AI Economic Series

The Beyond Private or Public: Large Language Models as Quasi-Public Goods in the AI Economy

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Background &Motivation

- Large Language Models (LLMs) exhibit economic properties that fundamentally depart from standard goods. Once trained, their marginal cost of use is close to zero, enabling massive non-rival consumption, yet access remains selectively controlled through pricing, APIs, and licensing choices. At the same time, LLMs generate pervasive spillovers—accelerating knowledge diffusion and downstream innovation while also creating risks such as concentration, information pollution, and lock-in. This combination of near-zero marginal cost, variable excludability, and large positive and negative externalities places LLMs in a gray zone between private and public goods, making their economic nature inherently dynamic and strategic..

- Existing theories are ill-equipped to capture these features. Classical public goods theory treats rivalry and excludability as fixed attributes and focuses on static provision efficiency, while platform economics emphasizes network effects and pricing without modeling the public-good character of core technologies. Innovation and antitrust frameworks, in turn, often rely on price signals and market shares that become uninformative when prices approach zero and value is created through ecosystem-wide spillovers. As a result, policymakers and firms lack a coherent framework to assess welfare trade-offs or to design governance mechanisms for foundation models..

Research Questions

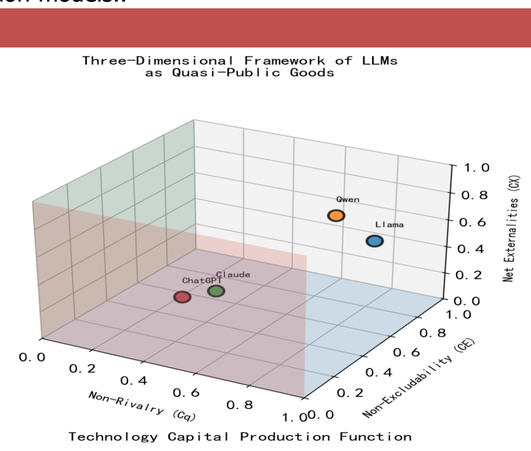
This paper addresses three core research questions.

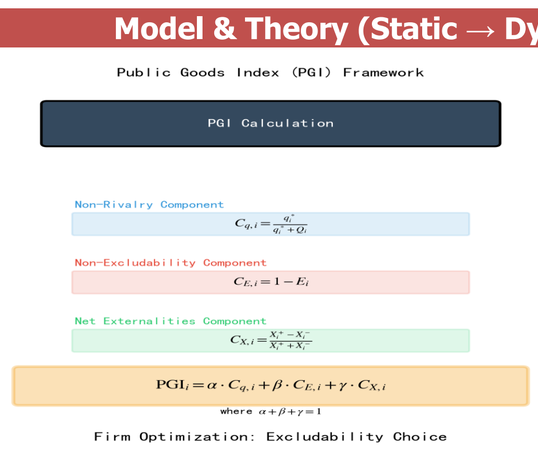
- First, how can the public-good characteristics of LLMs be modeled as continuous and endogenous outcomes of firm strategy and technological evolution rather than as fixed labels?

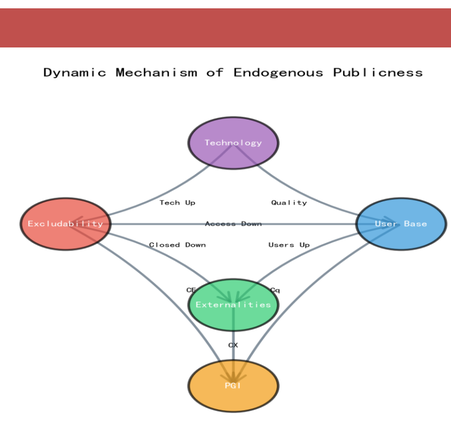
- Second, how do different architectural and business choices—such as open versus closed models—shape allocative efficiency, innovation dynamics, and access equity through their effects on non-rivalry, excludability, and externalities?

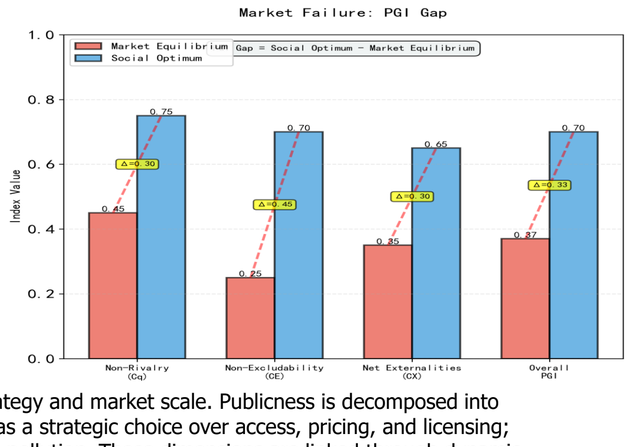
- Third, what governance instruments can correct the resulting market failures and steer the LLM ecosystem toward higher social welfare without undermining innovation incentives?

Model & Theory (Static → Dynamic)





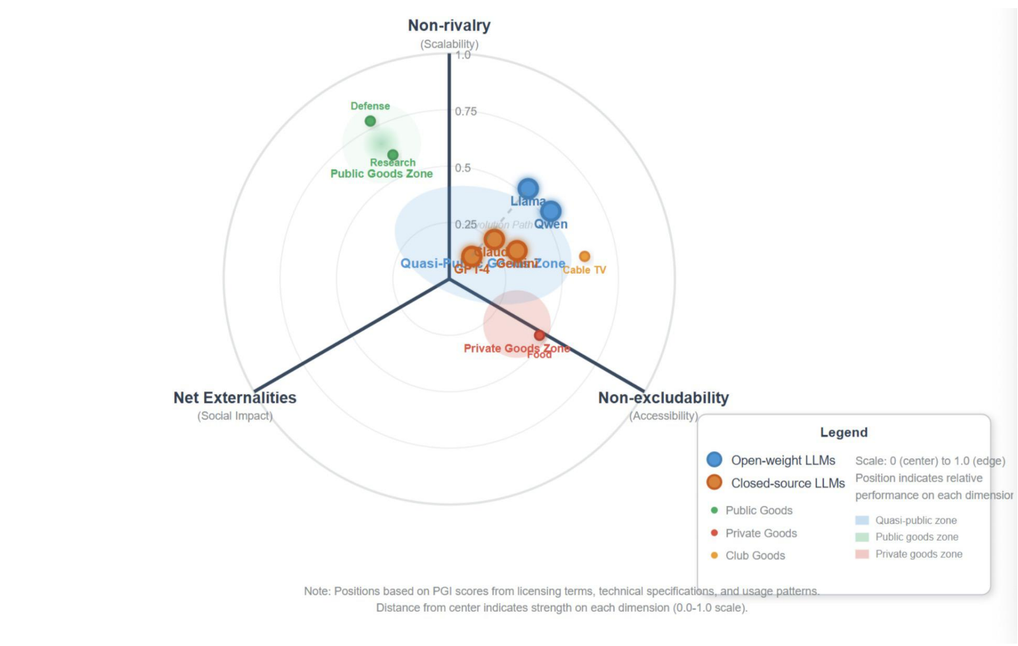


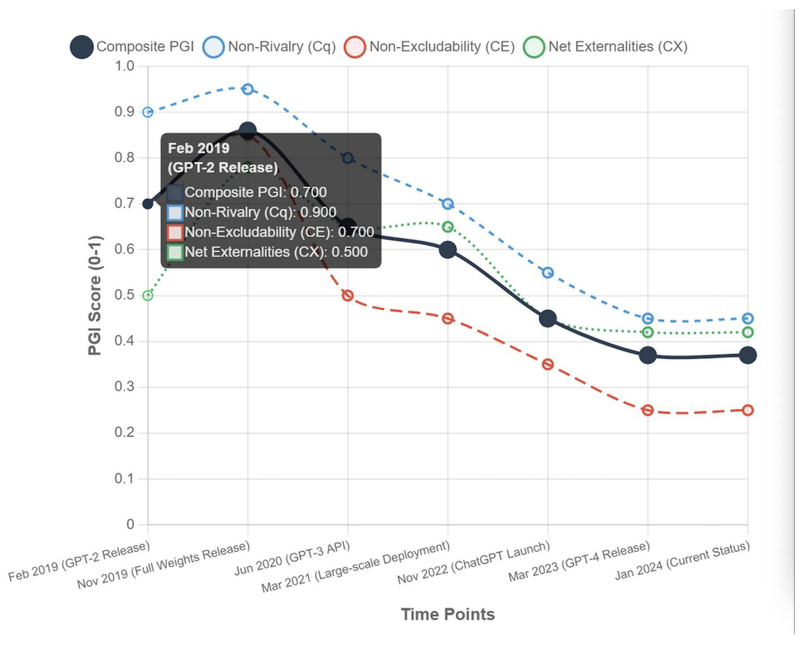


- We propose an endogenous publicness framework that models LLMs as quasi-public goods whose economic characteristics evolve with firm strategy and market scale. Publicness is decomposed into three interacting dimensions: **non-rivalry**, captured by a rivalry (or congestion) threshold that reflects capacity limits; **excludability**, treated as a strategic choice over access, pricing, and licensing; and **externalities**, encompassing both positive spillovers from knowledge diffusion and negative effects such as concentration and information pollution. These dimensions are linked through dynamic feedback loops in which openness and user scale shape data accumulation and learning, learning enhances model capability, and rising capability alters firms' optimal excludability, generating path dependence and potential publicness decay over time.
- **Metric: Public Goods Index (PGI).**
  To operationalize the concept of endogenous publicness, we introduce the **Public Goods Index (PGI)** as a weighted composite measure of the three core dimensions—non-rivalry, excludability, and net externalities. The PGI maps firm strategies and technological conditions into a single, interpretable metric that captures the degree to which an LLM functions as a public good. By comparing the PGI implied by firms' private profit-maximizing choices with the PGI that maximizes social welfare, we identify a systematic **PGI gap** between private and social optima. This gap provides a quantitative measure of market failure, reflecting the tendency of firms to under-provide publicness relative to what is socially efficient.

Evidence: Cross-Model PGI and OpenAI Longitudinal

- **Key finding：** Applying the Public Goods Index (PGI) across major LLMs reveals a clear structural divergence between open and closed models: open-weight architectures systematically achieve higher PGI scores due to lower excludability and stronger positive externalities, while closed-source models are constrained by access controls despite comparable technical capacity. Complementing this cross-sectional evidence, a longitudinal case study of OpenAI shows a pronounced **publicness decay** over time, with the PGI declining sharply from GPT-2 to GPT-4 as models became more capable and commercially entrenched. Together, these results validate the theory that publicness is not an intrinsic technological property but an endogenous outcome of strategic choices that evolve with market position and competitive incentives.





Policy Implication And Conlusion

- We implement an agent-based model (ABM) to compare four governance regimes—**openness subsidies** (to reduce effective excludability and expand access), **Pigouvian taxes** (to internalize negative externalities), **antitrust-style constraints** (to curb concentration and lock-in), and an integrated **policy portfolio** that combines multiple instruments. Across simulations, single-instrument interventions improve targeted dimensions (e.g., subsidies raise openness; Pigouvian taxes reduce harm), but they leave residual failures in the other channels and often shift distortions rather than eliminating them. In contrast, the **multi-instrument portfolio** consistently delivers the highest welfare by jointly narrowing the PGI gap: it expands access and diffusion, internalizes external costs, and mitigates path dependence and market tipping—thereby achieving the strongest and most stable system-level improvements.