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Revisiting Bubble Theory in Age of Artificial Intelligence

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Abstract: The paper talks about Artificial Intelligence today that embodies a hybrid bubble, combining speculative excess with general-purpose technological potential. It revisits classic bubble theories and applies macroeconomic models, valuation metrics and capex data to AI firms, finding explosive price behaviour and circular vendor-financing loop, in a handful of firms, rather than sector-wide mania. At the same time, strong earnings, moderate AI capex as a share of GDP, and projected labour productivity gains support structural repricing rather than irrational enthusiasm. The paper concludes with AI marked as "revolution wrapped in speculation," likely to experience a price restructuring which will filter fragile models leaving behind core infrastructure.

IndexTerms **- Artificial Intelligence, Generative AI, Market Bubble, AI Bubble, Dot-com comparison, GSADF Test.**

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1. INTRODUCTION

Since 2022, Artificial Intelligence (AI), especially generative AI, has been the core of the current market cycle. This has led to huge increases in equity valuations, capital expenditures (capex), and global interest. Nvidia is a good example of this trend. It has a lot of growth potential but also a lot of bubble risk. This is because overall market sentiment and optimism in the technology sector depend more and more on its earnings performance and the viability of big investments in AI infrastructure. This post-2022 euphoria phase has coincided with record data center and chip spending, alongside intense media and policy focus, positioning AI as the vanguard of a "Fourth Industrial Revolution" with promises of transformative productivity gains and trillions in economic value.

Central banks and analysts are sounding alarms about potential bubble formation similar to those seen during the late-1990s dot-com boom. They pointed towards stretched valuations in AI-related stocks, financing loops among major tech companies, and a heavy reliance on handful of large-cap companies. On the other hand, some argue that AI is a game-changing technology, backed by substantial earnings and strong financial health among top public companies, which sets this phase apart from past speculative bubbles. The evidence is mixed: while some macroeconomic models indicate long-term growth, short-term productivity gains seem limited, raising the risk of corrections if expectations fail to live up. This tension highlights the main market concern: is AI a sign of lasting change or just a bubble that could burst suddenly?

2. WHAT IS A MARKET BUBBLE? WHAT IS AN AI BUBBLE?

A Market Bubble is when asset values, capital expenditures, and reported revenues from sustainable cash flows don't line up. This arises because of reflexive capital loops, leveraged investments, and too much credit until financing concerns demonstrate that there is too much capacity. A financial bubble is when prices go rapidly up, values are higher than they should be, big investments don't pay off, and people are more sensitive to changes in their expectations. These things normally unfold in stages: an irruption, a frenzy, a mania, a fall, and eventually a consolidation. From a technical point of view, bubbles occur when prices go up and down quickly, regulations change, and prices are always too high relative to historical standards. GSADF tests and MS-GARCH models can be used to measure these things.

The AI bubble is an example of something that happens in a given industry, where the prices of AI gear, labs, and platforms are very high because of large transactions amongst insiders. Most of the money for these deals comes from loans, vendor funding, and capital expenditure from hyperscalers, not from established cash flows from end users. Some people say that AI is a fake technology, but the real problem with the bubble is that it is based on financing structures that make it look like there is more demand from paying customers than there really is. There are circular vendor-financing loops, a big rise in receivables and inventory that are higher than cash conversion rates, and a market performance that is very focused on a small number of companies, like Nvidia. This situation is similar to other technology bubbles, especially the dot-com bubble, when prices were based on stories that had little to do with making money, media hype made people afraid of losing out, and there wasn't enough strong regulatory control during a time when there were a lot of initial public offerings.

The two sides of AI bubbles make the market much riskier. One side is financial excess in stocks and credit, such high price-to-earnings ratios and capex driven by debt. On the other hand, there are too many data centers being built, which exceeds the productivity and adoption rate. People assume that generative AI is an essential step forward because of hype cycles. This is why it is being introduced to infrastructures too fast, even if there are still technical issues, high costs, and unproven value propositions. New ways of valuing things, such as model parameters, data amounts, and benchmarks, make market values distinct from what is possible for cash flow and adoption. This makes it more probable that the market will fix itself, like it did during the dot-com boom in the late 1990s. Due to herd behavior and overly positive expectations, the discrepancy between the underlying value and the market price stays quite large. Large-cap companies are scared for AI having a big impact on how well the index does and how risky the system is?

3. Evidence Supporting the Current Bubble Hypothesis

3.1Variations in Valuation and Price Movements

Equities that are impacted by AI show signs of a classic bubble, such as quickly rising prices and valuations that are too high and not based on the underlying fundamentals. Mega-cap AI leaders are currently trading at multiples that are reminiscent of the peaks observed during the late-stage dot-com era, contributing significantly to index gains and representing a considerable portion of projected US equity returns for 2025. A time-series analysis shows that about 37% of AI-related companies in major indices have explosive root behavior. The price movements of some companies are very similar to the euphoria phase of the Nasdaq during the dot-com bubble, which indicates that they are more likely to make corrections. Central banks and international organizations have made it clear that "stretched" AI valuations are a problem. They have compared them to the excesses of the 1990s and warned that if expectations fall, there is an immense risk of repricing.

According to data gathered, the combined funds raised by AI startups jumped to $73.4bn by Q4 2020, making the a $15bn jump since the beginning of year. After 2022, the prices of generative AI companies rose more than expected, similar to what happened in the dot-com and cryptocurrency bubbles, when market prices were higher than the actual economic contributions. The elevated price-to-earnings ratios among leading AI firms, which greatly surpass market averages, coupled with a concentration of investment in a limited number of companies, heightens systemic fragility.

3.2 Reactive Financing and Circular Flows

AI infrastructure investment is characterized by reflexive funding loops, where hyperscalers, model providers, and chipmakers all function as investors, suppliers, and consumers at the same time. This makes it seem like there is more demand than there really is through vendor financing and circular deals. This system maintains high reported revenues and capital expenditure levels despite weak end-user monetization, comparable to pre-crisis capacity trading that collapsed under debt pressure.AI funding grew by about 75% year over year, from $45.8 billion in 2022 to over $200 billion in 2025. This was mostly due to OpenAI and Anthropic, as well as herd behavior and FOMO, rather than real demand. The US and China were the main hubs for AI funding, with the biggest players being located there. Leveraged structures make risks worse: neo-cloud GPU renters and data-center operators depend on long-term leases and credit that looks like subprime chains. At the same time, receivables growth is faster than cash conversion, which hides real demand through aggressive accounting. This sort of reflexivity leads to mathematical overcapacity, where internal transactions keep values high until external funding runs out.

3.3 Weak Realized Returns and Productivity Paradox

Despite significant capital expenditures, the realized fundamentals are not what we expected: about 95% of corporate generative AI experiments do not lead to significant revenue increase, and major companies are already starting to use them less often. The benefits on the job market are still minimal with just 3% time-saving and no real change in salaries. This goes against the trillion-dollar productivity claims made by consulting firms. Training the model takes hundreds of millions of dollars and uses a lot of energy, which makes it hard to see a return on investment in the short term unless there are clear methods for earning. Instead of using discounted cash flows or EBITDA, valuation practices use flawed metrics like parameters, benchmarks, and GitHub stars. This makes it easier for companies to use AI-washing, which is when they add superficial AI to make their stock prices look better. Key players in the industry are now questioning why they are spending so much money, seeing a situation of "too much spend, too little benefit," as GPU and cloud costs exceed income generation.

3.4 Hype Cycles and the Associated Risks of Expectations

Narrative amplification sustains decoupling: promoters rebrand operations as "AI-powered," media advocates for widespread upskilling to prevent obsolescence, and consultancies forecast a valuation of $2.6-4.4 trillion gains persist despite inherent technical limitations such as hallucinations. Existing regulatory gaps, coupled with retail fear of missing out (FOMO) and insufficient oversight, perpetuate speculative dynamics, while geographic concentration exacerbates geopolitical vulnerabilities.

The macroeconomic effects make risks even worse: investments in AI capex have a big effect on US GDP, energy and water use, and investment portfolios. If the pace slows down, these investments might lead to systemic exposure. This convergence, marked by rapid price rises, reflexive capital flows, poor returns, and more hype, is strong proof that an AI bubble is forming and that expectations might change.

4. Arguments Against the Presence of AI Bubble Hypothesis

4.1 Core Abilities in Well-established Organizations

Counterarguments emphasize that leaders familiar with AI exhibit robust principles that distinguish them from simply theoretical phenomena. In contrast to pre-revenue dot-com startups, established cloud platforms and semiconductor manufacturers

exhibit significant current earnings, robust free cash flows, diversified revenue streams, and solid balance sheets. The Magnificent 7 (Apple, Microsoft, Amazon, Alphabet, Meta, Nvidia & Tesla) generate significant cash flows, engage in buybacks and distribute dividends, practices that were uncommon in 1999; thereby linking high valuations to actual profitability rather than mere narratives. Current forward P/E, EV/sales, PEG ratios, and price-to-book metrics for leading technology companies remain elevated yet below the extremes observed in the late 1990s, with market-implied growth expectations slightly exceeding historical averages. Time-series analysis provides evidence for this caution: GSADF tests indicate no widespread bubble-like explosive behavior among AI-related equities, with notable companies exhibiting limited or nonexistent speculative regimes from 2010 to 2025. Prominent indices influenced by AI (such as the Nasdaq Composite and Nasdaq 100), exhibit a lack of synchronized speculative behavior. Furthermore, instances of heightened activity in specific firms frequently arise without corresponding high-volatility fluctuations, indicating a trend of structural repricing rather than a collective frenzy. Additionally, initial public offering activity and primary equity issuance are notably muted compared to previous peaks, reflecting a degree of discipline within the capital markets.

4.2 Constructive Capex and Long-Run Productivity Potential

Expenditures on AI infrastructure, although substantial, represent less than 1% of the US GDP—this is notably smaller than the historical investments seen during electrification or the IT booms of the late 1990s when adjusted for scale. This spending is indicative of actual compute demand rather than illusory capacity. Macroeconomic forecasts suggest that generative AI has the potential to enhance US labor productivity by 15% in next decade, resulting in a present-discounted value of $8 trillion for US companies, which surpasses multi-trillion capital expenditure predictions under plausible adoption scenarios. This makes AI a general-purpose technology that justifies structural valuation premiums. Overshoot is more like cyclical capex booms than total fiction. Speculative phases follow normal innovation cycles: technological revolutions go through irruption, frenzy, crash, and synergy, where corrections filter out weak models, build up strong infrastructure, and redirect capital toward sustainable applications. Like the dot-com overbuild financing that helped build long-lasting internet infrastructure, AI "bubbles" pay for compute, data centers, talent, and platforms that last after the correction, allowing for maturity. After the corrections, investment moves to specialized sectoral applications (health, agriculture, education), which improves ROI alignment.

4.3 Discipline and Adjustment Signals in Emerging Markets

Market reactions to balance sheet concerns, growing receivables, and inventories show that investors are paying close attention to cash flows. Price reversals after earnings show that investors are more stable than blindly excited. Large tech companies are quietly lowering their expectations for generative AI, regulators are denying special exemptions, and investors are looking into revenue models, which suggests that things will fix themselves before they get too bad. There are gaps in private and public valuations, but public markets use profit-based frameworks while software and platform names are trading at low prices because of fears of disruption, which goes against the idea that things are getting too hot. Bubble-like traits are more common in specialty areas like private valuations, debt-financed data centers, and quantum computing than in broad stocks. Most AI platform companies have acceptable multiples that are linked to their financial health. This bifurcation, speculative pockets amid durable core, mirrors historical tech cycles where shakeouts strengthened survivors, implying AI's transformative potential endures even if financing excesses correct.

4.4 Synthesis: Revolution in the Context of Speculation

The hybrid perspective is dominant. Artificial intelligence represents a significant long-term value as a productivity frontier, while simultaneously exhibiting short-term speculative excess that is susceptible to repricing. This phenomenon is more akin to the evolution of the dot-com era, characterized by cycles of boom, bust, and transformation, rather than the collapse seen during the tulip mania. Concerns regarding financing—such as leverage and circularity—warrant a cautious approach; however, the durability of technology, the stability provided by earnings, and a measured scale of capital expenditures serve to mitigate the risks associated with a complete bubble. Furthermore, the rise of a disciplined attitude among investors, companies, and regulators makes it even less likely that systemic escalation will happen. This makes corrections seem like a beneficial filtering process instead of a threat to life itself.

5. Comparative Analysis: Present AI Hypothesis and Historical Bubbles

5.1 Parallels with Previous Technological Bubbles

The recent rise in AI investments is quite comparable to previous technological bubbles, especially the dot-com boom of the late 1990s. The growth rates of US tech-sector capex over the past five years are now similar to or close to those seen before the 2000 burst. This means that there is a risk of overinvestment and possibly too much capacity. Vendor-financing loops between hyperscalers, model providers, and chipmakers are similar to capacity trading during the telecom/dot-com era, when mutual financing inflated reported growth until funding chains broke. Speculation based on narratives—media euphoria, FOMO-fueled retail participation, regulatory lag, and new valuation paradigms (parameters, benchmarks)—reproduces classic patterns seen in dot-com, crypto, and Chinese tech waves. Central banks and analysts map AI against bubble diagnostics: rapid price surges, concentrated index weightings, circular spending, and expectation sensitivity akin to late-dot-com excesses. GSADF tests confirm multiple bubble episodes in ~37% of AI-related firms and indices, with select price paths matching Nasdaq's euphoria phase. Capex concentration, herd behavior, and leverage amplify transmission risks, where reversals in leading names propagate broadly.

5.2 Key Differences and Mitigating Fundamentals

In contrast to numerous dot-com enterprises, prominent AI companies exhibit significant current profits, robust cash flows, and a range of revenue streams, thereby linking their valuations to actual economic performance rather than mere speculation. Analysis of time-series data indicates that explosive dynamics are primarily observed in specific subsets, particularly among infrastructure leaders, while major platforms and indices devoid of synchronized speculative trends do not reflect such

patterns. Currently, AI capex account for 0.8%-1.3% of US GDP as in 2024-25, which is relatively modest compared to the peaks seen during electrification and information technology, suggesting that any overshoot should be interpreted as a cyclical infrastructure development rather than an illusory phenomenon. This leads to varying interpretations regarding the severity of the bubble.

5.3 Pro-bubble focus on the harshness

Recent selloffs linked to fears of a slowdown in demand have brought back worries about valuations, with circularity, weak cash conversion, and capex following pre-crash trends. Reflexive equity-financed deals and bottleneck concentration make the system more fragile. Skeptical counterarguments: Fundamentals (earnings, centrality to digital infrastructure) suggest financing—not technology—forms the true bubble, with corrections filtering weak models while preserving viable infrastructure. Productivity projections (~15% labor uplift, $8tn PDV) rationalize premia as general-purpose technology repricing. Historical analogies diverge: Economic analyses frame AI within Perez/Minsky cycles (frenzy filtering to synergy), constructive like dot-com infrastructure legacy. Critical views highlight persistent externalities—energy demands, lock-in harms—beyond financial correction, distinguishing AI's social costs. Empirical tensions: Macro/institutional warnings stress stretched valuations and reflexivity; granular econometrics finds selective pockets amid broader repricing. Goldman Sachs notes subdued IPOs and metrics below 1999 extremes; Storm counters with capex intensity matching/exceeding priors amid questionable LLM limits.

5.4 Synthesis: Hybrid Bubble Characterization

Artificial intelligence integrates traditional indicators—reflexivity, capex surges, and market enthusiasm—with sustainable profit foundations and infrastructural utility that are lacking in mere speculative ventures. This phenomenon, described as a "revolution wrapped in bubble," mirrors the trajectory of the dot-com era: characterized by cycles of boom, bust, and consolidation that lead to transformation. In this context, market corrections tend to fortify the resilient entities while revealing vulnerabilities associated with leverage. The resolution of these dynamics is contingent upon debated productivity pathways and the sustainability of financing, thereby framing the risks associated with AI as a process of sectoral repricing with limited systemic repercussions.

6. My Take on The Current Bubble Situation

Artificial Intelligence has become a central theme in modern economic discourse, characterized by an unusual degree of investor enthusiasm that converges with technological potential and inherent structural obstacles. Based on observed market patterns, this analysis underscores a tension between transformative potential and increasing risks, necessitating an in-depth investigation rather than simplistic binary conclusions.

Conventional financial metrics such as ROI, P/E ratios, EBITDA, and cash flows have increasingly been overshadowed by alternative indicators including GitHub stars, model parameter counts, data volumes, open-source contributions, and the momentum of meme stocks. The momentum of this shift was significantly influenced by the launch of ChatGPT in November 2022, which intensified the pursuit of AI-integrated assets, frequently surpassing the focus on rigorous fundamentals and actual development. OpenAI illustrates a significant disparity: its AI training expenses for 2024 reached $8.5 billion, accompanied by a $5 billion loss, followed by a revenue of $4.3bn in H1 2025 with net loss of $13.5bn tracking net loss for whole year to be over $16bn, simultaneously having secondary valuation including sale to be more than $500bn. The phenomenon of fear of missing out (FOMO) aggravates this situation, directing retail capital towards AI stocks without thorough evaluation. Concurrently, companies are integrating AI into their operations prematurely in an effort to attract investors, echoing the behavior of dot-com enterprises that appended ".com" to their names to enhance their credibility.

The amplification of media fuels the cycle. Headlines highlighting advancements in artificial intelligence generate feedback loops with venture capital and retail investors, leading to inflated perceptions of its capabilities and potential. The ethical implications become increasingly pronounced as enhanced capabilities give rise to concerns regarding misinformation, privacy violations, algorithmic biases, job displacement, and the environmental impact of energy-intensive operations. Overleveraged bets are increasingly evident across various sectors, reflecting the vulnerabilities seen in the housing market of 2008. This trend persists despite the optimistic projections from firms such as Morgan Stanley, which identifies AI as a key to $6 trillion opportunity, and McKinsey, which estimates a productivity frontier ranging from $2.6 to $4.4 trillion, suggesting potential growth for both technology and investors.

Recent signals moderate the prevailing narrative. The expansion of artificial intelligence encounters challenges due to elevated costs and discrepancies in accuracy, leading Amazon and Google to reconsider their projections for generative AI as expenditures associated with cloud services and training surpass anticipated returns. The global equity head of Goldman Sachs has characterized AI as "exceptionally too expensive," suggesting it is inadequate for addressing complex problem-solving when considering the associated costs. The increasing public disillusionment is evident as the anticipated work augmentation frequently results in inadequate delivery. The intensification of sustainability conflicts is evident as U.S. data centers consume significant amounts of power, coinciding with a 40% reduction in coal plant operations. This situation may hinder the momentum surrounding conservation efforts.

The risks are constrained by geopolitical biases and vulnerabilities in supply chains, as the United States and China account for over 70% of artificial intelligence investments, resulting in European AI Applications being 70% dependent on U.S. infrastructure and raising concerns regarding its sovereignty. Nvidia's dominance, exceeding 92% in the data center market, combined with significant capital barriers, creates a fragile supply chain; as any instability from a leading entity could lead to widespread impacts.

The trajectory of artificial intelligence encompasses various dimensions, including metric erosion, hype loops, ethical strains, modest returns, and systemic exposures, requiring a careful balance and ongoing evaluation. The potential for transformative benefits exists alongside cautionary examples, highlighting the necessity for realistic expectations during periods of change.

7. Comparative Analysis: Present AI Hypothesis and Historical Bubbles

The analysis indicates a complex AI market characterized by speculative excesses in conjunction with authentic technological potential. Although Nvidia and Tesla display characteristics reminiscent of market bubbles, characterized by rapid price movements as indicated by GSADF tests and elevated volatility, these phenomena are not prevalent across the entire sector. Prominent leaders in the AI sector, such as Microsoft, demonstrate a structural repricing supported by earnings, alongside anticipated productivity gains of 15% over the forthcoming decade.

7.1 Key Findings

Bubble signals encompass accelerated valuations, circular financing among hyperscalers and chipmakers, as well as Nvidia's lengthened cash conversion cycle (taking longer to turn investment in inventory and service in cash), which contributes to inflated demand in the absence of consumer revenue and also raises concern about the working capital efficiency of company despite its strong financial growth. Analysis of time-series data reveals that 37% of AI stocks exhibit explosive behavior, notably characterized by Nvidia's episodes from 2019 to 2020 and Tesla's spikes anticipated in 2024, both of which are associated with FOMO-driven hype. Counterpoints indicate that AI capex represent less than 1% of U.S. GDP, which is lower than previous economic booms, while also highlighting a potential value of $8 trillion as a general-purpose technology.

7.2 Implication

This phenomenon of "revolution in speculation" mirrors the cycles observed during the dot-com era, where corrections serve to eliminate weaker participants, thereby fortifying those who remain. There exists a significant risk factor, quantified at 95%. GenAI pilots exhibit failures, with hallucinations remaining a significant issue. Projections indicate that data centers currently are accounting for 2-4% of total US electricity consumption as of now and can rise to 10-12% or more by 2030, thereby exacerbating energy strains and fragility, particularly in light of Nvidia's dominant 92% share in data center market. Emerging indicators such as a +89% increase in receivables and strategic exits by informed investors, as demonstrated by Burry's put options, suggest a potential for self-correction in the market.

Policy should focus on identifying leverage points and addressing existing gaps, directing capital towards sectors with high returns on investment, such as health and education. The trajectory of artificial intelligence is reliant upon the alignment of public expectations with actual developments, emphasizing the importance of promoting equitable growth rather than succumbing to transient trends.

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