

# On the Determinants of Platform Boundary: A Study from the Perspective of Transaction Cost Theory

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## ABSTRACT

In the digital economy era, the rapid expansion of internet platforms has resulted in highly concentrated market structures in online markets, thereby eliciting intensified scrutiny from regulatory authorities. In this paper, we aim to explore the key factors that shape the boundaries of platform firms by extending the transaction cost theory. We first define the boundaries of platform enterprises and provide specific measurement methods for their boundaries. By analyzing the distinctions between platform enterprises and manufacturing firms, we adapt the classical transaction cost theory to identify the key determinants of platform enterprise boundaries across three dimensions: data assets and digital technology, network effects, and organizational models. Finally, we offer policy recommendations to foster the healthy development of the platform economy based on our theoretical analysis. Our study highlights the critical role of platform boundary decisions within the framework of crowd science, as they fundamentally shape how diverse smart entities are coordinated on the platform to impact resource allocation efficiency and market stability.

## KEYWORDS

transaction cost; platform enterprises; platform boundary

In the digital economy era, the rapid expansion of internet platform boundary has led to pronounced monopolistic market structures. A highly concentrated market structure is widely regarded as a primary driver of monopolistic behavior among platform firms such as exclusive agreements, data-driven discriminatory pricing, algorithmic collusion, and self-preferencing, thereby eliciting intensified scrutiny from regulatory authorities. To address these issues, it is imperative to begin by defining the boundaries of platform enterprises in practical terms and analyzing the factors that shape them. Clarifying these matters is fundamental to enhancing the quality and efficiency of platform economy governance and promoting high-quality development in the digital economy.

Originating in the industrial economy era, transaction cost theory explains why firms exist and how their boundaries are determined. Firms must weigh the trade-offs associated with transaction costs, which ultimately influence firm size, i.e., the boundary of the firm. Inspired by this, we construct a theoretical framework for the boundaries of platform enterprises. We provide a practical definition of platform enterprise boundary and measure it quantitatively in both absolute and relative terms. Furthermore, we examine the mechanism which determines platform enterprise boundary from the dimensions of assets, transactions, and markets. We analyze the impact of data assets, digital technology, network effects, and organizational models on platform enterprise boundaries. The goal of this paper is to fundamentally promote the healthy development of platform enterprises.

The determination of platform boundaries is not only a central issue in industrial organization and transaction cost economics in the digital economy era, but also holds significant implications for

the emerging field of crowd science. Crowd science focuses on understanding how diverse smart entities—composed of individuals, enterprises, and governmental agencies—can be effectively coordinated to enhance the stability of the economic system and the efficiency of resource allocation. Digital platforms, acting as pivotal intermediaries and organizers, are quintessential governance mechanisms where such coordination occurs. Their boundary decisions directly govern the scale, scope, and operational rules through which these heterogeneous entities interact, transact, and collaborate. Consequently, understanding the determinants of platform boundaries, as explored in this study through the lens of transaction cost theory extended to platform features (data assets and digital technology, network effects, and organizational models), provides crucial insights into the crowd science objective of optimizing large-scale, multi-entity coordination for systemic stability and efficiency.

## 1 Literature Review

In the 1930s, the interplay among traditional economics, legal studies, and organizational theory became a central focus of academic inquiry, leading to the emergence of transaction cost economics. The concept of transaction costs was initially introduced by Coase<sup>[1]</sup>. In his seminal paper, “The Nature of the Firm”, Coase<sup>[1]</sup> argued that transaction costs are the costs of organizing production through the price mechanism. Regarding the determinants of transaction costs, Williamson<sup>[2]</sup> identified critical variables to characterize a transactions. The three key variables of transactions are: asset specificity, transaction frequency, and uncertainty. Asset specificity refers to the extent to which an asset can be redeployed to alternative uses and users without sacrificing its productive value. Transaction frequency

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denotes the number of times a transaction occurs within a given period, which influences the relative costs of transactions. Uncertainty arises from both the unpredictability of the transaction environment and the behavioral unpredictability of the transacting parties.

Regarding the boundary of the firm, Coase<sup>[1]</sup> argued that the choice between market and hierarchy is primarily determined by differences in transaction costs. Firms will continue to expand until the cost of organizing an additional transaction internally equals the cost of conducting the same transaction through the open market or within another firm. Williamson<sup>[3]</sup> addressed the issue of vertical boundaries of the firm from the perspective of asset specificity. Williamson<sup>[3]</sup> viewed the firm as a vertically integrated entity, arising from incomplete contracts in continuous production processes. When contractual relationships are incomplete, vertical integration can effectively mitigate or reduce opportunistic behavior stemming from asset specificity, owing to its advantages in administrative control and adaptability. Williamson<sup>[4]</sup> conceptualized the firm as a governance structure that holds a comparative advantage in managing transactions involving high-frequency. However, this comparative advantage is undermined by incentive distortions and the impossibility of selective intervention, which limits the firm's ability to expand indefinitely. Williamson<sup>[5]</sup> posited that an increase in uncertainty does not affect non-specific transactions. However, for transactions involving specific investments, when uncertainty is high, a contingency mechanism acceptable to both parties must be designed to ensure that they can negotiate on equal footing when unforeseen events occur. Such additional contractual provisions inevitably increase transaction costs. In summary, Williamson<sup>[3-5]</sup> constructed an analytical framework based on the three dimensions of asset specificity, transaction frequency, and uncertainty to distinguish between firms, markets, and hybrid organizations. This framework has been widely supported by empirical evidence.

Entering the 21st century, China's platform economy has gradually emerged. As a novel economic model, the platform economy is characterized by economies of scale, economies of scope, network externalities, multi-sided markets, and big data analytics<sup>[6]</sup>. These features collectively foster the rise of large-scale "super platforms" with significant market power<sup>[7]</sup>. Such firms often dominate multi-sided markets, triggering growing concerns across society regarding monopolistic practices and unfair competition<sup>[8]</sup>. Against this backdrop, the question of platform firm boundary has attracted increasing attention from both academia and industry.

A central question in this field is whether the analysis of platform boundary should continue to follow the traditional Transaction Cost Economics (TCE) framework or instead incorporate alternative theoretical perspectives. Gawer<sup>[9]</sup> explored the factors influencing how digital platforms define and adjust their boundary, arguing that platform scope, the users on both sides of the platform, and digital interfaces jointly shape these boundary. Boudreau<sup>[10]</sup> suggested that platform boundary can be flexibly managed through modular architectures and dynamic governance rules. Sun<sup>[11]</sup> based on transaction cost theory, proposed that the decision-making criterion for the boundary expansion of internet firms is to minimize the sum of internal and external transaction costs after the completion of transactions. Wang<sup>[12]</sup> argued that platform firms possess dual attributes of transaction and innovation, and the boundary of platform are determined by the interplay of Transaction Cost Economics (TCE), Resource-Based View (RBV), and the cross-side network

effects of platforms. Thus, starting from transaction cost theory, linking the characteristics of the platform economy, such as network effects, with the issue of platform boundary has become a pivotal point for theoretical innovation.

## 2 Definition and Measurement of Platform Boundary

Based on the current research landscape regarding the boundary of platform firms, we take the characteristics of platform firms as its starting point to propose a conceptual framework for understanding the boundary of platform firm. Specifically, the boundary of platform firms is further categorized into horizontal boundary and vertical boundary. Building on this framework, we introduce methods for measuring both the absolute and relative boundaries of platform firms. These methods are then applied to calculate the absolute and relative boundary of three distinct types of platform firms.

### 2.1 Definition of platform boundary

A defining characteristic of platform firms, which distinguishes them from traditional firms, is their dual nature as both enterprises and markets. On one hand, platform firms operate as profit-maximizing enterprises, acting as market participants. On the other hand, they function as market organizers, facilitating transactions between supply and demand sides in two-sided markets through digital platforms. Additionally, platform firms possess significant advantages over traditional firms in terms of data and digital technologies. One key feature of data is its near-zero replication cost, while digital technologies substantially reduce transaction costs in processes such as search, production, and transportation of digital products<sup>[13]</sup>. Given these factors, the framework of transaction cost theory for defining firm boundary exhibits certain limitations in the context of the digital economy. Against this backdrop, we define the boundary of platform firms as the scale boundary determined by production factors such as data and digital technologies.

We further divide the boundary of platform firms into horizontal and vertical boundary. The horizontal boundary refers to the collection of related products or services offered by a platform firm. Platform firms often expand their horizontal boundary by horizontally merging or replicating related products or services, thereby extending their operations into adjacent markets. In contrast, the vertical boundary refers to the collection of products or services provided by a platform firm that lie within the same value chain. Platform firms typically expand their vertical boundary by vertically integrating products or services from upstream or downstream platforms within the same value chain. In summary, the horizontal boundary of platform firms focuses on the business level, while the vertical boundary emphasizes the value chain level.

### 2.2 Measurement of platform boundary

Based on the definition, the boundary of platform firms are essentially scale boundary. Traditional measures of firm scale include total assets, revenue, and the number of employees. Unlike traditional firms, platform firms provide services to users through internet platforms, making user scale a significant reflection of their size. Therefore, we use the number of users as one of the indicators to measure a platform firm's market share in relevant markets. Additionally, for transaction-oriented platforms, Gross Merchandise Volume (GMV) or sales revenue serves as a suitable measure of scale.

To measure platform firm boundary from different

perspectives, the boundary is further divided into absolute boundary and relative boundary. Given the significant differences in the overall size of different markets, relative boundary provides a more accurate reflection of the relative size of boundary among different platform firms of the same type. We define the relative boundary as the ratio of a platform firm's user base or transaction volume (sales revenue) to the total number of users or total transaction volume (total sales revenue) in its respective country or industry. Based on this analysis, Table 1 presents the formulas for measuring boundary of platform firm.

We measure the boundary of three typical types of platforms: social platforms, content platforms, and transaction platforms. Regarding the selection of measurement metrics, it is essential to conduct a specific analysis based on the sample firms. For both social and content platforms, which are user-centric, we select the number of monthly active users (MAU) as the core metric for measuring their boundary. It is important to note that, given the globalized development trend of social platforms, the total number of global social media users is chosen as the metric for measuring the market size of such platforms when calculating their relative scale. Additionally, unlike non-subscription based platforms such as TikTok and Netflix, as a subscription-based streaming platform, it is better represented by its global paid subscription user count rather than MAU. For transaction-oriented platforms, which primarily provide online transaction services, both MAU and Gross Merchandise Volume (GMV) or net sales revenue can serve as core metrics for measurement. Since Amazon's financial reports disclose net sales revenue, we use net sales data to calculate Amazon's absolute and relative boundary. Considering data availability and comparability, we select data from 2021 to measure the absolute and relative boundary of the three types of platform firms. Table 2 presents the specific measurement results.

### 3 Determinant of Digital Platform Boundaries

The determination of firm boundaries is a central issue in

transaction cost theory. Williamson<sup>[2]</sup> linked transaction dimensions to the problem of firm boundary, arguing that asset specificity, transaction frequency, and uncertainty influence transaction costs, thereby shaping firm boundary. These three factors can be broadly categorized into three dimensions: assets, transactions, and markets. Based on this framework, we further clarify the determinants of platform firm boundary from a theoretical perspective by analyzing the unique characteristics of platform enterprises in terms of assets, transactions, and markets.

#### 3.1 From asset specificity to data assets and digital technologies

In the industrial economy, transaction cost theory posits that the higher the degree of asset specificity, the lower the cost of completing transactions within the firm, and thus the larger the firm boundary. Table 3 identifies asset-dimension determinants of industrial enterprise boundary and potential constraints. From the perspective of asset dimensions, the boundary of internet platform firms is more influenced by data assets and digital technologies, with the importance of asset specificity diminishing. In the era of the digital economy, platform firms can not only leverage the acquisition, storage, processing, and analysis of a certain scale of data to support their business decisions, but also optimize operations through the application of digital technologies. As a result, the data and digital technologies possessed by platform firms exhibit asset-like properties. Compared to traditional assets, data assets are non-rivalrous, and digital technologies are more versatile, which consequently leads to a larger firm boundary for platform firms.

For platform enterprises, data assets and digital technologies reduce transaction costs in the following ways: First, consumers can quickly find and purchase the goods or services they need through digital technologies, significantly reducing search costs. Second, platform enterprises can use big data, cloud computing, and other digital technologies to analyze transaction data, enabling them to better understand consumer demand. This allows for

**Table 1 Measurement formulas for platform enterprise boundaries.**

| Type of index              | Absolute boundary                         | Relative boundary                                                                     |
|----------------------------|-------------------------------------------|---------------------------------------------------------------------------------------|
| Based on user count        | Absolute user count                       | User count/Total user count in the market                                             |
| Based on transaction value | Absolute transaction value (sales volume) | Transaction value (sales volume)/Total transaction value (sales volume) in the market |

**Table 2 Measurement results of boundary for three types of platform enterprises.**

| Type of platform       | Platform | Measurement formula of absolute boundary | Result of absolute boundary | Measurement formula of relative boundary                               | Result of relative boundary (%) |
|------------------------|----------|------------------------------------------|-----------------------------|------------------------------------------------------------------------|---------------------------------|
| Social platform        | Facebook | MAU                                      | 2.91 billion users          | MAU/Total number of global social media users                          | 63.03                           |
|                        | WeChat   | MAU                                      | 1.27 billion users          | MAU/Total number of global social media users                          | 27.45                           |
| Content platform       | Netflix  | Global paid subscribers                  | 0.22 billion users          | Global paid subscribers/Total number of US streaming media subscribers | 65.29                           |
|                        | Douyin   | MAU                                      | 0.67 billion users          | MAU/Total number of global social media users                          | 73.04                           |
| Transactional platform | Taobao   | GMV                                      | 8.12 trillion RMB           | GMV/Total e-commerce GMV in China                                      | 19.24                           |
|                        | JD.com   | GMV                                      | 3.29 trillion RMB           | GMV/Total e-commerce GMV in China                                      | 7.80                            |
|                        | Amazon   | Net sales                                | 0.47 billion US dollars     | Net sales/Total e-commerce sales in the US                             | 51.95                           |

**Table 3 Mechanism and potential problems of industrial enterprise boundary: Asset dimension.**

| Key attribute     | Mechanism                                                               | Potential problem                                                                                                                                       |
|-------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| Asset specificity | The stronger the asset specificity, the larger the platform's boundary. | The non-rivalry of data assets and the general purpose nature of digital technology reduce the importance of asset specificity in the platform economy. |

more effective matching of consumers with merchants, thereby improving the efficiency of product or service matching and further lowering transaction costs. Third, digital technologies empower platform enterprises to streamline processes such as product sale, logistic, and after-sale service. By leveraging these technologies, platform enterprises can tightly regulate merchants' business practices, greatly reducing the likelihood of transaction disputes and further decreasing post-transaction costs. Overall, the widespread application of data assets and digital technologies greatly reduces transaction costs in areas such as information search, which in turn expands the boundary of platform enterprises.

However, data assets and digital technologies can also have a negative impact on platform enterprises' boundary. First, as the volume of data increases, existing digital technologies may struggle to support the complex data, leading to higher storage and processing costs. Second, since user data may involve personal privacy information, platform enterprises must comply with data protection regulations and use technologies such as data encryption to protect sensitive data. This process incurs additional costs related to compliance audits and other related activities. From this perspective, when data assets and digital technologies reach a certain stage, they may result in increased transaction costs, which could negatively affect the boundary of platform enterprises. Table 4 identifies asset-dimension determinants of platform enterprise boundary.

### 3.2 From transaction frequency to network effects

According to transaction cost theory, an increase in transaction frequency leads traditional firms to internalize transactions to save on transaction costs. Table 5 identifies transaction-dimension determinants of industrial enterprise boundary and potential constraints. From the perspective of transaction dimensions, network effects are a decisive factor in the boundary of platform firms. The platform economy is a typical example of a two-sided market, characterized by network effects and other features that distinguish it from traditional one-sided markets. Network effects refer to the phenomenon where the utility a user derives from a product or service changes with the number of users adopting the same product or service. These effects can be further categorized into direct and indirect network effects<sup>[14]</sup>. Platform firms achieve

the aggregation of transaction users and a reduction in transaction costs by stimulating network effects among bilateral or multilateral users<sup>[15]</sup>.

Direct network effects, which arise among users of the same type, drive the continuous expansion of the scale boundary of platform firms. If the formation of user networks is viewed as a dynamic process, early users establish an installed base, and subsequent users tend to join networks with larger installed bases<sup>[16,17]</sup>. As more users join and the installed base reaches a critical threshold, a positive feedback mechanism emerges under the influence of direct network effects. This positive feedback mechanism further triggers lock-in effects and increases consumer switching costs, ultimately leading to a "winner-takes-all" Matthew effect<sup>[18]</sup>, which drives the expansion of the platform boundary.

Indirect network effects, which arise among users of different types, have a positive impact on the boundary of platform firms. In platform firms where indirect network effects are present, users of different types influence each other, and the utility one type of user derives from the platform is affected by changes in the scale of other user types. Taking transaction-oriented platform firms as an example, under the influence of indirect network effects, a larger number of consumers on the platform increases the profit potential for merchants, attracting more merchants to join. Similarly, a greater number of merchants expands the variety of products and services available, enhancing the utility consumers derive from the platform and attracting even more consumers. As a result, under the influence of indirect network effects, the scale of bilateral users on the platform continues to grow, leading to the expansion of the platform boundary. Table 6 identifies transaction-dimension determinants of platform enterprise boundary.

### 3.3 From uncertainty to organizational models

Based on transaction cost theory, the uncertainty stemming from the behavior of transactors and the transaction environment determines the boundary of traditional firms. Table 7 identifies market-dimension determinants of industrial enterprise boundary and potential constraints. In response to the various uncertainties in platform markets, platform firms typically adopt different organizational models to address these challenges. There are three common organizational models: the first is the integrated model,

**Table 4 Mechanism of platform enterprise boundary: Asset dimension.**

| Key attribute                      | Mechanism: Expand boundary                                                                                                                                                                                                       | Mechanism: Shrink boundary                                                                                                                                                                                                      |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data assets and digital technology | Data assets and digital technology help reduce consumers' information search costs, improve supply-demand matching efficiency, and lower post-transaction costs, thus prompting platform enterprises to expand their boundaries. | When a platform enterprise owns too much data and digital technology, it may bring corresponding data storage, processing costs, and compliance costs, thus having a negative impact on the boundaries of platform enterprises. |

**Table 5 Mechanism and potential problems of industrial enterprise boundary: Trading dimension.**

| Key attribute         | Mechanism                                                                                                                                                                           | Potential issue                                                                                                                                                                                                                                                |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Transaction frequency | Under certain conditions, the higher the trading frequency, the more inclined companies are to choose an integrated governance structure, resulting in larger corporate boundaries. | Network effects have a more direct and significant impact on the boundary of platform enterprises. The existence of network effects can lead to changes in the price structure of the two-sided market, thus affecting the transaction volume of the platform. |

**Table 6 Mechanism of platform enterprise boundaries: Trading dimension.**

| Key attribute  | Mechanism: Expand boundary                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Network effect | When the installation base reaches a critical value, under the direct network effect, to gain greater utility, more users join the platform, continuously expanding the boundaries of the platform enterprise. Due to the mutual promotion of the utility of different types of users, under the indirect network effect, the growth of the user base on one side drives the growth on the other side, achieving growth in the user base on both sides, thus expanding the boundaries of the platform enterprise. |

**Table 7 Mechanism and potential problems of industrial enterprise boundary: Market dimension.**

| Key attribute | Mechanism                                                        | Potential issue                                                                                                                                                                                                                                                                                                                          |
|---------------|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Uncertainty   | The greater the uncertainty, the larger the platform's boundary. | One of the basic characteristics of the platform economy is that it belongs to a two-sided market. Thus, to cope with the shocks of uncertainty on both supply and demand, platform firms adopt different organizational models. In the market dimension, platform firms are more distinguished by differences in organizational models. |

which expands upstream and downstream along the value chain; the second is the market model, which solely acts as a provider of the transaction platform without directly engaging in transaction activities; and the third is the hybrid model, which lies between the two.

Different organizational models have distinct advantages in addressing uncertainties on both the supply and demand sides. Market-oriented platform firms are more proactive and agile in responding to uncertainties arising from the demand side. For market-oriented platform firms, the larger the number of active users and the greater the transaction volume in their online markets, the higher the advertising revenue and transaction service fees they can generate. Therefore, market-oriented platform firms tend to continuously expand their boundary to achieve profit maximization. In contrast, integrated platform firms have a clear advantage in dealing with uncertainties on the supply side. To better coordinate the interests of various stakeholders, integrated platform firms must exercise effective control over platform participants and the products or services offered. To achieve this, integrated platform firms often focus on a specific niche market rather than indiscriminately expanding the variety of goods or services. As a result, the scale boundary of integrated platform firms tends to be smaller. Hybrid platform firms combine the characteristics of both market-oriented and integrated platform firms. The boundary of hybrid platform firms falls in the middle range, as a moderate boundary not only provides strong individual incentives for participants within the platform, but also enables effective coordination of goods or services to a certain extent. Table 8 identifies market-dimension determinants of platform enterprise boundary.

Organizational models are also related to the horizontal boundary and vertical boundary of platform firms. Taking the market-oriented platform Taobao as an example, Alibaba started with Taobao and expanded its business into related fields such as the third-party payment services, local life services, and information services, demonstrating significant horizontal boundary expansion. In contrast, the integrated platform JD.com primarily focuses on expanding along the value chain by establishing its own logistics system and providing financial services to suppliers, thereby extending its vertical boundary.

From a broader perspective, the determinants of platform firm boundary across the three dimensions exhibit certain intrinsic connections. On one hand, network effects and data assets, along with digital technologies, mutually reinforce each other. The

presence of network effects leads to a continuous increase in the number of platform users, thereby generating more data assets. On the other hand, driven by data assets and digital technologies, the organizational models of platform firms are also evolving. Digital platforms, supported by digital technologies, enable firms to integrate formal structures of offline organizations into online virtual spaces and achieve efficient coordination between online and offline operations. This enhances internal efficiency and helps firms better respond to external uncertainties<sup>[19]</sup>.

## 4 Conclusion and Implication

The boundary of the firm is one of the critical topics in modern firm theory. We extend and refine the transaction cost theory framework regarding firm boundary by incorporating the characteristics of platform firms, primarily addressing two fundamental questions: "How are the boundary of platform firms defined and measured?" and "How are the boundary of platform firms determined?" The study finds that: (1) in the asset dimension, the boundary of platform firms is determined by data assets and digital technologies; (2) in the transaction dimension, direct and indirect network effects play a decisive role in defining and expanding the boundary of platform firms; and (3) in the market dimension, platform firms exhibit different organizational models, which determine their boundary.

Based on prior theoretical analysis, the following policy recommendations are proposed to promote the healthy and sustainable development of the platform economy. First, recognize the role of data assets, digital technology, and network effects in determining the scale of platform enterprises. Be vigilant about the potential for early-entering platforms to leverage their first-mover advantages in these areas to expand their scale excessively, leading to a highly concentrated market structure. Second, tailor the regulation of platform enterprises to their organizational models. For transaction-oriented platforms, a certain degree of expansion in their business scope should be permitted. In contrast, integration-oriented platforms should be guided to focus on core areas and avoid over-expansion.

Admittedly, this study has two main limitations. First, although it delineates the boundary of platform enterprises from both horizontal and vertical dimensions, it does not provide a quantitative assessment of these boundaries. Second, due to limitations in data availability, the proposed mechanisms underlying the determination of platform boundary have not been

**Table 8 Mechanism of platform enterprise boundary: Market dimension.**

| Key attribute        | Mechanism                                                                                                                                                                                                       |                                                                                                                                                                                                            |                                                                                                                                                                                                                                       |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                      | Market-oriented organizational model                                                                                                                                                                            | Hybrid organizational model                                                                                                                                                                                | Integrated organizational model                                                                                                                                                                                                       |
| Organizational model | Market-oriented platform enterprises effectively motivate merchants by granting them greater decision-making power, and they tend to choose larger scale boundaries to better handle demand-side uncertainties. | Hybrid platform enterprises combine market-oriented and platform-oriented characteristics. They can achieve both individual incentives and synergies, making them well-suited for medium scale boundaries. | Integrated platform enterprises coordinate and control platform participants and complementarities to realize synergies and mutual benefits. They tend to choose smaller scale boundaries to better handle supply-side uncertainties. |

empirically tested using large-scale data. Future research should aim, on one hand, to develop more feasible and operationalizable indicators for measuring horizontal and vertical boundaries, thereby enabling a quantitative analysis of platform boundaries; and on the other hand, to collect longitudinal data to empirically examine the dynamic mechanisms that shape the evolution of platform boundaries over time.

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