Data-Driven Quality and Market Dynamics in Digital Economies

Doctoral School: Doctoral School in Societies, Humanities, Arts and Literature (ED SHAL)

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Subject description:

Data has become a vital asset for firms aiming to enhance product quality in recent years. This is particularly true for digital products, which inherently generate user data that can be stored, aggregated, and transformed into valuable data pools. For many AI-powered digital products, maintaining a large and up-to-date data pool is essential for effectively training algorithms and ensuring high product quality. Consequently, there exists a direct positive relationship between both the size and recency of the data pool and the quality of AI-driven products.

Furthermore, product quality is positively linked to consumer demand. When the use of a digital product generates additional data, a positive feedback loop can emerge: higher quality leads to greater usage, which in turn produces more data, further enhancing product quality. This mechanism has significant implications for the evolution of market dynamics, particularly in digital and data-intensive industries.

The proposed dissertation project aims to investigate the interdependent relationships between product usage, data accumulation, and product quality dynamics in greater detail. The project is structured around three core aspects, each of which will be addressed in a dedicated part of the project.

1. Incentive Schemes of Firms in Competitive Market Environments

This first part of the project will examine the pricing strategies of firms competing in markets characterized by a positive feedback loop between product usage, data accumulation, and product quality. It explores how this dynamic may create intertemporal incentives for firms to adopt aggressive pricing strategies—such as setting very low prices or even offering products for free during early periods—to rapidly accumulate data. These strategies can improve product quality and potentially enable firms to gain a competitive advantage over time. A differential game approach could be employed to model the dynamic incentives of firms in pricing strategies.

2. The Effect of a Positive Quality Data Feedback Loop on Market Dynamics

Building on the insights from the first part, the second part of the project will develop an agent-based industry model in which heterogeneous firms compete within a dynamic market environment. The model incorporates a quality-data feedback loop, allowing for the endogenous evolution of firm performance. Using simulation experiments, the study will examine how this mechanism influences key market outcomes, including market concentration, price dynamics, and average product quality over time.

Additionally, it will investigate whether data joint ventures or data pooling arrangements among lagging firms can serve as effective strategic responses to close the performance gap with market leaders. These findings will contribute to understanding the potential of cooperative data strategies to support more balanced and competitive market structures.

From a welfare perspective, the interaction of strategic pricing and the data feedback loop may generate an intertemporal trade-off: while aggressive pricing strategies in the short term can enhance consumer surplus – by lower prices and data driven quality improvements – diverging quality dynamics between firms may contribute to increasing market concentration over time. In the long run, this concentration can enable dominant firms to leverage their market power, potentially undermining initial consumer benefits through diminished competition and reduced innovation. The project will examine the policy and regulatory implications of the positive feedback loop between data accumulation and product quality.

3. Digital Platforms, Data Feedback Loop, and Value Extraction

The third part of the project aims at extending the model developed in the second part by introducing a digital platform. In this setting, firms can choose between two distribution channels: individual distribution or distribution via the digital platform. A key assumption is that the marginal cost of producing the digital product is effectively zero. Firms opting for individual distribution must maintain their own digital infrastructure, which entails fixed costs. In contrast, selling via the platform eliminates the need for infrastructure but incurs a revenue-based fee charged by the platform.

An important distinction between the two channels lies in data ownership and access. Firms that distribute their products independently retain full access to the user data they generate. However, firms that sell through the platform do not have direct access to user data, as it is collected and controlled by the platform operator. The platform may choose to offer access to this data to participating firms, but only in exchange for additional fees.

The sub project will explore various static and dynamic scenarios of platform utilization, as well as alternative pricing policies of the platform. Particular attention will be given to the implications of platform participation on industry dynamics among suppliers, including shifts in competitive positioning and access to data. The analysis will also examine the extent to which the platform is able to extract value from participating firms through its control over distribution and data access. In addition, the sub project will consider potential regulatory interventions aimed at mitigating negative welfare effects, such as market concentration, data asymmetries, and excessive platform rents.

Literature Contribution:

This thesis proposal contributes to multiple strands of literature. First, it engages with the broad and expanding body of research on the risks and opportunities associated with artificial intelligence. Brynjolfsson et al. (2019), for example, take a more optimistic perspective, characterizing AI as a general-purpose technology (GPT) with far-reaching implications for productivity growth and economic transformation. In contrast, Acemoglu (2023) adopts a more cautious view, identifying several domains in which the continued unregulated development of AI may lead to harmful consequences. Beyond its potential impacts on labor markets, democratic institutions, and public discourse, Acemoglu raises significant concerns regarding the control and ownership of data and information—particularly how these dynamics can distort competition and shift economic surplus from users to dominant digital platforms.

Second, the proposal contributes to the literature on digital markets, particularly with respect to their structural tendency toward concentration. A substantial body of research has examined how digital markets frequently give rise to dominant firms. This literature identifies several key features that contribute to winner-takes-all dynamics: direct and indirect network effects, privileged access to vast amounts of data, advanced machine learning capabilities, and high switching costs that create strong consumer lock-in (e.g., Barwise & Watkins, 2018; Calvano & Polo, 2021). A related subfield focuses on data-driven market power, wherein firms gain competitive advantages through superior access to and processing of data (e.g., Fumagalli et al. 2019, Gans, 2024). Some contributions further conceptualize data as a by-product of economic activity and examine the role of data feedback loops, wherein data enhances firm efficiency, enabling data-savvy firms to become more productive, grow more rapidly, and consequently accumulate even more data. Such mechanisms can significantly amplify market dominance, reinforcing the advantages of leading firms over time (e.g., Farboodi, Jarosch, & Shimer, 2019).

A central strand of this thesis relates to the literature on platform economies and two-sided markets, which has become increasingly prominent in the analysis of digital economies. The economic foundations of two-sided markets were formally introduced by Rochet and Tirole (2003, 2006), who show that pricing and investment strategies in such markets differ fundamentally from those in traditional one-sided markets due to the presence of cross-group externalities. Related work by Caillaud and Jullien (2003) and Armstrong (2006) further explores the competitive dynamics and strategic decisions of platforms. More recent contributions have extended this literature to examine how platforms leverage data and algorithmic capabilities to scale their operations, reinforce market dominance, and extract economic rents (e.g., Evans & Schmalensee, 2016, Bergemann and Bonatti, 2024).

This thesis proposal contributes to the existing literature by emphasizing the dynamic and strategic dimensions of data-driven feedback loops. Specifically, it explores the interdependence between product usage, data generation, and product quality, extending current models by analyzing how firms' pricing strategies affect data accumulation and, in turn, shape the evolution of product quality and market performance. By employing an agent-based simulation framework, the study offers enhanced flexibility to incorporate key mechanisms—such as firm heterogeneity, platform effects, and data access constraints—allowing for a more comprehensive and nuanced investigation of market dynamics.

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