Why Tech Outperformance Persists: A Unifying Theory of Returns on Innovation

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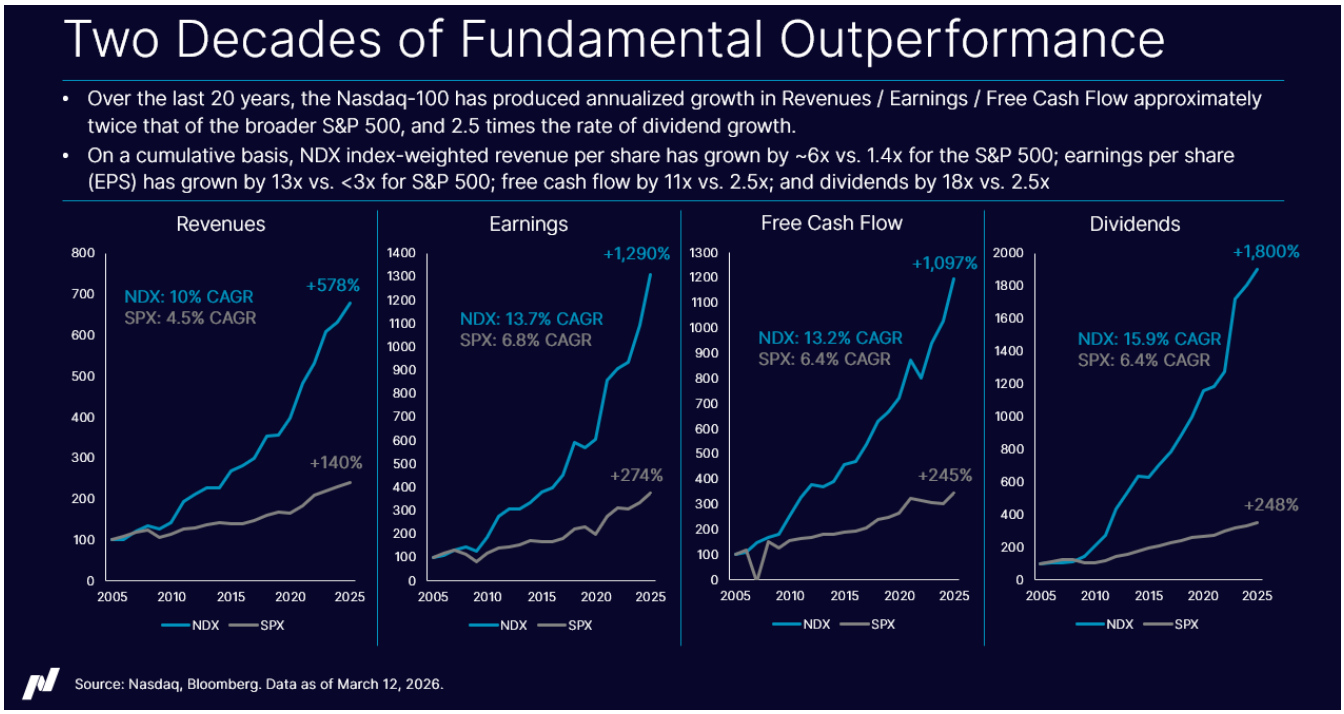
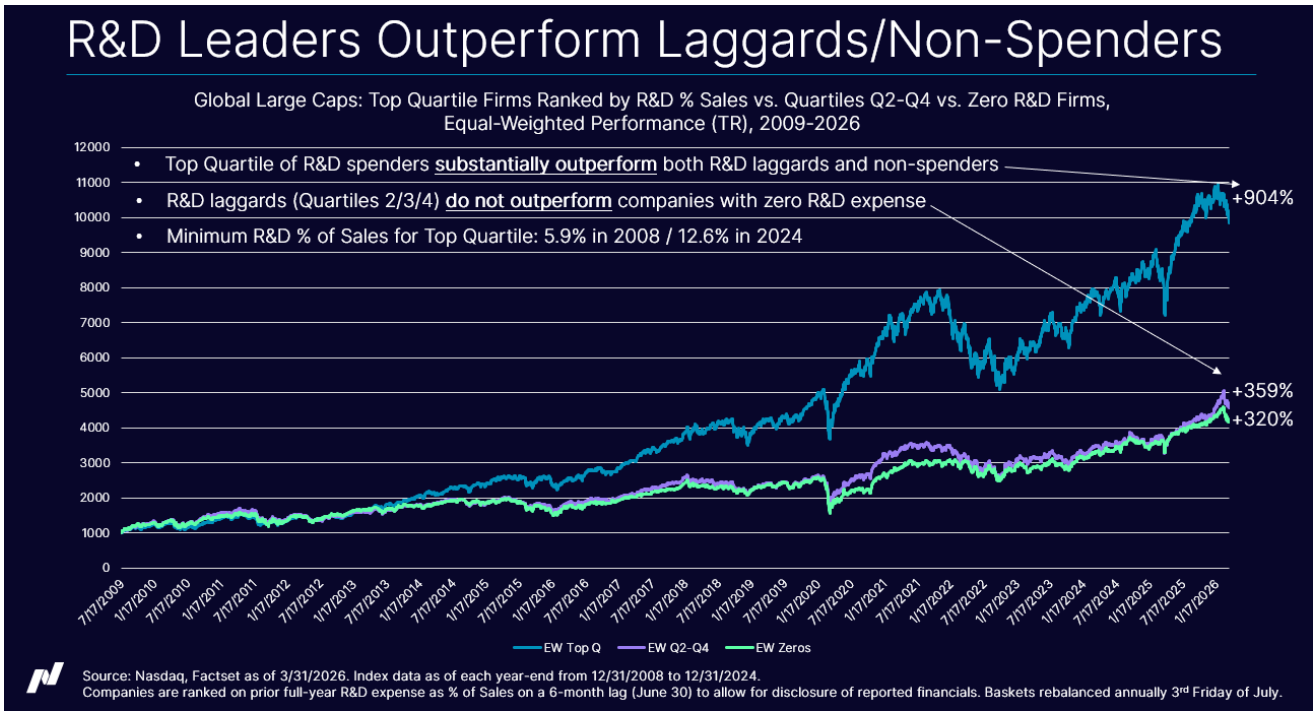
The Nasdaq-100® (NDX®) has generated remarkably consistent outperformance – against broad US equity benchmarks like the S&P 500 Index, as well as leading US large cap growth products like the Russell 1000 Growth Index – over the course of nearly the entire 21st century. From year-end 2005 through year-end 2025, NDX delivered annualized total returns of **15.7%** vs. the S&P 500's **11.0%**, resulting in a cumulative outperformance of approximately 2.5 times (1,745% vs. 706%)[1]. The Russell 1000 Growth generated annualized performance of only **13.2%** (1,100% cumulative). The track record is similarly impressive extending all the way back to the launch of NDX on January 31, 1985 with a near-tripling of both rival benchmarks' total return performance.



Long-term *fundamental outperformance* is a prerequisite in explaining a track record of such prolonged *equity market outperformance*. Equity investors reward exponential growth in revenues, earnings, free cash flow and dividends with exponential growth in market values. That is all fairly straightforward in terms of cause and effect. There is more to this story, however. The central question that remains on the minds of many investors after such a long period of outperformance is: how much longer can it go on? Steeped in widely accepted academic research around the tendency of markets to mean-revert, and around the tendency of smaller, "cheaper" firms to outperform in the long run (size and value factor premiums, respectively), investors have been debating the drivers behind why certain segments of the equity market (and by extension, the Nasdaq-100) continue to outperform: large cap, not small; growth, not value; Technology and adjacent sectors vs. all others. Many Nasdaq-

[1] Source: Nasdaq, Bloomberg. All performance comparisons referenced herein are based on historical index performance over the periods specified and should not be interpreted as indicating that similar results will occur in the future.

100 constituents have neatly fit the profile of "asset-light" innovators with heavy spending on R&D, leading to more favorable balance sheets and income statements: fewer fixed assets and associated capital expenditures, more intangible assets with higher operating leverage and lower financial leverage. Analysis shows that over the past two decades, large-cap companies in the US and globally produced compelling outperformance if they ranked in the top quartile of R&D spenders (as a percentage of their total revenues) each year, nearly tripling the returns of firms with lower rates of R&D or none at all. Some of that may be changing as AI-related capex transforms the business models of several of the largest, most successful Nasdaq-100 names such as Microsoft, Amazon, Alphabet, and Meta Platforms. At the same time, AI is pressuring many of the more successful business models within the famously asset-light SaaS space.



To understand the current moment in financial history and address the question of "how much longer can it go on" *especially in light of recent developments*, it seems entirely appropriate – necessary, even – to consider something of a unifying framework that can explain **why firms driven by technological innovation have outperformed for so long in the first place**. The answer must at least somewhat relate back to:

1) The highly deflationary nature of technological progress
2) The exponential adoption curves of new forms of technology
3) The exponential performance curves of new forms of technology
4) The interplay between all of the above, which can be thought of as a unique ability to scale, compound returns on investment at increasingly higher rates, and generate consumer surplus which creates a self-reinforcing cycle of increasing spending on technology products and services

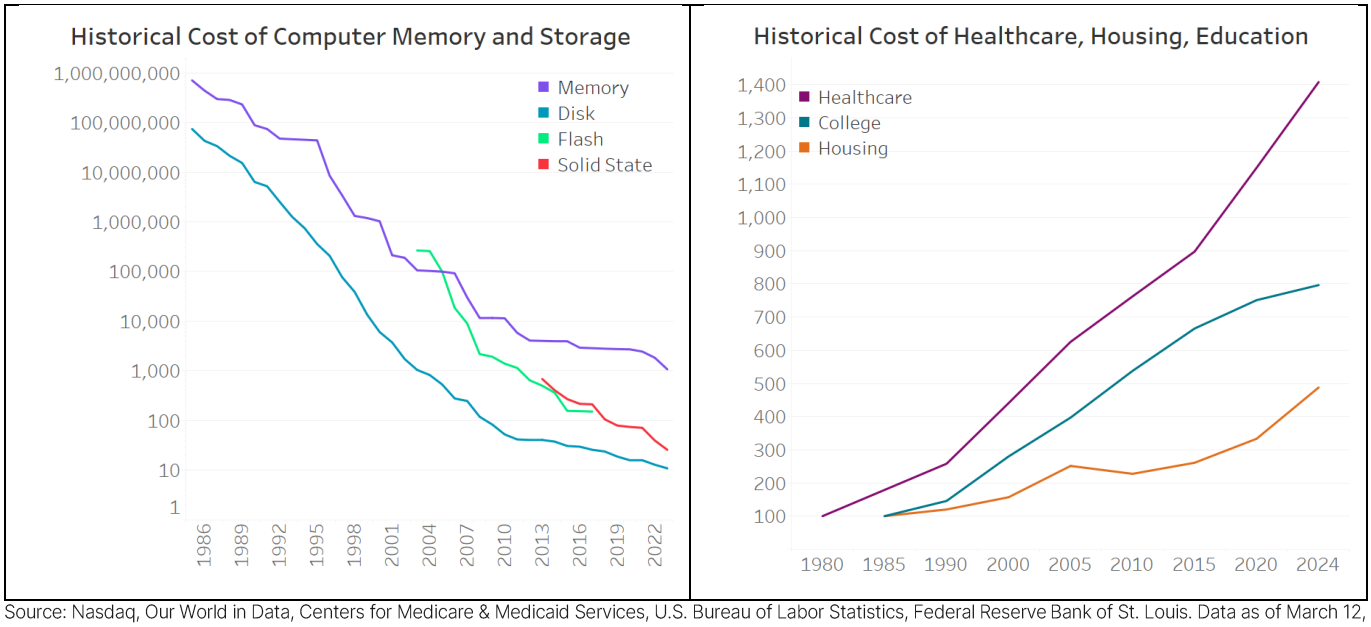
Beyond that framework which one may think of as the **four factors of tech scaling**, one must also consider the unique backdrop of the 21st century global economy, which presents at least **three macro dynamics that potentially favor business models driven by technological innovation**, namely:

1) The long-running demographic trends toward lower fertility rates and converging birth/death rates
2) The more recent trend toward deglobalization following a very long and powerful wave of globalization beginning in the mid-20th century
3) The reemergence of inflation post-Covid as a far more structural macroeconomic driver

This framework is not a forecast, as the future is largely unknowable. Rather, it is an attempt to explain the past and look for clues to understanding the future, using the broadest context available.

Technology Products Are Highly Deflationary

Some of the longest time series that demonstrate the highly deflationary nature of technological innovation are those measuring the cost of computer memory and storage. Since the Nasdaq-100 launched in 1985, both Disk and Memory prices have collapsed by more than 99.99%. Even the much shorter timelines for Flash and Solid State prices have collapsed by 99.9% and 96.3% since 2003 and 2013, respectively. Of course, what *did not* occur as a result was a collapse in the memory industry, as end-products and users grew the demand for memory exponentially in response. On the other hand, over this same timeframe the cost of healthcare in the US rose by ~1,300%, the cost of a college education rose by ~700%, and the cost of housing rose by ~400%.

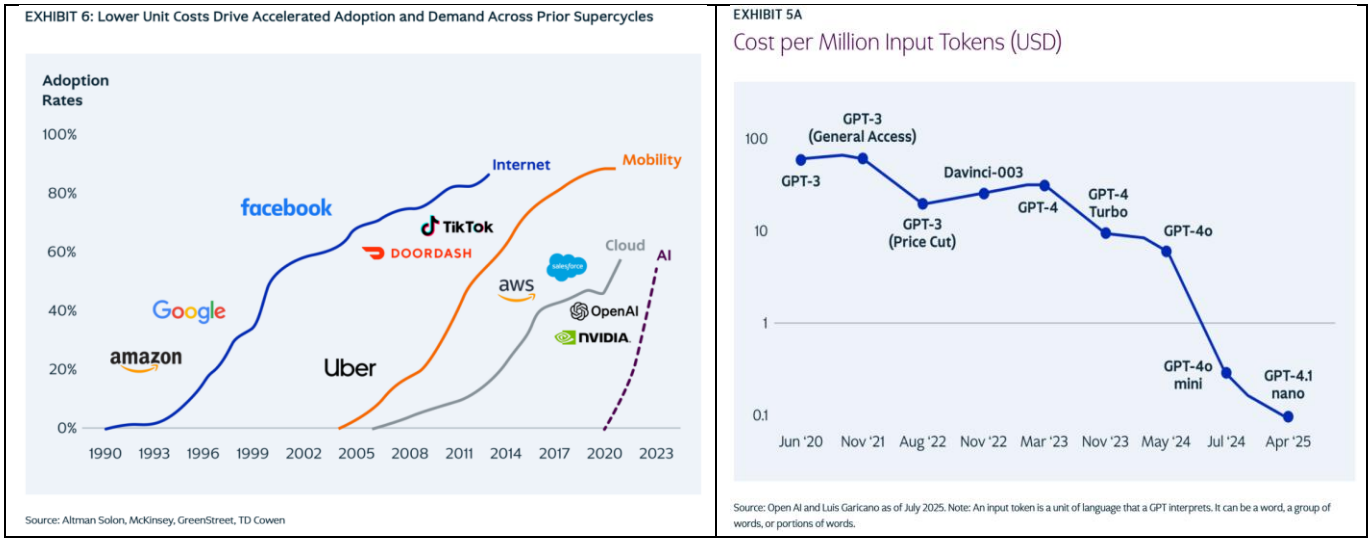


Source: Nasdaq, Our World in Data, Centers for Medicare & Medicaid Services, U.S. Bureau of Labor Statistics, Federal Reserve Bank of St. Louis. Data as of March 12, 2026. Housing figures based on S&P Cotality Case-Shiller Home Price Indices. College figures based on average of all U.S. city data for college tuition and fees. Healthcare reflects per capita healthcare spending tracked by the National Health Expenditure Accounts (NHEA).

AI Adoption, Cost, and Performance Curves Illustrate the 4 Factors of Tech Scaling

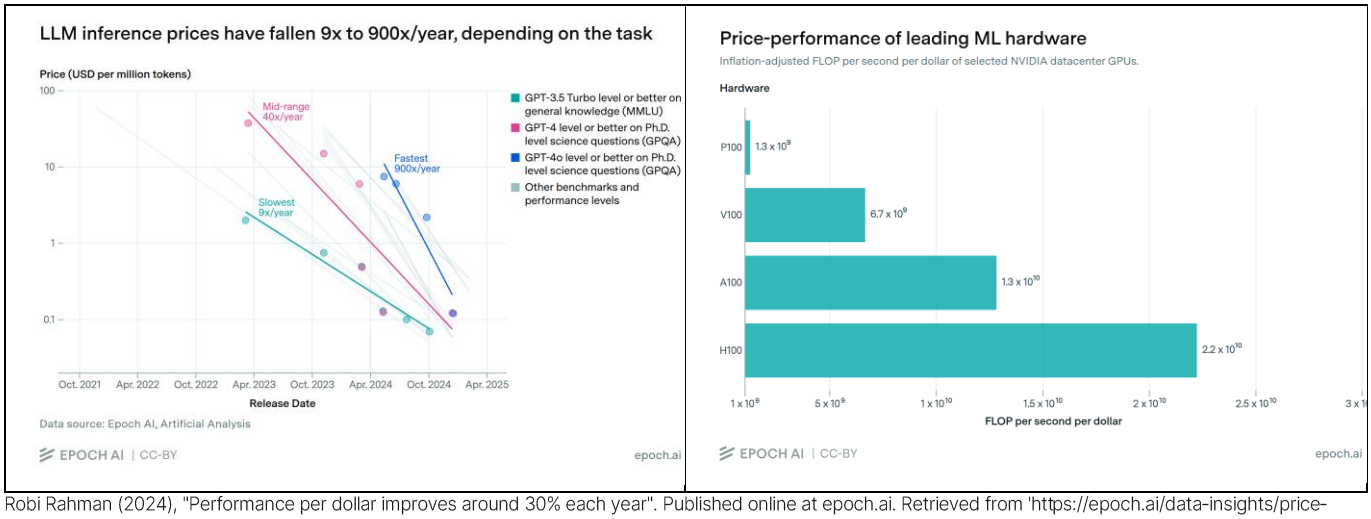
Investigations of the origins of scaling laws date back many years. In 2007, Luis Bettencourt published a landmark piece of research with Geoffrey West titled "Growth, innovation, scaling, and the pace of life in cities" which, while focused on explaining dynamics related to urbanization, identified scaling exponents relating to "wealth creation and innovation" of at least ~1.2 > 1 (superlinear), while those relating to physical infrastructure scaled at ~0.8 > 1 (sublinear); a third category of exponents at ~1 explain the rate of growth in human needs (jobs, housing, utility usage; linear). The superlinear exponent they observed "signifies increasing returns with population size and is manifested by quantities related to social currencies, such as information, innovation or wealth." In other words, their research establishes the empirical grounding for why technological innovation – especially information technology such as artificial intelligence – naturally lends itself to exponential scaling.

AI adoption curves have been trending nearly vertical since ChatGPT's initial rollout in November 2022 – notably steeper than any of the major technological advancements since the 1990s across internet, mobility and cloud. To some extent this is a result of widespread internet and cloud adoption both having taken place well in advance, enabling the rise of AI. To some extent it is also a result of the nearly universal application of AI technology across individuals, tasks, and sectors. But also to a large extent it is a result of the shape of its cost curves, which have incentivized the rapid expansion of use cases across sheer variety as well as intensity.



Source: KKR

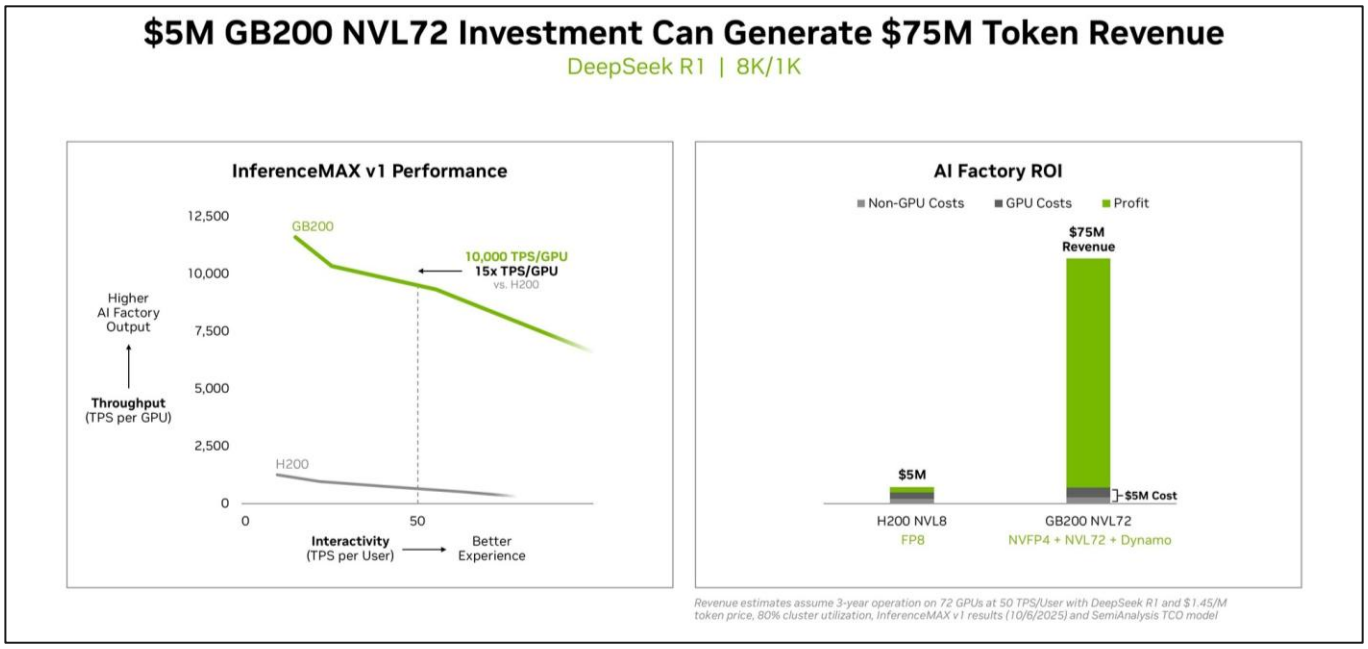
Cost per million input tokens collapsed even faster than computer memory and storage, which is intuitive given that multiple cost curves are converging with AI technology: individual hardware inputs (GPUs, CPUs, memory and networking); software (raw cost to code as AI replaces a growing share of code generation previously performed by humans, as well as ongoing efficiency gains in the design of both training and inference algorithms); and hardware-software co-design. As a result, per leading AI researchers such as Epoch AI, LLM inference prices are falling by a minimum of 9x per year, and as much as 900x per year depending on the task. Meanwhile, price performance per dollar is improving around 30% each year for leading machine learning (ML) hardware.



Robi Rahman (2024), "Performance per dollar improves around 30% each year". Published online at epoch.ai. Retrieved from 'https://epoch.ai/data-insights/price-performance-hardware' [online resource]. Accessed 29 Apr 2026.

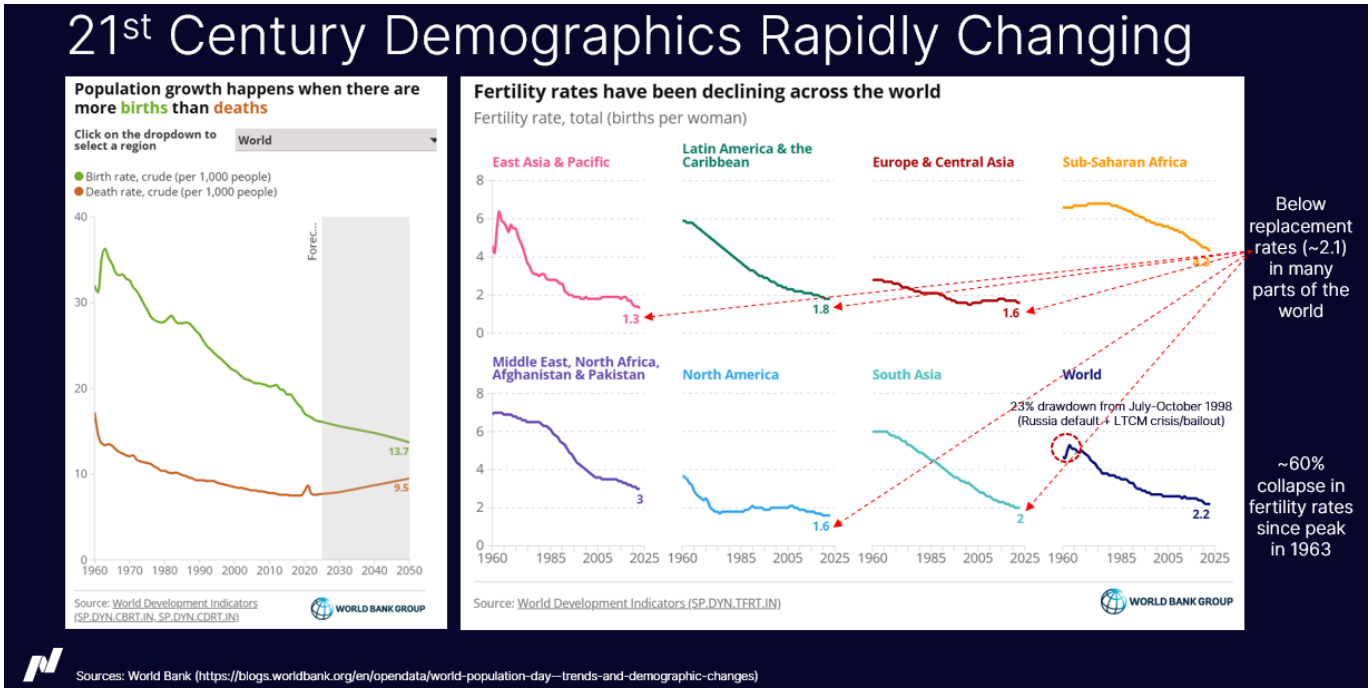
AI illustrates how exponential adoption curves, exponential performance curves, and exponential (declining) cost curves are all working in concert to scale a massively disruptive, new technological innovation globally within just a few years. There are "laws" which explain these three exponential dynamics with surprising accuracy: Metcalfe's Law, Moore's Law, and Wright's Law, respectively. Of course, there are also separate scaling laws at work in AI model development itself, including around model parameters, dataset size, and compute, but that is not the main focus of this paper. For the various types of innovation leaders in the AI ecosystem – from chip designers and manufacturers, to frontier model developers and cloud computing providers – the convergence and reinforcement of these factors of tech scaling together represent potentially the greatest economic opportunity in history. Nasdaq-100 constituent Nvidia illustrated the rapidly expanding opportunity set with a recent display of the increased throughput (tokens per second per GPU) of its GB200 chip (15x vs. their older H200 chip) directly

leading to a 15x reduction in cost per million tokens. Adopters of the "AI Factory" model that combines Nvidia's leading edge chips and networking solutions into a full "intelligence stack" are now enabled to convert an investment of $5 million into $75 million of revenue and ~$70 million of profit, massively expanding the upside from running AI inference workloads that were previously deemed prohibitively expensive. Per leading semiconductor research firm SemiAnalysis, Anthropic's inference gross margins have already improved from ~38% to ~70% in the first four months of 2026 as a result of adopting ongoing efficiency improvements in AI hardware and software.



Source: Nvidia, SemiAnalysis. Example meant to be for illustrative purposes only, and does not represent expected, typical, or guaranteed financial outcomes.

21st Century Demographic and Macroeconomic Dynamics May Raise Innovation Premium



At a fundamental level, the growth in the world's population and economy in the 21st century continues to evolve very differently from that which predominated in the 20th century. Whereas the former is characterized by rapidly

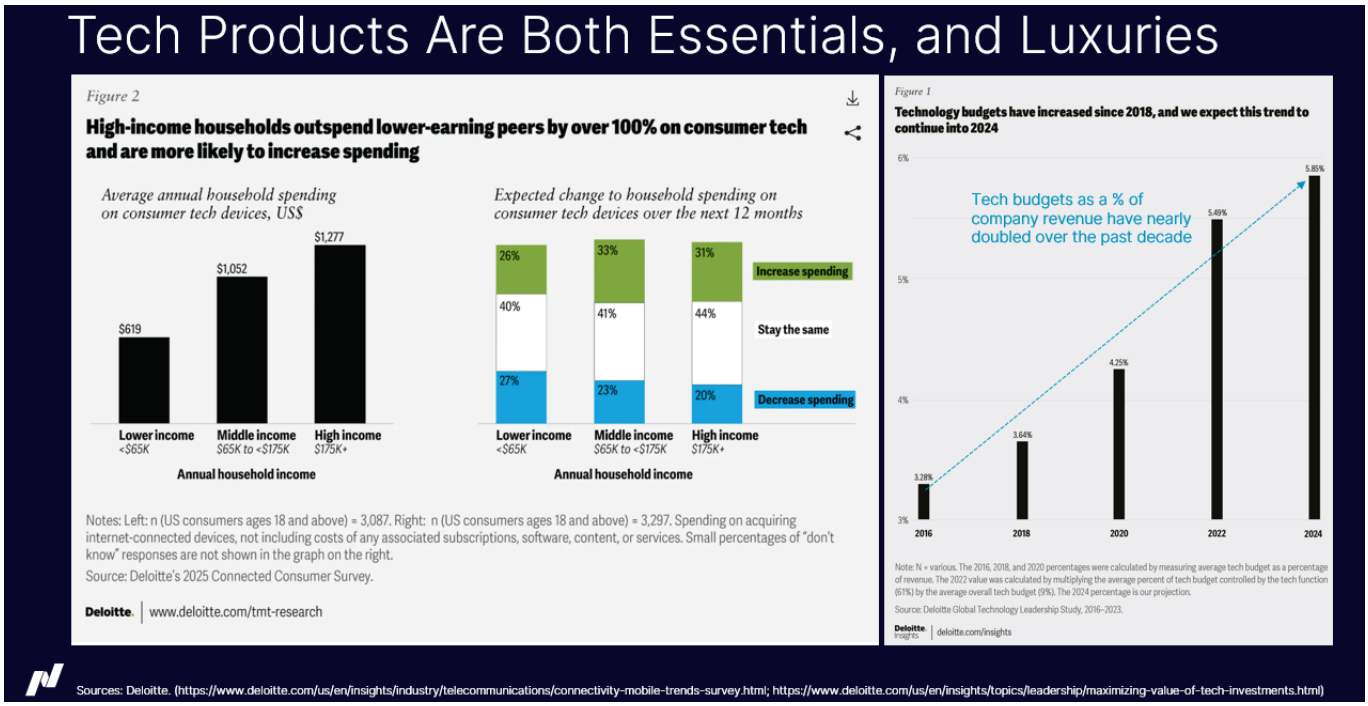
declining fertility rates, the latter was characterized by all-time highs in the same. Nowadays, not only are declining birth dates reducing the *absolute levels of population growth*, but the *decline in death rates is also bottoming*. As a result, the world is growing much more slowly, while people on average live longer. The practical consequences are twofold:

1) Many firms that previously relied on an expanding economic pie to grow revenues and profits are now at a disadvantage, as they cannot simply expect volumes to expand as a function of population growth
2) Spending power is becoming more concentrated in older, wealthier population cohorts, which means discretionary spending on luxury items will likely grow relative to nondiscretionary spending on essentials – while the meaning of "essentials" may be shifting as certain legacy spending categories face pressure

At the same time, the reemergence of structural inflation (on top of decades of above-trend inflation in several of the biggest spending categories over the course of a lifetime such as housing, education, and healthcare) implies a higher proportion of consumers getting squeezed across all but the highest wealth brackets of the US economy (and in other Developed Markets). The question many firms face now is: how do I keep growing?

For most types of companies, the answer is: if you cannot sell more product to more customers, you must find a way to deliver more value to each existing customer, and deepen your relationships to be able to upsell, cross-sell, or perhaps establish a recurring revenue stream via subscription. The only way to reliably do any of these is to innovate. For technology sector companies, this may sound obvious – after all, Apple is probably the world's most successful company in terms of growing a single highly successful physical product (iPod) into an entire ecosystem (iPhone, iPad, iMac, Watch, etc), and then bundling a software & subscription business on top of everything, growing Services from 8.5% of total revenue in fiscal 2015 to 26.2% in fiscal 2025.

There's more evidence beyond the anecdotal. In a recent survey of thousands of consumers by Deloitte, respondents clearly indicated higher levels of satisfication and a higher level of spending with tech companies that lead on innovation. Companies were segmented into a four-quadrant matrix based on their Level of Innovation and Level of Data Responsibility. "Fast Innovators" (high innovation, low level of data responsibility) generally scored high on satisfaction and spending intent, while "Trusted Trailblazers" (high innovation, high level of data responsibility) scored highest overall. Simply put, innovation commands a premium in the marketplace.

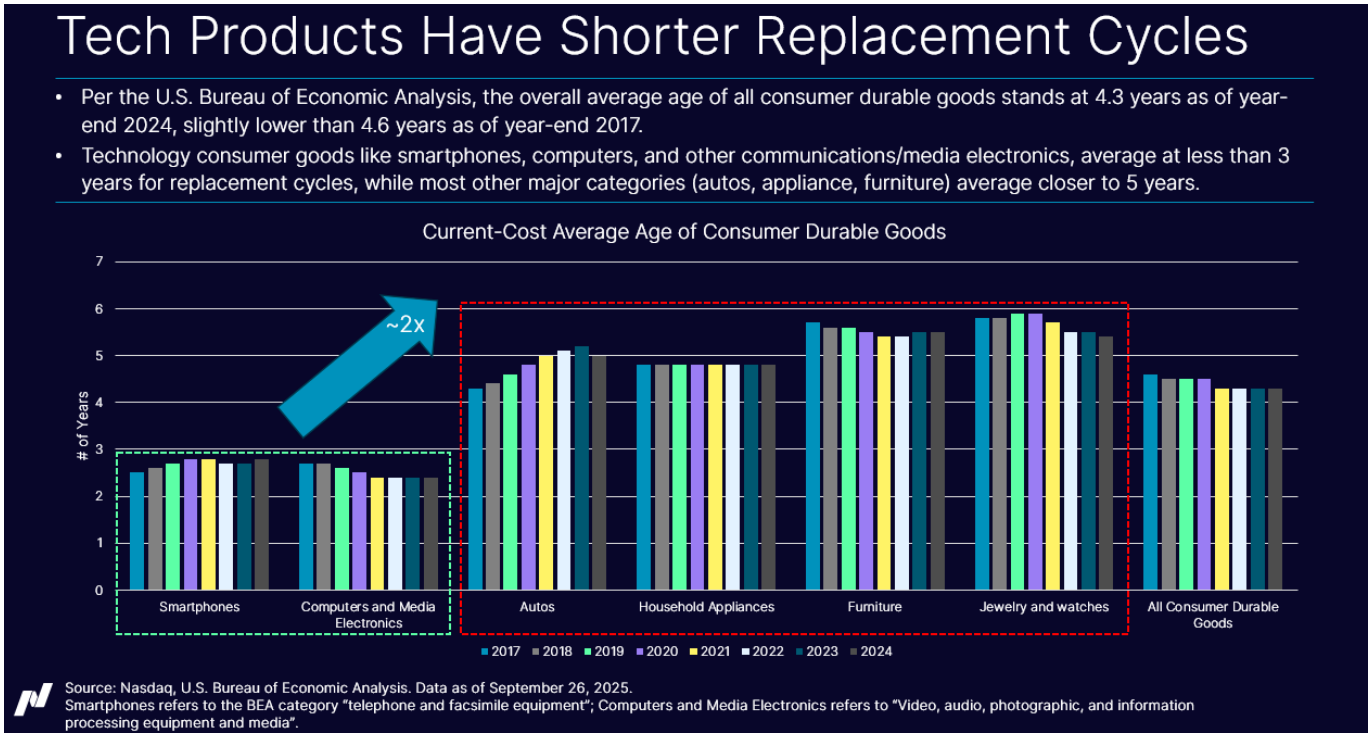


From a similar survey (results shown above), Deloitte also found that technology products have achieved status as both essentials (with robust spending by lower income consumers) as well as luxuries (high income consumers spend much more and are more likely to increase or at least maintain). From the standpoint of an industry analyst, there is hardly more you could ask for in terms of solid microeconomic drivers than a high propensity for an individual to consume more of your product as his/her income increases, paired with a resilient ability to maintain consumption even if income remains low.

There is moreover a natural limit to how much consumers can spend on almost every physical product that defines other sectors: food & beverage, travel, housing, transportation, furniture, appliances, and the like. Those limits are as often a function of cost as they are of our ability to consume them, limited as we are by space and time. Not so for technology – especially the type of technology that is productivity-enhancing and/or a deflationary force in everyday life. Year after year, consumers demonstrate that our appetite for technology shows no obvious limits.

And that's just the story for consumers. Enterprise spending on technology continues to capture a larger and larger share of spending as a percentage of company revenue, nearly doubling from 3.28% in 2016 to 5.85% in 2024. In a global economy where trade in physical goods is becoming more challenging and more expensive, together with a backdrop of above-trend inflation, technology products stand out as an area that could see continued strong growth even as other areas slow down. For one thing, much of technology sector revenues are now derived digitally and do not require crossing physical borders; we previously wrote about the Nasdaq-100's high degree of insulation against tariff-driven cost pressures as a function of its elevated exposure to services-driven business models. And even for those business models dealing in physical goods, exemptions to tariff policies enacted in 2025 ended up favoring the technology sector moreso than others.

Technology Delivers Consumer Surplus That Gets (Largely) Reinvested into Technology



Perhaps no better evidence exists of the unique ability of the Tech sector to deliver ongoing surplus to consumers than in the data that tracks the average age of consumer durable goods (and by extension, the frequency of replacement cycles). The U.S. Bureau of Economic Analysis tracks this data across 22 categories of consumer

spending, and the gap for technology products (e.g. Smartphones; Computers and Media Electronics) is profound. On average, these products are ~35-45% below the blended average age for all consumer durable goods. When comparing against some of the biggest single categories of spending (e.g. Autos, Household Appliances, Furniture, Jewelry and Watches), tech product ages are about half the length – meaning replacement cycles occur twice as frequently. The definition of a "well-made" product in many of these other areas is often one that can last a decade or more. For technology products, the accelerated pace of innovation cycles and the delivery of consumer surplus across those cycles ensures **tech spending remains robust not because products are poorly made, but because they simply do not have the ability to compete with newer versions of the same.**

The unique nature of technological innovation continues to find a way to grab a growing share of the total economic pie, with all eight of the largest public companies in the world now Nasdaq-listed megacaps in Technology or tech-adjacent sectors like Consumer Discretionary (Amazon & Tesla); from approximately 5-6% of the broader US equity market capitalization in the late 1980s/early 1990s to more than 40% today; from a rounding error in terms of economic growth to driving US GDP expansion in recent quarters amid the AI capex buildout. The unmatched growth trajectories of these companies demonstrate how 21st century technological innovation scales in an exponential fashion that feels different from the more typical growth success stories that predominated across the 20th century, limited as they were by physical contraints and the sublinear scaling of tangible assets. While nothing in life is certain, there is much evidence to suggest that technological innovation will continue its decades-long trend of exponential growth in adoption, exponential growth in performance, exponential decline in cost, and growth in consumer surplus. Anyone's guess as to when it will end.

Sources: Nasdaq, Bloomberg, Factset, US Bureau of Economic Analysis, Deloitte, Nvidia, SemiAnalysis, Epoch AI, World Bank, KKR, Our World in Data, Centers for Medicare & Medicaid Services, US Bureau of Labor Statistics, Federal Reserve Bank of St. Louis.