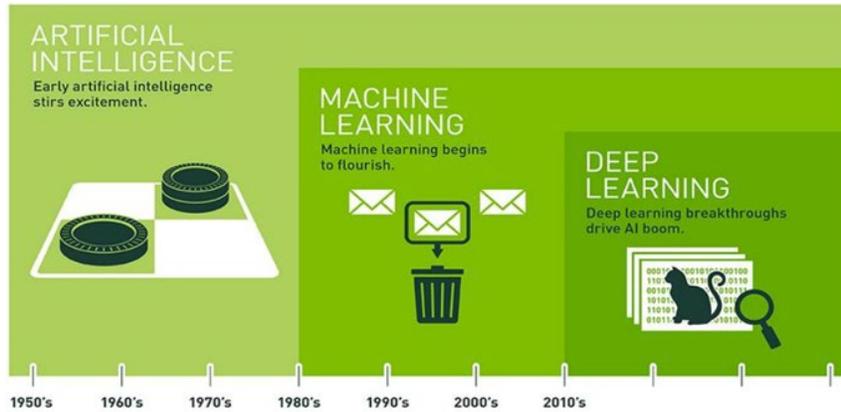


Exhibit 62. *The Era of Deep Learning, source Nvidia and JP Morgan.*

It was only recently in 2020 that AutoML Zero, developed by scientists at Alphabet, elevated the idea of automatic machine learning algorithms that are machine-created and can automatically improve themselves through Darwinian style evolution. This approach elevated machine learning innovation to a different level by un-constraining the hand-designed machine learning algorithm building and discovery process that can bias searches in favor of human-designed algorithms that are inherently limiting in the number of options they consider – as “you cannot search for what you cannot discover”.

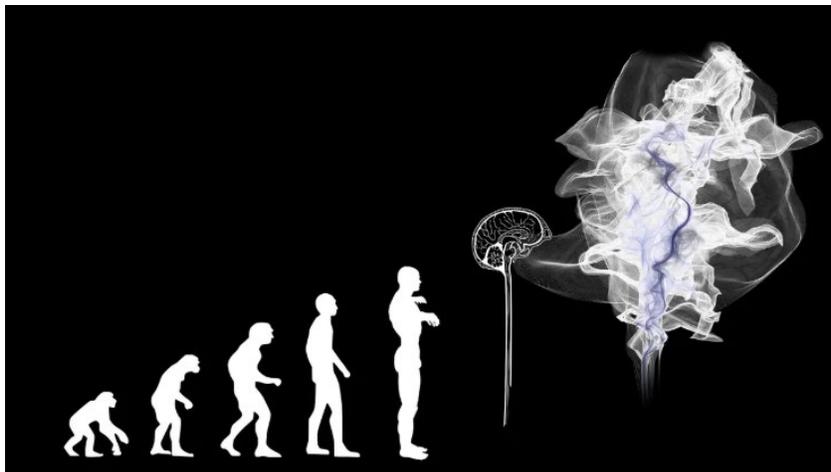


Exhibit 63. *AutoML-Zero: Evolving Machine Learning Algorithms from Scratch, source Bigthink.*

Such models, trained on vast amounts of data, necessitated the creation of powerful compute platforms between 2020 and 2022 that could attack AI problems of tremendous complexity. This ultimately led to the tipping point for generative AI at the very end of 2022, when large language models became capable of understanding and generating human-like text. These models were, for the first time, creative and empathetic, imaginative and generative.

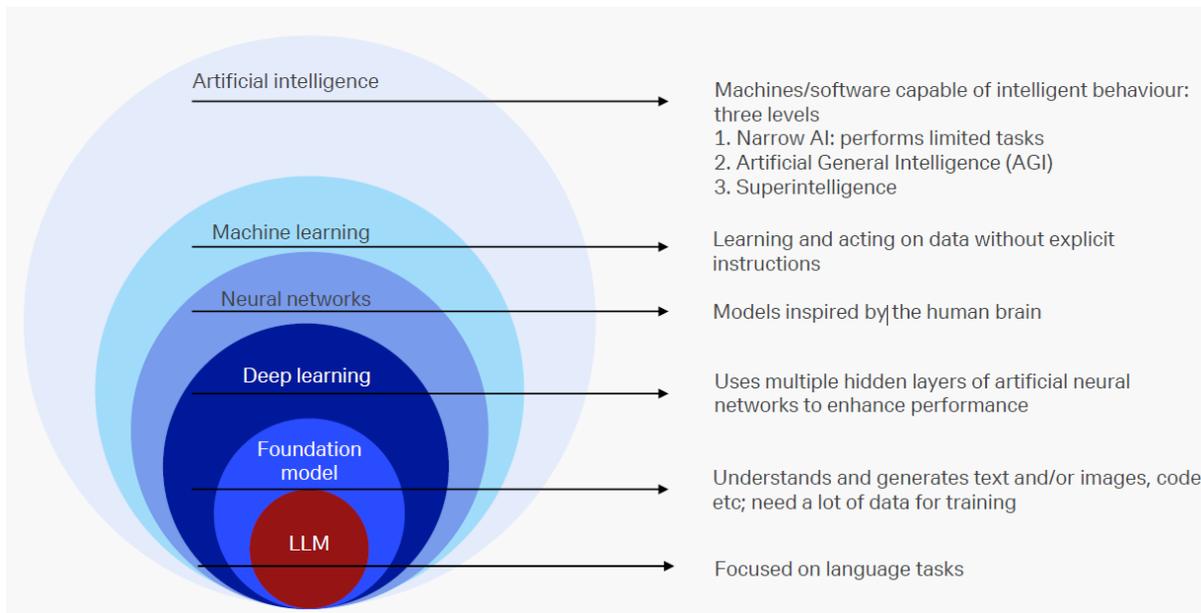


Exhibit 64. *What is a Large Language Model and Where Does it Fit into AI?, source Deutsche Bank.*

Advancing and bringing AI to the mainstream at the end of 2022 was a hugely important milestone, as only in the last few years have advances in computing power (a more than 30,000-fold increase in seven years) enabled this new era of AI training. It took one GPU to train AlexNet (the convolutional neural network architecture designed by Alex Krizhevsky) a decade ago, while GPT-3 required 10,000 GPUs for training, all linked together.²³

Incredibly, and as we were marking an inflection point of change in 2023-2024, advancing algorithmically closer to cognitive AI, the hardware needed to optimally process huge quantities of data and train these advanced AI models also advanced exponentially, reaching new milestones at the same time. Enter the era of Accelerated Computing, advanced computing in the post-Moore’s Law era, which can handle problems with tremendous complexity.

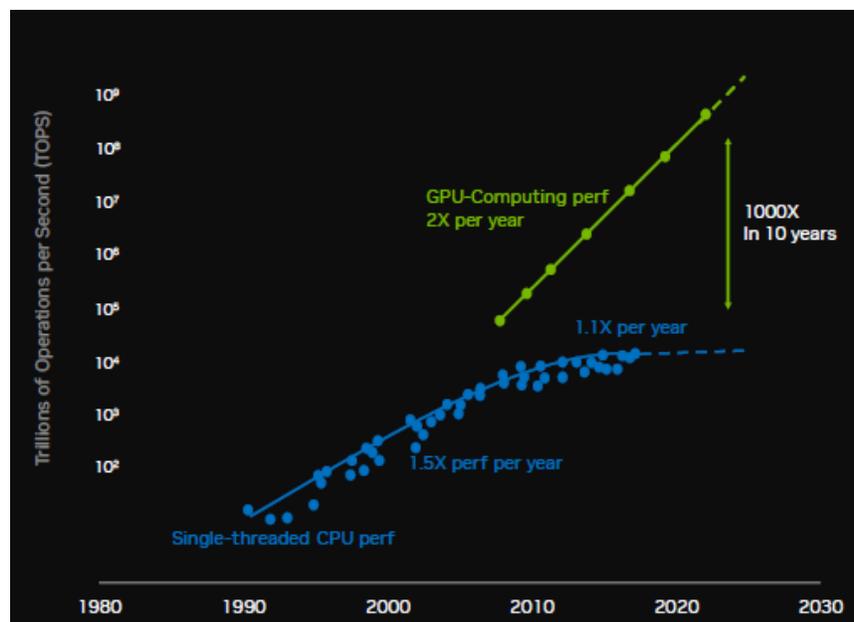


Exhibit 65. *Dramatic Acceleration in Inference Performance, source Nvidia.*

To enable AI models with billions and recently trillions of parameters, AI chips are becoming larger and larger, with designers now embedding significant amounts of fast memory on the chip to handle the demands of AI training algorithms that require a huge amount of communication and a modest amount of relatively easy compute.

Private startup Cerebras has showcased the largest chip ever built. This wafer-scale chip, which is purpose built to accelerate AI applications, has 2.6 trillion transistors and embeds 850,000 AI-optimized cores.



Exhibit 66. *The World's Largest Chip, source Cerebras.*

Such important hardware advances are coming at the right time, as only a few years ago the amount of data generated by machines surpassed the amount of data generated by humans, and that gap is now widening exponentially.

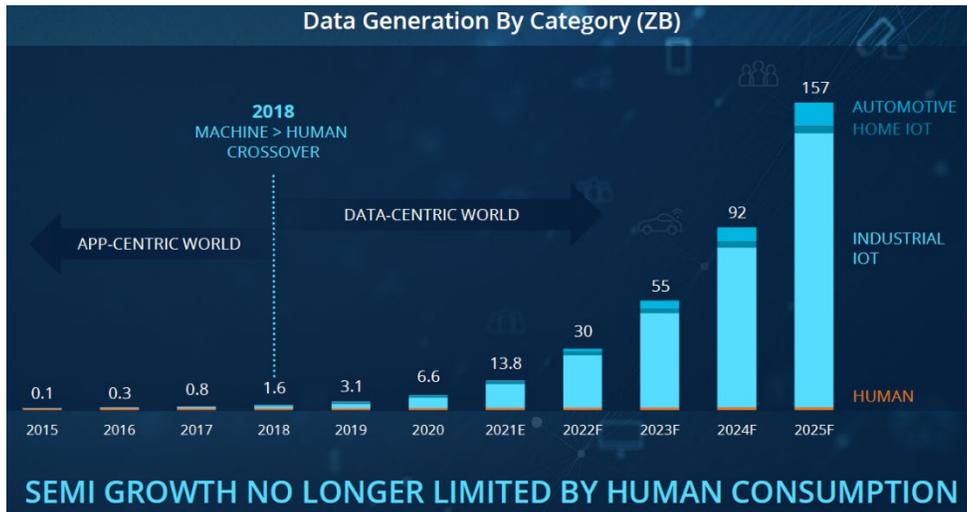


Exhibit 67. *Data Generation by Category (in Zettabytes), source Applied Materials.*

Having now built an advanced computational foundation, the new modern AI era is expected to be the biggest and most transformational era of computing, with positive secular implications across software and hardware.

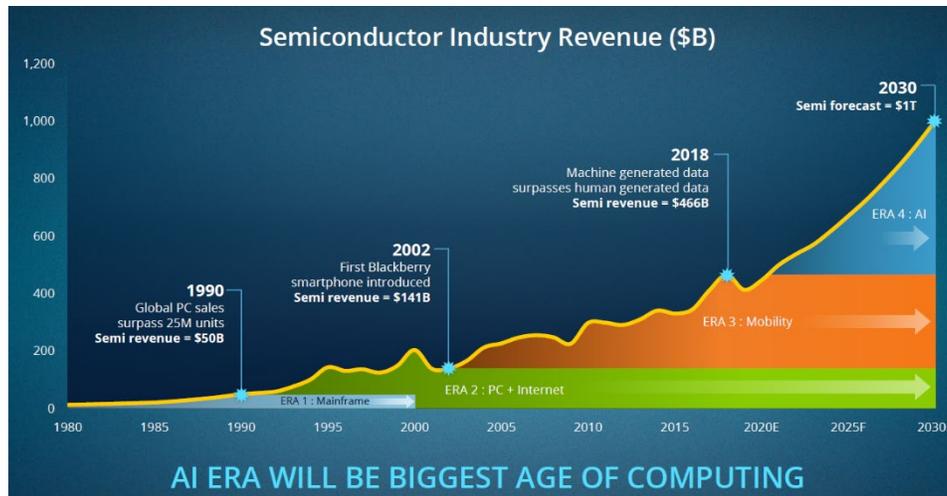


Exhibit 68. *Semiconductor Industry Revenue, Billions, source Applied Materials.*

We now find ourselves at the very early stages of the incredible modern generative AI revolution, which has the potential to be the most disruptive and transformative cycle of technological innovation humans have ever witnessed, in our view.

Early in 2024, we wrote and talked about the recent emergence of advanced AI models that bring us closer to generalized reasoning. These models can advance on several layers of analysis and reasoning (“deep-path reasoning”), solving complex problems (such as advanced geometry problems) that even powerful LLMs were unable to solve. An example was DeepMind’s “Tree of Thoughts” that can evaluate different reasoning paths, and can look ahead or back-track as needed before making optimal choices.

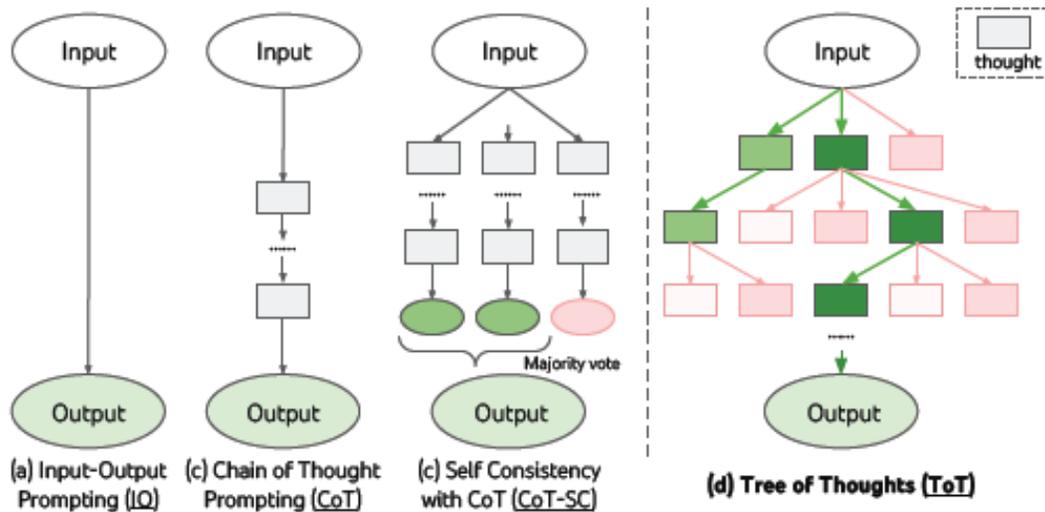


Exhibit 69. *Approaches to Problem Solving with LLMs – Each Rectangle Box Represents a Thought, source Google DeepMind and Princeton University.*

Then, in a seminal moment that marks the start of the pre-AGI era, OpenAI, in September 2024, released a powerful new model, named o1, a model that thinks and self-reflects before responding.

Like a human, the longer o1 thinks the better it does on complex reasoning tasks, such as math and code generation.



Hunter Lightman @hunterlightman

For a lot of the time that I have been here we have been trying to make the model better at solving math problems as an example. And we put a lot of work into this, and we've come with different methods.. One thing I kept, every time I would read one of these outputs from the model I would be so frustrated that the model would never seem to question it was wrong or it making mistakes, or things like that. (September 2024)

But one of these early o1 models we actually started talking to it and sort of asked these questions, and it was scoring higher on these math tests we were giving it, we could look at how it was reasoning, and you could see it started to question itself, and had interesting reflections, and that was the moment for me. (September 2024)

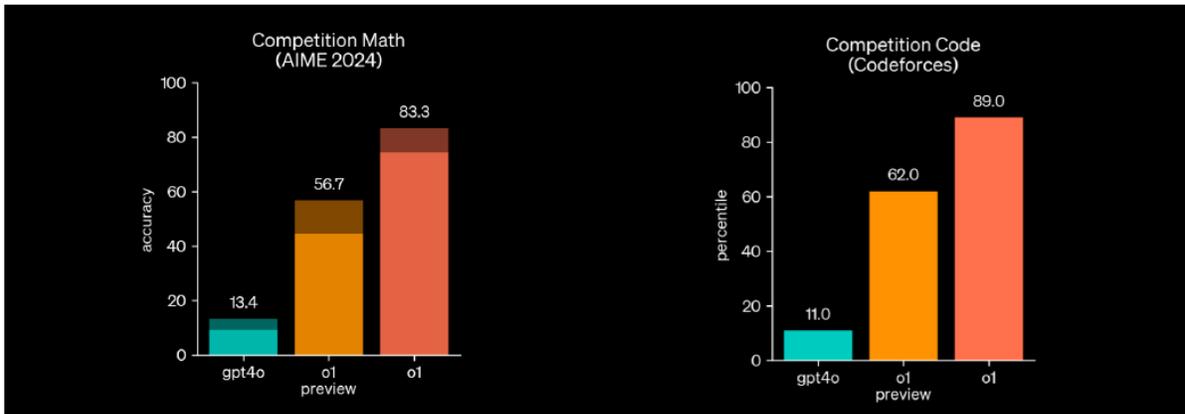


Exhibit 70. o1 Competition Math and Code Scores, September 2024, source OpenAI.²⁴

o1 also opens up a new dimension of scaling, scaling inference in addition to training.



Michael Dell

o1 is trained to "think" before responding. The longer it thinks, the better it does on reasoning tasks. It opens up a new dimension for scaling. We are no longer bottlenecked by pre-training. We can now scale inference compute too. (September 2024)

We haven't even talked about inference, and inference will be 90% of the AI workload by the end of the decade. (September 2024)



Noam Brown @polynoamial



Exhibit 71. Pre-Training, Post-Training and Inference Proportions, September 2024, source OpenAI.²⁵

For the first time we can see the model think, self-reflect and improve itself, and we can actually watch its chain of thoughts (see Appendix, Exhibits 94-95 at the end of this letter).²⁶



Noam Brown
@polynoamial

@OpenAI's o1 thinks for seconds, but we plan for future versions to think for hours, days, even weeks. Inference costs will be higher, but what cost? Would you pay for a new cancer drug? For breakthrough batteries? For a proof of the Riemann hypothesis? (September 2024)



Will Depue
@willdepue

@Scaling inference time compute can compete with scaling-time compute! (September 2024)

As scaling dramatically occurs during inference, the amount of compute power needed to analyze complex problems for hours can be astronomical. As such, recent advances in inference performance become crucial to the success of models with generalized reasoning capabilities.

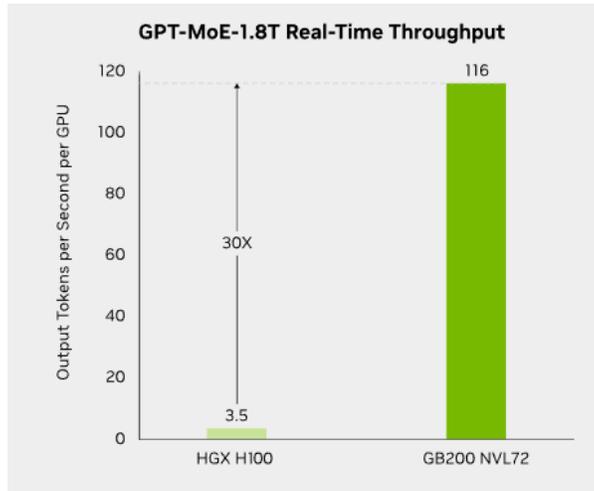


Exhibit 72. 30x Improvement in Inference Performance, source Nvidia.

Incredibly, three months after the introduction of o1, in December 2024, OpenAI introduced a new, even more advanced model that brought generalized reasoning capabilities to a human PhD level. Enter the era of o3!

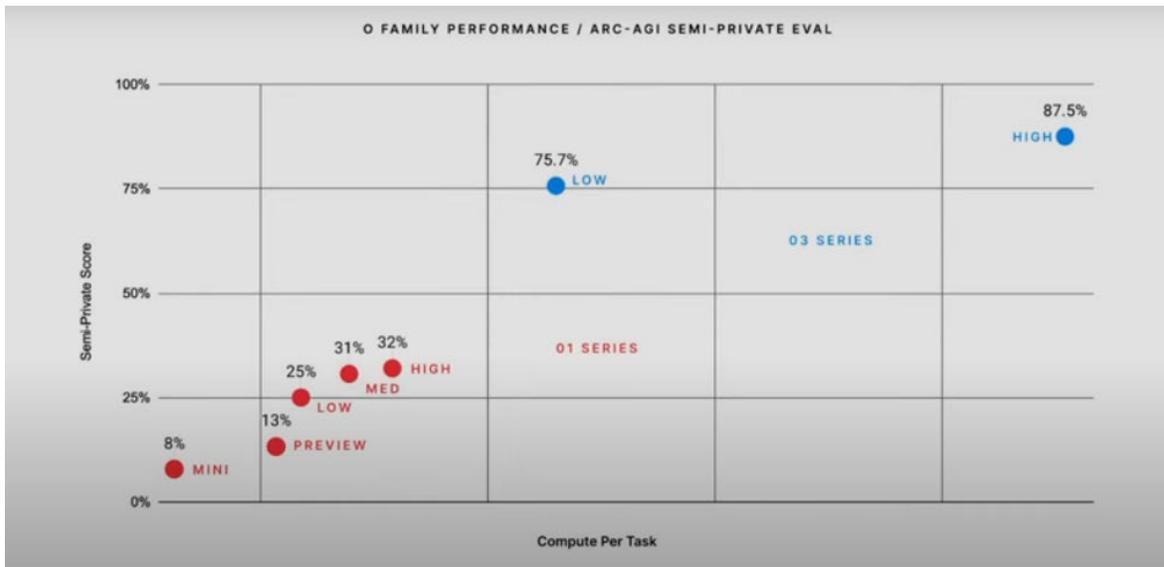


Exhibit 73. Getting Closer to AGI – o3 Achieves New Record 87.5% Accuracy on ARC AGI Benchmark Eval, Exceeding Human Intelligence at 85% Level, source OpenAI.

o3 surpassed the human score on ARC AGI benchmark evaluation, officially marking the start of the pre-AGI era. If prior years brought exponential improvement in AI scoring, o3 extends a vertical path in AGI scoring.

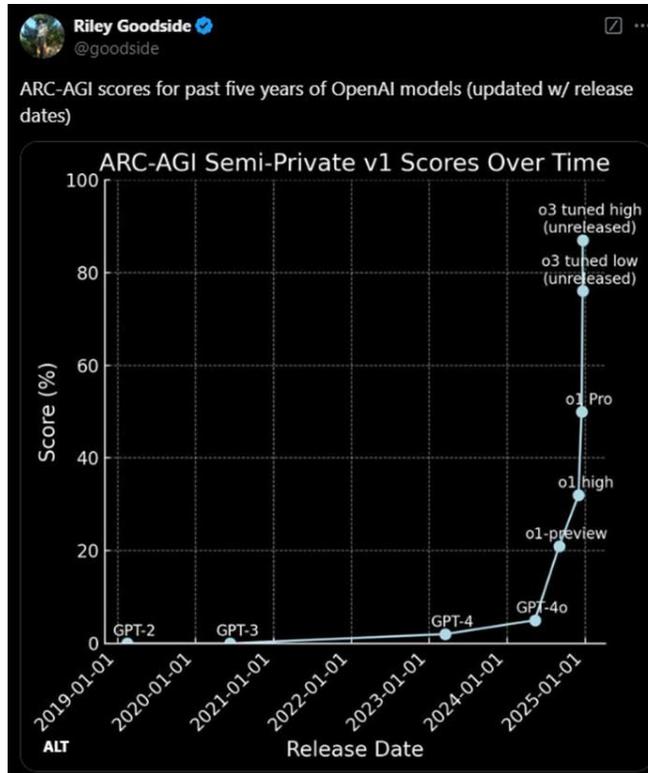


Exhibit 74. Vertical Improvement in AGI Scoring – ARC-AGI Scores for Past Five Years of OpenAI Models, source Morgan Stanley, X.

As AI progress was taking place at unimaginable speed, 2024 also marked a year of significant new advances in multimodality and AI-powered humanoid robots.

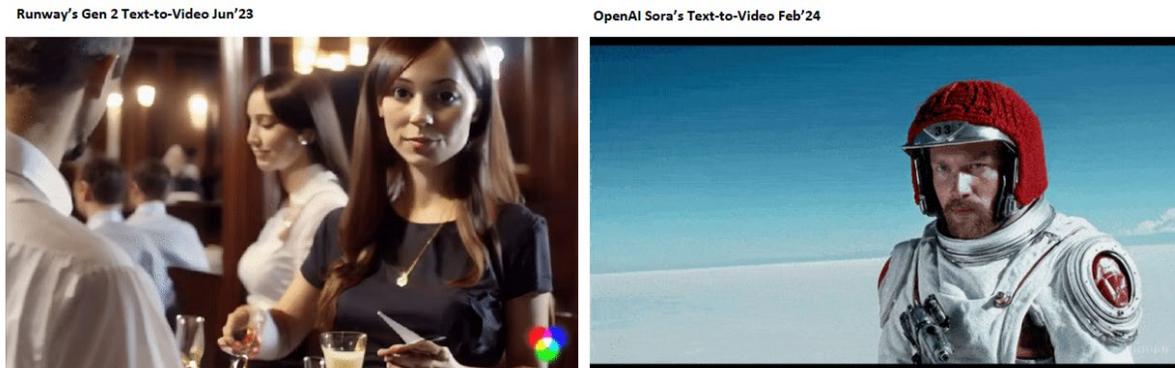


Exhibit 75. New Powerful Text to Video Models June 2023 and February 2024, source Runway and OpenAI.

Introduced in December 2024, Google's Deepmind Veo 2 created incredible videos with realistic motion and high quality, surpassing OpenAI's early versions of Sora.



Exhibit 76. *Veo Compilation*, source <https://www.youtube.com/watch?v=G9RDHs9nx04>.

Multimodality refers to AI models that can understand, transform and generate all data forms, including, text, image and video. These new models are now also powering humanoid robots, such as the newly launched Figure robots, which are powered by a large multimodal OpenAI model.

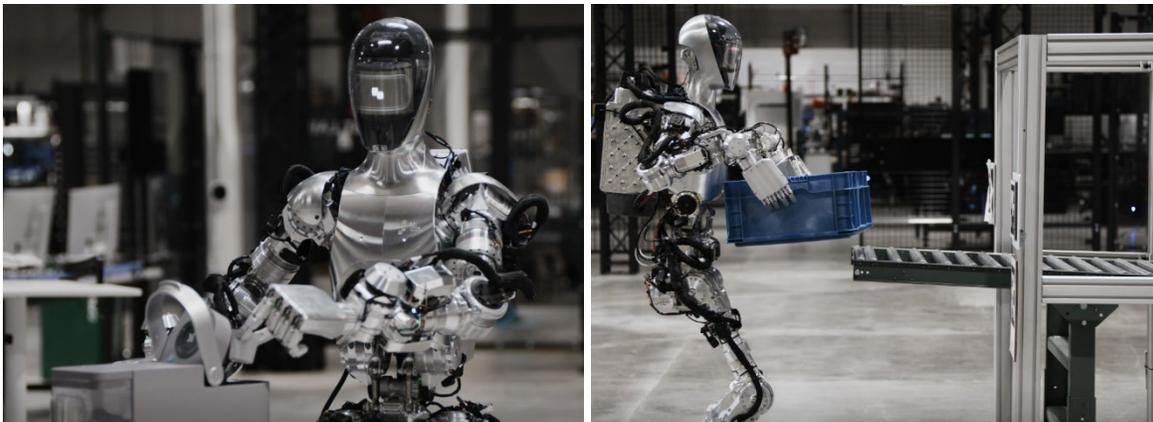


Exhibit 77. *Humanoid Robots*, source *Figure*.

The founder of humanoid robotics firm Figure has famously said, “Every human will own a robot in the future, similar to owning a car/phone today”, which is a belief that other visionaries such as Elon Musk have shared.²⁷ In this connection, Figure believes that there will be significant labor shortages in certain occupations, with almost 10 million unsafe or undesirable jobs in the US alone, and that “humanoids will revolutionize a variety of industries, from corporate labor roles (3+ billion humans), to assisting individuals in the home (2+ billion), to caring for the elderly (~1 billion), and to building new worlds on other planets”.²⁸

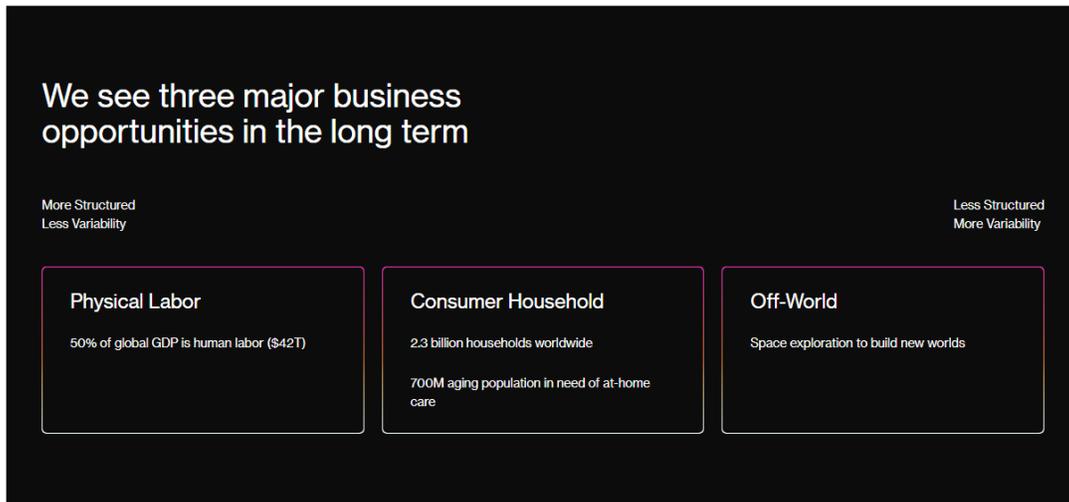


Exhibit 78. AI & Robotics Possibility, source Figure.

Traditionally, robotics and AI were different fields. But now, with the advent of multimodality for training robots, much more efficiently and faster than the past, the two fields are converging, giving rise to a number of startups that are producing next generation humanoid robots, that can observe, emulate and learn quickly.

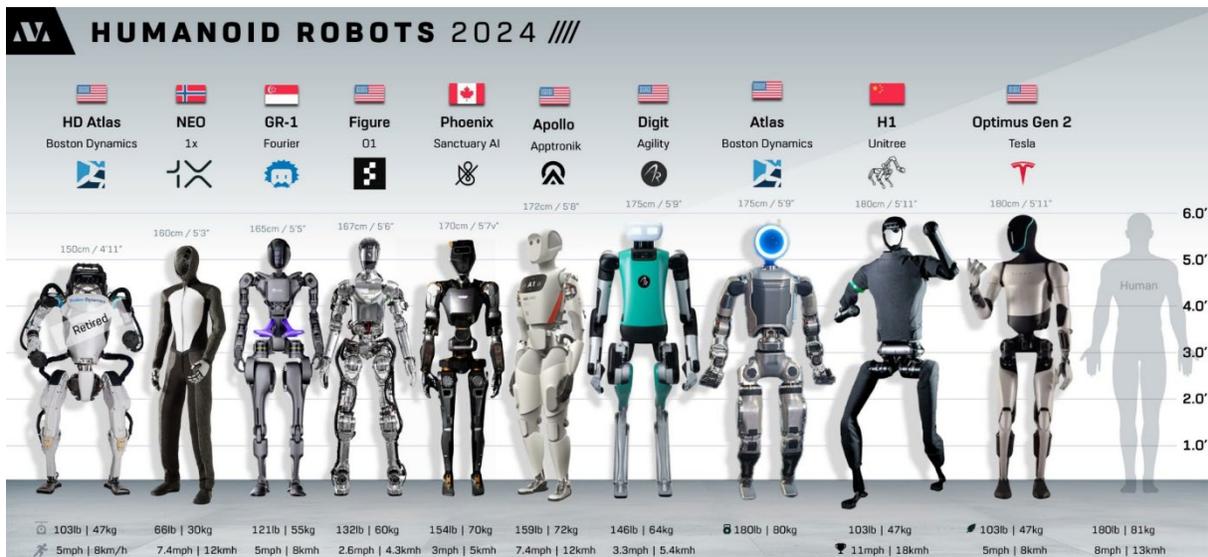


Exhibit 79. Humanoid Robots 2024, source LifeArchitect.ai.

A humanoid is a robot that resembles a human in bodily shape. This is a powerful idea, as the world is already setup for humans to operate in, providing a brownfield environment for humanoids, and expanding the Total Addressable Market (TAM) from manufacturing and warehousing to home assisting, caring for the elderly, education, entertainment and corporate labor.

Type	Industrial robot		Service robot	Humanoid robot
	Traditional industrial robot	Collaborative robot (Cobot)		
Definition	Industrial robots are heavy-duty machines designed to automate the manufacturing process	Cobots are intended for direct human-robot interaction within a shared space, or where humans and robots are in close proximity	Service robots are robots in personal use or professional use that performs useful tasks for humans or equipment.	Humanoid robots are robots designed to resemble humans in appearance and behaviour
Capability	<ul style="list-style-type: none"> - Material handling - Assembly - Welding - Painting & Coating - Quality inspection - Picking, sorting and packing 	<ul style="list-style-type: none"> - Assembly (part selection, dispensing of adhesive, fastening of screws, etc.) - Machine tending - Material handling - Quality inspection - Welding 	Service robots include consumer service robots (domestic cleaning robots, automated wheelchairs, and social interaction robots), and professional service robots (cleaning robots for public places, delivery robots, fire-fighting robots, rehabilitation robots and surgery robots in hospitals, as well as autonomous mobile robots (AMR))	<ul style="list-style-type: none"> - Moving / walking - Interact with humans
Features	<ul style="list-style-type: none"> - Do work in place of human beings; - Can handle heavier and larger materials than cobots; - Moves at a faster speed than cobots; - Engineers need to re-write codes for any changes; - Often needs safety cages to keep humans out of the workspace 	<ul style="list-style-type: none"> - Do work alongside human beings; - More easily programmable than industrial robots; - Not designed for heavy manufacturing; - Usually cheaper than industrial robots 		<ul style="list-style-type: none"> - Could perform complex actions that require human-like dexterity, such as picking up objects, walking and climbing stairs; - Able to behave like humans and interact with humans
User case	<ul style="list-style-type: none"> - Manufacturing factory - Warehouse 	<ul style="list-style-type: none"> - Manufacturing factory - Agriculture - Medical - Pharma 	<ul style="list-style-type: none"> - Transportation & logistics - Hospitality - Medical robotics - Professional cleaning - Agriculture 	<ul style="list-style-type: none"> - Manufacturing factory - Warehouse - Entertainment - Education - Home assistance - Elderly care
Example				

Exhibit 80. *Types of Robots – Humanoid Robots Are a New Addition to the Robot Industry, July 2024, source Deutsche Bank.*

For example, Tesla’s Optimus, a general-purpose humanoid, is designed to emulate a human, with hands and fingers capable to feel and sense textures and mass. As the robot simply mimics the human, training becomes very natural. Tesla is paying up to \$48 an hour for individuals to “play robot”, wearing a suit to capture movements and various motions as well as a VR headset, and perform tasks that Optimus observes, analyses and mimics.

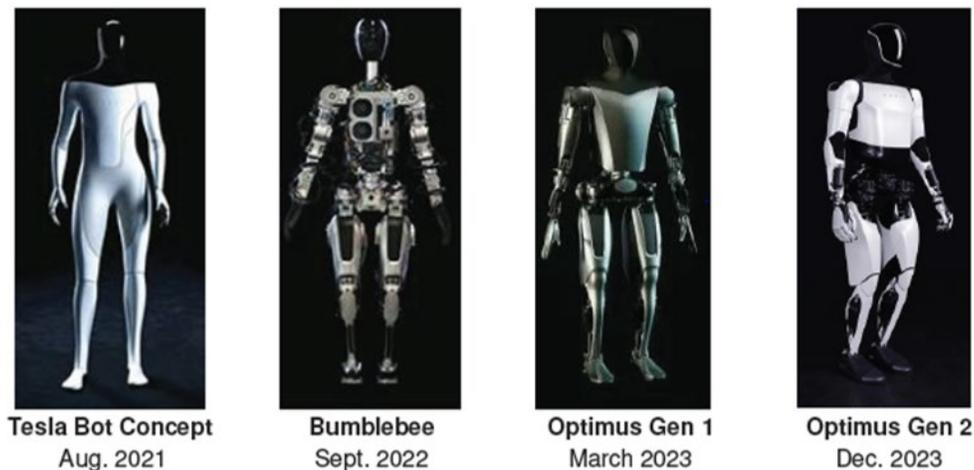


Exhibit 81. *Tesla Optimus Versions, September 2024, source Morgan Stanley.*

In short, we believe the journey towards AGI has been significantly advanced by the 2024 breakthroughs in AI. Simply stated, we believe AI is the most fascinating technological discovery of our lifetime. It has the potential to be the most transformative and disruptive cycle of innovation we have ever witnessed and will revolutionize the way businesses operate, and the way consumers behave, in our view.

Following the significant advances in software and hardware in the last few years, and as AI has begun to handle models with tremendous complexity, AI algorithms are becoming more “human-like”. Additionally, next-level use cases require gigantic models. Advanced AI models are becoming massive and highly complex, and this is the only way to approach models of human intelligence.

These days a large language model can be over 1 trillion parameters. The growth in model complexity has been exponential.

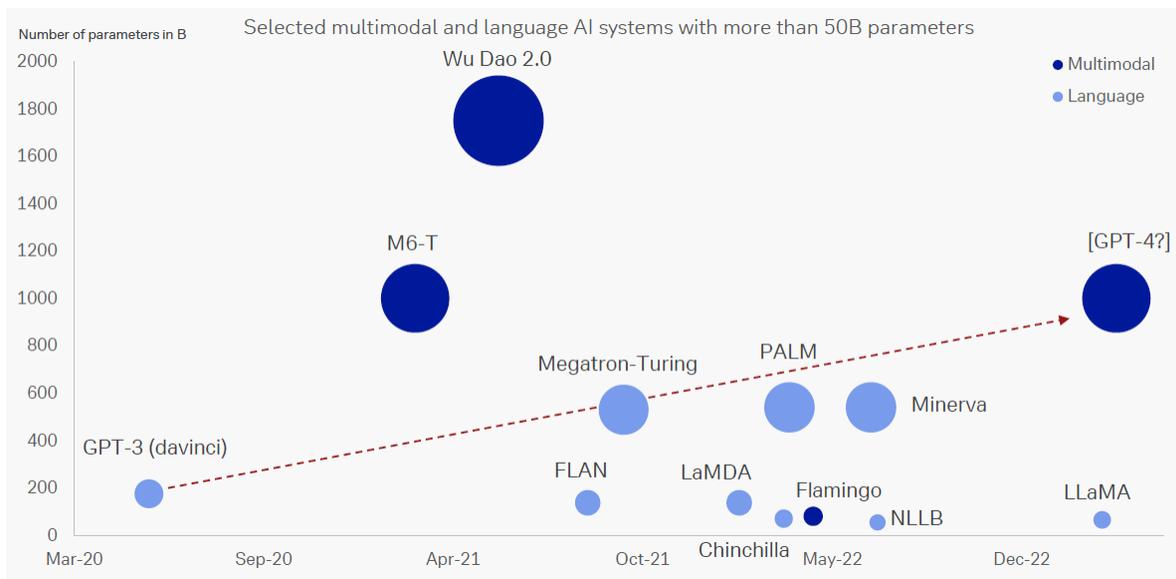


Exhibit 82. *The Number of Parameters in LLMs Has Surged, Surpassing 1 Trillion, source Deutsche Bank.*

One of the key moments that led to the current AI breakthrough was the 2021 introduction of OpenAI’s Generative Pre-Trained Transformer (“GPT-3”), one of the largest language models ever trained at 175 billion parameters, that received much attention in 2021 and set the stage for the late 2022 inflection point of bringing AI to the mainstream. There was great hype around GPT-3 from the very beginning. As Jen-Hsun Huang described at GTC 2021 – and we communicated in our 2021 letters:

OpenAI’s GPT-3 is 175 billion parameters. That is 3,000 larger in just three years. The applications for GPT-3 are really incredible. Generate document summaries, email phase completion, GPT-3 can even generate Java script and HTML from plain English. Essentially telling AI to write code based on what you wanted to do.²⁹

GPT-3 gave rise to the most important recent breakthrough in AI, namely generative AI, which builds models that allow computers to create new content.

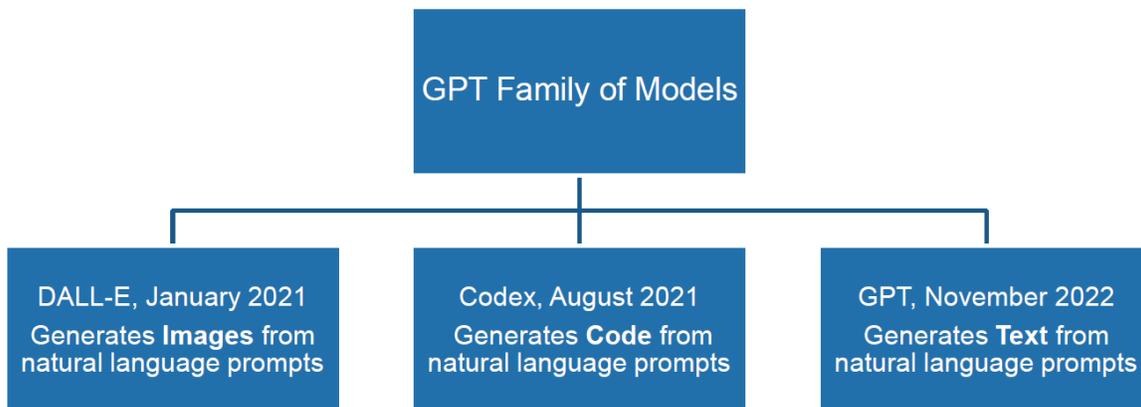


Exhibit 83. *OpenAI’s Contribution in Focus, source Microsoft.*

ChatGPT, released at the end of November 2022, quickly became one of the most viral technologies of the year. ChatGPT was created by OpenAI as a conversational AI or chatbot. It is a generative AI based on the large language model (LLM) called GPT-3.5, a fine-tuned, more intuitive version of GPT-3 refined through reinforcement learning from human feedback (RLHF). As noted above, GPT-3 was one of the largest language models ever trained at 175 billion parameters. ChatGPT is a smaller, more condensed version of GPT-3.5 and included an additional layer of safety guardrails for users. It was trained on large amounts of data, 300 billion words or 570GB from the internet through 2021, including Wikipedia, social media and news articles.

The game changer for ChatGPT was its free-to-use, open-source model, with a user-friendly UI, reminiscent of iMessage or WhatsApp. This makes it well suited for mass distribution and has enabled the widespread adoption and creative explosion on ChatGPT to date. In fact, ChatGPT reached its first one million users in five days. It took three months for Instagram and three and a half years for Netflix to reach the same milestone. Users could write questions or prompts, and ChatGPT responded in an intelligent, uncannily human-like manner on any topic that the user wanted, even writing poems, essays, songs, code, and witty jokes. This instantly became a mass market, general purpose, sophisticated chatbot that could write like a human.

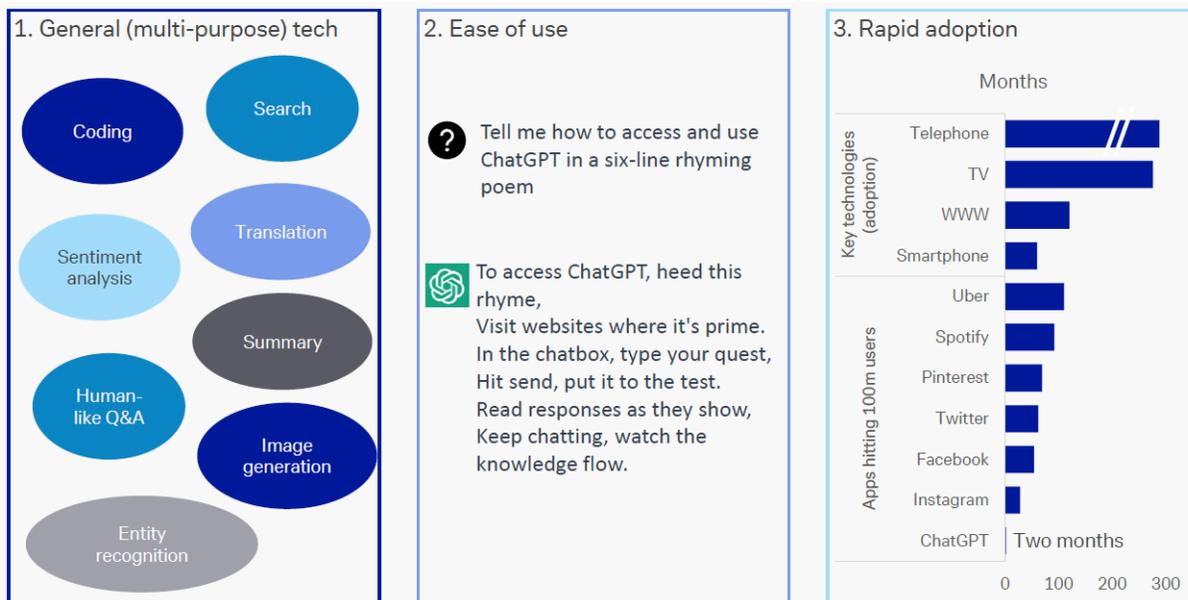


Exhibit 84. *What Is Special About Generative AI?, source Deutsche Bank.*

To highlight the dramatic advances of the last four years, in another breakthrough moment, around 2021 researchers at Alphabet developed the world's first trillion parameter model, T5-XXL, a language model with 1.6 trillion parameters. Also, on June 1, 2021, China announced Wu Dao 2.0 ("Wu Dao" means enlightenment), a model similar to GPT-3 only 10 times larger: 1.75 trillion parameters! Wu Dao, like Alphabet's early MUM model, used multi-modality, the ability to learn from text, audio, images and video.

Claimed by its own creators to be 10 times more powerful than GPT-3, Wu Dao could not only understand what people said but also created images, sang and painted. Hua Zhibing, Wu Dao's virtual female child, was reportedly showing signs of relational reasoning and emotional interaction, providing hope that "the virtual girl will have a higher EQ and be able to communicate like a human".³⁰ Although much of this has yet to be proven, we currently believe there is now a path towards using mega-models to conquering human cognition.



Exhibit 85. *Human Mind, source Getty.*

To visualize the incredible potential of next generation AI applications, it is instructive to look at the computational graph of a machine learning system – this is a representation of the model the system builds. Back in 2017, AI startup Graphcore had published an amazing set of images of the computational graphs mapped to its machine learning system, which strikingly looked much like a brain scan.³¹

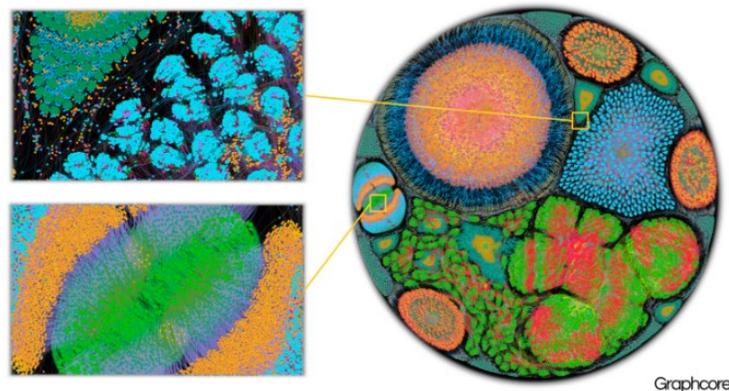


Exhibit 86. *Example of a Machine Learning Model Used in Data Analysis, source Graphcore.*

These breakthrough developments in image and speech recognition, conversational AI and AutoML –over just the last couple of years–, are now about to fundamentally change our relationship with machines and computers forever, as computers begin to learn our language and understand what we see and hear.

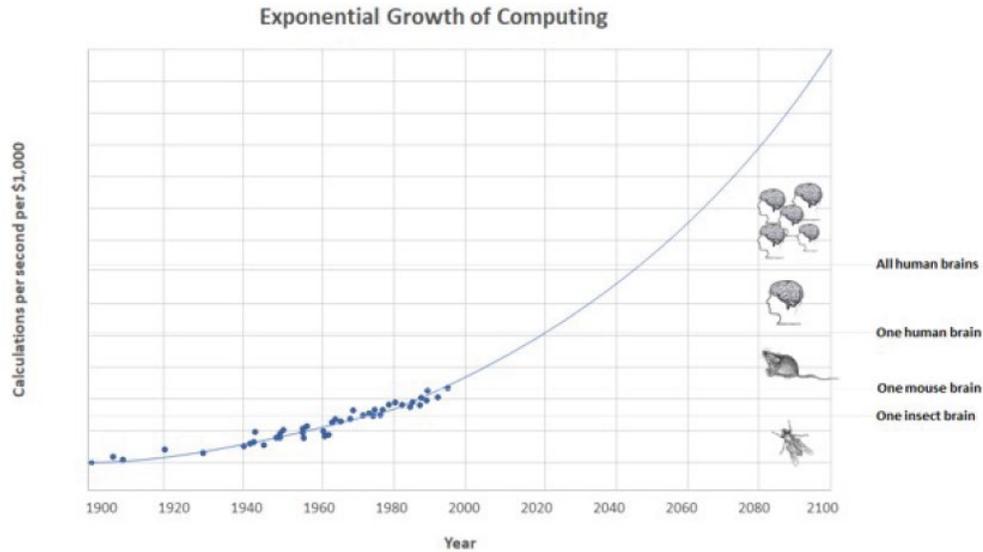


Exhibit 87. *Computing Power Roadmap, source Ray Kurzweil and Morgan Stanley.*

“As that happens the human-computer interface [will] no longer exist. We will become the interface. We will talk to computers and they will talk back. We [will] see information directly in our eyes. The new form factor is VR/AR.”³²

As AI slowly becomes more intelligent than the human mind, advances in brain technologies could make the communication between machines and humans seamless. Ultimately, the distinction between the physical mind and the digital mind may not even exist.

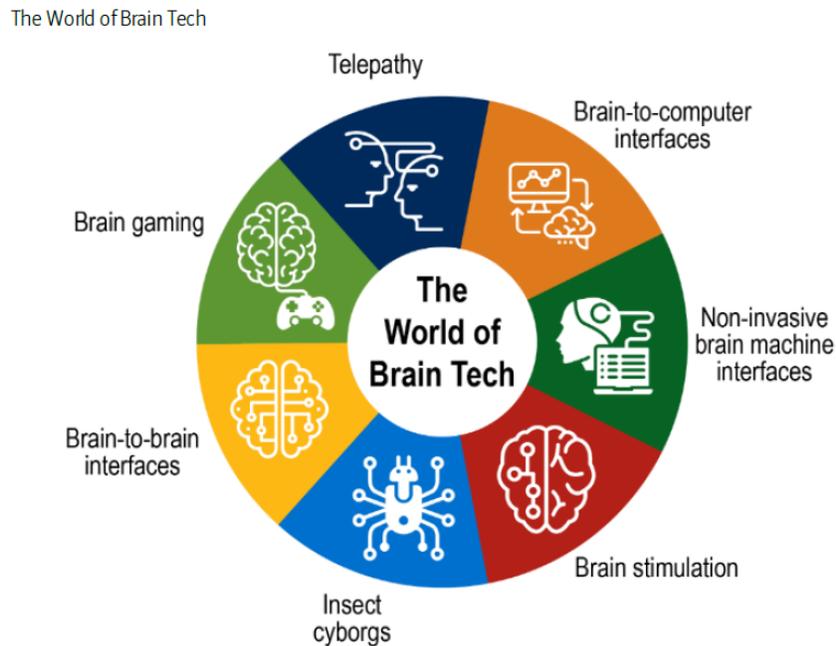


Exhibit 88. *Advances in Brain Technology, source BofA Global Research.*

2022 also marked an era in which writing code becomes automated, moving rapidly to the stage where AI will write the majority of computer code. Essentially, you tell AI what to do, and it will write the code.

In 2022, for the first time AI surpassed the average programmer (top 54th percentile) in competitive coding. AlphaCode wrote competitive computer programs, generating code using a transformer model, similar to language translation tasks.

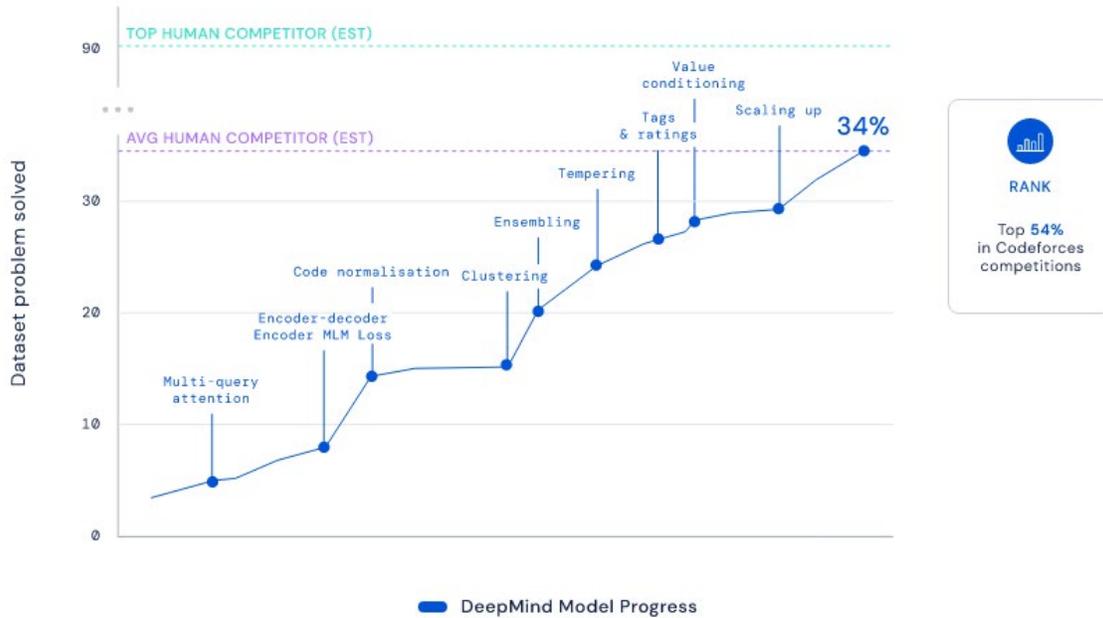


Exhibit 89. DeepMind Model Progress, source Google.

If 2022 was a pivotal year in which AI went mainstream, (the end of) 2024 became the time we marked the start of Generalized Reasoning, Inference-time Compute and Next-gen Multimodality.

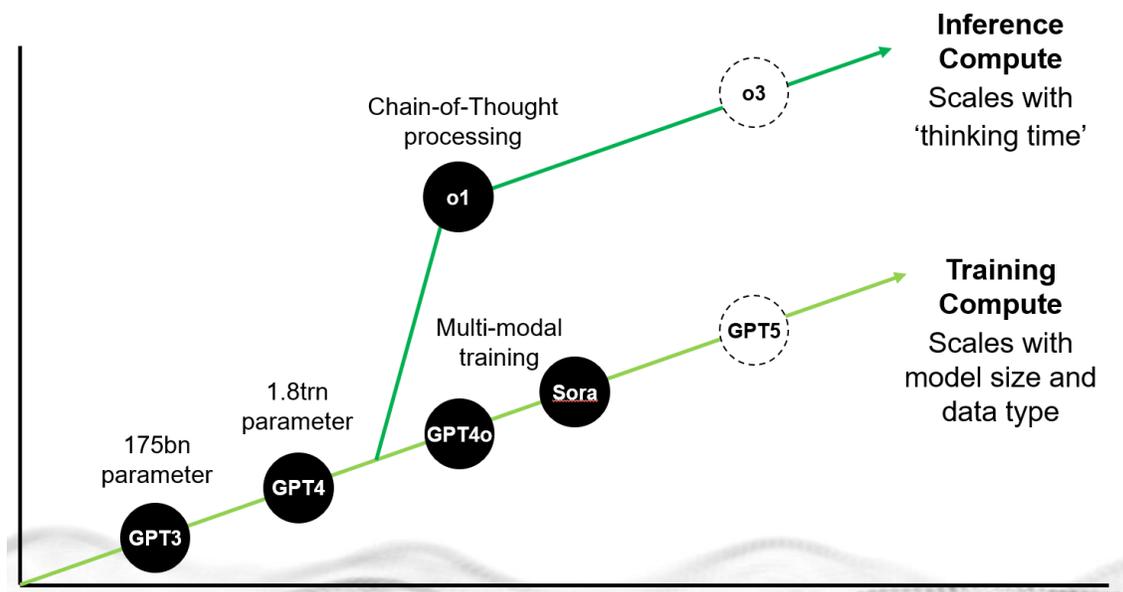


Exhibit 90. AI Scaling Evolution – Pre-Training and Inference, source Alkeon.

In summary, and in our view, AI will be the greatest technological innovation of our time, fundamentally redefining and extending the boundaries of human intelligence, analysis, planning, creativity and invention. For businesses, this means radically changing how the world's largest industries operate.

"AI is quite possibly the most important – and best – thing our civilization has ever created, certainly on par with electricity and microchips, and probably beyond those." Marc Andreessen, General Partner of Andreessen Horowitz

And although AI is attracting most of the headline attention, the underlying foundational components of this upcoming Fourth Industrial Revolution, such as 5G, 6G and IoT applications, are fundamentally equally important.

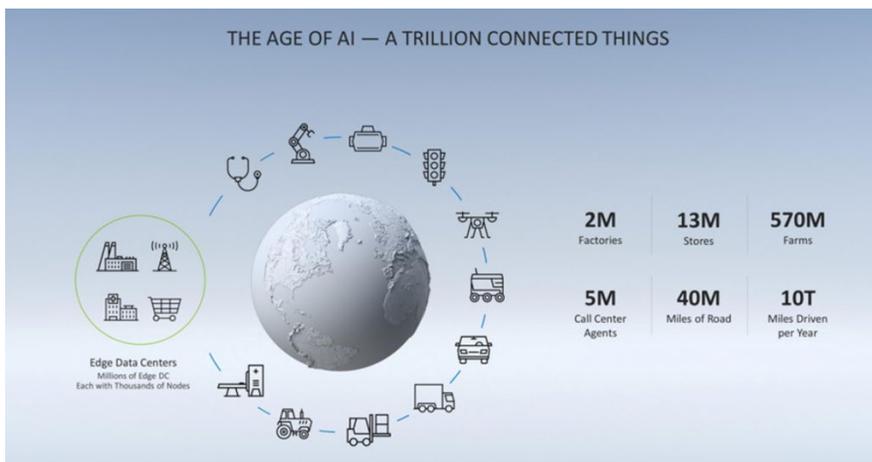


Exhibit 91. *The Age of AI, a Trillion Connected Objects, source Nvidia.*

As such, newly formed applications on top of this new powerful physical layer will be sizable – and are growing rapidly. For example, by 2030, the size of the US IoT market is expected to grow fifteen-fold relative to 2019.

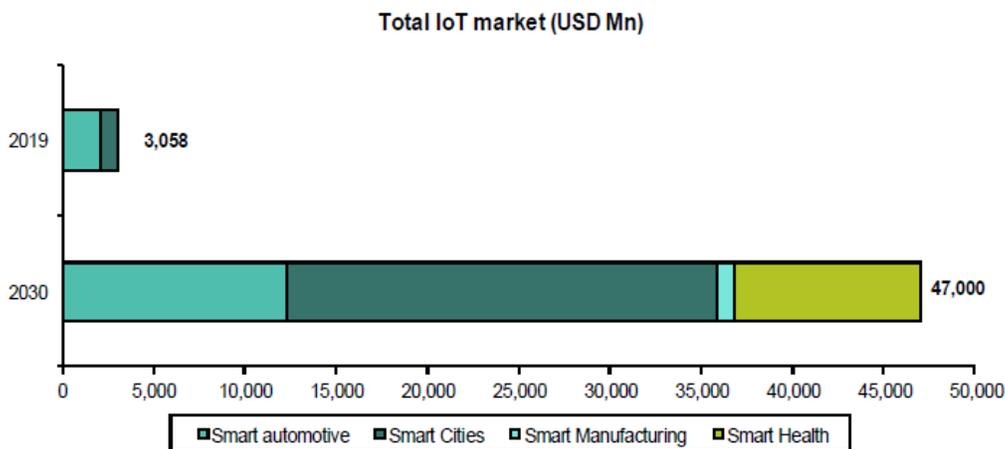


Exhibit 92. *Estimated US IoT Market Growth, July 2020, source Bernstein.*

5G can also transform another huge end market, namely logistics, from driverless long-haul transportation, to last-mile delivery robots, to smart delivery boxes, to IoT-5G-assisted sorting centers and fully automated warehouses. In China, companies like Alibaba and JD Logistics are already building intelligent 5G-enabled logistics parks.



Exhibit 93. JD Logistics using 5G in Warehousing and Last-Mile Logistics, source Bernstein.

Our most recently published quarterly letter provides an in-depth analysis of this broad-based wave of technological innovation, which is about to redefine the way we work, live and interact.

In closing, we remain the largest investors in the strategy and have our interests aligned with those of our limited partners.

Sincerely,

Alkeon Capital Management Investment Team

¹ Alkeon Growth Partners, LP (AGP) is one of the original feeder funds into Alkeon Growth Master Fund, Ltd. You may be invested in a different feeder fund that also feeds into that master fund. Performance data presented above is on a fund level and reflects AGP performance, net of actual fees and expenses. AGP commenced operations in January 2003, and investors in AGP are generally subject to a 20% incentive allocation and management fees ranging from 1.25% to 2% depending on the series of interests they hold in AGP. Certain AGP investors (such as Alkeon affiliates) have been or are entitled to management fee and/or performance allocation waivers and have at times constituted, and may constitute in the future, a significant portion of AGP's assets. Therefore, AGP's fund-level returns generally are higher than the performance shown herein for the Alkeon Growth Strategy ("AGS"), whose investors have not received such waivers. In addition, the historical fund-level performance for AGP incorporates various fee classes, some of which are subject to lower fees than the highest fee classes currently offered. Therefore, investors in AGP likely would have experienced lower returns than those shown herein if they were subject to the current highest fee classes during all time periods.

² Performance data is from another investment vehicle which is managed substantially pari-passu to AGP and follows substantially the same investment strategy (the "Alkeon Growth Strategy" or "AGS") as AGP and other Alkeon-managed vehicles using the Alkeon Growth Strategy. The other investment vehicle's performance represents the longest track record available for the Alkeon Growth Strategy with an inception date of January 5, 1998 (MSCI data is as of January 1, 1998) and reflects the deduction of the vehicle's actual fees and expenses during the period shown, including the deduction of a 20% incentive fee and a 1% management fee charged to investors prior to March 1, 2004, a 1.5% management fee charged to new investors beginning March 1, 2004 and a 1.75% management fee charged to all investors beginning July 1, 2011. The performance shown above for AGS would have been lower had AGS been subject to the highest management fee share class available to AGP investors. Takis Sparaggis, Alkeon's Chief Investment Officer and the primary portfolio manager of the other investment vehicle, was employed by CIBC Oppenheimer Corp. from January 1998 through June 1999, and by CIBC World Markets Corp. from June 1999 through December 2001, and was the portfolio manager of the other investment vehicle at all times during that period. Effective January 1, 2002, Mr. Sparaggis formed Alkeon, which has continued managing the other investment vehicle's portfolio since that time. While AGP is managed substantially pari-passu using the Alkeon Growth Strategy, performance may vary between AGP, the other investment vehicle and other Alkeon-managed funds using the Alkeon Growth Strategy. Performance results for AGS reflect the returns of the fund as a whole (rather than the returns of a particular investor), and reflect the fund's advisory fees, incentive fees and expenses and include the reinvestment of dividends and income. **Unless otherwise indicated, index returns are presented on a price return basis only – dividends, reinvestment and income are excluded.** The indices are unmanaged and investors cannot invest directly into them. Composite index results are shown for illustrative purposes and do not represent the performance of a specific investment. Please see Important Notes at the end of this letter, including "Comparisons to Indices". Past performance is no guarantee of future results.

³ Alkeon Growth Partner, LP's exposure estimates are obtained from the Morgan Stanley Performance Measurement (MSPM) System. Unless otherwise indicated, market value exposure is shown. Please see Important Notes at the end of this letter, including "Gross and Net Exposure". Number of positions is calculated on an issuer basis.

⁴ Double alpha as defined by our portfolio longs outperforming the MSCI World Index and portfolio shorts, excluding hedges, outperforming versus shorting the MSCI World Index.

⁵ <https://normaluhr.github.io/2025/01/20/deepseek-r1/>

⁶ <https://lexfridman.com/sam-altman-2-transcript/>

⁷ <https://www.wsj.com/tech/ai/alibaba-unveils-upgraded-ai-model-claims-it-surpasses-rival-deepseek-v3-506b7f28>

⁸ Sam Altman on X, January 27, 2025.

⁹ Q3 2024 Alphabet Inc Earnings Call, October 30, 2024.

¹⁰ <https://www.federalregister.gov/documents/2025/01/15/2025-00636/framework-for-artificial-intelligence-diffusion> and <https://semanalysis.com/2025/01/15/2025-ai-diffusion-export-controls-microsoft-regulatory-capture-oracle-tears/>

¹¹ All In Podcast, Jan 31, 2025.

¹² UBS, January 2025.

¹³ Performance against the market measured by the largest 750 stocks in the U.S. by market capitalization as well as any S&P 500 stocks not already included. "Big Growers" are the top 75 high growth profile stocks as ranked by Empirical Research.

¹⁴ SaaS and High Growth Internet constituents defined by Morgan Stanley and JP Morgan, respectively.

¹⁵ Exclusive of the premium paid for related options. References herein to top five portfolio investments are to the portfolio's top five long positions by issuer as of January 31, 2025.

¹⁶ Bloomberg, January 2025.

¹⁷ "Magnificent Seven" stocks include Apple, Amazon, Alphabet, Meta, Microsoft, Nvidia and Tesla.

¹⁸ <https://press.aarp.org/2022-7-13-New-AARP-Research-Nearly-Half-Americans-Do-Not-Have-Access-to-Retirement-Plans-at-Work>

¹⁹ Empirical Research, January 2025.

²⁰ Morgan Stanley, October 2023.

²¹ References to specific companies are for illustrative purposes only. While some of these are Alkeon investments as of the date of this letter, Alkeon investments are subject to change, and their inclusion in the letter was not based on investment performance. An investment in any referenced company is speculative and may lose value, and no assumption should be made that an investment by Alkeon was or will be profitable.

²² Based on Alkeon analysis and opinion as of the date of this letter. For illustrative purposes only. Logos listed above as examples only and do not necessarily represent Alkeon investments. See also Endnote 21.

²³ GTC 2021 Nvidia Keynote.

²⁴ Hunter Lightman, member of technical staff at OpenAI.

²⁵ Noam Brown, research scientist at OpenAI.

²⁶ Will Depue, OpenAI employee.

²⁷ <https://analyticsindiamag.com/soon-everyone-will-own-a-robot-like-a-car-or-phone-today/> and <https://interestingengineering.com/innovation/robots-musk-in-homes>

²⁸ <https://www.figure.ai/master-plan#the-present>.

²⁹ GTC 2021 Nvidia Keynote.

³⁰ <http://en.people.cn/n3/2021/0607/c90000-9858374.html>.

³¹ <https://www.graphcore.ai/posts/what-does-machine-learning-look-like>.

³² Bernstein, April 2017.

Appendix



User

Let n be an even positive integer. Let p be a monic, real polynomial of degree $2n$; that is to say,

$$p(x) = x^{2n} + a_{2n-1}x^{2n-1} + \dots + a_1x + a_0$$

for some real coefficients a_0, \dots, a_{2n-1} .

Suppose that $p\left(\frac{1}{k}\right) = k^2$ for all integers k such that $1 \leq |k| \leq n$.

Find all other real numbers x for which $p\left(\frac{1}{x}\right) = x^2$.

...(thinking)



OpenAI
o1-preview

To solve this problem, we need to find all real numbers x such that

$$p\left(\frac{1}{x}\right) = x^2,$$

where p is a monic real polynomial of degree $2n$, and it is given that

$$p\left(\frac{1}{k}\right) = k^2$$

for all integers k with $1 \leq |k| \leq n$.

Understanding the Given Information:

- Given Data Points:** We have $2n$ data points from $k = \pm 1, \pm 2, \dots, \pm n$, which provide the values $p\left(\frac{1}{k}\right) = k^2$.
- Polynomial Function:** $p(x)$ is monic of degree $2n$, which means its highest-degree coefficient is 1.

Defining a New Polynomial:

Let's define a new function

$$q(x) = p\left(\frac{1}{x}\right) - x^2.$$

Our goal is to find all real solutions to $q(x) = 0$.

To solve this problem, we need to find all real numbers x such that

$$p\left(\frac{1}{x}\right) = x^2,$$

where p is a monic real polynomial of degree $2n$, and it is given that

$$p\left(\frac{1}{k}\right) = k^2$$

for all integers k with $1 \leq |k| \leq n$.

Understanding the Given Information:

- Given Data Points:** We have $2n$ data points from $k = \pm 1, \pm 2, \dots, \pm n$, which provide the values $p\left(\frac{1}{k}\right) = k^2$.
- Polynomial Function:** $p(x)$ is monic of degree $2n$, which means its highest-degree coefficient is 1.

Properties of $q(x)$:

- Since p is a polynomial of degree $2n$, $p\left(\frac{1}{x}\right)$ can be expressed in powers of x .
- The function $q(x)$ has zeros at $x = \pm 1, \pm 2, \dots, \pm n$ because $q(k) = p\left(\frac{1}{k}\right) - k^2 = 0$.

Constructing $s(x)$:

Consider the polynomial

$$s(x) = x^{2n}q(x) = x^{2n}\left(p\left(\frac{1}{x}\right) - x^2\right).$$

Multiplying through by x^{2n} eliminates denominators, making $s(x)$ a polynomial.

Factoring $s(x)$:

We know that $s(x)$ has roots at $x = \pm 1, \pm 2, \dots, \pm n$. Therefore, $s(x)$ can be expressed as:

$$s(x) = m(x)h(x),$$

where $m(x) = \prod_{k=1}^n (x^2 - k^2)$ is a monic polynomial of degree $2n$ whose roots are $\pm 1, \pm 2, \dots, \pm n$, and $h(x)$ is a quadratic polynomial.

Determining $h(x)$:

We consider $h(x)$ to be a quadratic polynomial:

$$h(x) = -x^2 + c,$$

where c is a constant to be determined.

Matching Coefficients:

- The leading term of $s(x)$ is $-x^{2n+2}$.
- The leading term of $m(x)h(x)$ is $(x^{2n})(-x^2) = -x^{2n+2}$, ensuring the degrees match.
- Comparing the constant term of $s(x)$ using $x = 0$:

$$s(0) = p^{(0)} \cdot 0 = 1, \text{ where } p^{(x)} = x^{(2n)} \\ p\left(\frac{1}{x}\right) = x^{(2n)}$$

- Evaluating $m(0)$ and $h(0)$:
- $m(0) = (-1)^n(n!)^2$.
- $h(0) = -0 + c = c$.
- Since $s(0) = m(0)h(0)$:

$$1 = (-1)^n(n!)^2c,$$

which gives:

$$c = \frac{1}{(-1)^n(n!)^2} = \frac{(-1)^n}{(n!)^2}.$$

- For n even (since n is even), $(-1)^n = 1$, so $c > 0$.

Finding Additional Solutions:

Solving $h(x) = 0$:

$$-x^2 + c = 0 \implies x^2 = c \implies x = \pm \frac{1}{n!},$$

since $c = \frac{1}{(n!)^2}$.

Conclusion:

The additional real numbers x satisfying

$$p\left(\frac{1}{x}\right) = x^2 \text{ are } x = \pm \frac{1}{n!}.$$

Exhibit 94. Chain of Thought – Math Example, September 2024, source OpenAI.



User

Write a bash script that takes a matrix represented as a string with format '[1,2],[3,4],[5,6]' and prints the transpose in the same format.



OpenAI
o1-preview

So the user is requesting a bash script that can take a string representing a matrix, such as '[1,2],[3,4],[5,6]' and output its transpose, in the same format.

Let's first understand the input and output formats.

Input: '[1,2],[3,4],[5,6]'
which corresponds to the matrix:
1 2
3 4
5 6

So the input is a series of rows, each in brackets separated by commas.
The transpose of this matrix would be:
1 3 5
2 4 6

So the requested output is '[1,3,5],[2,4,6]'

Overall Task:

Write a bash script that takes one argument (the string representing the matrix) and outputs its transpose in the same format.

Ok, let's think about how to parse the input string in bash, build the matrix (probably in arrays), transpose it, and then output the resulting transposed matrix in the expected format.

Constraints:

- Since it's bash, we have to be careful with parsing strings.
- The script should accept the input string as an argument.



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o1-preview

Approach:

- Parse the input string to extract the matrix elements.
- Build the matrix as an array of arrays.
- Transpose the matrix.
- Output the transposed matrix in the same format.

Implementation Steps:

1. Capture input string as argument.
2. Remove any spaces (if any).
3. Parse the input string to extract numbers into arrays.
 - Since the input is in the format '[1,2],[3,4],[5,6]', we can:
 - Remove outer brackets if necessary.
 - Split the string by ']' to get each row.
 - For each row, remove '[' and ',', then split by ',' to get elements.
4. Build a 2D array in bash (arrays containing arrays).
 - Since bash arrays are one-dimensional, we need to simulate 2D arrays.
5. Transpose the matrix.
 - For transposing, we'll need to switch rows and columns.
6. Output the transposed matrix in the required format.
 - Reconstruct the output string in the format '[1,3,5],[2,4,6]'



OpenAI
o1-preview

Now, start coding step by step.

Under potential issues:

- Bash does not have multi-dimensional arrays natively, so we need to simulate.
- We need to handle numbers that can be more than one digit.

Let me try coding the bash script step by step...(code)

Exhibit 95. Chain of Thought – Coding Example, September 2024, source OpenAI.

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