SBCM Note #6: The Thermodynamic Limit of AI-Driven Growth (v2.0)

— Digital Sprawl and the Conservation of Management Cost —

Author: Hokuto Koyama (SBCM Alliance)
Date: January 7, 2026
DOI: 10.5281/zenodo.18168070
Target: Critique of Aghion, Jones, and Jones (2019) & GPT-5.2 Pro's Proof

1. Introduction: The "Vacuum" Fallacy

Recent demonstrations by GPT-5.2 Pro have validated the mathematical correctness of the Aghion-Jones growth model, which predicts a "Finite-Time Singularity" driven by AI self-improvement.

However, this proof relies on a fatal assumption: **The dematerialization of cost.**
Techno-optimists argue that as Intelligence (A) increases, physical constraints vanish.
This note presents a counter-proof based on the **SBCM Field Theory**: Information is Physical. Just as urban expansion led to administrative inefficiency, unmanaged AI growth triggers **"Digital Sprawl,"** causing management costs to explode exponentially, thereby canceling out the Singularity.

2. The Techno-Optimist Model (The Trap)

The standard model assumes that the depreciation rate (δ) of capital (infrastructure/hardware) is constant or decreasing as technology improves.

$$\frac{\dot{A}}{A} \propto A^{\phi} \quad (\phi > 0), \quad \delta(t) = \text{const} \to 0$$

Under these conditions, output approaches infinity ($Y \to \infty$) while maintenance costs remain negligible.

3. The SBCM Counter-Proof: Law of Digital Sprawl

3.1 The Physicality of Intelligence

Intelligence is not magic; it is **Compute**. Compute requires **Energy** and **Land** (Server Farms).
History shows that as systems become more complex, the "Management Cost" (Entropy) does not decrease; it increases non-linearly.

- **20th Century (Urban Sprawl):** Population growth $\to$ Urban expansion $\to$ Infrastructure maintenance costs exploded.
- **21st Century (Digital Sprawl):** Intelligence growth $\to$ Model parameter expansion $\to$ Energy/Cooling/Land costs explode.

3.2 The Revised Depreciation Function

We introduce the **Complexity Penalty (γ)**. The maintenance cost δ is a function of Intelligence A:

$$\delta(A) = \delta_{base} \cdot A^{\gamma} \quad (\gamma > 0)$$

This represents the thermodynamic cost of maintaining "Order" (Intelligence) against "Chaos" (Heat/Decay).

3.3 The Impossibility of Singularity

The net growth equation is corrected as follows:

$$\text{Net Growth} = \underbrace{A(t)K^{\alpha}}_{\text{AI Output}} - \underbrace{\delta_{base}A(t)^{\gamma}K}_{\text{Management Cost}}$$

If the Complexity Penalty γ (Cost of managing AI/Land) scales faster than or equal to the Production exponent, the system stalls.
Recent data on Data Center energy consumption suggests γ is rising, not falling.

Result:
Instead of a Singularity, the system hits a **"Thermal Wall"** (Fiscal or Physical Meltdown). The "Tokyo Concentration" is merely a prelude to this thermal runaway.

4. Conclusion: The Necessity of Partitioning (SBCM)

To prevent Thermodynamic Collapse, we cannot rely on "faster engines" (AI). We must optimize the "radiator" (Structure).

SBCM (Standard Block Comparison Method) provides the only engineering solution:

1. **Mesh Refinement:** Partitioning the system (State or AI Cluster) into optimal units (B_{std}) to localize entropy.
2. **Forced Circulation:** Preventing the concentration of Heat (Wealth/Data) in one location (Tokyo/Central Server).

Final Verdict:
Without the "Standard Block" architecture to manage the cost of complexity, **the Singularity will consume itself before it saves us.**
Code is Law, but Physics is the Absolute Judge.

References

1. **Aghion, P., Jones, B. F., & Jones, C. I. (2019).** *Artificial Intelligence and Economic Growth*. In The Economics of Artificial Intelligence: An Agenda. University of Chicago Press.
   (The target hypothesis: Prediction of explosive growth assuming constant depreciation.)

2. **OpenAI. (2026).** *GPT-5.2 Pro Technical Report: Mathematical Verification of Infinite Growth Models*.
   (The trigger event: AI proving the mathematical correctness of the "Vacuum" model.)

3. **Koyama, H. (2025).** *SBCM Field Theory: The General Equations of Regional Flux*. Zenodo.
   (The counter-theory: Establishing the "Administrative Hydraulics" and leakage constraints.)

4. **Landauer, R. (1961).** *Irreversibility and Heat Generation in the Computing Process*. IBM Journal of Research and Development.
   (The physical law: "Information is Physical." Proof that computation inevitably generates heat/cost.)

5. **West, G. (2017).** *Scale: The Universal Laws of Growth, Innovation, Sustainability, and the Pace of Life in Organisms, Cities, Economies, and Companies*. Penguin Press.
   (The scaling law: Proof that as systems (Cities/AI) grow, energy maintenance costs scale super-linearly unless optimized.)