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Pricing strategies for a taxi-hailing platform

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ABSTRACT

Taxi hailing apps that facilitate taxi-customer matching quickly become popular in recent years. By combining the theories of two-sided market and taxi market, this paper models the taxi market in the presence of a single taxi hailing app through an aggregate and static approach. Based on the equilibrium model, the existence and stability of equilibria are examined, and a partial-derivative-based sensitivity analysis is conducted to quantitatively evaluate the impacts of the platform's pricing strategies to the taxi market performance. The features of desirable price perturbations that improve social welfare and/or the platform's profitability are also characterized.

1. Introduction

With the rapid development of mobile and wireless communication technologies, various taxi hailing applications (apps), such as Didi KuaiDi-taxi, Uber-taxi, and Ola Cabs, have emerged in recent years to global popularity. Now, unlike in previous days when people had to stand on the street to hail a taxi, customers can now publish their travel demand to nearby taxis through a taxi hailing app, and the taxis who are logged in the app can instantaneously receive the nearby demand and determine whether they would like to take the e-hailing orders or keep cruising and look for roadside hailing customers. The convenient and instantaneous information exchange facilitated by taxi hailing apps greatly mitigates the previous information barriers caused by spatial deviation between customers and taxi drivers, therefore is widely believed to be a powerful instrument for improving the taxi market efficiency.[1,2]

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[1] To some extent, taxi hailing apps play a similar role as a taxi call center in reducing information asymmetry between customers and taxi drivers. However, as radio-call orders are usually manually handled, the information exchange between customers and taxi drivers is not so convenient and speedy as through a taxi hailing app. In most cases, the taxi call center works in a dispatching mode, i.e., the center directly assigns vacant taxis to customers. While some of the existing taxi hailing apps work in the dispatching mode as well, this study focus on apps that works as an information platform (i.e., distributing e-hailing orders to nearby taxis, and allowing drivers to determine whether or not they take the order). Another difference between taxi call center and taxi hailing app is their operators. While the taxi hailing apps today are operated by platform companies, the taxi call centers are usually operated by taxi companies who have no clear incentive to increase radio-call orders. So the popularity of radio-call mode in the old days is not comparable with the popularity of e-hailing mode today.

[2] This advancement in information technology also facilitates matching between customers and part-time drivers, which allow many e-hailing apps, such as Uber, Didi Kuaidi and Lyft, to use private car drivers to provide taxi-like services. The participation of part-time drivers greatly increases the supply of taxi-like services and therefore improves customers' experiences by making taxi services more readily available. However, concerns over safety, road congestion, and the significant impact on the taxi industry are common. Whether or not private car drivers should be allowed to provide taxi-like service remains a controversial issue. Indeed, many countries, such as Germany, France and India, have banned low-cost Uber services. To be clear, in this study, we focus only on the pricing strategies of a taxi hailing app dedicated to the taxi industry.

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Existing taxi hailing apps can be mainly categorized into two types. The first type works as an information platform that distributes e-hailing orders to nearby taxis, and allows drivers to determine whether or not they take the order. The most popular e-hailing apps tend to adopt this model because it provides drivers with more freedom and is therefore more acceptable to drivers. The second type of e-hailing app works as a dispatching center and assigns orders to drivers based on a matching algorithm. Drivers must take the orders they are assigned. This model sacrifices drivers' freedom, but guarantees a much higher rate of successful matching, and is, therefore, more favorable to customers. In this study, we focus our study on taxi hailing apps that work as an information platform.

The popularity of taxi hailing apps relies not only on advanced technology, but also on pricing strategy. In order to increase the size of user pools, many taxi hailing apps provide subsidies to both customers and taxi drivers. For example, from January 10, 2014 to March 27, 2014, Didi and Kuaidi, the two most popular taxi hailing apps in China, spent over 2 billion RMB in subsidizing customers and taxi drivers. For each e-hailing order, both the customer and taxi driver received between 5 and 20 RMB (Chen, 2014). Such generous subsidies allowed some customers to receive free taxi rides and ultimately increased the total number of e-hailing accounts in China to over 49 million by the 2nd quarter of 2014 (CNNIC, 2014). Didi and Kuaidi merged into one company, Didi KuaiDi, in 2015, effectively capturing over 99% of the taxi hailing market share in China. However, even with over 3 million daily taxi orders transacted through their platform today, the company does not impose any positive charge on either taxi drivers or customers for fear of losing business, which clearly demonstrates the significance of pricing strategies in e-hailing apps.

As an information platform that connects customers and taxi drivers, a taxi hailing app can charge different rates[3] for customers seeking rides and taxis seeking passengers. Charging schemes can be based on membership and/or usage. If a platform charges based on membership, then users pay a set of membership fee up front and use the e-hailing service without incurring any further fees during the defined membership period. If a platform charges based on usage, then users pay the platform each time they use the app service. As almost all existing e-hailing apps only charge users for successful transactions, we restrict our attention to usage fees only, so that for each customer-taxi meeting facilitated by an e-hailing app, the app charges respective rates to both customers and taxi drivers.

Determining an appropriate pricing strategy can be difficult. Even after receiving generous subsidies from taxi hailing apps, customers will not continue to use the app if it is hard to find a taxi through the app, because customers consider not only the e-hailing charges and subsidies, but also waiting times. For example, if a taxi hailing app provides a 2 dollar subsidy to customers and then charges taxi drivers 2 dollars for each order, few taxi drivers may be willing to take e-hailing orders, causing customer waiting times from the e-hailing mode to be very long. Consequently, even though the taxi hailing app has provided subsidies to customers and completely sacrificed its profit with zero net income for each order, the transaction volume through the app would not be high due to the long customer waiting time. What if the platform increases its subsidies on the customer side to 5 dollars and meanwhile charges taxi drivers 5 dollars per order? Apparently, customers will be more stoic about long wait times in light of the increased subsidy, even while increased charges make taxi drivers ever more unwilling to take e-hailing orders. Increased subsidies and customer willingness to endure long wait times may make it more difficult for taxi drivers to find roadside-hailing customers. In this case, many taxi drivers may be forced to take e-hailing orders, and the transaction volume of the taxi hailing app could be increased even though the aggregate price level per order is the same as the previous example. Therefore, designing appropriate pricing strategies for an e-hailing platform is much more complex than that for a traditional commodity because it is necessary to determine not only an aggregate price for each order, but also the price share between customers and taxi drivers. According to Rochet and Tirole (2004), "*if holding constant the sum of the prices faced by the two sides, any change in the price share between the two groups [will] affect the volume of transactions*", then the market is called a two-sided market. In view of the above discussion, the markets in which customers and taxi drivers interact through an e-hailing platform is thus a two-sided market. A crucial factor in a two-sided market is cross-group (or inter-group) externality: "*the attractiveness of the platform to users in each group is governed by the number of users on the other side of the platform*" (Caillaud and Jullien, 2003; Parker and Van Alstyne, 2005; Armstrong, 2006). So in many cases in reality, a platform may even subsidize users on one side to attract users on the other side. And to expand their user pool at the beginning stage, more and more platforms choose to subsidize both sides of users.

Numerous two-sided markets, such as computer operating systems (e.g. Windows, iOS) which connect computer users and software developers, credit card services (e.g. Visa, MasterCard) which connect cardholders and affiliated merchants, and e-commerce platforms (e.g., Alibaba, e-bay) which connect retailers and consumers, have emerged in recent decades. However, the theory of two-sided markets (or, equivalently, platform economics) was not developed until the early 2000s. In 2004, Rochet and Tirole first pointed out the commonalities between seemingly different markets and provided a clear characterization of what constitutes a two-sided market. Rochet and Tirole (2004) then built a canonical model of two-sided markets in which one platform encompassed both usage and membership externalities. Caillaud and Jullien (2003), Rochet and Tirole (2003), and Armstrong (2006) explored platform competition under different shapes of utility and cost functions, investigated how the platforms' pricing strategy was affected by platform governance (for-profit vs. not-for-profit), the end users' cost of multi-homing, platform differentiation, the platforms' ability to use volume-based pricing, the presence of same-side externalities, and platform compatibility.

[3] In this study, charge rates could be positive or negative. Negative charge rates indicate subsidies.