AI Economic Series

Generative AI as a Non-Convex Supply Shock: Market Bifurcation and Welfare Analysis

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Background &Motivation

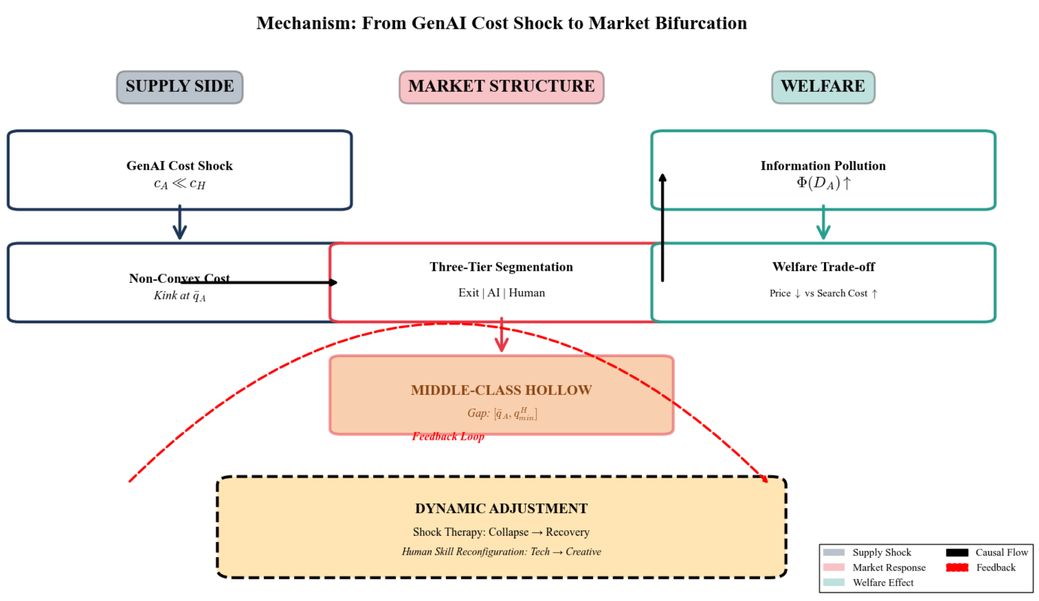
Generative AI (GenAI) is an unprecedented **supply shock** in digital markets: it drives the marginal cost of semantic production toward zero and sharply lowers entry barriers for content creation. Yet unlike standard productivity shocks, GenAI expansion also produces a **congestion externality**—a flood of synthetic content that degrades the signal-to-noise ratio in attention-constrained platforms. When discoverability becomes the binding constraint, more output can reduce effective market efficiency by raising search costs, cognitive load, and misallocation, creating what we term **information pollution**.

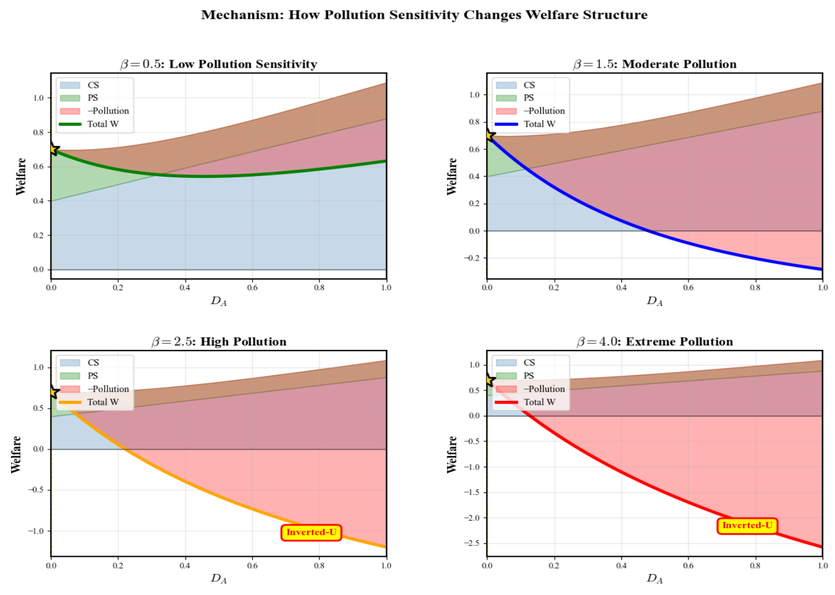
This paper is motivated by a gap in existing work: most studies emphasize either displacement/inequality or platform recommendation dynamics, but lack a unified framework that links **non-convex technology choice**, **market structure**, **transition dynamics**, and **welfare** under endogenous congestion. We develop a three-layer general-equilibrium approach (static vertical differentiation + mean-field evolution + calibrated agent-based simulation) to show that GenAI can **bifurcate markets** into exit/AI/human segments with a "middle-class hollow," generate a non-monotonic "shock therapy" transition (collapse → selective recovery), and produce an **inverted-U welfare effect** when pollution intensity is high—implying that efficient governance should shift from input regulation toward **output-side congestion management**

Research Questions / Hypotheses

1. **RQ1: Market Structure — Does Generative AI induce structural bifurcation rather than smooth substitution?**
   We ask whether a near–zero marginal cost AI technology reshapes market structure through continuous displacement of human producers, or instead generates a *non-convex* reorganization. We hypothesize that GenAI creates a kinked production frontier that bifurcates the market into exit, AI-dominated low-quality production, and human-dominated high-quality niches, leading to a "middle-class hollow" in the quality distribution.
2. **RQ2: Transition Dynamics — Is the adoption path monotonic or characterized by instability?**
   Standard diffusion models predict a smooth S-curve transition following technological adoption. We test the alternative hypothesis that, under search frictions and delayed skill adaptation, the GenAI shock produces a *non-monotonic* transition with a temporary ecological collapse of human creators, followed by selective recovery through specialization rather than gradual convergence.
3. **RQ3: Welfare — Can AI expansion reduce total welfare despite lower prices?**
   While GenAI lowers prices and expands output, it also increases information pollution and search costs. We hypothesize that total welfare is *non-monotonic* in AI penetration: welfare rises under low congestion but follows an inverted-U pattern when pollution intensity is high, implying that laissez-faire AI expansion can be inefficient without output-side congestion management. governance should shift from input regulation toward **output-side congestion management**.

Theory Framework





- We model Generative AI as a **non-convex supply shock** in an attention-constrained digital market. On the demand side, consumers differ in their valuation of quality and face an endogenous congestion externality: as the volume of AI-generated content increases, search and matching costs rise, reducing effective utility through an information-pollution penalty. This pollution term is an equilibrium object, linking individual consumption decisions to aggregate AI output.

- On the supply side, creators choose between two production technologies with fundamentally different cost structures. Human production features convex costs tied to cognitive effort and skill, while AI production exhibits near-zero marginal cost but is subject to a quality ceiling and fixed adoption costs. The resulting production set is non-convex, generating discrete technology choice rather than smooth substitution. Equilibrium is characterized by endogenous segmentation—exit, AI adoption, and human specialization—together with quality gaps that eliminate mid-tier production. By embedding congestion into preferences and non-convexity into technology choice, the framework captures how GenAI simultaneously reshapes market structure, transition dynamics, and welfare

Methodology &Key Finding

- **Methodology**：We combine analytical modeling with large-scale computational experiments to study the general-equilibrium effects of Generative AI. First, we develop a vertical differentiation model with endogenous information pollution and a non-convex production set, allowing us to characterize equilibrium market segmentation and welfare analytically. Second, we model creator adjustment as an evolutionary process with bounded rationality, where skills and technology choices evolve under noisy profit gradients. Third, we implement these dynamics in a calibrated agent-based model that captures heterogeneity, learning frictions, and path dependence, enabling us to trace transitional dynamics beyond static equilibria.
- **Key finding**：

(i) **Market bifurcation:** GenAI does not smoothly substitute for human labor; it splits the market into exit, AI-dominated low-end production, and human high-end niches, producing a persistent "middle-class hollow."

(ii) **Non-monotonic transition:** The adjustment path features a temporary ecological collapse of human creators when income shocks outpace re-skilling, followed by selective recovery through specialization rather than convergence.

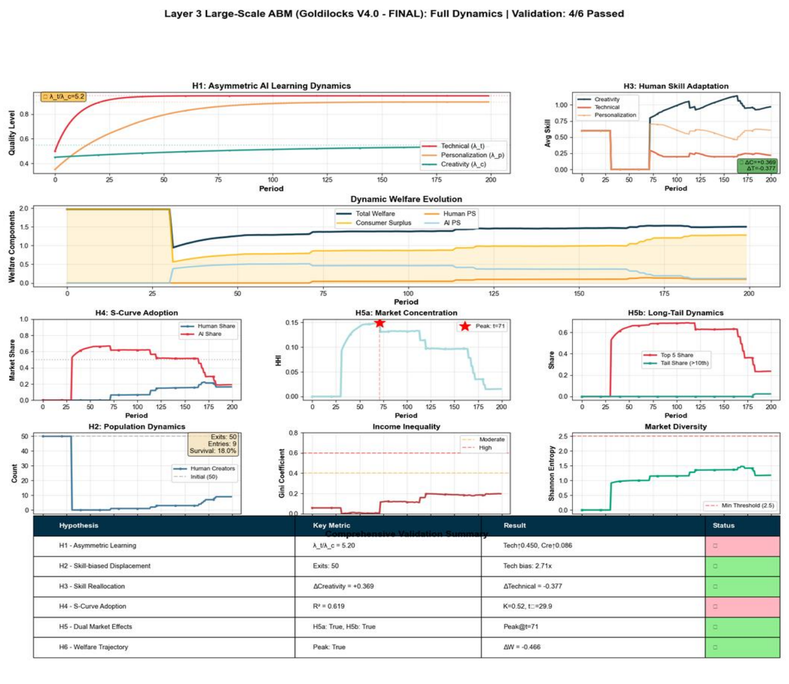
(iii) **Welfare inversion:** While AI adoption raises welfare under low congestion, high information pollution generates an inverted-U relationship in which further AI expansion reduces total welfare. These results imply that efficient governance must move beyond input-side regulation toward output-side congestion management.

Coexistence Condition	Value	Status
Human Market Share	0.128	☐
AI Market Share	0.354	☐
Human Profit	0.082	☐
Indifferent Consumers	0	☐
Overall		☐ FAIL

Metric	Pre-AI	Post-AI	Change
Avg Price	$2.32	$0.64	-72.3%
Consumer Surplus	0.132	0.558	+0.426
Human PS	0.131	0.082	-0.049
AI PS	0.000	0.312	+0.312
Total Welfare	0.264	0.952	+0.688

Validation Summary

Proposition	Test	Result
3.2: Segmentation	ρ=0.937	☐ PASS
3.3: Price Effects	-72.3%	☐ PASS
3.4: Welfare Redist	All signs correct	☐ PASS
Coexistence Check	D_H=0.13	☐ FAIL



Comprehensive Validation Summary

Hypothesis	Key Metric	Result	Status
H1 - Asymmetric Learning	λ_t/λ_c = 5.20	Tech:0.450, Cre:0.086	☐
H2 - Skill-biased Displacement	Exits: 50	Tech bias: 2.71x	☐
H3 - Skill Reallocation	ΔCreativity = +0.369	ΔTechnical = -0.377	☐
H4 - S-Curve Adoption	R² = 0.619	K=0.52, t□=29.9	☐
H5 - Dual Market Effects	H5a: True, H5b: True	Peak@t=71	☐
H6 - Welfare Trajectory	Peak: True	ΔW = -0.466	☐

Policy Implication And Conlusion

- **Policy Implications.**
  The analysis shows that the central market failure induced by Generative AI is not primarily intellectual property appropriation, but an uninternalized **congestion externality** arising from excessive algorithmic output. Even when AI lowers prices and expands access, individual adoption decisions ignore the marginal increase in system-wide search costs and information pollution. As a result, laissez-faire expansion can push the market beyond the welfare-maximizing level of AI penetration. Efficient governance should therefore shift from input-side regulation (e.g., training data ownership) toward **output-side congestion management**, such as mechanisms that discipline AI volume or improve signal extraction. Corrective instruments that scale with market saturation—rather than flat restrictions—can align private incentives with social welfare by internalizing pollution costs and stabilizing the transition.
- **Conlusion.**
  This paper reframes Generative AI as a **non-convex supply shock** in an attention-constrained economy. By jointly modeling technology choice, information pollution, and market adjustment, we show that GenAI can bifurcate market structure, generate non-monotonic transition dynamics, and produce welfare losses at high levels of congestion despite lower prices. The key insight is that productivity gains alone do not guarantee welfare improvement when attention is scarce. Sustainable integration of GenAI therefore requires governance frameworks that recognize information pollution as a first-order economic externality and manage the AI transition accordingly.