

The Good, the Bad and the Ugly: on tech valuations, AI, energy and US politics

Last week I spoke to the firm’s tech CEO clients at a conference in Montana. This note is a partial summary of that presentation, entitled “The Good, the Bad and the Ugly: an investor lens on tech valuations, AI, energy and the US Presidential Election”.

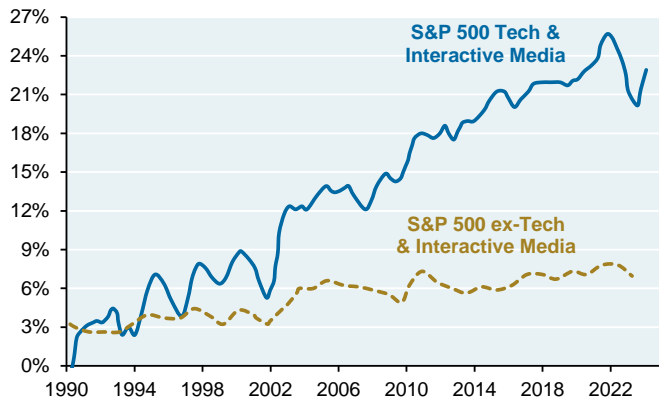
On tech profitability, valuations, IPOs and antitrust

The good: We’ve reached the 30th anniversary of tech sector profitability crushing other sectors. As things stand now, tech and interactive media free cash flow margins are 3x higher than the rest of the market. Since 1990, large cap US tech stocks outperformed the MSCI World Equity Index by 8,000% to 1,000%. Also good: unlike in 2020/2021, there’s less of a spike in the market cap of unprofitable tech companies (the YUCs).

The bad: Tech valuations are back at 2020/2021 highs even when using forward earnings expectations, setting a higher bar for future investor returns.

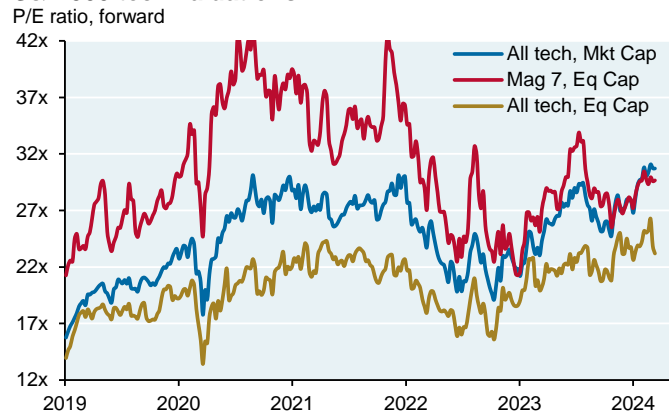
The good: Despite elevated investor risk appetite, tech IPOs have slowed to a trickle with little receptivity to IPOs by unprofitable companies. This is a partial response to the terrible returns on tech IPOs/SPACs in 2020 and 2021 (the “spac-tastrophe”), which we documented in detail last July¹. This kind of cleansing is typically good for investors once the IPO calendar resumes, since more investor scrutiny tends to result in higher quality companies going public. We will find out shortly, as we expect more tech IPOs in the weeks ahead.

Free cash flow margins



Source: Empirical Research, February 2024. Excludes financials and REITS

S&P 500 tech valuations



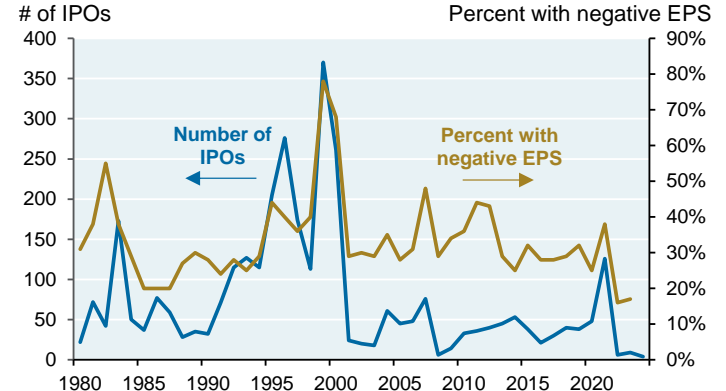
Source: Bloomberg, JPMAM, March 15, 2024

Market cap of young unprofitable technology companies



Source: Factset, JPMAM. March 6, 2024.

Tech IPOs



Source: Jay Ritter, University of Florida, 2024

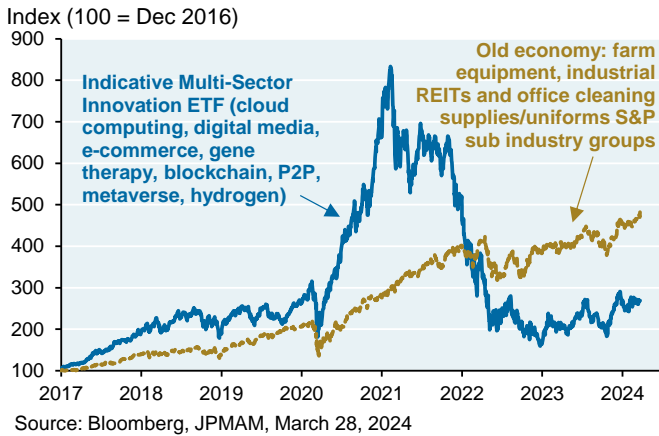
¹ “Mr. Toad’s Wild Ride: the impact of underperforming 2020/2021 US IPOs”, Eye on the Market, July 18, 2023

Past performance is no guarantee of future returns. It is not possible to invest directly in an index.

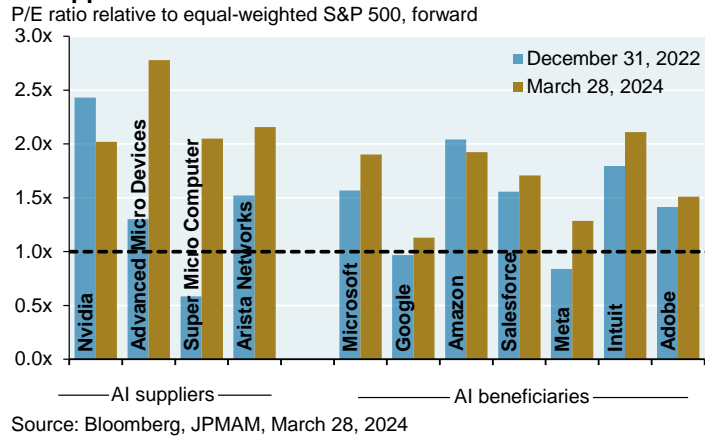
The ugly: what makes tech interesting is not innovation per se, but *profitable* innovation. Investments in innovation for its own sake has been a fool’s errand, badly trailing old economy investments in things like farm equipment, industrial REITs and office cleaning supplies. Not-so-fun fact: we calculated investor losses for 2,300 US ETFs based on the timing of investor inflows and outflows. The innovation ETF shown below lost \$7.1 billion of investor capital through December 2023, more than any other long ETF we analyzed.

The good: equity markets are applying higher multiples to AI suppliers than to AI beneficiaries; while there’s some valuation excess, markets are not (yet) pricing in the full potential impact of commercial AI adoption.

The Tortoise and the Hare



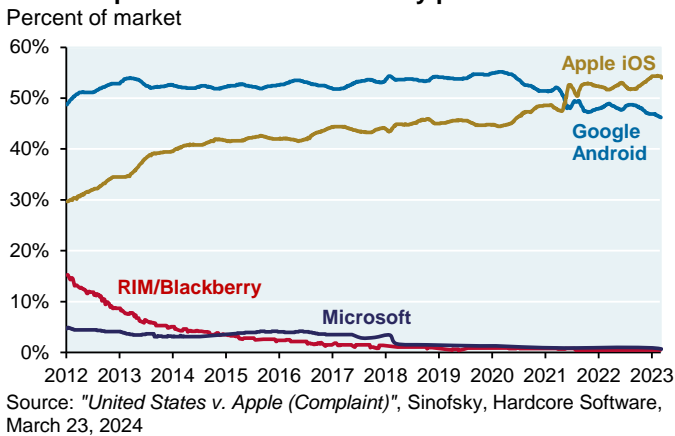
AI suppliers vs beneficiaries



The good/ugly, depending on your vantage point: I wrote about antitrust in the 2024 Outlook given the prevalence of exclusivity arrangements, traffic acquisition payments and other practices. At the end of 2023, Google lost a jury trial against Epic Games and also settled with 38 Attorney Generals regarding anticompetitive behavior ([see antitrust section in 2024 Outlook](#)).

Now the DOJ has filed an antitrust lawsuit against Apple. The process will take years: filings, discovery, preliminary rulings, appeals and possible remedies. But the gauntlet has been thrown, with the DOJ trying to find vulnerability after a judge ruled against Epic in its lawsuit vs Apple last year. The Appendix on page 9 walks through the details of the DOJ lawsuit. **The short version: the DOJ has a very steep hill to climb, as shown in the box.** The courts have broadly rejected the Biden antitrust approach: the current FTC Commissioner has lost every merger challenge brought via litigation in Federal and administrative courts, losing on all appeals as well.

US smartphone subscriber share by platform



Note: Apple’s US market share is 39% across all mobile phone customers, including flip phones. Globally, Apple’s market share is 29% (Android = 70%)

DOJ hurdles in lawsuit vs Apple

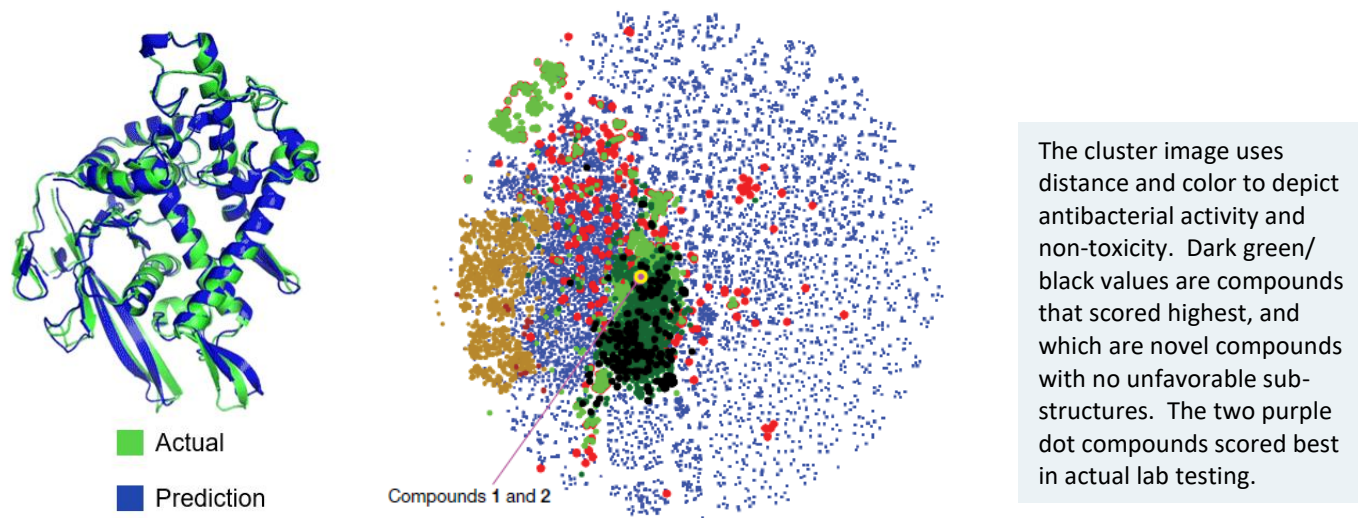
- Defining the market as “performance smartphones”, excluding entry-tier smartphones, flip phones and other devices which can perform some of the same functions (tablets)
- Limiting the geographic area to the US, ignoring the rest of the world
- Measuring monopoly power via share of revenues instead of share of units sold (the latter being a more typical antitrust standard)
- Unlike the Epic vs Google jury trial, the DOJ suit will be a judge trial like the Epic vs Apple case (the Federal gov’t cannot sue for damages, only injunctive relief, in which case a jury trial is typically not applicable)

On artificial intelligence, biomedicine, language models, semiconductor production, Taiwan, etc.

There have been remarkable accomplishments in biomedicine, none of which would be possible without the latest generation of AI.

The good: The first image below shows the insanely complex shape of a certain DNA replication enzyme in green, and how AI can be used to predict its shape (blue). Scientists need to know the shape of enzymes and other proteins to enhance or destroy them (e.g., the SARS-Cov-2 spike protein). It used to take years and millions of dollars for MRI and x-ray crystallography analysis to reveal the true shape of proteins; as of 2021, only 20% were mapped. Now Google's AI-driven AlphaFold program can get the job done in hours and at minimal cost. Today, 99% of proteins are now mapped according to the Institute for Cancer Research.

The good: I spent time with Jim Collins at MIT/Harvard and Felix Wong at Integrated Biosciences last month to learn about their work. Jim and his team just discovered **the first new class of antibiotics in decades**. They were trying to find a needle in a haystack: is there a molecule that could treat MRSA, a staph infection which accounts for 70,000 severe illnesses and 7,000 deaths each year? They trained an AI model on 39,000 molecular compounds regarding antibacterial inhibition and toxicity to humans. Then, they used neural networks and Monte Carlo tree search methods to identify potential candidates in a database of 12 **million** commercially available molecular compounds. As shown in the second image, they found two: both are being tested in mice models with very promising results so far².



The good: Researchers at McMaster University used a generative AI model to combat *Acinetobacter baumannii*, which typically occurs in healthcare settings and is resistant to many antibiotics. Billions of potential molecules were screened; ~13,500 were actually synthesized and 6 have showed promising antibacterial results³.

The good: AI diagnostics can detect early signs of diabetic retinopathy, the leading cause of adult blindness. Using a retinal camera, clinicians with little training can now administer tests and deliver immediate results. Benefits: expanded coverage, early detection and treatment.

² The initial training process doesn't just measure bacterial inhibition and toxicity; it also captures the detailed atomic substructures of the molecules to provide more training information. During the filtering process: ~10,000 molecules exhibited potential for strong antibiotic behavior. This cohort was narrowed down to 280 for toxicity/chemistry reasons, to exclude existing antibiotics and to find unique substructures that are not one-off candidates. This group was tested in a lab setting with 2 showing strong results. Further reading: "*Discovery of a structural class of antibiotics with explainable deep learning*", Nature, Collins et al, December 2023

³ Further reading: "*Generative AI for designing and validating easily synthesizable and structurally novel antibiotics*", Nature Machine Intelligence, Stokes et al, March 2024

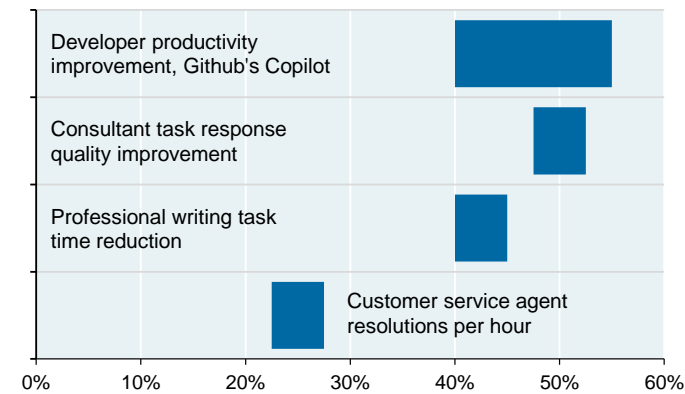
Then we reviewed the performance of large language models in the real world:

The good: the first batch of real-world LLM analyses are being published. As shown below on the left, LLMs are helping consultants improve quality of their responses; they’re increasing speed of customer service agent responses; they’re helping marketers, grant-writers and other analysts on professional writing tasks; they’re improving the speed of programmer coding; and they’re improving bank KYC (know your client) accuracy.

The good: NVIDIA partnered with Hippocratic AI to roll out Polaris, an LLM-based nurse application. Nurses and doctors ranked Polaris on medical safety, bedside manner, patient education, conversation quality and clinical readiness. Polaris was as good or better on almost all metrics than live nurses. Benefits: better patient care, particularly given a projected shortage of 195,000 nurses in the US by 2031.

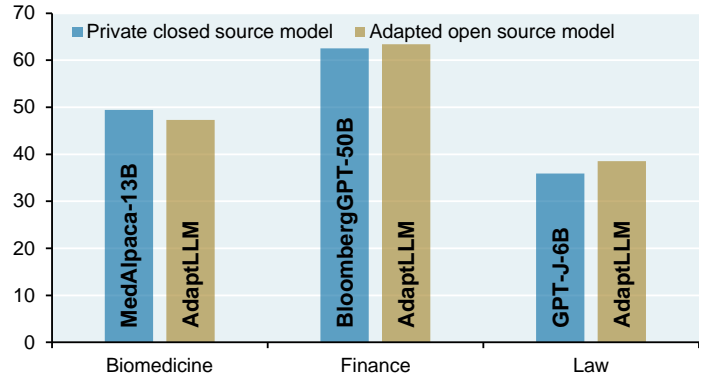
The good: performance of open-source models continues to improve. The second chart shows a model developed by Microsoft using Meta’s open-source Llama model; its performance matches closed source models on biomedicine, finance and law. Also: Databricks just released DBRX, its open source “mixture-of-experts” LLM with higher performance across multiple benchmarks than other open source models; DBRX also offers greater speed, smaller size and less compute time⁴. Another milestone: AI21’s Jamba which matches the performance of other open source models but with much higher throughput in large context windows⁵.

LLM improvements in the real world



Source: Harvard Business School, BCG, NBER, MIT, Microsoft, JPM, 2023

LLM performance on domain-specific multiple choice exams



Source: "Adapting large language models via reading comprehension", Huang et al, Microsoft, September 2023

The bad: we conducted a real-world test of GPT-4 last September⁶. We asked GPT-4 71 questions from the Eye on the Market archives on markets, economics, energy and politics. Its GPA was 2.54; it got half the questions right but a lot wrong even when we included web search plug-ins and advanced data analysis. Hallucinations were frequent and unpredictable, so that we could not reliably accept any answer without double-checking it.

That said, my analysts use GPT-4 as a supplement to Google to get a good baseline understanding of a new topic. Examples from this week: magnesium extraction from seawater, an equation for hydrogen compression and real-world emissions profiles of plug-in hybrid vehicles based on driving and charging behavior.

The bad: some models overstate performance by not accounting for the benefits of training data

- Changing the position of multiple choice ABCD response options from their original position caused Llama and Mistral performance scores to decline by 5%-10%⁷. Furthermore, using different symbols (\$&#@) rather than ABCD and leaving everything else the same resulted in performance declines of ~10%
- Changing protagonist names and months in a logic question caused GPT-4 to give the wrong answer, mention months that don’t exist in the revised question and fail to recognize interim reasoning mistakes⁸

⁴ "Introducing DBRX: A New State-of-the-Art Open LLM", March 27, 2024

⁵ "Jamba: A hybrid transformer mamba language model", AI21 Labs, March 2024

⁶ "What was I made for: large language models in the real world", Eye on the Market, September 26, 2023

⁷ "When Benchmarks are Targets", Saudi Arabia National Center for AI, Alzhrani et al, February 2024

⁸ "Testing the cognitive limits of large language models", BIS Bulletin, Perez-Cruz and Shin, January 4, 2024

The bad: unreliable AI content is already present in news sources and legal proceedings, and could get worse as new models are trained on this unreliable content

- Fake legal cases are already making their way into US, UK and Canadian courts⁹; over 400 AI-generated news sites exist with unreliable content and no human oversight¹⁰; according to CNET, 77 AI-generated articles were published in January 2024 that were riddled with basic math errors
- In a paper last year¹¹, Oxford researchers illustrated the concept of “model collapse”, also referred to as “AI inbreeding” in which performance of language models degrades after being trained on synthetic data which is increasingly comprised of AI output

A few panels at the conference covered the contours of AI looking into the future. Most presenters expect continued non-linear improvement in LLM performance and declines in hallucinations and other errors. If that’s the case, some of the performance issues cited above will continue to decline. Many presenters also believe that the power of LLMs to process information will continue to grow. One example: with the expansion of LLM context windows¹² to millions of tokens, firms with rich proprietary data may be able to reduce the costs, complexity and technical expertise associated with retrieval augmented generation and fine-tuning methods.

That’s a LOT of jargon! Simple version: greater commercial adoption of AI is needed to support AI valuations, both of suppliers and beneficiaries; and lower cost/greater ease of use may be needed for this to happen. A positive sign: NVIDIA’s inference revenues (i.e., on models currently in use) exceeded expectations vs revenues earned from those training new models; inference was 40% of NVIDIA data center revenues in 2023¹³.

The good: GPT-4 and other language models can create images based on user-defined prompts. Don’t ask why, but I needed a mash-up image of a famous cartoon character in a famous TV show about a high school chemistry teacher who has an illicit side job. The OpenAI Dall-E results were great, and also instantaneous.

LLM context window size, # of tokens

Google Gemini 1.5 (research mode)	10,000,000
Google Gemini 1.5	1,000,000
Anthropic Claude 3.0	200,000
Cohere Command R	128,000
OpenAI GPT-4 Turbo	128,000
Meta Code Llama	100,000
OpenAI GPT-4	32,768
Mistral 7B	8,192
Meta Llama 2.0	4,096

Google cites 1 million of its tokens as being equivalent to 1 hour of video, 11 hours of audio, 30,000 lines of code or 700,000 words. Source: JPMAM, March 2024



⁹ “AI is creating fake legal cases and making its way into real courtrooms”, The Conversation, March 12, 2024

¹⁰ “A disturbing AI phenomenon could upend the internet”, Business Insider, August 2023

¹¹ “The curse of recursion: training on generated data makes models forget”, Shumailov et al, May 2023

¹² A **context window** refers to how much information an LLM can process at once. It is a combination of both the prompt and information about the problem domain. Research shows sharply improved LLM performance with larger context windows

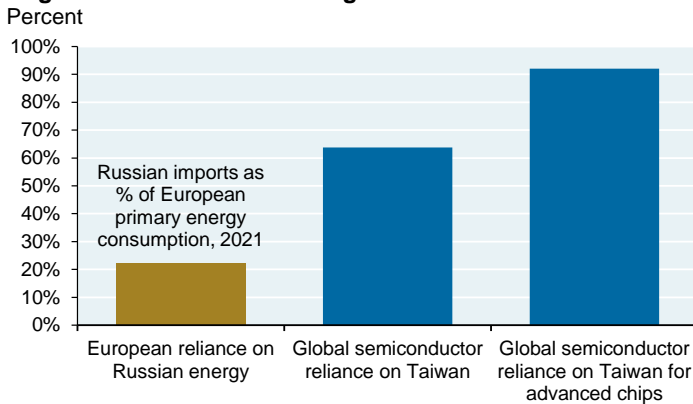
¹³ NVIDIA 10-K, released February 21, 2024

I also talked about AI’s reliance on Taiwan in what is arguably the most concentrated supply chain risk in the history of global commerce.

The bad: if you thought that Europe’s exposure to Russian energy before 2022 was bad, it pales in comparison to the world’s reliance on Taiwan for semiconductors, and in particular, advanced semiconductors. The AI industry may have to eventually accelerate production of advanced chips outside of Taiwan, which will be very costly, energy-intensive and time-consuming.

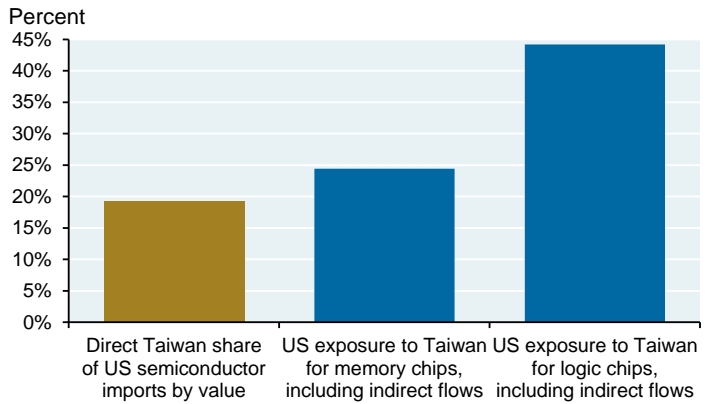
For the US specifically, determining semiconductor exposure to Taiwan is a complex exercise requiring tracking of process flows through Taiwan and third-party countries. The US International Trade Commission just completed an analysis to do exactly that¹⁴; results appear on the right. For specific US companies, the numbers are even higher: 90% of advanced chips designed by NVIDIA, Apple and Broadcom are reportedly made by TSMC in Taiwan. According to Commerce Secretary Raimondo, the US will manufacture 20% of the world’s most advanced logic chips in 2030 from 0% today; but now TSMC has delayed its \$40 bn chip project in Arizona due to concerns about the level of US government subsidies and the exact products it will make¹⁵.

Regional reliance for critical goods



Source: BP Statistical Review, ROC Taiwan, Global Guardian, 2024

US semiconductor reliance on Taiwan



Source: USITC, November 2023

The ugly: War game analysis of a Chinese invasion of Taiwan is not pretty¹⁶. Assume the following: the US immediately gets involved militarily (despite the absence of any treaty); Japan permits the US to use Japanese bases for aircraft operations; and the US has ample long-range air-launched cruise missiles. While Taiwan would retain its territorial autonomy, the US suffers the worst force losses since WWII, most of Taiwan’s navy and air force is destroyed and Taiwan would be highly damaged without electricity and basic services.

US force losses defending Taiwan after China invasion

Blue = best case, Red = worst case

Assumes participation of Japanese Defense Forces



Source: CSIS, JPMAM, January 2023

China’s other option: Blockade of Taiwan

- 70% of food, 88% of energy and 50% of materials for produced pharmaceuticals are imported
- Taiwan’s energy inventories: five months of oil, 40 days of coal and 10 days of natural gas
- China may continue low-grade confrontation via warships circling Taiwan, cyberattacks on gov’t websites and attacks on undersea cables
- China has the world’s largest coast guard; Chinese Maritime Militia commands over 1000 vessels
- Half the world’s containerships and 80% of large container ships pass through the Taiwan Strait

¹⁴ “US exposure to the Taiwanese Semiconductor Industry”, USITC, November 2023

¹⁵ “TSMC delays its \$40 bn chip project in Arizona”, CNN, January 19, 2024

¹⁶ “First battle of the next war: war-gaming a Chinese invasion of Taiwan”, CSIS, January 2023

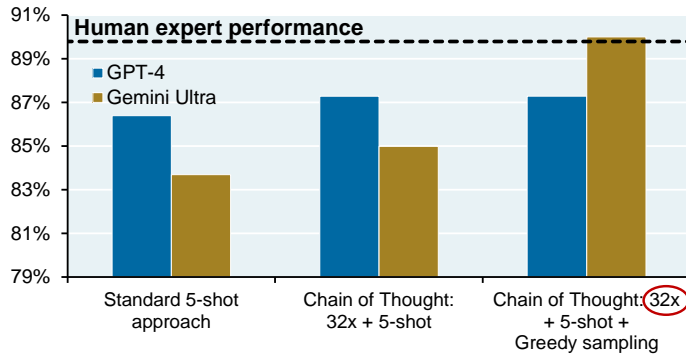
On AI and energy consumption

Last December, Google announced that its Gemini Ultra LLM finally outperformed GPT-4. But look closely at the labelling: **32x means that Gemini ran through its paces 32 times**, picking the best answer from the set. In other words, this took 32x more compute time and energy than a typical prompt.

Energy is a hot topic in AI circles. As shown on the right, Dominion Resources which serves 6 million customers in 15 states has sharply increased its projected power needs for the coming decade. The sole reason for the change: **increased demand from data centers**. Dominion may not be representative of all utilities, but with the cost of transformer equipment already rising sharply (3rd chart), electrification of transport/heating and increased power demand from AI may turn electricity into a much scarcer resource. McKinsey, BCG and S&P Global all expect US power demand to grow by 13%-15% per year until 2030.

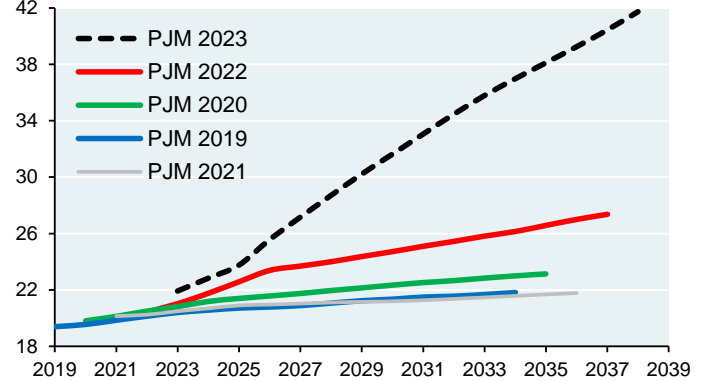
Gemini Ultra vs GPT-4

Accuracy on Massive Multitask Language Understanding tests



Source: "Gemini: A Family of Highly Capable Multimodal Models", Google DeepMind, December 19, 2023. 32 denotes the sample count.

PJM progression of power demand forecasts for Dominion Resources, Gigawatts

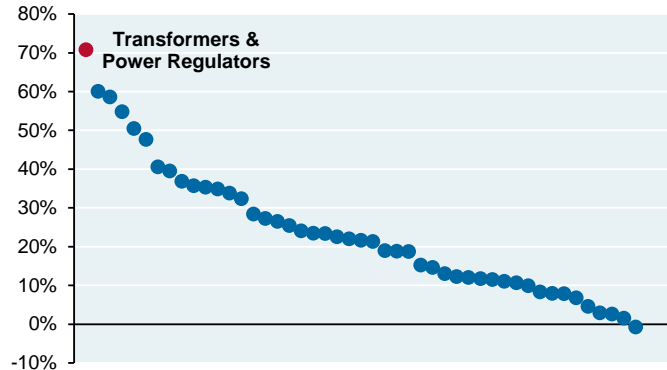


Source: PJM 2023 Power Demand Outlook, January 28, 2024

Where will AI suppliers/beneficiaries get their energy from? There were a lot of media articles on Amazon which acquired data centers and up to 40% of the output from the Susquehanna nuclear plant, both owned by Talen Energy. Amazon paid a premium of 50% over what Talen could earn from the grid. **But these articles missed an important point: taking baseload power off an existing grid may not be feasible everywhere.** In states with vertically integrated/regulated utilities, regulators would likely block the sale of baseload power from nuclear plants which are included in the rate base. According to EIA data, ~50% of US nuclear generation is based in regulated states. If data centers need nuclear power, owners may need to develop it themselves. As discussed in the energy paper this year, Western nuclear completions since 1990 took many years and resulted in massive cost overruns. We estimate that levelized nuclear costs were 2x-4x higher than a baseload power system derived from wind, solar and sufficient backup thermal (natural gas) capacity.

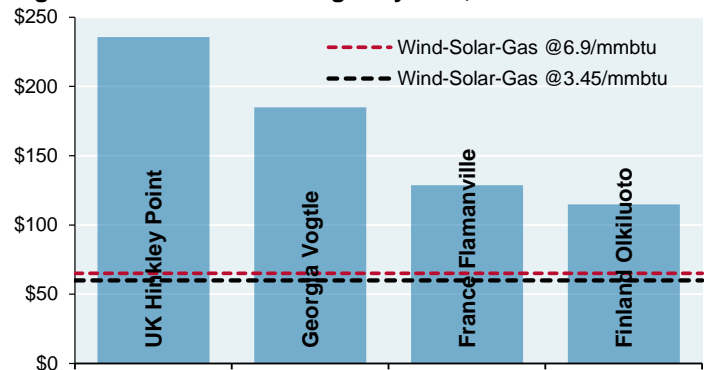
Core goods PPI component inflation

% increase vs 2018 for each of the 47 core goods categories



Source: Bloomberg, JPMAM, February 2024

Levelized cost of 4 specific nuclear plants vs cost of high renewable wind-solar-gas system, US\$ / MWh



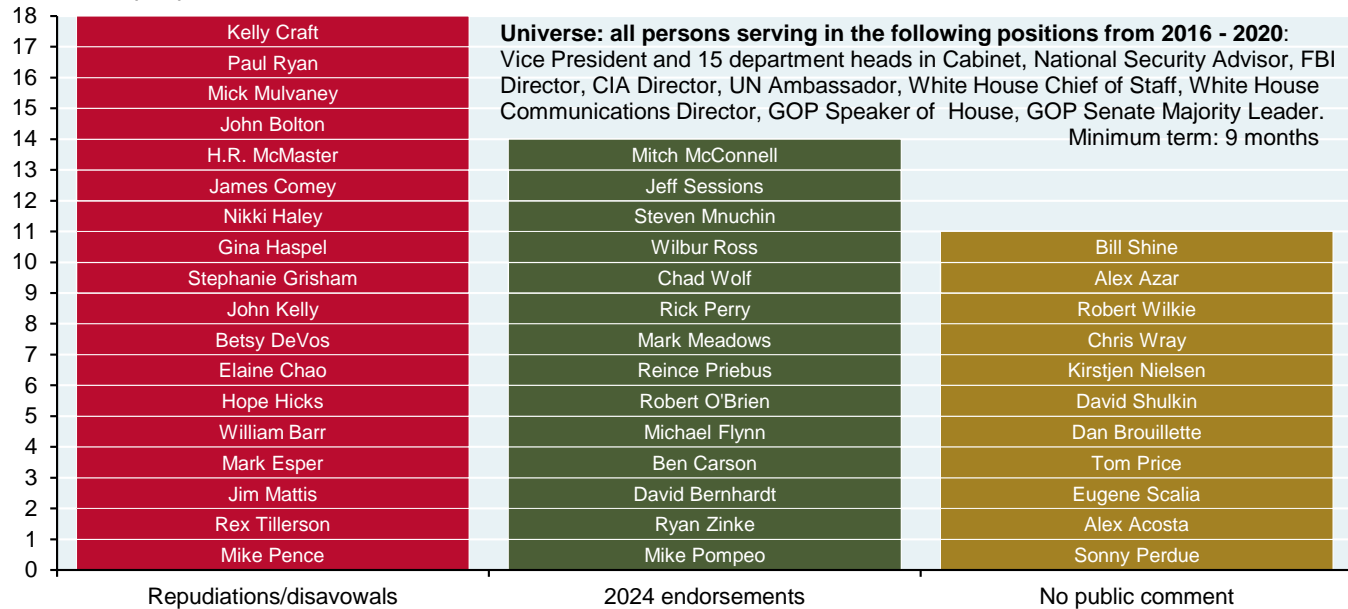
Source: EIA, JPMAM, 2024

US Presidential election, a 360 team review and the Federal debt

We used to have 360 performance reviews at JP Morgan in which all of your colleagues give you feedback as you sit in the middle of a room. I pulled one together for the presumptive GOP nominee based on people who worked for him from 2016-2020, **using my subjective interpretations of their public statements**. I think this outcome is bad, but your mileage may vary. Some “no comment” individuals hold positions that effectively prevent them from speaking publicly (FBI Director, Chancellor of University Systems).

Trump 360 review by former Trump Cabinet members and other senior positions

Number of people



Source: JPMAM, March 11, 2024. Categorizations based on our interpretation of public statements. The information presented is not intended to be making value judgments on the preferred outcome of any government decision or political election.

I also discussed two triple witching hour (TWH) scenarios regarding the 2024 US Presidential election. They are not good/bad/ugly per se; I’m agnostic as long as Constitutional rules and precedents are followed.

TWH #1: Insurrection redux: Trump wins the general election, but Democrats gain control of both houses of Congress. The new Congress is seated on January 3rd. At the January 6th Joint Session, by simple Democratic majority, both chambers rule that Trump is ineligible to run/serve citing insurrection as the reason, relying on the Electoral Count Act, 12th Amendment, and the Supreme Court’s recent recognition of Congress’ exclusive role in enforcing Section 3 of the Fourteenth Amendment. Since Biden would not obtain 270 electors either, a Contingent Election is held in the House but Biden would be the only eligible candidate that Congressional delegations could vote for¹⁷. It is extremely unlikely that judicial review would be available to Trump or the RNC.

TWH #2: 12th Amendment Contingent Election. The No Labels movement and/or RFK win enough electors to prevent Trump and Biden from obtaining 270 electors. A Contingent Election is held in the House. Third party candidates are unable to horse-trade electors to influence the outcome, which we discussed in the February 8th EOTM. The GOP now controls a narrow majority of Congressional delegations; the make-up of Congressional delegations seated on January 3rd would be the ones voting in any Contingent Election.

¹⁷ **Notes from our constitutional law sources.** The 14th amendment allows the removal of candidates from office and is not only meant to bar people from running prospectively. In addition, Trump’s acquittal by the Senate in 2021 does not prevent the Senate and House from making a determination on insurrection pursuant to Section 3 of the 14th amendment in January 2025. Only criminal proceedings are subject to “double jeopardy” protections; in contrast, the Senate proceeding in 2021 was a civil proceeding and not a criminal one.

Meanwhile, the Federal debt crossover point (when mandatory entitlements and interest exceed Federal revenues) is coming in the early 2030's, which may be very ugly. We have created a new online Federal debt monitor which you can access via the link in the header with charts on debt, interest, entitlements, etc.

Appendix: United States vs Apple, 2024

Last year a judge ruled in Apple's favor when sued by Epic Games for antitrust behavior. In that case, the judge found that Apple possessed market power over "mobile game transactions" (iOS plus Android) since Apple has a 52%-57% share of this market, and charges "supra-competitive commissions" that result in a 75% operating margin. The court also found that its App Store restrictions reduce competition and stifle innovation. So why did Apple prevail? Apple proved to the court that it had sufficient procompetitive justifications for its closed ecosystem. The court agreed with Apple for reasons related to reasonable exploitation of intellectual property, a distinct user experience and better user privacy/security; the 9th Circuit Court then affirmed this ruling.

Epic did win on 1 of 11 counts: Apple is now required to allow "steering", which permits App developers to include a single link to their website on which in-App purchases can be made. But: developers have to pay Apple 27% of any purchases that take place within a week of the user clicking the link. **And get this:** if an App developer sells subscriptions/products/services on their website but does not include a link in the App allowing in-App purchases (of which Apple takes 30%), they're reportedly not allowed in the Apple App Store (!).

While the Epic vs Apple lawsuit was mostly about Apple's App Store policies, the new lawsuit is focused on Apple's integrated approach which the DOJ argues provides advantages to Apple at the expense of third parties. According to the DOJ, Apple uses its power to thwart innovation that would make it easier for consumers to switch phones, and is essentially accusing Apple of being more focused on protecting its existing moats than on continued innovation. From the DOJ:

- Apple does not allow Super Apps, which perform multiple tasks without having to log into multiple apps. In China which requires Apple to run a more open ecosystem, the iPhone retention rate is reportedly ~50%. The reason it's easier to switch in China: Super Apps like Alipay and WeChat work seamlessly across iOS and Android. In the US where no Super Apps are allowed by Apple, the iPhone retention rate is 90%+¹⁸
- Apple does not allow cloud streaming apps which perform compute-intensive tasks in the cloud. This effectively forces users to buy more expensive hardware like the iPhone since computations are done locally
- Apple does not have a good cross-platform messaging experience (degraded video quality, no encryption)
- Apple's smartwatch is only compatible with the iPhone and not Android phones; non-Apple smartwatches don't sync well with the iPhone
- Apple does not allow third-party digital wallets; only Apple wallets can use the tap-to-pay chip

The DOJ argues that fewer than 10% of US smartphone purchasers are buying their first phone, so rivals have to convince people to switch, in which case Apple policies that raise switching costs are relevant to antitrust. It remains to be seen if the Courts will accept the DoJ's line of thinking; the box on page 2 cites all the hurdles the DoJ will face. Applying the essential facilities doctrine to the tap-to-pay chip seems like a stretch as well.

Some observers believe that while the App Store policies on steering and in-app purchases are not the crux of the DoJ lawsuit, these policies generated the frustration in the developer community which led to the lawsuit being filed¹⁹. Furthermore, these analysts have been surprised at Apple's intransigence on this issue since App store revenues of \$10 billion per year are a small share of its annual revenues of \$385 billion.

For a sharply critical view of the legal underpinning and politics behind the DoJ lawsuit vs Apple, see this long-form piece by Steve Sinofsky, former President of Microsoft Windows (2009-2012)²⁰. Sinofsky is similarly critical of the DoJ lawsuit filed vs Microsoft 20 years ago.

¹⁸ "Why the Apple Antitrust Suit Matters", Matt Stoller, American Economic Liberties Project, March 24, 2024

¹⁹ "United States v Apple", Ben Thompson, Stratechery.com, March 25, 2024

²⁰ "United States v Apple (Complaint)", Steve Sinofsky, Hardcore Software, March 23, 2024

IMPORTANT INFORMATION**INDEX DEFINITIONS**

Old economy basket includes: S&P 500 Diversified Support Service Sub Industry GICS Level 4 Index; S&P 500 Industrial REITS Sub Industry GICS Level 4 Index; S&P 500 Agricultural & Farm Machinery Index

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