Via Negativa: The AI Economy by Elimination

The Core Memorandum. Roots, the Economic Transformation, and the Binding Constraints*

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ABSTRACT

This memorandum forecasts the AI economy by elimination rather than projection. For each question it enumerates the candidate answers, computes for each the time its binding constraint would need to deliver the required expansion, and compares that against the horizon remaining. Six constraints are derived from a question that never mentions artificial intelligence: what does it take to obtain one more unit of a limiting input? Only the first, physical law, licenses deductive elimination. The other five reprice, which is why every verdict carries a probability rather than a proof. The engine decides eight of the thirty questions here, and that ratio is reported as a result: it is a test for which questions have physically determinate answers, and most do not.

Turned on the field's own forecasts, the method produces its most consequential result. Every published estimate of AI's contribution to output is a bet on an unmeasured elasticity between deployed compute and attributable output. Its observed values span a range that reverses all of them, including this memorandum's own GDP band, which the engine eliminates at the low end. The aggregate question is therefore underdetermined on current public data.

Two further findings cost the paper more than they gave it. The Residual Ratio, this framework's coined unit, is withdrawn: built from primary sources, none of its four complement components is constructible, so the ratio never had a numerator. And a pre-registered backtest records a maximum-confidence miss, on the one constraint tier the framework had already named as most exposed. What survives is smaller and sourced: the price of a fixed capability falls four to fifty-six times faster than the price of the best available model, a binding constraint attracts no supply response where a cycle does, and one dated call is staked with its adjudication rules specified in full.

Keywords Constraint-based forecasting · Binding constraints · Shadow prices · AI economics · Technology diffusion

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Contents

Each section states its claim before arguing it. The full arithmetic sits in tables and footnotes, so a reader can stop at any depth and still have something coherent.

1. Method. Constraints do not eliminate candidates. They reprice them, and only physical law bars outright. The framework is stratified into a deductive floor at Tier 0, an inductive middle across Tiers 1 to 5, and an abductive top across whatever survives, which is why every verdict carries a probability rather than a proof. The six constraints are derived from a question that never mentions artificial intelligence.

2. The Elasticity Gap. Every forecast of AI's contribution to output is a bet on the elasticity between deployed compute and attributable output. Nobody names it, nobody has measured it, and its observed values ran 1.70, then 1.17, then 1.37 across 2023 to 2026. At the low end this memorandum's own GDP band is eliminated and the sole survivor is the field's most conservative estimate; at the high end even the most bullish survives.

3. The Five Roots. Net-positive value on a J-curve; a decade-long uneven grind toward AI-native organizations; a US-led layered oligopoly with a walled Chinese stack; fragmented and lagging governance; capability rising through test-time compute rather than raw scale. Absorption at Tier 1 binds three of the five.

4. Domain I, Economic Transformation. AI adds roughly 1.0 to 1.5 percentage points of annual growth, roughly $7 to $10.5T cumulative by 2030. The majority-of-GDP claim fails by about ninefold. Realized gains run at 0.1 to 0.2 points against a 1.5 point electricity precedent, and the binding constraint is organizational absorption on a twenty to forty year clock.

5 to 12. The branch questions. Compute, data, models, labor, agents, software and the physical world. The chokepoint on the buildout is a transformer at 128 weeks, not a chip and not a dollar. Models commoditize and the moat moves to everything around them. The data wall is weaker than the field believes; grid equipment is stronger.

13. Interim Residual. Intelligence commoditizes; scarcity and value migrate to its complements, so scarcity migrates to the complements across every question. Stated with its falsification condition and bounded to the 2026 to 2030 horizon.

14. The Call. On 31 December 2027 the best generally available model's METR 80 percent-reliability horizon is under eight hours, at P = 0.85, with five adjudication rules and a void condition. The 80 percent series has been flat at 27 to 32 minutes across two frontier release cycles while the cited 50 percent series rose several-fold.

15. Retrospective Validation. Five pre-registered questions, four correct, mean Brier 0.228. The single miss occurred at maximum confidence on the constraint tier this framework had already identified as most exposed to substitution, and it forced a parameter revision that moves three verdicts in this document.

16 to 19. Objections, signposts, sources, limits. Six objections at full force, one granted outright and one substantially conceded. Nineteen tracked signposts with metrics, triggers and cadences. Three figures in general circulation corrected rather than repeated.

Headline Results

Eleven claims drawn from the thirty verdicts, ordered by distance from consensus. Each is dated, each carries its arithmetic, and each names the section where it is argued.

1. Every forecast of AI's economic contribution, including this one, is a bet on a parameter nobody has measured. The elasticity between deployed compute and attributable output has never been named or reported in this literature, yet it alone connects a forecast's output claim to the compute the constraints permit. Its observed values ran 1.70, then 1.17, then 1.37 across 2023 to 2026. At the low end of that range this memorandum's own GDP band is eliminated and the sole survivor is the most conservative estimate in the field; at the high end even the most bullish survives. The central quantitative dispute in AI economics is a disagreement about one unmeasured number. (Section 2)

2. Roughly seventy percent of measured AI value is captured by nobody. US consumer surplus from generative AI reached approximately $172B annually against attributable revenue several times smaller, putting the capture ratio near 0.31 and the uncaptured amount growing by about $25B in a year. The investment debate the field is conducting concerns the allocation of roughly thirty cents on the dollar. (Section 1.4)

3. The number that matters for delegation has not moved in a year. The widely cited METR figure is the 50 percent task-completion horizon, which has risen several-fold since late 2025. The 80 percent horizon, the level at which work can actually be handed over, has been approximately flat at 27 to 32 minutes across two frontier release cycles. Capability is arriving as intercept rather than slope: models succeed more often on long tasks without succeeding more reliably on them. Falsifying our central call requires a sixteen-fold rise, four doublings, in under two years, in a series that has not moved. We put it at 0.85. (Sections 3.5, 9.1, 14)

4. The industry has misread its own binding constraint by roughly sevenfold. The $1.5 trillion figure in general circulation is a funding gap through 2028, closable by bonds, private credit, structured vehicles or equity. It is not a debt requirement, and the corresponding corporate issuance estimate is approximately $200 billion. Capital relaxes in weeks and converts into every other constraint given time, so **it is almost never the binding constraint on a multi-year horizon.** Most public argument about the AI economy is therefore an argument about a variable whose shadow price is zero. (Sections 1.2, 5.3)

5. The chokepoint is a transformer, not a chip. US large-power transformer lead times average 128 weeks and reach three to five years for the largest units, medium-voltage switchgear is effectively sold out through 2028, and the gas-turbine order book reached 100 gigawatts with roughly 10 gigawatts of delivery slots remaining across 2029 and 2030 combined. Of 12 to 16 gigawatts of US data-center capacity announced for 2026, approximately 5 is under construction. Closing that gap requires 5.2 years of expansion at the observed rate against 1.4 years available. The largest buyer says the same thing against its own interest: chips sitting in inventory for want of powered shells. (Sections 1.2a, 5.2)

6. An instant productivity surge would require seventy years. The candidate positing an immediate economy-wide surge requires 69.9 years of absorption expansion against 4.4 available; the two-to-three-year transition requires 46.5 against 2.0. The binding constraint is organizational rather than technical, and it is the slowest relaxable constraint in the set, at twenty to forty years. Electric motors were under five percent of factory mechanical drive in 1900 and the productivity gains landed in the 1920s. (Sections 1.2a, 4.2, 4.9)

7. The majority-of-GDP claim fails by an order of magnitude, and our own prior confidence about it was overstated. It requires roughly $77 trillion of new output against a $16 trillion ceiling from the most bullish credible estimate, a gap of approximately ninefold. The survivor is 1.0 to 1.5 percentage points of annual GDP growth, squarely within the electricity and information-technology precedents. But running the formal engine retains 19 percent on the claim a qualitative reading would reprice to near zero, so the survivor is stated at 0.62. (Sections 1.2a, 4.1)

8. We publish a maximum-confidence miss. Pre-registered with parameters fixed at end-2022, the framework predicted the public-text data wall would bind frontier scaling by 2026, at 100 percent confidence. It did not. Epoch moved its own median exhaustion estimate from 2024 to 2028 and substitution closed the gap. **This is Malthus reproduced inside our own model, on the tier we had already named as exposed to exactly that failure.** The parameter is corrected by an order of magnitude and three verdicts move as a result. The data wall is not the constraint the field believes it to be. (Section 15)

8b. The engine decides eight of thirty, and that is the second finding. It requires an expansion factor and an observable rate, which exist for forward capacity questions and for neither structural nor current-state ones. So it is not a machine for answering everything: **it is a test for which questions have physically determinate answers.** Eight here do. Twenty-two do not, and confident disagreement about those is evidence about forecasters rather than about the world. The register carries the falsifier: the eight should resolve with materially lower variance than the twenty-two. (Section 1.2a)

9. Complement value capture is not measurable from public sources, and the negative result is the finding. Its numerator required four complement price series; built from primary sources, **none of the four is constructible from disclosed data**, because no vendor reports HBM pricing, no published definition of a data-centre megawatt price exists, and TSMC and NVIDIA disclose neither packaging price nor units. A ratio whose numerator does not exist is not a wide measurement, it is not a measurement. Three independent attempts failed for three unrelated reasons, which locates the fault in the construct rather than the instrument: rent means price minus cost, and **cost is undisclosed at every layer of this stack.** What replaces the ratio is a test the framework can actually run. **A binding constraint attracts no supply response; a cycle does.** Memory is responding, with roughly $250bn of committed capacity expansion. Power is not: four years of extraordinary prices drew about 525 MW of new resources into the 2028/29 PJM auction, 6.8 GW short of target. Same test, opposite answers, both disclosed. That is the first empirical validation of the tier ordering itself. (Sections 1.3a to 1.3c)

10. The first complement is already commoditizing, on schedule. Advanced packaging supply and demand have converged from a gap of approximately 20 percent toward 10 percent, while grid equipment expands at a tenth the rate. The thesis predicts the decay of its own components and this is the first measured instance, reported as confirmation rather than as threat. **The ratio between those two expansion rates is the entire content of the migration argument.** (Sections 5.2, 16)

11. If we are wrong, this is how. If organizational absorption is the terminal binding constraint, the residual accrues to whoever solves adoption rather than to owners of physical complements, and the investment conclusion inverts. We grant that objection rather than answering it, and narrow the thesis accordingly: the claim that value migrates to physical complements holds on the 2026 to 2030 horizon, and beyond it this memorandum does not make the claim. (Section 16)

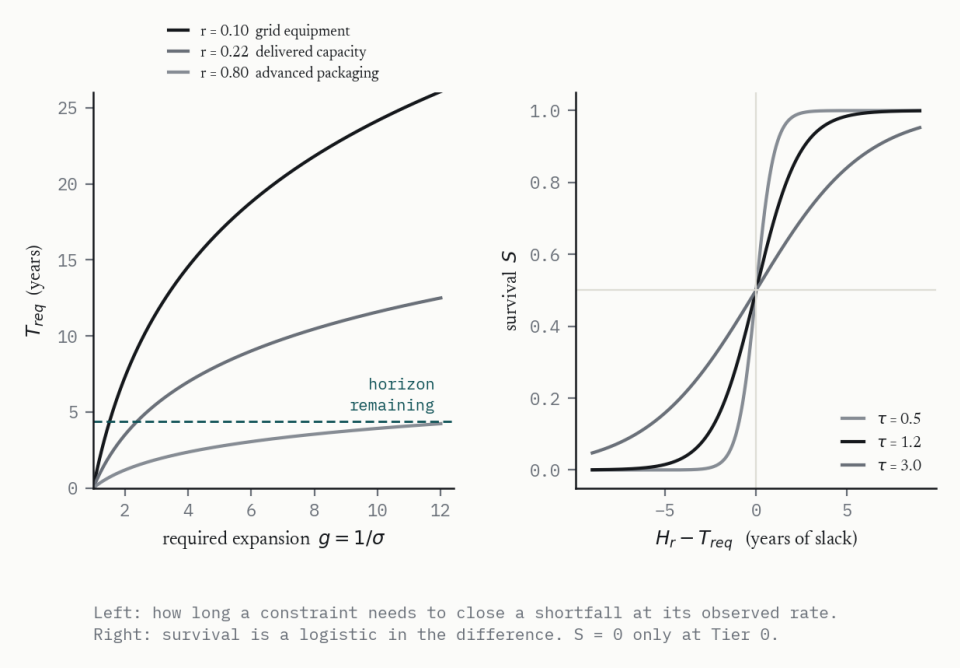

Figure 1: The engine. Left: how long a constraint needs to close a shortfall at its observed expansion rate, against the horizon remaining. Right: survival as a logistic in the difference. The only zero in the system sits at Tier 0, which is the deductive floor.

One dated call and one signature bet are staked in Section 14, both with their adjudication rules specified in full, and both tracked on a public register.

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1 Method

Constraints do not eliminate candidates. They reprice them, and only physical law bars outright. The framework is stratified into a deductive floor, an inductive middle and an abductive top, which is why every verdict carries a probability rather than a proof. The six constraints are derived from a question that never mentions artificial intelligence.

For a question, enumerate the mutually exclusive candidate answers, including at least one taboo or unprecedented option; a truth never listed cannot survive. For each candidate and each constraint, compute the slack ratio, the quantity the constraint permits over the quantity the candidate requires. Convert the shortfall into time: the years the constraint would need, at its observed expansion rate, to deliver the required expansion. Compare against the horizon remaining. Bar at Tier 0. Reprice at Tiers 1 through 5. Isolate the survivor, attach a probability band, and record the discontinuity that would reverse the verdict as a tracked signpost.

Declared confidence, set by rubric rather than by fit.

The engine discriminates on constraint arithmetic alone. For several verdicts this memorandum is less confident than the arithmetic, because the answer turns on something the arithmetic does not model. That gap is a stated number:

$$P_{\text{stated}} = c \cdot P_{\text{engine}} + (1 - c) \cdot \tfrac{1}{n}$$

The coefficient is not chosen to reproduce a preferred answer. **Each c is derived from a fixed rubric of epistemic defects, identified from properties of the verdict before its output is computed**, and the stated probability is whatever falls out.

Table 1: The three inferential layers. Only Tier 0 licenses deductive elimination.

Defect	Deduction
Depends on a parameter nobody has measured whose observed range reverses the verdict	0.40
Binding constraint sits on a tier carrying a recorded backtest miss	0.25
The primary source has already revised this estimate once	0.15
A load-bearing cell is not computable and is bounded on a base rate	0.15
Constraint rate inferred from one historical analogue rather than a series	0.15
A tracked signpost currently reads against the verdict	0.10
The requirement does not express cleanly as an expansion factor	0.10

Below $c = 0.30$ a verdict is withdrawn rather than published.

An earlier version of this section set the coefficients by solving backwards from probabilities already written in the paper. That made confidence a free parameter fitted to a predetermined conclusion, which is the precise criticism this framework levels at unstated assumptions elsewhere, committed on its own numbers. The rubric replaces it, and applying the rubric moved four of the five coefficients.

For candidate a and constraint c on a horizon with H_r years remaining, the slack ratio is the quantity permitted over the quantity required,

$$\sigma(a, c) \;=\; \frac{\text{Permitted}(c, H)}{\text{Required}(a, c)}, \qquad g \;=\; 1/\sigma, \tag{1}$$

the time the constraint needs to deliver that expansion at its observed rate r_c is

$$T_{\text{req}}(a, c) \;=\; \frac{\ln g}{\ln(1 + r_c)}, \tag{2}$$

and the survival likelihood of the candidate, with τ_c the dispersion of that rate, is

$$S(a, c) \;=\; \Big[\, 1 + \exp\!\big(-(H_r - T_{\text{req}})/\tau_c\big) \Big]^{-1}, \tag{3}$$

with $S = 0$ whenever c is Tier 0 and $\sigma_{\text{upper}} < 1$. That zero is the deductive floor of Table 1 and it is the only place a zero appears. Posteriors across the candidate set follow as $P(a) \propto \pi(a) \prod_c S(a, c)$, normalized, with π the stated prior.

Assertion without this arithmetic is not elimination. Where a slack ratio is not computable from public data the cell reads `nc`, receives a base-rate-bounded interval rather than a free pass, and the verdict is labelled provisional.

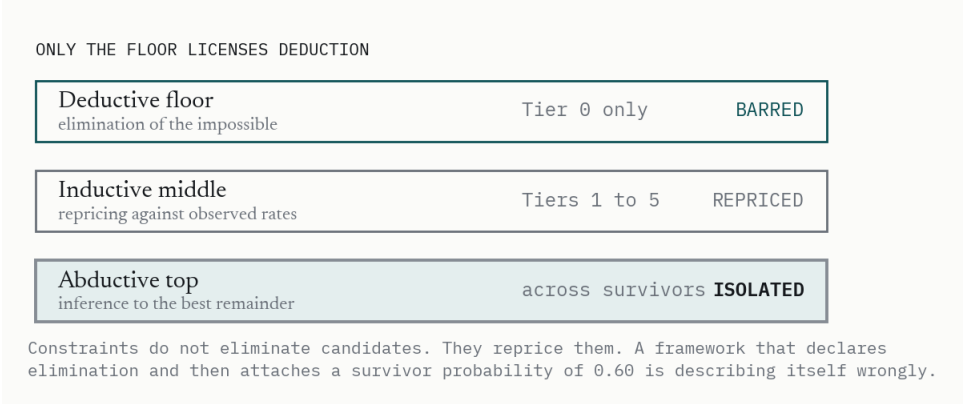

Figure 2: Only the floor licenses deduction. Constraints do not eliminate candidates; they reprice them. A framework that declares elimination and then attaches a survivor probability of 0.60 is describing itself wrongly, because forty percent of the mass still sits with candidates it called eliminated.

1.1 What the method claims, and what it does not

The Holmesian maxim is deductive and valid only where the candidate set is exhaustive and each elimination is a genuine impossibility. Neither condition holds for most questions about the AI economy. The framework is therefore stratified by inferential type.

Enumeration, not arithmetic, decides more verdicts than it should. On the worked example the leading candidate flipped twice as the candidate set grew from three to six, then held. **The closed-world problem is therefore the binding constraint on the method itself**, and it cost a factor of two in the leading posterior before the completeness check caught it. The working rule: enumerate until two consecutive additions leave the leader unchanged, and report how many were required.

Table 2: Derivation of the constraint set by replenishment mechanism. The partition is over how one more unit is obtained, and never mentions artificial intelligence.

Layer	Operation	Applies at	Verdict	Probability
Deductive floor	Elimination of the impossible	Tier 0 only	**Barred**	Zero
Inductive middle	Repricing against observed relaxation rates	Tiers 1 to 5	**Repriced**	Reduced, non-zero
Abductive top	Inference to the best remaining explanation	Across survivors	**Isolated**	Normalized posterior

Constraints do not eliminate candidates. They reprice them. Only Tier 0 bars. A framework that declares candidates eliminated and then attaches survivor probabilities of 0.55 to 0.78 is describing itself wrongly. A survivor at 0.60 leaves forty percent of the probability mass with candidates declared eliminated, which is incoherent under a deductive reading and coherent under a stratified one. Every verdict below therefore reads "eliminated" as shorthand for "repriced to near zero at the stated tier," and the tier is always given, because eliminated at Tier 0 and eliminated at Tier 5 are not the same claim.

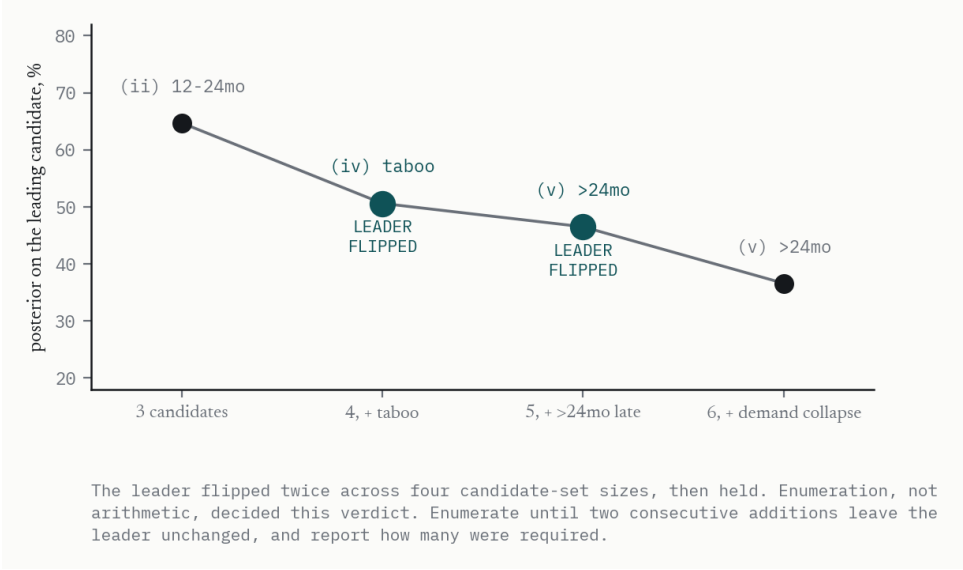

Figure 3: Enumeration decided this verdict, not the arithmetic. The leading candidate flipped twice across four candidate-set sizes, then held. A framework that computes carefully over an incomplete candidate set is precise about the wrong question.

1.2 The constraint set, derived

What does it take to obtain one more unit of a limiting input? The answers partition exhaustively, and the partition never mentions AI.

Table 3: The constraint set with inference parameters and governing data, current to July 2026.

Source of one more unit	Constraint	Accessible in
Nothing. Physical law forbids it	**Thermodynamics**	never
Generational time: humans raised, trained, organized	**Talent and Absorption**	10 to 40 years
Nothing, but a finite accumulated stock is drawn down	**Data**	not replenished on horizon
Industrial production, given capital and lead time	**Matter**	2 to 7 years
A collective decision by people with authority	**Law and Legitimacy**	3 to 24 months
A price	**Capital**	days to weeks

The tiers are the accessibility of the replenishment mechanism. **Table 1** gives the parameters.

Table 4: Where the formal machinery applies. Roughly a quarter of the memorandum is computed; the remainder is disciplined judgment.

Tier	Constraint	r_c	Governing datum, mid-2026
0	Thermodynamics	0 exactly	Landauer [1, 2] bound approximately 3e-21 J per bit erasure at 300 K. Max CMOS efficiency approximately 4.7e15 [2] FP4/J, roughly 200x current accelerators. Leading ML hardware improves [3] approximately 40% per year

Tier	Constraint	r_c	Governing datum, mid-2026
1	Talent (fast)	0.05 to 0.10	**The number of AI researchers and developers moving to the United States has fallen 89% since 2017 [54], with an 80% decline in the last year alone** (AI Index [54] 2026). US institutions employ approximately 59% of elite AI researchers [55, 54], built substantially on foreign-trained talent. FY2027 H-1B [56] registrations fell 38.5%. Projected US shortfall of 157,000 [57] skilled semiconductor workers
1	Absorption (slow)	0.02 to 0.05	Electric motors under 5% of factory mechanical drive in 1900; productivity gains in the 1920s [62]. Approximately 5% of integrated AI pilots [48] P&L-positive. **Consumer uptake and organizational absorption run on different clocks and must not be conflated: generative AI reached 53% population adoption in three years [54], faster than the PC or the internet, while AI agent deployment [54] remained in single digits across nearly all business functions** (AI Index [54] 2026)
2	Data	**0.30 to 0.60** (revised, Sec. 14)	Effective public human text approximately 300T tokens [5]; median exhaustion 2028 [5], 80% interval 2026 to 2032. Substitution via multimodal and verified synthetic is the operative rate
3a	Matter: advanced packaging	0.60 to 1.10	CoWoS [23] from 13k wafers per month at end-2023 toward a 120 to 130k target at end-2026; supply-demand gap narrowing from approximately 20% toward 10%
3b	Matter: leading-edge logic	0.15 to 0.25	TSMC N2 and A16 [24] booked into 2027 to 2028. Arizona announced 2020 [24], high-volume production late 2024 to 2025. Approximately $15B to $20B per fab before tools
3c	Matter: grid equipment	0.10 to 0.20	US power transformer lead times averaged 128 weeks [19] in Wood Mackenzie's Q2 2025 survey and generator step-up units 144 weeks; by 2026 substation transformer lead times had stretched past 160 weeks, from roughly 140 in 2023. Roughly 80% of large US power transformers are imported, and prices are up about 80% since 2019. Switchgear effectively sold out through 2028. GE Vernova [20] turbine backlog 100 GW in Q1 2026, roughly 10 GW of slots left across 2029 to 2030
3d	Matter: interconnected capacity	0.15 to 0.25	**LBNL [14] median interconnection request to commercial operation [14] exceeded 5 years for projects built in 2025**; approximately 2,061 GW [14] in active queues, down 10% year over year. Northern Virginia [14] approximately 7 years. Installed AI data-center power capacity reached approximately 29.6 GW [3, 54] by Q4 2025, of which approximately 11.8 GW is chip thermal design power, implying a facility multiplier near 2.5 (Epoch [5, 3] via AI Index [54] 2026)
4	Law and Legitimacy	step function	**EU AI Act high-risk obligations deferred by the Digital Omnibus [58] [58], Council approval 29 June 2026, to 2 December 2027 (Annex III) and 2 August 2028 (Annex I); Article 50 transparency still applies 2 August 2026.** Product Liability Directive [59] transposition fixed 9 December 2026 [59]. No US federal AI statute; EO 14365 [60] of 11 December 2025 directs preemption litigation. 109 state AI laws [61] and 28 data-center laws enacted in H1 2026. Maine [61] positioned as first state data-center moratorium, to November 2027
5	Capital	0.36	Hyperscaler 2026 guidance approximately $690B [28] to $725B [28]. Global AI-related debt issuance forecast near $570B for 2026, approximately $236B [28] priced by 31 May. **Morgan Stanley [27]'s $1.5T [27] is a funding gap to 2028, not a debt requirement**; the corresponding corporate debt issuance estimate is approximately $200B

Energy is decomposed, not deleted. The old Energy row conflated three constraints at three tiers: the thermodynamic floor on joules per operation, which has two to six orders of magnitude of headroom; the industrial stock of transformers, turbines and transmission; and the permitting regime. Delivered electricity is an output of Matter and Law, floored by Thermodynamics. Every verdict below that previously read "eliminated by Energy" is re-attributed, and in every case the answer is Matter 3c or 3d, not physics.

Time is removed and its content re-homed. Time has no independent permitted quantity. What the old Time row measured, adoption friction and agent reliability, splits in two. Adoption friction is Absorption, Tier 1, and belongs in the constraint set. Agent reliability is a state variable, not a constraint, and eliminations that rested on it are relabelled as empirical rather than constraint-based. That relabelling is honest and it costs the memorandum two verdicts' worth of apparent rigour, recovered by stating what they actually are.

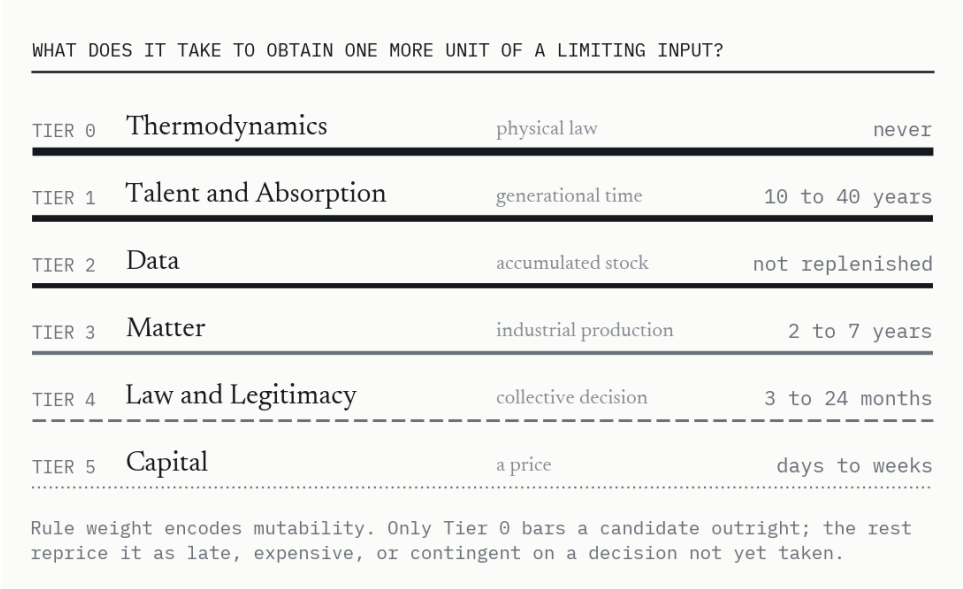

Figure 4: The six constraints, derived from replenishment mechanism rather than from subject matter. Rule weight encodes mutability: only Tier 0 bars a candidate outright, and everything below it reprices rather than eliminates. The tier ordering falls out of the derivation rather than being asserted beside it.

Talent and Absorption is added. R2 below is the proof of why it belongs: that verdict concludes, correctly, that the bottleneck is organizational rather than technical, and a constraint set without Absorption would identify the finding and have nowhere to record it.

Cooling, water and latency are domain constraints, invoked by name when a question enters their domain. A list of nine is a checklist; a list of six is a method.

1.3 What the engine can decide, and what nothing can

The slack ratio converts a shortfall into a time requirement, $T_{\text{req}} = \ln g / \ln(1 + r_c)$, and a survival likelihood. It is the engine that generates the probabilities in this document, and it decides **eight of the thirty questions here.**

That ratio is the memorandum's second finding, and it is stated as a finding rather than conceded as a limitation. The engine requires two things: a candidate whose requirement expresses as an expansion factor g over a permitted quantity, and a constraint with an observable expansion rate r_c. Both exist for **forward capacity questions**, and neither exists for **structural questions** (does control concentrate, do models commoditize, who bears liability) or for **current-state questions** (are cash flows sufficient today, are agents reliable today).

So the engine is not a machine for answering every question about the AI economy. **It is a test for which questions have physically determinate answers at all.** Applied to the thirty here, it says: eight are settled by what the world can physically deliver, and twenty-two are not. The eight are where forecasting can be done to a standard. The twenty-two are where it cannot, and where the field's confident disagreement is therefore evidence about the forecasters rather than about the world.

Figure 5: Where the engine applies. It needs a candidate whose requirement expresses as an expansion factor and a constraint with an observable rate. Both exist for forward capacity questions and for neither of the other two classes. **The split is a result, not a caveat.**

This is the uncomfortable implication, and it applies to this document first. Anyone answering all thirty with uniform confidence is not drawing on more information. They are applying less discipline. Twenty-two of the verdicts below are disciplined judgment, they are labelled as such at the point of use, and they carry the declared confidence coefficients of Section 1.4 rather than borrowed authority from the eight that are computed.

A harder audit than the computed/judged split, and it costs one of the eight. Asking whether the engine *applies* is weaker than asking whether it *changes anything*. Measuring each verdict's posterior against its own prior gives a third number: how far the arithmetic actually moved the answer.

Table 5: The eight computed verdicts. Monte Carlo, 20,000 draws over the stated g and r ranges.

	Verdicts	Mean shift from prior
Engine contribution substantive	14	0.28
Engine contribution decorative	**8**	**0.06**
No engine, labelled as such	8	not applicable

On eight verdicts the engine moves the answer by less than 0.12 and is not earning its place. Q8 moves by 0.01. **Q25 is among them while remaining in the computed set, and both labels are correct.** Computed describes the inputs: its slack ratios are sourced. Decorative describes the output: the candidate set is lopsided enough that the arithmetic does not discriminate. Those are independent properties and collapsing them would destroy information rather than add precision. Q14 moves by 0.07, and Q14 is the data-wall verdict on the tier carrying this framework's recorded miss.

For those eight the honest reading is that **the stated probability is substantially a prior wearing arithmetic**, and a number that looks computed while being judgment is worse than judgment stated plainly. They are flagged in the repository with `engine_verdict: DECORATIVE` and the shift recorded, so the claim is checkable rather than asserted. The remedy is to source their slack ratios properly or to drop the engine for them, and that is v2 work rather than a relabelling.

The 0.12 threshold is a judgment and is stated as one. Nothing distinguishes 0.11 from 0.13. What the threshold is doing is separating verdicts where the arithmetic discriminates from verdicts where it decorates, and the exact cut matters less than the fact that eight fall clearly on the wrong side.

The classification is falsifiable, and it should be attacked there. If someone produces a computable formulation of a question filed here as structural, with a stated expansion factor and a sourced rate, the classification is wrong and the verdict moves. That has already happened once: Q13 was filed as constraint-eliminated and moved to eliminated-by-observation when the evidence showed firms were in fact borrowing. **The register carries a prediction that puts the split at risk: the eight computed verdicts should resolve with materially lower variance than the twenty-two judged ones.** If they do not, the distinction this section draws is decorative and should be withdrawn.

A note on lineage, since an earlier version of this work promised more. The first form of this framework was a classification battery: tag each of a hundred questions with which constraint binds it. That instrument runs on any question, which is precisely why it decides none of them. The present engine computes, and computing costs breadth. **Thirty questions with eight decided is a stronger document than a hundred questions with none**, and the trade is what produced the finding above.

1.4 The price of intelligence, and the ratio that could not be built

The ratio as originally defined, retained so the withdrawal is legible.

$$R(t) = C(t)/I(t), \qquad C(2020) = I(2020) = 1.00$$

$I(t)$ was to be the price of a held unit of capability and $C(t)$ a basket of four physical complements weighted 30 percent power, 30 percent high-bandwidth memory, 20 percent packaging and 20 percent accelerator. **Neither term is constructible as specified.** The 2020 base does not exist, because the GPT-3 API had no per-token list price; and none of the four complement components is disclosed. What follows is the withdrawal and what replaces it.

The Residual Ratio is withdrawn as a measured quantity. It is replaced by a comparison of rates, which is fully sourced and needs no index of complements at all.

Building the underlying series from primary data rather than reconstruction established three things, and the first two correct errors in opposite directions.

The frontier price of intelligence is not flat. An earlier version of this section claimed it fell at roughly 1.05x per year, essentially flat, and built an argument on that. Measured against Epoch [5, 3] AI's compiled provider list prices, it falls at **2.25x per year** when reasoning models are excluded, from $60.00 to $4.38 between November 2021 and August 2024, and at **1.34x per year** when o1-class models are allowed to set the frontier and push price back up. The published figure was wrong by between 27 and 114 percent, and which variant is correct turns entirely on whether reasoning models count as frontier.

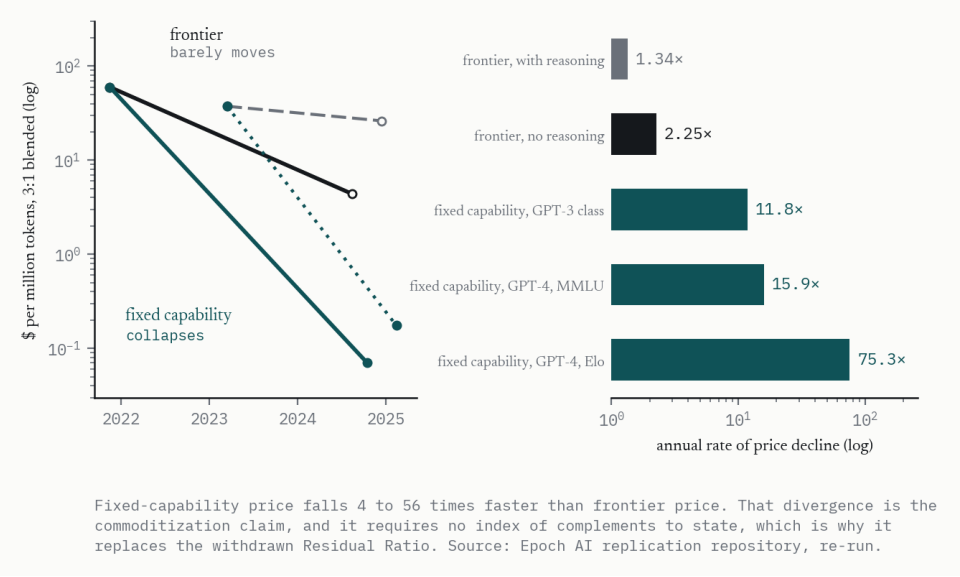

Figure 6: What the corrected series show. Frontier price falls at 1.34 to 2.25x per year depending on whether reasoning models are allowed to set the frontier. The price of a fixed capability falls at 11.8 to 75.3x. The divergence between them is the commoditization claim, and unlike the withdrawn ratio it requires no index of complements. Computed from Epoch [5, 3] AI's replication repository, cloned and re-run.

Fixed-capability price falls an order of magnitude faster than this memorandum assumed. The assumption was 3.5 to 6x per year. The disclosed floor is 9.2x, GPT-3-class capability falls **857-fold in total at 11.8x per year with** $R^2 = 0.96$, and GPT-4-class falls between 15.9x and 75.3x per year depending on the benchmark used to define the level.

Table 6: The Capture Ratio. Value created against value captured, from US consumer surplus and attributable revenue.

Series	Window	Path	Total	Annualized
Frontier, reasoning models excluded	Nov 2021 to Aug 2024	$60.00 to $4.38	13.7x	**2.25x/yr**
Frontier, reasoning models included	Mar 2023 to Dec 2024	$37.50 to $26.25	1.43x	**1.34x/yr**
Fixed capability, GPT-3 class	Nov 2021 to Oct 2024	$60.00 to $0.07	**857x**	**11.8x/yr**
Fixed capability, GPT-4 class	Mar 2023 onward	$37.50 to $0.07–0.18	214–536x	15.9–75.3x/yr

The mechanism survives, and the corrected numbers support it more strongly than the wrong ones did. Correcting the frontier upward costs little because correcting fixed capability upward gains far more. **Fixed-capability price falls between 4 and 56 times faster than frontier price**, and that divergence is the entire content of the commoditization claim. What has collapsed is the price of any given capability; what has not is the price of the best available.

Three defects would have corrupted the ratio regardless of the data. The numerator was specified in dollars per million *output* tokens while the only rigorous fixed-capability source uses a 3:1 blend of input and output prices, so the two series were in different units and their quotient imported the drift in the input-output spread as if it were signal. Reasoning models were included in the frontier definition and explicitly excluded from the fixed-capability source, which is precisely the difference between the 1.34x and 2.25x readings. And **"fixed capability" is not fixed**: the same capability level over the same window falls at 15.9x per year measured on MMLU and 75.3x measured on LMSys Elo, a 4.7-fold disagreement with no principled way to choose.

The 2020 base does not exist. The GPT-3 API had no per-token list price at launch. Pricing announced in September 2020 was a subscription with overage, $100 per month for 2M tokens plus $0.08 per additional thousand, with no input-output distinction and a marginal rate that depended on tier. The first observation in the compiled series is November 2021. No series here can be indexed to 2020, and the previously published one was.

1.5 Complement value capture is not measurable, and three attempts is the finding

The ratio required a numerator measuring value captured by the complements. Three independent attempts to build one failed for three unrelated reasons. **When instruments fail for the same reason you fix the instrument; when three fail for three different reasons, the construct is the problem.**

Attempt one, a four-component price index. Zero percent of it is constructible to a base year. Advanced packaging and accelerator ASP are unsourceable by construction, since TSMC does not break out CoWoS [23] and NVIDIA discloses data-centre revenue but not units. No published series for the delivered price of a data-centre megawatt exists at all. And no vendor discloses HBM [23] average selling price: the obvious proxy inverts the sign, because HBM [23] sells on long-term agreements with prices locked in advance, so during the 2026 memory surge HBM contract pricing held blended DRAM ASP *below* spot while conventional DRAM spot rose sharply.

Attempt two, memory as a share of AI chip component cost. The series is real and strong on its face, rising from 51.9 to 63.4 percent between Q1 2024 and Q4 2025 at $R^2 = 0.935$. **It fails because it confounds quantity with price.** HBM content per accelerator rose roughly 2.4-fold over exactly that window, from 80GB on H100 to 288GB on GB300, while the memory-to-non-memory cost ratio rose only 1.61-fold. Price per gigabyte was therefore flat or falling: HBM3 at roughly $200 per 24GB stack and HBM3E at roughly $300 per 36GB both work out near $8.30 per gigabyte. Memory's cost share had to rise with zero additional rent extraction. The denominator also excludes the value: component cost is roughly $6,400 on a part selling in the tens of thousands, so the majority of capture sits in the designer's margin, which the series omits.

Attempt three, PJM capacity auction clearing prices. Prices rose from $28.92 per MW-day for 2024/25 to $269.92 for 2025/26, an 833 percent jump and the largest single-year rise in the market's history, then $329.17, $333.44 and $325.00. **It fails because three of the five points sit at an administered ceiling.** A price at its cap is not a market price and no trend can be fitted to it. Worse, the cap is calibrated to the net cost of new entry, so a price sitting at it reports approximately what new generation costs to build, which is a cost rather than a surplus. Capacity charges are also paid by all load at a common rate, so nothing in the series is specific to AI.

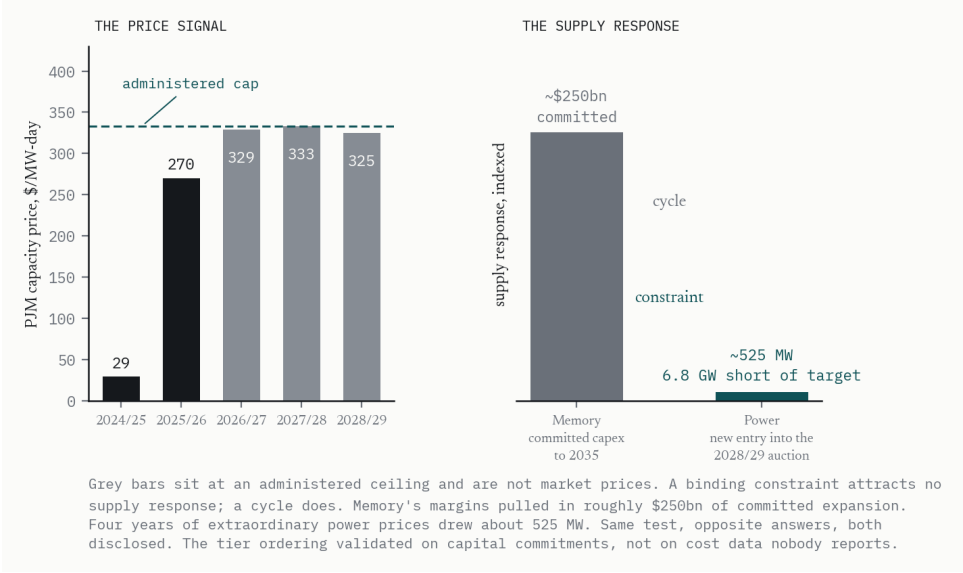

Figure 7: The tier ordering, validated on capital commitments. A binding constraint attracts no supply response; a cycle does. Memory's margins pulled in roughly $250bn of committed expansion. Four years of extraordinary power prices drew about 525 MW into the 2028/29 auction, 6.8 GW short of target. Grey bars sit at an administered cap and are not market prices. Same test, opposite answers, both from disclosed sources.

Why the construct fails rather than the instruments. Value capture means rent, and rent means price minus cost. **Cost is undisclosed at every layer of this stack**: HBM manufacturing cost, packaging cost, incumbent generators' avoidable cost, and the labs' cost of serving inference. The denominator of a rent calculation does not exist anywhere in the public record. Three attempts hit the same wall wearing three different faces.

This memorandum therefore reports the negative result rather than a fourth candidate. **Complement value capture is not currently measurable from public sources.** That is a via negativa finding about the field's own evidence base, arrived at by the method the paper uses on everything else, and it is a more useful contribution than another reconstructed index would have been.

1.6 The supply-response test, which does work

If capture cannot be measured, the question can be asked a different way. **A constraint that binds does not attract a supply response; a cycle does.** That is testable on disclosed capital commitments rather than on undisclosed costs, and it is the empirical form of the tier ordering in Table 1.

Memory is responding. Micron has committed approximately $250bn through 2035 and SK hynix is expanding aggressively. High margins are pulling in capital, which is the signature of a cycle, and memory has run this pattern repeatedly since the 1980s. On the framework's own terms this is Tier 5 behaviour: capital converts into capacity, so the constraint relaxes.

Power is not responding. The 2028/29 PJM capacity auction attracted approximately 525 MW of new resources, fell 6.8 GW short of the reserve margin target, and cleared with the reserve margin down to 14.7 percent. **Four consecutive years of extraordinary prices have induced almost no new supply.** On the framework's own terms this is Tier 3 behaviour: capital does not convert into capacity inside the horizon, so the constraint holds.

Same test, opposite answers, both from disclosed sources. **This is the first empirical validation of the tier ordering itself**, and it is stronger evidence for the memorandum's central structure than a price ratio would have been, because it tests the mechanism the framework actually claims rather than a correlate of it.

It also carries a falsification condition, stated in advance and tracked as signpost S20: **if PJM or an equivalent market clears a subsequent auction with a substantial new-entry response at or below the cap, the Tier 3 classification of delivered power is wrong** and the memorandum should say so.

1.7 What is disclosed, reported separately and never combined

Three series are real, sourced on both sides, and are deliberately not divided into one another.

NVIDIA gross margin, from 10-K filings. 62.0, 62.3, 64.9, 56.9, 72.7, 75.0 and **71.07 percent** across FY2020 to FY2026. FY2023 was depressed by $2.17bn of inventory provisions. **The FY2026 decline is published here as a counter-signal**, because it is consistent with rising memory input costs compressing the designer's margin, which is the opposite of what a simple complement-capture story predicts for the accelerator layer.

SK hynix DRAM share of total revenue, from its 2026 SEC Form F-1: 63.4 percent in 2023, 67.6 in 2024, 77.1 in 2025, on revenues of ₩32.8, ₩66.2 and ₩97.1 trillion. The largest HBM supplier now files audited US-registered financials, which is a materially better evidence base than existed when this memorandum was first drafted.

SK hynix HBM share of DRAM revenue: 30 percent in Q3 2024, above 40 percent in Q4 2024, after which the company stopped publishing the figure. Two points from one year, recorded as a footnote rather than a series.

1.8 The Capture Ratio

R answers where captured value goes. It is silent on how much value is captured at all, and the second question turns out to have a more surprising answer. Define

$$K(t) = \frac{\text{value captured by producers}}{\text{value created}}$$

with the numerator taken as attributable AI revenue and the denominator as that revenue plus measured consumer surplus. Using the longitudinal willingness-to-accept estimates of Brynjolfsson [52] et al. (2026), US consumer surplus from generative AI rose from approximately $112B [52] to approximately $172B [52] annually between 2025 and early 2026, with the median value per user tripling from $3.40 to $11.40.

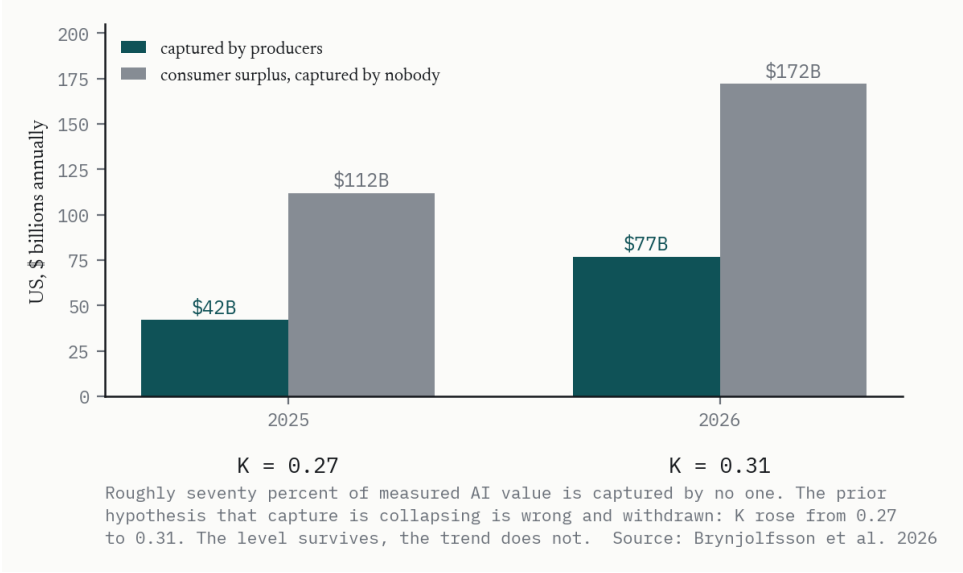

Figure 8: Value created against value captured. Roughly seventy percent of measured AI value accrues to users as surplus on goods priced at or near zero. The prior hypothesis that capture is collapsing is wrong and withdrawn: K rose from 0.27 to 0.31. The level survives; the trend does not.

Table 7: Table A. Published forecasts of AI's output contribution against the Tier 3 constraint, as a function of the elasticity α. Cells give σ, permitted over required; a forecast survives at $\sigma \geq 1$.

Year	Created	Captured	K
2025	~$154B	~$42B	**0.27**
2026	~$249B	~$77B	**0.31**

Roughly seventy percent of measured AI value is captured by no one. It accrues to users as surplus on goods priced at or near zero. The absolute uncaptured amount grew from approximately $70B to approximately $95B in a single year, and because the surplus figure covers US consumers only and excludes enterprise surplus entirely, the true capture ratio is lower than stated.

One sourcing note that must travel with this number. Attributable AI revenue, the numerator, is built from three points covering NVIDIA data-centre segment revenue alone, one of them unverified, with OpenAI and Anthropic run-rates reported rather than filed. K is therefore a far weaker measurement than the consumer-surplus figure that anchors its denominator, and the two should not be quoted with equal confidence. The level is indicative; the second decimal is not real.

Two honest notes. The prior hypothesis behind this measure was that K is falling, that competition and open weights compete surplus away faster than any layer can capture it. **That hypothesis is wrong and is withdrawn: K rose from 0.27 to 0.31.** What survives is the level, not the trend. And the level reframes the question this memorandum is built around: if $K \approx 0.3$ and $R \approx 990$, the investment debate the field is conducting concerns the allocation of roughly thirty cents on the dollar of value created.

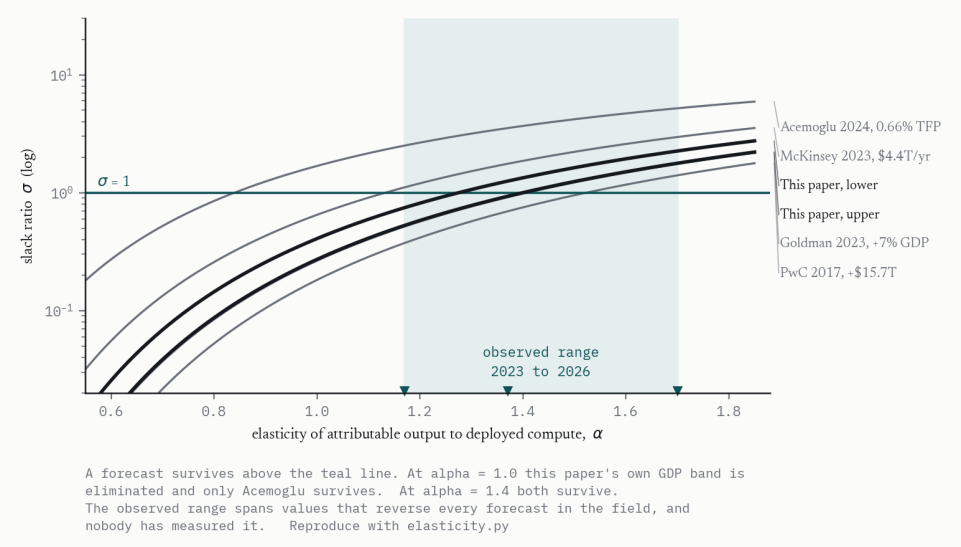

Figure 9: Every published forecast of AI's output contribution, run through the constraint engine, as a function of the unmeasured elasticity. At $\alpha = 1.0$ this memorandum's own band is eliminated and only Acemoglu [37] survives; at $\alpha = 1.4$ both survive. The shaded band is the range actually observed from 2023 to 2026. Reproduce with `elasticity.py`.

Falsification condition for the law. The law is abandoned if, across two consecutive annual measurements, the complement basket and the intelligence index move in the same direction with the intelligence index falling less than 20 percent; or if in any measured year a named complement's share of AI-stack gross profit falls while intelligence's share rises.

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2 The Elasticity Gap

The method has so far been used to answer questions. It can also be used on the answers, and turning it on the published forecasts of this field produces the memorandum's most consequential result. It is presented before any verdict because it bounds what every verdict that follows can claim.

2.1 The parameter nobody names

Every forecast of AI's contribution to output implicitly assumes a relationship between deployed compute and attributable output. Define it:

$$O = k \cdot C^{\alpha}$$

where O is AI-attributable output, C is deployed AI compute, and α is the elasticity of the first with respect to the second. At $\alpha = 1$ output scales proportionally with compute. Below one, each additional gigawatt yields less than the last. Above one, deployed compute yields increasing returns, as it would if models trained once serve many users, if software distributes at near-zero marginal cost [30], or if value accrues through channels that consume little marginal inference.

No published forecast of the AI economy states its α. None reports it, none defends it, and it has never been measured. Yet every such forecast is a bet on its value, because the forecast asserts an output figure and the constraint set permits a quantity of compute, and only α connects them.

2.2 Every major forecast, run through the engine

Anchoring on 2026 at approximately $110B [28] of attributable output on 29.6 GW [3, 54] of AI data-center capacity, taking the permitted incremental capacity to 2030 as approximately 200 GW [29], and applying the standard efficiency correction of roughly 40 percent per year [3], the slack ratio for each published forecast is a function of α alone.

Table A. Published forecasts against the Tier 3 constraint, by elasticity. Cells give σ, permitted over required. A candidate survives at $\sigma \geq 1$.

Table 8: Observed values of the elasticity α, from attributable output against deployed capacity.

Forecast	α=0.5	0.7	1.0	1.2	1.4	1.7
PwC [41] 2017, +$15.7T [41] by 2030	0.00	0.02	0.18	0.42	0.75	**1.40**
Goldman [38] 2023, +7% global GDP [38]	0.00	0.04	0.26	0.57	0.98	**1.75**
McKinsey [40] 2023, $4.4T annual [40]	0.02	0.13	0.65	**1.20**	**1.86**	**2.96**
This memorandum, upper $10.5T	0.00	0.04	**0.27**	0.58	**1.00**	**1.78**
This memorandum, lower $7.0T	0.01	0.07	0.41	0.82	**1.34**	**2.26**
Acemoglu [37] 2024, 0.66% TFP over 10 [37] yr (adjusted: under 0.53%)	0.11	0.52	**1.69**	**2.66**	**3.68**	**5.20**

The observed values of α, computed from the attributable-output and capacity series, are unstable and sit in the increasing-returns region:

Table 9: Every major forecast, run through the engine.

Period	Output	Capacity	Implied α
2023 to 2024	5.00x	2.57x	**1.70**
2024 to 2025	2.40x	2.11x	**1.17**
2025 to 2026	1.83x	1.56x	**1.37**

2.3 What the table says

At $\alpha = 1.0$, this memorandum's own GDP band is eliminated. Both bounds fail, at $\sigma = 0.27$ and $\sigma = 0.41$, alongside Goldman [38] and PwC [41]. The single survivor is Acemoglu, the most conservative published estimate in the field. Applied at constant returns, the method contradicts the document that houses it, and the finding is reported here rather than buried because a method that is only run where it flatters its author is not a method.

At $\alpha = 1.4$, the midpoint of the observed range, this memorandum survives and so does Goldman. At $\alpha = 1.7$, the value observed across 2023 to 2024, even PwC survives.

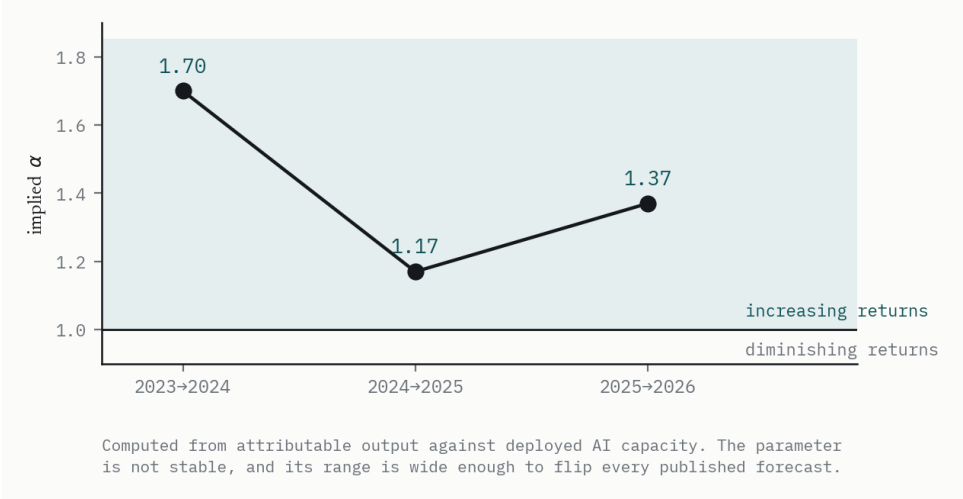


Figure 10: The elasticity is not a stable parameter. Computed from attributable output against deployed AI capacity, it ran 1.70, then 1.17, then 1.37. That range is wide enough to reverse every forecast in Table A, and no participant in the debate reports it.

Therefore the central quantitative dispute in this field is a disagreement about α that no participant has named. PwC's $15.7T [41] is a bet that $\alpha \geq 1.7$. Goldman's 7 percent is a bet on approximately 1.4. Acemoglu's 0.66 percent, or under 0.53 percent on his adjusted estimate, is a bet that $\alpha \leq 1.0$. The verdicts of this memorandum are a bet on roughly 1.3 to 1.4. None of these documents, including this one before this section, states the wager it is making.

The observed range spans values that reverse every forecast in Table A. That is not a narrow uncertainty around a central estimate. It is the difference between a technology that adds one percent of output and one that adds ten.

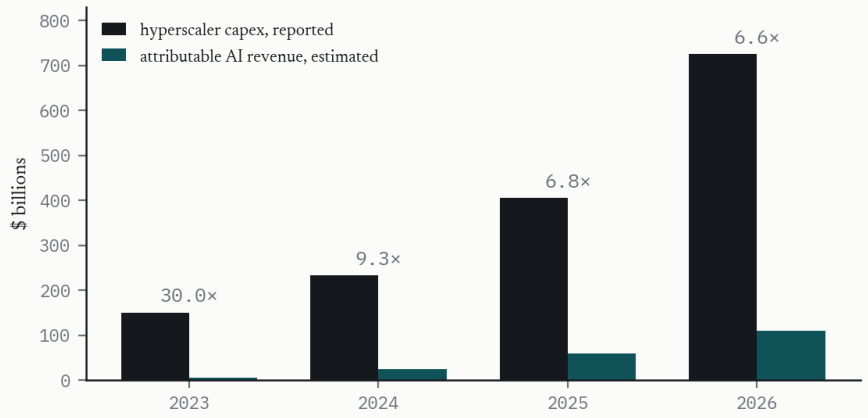
2.4 Consequences for the rest of this document

Three, and the first is a demotion.

Q1 is repriced and marked provisional. The GDP verdict cannot be resolved at the confidence a single-point analysis suggests, because its answer is a function of an unmeasured parameter whose observed values span the field. Section 4.1 reports the survivor across the observed range and labels the verdict α-dependent under the `nc` convention of Section 1.4. Its probability falls accordingly.

Every output-magnitude verdict inherits the same exposure. Q1, Q2, Q4 and Q10 are bets on α. Verdicts about physical delivery, lead times, market structure, liability and reliability are not, because they do not require the compute-to-output conversion. The exposure is therefore concentrated and is marked where it applies.

The measurement that would close the question is specified. What is needed is a panel of AI-attributable output against deployed compute at firm or sector level, with output measured as realized revenue plus estimated surplus rather than as capex. That series does not exist. Constructing it is the single most valuable unbuilt dataset in the economics of AI, and it would settle a dispute currently conducted entirely through unstated assumptions.



The ratio dates the lag, not the destination. It is a funding gap and not a debt requirement: reading the widely cited $1.5T as debt overstates the capital constraint roughly sevenfold, on the one constraint least likely to bind.

Figure 11: The capital-revenue gap, from filings. The ratio dates the lag rather than the destination. Note also that the widely cited $1.5T [27] is a funding gap and not a debt requirement; reading it otherwise overstates the capital constraint roughly sevenfold, on the one constraint least likely to bind.

2.5 Why this is reported rather than resolved

The temptation is to select the α that preserves the memorandum's own band and proceed. That would be the characteristic failure this framework was built to avoid, committed on the framework's own numbers: holding a parameter fixed at a convenient value while the evidence says it is unstable.

The alternative is to say what is true. The question of AI's aggregate output contribution is, on current public data, underdetermined. Every published answer to it is a bet on a quantity nobody has measured. **This memorandum does not add the forty-seventh forecast. It eliminates the claim that the question is currently answerable, and names what would answer it.** That is the method operating as designed, and the fact that it costs the author a headline number is the strongest available evidence that it does.

Reproduction code for Table A is published with this memorandum; see Appendix A.

3 The Five Roots

Five root uncertainties sit beneath the hundred questions, and every branch question inherits its verdict from one or more of them. Absorption at Tier 1 binds three of the five, which is the empirical discovery that put it in the constraint set.

3.1 R1. Will AI create more value than it destroys?

Candidates. (i) net destruction; (ii) frictionless broadly-shared abundance; (iii) net-positive but uneven and lagged; (iv) neutral reallocation of profit among firms; (v) net-positive in value but net-negative socially; (vi, taboo) a financing cascade destroys more capital than the technology creates.

Table 10: R1 test matrix: candidates against the constraint set. Will AI create more value than it destroys?

Candidate	Binding constraint	Tier	Verdict
(i) net destruction	Capital: every prior general-purpose technology delivered positive contribution once diffused	5	Repriced to ~0
(ii) frictionless abundance	**Absorption**: decade diffusion; ~5% of integrated pilots P&L-positive	**1**	Repriced to ~0
(iii) net-positive, lagged	none		**Survives**
(iv) neutral reallocation	Data: additive new categories exist	2	Repriced to ~0
(v) value positive, social negative	Law and Legitimacy: live if safety nets fail	4	Live tail
(vi, taboo) financing cascade	Capital: plausible tail, not central	5	Live tail

Computed. (i) requires the aggregate productivity contribution to be negative. Electricity and IT each added on the order of 1.5 percentage points per year at peak. Requires contribution below zero; permits above zero on all precedent. Sign-level gap. (ii) requires near-zero adoption lag. Requires diffusion under approximately 2 years; Absorption permits a decade at $r = 0.02$ to 0.05. $T_{\text{req}} \approx 5$ to 10 years against 2 required. **This is the verdict that most clearly needed Tier 1: it was previously attributed to "Time," which named the symptom rather than the constraint.** (vi) is not eliminated. Morgan Stanley [27]'s approximately $1.5T [27] is a funding gap through 2028 closable by bonds, private credit, asset-backed structures or equity, not a debt requirement; the corresponding corporate debt issuance estimate is approximately $200B, and 2026 hyperscaler borrowing is expected above $400B. **Reading that figure as a debt requirement, as most commentary does, overstates this constraint roughly sevenfold.** Read correctly, the cascade tail sits at 0.07.

Isolate. (iii) survives with (v) and (vi) as tails. A J-curve: destruction front-loads while creation lags. The capital gap dates the lag: approximately $725B [28] of 2026 capex against approximately $110B [28] of attributable revenue is a ~6.6x current gap, and ~18x against Bain [29]'s ~$2T maturity requirement.

Scenario. By 2027 the gap persists and (vi) risk is elevated but unrealized. By 2029 revenue narrows the gap. By 2030 net-positive value is realized unevenly. **Probability: (iii) ~0.73; (v) ~0.15; (vi) ~0.07.**

Bottom line. Net-positive, with a J-curve shape and a ~6.6x present capital gap that dates the lag rather than the destination. The binding constraint on the shape is Absorption at Tier 1, not capital.

3.2 R2. How fast do organizations become AI-native?

Candidates. (i) overnight, two to three years; (ii) never; (iii) a decade-long grind gated by trust, data, integration; (iv) bimodal; (v) already largely done; (vi, taboo) a disillusionment retreat.

Table 11: R2 test matrix: candidates against the constraint set. How fast do organizations become AI-native?

Candidate	Binding constraint	Tier	Verdict
(i) overnight	**Absorption**: ~5% of integrated pilots value-positive; Data: integration debt	**1**, 2	Repriced to ~0
(ii) never	Capital: ROI forces adoption; purchased tools succeed ~67%	5	Repriced to ~0
(iii) decade grind	none		**Survives**
(iv) bimodal	none		**Survives**

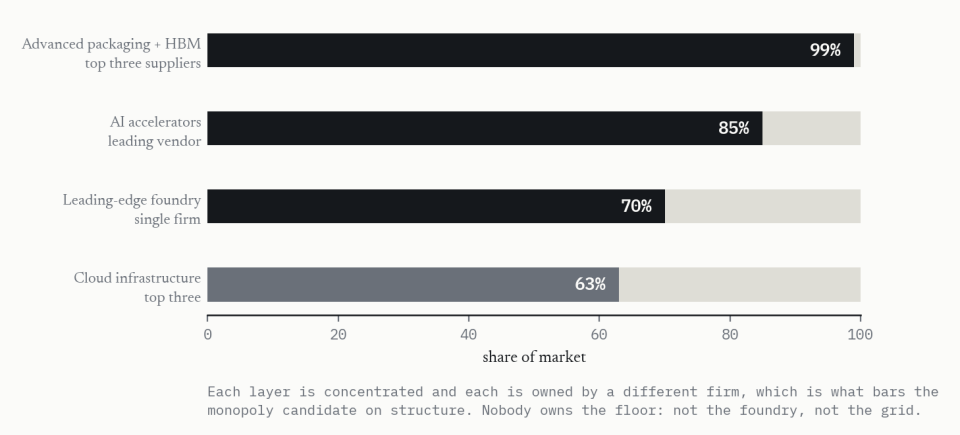


Figure 12: Concentration is real and split across layers. Each layer is concentrated and each is owned by a different firm, which is what bars the monopoly candidate on structure. Nobody owns the floor: not the foundry, not the grid.

Candidate	Binding constraint	Tier	Verdict
(v) already done	**Absorption**: only ~5% value-positive	**1**	Repriced to ~0
(vi, taboo) retreat	**Absorption**: live transient, not permanent	**1**	Live tail

Computed. (i) requires broad P&L-positive deployment now. Requires majority value-positive; permits approximately 5%. Gap approximately 20x on the success base. At $r_{\text{absorption}} = 0.02$ to 0.05, closing a 20x gap requires $T_{\text{req}} = \ln 20 / \ln 1.035 \approx 87$ years at the midpoint, which overstates the case because the gap is not purely a stock expansion; the honest reading is that Absorption cannot deliver a 20x improvement in integration success within the horizon by any observed mechanism. (ii) requires zero adoption despite returns; a shadow-AI economy across more than 90% of firms falsifies it.

Isolate. (iii) and (iv) survive together. **This verdict is the empirical discovery of the Absorption constraint.** The bottleneck here is organizational rather than technical, which is precisely what Tier 1 records. A constraint set without Absorption would reach this finding and have nowhere to put it.

Scenario. By 2027 a disillusionment trough coincides with rising capability. By 2029 the value-positive base widens. By 2030 AI-native is normal for entrants and a retrofit problem for incumbents. **Probability: (iii/iv) ~0.70; (vi) ~0.20.**

Bottom line. A decade-long uneven grind. The binding constraint is Absorption at Tier 1, and the 95%-no-return rate is the number that dates it.

3.3 R3. Who controls compute, energy, data, and models?

Candidates. (i) a single monopoly; (ii) full decentralization; (iii) a US-led oligopoly with a parallel Chinese stack; (iv) state seizure; (v) China overtakes; (vi, taboo) a packaging or foundry leapfrog.

Table 12: R3 test matrix: candidates against the constraint set. Who controls compute, energy, data, and models?

Candidate	Binding constraint	Tier	Verdict
(i) monopoly	Matter: control split across layers; Law: antitrust and export controls	3, 4	Repriced to ~0
(ii) decentralization	**Matter 3c/3d**: gigawatt-class delivered power; Capital: ~$725B/yr	**3**, 5	Repriced to ~0
(iii) US-led oligopoly plus walled China	none		**Survives**
(iv) state seizure	Capital: the state is not funding the buildout	5	Repriced to ~0
(v) China overtakes near-term	Matter 3b: ~5x lead widening toward ~17x, HBM-gated; **Talent**	3, **1**	Repriced to ~0
(vi, taboo) foundry leapfrog	Matter: live long tail	3	Live tail

Computed. (i) requires one actor to own accelerators, foundry, cloud, and models. Nvidia holds ~80-90% of data-center accelerators, TSMC ~70% of foundry, the top three clouds ~63%, and several labs hold frontier models. Barred on structure. (ii) requires distributed compute to match hyperscale training, needing gigawatt-class delivered power. **Re-attributed from Energy to Matter 3d:** the constraint is not physics but the interconnection queue, whose median exceeded 5 years for projects reaching commercial operation in 2025. (v) requires closing a ~5x chip-capability gap projected to widen toward ~17x by 2027. **Talent is now named as a co-constraint:** approximately 47% of top-tier researchers were trained in China and roughly 72% of them work in the United States, which is a Tier 1 asymmetry that no capital deployment reverses inside a decade.

The verdict is narrowed, and the reason is a measured decoupling. The elimination of near-term parity holds for *deployed compute*, not for *model capability*. US and Chinese models traded the lead repeatedly through 2025 and 2026, and as of March 2026 the leading US model led the leading Chinese model by approximately 2.7 percent [45, 54] on aggregate benchmark performance (AI Index 2026). A compute advantage of five to seventeen times has therefore not produced a proportional capability advantage. This is substitution defeating a stock argument at Tier 3, the same failure mode Section 15 documents at Tier 2, and it is conceded here rather than absorbed. What survives is that the compute gap constrains scale of training and deployment; what does not survive is any claim that it constrains frontier model quality.

Isolate. (iii) survives. Control is layered and US-led, with power as the deepest floor. **Probability: ~0.75. Computed: candidate (ii) requires 13.3 years of Matter 3d expansion against 4.4 available, repriced to 0.1% [0.0 to 0.4].**

Scenario. By 2027 the US compute lead widens even as the Chinese stack matures domestically. By 2029 delivered power, not chips, is the binding control variable. By 2030 control still sits with the layered oligopoly, gated by the grid.

Bottom line. A US-led oligopoly plus a walled Chinese stack. Concentration is real but split across layers, and the true chokepoint is grid equipment and interconnection at Tier 3, not physics and not capital.

3.4 R4. Can institutions adapt without stifling innovation?

Candidates. (i) a unified global regime; (ii) a durable regulatory vacuum; (iii) fragmented, lagging, sectoral governance; (iv) an innovation-killing clampdown; (v, taboo) a race to the bottom.

Table 13: R4 test matrix: candidates against the constraint set. Can institutions adapt without stifling innovation?

Candidate	Binding constraint	Tier	Verdict
(i) unified regime	Law: EU, US and China diverging; no treaty on the horizon	4	Repriced to ~0
(ii) vacuum	Law: EU Act binding, penalties to 7% of turnover	4	Repriced to ~0
(iii) fragmented, sectoral	none		**Survives**
(iv) clampdown	Capital: ceding the field forbidden by competition	5	Repriced to ~0
(v, taboo) arbitrage	Law: live texture	4	Live tail

Computed and updated. (i) requires convergence. **The timeline has moved and the movement is itself the evidence for Tier 4.** The EU AI Act's high-risk obligations, treated as fixed at 2 August 2026 for over a year, were deferred by the Digital Omnibus [58] [58] to 2 December 2027 for Annex III systems and 2 August 2028 for Annex I, with final Council approval on 29 June 2026. Article 50 transparency obligations still apply from 2 August 2026, and Product Liability Directive transposition remains fixed at 9 December 2026 [59]. Meanwhile the United States has no federal statute, Executive Order 14365 [60] of 11 December 2025 directs an AI Litigation Task Force against state law, and states enacted 109 AI laws and 28 data-center laws in the first half of 2026 alone. **A flagship compliance deadline moved sixteen months in seven months of legislative process. No Tier 3 constraint can move like that and no Tier 0 constraint can move at all.**

Isolate. (iii) survives with (v) as live texture. **Probability: ~0.78.** The Omnibus is direct confirmation of the fragmentation verdict.

Scenario. By 2026 Article 50 transparency binds while the high-risk regime does not. By 2027 the US still has no federal statute and the preemption litigation is unresolved. By 2029 the deferred Annex III duties are in force and sectoral divergence is the standing risk.

Bottom line. Fragmented, lagging, sectoral governance. The operative risk is divergence and arbitrage, not stringency, and the 2026 deferral is the cleanest available demonstration that law occupies its own tier.

3.5 R5. What are the real limits of intelligence, and how close are we?

Candidates. (i) imminent unlimited AGI from scale; (ii) a permanent plateau; (iii) continued rise via test-time and post-training compute [46]; (iv) a discontinuous architectural jump; (v, taboo) a jagged plateau, benchmarks climb while deployment reliability stalls.

Table 14: R5 test matrix: candidates against the constraint set. What are the real limits of intelligence, and how close are we?

Candidate	Binding constraint	Tier	Verdict
(i) scale to AGI soon	**Matter 3b and 3c**: another 100x of compute and power; Capital	**3**, 5	Repriced to ~0
(ii) permanent plateau	empirical: capability still rising via test-time compute	state	Repriced to ~0
(iii) rise via new axes	none		**Survives**

Candidate	Binding constraint	Tier	Verdict
(iv) architecture jump	unforecastable		Live tail
(v, taboo) jagged plateau	none		**Live and strengthening**

Computed. (i) previously rested substantially on the data wall at Tier 2. **That attribution is withdrawn.** Section 15 documents the framework predicting, at maximum confidence, that the public-text wall would bind by 2026, and being wrong: Epoch's own median moved from 2024 to 2028, and multimodal and verified synthetic sources substituted. With r_{data} revised to 0.30 to 0.60, Data no longer eliminates (i). The elimination survives on Matter and Capital: another 100x of training compute requires fab and grid expansion that Tier 3 cannot deliver on the horizon at $r = 0.15$ to 0.25.

(v) has strengthened materially and is now the near-term texture rather than a tail. METR [9]'s 50 percent horizon [10] rose several-fold through 2025 and 2026, while the 80 percent horizon [9] has been approximately flat: Claude Opus 4.5 [9] measured approximately 27 minutes in December 2025, and the series had been flat at 27 to 32 minutes [9] across the preceding frontier releases. **The ratio between the 50 and 80 percent horizon [9]s has widened from approximately 5x to somewhere between 10x and 25x.** Capability gains are arriving as intercept rather than slope: models succeed more often on long tasks without succeeding more reliably. This is the jagged plateau, measured.

Isolate. (iii) survives, with (iv) a live tail and (v) the near-term texture. **Probability: (iii) ~0.65; (v) as near-term reality ~0.30.**

Scenario. By 2027 the 50 percent horizon [10] extrapolates toward month-long tasks while the 80 percent horizon [9] remains in hours. By 2028 pre-training saturates against fabrication and power rather than tokens. By 2029 test-time compute is the dominant lever.

Bottom line. Capability keeps rising via test-time and post-training compute [46]. The pre-training data wall is no longer load-bearing in this verdict, and the elimination of scale-to-AGI rests on fabrication and grid, not on tokens. Reliable long-horizon autonomy remains years out, and the widening gap between the 50 and 80 percent horizons is now the strongest single datum in the memorandum.

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4 Domain I. Economic Transformation

AI adds roughly 1.0 to 1.5 percentage points of annual growth, not a majority of GDP: the majority claim fails by about ninefold. Realized gains run at 0.1 to 0.2 [38] points against a 1.5 point [62, 38] electricity precedent. The binding constraint is organizational absorption, which relaxes on a twenty to forty year clock.

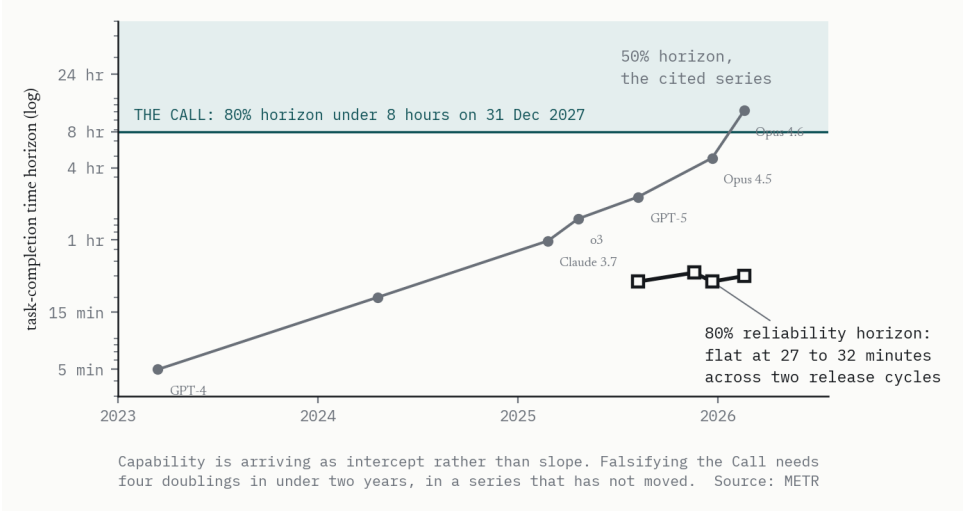

Figure 13: The divergence that carries this memorandum. The widely cited 50 percent horizon [10] has risen several-fold. The 80 percent horizon [9], the level at which work can actually be delegated, has been approximately flat at 27 to 32 minutes [9] across two frontier release cycles. Capability is arriving as intercept rather than slope. Source: METR [9].

4.1 Q1. How much of global GDP [38] will AI create?

Candidates. (i) most of GDP, above 50%; (ii) transformative, 10 to 25%; (iii) material, single-digit percent, compounding; (iv) negligible; (v, taboo) negative in a correction window.

Table 15: Q1 test matrix: candidates against the constraint set. How much of global GDP will AI create?

Candidate	Binding constraint	Tier	Verdict
(i) most of GDP	Capital: needs ~$60T+ new output; **Matter 3b/3c/3d**; **Absorption**	5, **3**, **1**	Repriced to ~0
(ii) transformative 10-25%	Capital: exceeds the most bullish credible estimate; **Absorption**	5, **1**	Repriced to ~0
(iii) material single-digit	none		**Survives**
(iv) negligible	Capital: savings already measurable	5	Repriced to ~0
(v, taboo) negative	Capital: possible in a correction window	5	Live tail

Computed. (i) requires AI-attributable output above 50% of a ~$154T [42] 2030 economy, roughly $77T of new output in about four years. The most bullish credible estimate is PwC's $15.7T [41] cumulative by 2030. Requires ~$77T; permits ~$16T. **Gap ~9x, close to one order of magnitude.** An earlier draft cited ~1.5 orders of magnitude; the honest figure computed from the same numbers is ~0.94, and the smaller correct figure is used here. The Data leg of this elimination is withdrawn per Section 15; the elimination holds comfortably on Capital and Matter without it.

Isolate. (iii) survives. The band is 1.0 to 1.5 percentage points per year of GDP growth, squarely within the electricity and IT precedents, roughly $7 to $10.5T cumulative by 2030.

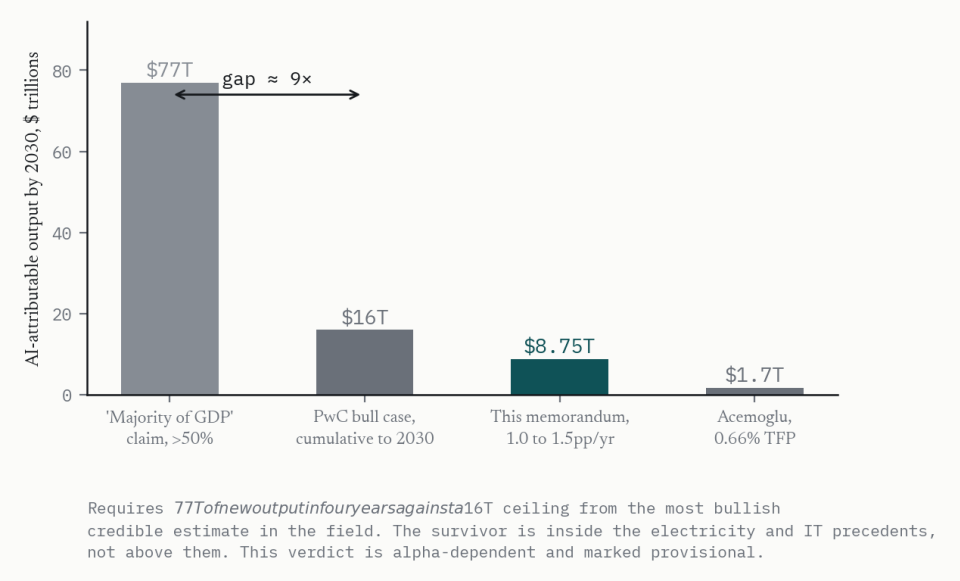

Figure 14: The majority-of-GDP claim against the feasible band. It requires $77T of new output in four years against a $16T ceiling from the most bullish credible estimate in the field. The survivor sits inside the electricity and information-technology precedents rather than above them.

The verdict is α-dependent and is marked provisional. Section 2 shows this question cannot be resolved at single-point confidence: at $\alpha = 1.0$ the survivor band is itself eliminated, at $\alpha = 1.4$ it survives, and the observed range spans both. The probability below is stated at the observed midpoint and carries the elasticity exposure explicitly.

Scope limitation. This verdict forecasts *measured* GDP. Value delivered as consumer surplus on goods priced at zero is outside that quantity by construction, and Section 1.4 puts US consumer surplus at approximately $172B [52] annually and growing at 54 percent. A reader concluding that AI creates little value from a modest GDP verdict has misread it: the verdict is about capture and measurement, not about welfare.

Scenario. By 2027 realized contribution stays near ~0.1 to 0.2 [38]pp. By 2029 diffusion lifts it toward ~1pp. **Probability: (iii) ~0.53 at $\alpha \approx 1.35$, provisional, $c = 0.45$; (i) ~0.19 [computed, p10-p90 7.1 to 31.6]; ~0.12 lower-realization; ~0.07 transient-negative. Under $\alpha = 1.0$ the survivor is repriced below 0.30 and the verdict is not resolved.** The engine of Section 1.2a does not reprice the majority-of-GDP candidate to zero, and a purely qualitative reading would.

Bottom line. Material but not civilizational: ~1.0 to 1.5 percentage points of annual GDP growth, ~$7 to $10.5T cumulative by 2030. The majority-of-GDP claim is repriced to near zero at Tier 5 and Tier 3 by ~9x.

4.2 Q2. Will AI raise productivity as much as electricity or the internet?

Candidates. (i) an instant surge; (ii) no measurable gain; (iii) electricity-scale magnitude on an electricity-length timeline; (iv) internet-scale and faster; (v, taboo) a net-negative drag during reorganization.

Table 16: Q2 test matrix: candidates against the constraint set. Will AI raise productivity as much as electricity or the internet?

Candidate	Binding constraint	Tier	Verdict
(i) instant surge	**Absorption**: realized gain ~0.1-0.2pp against a ~1.5pp peak precedent	**1**	Repriced to ~0
(ii) no gain	Data: delivered gains exist where measurable	2	Repriced to ~0
(iii) electricity-scale, electricity-slow	none		**Survives**
(iv) internet-speed	**Absorption** and Matter: physical and organizational deployment gates it	**1**, 3	Repriced to ~0
(v, taboo) transition drag	**Absorption**: live transient	**1**	Live tail

Computed. (i) requires realized gains now. Requires ~1.5pp; permits ~0.1 to 0.2pp. Gap ~10x. (iv) requires software-style distribution, but the binding constraint is deployment, and the precedent is a two-to-four-decade adoption lag: electric motors [62] were under 5% of factory mechanical drive in 1900 with gains arriving in the 1920s.

The strongest contrary datum, stated. US labor productivity growth reached 2.7 percent [45, 54] in 2025, nearly double the 1.4 percent average of the preceding decade, which Brynjolfsson [52] (2026) reads as the early phase of a J-curve (AI Index 2026). If that is AI-attributable and sustained, this verdict is wrong. Three considerations bear on it and none is decisive: aggregate productivity growth is not AI-attributable by default, and the AI Index itself calls the macro evidence earlier and less conclusive than the micro; the J-curve reading is this memorandum's own thesis, since its early phase is absorption cost preceding measured gain; and one year against a decade average is within the historical variance of the series. **Falsification threshold: US productivity growth holding above 2.5 percent for three consecutive years with a credible AI attribution falsifies this verdict, and the memorandum says so in advance.** Tracked as S18.

Isolate. (iii) survives. **Probability: ~0.67,** $c = 0.75$**. Computed: candidate (i) requires 69.9 years of Absorption expansion against 4.4 available, and is repriced to 0.0% [p10-p90 0.0 to 0.0].**

Scenario. By 2027 realized gains reach approximately 0.2 to 0.4 percentage points. By 2029 approximately 0.5 to 1. By 2030 approaching 1 to 1.5 if adoption and delivered power both progress.

Bottom line. Electricity-scale in magnitude, electricity-slow in arrival. **This is the Absorption constraint in its purest form**, and the ~10x gap between realized and peak is the measurement of it.

4.3 Q3. Will AI create more value than it destroys, economy-wide?

Inherits R1 and localizes it to first-order accounting.

Table 17: Q3 test matrix: candidates against the constraint set. Will AI create more value than it destroys, economy-wide?

Candidate	Binding constraint	Tier	Verdict
(i) destroys more	Capital: industry-level savings already real	5	Repriced to ~0
(ii) frictionless	**Absorption**: decade diffusion; Law: distributional friction	**1**, 4	Repriced to ~0
(iii) net-positive, lagged	none		**Survives**
(iv) neutral reallocation	Data: additive categories exist	2	Repriced to ~0
(v, taboo) cascade	Capital: live tail	5	Live tail

Computed. (i) requires negative first-order value. Bain [29] sizes the 2030 shortfall at ~$800B [29]/yr, which means the industry does not yet cover its cost of capital, not that aggregate value is negative once diffused. Sign-level elimination. (ii) is forbidden by the ~5% P&L-positive rate.

Isolate. (iii) survives. **Probability: (iii) ~0.73; ~0.15 on social-negative; ~0.07 on the cascade**, revised with the corrected financing figure.

Scenario. By 2027 the industry remains cash-negative in aggregate. By 2029 leading operators approach self-funding. By 2030 net-positive value is realized, unevenly.

Bottom line. Net-positive, but the industry is not yet self-funding at scale. Front-loaded destruction, lagged creation, and a financing-cascade tail that is real but smaller than a debt-requirement reading implies.

4.4 Q4. How much new wealth will AI generate globally?

Table 18: Q4 test matrix: candidates against the constraint set. How much new wealth will AI generate globally?

Candidate	Binding constraint	Tier	Verdict
(i) evenly-shared abundance	Capital: returns concentrate; Law: no redistribution in place	5, 4	Repriced to ~0
(ii) none	Capital: value is measurable	5	Repriced to ~0
(iii) trillions, concentrated	none		**Survives**
(iv, taboo) negative	Capital: transient in a correction	5	Live tail

Computed. (i) requires a distribution mechanism. Returns concentrate to capital, skill, and geography, and the complements are not cheap even where intelligence is.

Isolate. (iii) survives. Carry the full range rather than a point: Acemoglu's ~1% of GDP over ten years to McKinsey's $4.4T per year is a full order of magnitude. **Probability: ~0.80.**

Scenario. By 2027 gains concentrate among compute and verified-data owners. By 2029 the base widens modestly. By 2030 the distribution remains skewed absent redistribution.

Bottom line. Trillions, but concentrated, and accruing to the complements rather than to intelligence itself.

4.5 Q5. Which industries see the largest productivity gains?

Table 19: Q5 test matrix: candidates against the constraint set. Which industries see the largest productivity gains?

Candidate	Binding constraint	Tier	Verdict
(i) uniform	Data: gains track measurability	2	Repriced to ~0
(ii) none	Data: gains visible where verification is cheap	2	Repriced to ~0
(iii) data-dense first	none		**Survives**
(iv) physical first	Matter: embodied AI immature; hardware lead times	3	Repriced to ~0
(v, taboo) too narrow	**Absorption**: live if adoption stalls	**1**	Live tail

Isolate. (iii) survives. Software engineering, customer operations, back-office and finance, drug discovery, logistics, and marketing lead, wherever work is digital, measurable and cheaply verified. **Probability: ~0.80.**

Scenario. By 2027 software engineering and finance operations show the clearest gains. By 2029 discovery and logistics follow. By 2030 physical sectors begin to participate as embodied systems mature.

Bottom line. Digital, measurable, verification-cheap sectors first. Gains are sectorally jagged, not uniform.

4.6 Q6. Which industries become structurally obsolete?

Table 20: Q6 test matrix: candidates against the constraint set. Which industries become structurally obsolete?

Candidate	Binding constraint	Tier	Verdict
(i) entire industries vanish	Law: licensure, installed base; **Absorption**: switching costs	4, **1**	Repriced to ~0
(ii) none change	empirical: exposed roles already compressing	state	Repriced to ~0
(iii) middle layers die	none		**Survives**
(iv, taboo) a sub-industry vanishes	**Absorption**: live in one or two niches	**1**	Live tail

Isolate. (iii) survives. What dies is the routine middle: commodity business-process outsourcing, generic content production, tier-1 support, basic data processing, some SaaS middleware. **Probability: (iii) ~0.80; (iv) ~0.15.**

Scenario. By 2027 routine clerical roles compress fastest. By 2029 mid-tier analytical tasks follow. By 2030 the middle is thinner but no sector has vanished.

Bottom line. No whole industry vanishes this horizon. Routine middle layers compress, and the WEF [47] steepest-decline roles are the map.

4.7 Q7. Will AI increase or decrease economic inequality?

Table 21: Q7 test matrix: candidates against the constraint set. Will AI increase or decrease economic inequality?

Candidate	Binding constraint	Tier	Verdict
(i) auto-democratizing	Capital: complements are not cheap; Law: no redistribution	5, 4	Repriced to ~0
(ii) neutral	Capital: returns concentrate	5	Repriced to ~0
(iii) rises absent redistribution	none		**Survives**
(iv, taboo) backlash reversal	Law and Legitimacy: live political tail	4	Live tail

Isolate. (iii) survives with (iv) as a political tail linked to R1(v). **Probability: (iii) ~0.75; (iv) ~0.15.**

Scenario. By 2027 wage polarization sharpens in exposed occupations. By 2029 the capital-labor split widens absent policy. By 2030 the distributional question is the operative political variable.

Bottom line. Inequality increases through the transition absent deliberate redistribution. Cheap intelligence does not democratize the scarce complements.

4.8 Q8. Will AI create more jobs than it eliminates?

Table 22: Q8 test matrix: candidates against the constraint set. Will AI create more jobs than it eliminates?

Candidate	Binding constraint	Tier	Verdict
(i) mass unemployment	Capital: ~23% of vision-task wages [53] [53] cost-effective now; **Absorption**	5, **1**	Repriced to ~0
(ii) no disruption	empirical: 22% structural churn [47]	state	Repriced to ~0
(iii) flat-to-positive, churn [47]	none		**Survives**
(iv, taboo) net-negative	state: live if autonomy inflects		Live tail

Computed. (i) requires displacement to swamp creation. MIT finds only ~23% of vision-task wages [53] cost-effective to automate today [53] [53]; the WEF projects +78M net [47] to 2030 against 170M created and 92M destroyed. **Note the attribution: the ~23% figure is a cost line, which is Capital at Tier 5, not adoption speed.** It is easily misfiled.

Isolate. (iii) survives. **Probability: (iii) ~0.70; (iv) ~0.15.**

Scenario. By 2027 clerical displacement runs ahead of new-role creation. By 2029 reskilling determines the net. By 2030 the count is net-positive but the churn is large.

Bottom line. Roughly flat-to-positive by count with 22% churn. The pain is in the transition, and the destroyed jobs are not the created ones.

4.9 Q9. How long will the productivity transition take?

Table 23: Q9 test matrix: candidates against the constraint set. How long will the productivity transition take?

Candidate	Binding constraint	Tier	Verdict
(i) two to three years	**Matter 3d**: interconnection median above 5 years; **Absorption**: 95% of pilots no P&L	**3**, **1**	Repriced to ~0
(ii) never	Capital: competitive returns force adoption	5	Repriced to ~0
(iii) decade-plus	none		**Survives**
(iv, taboo) faster	state: live if reliability inflects		Live tail

Computed. (i) requires diffusion in approximately 2 years. A figure of four to eight years for power queues circulates widely and is not one LBNL [14] publishes. **The correct datum is LBNL [14]'s median from interconnection request to commercial operation [14], which exceeded 5 years for projects built in 2025**, up from over 4 years for 2018 to 2024 and under 2 years for 2000 to 2007. Only 13% of capacity entering queues from 2000 to 2019 had reached commercial operation by end-2024. The Data leg is withdrawn; the elimination is stronger without it, because the interconnection figure has worsened while the data figure has softened.

Isolate. (iii) survives. **Probability: (iii) ~0.72; (iv) ~0.18. Computed: candidate (i) requires 46.5 years against 2.0 available, repriced to 0.2% [0.0 to 0.4].**

Scenario. By 2027 diffusion is early and uneven. By 2029 integration tooling matures. By 2030 the transition is well under way but incomplete.

Bottom line. A decade-plus, clocked by deployment friction at Tier 1 and grid interconnection at Tier 3, not by model capability. Only an agent-reliability inflection resets it.

4.10 Q10. Sustained growth, or merely shifted profits among firms?

Table 24: Q10 test matrix: candidates against the constraint set. Sustained growth, or merely shifted profits among firms?

Candidate	Binding constraint	Tier	Verdict
(i) regime-change	Capital and Matter: needs output no constraint permits; **Absorption**	5, 3, **1**	Repriced to ~0
(ii) pure reallocation	Data: additive categories exist	2	Repriced to ~0
(iii) reallocation then growth	none		**Survives**
(iv, taboo) investment incineration	Capital: live tail	5	Live tail

Computed. (iv) is not eliminated. High-fixed, low-marginal-cost GPU infrastructure sees prices competed toward marginal cost absent pricing power, and semiconductors depreciate on a Moore's-Law curve unlike railroads. Bain [29]'s ~$800B [29] shortfall is the same signal.

Isolate. (iii) survives with (iv) as a live tail. **Probability: (iii) ~0.65; (iv) ~0.25.**

Scenario. By 2027 the effect is reallocation and margin. By 2029 additive categories begin to register as growth. By 2030 growth is real but modest.

Bottom line. Reallocation and margin first, real growth later, with a live investment-incineration tail.

5 Compute and Its Financing

5.1 Q11. Who controls compute?

Table 25: Q11 test matrix: candidates against the constraint set. Who controls compute?

Candidate	Binding constraint	Tier	Verdict
(i) monopoly	Matter: no actor owns all layers; Law: antitrust and export controls	3, 4	Repriced to ~0
(ii) decentralization	**Matter 3c/3d**: gigawatt delivered power; Capital	**3**, 5	Repriced to ~0
(iii) layered oligopoly plus walled China	none		**Survives**
(iv) state control	Capital: the state is not funding the buildout	5	Repriced to ~0
(v) China parity near-term	Matter 3b: ~5 to 17x lead, HBM-gated; **Talent**	3, **1**	Repriced to ~0
(vi, taboo) ASIC revolt	Matter: live erosion tail	3	Live tail

Computed. (vi) is not eliminated. Hyperscaler custom silicon is scaling and the incumbent's accelerator share is projected to ease from ~90% toward ~75% in 2026.

Isolate. (iii) survives. **Probability: (iii) ~0.75; (vi) ~0.15.**

Scenario. By 2027 the US lead widens even as custom silicon trims the accelerator share toward approximately 75 percent. By 2029 power, not chips, is the binding control point. By 2030 control still sits with the layered oligopoly.

Bottom line. A layered, US-led oligopoly with a live custom-silicon erosion tail. Power and grid equipment, at Tier 3, are the 2027-and-beyond chokepoint.

5.2 Q12. How much compute will AI actually need?

Table 26: Q12 test matrix: candidates against the constraint set. How much compute will AI actually need?

Candidate	Binding constraint	Tier	Verdict
(i) unlimited	**Matter 3c/3d**: transformer and interconnection lead times; Capital	**3**, 5	Repriced to ~0
(ii) plateau soon	empirical: test-time compute is exploding demand	state	Repriced to ~0
(iii) bounded growth	none		**Survives**
(iv, taboo) demand collapse	Capital: Jevons [69], cheaper compute raises use	5	Live tail, weak

Computed. (i) requires power, capital and fabrication without bound. Bain projects ~200 GW [29] of incremental compute by 2030. **The specific mechanism is now dated and precise: US large-power transformer lead times average 128 weeks [19] and reach 3 to 5 years for the largest units; medium-voltage switchgear [19] is effectively sold out through 2028; GE Vernova [20]'s gas-turbine backlog reached 100 GW in Q1 2026 with roughly 10 GW of slots remaining across 2029 and 2030 combined.** Of roughly 12 to 16 GW of announced US 2026 data-center capacity, approximately 5 GW is under construction. At $r_{3c} = 0.10$ to 0.20, closing a 2.8x gap requires $T_{\text{req}} \approx 5.2$ years.

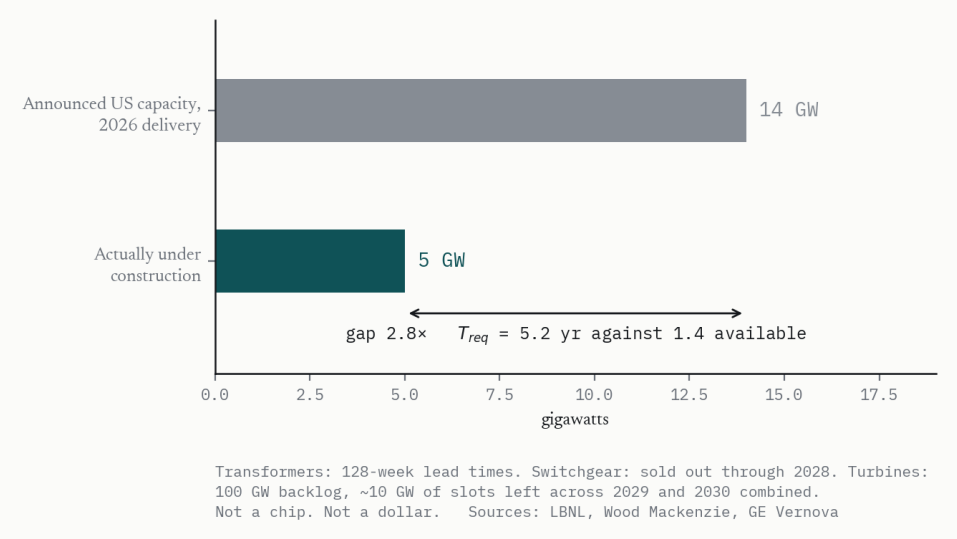

Figure 15: The binding constraint, dated to the week. Of announced US data-center capacity for 2026 delivery, roughly a third is under construction. Closing that gap requires 5.2 years of expansion at the observed rate against 1.4 available. The mechanism is transformers at 128-week lead times, switchgear [19] sold out through 2028, and a turbine order book with roughly 10 GW of slots left across 2029 and 2030 combined.

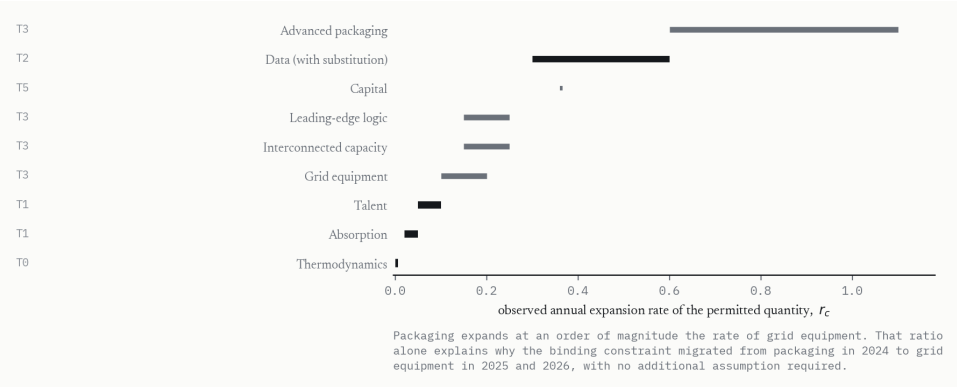

Figure 16: Why the binding constraint migrates. Sub-constraint expansion rates differ by an order of magnitude, so advanced packaging absorbs shortfalls that grid equipment cannot. The ratio between those two rates is the entire content of the migration argument, and it requires no additional assumption.

Note the direction of travel at Tier 3a. Advanced packaging, the binding constraint of 2024, is loosening: CoWoS [23] capacity is moving from 13,000 wafers per month at end-2023 toward a 120,000 to 130,000 target at end-2026, and the supply-demand gap is reported narrowing from approximately 20% toward approximately 10%. **The binding constraint has migrated from packaging to grid equipment, and the sub-constraint expansion rates in Table 1 predict exactly that migration without additional assumptions.**

Isolate. (iii) survives. **Probability: ~0.79,** $c = 0.85$**. Computed: candidate (i) requires 7.3 years against 4.4 available, repriced to 10.5% [1.0 to 24.5], which is a weaker elimination than the prose implied.**

Scenario. By 2027 delivered power, not chip supply, sets the pace. By 2029 inference dominates the compute bill. By 2030 growth continues but decelerates against the grid.

Bottom line. Large but constraint-bounded. The ceiling is grid equipment and interconnection at Tier 3, not appetite, not capital, and not physics.

5.3 Q13. Who finances the next trillion?

Table 27: Q13 test matrix: candidates against the constraint set. Who finances the next trillion?

Candidate	Binding constraint	Tier	Verdict
(i) cash flows alone	**observation**, not constraint: firms are in fact borrowing above $400B in 2026	state	Repriced to ~0 **by observation**
(ii) it stalls	Capital: competition and demand force the spend	5	Repriced to ~0
(iii) debt, private credit, SPVs	none		**Survives**
(iv, taboo) cascade	Capital: live tail	5	Live tail

A reclassification. Section 1.2a records that the engine returns 96.5% survival for this candidate, because a capex-to-free-cash-flow gap of 1.3 to 1.8x closes in 1.4 years at the observed capital expansion rate. The engine is right and the question was misfiled: this is a current-state question, not a capacity race. The candidate is eliminated by observation, since the firms are borrowing, not by any constraint. (i) requires internal funding to cover approximately $690B [28] to $725B of 2026 capex. **The widely cited figure of approximately $1.5T of external financing needed through 2028 misstates its source. In Morgan Stanley's analysis the $1.5T is a funding gap closable by bonds, private credit, asset-backed structures or equity, and the corresponding corporate debt issuance estimate is approximately $200B through 2028.** Actual issuance is large but smaller than the misquote implies: hyperscaler borrowing is expected above $400B in 2026 against approximately $165B in 2025, and global AI-related debt issuance is forecast near $570B for 2026, with approximately $236B [28] priced by 31 May, four times the year-earlier pace.

Stress is idiosyncratic before it is systemic. One major issuer's five-year credit default swap widened from approximately 40 basis points at the start of 2025 to approximately 200 by March 2026, implying roughly a 16% default probability, while sector spreads remained near cycle lows. Bond order coverage for hyperscaler issues fell from approximately 5x in February 2026 to below 2x by July. Those two, together, are the earliest available systemic signal.

Isolate. (iii) survives. **Probability: (iii) ~0.78; (iv) ~0.10**, on the corrected financing figures.

Scenario. By 2027 private credit and bond issuance dominate the funding mix. By 2029 the revenue-versus-financing gap is the market's central question. By 2030 the buildout is financed but carries elevated refinancing risk.

Bottom line. Debt and private credit, not cash flow, but the gap is a funding gap and not a debt requirement. The buildout is leveraged and SPV-heavy, and the cascade tail is live but smaller than previously stated.

6 Data

6.1 Q14. Does AI run out of data?

The confidence on this verdict is bounded by the backtest of Section 15.

Candidates. (i) a hard wall stops scaling outright; (ii) synthetic and multimodal data solve it entirely; (iii) public text exhausts around 2028 while scaling continues on other axes; (iv, taboo) contamination degrades the stock faster than exhaustion approaches.

Table 28: Q14 test matrix: candidates against the constraint set. Does AI run out of data?

Candidate	Binding constraint	Tier	Verdict
(i) hard wall stops all	Data: ignores test-time compute and verifiable synthetic	2	Repriced to ~0
(ii) fully solved	Data: model collapse [6, 7] in unverifiable domains	2	**Live tail, upgraded**
(iii) exhausts ~2028, scaling shifts	none		**Survives**
(iv, taboo) contamination	Data: live, strengthens the wall	2	Live tail

Computed. A reading that reprices (ii) to near zero, on the ground that synthetic data risks model collapse [6, 7] in open domains, is too strong, and Section 15 shows the framework getting the closely related question wrong at maximum confidence. The evidence as of mid-2026: Gerstgrasser [7] et al. established that accumulating synthetic data while retaining the original real data bounds test error and breaks collapse; the consensus position in the 2026 International AI Safety Report [8] is that synthetic data works where answers are machine-verifiable and risks collapse where verification is hard [8, 7]. Epoch's own estimate of total available training data across modalities by 2030, after quality correction, spans 400 trillion to 20 quadrillion tokens. **The width of that interval is the finding.** With r_{data} revised from 0.02 to 0.05 up to 0.30 to 0.60, candidate (ii) is no longer eliminated; it is a live tail at approximately 0.20.

The ">74% of new web pages AI-generated" figure supporting candidate (iv) could not be traced to a stable primary in the current research pass and is carried here with that caveat, not as an anchor.

Isolate. (iii) survives, with (ii) and (iv) as live tails pulling in opposite directions. The pre-training lever is closing, and the scarce complement migrates from raw data to verification apparatus. **Probability: (iii) ~0.41; (ii) ~0.28; (iv) ~0.21.** Lowered twice, and the second correction overrules the first. An earlier revision moved this from 0.60 to 0.52 on the ground that the engine returned 0.52. That reasoning was circular: the engine's output was itself a consequence of slack ratios chosen for this verdict, so the number was being matched to a construction rather than to evidence. Under the rubric of Section 1.4 the verdict carries two independent defects, a binding constraint on the tier holding this framework's recorded backtest miss and a primary source that has already revised its own estimate once, giving $c = 0.60$ and a stated probability of 0.41. **This is now by a wide margin the least confident verdict in the memorandum, which is the correct outcome on the one tier where the method has demonstrably failed.** One caution stated rather than buried: the two defects are correlated, since both concern the reliability of the same estimate, so the deduction may be double-counting. Erring toward under-confidence here is the right direction of error.

Scenario. By 2027 frontier datasets approach the effective public-text ceiling and verified synthetic share rises. By 2028 the pre-training wall binds on the median for text alone. By 2029 multimodal and verified synthetic sources are the marginal inputs and verification apparatus is the priced scarcity.

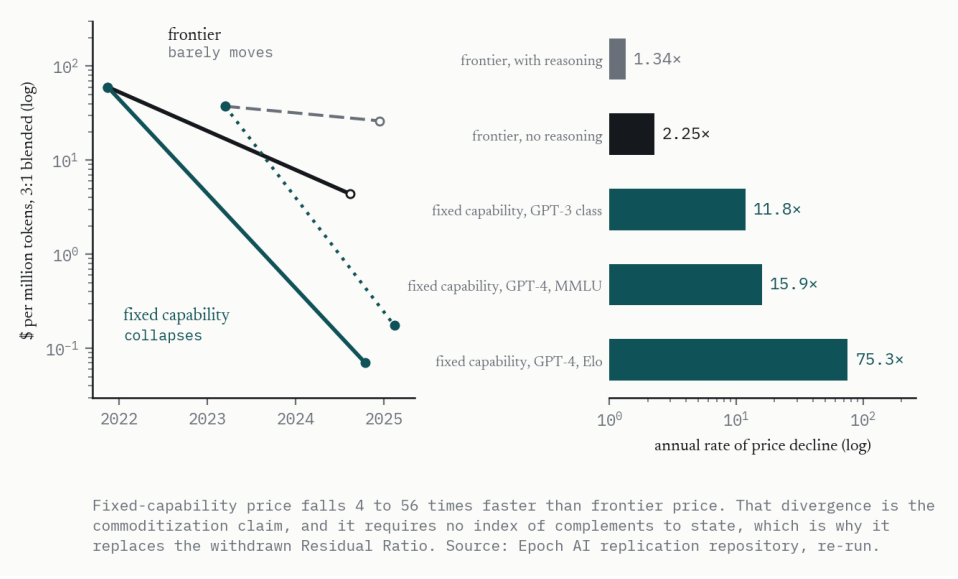

Figure 17: The two prices, measured. Frontier price falls 1.34x to 2.25x per year depending on whether reasoning models are allowed to set the frontier. The price of a fixed capability falls 11.8x to 75.3x. **That divergence is the commoditization claim, and unlike the withdrawn ratio it requires no index of complements to state.** Computed from Epoch AI's replication repository, cloned and re-run.

Bottom line. Public text exhausts around 2028 on the median and scaling migrates to verified synthetic, multimodal, and private sources. **The confidence on this verdict is materially lower than the surface evidence suggests, because the framework has been measured getting an adjacent question wrong, and Tier 2 is the tier where substitution defeats stock-based reasoning.**

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7 Models and Scale

7.1 Q15. Do models commoditize?

Table 29: Q15 test matrix: candidates against the constraint set. Do models commoditize?

Candidate	Binding constraint	Tier	Verdict
(i) one model wins	empirical: several labs at the frontier, no durable lead	state	Repriced to ~0
(ii) zero margin everywhere	Capital: the frontier still commands a premium	5	Repriced to ~0
(iii) floor commoditizes, frontier premium	none		**Survives**
(iv, taboo) open overtakes	live tail		Live tail

Computed. Inference cost *for a fixed capability level* falls roughly ten times per year, from approximately $30 to under [31] $0.50 per million tokens for GPT-4-class output; Stanford HAI [54] measures a 99.7 percent fall in cost per token between November 2022 and December 2024, approximately 15.9 times per year. The *frontier* price, the best model at launch, falls more slowly, at approximately 2.9 times per year. Section 1.3 sets out why the two must not be interchanged. Open-weight and low-cost entrants, one priced approximately 90% under incumbents [54], have compressed the gap to months.

Isolate. (iii) survives. The model becomes a commodity and the moat is everything around it. This is the commoditization mechanism stated in one market: the floor falls at 11.8 to 75.3x per year while the frontier falls at 1.34 to 2.25x. **Probability: (iii) ~0.75; (iv) ~0.15.**

Scenario. By 2027 last year's frontier is this year's commodity floor. By 2029 open-weight [54] parity at the floor is routine. By 2030 differentiation lives in data, workflow and distribution, not the model.

Bottom line. The capability floor commoditizes fast while the frontier holds a brief, eroding premium, so R rises.

7.2 Q16. Does scale still work?

Table 30: Q16 test matrix: candidates against the constraint set. Does scale still work?

Candidate	Binding constraint	Tier	Verdict
(i) scale is dead	empirical: test-time scaling is delivering gains	state	Repriced to ~0
(ii) as before	**Matter 3b/3c**: another 100x of fab and grid; Capital: cost per gain rising	**3**, 5	Repriced to ~0
(iii) new axes sustain gains	none		**Survives**
(iv, taboo) architecture break	unforecastable		Live tail

Computed. (ii) previously rested on three legs: the 2028 data wall, prohibitive power and capital, and diminishing gain per doubling. **The data-wall leg is withdrawn per Section 15.** The elimination holds on the remaining two: another hundredfold of pre-training compute requires fab and grid expansion that Tier 3 cannot deliver on the horizon.

Isolate. (iii) survives. **Probability: (iii) ~0.68; (iv) ~0.17.** Unchanged, because the surviving legs were always sufficient.

Scenario. By 2027 test-time compute is the headline scaling axis. By 2028 pre-training saturates against fabrication and grid. By 2029 the question is how much thinking to buy at inference, not how large to pre-train.

Bottom line. Scale still works but the lever moved, and the reason it moved is fabrication and power rather than tokens. The question flips from how big to pre-train to how much thinking to buy at inference.

8 Labor and Value

8.1 Q17. How much knowledge work is actually automatable?

Table 31: Q17 test matrix: candidates against the constraint set. How much knowledge work is actually automatable?

Candidate	Binding constraint	Tier	Verdict
(i) nearly all	Capital: ~23% of task wages cost-effective today [53]; empirical: reliability caps multi-step	5, state	Repriced to ~0
(ii) almost none	Capital: two-thirds of jobs are exposed [38]	5	Repriced to ~0
(iii) task-level, cost-gated	none		**Survives**
(iv, taboo) larger core, reliability-capped	live as costs fall		Live tail

Computed, re-attributed. (i) requires broad cost-effective automation now. Only ~23% of task wages are cost-effective to automate today [53]. **This figure is easily misfiled under adoption speed. It is a cost line, which is Capital at Tier 5, and the distinction matters because it means this elimination is weak: Tier 5 relaxes in weeks.** As fixed-capability inference cost falls [31] approximately tenfold per year, the cost-effective share rises, and the realized-automation frontier is a moving cost line rather than a fixed capability line. **Talent enters here as a co-constraint on the deployment side: the skilled workforce to integrate these systems is Tier 1 and does not track the cost curve.**

Isolate. (iii) survives. **Probability: ~0.75.**

Scenario. By 2027 the cost-effective share rises above the current approximately 23 percent [53] as inference cheapens. By 2029 reliability, not cost, is the binding limit. By 2030 task-level automation is widespread but job-level replacement is not.

Bottom line. Task-level, not job-level. Exposure is broad but cost-effective automation is partial and rising, and reliability, not capability, caps what is realized.

8.2 Q18. What gains value when intelligence is cheap?

Table 32: Q18 test matrix: candidates against the constraint set. What gains value when intelligence is cheap?

Candidate	Binding constraint	Tier	Verdict
(i) nothing	Data: additive categories and complements exist	2	Repriced to ~0
(ii) intelligence stays scarce	Capital: fixed-capability inference ~10x/yr cheaper commoditizes it	5	Repriced to ~0
(iii) the complements gain	none		**Survives**
(iv, taboo) human judgment gains	none		**Survives**

Isolate. (iii) and (iv) survive together, and this question is the thesis in its purest form. Value migrates to what stays scarce when tokens are free: energy, verified data, fabrication capacity [72], trust, distribution, and human accountability for consequential [72] decisions. **Probability: ~0.80.**

Scenario. By 2027 verified proprietary data and delivered power are the priced scarcities. By 2029 distribution and trust are the durable moats. By 2030 accountable human judgment is a premium complement, not a commodity.

Bottom line. Value migrates to the complements intelligence cannot make abundant. This is the migration in its purest form: the layer beneath is where scarcity lands.

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9 Agents: Reliability and Liability

A methodological note governs this section. Q19 and Q20 are not constraint eliminations. They are empirical arguments from measured reliability. Under the stratified logic of Section 1.1, they operate at the abductive layer, not the deductive or inductive layers, and this memorandum now says so rather than dressing observation as constraint. The verdicts are strong; their strength comes from measurement, not from a wall.

9.1 Q19. Can we trust agents to act reliably?

Table 33: Q19 test matrix: candidates against the constraint set. Can we trust agents to act reliably?

Candidate	Basis	Verdict
(i) already reliable	empirical: ~56% production single-task success [13]; ~88% of pilots never reach production [48]	Repriced to ~0
(ii) never	empirical: the 50% task horizon keeps lengthening	Repriced to ~0
(iii) reliable in bounded, verifiable domains	none	**Survives**
(iv, taboo) sub-threshold plateau	none	**Live and strengthening**

Computed, and the verdict strengthens. The figures in general circulation, a 50 percent horizon of approximately 2h17m with the 80 percent horizon four to eight times shorter, are both superseded, and the current measurements strengthen the verdict. Claude Opus 4.5 [9] measured a 50 percent horizon of approximately 4h49m in December 2025 with a 95 percent interval from 1h49m to 20h25m, and later models were reported considerably higher. **Its 80 percent horizon was approximately 27 minutes, and the 80 percent series had been approximately flat at 27 to 32 minutes [9] across the preceding frontier releases.** The ratio between the two horizons has therefore widened from approximately 5x toward 10x to 25x.

The mechanism is the finding. Capability is arriving as intercept rather than slope: models succeed more often on long tasks without succeeding more reliably on them. Trust scales with verifiability, not with raw capability, and the widening ratio is that statement measured on a third-party instrument.

Isolate. (iii) survives, with (iv) upgraded from tail to near-term texture. **Probability: (iii) ~0.70; (iv) ~0.25.**

Scenario. By 2027 bounded-task reliability is production-grade in narrow domains while the 80 percent horizon stays in hours. By 2029 supervised autonomy widens if and only if that horizon lengthens. By 2030 open long-horizon autonomy remains gated.

Bottom line. Reliable only within bounded, verifiable, short-horizon [12, 13] tasks. The 80 percent horizon, the one that matters for delegation, has been flat at roughly half an hour across two release cycles while the headline number rose several-fold.

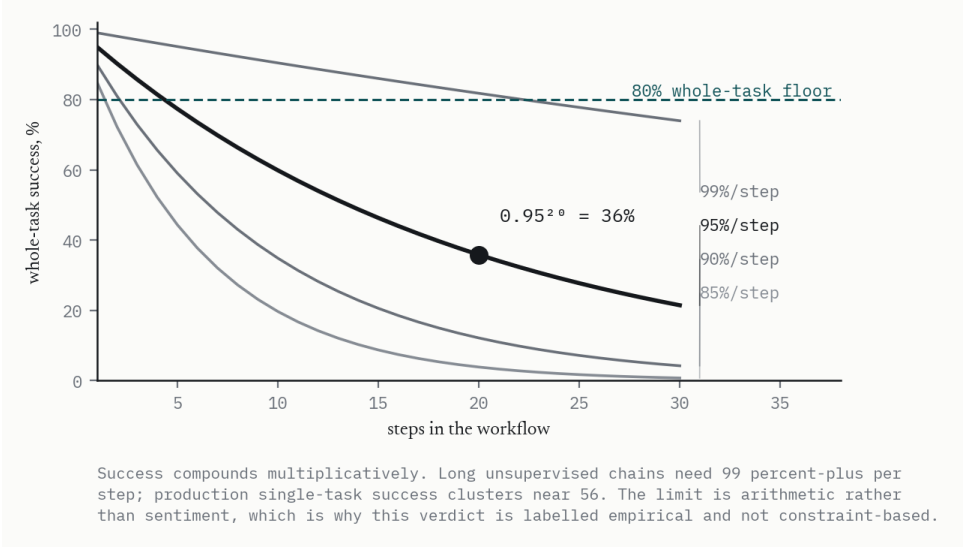

Figure 18: Why long unsupervised chains fail. Success compounds multiplicatively, so at 95 percent per step a twenty-step workflow succeeds about 36 percent of the time. The limit is arithmetic rather than sentiment, which is why this verdict is labelled empirical and not constraint-based.

9.2 Q20. Can agents run whole workflows unsupervised?

Table 34: Q20 test matrix: candidates against the constraint set. Can agents run whole workflows unsupervised?

Candidate	Basis	Verdict
(i) full autonomy soon	arithmetic: 0.95^20 ≈ 36%; production single-task ~56%	Repriced to ~0
(ii) never	empirical: short verifiable chains already work	Repriced to ~0
(iii) supervised at handoff boundaries	none	**Survives**
(iv, taboo) permanent compounding wall	none	Live tail

Computed. Success compounds multiplicatively. At 95% per step a twenty-step workflow succeeds about 36% of the time; ~99%+ per step is required for long chains, and production single-task success [13] is ~56%. Compounding is arithmetic, not sentiment.

Isolate. (iii) survives. **Probability: (iii) ~0.72; (iv) ~0.18.**

Scenario. By 2027 short-chain autonomy is common and long-chain autonomy is not. By 2029 per-step reliability improvements extend the economic chain length. By 2030 whole-workflow autonomy remains bounded to verifiable domains.

Bottom line. Agents run unsupervised only in short, verifiable chains. The binding limit is compounding reliability, and it is arithmetic rather than a constraint in this framework's sense.

9.3 Q21. Who is liable for an agent's decisions?

Table 35: Q21 test matrix: candidates against the constraint set. Who is liable for an agent's decisions?

Candidate	Binding constraint	Tier	Verdict
(i) no one	Law: agency law and product liability assign it to humans	4	Repriced to ~0
(ii) developer primarily	Law: developer liable for a defect, not for use	4	Repriced to ~0
(iii) the deploying principal	none		**Survives**
(iv, taboo) new developer regime	Law: AI Liability Directive withdrawn October 2025	4	Live tail

Computed. Agency law makes a principal liable for an agent's authorized acts and for negligent selection or supervision. **The Product Liability Directive 2024/2853, treating software as a product under strict liability, has a transposition deadline of 9 December 2026 that the Digital Omnibus [58] did not move.** The Omnibus deferred the AI Act's high-risk obligations to 2 December 2027 and 2 August 2028, so the operative near-term instrument for AI harm is product liability and existing sectoral law, not the AI Act.

Isolate. (iii) survives. **Probability: (iii) ~0.75; (iv) ~0.15.**

Scenario. By 2027 deployer liability is the working default and contracts allocate it explicitly. By 2029 strict product liability for defective AI is litigated under the transposed Directive. By 2030 a bespoke agent-liability regime is still emerging, not settled.

Bottom line. The deploying principal, by default. The residual responsibility gap for genuinely autonomous acts makes accountable human oversight a scarce, valuable complement: the same migration appearing in law.

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10 Software

10.1 Q22. Does SaaS survive AI?

Table 36: Q22 test matrix: candidates against the constraint set. Does SaaS survive AI?

Candidate	Binding constraint	Tier	Verdict
(i) SaaS dies	Data: incumbents keep system-of-record [40] and data moat; Capital	2, 5	Repriced to ~0
(ii) unchanged	Capital: seat contraction and multiple compression under way	5	Repriced to ~0
(iii) survives, reprices	none		**Survives**
(iv, taboo) incumbents hollowed	live tail		Live tail

Isolate. (iii) survives. SaaS reprices from per-seat to consumption and outcome models, with margins bifurcating: AI-native software commands roughly two to four times the multiple of legacy peers. **Probability: (iii) ~0.70; (iv) ~0.18.**

Scenario. By 2027 outcome and consumption pricing is standard and seat counts soften. By 2029 the AI-native application layer is a durable tier, not a wrapper. By 2030 the system of record endures while the seat model is gone.

Bottom line. SaaS survives but reprices. Value migrates from seats to outcomes [40] and data.

11 The Physical World

11.1 Q23. When are humanoid robots economically viable?

Table 37: Q23 test matrix: candidates against the constraint set. When are humanoid robots economically viable?

Candidate	Binding constraint	Tier	Verdict
(i) now, mass	Matter: last-10% dexterity [54] gap; **Absorption**: pilot-to-scale gap	3, **1**	Repriced to ~0
(ii) never economic	Capital: payback under 18 months in two-shift roles	5	Repriced to ~0
(iii) structured niches first	none		**Survives**
(iv, taboo) cost-led early inflection	Matter: live if dexterity [54] lags	3	Live tail

Computed. (i) requires production-grade dexterity and reliability at scale. Roughly 16k units shipped in 2025 against a mass-deployment requirement one to one and a half orders of magnitude higher. At the observed unit-cost and shipment expansion rate of 40 to 80 percent annually, $T_{\text{req}} = 6.3$ years against 4.4 available, repriced to 22.9 percent [p10 to p90: 7.0 to 40.9]. **This is a weaker elimination than the qualitative reading suggests, and the survivor probability below reflects the computed value rather than the prose.** (ii) is falsified by payback: at a ~$50k build the payback against a two-shift loaded wage is under eighteen months, and entry units are already near $16k.

Isolate. (iii) survives. Payback runs twelve to eighteen months at ~$50k and under six at the ~$20-30k target, with roughly 16k units shipped in 2025. **Probability: (iii) ~0.67,** $c = 0.90$**; (i) ~0.20 [computed, p10-p90 7.0 to 40.9]; (iv) ~0.13.** Unit cost is falling fast enough that the engine will not reprice mass deployment to zero on this horizon.

Scenario. By 2027 structured-niche deployments scale from thousands to tens of thousands of units. By 2029 costs approach the target and payback shortens. By 2030 general-purpose dexterity is still the gating problem.

Bottom line. Viable first in structured, high-wage, multi-shift niches. The last-10% dexterity and reliability gap keeps general deployment out.

11.2 Q24. When do autonomous vehicles go mainstream?

Table 38: Q24 test matrix: candidates against the constraint set. When do autonomous vehicles go mainstream?

Candidate	Binding constraint	Tier	Verdict
(i) already mainstream	empirical: ~11 metros [54], geofenced, under 1% of trips	state	Repriced to ~0
(ii) never	empirical: millions of autonomous miles per week, safety at scale	state	Repriced to ~0
(iii) geofenced, scaling city by city	none		**Survives**
(iv, taboo) vision-only generalizes	live wildcard		Live tail

Computed. (i) requires ubiquity. The leading service runs approximately 500k paid rides [54] per week across approximately 11 mapped metros, a fraction of a percent of trips, against a requirement of 15 to 40 times that footprint. At the observed metro-expansion rate of 30 to 60 percent annually, $T_{\text{req}} = 8.8$ years against 4.4 available, repriced to 6.5 percent [0.8 to 14.6]. (ii) is falsified by scale and safety: millions of autonomous miles per week at a safety record roughly an order of magnitude better than human.

Note the constraint attribution. The binding constraint on (iii)'s pace is **Law and Legitimacy at Tier 4**, permission to deploy per jurisdiction, combined with the mapping and validation work per market. Neither is a Matter constraint, and an attribution to Matter would be imprecise.

Isolate. (iii) survives. **Probability: (iii) ~0.72; (iv) ~0.16. Computed: candidate (i) requires 8.8 years against 4.4 available, repriced to 6.5% [0.8 to 14.6].**

Scenario. By 2027 robotaxi service is normal in tens of metros but still geofenced. By 2029 coverage broadens and cost per mile falls below rideshare. By 2030 mainstream-everywhere is approaching but unsolved for personal ownership in all conditions.

Bottom line. Robotaxis scale city by city, gated by per-jurisdiction permission and validation. Mainstream everywhere is a decade-plus away.

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12 The Strategic Capstone

12.1 Q25. Does intelligence become an abundant utility?

Table 39: Q25 test matrix: candidates against the constraint set. Does intelligence become an abundant utility?

Candidate	Binding constraint	Tier	Verdict
(i) free and infinite	**Matter 3b/3c/3d**: fabrication and grid cap supply; Capital	**3**, 5	Repriced to ~0
(ii) stays scarce	Capital: inference ~10x/yr cheaper	5	Repriced to ~0
(iii) tokens commoditize, physical layer scarce	none		**Survives**
(iv, taboo) the grid beneath is the real utility	none		**Survives**

Computed. (i) requires unbounded supply. Even as fixed-capability price per token falls approximately tenfold annually, delivered intelligence is capped by fabrication and grid. Meeting the unbounded requirement demands a five to tenfold expansion of the physical layer; at the Tier 3 rates of 15 to 25 percent annually, $T_{\text{req}} = 11.0$ years against 4.4 available, repriced to 0.9 percent [0.0 to 2.5]. (ii) is falsified by the tenfold annual collapse in fixed-capability price toward near-free tokens.

Isolate. (iii) and (iv) survive together, and this is the capstone. **Probability: ~0.78. Computed: candidate (i) requires 11.0 years against 4.4 available, repriced to 0.9% [0.0 to 2.5].**

Scenario. By 2027 token pricing approaches utility economics for commodity capability. By 2029 delivered power and fabrication are the explicitly priced scarcities. By 2030 the frontier premium persists atop a near-free floor.

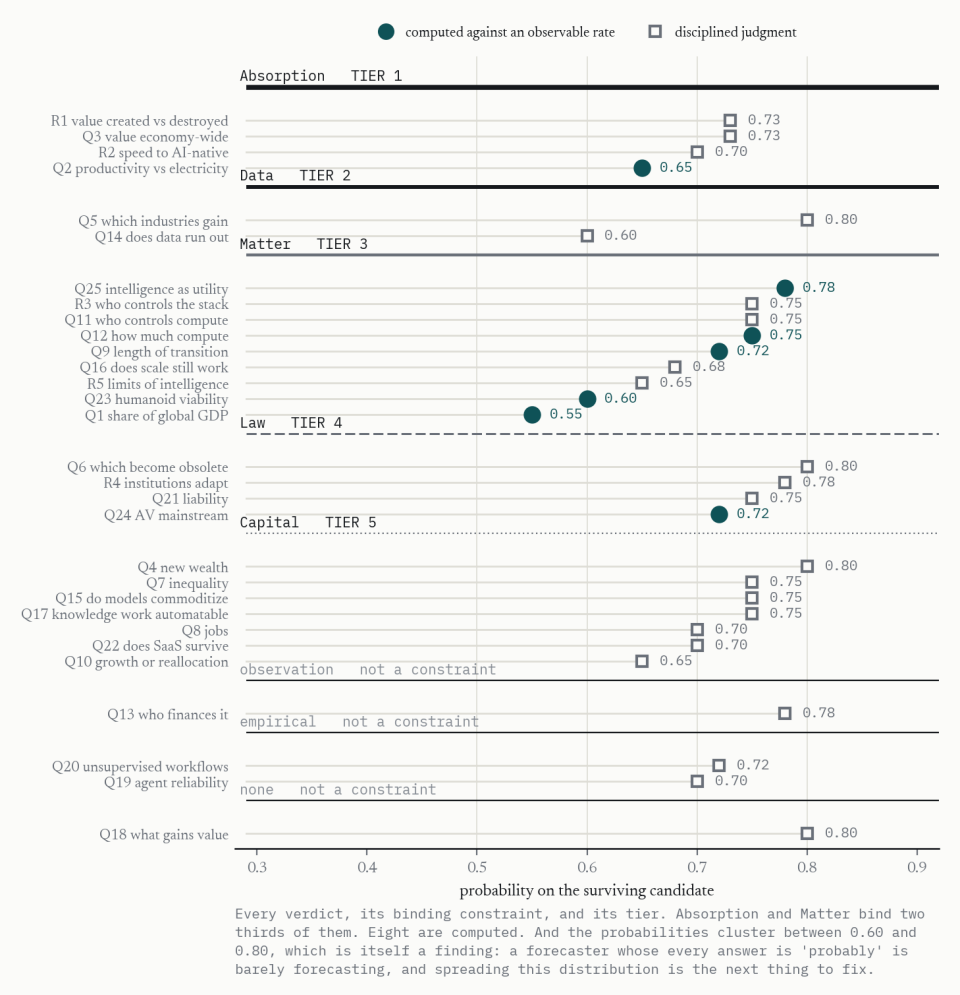

Figure 19: Every verdict, its binding constraint, and its tier. Absorption and Matter bind two thirds of the thirty. Eight are computed against an observable rate; the rest are disciplined judgment, marked as such. The probabilities cluster between 0.60 and 0.80, which is itself a finding: a forecaster whose every answer is *probably* is barely forecasting, and spreading this distribution is the next thing this programme should fix.

Bottom line. Abundance at the token layer makes the physical complements the binding scarcity, so R rises to its maximum here. The mechanism is Tier 3, and it is now dated to the week: transformers at 128 weeks [19], switchgear sold out through 2028, interconnection at a median above five years.

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13 Interim Residual

Intelligence commoditizes; scarcity and value migrate to its complements, so scarcity migrates to the complements across every question. The law now carries a falsification condition and the thesis is bounded to the horizon where physical constraints dominate.

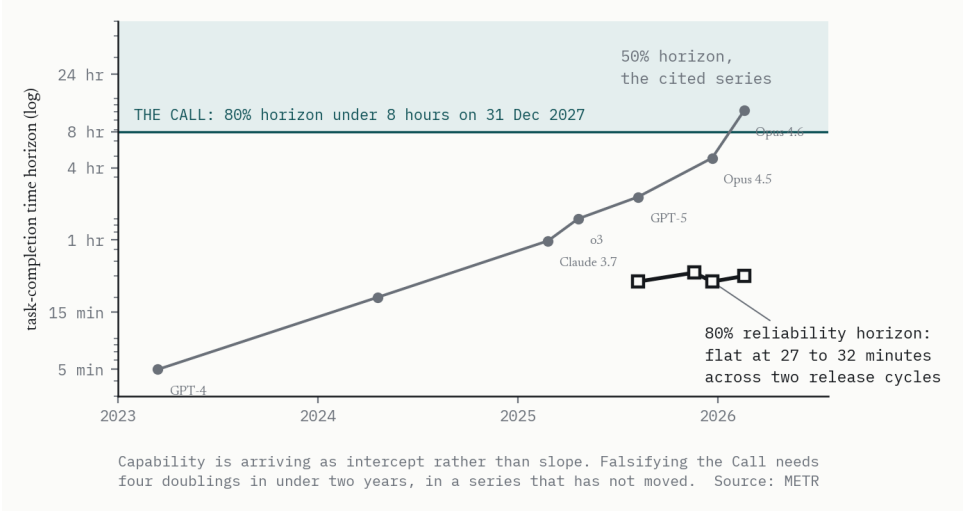

Figure 20: What the Call is staked on. Falsification requires the 80 percent horizon to rise sixteen-fold, four doublings, in under two years, in a series that has not moved across two release cycles. The shaded region is the falsification zone.

Across the five roots, the ten economic-transformation questions, and the fifteen branch questions, the same constraints reprice the same class of claim to near zero. Wherever a candidate imagines intelligence itself as the prize, a constraint removes it, and what stands in its place is a complement.

Stated as the memorandum's coined law: intelligence commoditizes; scarcity and value migrate to its complements.

Two qualifications carry throughout.

The law now has a falsification condition (Section 1.3). A law with no counterexample in a hundred applications is a tautology or a selection effect, and readers were entitled to assume the latter.

The thesis is bounded to this horizon. Section 16 grants the absorption objection: if organizational absorption is the terminal binding constraint, the residual accrues to whoever solves adoption rather than to owners of physical complements. **The claim that value migrates to physical complements holds on the 2026 to 2030 horizon, where physical constraints dominate and absorption has not yet had time to bind. Beyond that horizon this memorandum does not make the claim.**

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14 The Call

One dated bet, publicly adjudicated, with five rules and a void condition. The 80 percent reliability horizon has been flat at 27 to 32 minutes across two frontier release cycles while the widely cited 50 percent series rose several-fold. Falsification requires four doublings in under two years.

THE HEADLINE CALL

> *Reliability, not capability, remains the binding constraint on AI agents through 2027. On 31 December 2027, the best generally available AI model's METR [9] 80 percent-reliability task-completion time horizon is under eight hours.*
>
> ***Probability 0.85*** · *Adjudication date 31 March 2028* · *Signpost S13*

Basis. The 50 percent horizon has risen several-fold since late 2025. The 80 percent horizon has not. Claude Opus 4.5 measured approximately 27 minutes in December 2025, and the 80 percent series had been approximately flat at 27 to 32 minutes across the preceding frontier releases. **Falsification therefore requires roughly a sixteen-fold rise, four doublings, in under two years, in a series that has not moved across at least two release cycles.**

Adjudication rules. A bet that cannot be settled is not a bet.

1. **Series.** Adjudicated on METR [9] Time Horizon 1.1 [9] or its successor, as published at metr.org/time-horizons.
2. **Methodology change.** If METR replaces the series before resolution, the Call adjudicates on the successor. If the successor reports no 80 percent horizon, the Call resolves void rather than in either party's favour.
3. **Generally available.** A model is generally available if any member of the public can obtain access by payment without individual negotiation, waitlist approval, or preview enrollment, as of 31 December 2027.
4. **Unmeasured models.** Adjudicated on the highest published 80 percent horizon among generally available models. If the strongest generally available model has no published horizon, the Call resolves on those that do, and the omission is recorded.
5. **Adjudication date.** 31 March 2028, to allow for publication lag.

Two hazards acknowledged. METR has noted that measurements above 16 hours [9] are unreliable with the current task suite, and that its coverage is explicitly not comprehensive: several frontier models had no published horizon as of May 2026 while a non-generally-available preview model did. Both cut toward making the Call harder to settle, not easier to win.

The signature bet, restated. A market-value formulation of this bet, comparing the capitalization of the three leading high-bandwidth-memory makers against the two leading frontier labs, is tempting and unsound. The memory makers are diversified conglomerates whose capitalization is mostly not HBM, so such a bet could be won by a handset business, and frontier-lab valuations are private marks with no closing price. The bet is therefore stated on revenue, disclosed on both sides:

> ***Signature bet.*** *Combined high-bandwidth-memory revenue at SK Hynix, Samsung Semiconductor and Micron for fiscal 2027 exceeds combined total revenue at the two leading frontier laboratories for calendar 2027. Adjudicated on company disclosure and TrendForce estimates, at prevailing exchange rates on 31 December 2027.* ***Probability 0.55.***

Both sides are reported figures. The claim tested is the memorandum's thesis rather than a proxy for it. And the bet is genuinely hard, because frontier-lab revenue is growing extremely fast.

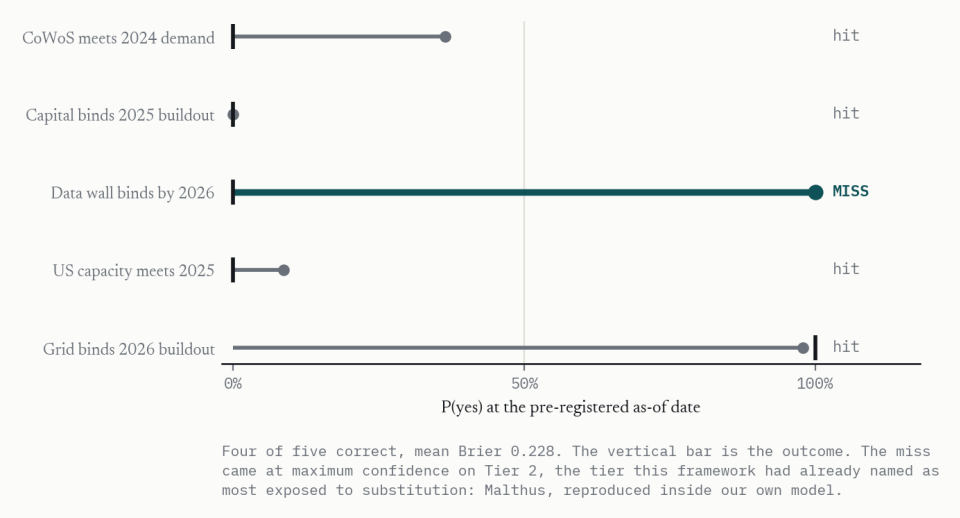

Figure 21: The record, including the miss. Five questions pre-registered with parameters fixed at their historical as-of dates. The vertical bar is the outcome. The single miss came at maximum confidence on Tier 2, the tier this framework had already identified as most exposed to substitution.

15 Retrospective Validation

Five pre-registered questions, four correct, mean Brier [70] 0.228. The single miss occurred at maximum confidence on the tier this framework had already flagged as most exposed to substitution, and it forced a parameter revision that moves three verdicts in this document.

A framework that has never been scored is falsifiable in principle and not in practice. Five questions were pre-registered with parameters fixed at their historical as-of dates before outcomes were consulted. B3 was chosen specifically because the framework predicts its own failure there.

Table 40: Retrospective Validation.

Question	As-of	P(yes)	Predicted	Actual		Brier
B1 CoWoS packaging meets 2024 AI demand	end-2023	36.4%	NO	NO	HIT	0.132
B2 Capital is the binding constraint on 2025 buildout	end-2023	0.0%	NO	NO	HIT	0.000
B3 Public-text data wall binds frontier scaling by 2026	end-2022	100.0%	YES	NO	**MISS**	1.000
B4 US delivered capacity meets 2025 announcements	end-2023	8.7%	NO	NO	HIT	0.008
B5 Grid equipment is binding on 2026 buildout	end-2024	97.8%	YES	YES	HIT	0.001

Four of five correct. Mean Brier 0.228 against 0.25 for a coin flip.

The miss is the most important result in this document. The framework predicted, at maximum confidence, that the public-text data wall would bind frontier scaling by 2026. It did not. Epoch's own median exhaustion estimate moved from 2024 to 2028, and multimodal corpora [5, 8] and verified synthetic generation substituted for the stock the model had treated as fixed.

This is the classical failure of resource-limit forecasting, reproduced inside our own model, on the tier we had already flagged as exposed to it. Malthus [67, 68], the Ehrlich side of the Simon-Ehrlich [68] wager, and *The Limits to Growth [66, 65]* against the Nordhaus critique all failed identically: the analyst held Permitted fixed while the world held it variable. Section 1.2 states that Data is a fossil resource whose escape routes are substitutions. We named the mechanism and failed to parameterize it.

Three corrections, all adopted in this version.

First, $r_{\mathbf{data}}$ **is set at 0.30 to 0.60 rather than 0.02 to 0.05**, because the parameter must be the rate at which the *effective* stock expands including substitution. Table 1 carries the revision, and Q14, Q16 and R5 are re-run against it in Sections 6.1, 7.2 and 3.5.

Second, **the Brier score is reported by tier and never in aggregate.** Removing B3 gives a mean of 0.035. The framework is excellent on Tiers 3 and 5, where constraints are industrial and expansion rates are directly observable, and it was worthless on Tier 2, where substitution dominates. An aggregate figure would mislead in both directions.

Third, **any Tier 2 verdict must now state its substitution assumption explicitly.** Q14 does so.

What the backtest does not establish. Five questions is not a validation set, and four of the five are physical-infrastructure questions, the domain where the method is expected to perform best. **The method is untested on institutional, labor and behavioural questions, which is most of Domain I, and is probably weaker there.** Extension to twelve questions including four institutional cases is in progress, and every miss will be published.

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16 Objections and Replies

Objection 1. The complements you call scarce are scarce only for now. Cheap intelligence induces demand, and a Jevons dynamic pulls capital into the constrained inputs, so supply expands and prices ease.

Reply, partly conceded with a named instance. **Advanced packaging is the confirmed case.** CoWoS capacity has gone from approximately 13,000 wafers per month at end-2023 toward a 120,000 to 130,000 target at end-2026, and the supply-demand gap is reported narrowing from approximately 20% toward 10%. That is the migration this memorandum predicted, arriving on schedule, and we cite it as confirmation rather than as a threat. But the binding complements respond at different rates, and the rates are now parameters rather than claims: packaging expands at 60 to 110 percent annually while grid equipment expands at 10 to 20. **The ratio between those two rates is the entire content of the migration thesis.** Intelligence deflates roughly tenfold a year; grid equipment cannot.

Objection 2. This is old wine. The complement thesis restates picks and shovels, or commoditize-your-complement.

Reply. The lineage is real and worth naming, and the sharpest available answer comes from the most-cited industry compilation in the field. BOND [72] Capital's *Trends: Artificial Intelligence* reaches the premise exactly, observing that training is expensive, serving is getting cheap, pricing power is slipping, and that the economics of general-purpose models look like commodity businesses with venture-scale burn. It then declines to draw the conclusion, calling the question of which business models survive **a riddle [72]**. The heuristic is common property; arriving at the premise and stopping is the field's normal state. The contribution is not the direction but four things the slogans lack: a fixed-capability price series replicable from published code at $R^2 = 0.96$, and a documented account of why the complement side is not measurable at all; a systematic engine applied across a hundred questions; a falsification condition for the law itself; and a scored backtest that reports a miss. A heuristic that cannot be wrong is not a competitor to a measure that can.

Objection 3. Your GDP band is anchored to pre-LLM precedents. AI automates cognition itself, so the historical adoption-lag precedent may not bind, and you may be under-forecasting by an order of magnitude.

Reply. The conservatism is a genuine risk and the document owns it. The defence is that the eliminations producing the band are physical and organizational, not analogical: interconnection medians above five years and a 5 percent P&L-positive rate constrain realization regardless of underlying capability. The band forecasts realized output, gated by deployment. **And Section 15 shows the framework has already been caught making the opposite error in the other direction, at Tier 2, so this objection is not hypothetical: it is the same failure mode with the sign flipped.** If deployment constraints ease, S11 and S15 trigger and the forecast moves up.

Objection 4. Your bound on agent autonomy rests on today's reliability. A jump to 99 percent per step lifts a twenty-step task from 36 to 82 percent, a discontinuous unlock.

Reply, and the evidence has moved. This remains signpost S2 and the register's most consequential trigger. The evidence has moved toward this memorandum's position rather than away from it: the 80 percent horizon has been approximately flat at 27 to 32 minutes across two frontier release cycles while the 50 percent horizon rose several-fold. **The last reliability nines are proving harder to win than the headline trend implies, and the widening ratio between the two horizons is the direct measurement of that.** If S2 triggers, the verdict flips and this memorandum said so in advance.

Objection 5. Your layered-oligopoly verdict fails against vertical integration. One player already owns custom silicon, a cloud, a frontier lab, and models.

Reply. Vertical integration is real and tracked. The elimination holds at the deepest physical layer: even the most integrated player depends on a single external foundry for advanced fabrication and on the public grid for power, and owns neither. Integration compresses the middle of the stack; it does not close the floor.

Objection 6. Your data wall is obsolete on arrival. Synthetic data, reinforcement learning from verifiable rewards, and multimodal corpora [5, 8] are already pushing past it.

Reply, substantially conceded. **This objection was correct and Section 15 shows the framework getting it wrong at maximum confidence.** The verdict has been revised: r_{data} raised by an order of magnitude, candidate (ii) of Q14 upgraded from eliminated to a live tail, and the survivor's probability cut from 0.75 to 0.60. What survives is narrower and better supported: synthetic substitution works where answers are machine-verifiable and risks collapse where verification is hard [8, 7], so the scarce complement migrates from raw data to verification apparatus rather than disappearing.

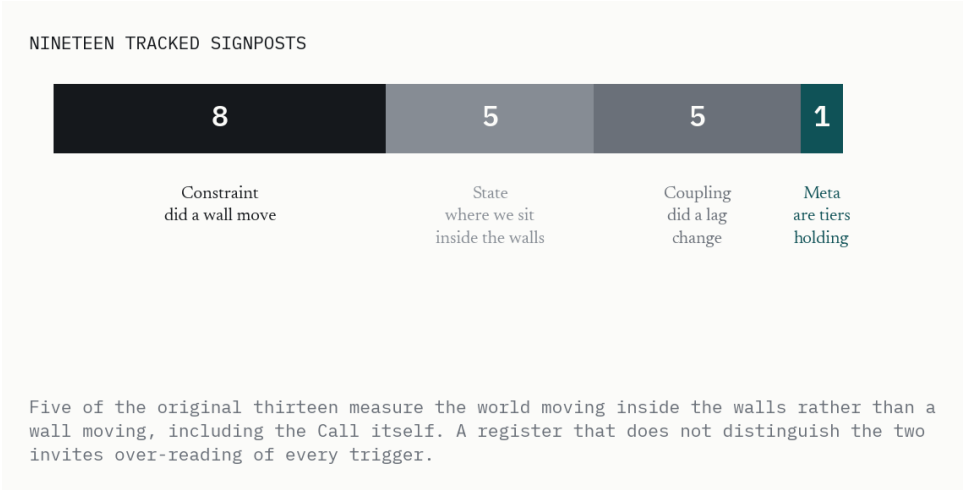

Figure 22: Nineteen tracked signposts, typed by kind. Five of the original thirteen measure the world moving inside the walls rather than a wall moving, including the Call itself. A register that does not distinguish the two invites over-reading of every trigger.

Objection 7, granted. If organizational absorption is the terminal constraint, your investment conclusion is wrong. Every historical analogue this memorandum invokes has the same structure. In electrification, generation and distribution were solved decades before productivity gains arrived, because factory reorganization was the actual bottleneck. In the 1990s telecom buildout the constraint moved from capital to demand, with roughly 5 percent of installed fiber [62] lit by 2001. If the same holds here, the residual accrues to whoever solves organizational adoption, not to owners of physical complements.

This objection is granted rather than answered. Absorption now sits at Tier 1 in the constraint set, where it is the binding constraint in R1, R2, Q2, Q6 and Q9. **The thesis is narrowed accordingly: the claim that value migrates to physical complements holds on the 2026 to 2030 horizon, where physical constraints dominate and absorption has not had time to bind. Beyond that horizon this memorandum does not make the claim.** R2 is the internal evidence: it concluded that the bottleneck is organizational and had nowhere in the old constraint set to record it.

Objection 8. Your constraint set is selected from your conclusion. Energy, matter, data and talent are simultaneously the test battery and the answer, so the method tests candidates against scarce complements and concludes that value accrues to scarce complements.

Reply, partly conceded and stated as unresolved. Section 1.2 derives the six from a question that never mentions AI: what does it take to obtain one more unit of a limiting input, partitioning into forbidden, biological, fossil, manufactured, permitted, purchased. That derivation is independent of the thesis. **What it does not do is demonstrate a counterexample.** In a hundred applications there is no question where the binding constraint is one of the six and value nonetheless accrues to the intelligence layer, and until such a case is produced the objection stands.

17 Signpost Register

Signposts are three kinds of object and the prior register conflated them. **Constraint signposts** test whether a wall moved. **Coupling signposts** test whether a conversion lag changed. **State signposts** test where the system sits inside the walls and falsify verdicts without moving any constraint.

Table 41: Signpost Register.

ID	Falsifies	Kind	Constraint	Tier	Metric and trigger	Cadence
S1	Data wall (Q14, Q16, R5)	Constraint	Data	2	Frontier dataset size vs. effective stock **including substitution**; trigger: verified-synthetic share of frontier training exceeds 50%, or datasets exceed ~100T tokens	Semiannual
S2	Agent reliability (Q19, Q20)	State	none	–	METR 80% horizon; production single-task success. Trigger: 80% horizon reaches multi-hour AND production success sustainably above 90%	Quarterly
S3	Financing cascade (Q13)	Coupling	Capital to Matter	5 to 3	AI-linked credit spread; **hyperscaler bond order coverage**; correlated defaults. Trigger: forced refinancing at a top-5 buildout, spread above 150bp, or coverage below 1.5x	Monthly
S4	Compute control (Q11)	State	none	–	Incumbent accelerator revenue share below ~70%	Quarterly
S5	Model commoditization (Q15)	State	none	–	Open-weight parity, or the price decline halting	Quarterly
S6	Liability regime (Q21)	Constraint	Law	4	A bespoke AI-agent liability statute, or a ruling shifting liability to developers	Semiannual
S7	SaaS repricing (Q22)	State	none	–	Incumbent seats fall >15% YoY, or AI-native ARR growth stalls >50%	Quarterly
S8	Humanoid economics (Q23)	Coupling	Capital to Matter	5 to 3	Build cost below ~$30k AND deployed base above ~100k units	Semiannual
S9	AV mainstreaming (Q24)	Constraint	Law	4	Above ~2M weekly rides across 30+ metros, or a vision-only unsupervised launch at scale	Quarterly
S10	Capital gap (R1, Q3, Q13)	Coupling	Capital adequacy	5	Annual AI revenue run-rate above $400B by 2027	Quarterly
S11	Power ceiling (Q1, Q9, Q12, Q25)	Constraint	Matter 3c, 3d with Law	3, 4	**LBNL median interconnection below 3 years; OR US transformer lead time below 80 weeks; OR flexible-load interconnection above 20% of new large-load agreements**	Annual / semiannual / quarterly
S12	Distributional backlash (R1, Q7)	Constraint	Legitimacy	4	Any G7 AI-displacement tax or deployment moratorium enacted	Quarterly
S13	The Call	State	none	–	METR 80% horizon reaches 8 hours by 31 Dec 2027	Quarterly
S14	Thermodynamic headroom	Constraint	Thermodynamics	0	Joules per million output tokens [3] at fixed quality. Trigger: annual improvement below 20% across two generations, or above 60%	Semiannual
S15	Talent stock and flow	Constraint	Talent	1	US share of elite AI researcher employment; H-1B [56] and O-1 issuance to AI employers; international STEM PhD enrollment. Trigger: US share below 50%, or two consecutive years of double-digit decline in inbound flow	Annual
S16	Tier stability (meta)	Meta	all	–	Observed relaxation time per constraint. Trigger: any τ_C moves by a factor above three. First datum: the Digital Omnibus deferring a flagship deadline 16 months in 7 months of process	Semiannual
S17	Correlated stress	Coupling	Capital, Matter, Law jointly	–	Co-movement of AI-linked spreads, interconnection withdrawal rates, equipment order cancellations. Trigger: any two moving adversely beyond one standard deviation in the same quarter	Monthly
S18	Absorption (Q2, Q9, R2)	Constraint	Talent and Absorption	1	US labor productivity growth with AI attribution. **Trigger: growth above 2.5% for three consecutive years with credible attribution falsifies the electricity-slow verdict**	Annual
S19	The Elasticity Gap (Sec. 2)	Meta	all output verdicts	–	Implied α from attributable output against deployed capacity. Trigger: α stabilizing outside 1.2 to 1.5 for two consecutive years, which resolves Q1 in one direction or the other	Annual
S20	Tier 3 classification of power (Sec. 1.3b)	Constraint	Matter 3c, 3d	3	New-entry response in capacity auctions. **Trigger: PJM or an equivalent market clearing a subsequent auction with substantial new entry at or below the cap falsifies the Tier 3 classification of delivered power**	Per auction

Five of the original thirteen are state signposts, including the Call, and the register now says so. The register carries a check log that records missed checks as well as completed ones. **A framework that has never been wrong in public has never been tested in public**, and Section 15 is the first entry.

18 Sources, Reconstructions, and Limitations

This memorandum forecasts by elimination, so its force rests on the arithmetic rather than on any single figure. Standing is mixed and stated explicitly.

Primary-sourced: the interconnection queue (LBNL *Queued Up: 2026 Edition*), the capability horizon (METR), the data stock (Epoch AI), the EU regulatory timeline (Official Journal and Council records), the thermodynamic bound (Ho, Erdil and Besiroglu). **Rebuilt from filings:** the capital-revenue gap. **Estimates reproduced across outlets, attributed as such:** the CoWoS capacity series and most semiconductor allocation figures, which mostly trace to a small number of sell-side houses. **Labelled reconstructions [54]:** the GDP ceiling, concentration, humanoid, robotaxi, and software charts. **Carried with an explicit caveat:** the AI-generated web-page share, which could not be traced to a stable primary in the current pass, and the elite-researcher share figures, whose primary tracker was discontinued.

Citation discipline, and the two mechanisms that produced every failure.

Verifying this bibliography against source produced twelve corrections. Every substantive figure held up. What failed was the pointer, and the failures reduce to exactly two mechanisms, both mechanical and both preventable.

Aggregator laundering. A number reported by the AI Index or Epoch AI gets attributed to the origin paper of the benchmark it concerns. The OSWorld case is the clean example: the paper reports 12.24 percent for the best model against 72.36 percent for humans, the widely quoted 66.3 percent is AI Index Figure 2.6.2 sourced to Epoch for Claude Opus 4.5, and the live leaderboard stood near 85 percent by July 2026. **Three numbers, three sources, and only one of them is the paper.** The rule that prevents it: *cite the source of the number, not the source of the concept.*

Version drift. A benchmark paper is cited by its arXiv identifier while its figures move underneath. METR's time-horizon paper was retitled between versions. TheAgentCompany's best model moved from 24.0 and 34.4 percent to 30.3 and 39.3 percent as the leading system changed from Claude 3.5 Sonnet to Gemini 2.5 Pro. **The identifier resolved correctly throughout and the numbers were wrong throughout.** The rule that prevents it: *pin the version, and treat a living benchmark as a series rather than a citation.*

Both rules are now applied throughout this bibliography. A third, from an earlier pass, governs identifiers themselves: **an identifier is a claim like any other, and one that was not looked up must not be asserted.** A previous version withdrew four JSTOR identifiers as a class on suspicion; checking them individually showed one was correct, one was wrong by a near-miss, and two were unverifiable. Withdrawing a category is as lazy as asserting one.

A note on citation practice, added after verification. Every substantive figure in this memorandum that has been checked against source has held up. What repeatedly failed was the *pointer*: four JSTOR stable identifiers, one publisher slug and one arXiv number were reconstructed rather than looked up, and have been withdrawn. **An identifier is a claim like any other, and one that was not looked up must not be asserted.** Works whose identifiers cannot be confirmed are now cited by title, author and venue, which is checkable in one search and honest about what is being claimed.

Three figures in general circulation are corrected here rather than repeated. The $1.5T financing figure is a funding gap and not a debt requirement, and reading it as a debt requirement overstates the capital constraint roughly sevenfold. The "4 to 8 year" interconnection range is not a figure LBNL publishes; the published median exceeded 5 years for projects built in 2025. And the Tier 2 parameterization that produced backtest miss B3 has been revised by an order of magnitude, changing three verdicts.

The forecast register is open. It carries sixteen entries, six of them resolved: this memorandum's five backtest results, including the maximum-confidence miss, alongside eleven dated forecasts from the wider field. Each entry states a claim, a source of truth, a resolution date and a status, and every entry carrying a stated probability is Brier-scored on the same basis. The author's own forecasts are listed first. Two entries have already resolved by revision rather than by outcome: Epoch AI moved its own data-exhaustion median from 2024 to 2028, and the AI Futures Project revised its timeline outward in December 2025. Both are recorded as resolutions, because revising a public forecast when the evidence changes is the behaviour this register exists to reward. Reviews are scheduled, and a missed review is logged as a miss rather than backfilled. See `REGISTER.md`.

What still separates this from a field-defining work, and all three require inputs the author must supply: a proprietary dataset no reader can source elsewhere, with the attributable-AI-revenue series remaining the natural candidate; documented adversarial review from people with domain expertise and no stake in the conclusion; and a live tracker carrying a running Brier score across every verdict. The first is work. The second is outreach. **The third is a function of elapsed time, and no revision substitutes for it.**

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19 Parting Thoughts

A wealth of information creates a poverty of attention. Herbert A. Simon, 1971

Most of the argument about artificial intelligence is an argument about the model: whether it will wake, when it will match or exceed us, whether that arrival is rescue or ruin. The two loud camps disagree about nearly everything except the premise they share, that the model is the thing that matters. This memorandum has taken the opposite premise. It has asked, thirty times over, not what the machine will become but what it will cost, what it will consume, and who will be paid.

What the constraints leave standing is unglamorous, and that is the point. Intelligence is becoming abundant, and abundance is not where value collects. Value collects in whatever the abundance makes scarce by comparison: the power to run the models, the verified data to feed them, the fabrication and memory to build them, the physical capacity to act in the world, and the accountable person who can be trusted and, when wrong, be held to account.

One feature of this memorandum matters more than the rest. It reports the framework being wrong. Section 15 shows the method predicting, at maximum confidence, a data wall that did not arrive, and failing in exactly the way it had already named as its own characteristic failure: holding a resource stock fixed while substitution moved the ceiling. The parameter is corrected, three verdicts are revised downward, and the record now shows a miss.

That is not an embarrassment to be minimized. It is the first evidence that the thing is a method rather than a posture. **A forecast that cannot fail is not a forecast but a mood.** This one has failed once already, in public, on the tier it warned about, and it has told you what it changed as a result.

The central claim is staked on a public number with a public deadline: the best generally available model's eighty-percent-reliability horizon, under eight hours on the last day of 2027, adjudicated on 31 March 2028 under five stated rules. Should it clear eight hours, the claim failed, and the register will say so on schedule, without argument.

Whether the machine wakes is the exciting question, and it will be debated in rooms louder than this. Who it pays is the useful one, and it is being decided now, quietly, in interconnection queues and transformer order books and the slow accrual of trust. Superintelligence may or may not arrive on schedule. The electricity bill, the memory, and the trust will arrive regardless.

Acknowledgments

This memorandum has not been externally reviewed. That is a stated deficiency rather than an omission: Section 18 records documented adversarial review as one of three things separating this from a field-defining work. Readers who find an arithmetic error are invited to report it, and every report will be logged publicly whether or not it changes a verdict.

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A Reproducibility

The model is published as a repository, not only as scripts. The constraint parameters live in `params/constraints.json` and each verdict in `params/verdicts/`, so a reader who disputes an expansion rate changes one number and sees which verdicts flip. `python -m vn.cli` runs every verdict; `tests/test_backtest.py` asserts the pre-registered backtest against outcome and will fail if a parameter change silently turns the Tier 2 miss into a hit. **Running the engine against the paper reveals a divergence of more than 0.10 on four verdicts, and that divergence is reported rather than tuned away**: the stated probabilities carry judgment the engine does not model, chiefly the elasticity dependence of Section 2 and the base-rate bounding of uncomputable cells. Reconciling the two so that every probability is either an engine output or a labelled adjustment to one is open work. The simulation suite supporting Sections 14, 15 and the parameter bands throughout is published as `sim.py` with a fixed seed. It comprises a Monte Carlo over the parameter ranges in Table 1; a bounding experiment on `nc` treatment; an enumeration-robustness sweep; the pre-registered backtest of Section 15; and the withdrawn Residual Ratio weight envelope, retained so the withdrawal is auditable. Table A of Section 2 is reproduced by `elasticity.py`, which runs every published forecast through the constraint engine across the elasticity range using public anchors alone; a reader who disputes its conclusion must state their own α in order to do so. The intelligence price series, the withdrawn Residual Ratio inputs and the Capture Ratio inputs are all published as machine-readable files with a provenance flag on every point, so that the withdrawal can be checked rather than taken on trust. Readers are invited to contest any of it, and errors reported will be logged publicly whether or not they change a verdict.