

Information Advantage, Differentiated Pricing and Consumer Surplus: Algorithm Driven Dynamic Pricing of Online Ride Hailing Platforms

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Abstract. With the development of digital platforms, algorithmic dynamic pricing has been gradually applied to ride-hailing and other markets. Taking ride-hailing platforms as the research object, this paper analyzes how platforms leverage consumer demand differences and information advantages to implement dynamic pricing based on third-degree price discrimination, two-sided market theory and game theory, and discusses its impacts on market equilibrium and consumer surplus. The differences in consumers' willingness to pay and price elasticity provide the basis for the platform to implement differentiated pricing, and the information advantage of the platform further enhances its price adjustment ability. In the strategic interaction, dynamic pricing can not only adjust the relationship between supply and demand, but also transfer some consumer surplus to the platform. There are differences in the impact on high- and low-elasticity consumers. Therefore, this paper believes that dynamic pricing itself has a certain role in resource allocation, but when the advantages of algorithmic information are used for excessive differentiated pricing, it may damage consumer welfare. In this regard, regulatory measures including price constraints and algorithm information disclosure can curb the excessive expansion of platform pricing power while preserving the efficiency of dynamic pricing.

Keywords: algorithmic dynamic pricing, ride-hailing platform, price discrimination, platform supervision

1. Introduction

With the advancement of digital platform technology, algorithms have evolved from auxiliary tools into a crucial instrument for corporate pricing decisions. Ride-hailing and flight-ticket platforms conduct real-time price adjustments based on supply, demand and market conditions, establishing dynamic pricing as an essential modern pricing mechanism. Traditional static supply-demand equilibrium theory focuses on aggregate market influences on prices yet fails to explain real-time price fluctuations. In the ride-hailing market, platforms link passengers and drivers and hold notable information advantages, accelerating price adjustments and reshaping strategic interactions with consumers. Existing literature shows algorithmic pricing improves firms' market-driven price-adjustment efficiency, whereas personalized pricing may redistribute corporate profits and

consumer surplus. Focusing on ride-hailing platforms' algorithmic dynamic pricing, this paper examines two core questions: how equilibrium prices form given heterogeneous consumer price elasticities and variable platform information, and how consumer surplus changes as platforms deploy information advantages for differentiated pricing. It further compares price-cap rules and algorithm information disclosure to identify consumer-protection measures that retain dynamic-pricing efficiency.

Existing studies mainly discuss dynamic pricing from the perspectives of price discrimination, personalized pricing, bilateral platforms, and consumer welfare. Manufacturers can adopt price discrimination according to differences in consumer demand, which provides a classic theoretical basis for analyzing algorithm-based differentiated pricing [1]. The concept of consumer surplus lays a foundation for further analyzing the influence of different pricing modes on consumer welfare [2]. Research suggests that personalized pricing driven by machine learning may raise corporate profits yet reduce the overall consumer surplus [3]. Evidence from taxi transaction data indicates that consumer heterogeneity shapes the welfare consequences of personalized pricing through consumer time-value factors [4]. Bilateral-market theory interprets how platforms serve and set prices for diverse market participants simultaneously [5]. Further research on platform competition explores pricing and competition mechanisms within bilateral markets, offering theoretical support for analyzing the two-sided attributes of ride-hailing platforms [6]. Technical research on spatio-temporal pricing algorithms further investigates ride-hailing pricing outcomes under the condition that drivers are allowed to reject order requests [7]. Research concerning dynamic pricing and matching mechanisms in ride-hailing platforms demonstrates that price adjustments exert influences on supply-demand matching and platform operational outcomes [8]. Additional marketing-oriented analysis reveals that algorithm-driven pricing will affect consumer trust and price-search behaviors in market transactions [9]. Additional research investigates how dynamic pricing affects market-equilibrium stability and welfare within stochastic ride-hailing networks [10].

Based on the above research, this paper takes the dynamic pricing algorithm of taxi Hailing platform as a specific case, combined with theoretical model, economic logic deduction and consumer welfare. With price discrimination and features of bilateral platforms, what's more, from the perspective of consumer surplus, this paper analyzes the impact of price elasticity changes on consumer welfare, and compares the effects of price ceiling regulation and algorithmic information disclosure as two regulatory methods. In fact, it provides an analytical framework for the algorithm supervision of digital platforms such as ride Hailing services, and suggests that the supervision work should focus on solving the problems of information asymmetry, algorithm transparency and extreme pricing in order to establish a more robust supervision mechanism.

2. Theoretical basis

Traditional microeconomics believes that market prices are determined by the supply and demand for goods or services. When consumers and producers make rational decisions based on prices, the market can reach an equilibrium through price adjustments. In traditional static equilibrium, consumers in the same market face uniform prices normally, while producers determine output and pricing based on demand. With advancements in digital platforms, these systems can continuously collect and process diverse data, enabling prices to adapt over time in response to demand and consumer characteristics. The theory of third-degree price discrimination refers to charging different prices for the same product across distinct markets, the premise is that consumers show different price elasticity. Producers tend to impose higher prices on consumers with inelastic demand, which is identified by users' historical behaviors, travel time and geographic location, so that traditional

price discrimination can be transformed into more dynamic and accurate differentiated pricing via algorithmic implementation.

The ride-hailing platform exhibits typical two-sided platform characteristics, connecting both passengers and drivers. Through this mechanism, the platform gains information advantages by harnessing vast volumes of transactions and user data. Compared to consumers who can only observe their own prices and possess limited market information, the platform can monitor market demand, historical transactions, and user behavior, enabling it to forecast demand fluctuations. In this study, the platform's pricing influences consumer purchasing decisions, while consumer demand also affects the platform's optimal pricing, resulting in strategic interdependence between the two parties. The rational firm profit maximization theory is the core of this model. Assuming the ride-hailing platform possesses rational decision-making capabilities, it aims to maximize expected profits. The platform does not simply pursue the highest prices but instead balances unit revenue with order volume.

3. Mechanism analysis of algorithmic dynamic pricing

3.1. Price discrimination and consumer surplus

Consumers with inelastic demand face higher prices given their low responsiveness to price changes, while elastic demand consumers receive lower prices to stimulate consumption. As shown in the diagram, firms apply one uniform price across the integrated market prior to price discrimination. Once consumers are segmented into sub markets, higher prices are set for inelastic demand groups and lower prices for elastic demand groups. Price discrimination raises total revenue (illustrated by graphical area notations), expands producer surplus and abnormal profits, and may spur long run dynamic efficiency through corporate reinvestment in innovation and quality improvement. This framework applies to ride hailing: users with urgent travel needs, who have few substitutes and low demand elasticity, tend to incur higher fares. For instance, a time pressured passenger with rigid arrival requirements differs in willingness to pay and price elasticity from flexible passengers who can opt for public transit. Traditional third-degree price discrimination requires firms to identify consumer groups, a process facilitated by digital platforms. Ride hailing platforms collect data on historical orders, travel features, cancellation records and price driven choices. Algorithms analyze such data to forecast user demand, enabling refined demand assessment beyond coarse consumer group categorization.

Consumer surplus refers to the gap between consumers' willingness-to-pay for a good or service and the actual price paid. As illustrated in Figure 1, equilibrium price P_1 denotes consumers' real payment, while the intercept of the demand curve on the y-axis marks the maximum willingness-to-pay; the shaded blue area corresponds to consumer surplus. Algorithmic systems collect and process user data to estimate consumers' expected valuations, enabling firms to maximize profits by setting prices close to consumers perceived maximum values. Under uniform pricing, consumers with higher willingness-to-pay capture greater consumer surplus. Once platforms detect consumer heterogeneity, they may raise charges for high-valuation users and divert part of consumer surplus into platform revenue. Personalized pricing raises corporate profits yet may reduce aggregate consumer surplus, with heterogeneous welfare outcomes across user groups. Two intertwined mechanisms operate within ride-hailing markets. Dynamic pricing's core function adjusts prices in response to aggregate supply-and-demand shifts. The second mechanism conducts refined price adjustments exploiting consumer demand differences, following the logic of price

discrimination. Growing reliance on this second mechanism further expands platforms' pricing power.

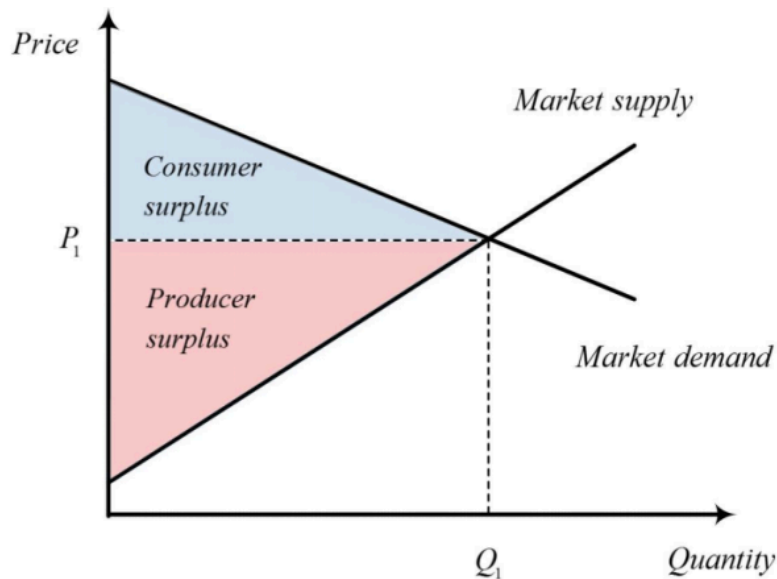


Figure 1. Consumer and producer surplus at market equilibrium (picture credit: original)

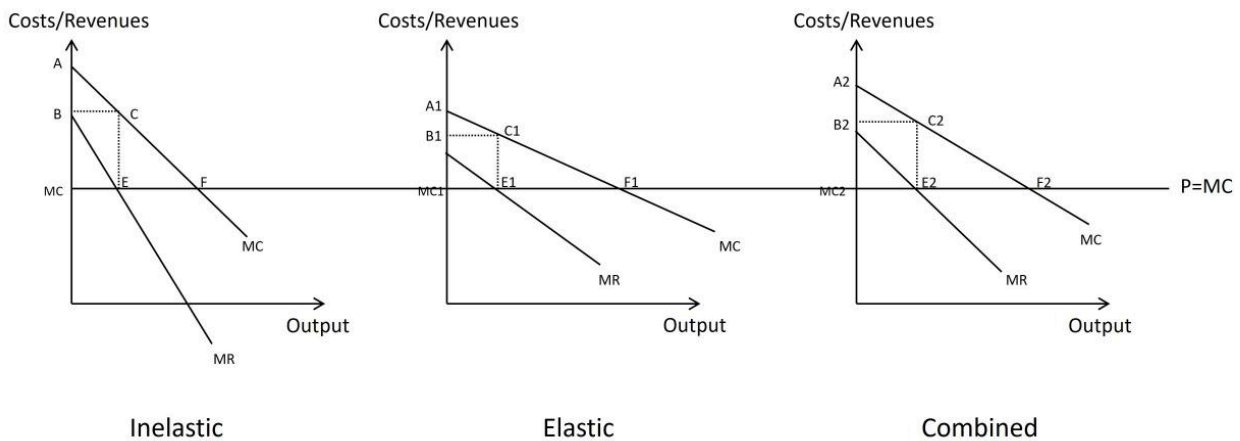


Figure 2. Consumer surplus under third-degree price discrimination (picture credit: original)

As shown in Figure 2, in the inelastic market, the equilibrium price is determined at C under profit maximization, corresponding to output at E. Therefore, consumer surplus is represented by triangle ABC. If the price falls to the marginal cost level Marginal Cost (MC), output expands from E to F, and consumer surplus increases to AMCF. Meanwhile, consumer surplus in the elastic market increases from A1B1C1 to A1MC1F1, which has a stronger effect on consumers with inelastic demand. In the combined market, consumers with different price elasticities coexist, and consumer surplus rises from A2B2C2 to A2MC2F2. These three figures illustrate that consumer surplus is compressed under personalized pricing to boost corporate profits, yet the impacts on different consumer groups differ. Therefore, in the ride-hailing market, there may be two mechanisms at the same time: the first layer is to adjust prices according to the changes in supply and demand in the overall market, which is the basic function of dynamic pricing. The second layer is to use the demand difference between consumers for more refined price adjustment, which reflects the logic of

price discrimination. When the second layer mechanism continues to strengthen, the pricing power obtained by the platform will also expand.

3.2. Bilateral platform features

Bilateral markets are centered around platforms and generate profits through two or more types of customers' interactions or transactions. Their core feature is the existence of cross-network externalities. In the case of ride-hailing platforms, the platform connects passengers and drivers, completing transactions through matchmaking between the two parties. Therefore, the platform is not selling one product to consumers, but organizing two interdependent markets at the same time. Two-sided market theory considers that platforms need to attract participants from both sides of the market simultaneously and determine price structures based on both sides' demand. This feature makes the price decisions of ride-hailing platforms significantly different from those of traditional manufacturers. For ride hailing platforms, prices charged to consumers also influence drivers' order acceptance behavior. Meanwhile, the scale of drivers and service supply further shape consumers' waiting time and travel experience. Dynamic pricing can help improve efficiency in the ride-hailing market. Price changes can regulate demand and supply, enabling the platform to respond to market changes in a short period of time. Algorithmic dynamic pricing does not mean that the platform is exploiting consumers, because price changes themselves may assume the function of coordinating market supply and demand.

Due to information asymmetry, consumers can usually only observe limited market information, while platforms can observe a large amount of transaction information from both passengers and drivers. For example, the platform can grasp the current order quantity, available driver quantity, historical demand changes, travel time, and consumers' past transaction behavior in a certain region. This grants platforms more comprehensive information relative to consumers. This information structure shows obvious characteristics of information asymmetry. Consumers know their willingness to pay, but often do not know how much information the platform has about them, nor can they fully understand why the algorithm gives a price at a certain time. The platform can assess market demand and consumers' reactions to price changes with this information advantage. This gives ride Hailing platforms two different levels of pricing power. The first category is dynamic pricing power at the market level: adjusting prices according to changes in overall supply and demand. The second category is differentiated pricing power at the consumer level: the platform uses the historical behavior and demand characteristics of consumers to determine the price sensitivity of different consumers, and makes more refined price decisions on this basis.

3.3. Game theory

Game theory expresses strategic choices among several interdependent participants. With high travel demand and limited driver supply, platforms may raise prices, giving consumers a choice between accepting higher fares or switching to alternative modes of transportation. Although rising prices have increased single revenue and alleviated supply and demand pressures by curbing some demand, excessive price increases may lead to widespread abandonment of orders and a reduction in total trading volume. The platform can choose to increase or maintain/reduce prices, while the consumer can choose to accept or reject orders. When the platform raises prices and consumers still accept orders, the platform can achieve higher returns; When the platform maintains or reduces the price, the revenue of the platform is relatively low, but consumers can get a higher consumer surplus. However, if consumers refuse orders, the transaction will not be completed, and neither the platform

nor consumers will get the benefits of the transaction. In this game context, when no one is encouraged to unilaterally adjust the strategy, Nash equilibrium will emerge. Due to the interaction between platform consumers, this equilibrium varies by consumer group, which depends on willingness to pay, demand urgency and price elasticity. Using historical data, the algorithm is able to use game theory decisions to update user behavior assessments. Accurate detection of consumer price elasticity differences enhances the information advantages of the platform and achieves finer grained pricing. Therefore, the algorithm is not an independent tool, but a key factor in reshaping the conditions of platform informatization.

To sum up, static game theory provides an important explanatory framework for the dynamic pricing of ride Hailing algorithms. Platforms and consumers do not make independent decisions, but balance mutual expectations and responses. As seen in Table 1, by improving the ability of the platform to analyse information, the algorithm enables the platform to predict consumer behavior more precisely, thus changing the original information conditions and pricing power. Equilibrium price will eventually affect consumer surplus through the price response of different consumers. Hence, the core problem of ride Hailing algorithm's dynamic pricing is not only price alternation, but also how information advantage changes the strategic interaction between platform and consumers, thus affecting the equilibrium price and consumer welfare.

Table 1. Payoff matrix of game between ride-hailing platform and consumers

Platform / Consumer	Accept the Ride	Reject the Ride
Raise Price	High payoff; Low consumer surplus	0; 0
Maintain / Lower Price	Medium payoff; High consumer surplus	0; 0

4. Conclusion

This study shows that algorithmic dynamic pricing is not simply a random change in price, but a pricing result formed by the platform after considering consumer demand heterogeneity, market supply and demand changes, and its own profits. Differences in consumers' willingness to pay and price elasticity create incentives for platforms to carry out differentiated pricing. The large amount of consumer behavior and market information possessed by the platform further enhances its ability to identify demand and adjust prices. Under incomplete information conditions, the platform needs to form an equilibrium price by predicting consumer demand. Further analysis of consumer welfare reveals that dynamic pricing is more likely to lead to a decrease in demand or even exit the market for high price elasticity consumers when prices rise. For consumers with low price elasticity, although their demand is more stable in response to price changes, they may still bear residual losses due to paying higher prices. Algorithmic pricing may generate significant residual redistribution effects. When platforms use information advantages for excessive differentiation pricing, relying solely on consumer autonomy and traditional market competition may not fully protect consumer welfare. It is necessary to establish stronger regulatory mechanisms.

The main contribution of this paper lies in constructing an integrated framework covering consumer heterogeneity, algorithm-driven information advantages, consumer welfare and regulatory policies. This framework facilitates the application of microeconomic theories to digital platform markets and offers new analytical perspectives for understanding algorithmic pricing issues within ride-hailing-oriented platform economies. The research in this article also indicates that algorithm regulation should not simply prohibit dynamic pricing, but should pay more attention to whether the

information advantages of the platform are excessively transformed, thus providing a theoretical basis for the combination of price regulation and algorithm transparency regulation. There are still certain limitations to this article, such as the fact that the internal algorithms of the platform are commercial secrets and cannot fully observe the pricing rules of the real platform. Future research can further introduce real transaction data and more complex game models to study the interaction between the platform, consumers, and drivers, and further compare the equilibrium results of algorithm pricing under different levels of market competition.

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