Exclusive Contracts and Platform Competition: Evidence from Hong Kong Food Delivery Industry (Preliminary version. Do not criculate.)

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September 13, 2024

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Abstract

This paper examines the competitive and welfare implications of exclusive contracts on a two-sided food delivery platform in Hong Kong. Policymakers have expressed concerns about these contracts, which require restaurants to provide their services exclusively on a single platform in exchange for additional benefits. In theory, dominant platforms could use exclusive contracts to hinder the growth of weaker rivals in markets if there were strong network externalities. However, the overall impact on consumers, restaurants, and market competition remains empirically ambiguous.

We use detailed consumer digital receipt data from Hong Kong to estimate consumer preference and find that exclusive status significantly boosts the restaurant's chance of being chosen on the platform. The underlying mechanism seems to differ across platforms — some are "diminishing", where having more exclusive restaurants on the platform weakens its positive effect; others are "reinforcing", where the benefit of being exclusive is strengthened by a larger exclusive restaurant share. We illustrate that, in our setting, the can have opposite welfare implications.

We then use an equilibrium model of restaurants' exclusive status choices to evaluate the impact of exclusive contracts and conduct various counterfactual policies. First, the exclusive contract poses a prisoner's dilemma for restaurants: when banning exclusive contracts, both independent and chain restaurants on average receive more than 25% of orders every month, by letting consumers have more choices and in turn order more often. Second, if exclusive contracts were only allowed for less popular platforms, based on a policy proposal by the Hong Kong authority, there would be substantial catching-up in market share without significantly damaging restaurant and consumer welfare. Lastly, banning exclusive contracts improves the overall consumer welfare as reflected by higher order volume. Taken together, banning exclusive contracts improves consumer and restaurant welfare at least in the short run, but limiting exclusive contracts to startup platforms can also be a useful tool to help new entrants compete with big players in the market without significant social costs.

1 Introduction

Exclusive contracts are commonly used in business. In the platform economy, exclusive contracts include exclusive supply obligations or incentive arrangements, where platforms impose restrictions on merchants which discourage these merchants from working with other platforms. Some platforms with market power use exclusive contracts to gain competitive advantage over their competitors by charging an exclusive cooperation deposit, using data and algorithmic techniques, and imposing punitive measures to ensure that merchants "choose one from two (platforms)." Policymakers have expressed concerns about these contracts. For example, China fined its largest food delivery platform Meituan $533m for such practices in 2021[1]. In theory, sometimes exclusive contracts are anticompetitive, dominant platforms could use exclusive contracts to hinder the growth of weaker rivals in markets if there were strong network externalities, while sometimes they can be efficiency-enhancing (Bernheim and Whinston, 1998). Their overall impact on consumers, merchants, and market competition remains empirically ambiguous.

Over the past few years, online platforms rapidly penetrated important service areas such as education, restaurant, and even health. However, how to maintain its growth momentum under an increasingly fierce competition landscape and how the government should regulate remains an open question. One of the key insights that economic theory provides is the "two-sided" nature of the online econ-system. In other words, the consumers would prefer the online marketplace with more existing merchants, while the merchants are attracted to platforms with a larger customer base. This phenomenon indicates that the modeling framework of platform competition needs to exploit the reinforcement from one side of the market to the other side. And when both consumers and merchants can choose to onboard multiple platforms (often called "multi-homing") in the competitive market, this modeling problem becomes more challenging. Due to the constraint of data availability, previous literature has mainly focused on theoretical studies.

Leveraging detailed consumer digital receipt data from a third-party business analytics company on the food delivery industry in Hong Kong, we constructed an equilibrium model of platform competition incorporating restaurants' exclusive status choices to evaluate the impact of exclusive contracts on consumers, restaurants, and platforms. Our model features two key components: firstly, it allows for multihoming on both sides of the platforms; secondly, it considers the externality of the

[1] https://www.globaltimes.cn/page/202110/1235798.shtml

restaurants' exclusive status. When modeling consumer decisions, it is not only the exclusive status of the focal restaurants that influences their choices, but also the status of all restaurants within their consideration sets. This consideration is crucial for revealing the overall impact of exclusive status on consumers.

The ways that the world eats have changed dramatically in recent years[2]. During the COVID-19 pandemic, the global online food-delivery market increased by 67%, achieving a revenue of US$101.1 billion in 2021[3]. Online food-delivery platforms, such as Uber Eats, allow customers to use computers or smartphones to order food to be delivered to their homes. This business model benefits both consumers and the platforms' restaurant partners: consumers find it convenient to search for and order food through an online food-delivery platform, while restaurant partners can use the platform as a sales channel to identify and target their customers. The online food-delivery market in Hong Kong is also enjoying rapid growth. In 2022, user penetration in the online food-delivery segment reached 38.7%[4]. Foodpanda (with a 75% market share) and Deliveroo (with a 46% market share) are the two main online food-delivery platforms.). Consumers and restaurants can choose to work with either one or all of the platforms (if they choose the latter, they are said to exhibit "multi-homing" behavior). Consumers can download online food-delivery platform applications (apps) freely from app stores and register for free; however, restaurants must pay a 30–35% commission fee to be listed on online platforms. The percentage of the commission fee depends on whether these restaurants sign an exclusive contract when they register with the platform. In early 2022, Hong Kong's Competition Commission began an investigation into suspected exclusionary conduct by Deliveroo and Foodpanda with regards to their dealing agreements with restaurants [5].

Consumers receive e-receipts after they order from online delivery services. These data include the date, total amount paid, payment method, delivery fees and addresses, and restaurant and order information. The collected data effectively represent the market and are quoted as the primary source of information by various newspapers when they discuss the online food-delivery industry in Hong Kong. We supplement this consumer-level transaction data with several other datasets. We have collected the exclusive dealing status of restaurants (as indicated, for example, by "only on deliver by Deliveroo") from their official websites on platforms and their Facebook accounts. We crosscheck this

[2]Ordering in: The rapid evolution of food delivery by McKinsey & Company 2021
[3]https://www.imarcgroup.com/online-food-delivery-market
[4]https://www.statista.com/outlook/dmo/eservices/online-food-delivery/
[5]https://www.compcomm.hk/en/media/press/files/PR_Online_Delivery_Platform_EN.pdf

information with the order information in our data. We collected other restaurant characteristics from the websites of online delivery platforms, and by searching food and restaurant guide websites (such as Openrice.com, the Asian version of Yelp) and Google. To make extrapolation, we also purchased sample data from the 2019/2020 Hong Kong Household Expenditure Survey.

We start with modeling consumers decisions and estimating their preference. We find that exclusive status significantly boosts the restaurant's chance of being chosen on the platform. And the underlying mechanism seems to differ across platforms — for Foodpanda, it's "diminishing", where having more exclusive restaurants on the platform weakens its positive effect; for Deliveroo, it's "reinforcing", where the benefit of being exclusive is strengthened by a larger exclusive restaurant share. We provide this new taxonomy and illustrate that, in our setting, they lead to entirely different welfare implications.

We then use an equilibrium model of restaurants' exclusive status choices to evaluate the impact of exclusive contracts and conduct various counterfactual policies. We find that first, the exclusive contract poses a prisoner's dilemma for restaurants: when banning exclusive contracts, both independent and chain restaurants on average receive more than 25% of orders every month, by letting consumers have more choices and in turn order more often. Second, if exclusive contracts were only allowed for less popular platforms, based on a policy proposal by the Hong Kong authority, there would be substantial catching-up in market share without significantly damaging restaurant and consumer welfare. Lastly, banning exclusive contracts improves the overall consumer welfare as reflected by higher order volume. Taken together, banning exclusive contracts improves consumer and restaurant welfare at least in the short run, but limiting exclusive contracts to startup platforms can also be a useful tool to help new entrants compete with big players in the market without significant social costs.

2 Literature Review

This project is related to the literature of exclusive contracts, platform competition, and the online food delivery industry.

2.1 Exclusive contracts

The effect of exclusive contracts heavily depends on the context and market structure. Some literature find it anti-competitive while others find it pro-efficiency (Aghion and Bolton, 1987; Rasmusen,

Ramseyer, and Wiley, 1991; Bernheim and Whinston, 1998; and Segal and Whinston, 2000). Various studies has been at the theoretical front. For example, Chen and Sappington (2011) studies the impact of exclusive contracts in a setting where research and development (R&D) drives industry performance. Segal and Whinston (2000) consider the effects of it on the level of investment undertaken in the relationship. Very few theoretical research studied exclusive contracts in the two-sided market, not to mention empirical ones. Armstrong and Wright (2007) developed a theoretical framework to analyze two-sided markets and explore the role that exclusive contracts play in preventing multihoming. Carroni, Madio and Shekhar (2024) studied the impact of superstar exclusive content provision on platform competition and complementors' homing decisions. Lee (2013) studied the dynamic impact of vertical integration and exclusive software on market structure of the US video game industry. We contribute to this literature by providing an empirical evaluation of the food delivery industry, and catagorize two types of exclusive effects that can leads to opposite welfare implications.

2.2 Platform competition and multihoming

Ever since the seminar paper by Rochet and Tirole (2003), the theoretical research on platform competition and two sided market have generated great insights about this area. Jullien, Pavan and Rysman (2021) provide a good literature review. One of the key insights that economic theory provides is the "two-sided" nature of the platforms. Consumers would prefer the online marketplace with more existing merchants, while the merchants are attracted to platforms with a larger customer base. This phenomenon indicates that the modeling framework of platform competition needs to exploit the reinforcement from one side of the market to the other side. And when both consumers and merchants can choose to onboard multiple platforms (often called "multi-homing") in the competitive market, this modeling problem becomes more challenging. Caillaud and Jullien (2003) and Armstrong (2006) who allow agents to multi-home in the markets with multiple platforms analyze the equilibrium price of the markets. Armstrong and Wright (2007) explore the role of exclusive contracts to prevent multihoming in the two-sided market. More recently, Athey et al. (2018) develop a model that allows consumer to multihome which generates inefficiency in the match between the advertisers and the consumers. Bakos and Halaburda (2020) shows that when both sides in a platform market multihome, the cross-network effect will diminish which suggests subsidizing one side to maximize profit may not work. Liu et al. (2022) developed a theoretical framework about platform competition which allows multihoming from both sides and discuss the implications on the pricing strategy.

For empirical work on this topic, due to the constraint of data availability, the previous literature using structural models tend to model the multihoming on one side of the market and usually treat consumers as singlehoming. As a result, the consumer demand is simplified as market share or adoption rate and consumer heterogeneity is neglected. Nair, Chintagunta and Dubé (2004) studies the indirect network effect of the third party developed software on the adoption of the personal data assistant markets. Ho (2006) studies the consumers choice of insurance networks with different compositions of hospitals. Dubé, Hitsch and Chintagunta (2010) evaluates the effect of indirect network effects on market concentration. Lee (2013) builds a dynamic model for the video game industry which includes consumer heterogeneus demand for software but still treat them as single-homing which purchase the game console only once. The research using reduced form analysis, allows multihoming on both sides but limits to use the aggregate market level data to empirically test or verify the conclusions generated by the theoretical predictions (e.g. Landsman and Stremersch2011, Li and Zhu 2021).

Sullivan (2024) uses similar e-receipt data to ours to study the effects of commission caps in the U.S. food delivery industry. Although our data don't include variables regarding various fees, our rich variables of restaurant characteristics, including exclusive status, and consumer geographic coordinates allow us to tackle another understudied, while important, question of exclusive contracts in a two-sided market.

2.3 Online Food Delivery and platform promotion

Online food delivery is a new and fast-growing industry. Previous research takes the perspective of the restaurant and treats online delivery platform as an alternative sales channel and study its substitutional effects with traditional channels such as take out or dine-in on the restaurants' revenue, both in theory Chen et al. (2022) and empirically (Li and Wang, 2022). A general framework that models the econ-system of this industry hasn't been developed yet. Our research will fill in the gap. Chuan, 2024 studies the effects of Amazon sponsered searches. We contribute to this literature by providing a new taxonomy of promotion: diminishing and reinforcing, and to illustrate that in our setting, these two types can lead to different welfare implications.

3 Industrial Background and the Data

3.1 Industrial Background

In Hong Kong and Taiwan, the online food delivery market saw a rapid growth in the past few years. User penetration in the online food delivery segment was at 38.7% in Hong Kong in 2022 [6]. Foodpanda (with 75% market share) and Deliveroo (with 46% market share) are the two main online food delivery platforms in Hong Kong [7]. Consumers and restaurants can choose to work with either one or both of the platforms (so called "multi-homing"). For consumers, there is no cost to download their Apps and the registration is free. For restaurants, they will pay a 30%-35% commission fee to the platform depending on whether or not they sign the "exclusive dealing agreement" when register, and platforms may also promote restaurants that agree to provide delivery service on it exclusively.

The Competition Commission, Hong Kong's competition authority launched an investigation into the suspected exclusive dealing conduct from Deliveroo and Foodpanda in early 2022 [8]. The exclusive dealing conduct includes exclusive supply obligations or incentive arrangements [9], where online food delivery platforms impose restrictions on restaurants which discourage these restaurants from working with other online food delivery platforms. Exclusive dealing is commonly used in business. Depending on the context, it may or may not be anti-competitive (Bernheim and Whinston 1998). Some platforms with market power uses it to foreclose competitors by charging exclusive cooperation deposit, using data and algorithm techniques, and imposing punitive measures to ensure restaurants "choose one from two (platforms)" [10]. For the case of Deliveroo and Foodpand, it remains an empirical question whether or not the exclusive dealing agreements potentially hinder competition among online food delivery platforms, as well as depriving consumers and restaurants of the benefits of effective competition.

3.2 Data

Our project relies on a unique dataset collected from a third-party business analytics company on the online food delivery industries in Hong Kong and Taiwan. The company, located in Hong Kong, collects e-receipt data from consumers in different emerging markets and provides research reports

[6] https://www.statista.com/outlook/dmo/eservices/online-food-delivery/
[7] https://www.statista.com/statistics/1149435/hong-kong-favorite-food-delivery-apps/
[8] https://www.compcomm.hk/en/media/press/files/PR_Online_Delivery_Platform_EN.pdf
[9] https://www.clic.org.hk/en/topics/Competition_Law/Second_Conduct_Rule/Scope/Exclusive_dealing
[10] https://www.globaltimes.cn/page/202110/1235798.shtml

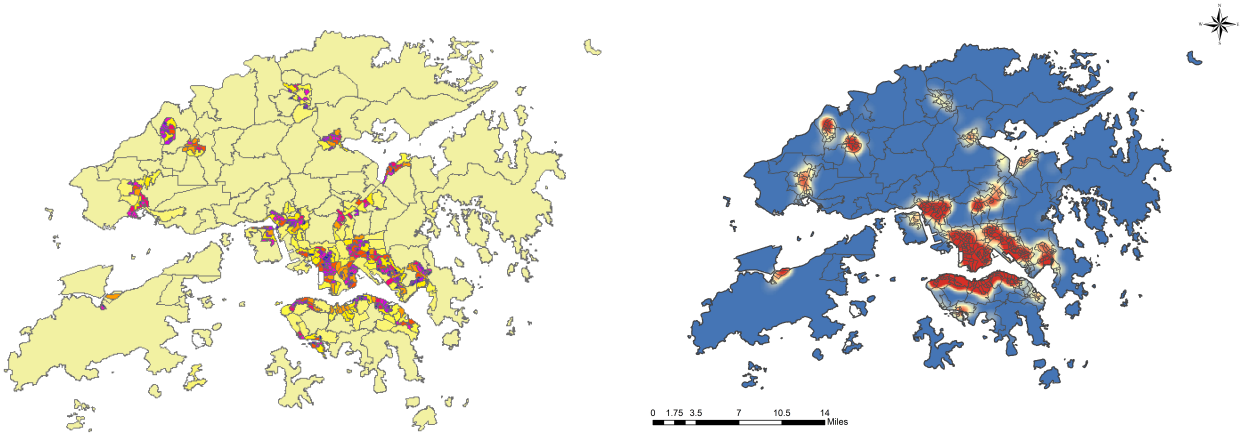
and market information to platforms, financial institutions and news agents. The data include typical information shown in the receipt consumer receives after they order online delivery service, such as the date, the total payment, the payment method, the delivery fee, the delivery address, the restaurant information, and the order information. This dataset has served as the single source of information by varies newspapers discussing the online food delivery industries in the two places [cite].

The consumers sampled are geographically representative, as shown in Figure 1, where we juxtapose the population density and sample distribution.

Figure 1

(A) Population Density

(B) Sample Distribution



We supplement this consumer level transaction data with several other datasets. We collected the exclusive dealing status of the restaurants from the official websites of the platforms (indicated by "Only on Deliveroo (Foodpanda)" on the webpages) and their Facebook accounts. We also cross-checked this information with the order information in our data. For other restaurant characteristics, we web scraped information from the websites of the online delivery platforms as well as searched on restaurant guide websites such as Openrice.com (similar to Yelp) and Google search. See Appendix for variable summary statistics.

We want to extrapolate our individual transaction data to the population of Hong Kong to estimate the total online delivery revenue of a restaurant. Therefore, we purchased a sample fom the 2019/20 Hong Kong Household Expenditure Survey data. The survey was conducted by the Hong Kong Government Census and Statistics Department (CSD) every five years to collect information on

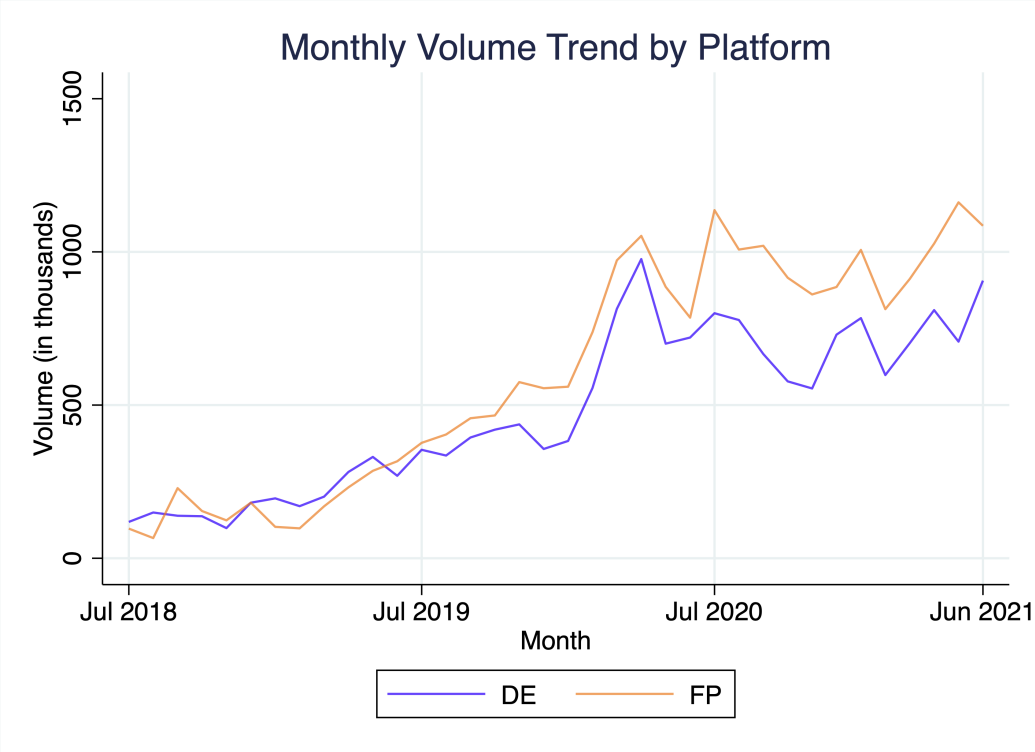
household consumption in Hong Kong. They surveyed 1,413 representative households and record their monthly consumption on various purchases from 2019-10 to 2020-09. The survey also included questions regarding the households' online food delivery expenditure. We use this data to validate the representativeness of our transaction data, and to extrapolate the restaurant order volume from our sample to all Hong Kong population.

Lastly, from the same company that provided online food delivery data, we also collected the individual transaction data of HKTVmall, the largest online shopping platform in Hong Kong from July 1, 2018, to June 30, 2021. We use this data to identify potential consumers who didn't have food delivery orders in our data period. Samples who had purchases on HKTVmall, but didn't have any food delivery orders in our data period, are included in the analysis and serve as the source of market expansion at the extensive margin.

4 Descriptive Analysis

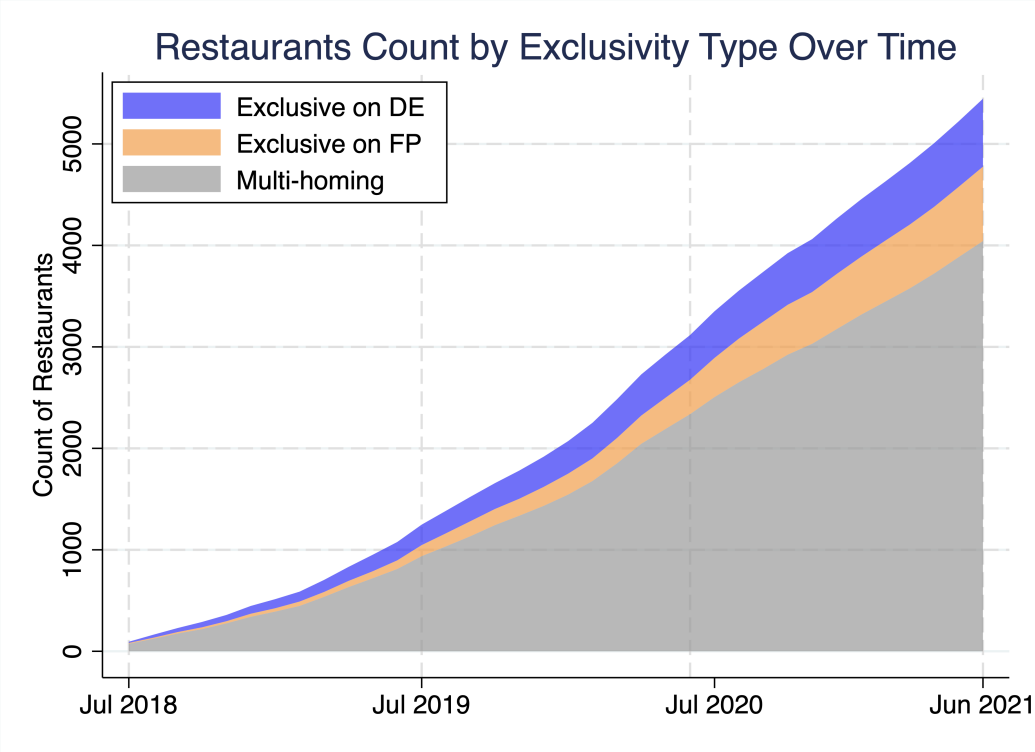
Both platforms saw substantial growth since COVID19 pandemic. Figure 2 plots monthly order volume of the two platforms from our data, weighting each consumer sample by the ratio of potential consumer size and sample size in each constituency. The order volume of two platforms went form around 100,000 in July 2018 to around 1,000,000 in June 2021. Foodpanda also gradually surpassed Deliveroo over this period, with the market share going from 40% in 2018 to nearly 60% in 2021.

Figure 2



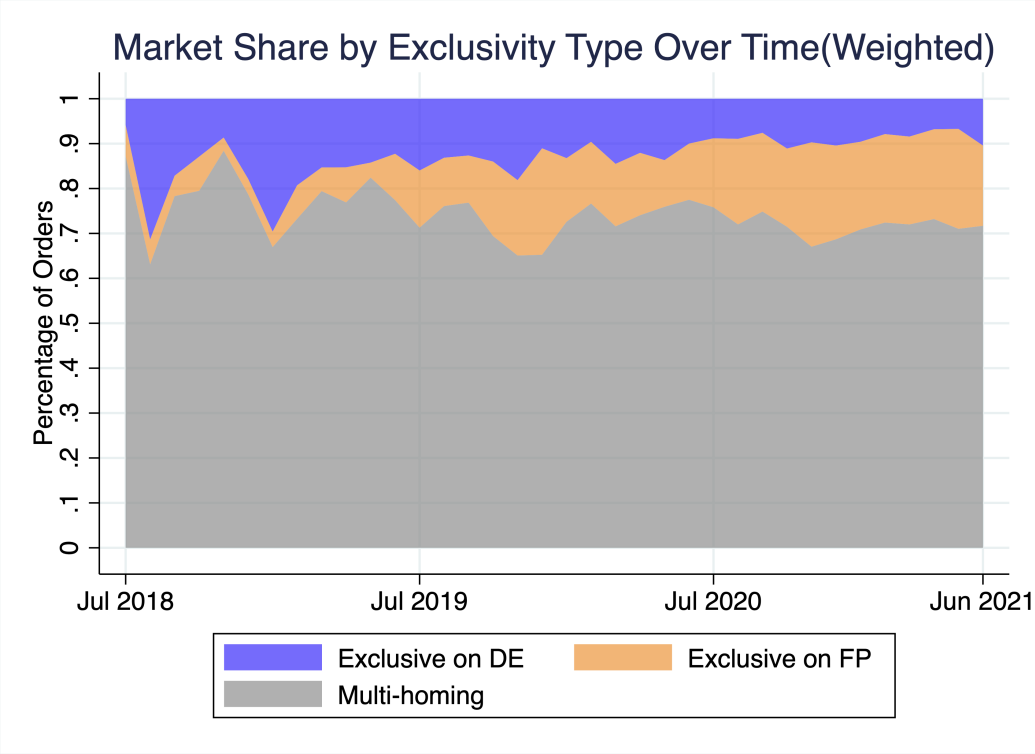
Meanwhile, more and more restaurants sign exclusive contracts with platforms. Figure 3 shows the percent of exclusive restaurants in our sample, with exclusive restaurant share going from virtually zero in 2018 to nearly 27% in 2021, although we do see the number of exclusive restaurants went stable in the last few month.

Figure 3



Two platforms seem to split the number of exclusive restaurants, however, the market share in terms of volumes differ a lot. Figure 4 shows the market share in order volumes by exclusive type. Among exclusive restaurants, Foodpanda-exclusive restaurants took nearly 2/3 of the orders in 2021, and exclusive restaurants from both platforms generated almost 30% of total orders.

Figure 4



These exclusive restaurants are not allowed to join other platforms, including potential new entrants. In other words, any new platform entrant cannot access 30% of the market right off the bat. This has raised anti-competition concerns and pushed Hong Kong government to nagotiate corrsponding regulations. In order to design efficient policy alternatives, it's important to first understand how exclusive contracts work and how they are linked to the welfare of different players in the market.

5 Data

6 Empirical Model

We develop and estimate an equilibrium model that captures key interactions in the market — especially, the effects of restaurants' platform exclusivity. We consider a pool of consumers, indexed by i, who order from restaurant r on platform j. First, restaurants select their own exclusive status to maximize their objective. Then each month t, the consumer first decides how many times she wants to order delivery online, and in each order, selects a platform and chooses a restaurant available on it.

One of our key innovations is introducing an *exclusive spillover* term in the demand system, which allows the exclusive effect to vary by the share of exclusive restaurants on the platform. This first enables us to explore two different natures of exclusivity advertising — *diminishing* and *Reinforcing*. More importantly, this spillover term creates a mechanism of potential prisoner's dilemma when restaurants making the exclusive decision, and ensures a more robust equilibrium structure where the coexistence of restaurants with different types of exclusive statuses doesn't solely depend on the random shock or consumer preference heterogeneity.

By leveraging the rich data on consumers' geographical coordinates, restaurant characteristics and exclusive status, and potential consumers who do not order online deliveries, we are also able to model detailed consumer preference, along with consumer order frequency, which allows for the overall market size to vary by restaurants' exclusive decisions — another key component to the prisoner's dilemma for restaurants.

6.1 Demand

We model consumer demand for online food delivery service in two stages. First, each month t, consumer i has a frequency of ordering delivery online that depends on the overall attractiveness of online ordering and consumer heterogeneity. Then, in each order, she selects a platform j and chooses a restaurant r available on j at her location. We describe the model details below in reverse order. For simplicity, we assume i's purchase condition (choice set, location, etc.) stays the same within the same month.

6.1.1 Restaurant Ordering

Having decided to order a delivery, consumer i chooses a restaurant r on platform j in her choice set to maximize her utility

$$u_{ijrt} = x_{ijrt} + \Psi_{ijrt} + z_{ijt} + (1 - \rho_j)\xi_{ijt} + \epsilon_{irjt}. \tag{1}$$

x_{ijrt} consists of consumer-platform-restaurants-specific characteristics that are not related to the restaurant's exclusive status: the distance between the r and i, the delivery fee (which depends on the distance and whether i has a premium membership on j), restaurant characteristics, etc.

Ψ_{ijrt} represents the exclusive effect, specifically,

$$\Psi_{ijrt} = \left[e_{rjt}, \frac{\sum_{k \in \mathcal{R}_{ijt}} e_{kjt}}{|\mathcal{R}_{ijt}|} e_{rjt} \right] \theta_i, \tag{2}$$

where e_{rjt} is an indicator of r being exclusive on j at t. $\mathcal{R}_{ijt}$ is the choice set of i on j at t, which means that

$$\phi_{ijt} \coloneqq \frac{\sum_{k \in \mathcal{R}_{ijt}} e_{kjt}}{|\mathcal{R}_{ijt}|} \tag{3}$$

is the share of exclusive restaurants on j at t observed by consumer i. This term, which we call *exclusive spillover*, helps regulate the exclusive effect. See Section 6.2.3 for detailed discussions on this term.

z_{ijt} represents the utility consumer i directly derive from using the platform j, e.g., the mobile App experience and other heterogeneous preference on platform selection that is independent from restaurants.

Lastly, $(1-\rho_j)\xi_{ijt} + \epsilon_{irjt}$ is the unobserved idiosyncratic taste, which we model as a logit shock nested at the platform level; both $(1-\rho_j)\xi_{ijt} + \epsilon_{irjt}$ and ϵ_{irjt} are assumed to be i.i.d. Type 1 Extreme Value.

6.1.2 Delivery Frequency

In each month t, the consumer orders delivery λ_{it} times:

$$\lambda_{it} = \exp(\omega EU_{it} + \zeta_{it} + c + \xi_i), \tag{4}$$

where EU_{ijt} is the expected utility of ordering online in month t:

$$EU_{ijt} = \ln \sum_{j \in \mathcal{J}} \exp \left(z_{ijt} + \rho_j \ln \left[\sum_{r \in C_{ij}} \exp \left(\left(x_{ijrt} + \Psi_{ijrt} \right) / \rho_j \right) \right] \right) + \gamma; \tag{5}$$

γ is the Euler's constant. ζ_{it} includes observed consumer-month online order frequency shifters, such as consumer demographics. c is a constant. We assume the unobserved consumer heterogeneity term, $\exp(\xi_i)$, to follow a Gamma distribution with mean 1 and variance α, which enables us to write the

expected order frequency of i in t as

$$\mathbb{E}(\lambda_{im}) = \exp(\omega EU_{im} + \zeta_{im} + c). \tag{6}$$

6.2 Supply

6.2.1 Restaurant Objective

Restaurants choose the exclusive option $x \in \mathcal{X}$ (e.g., exclusive on Deliveroo, exclusive on Foodpanda, or multihoming) to maximize its ex-ante order volume minuses its corresponding cost:

$$\pi_r(x) = OV_r(x) - C_{rx} + \eta_{rx}, \tag{7}$$

where η_{rx} is assumed to be EV1. We normalize the order volume to be the monthly order volume in the unit of 1,000, and C_{rx} for being multi-homing as 0.

We model restaurants' exclusive decisions as a simultaneous positioning game (Seim, 2006; Sullivan, 2024). We assume all restaurants simultaneously choose their exclusive options, which never change again. A restaurant that maximizes its long-run profit therefore chooses the exclusive option considering all restaurants in the market, regardless of when they join the online delivery market. And in our setting, the potential consumer pool is fixed. Therefore, in the following paragraphs, we drop the time subscript for simplicity.

The expected order volume of restaurant r from consumer i is

$$OV_{ir}(x_r|\overrightarrow{x_{-r}}) = \mathbb{E}(\lambda_i|\overrightarrow{x}) \sum_{j \in \mathcal{J}} (P_{ijr}|\overrightarrow{x}), \tag{8}$$

that is, r calculates the probability of each i ordering from it conditional on all other restaurants' decisions. The exact calculations of $\mathbb{E}(\lambda_i|\overrightarrow{x})$ and $\sum_{j \in \mathcal{J}}(P_{ijr}|\overrightarrow{x})$ are very complex; it requires r to know exactly how other restaurants in each i's choice set are going to choose. Even in a Bayesian setting, it requires r to form an expectation on all other relevant restaurants' choice probabilities, and

calculate the payoff in every scenario. So instead, we write

$$OV_{ir}(x_r|\overrightarrow{x_{-r}}) = \sum_{j\in\mathcal{J}}\{\mathbb{E}(\lambda_i|\overrightarrow{x}) \cdot \exp\left[\left(x_{ijrt} + \Psi_{ijrt}\right)/\rho_j\right] \cdot \frac{(P_{ijr}|\overrightarrow{x})}{\exp\left[\left(x_{ijrt} + \Psi_{ijrt}\right)/\rho_j\right]}\} \tag{9}$$

$$= \sum_{j\in\mathcal{J}}\{\exp\left[u(x_r|\overrightarrow{x_{-r}})\right] P(r \in C_{ij}|x_r) \cdot W_{ij}\} \tag{10}$$

In other words, we separate out the term $\exp\left[u(x_r|\overrightarrow{x_{-r}})\right]$ and the probability of r on platform j, $P(r \in C_{ij}|x_r)$, which are both directly affected by x_r. Rigorously speaking, x_r also affects other components in P_{ijr} and λ_i, such as the expected utility of ordering delivery, EU_{ij}. However, when i's choice set contains many restaurants, the effect of x_r on those terms is small. So, when r making the exclusive decision, we assume it takes W_{ij} as given.

Further, based on Equation (25) and Equation (3), notice that $\overrightarrow{x_{-r}}$ affects $u(x_r|\overrightarrow{x_{-r}})$ only via ϕ_{ij}, i.e., the ratio of exclusive restaurants in i's choice set. Thus,

$$OV_{ir}(x_r|\overrightarrow{x_{-r}}) = \sum_{j\in\mathcal{J}}\{\exp\left[u(x_r|\phi_{ij})\right] P\left(r \in C_{ij}|x_r\right) \cdot W_{ij}\} \tag{11}$$

and the total order volume of r is

$$OV_r(x_r|\overrightarrow{x_{-r}}) = \sum_{i\in\mathcal{I}_r}\sum_{j\in\mathcal{J}}\{\exp\left[u(x_r|\phi_{ij})\right] P\left(r \in C_{ij}|x_r\right) \cdot W_{ij}\}, \tag{12}$$

where $\mathcal{I}_r$ is the set of consumers whose choice set includes r. When making the exclusive decision, r only needs to form expectation on ϕ_{ij} and W_{ij}, for all $i \in \mathcal{I}_r$ and $j \in \mathcal{J}$ — these expectations are denoted as $\widehat{\phi_{ij}}$ and $\widehat{W_{ij}}$, respectively.

$$x^*|(\widehat{\phi_{ij}}, \widehat{W_{ij}} \;\forall\; i \in \mathcal{I}_r, j \in \mathcal{J}) = \max_{x\in\mathcal{X}} OV_r[x|(\widehat{\phi_{ij}}, \widehat{W_{ij}} \;\forall\; i \in \mathcal{I}_r, j \in \mathcal{J})] - C_{rx} + \eta_{rx} \tag{13}$$

and since η_{rx} is EV1,

$$P(x_j^* = x|\widehat{\phi_{ij}}, \widehat{W_{ij}} \;\forall\; i \in \mathcal{I}_r, j \in \mathcal{J}) = \frac{\exp\{OV_r[x|(\widehat{\phi_{ij}}, \widehat{W_{ij}} \;\forall\; i \in \mathcal{I}_r, j \in \mathcal{J})] - C_{rx}\}}{\sum_{k\in\mathcal{X}}\exp\{OV_r[x|(\widehat{\phi_{ij}}, \widehat{W_{ij}} \;\forall\; i \in \mathcal{I}_r, j \in \mathcal{J})] - C_{rx}\}} \tag{14}$$

6.2.2 Equilibrium

Once every restaurant has their own choice probabilities on the exclusive decision based on a *common* belief $\{\widehat{\phi_{ij}}, \widehat{W_{ij}} \ \forall \ i \in \mathcal{I}_r, j \in \mathcal{J}\}$, there are corresponding $\{\widetilde{\phi_{ij}}, \widetilde{W_{ij}} \ \forall \ i \in \mathcal{I}_r, j \in \mathcal{J}\}$ implied by their choice probabilities. The Bayesian Nash Equilibrium of this simultaneous game is when

$$\widehat{\phi_{ij}} = \widetilde{\phi_{ij}}, \tag{15}$$

$$\widehat{W_{ij}} = \widetilde{W_{ij}} \tag{16}$$

$$\forall \ i \in \mathcal{I}_r, j \in \mathcal{J}. \tag{17}$$

6.2.3 Discussions on Exclusive Spillover

In this section, we discuss the reasons and benefits of including the exclusive spillover term in Equation (3).

Two Types of Exclusive Advertising The exclusive spillover term enables us to explore two different outcomes of exclusivity advertising. The specific mechanism that leads to this difference is beyond the scope of our paper, but we provide some conjectures and intuitions. Suppose the effect of being exclusive itself, i.e., the coefficient on e_{rjt} in Equation (25), is positive, which is indeed the case as seen later in the model estimation. We categorize two different types of exclusive advertising:

- *Diminishing*: when the coefficient on ϕ_{ijt} is negative. In this case, when more restaurants on the platform are exclusive, the exclusive effect gets smaller. This can happen when, for example, the platform simply puts exclusive restaurants at the top of the page and consumers don't value it a lot. A few promoted restaurants may help with consumer awareness, but when there are too many of them, consumers may feel overwhelmed, deem such promotions "cheap", and end up scrolling through to look for restaurants they really like.

- *Reinforcing*: when the coefficient on ϕ_{ijt} is positive. In this case, the exclusive effect is strengthened as more restaurants become exclusive on the platform. This can happen when, for example, consumers believe a tag of "Exclusive on Platform X" also indicates higher quality. Therefore, the exclusive status generates some degree of "reputation", and as more restaurants start to have this tag, consumers become more concerned about those that don't have it.

A Structural Channel for Prisoner's Delimma The structural channels created by the spillover term are more important for our paper. First, in restaurants' positioning game, this term intensifies the spillover among players and creates a stronger pathway for a prisoner's dilemma. Consider diminishing advertising, where the exclusive effect decreases as more restaurants become exclusive. In this case, when not many restaurants are exclusive, a one-sided deviation may be very attractive due to the large effect from e_{rjt}. However, in a Nash Equilibrium, the overall reward for being exclusive may be weakened by a higher exclusive ratio. This weakening effect also decreases the overall expected utility of consumers from ordering online in Equation (4) and therefore shrinks the market at the equilibrium. In Section XX, we take the estimated model and play with model parameters to better demonstrate these linkages.

A More Robust Equilibrium The other structural reason for having the spillover term is to have a more robust equilibrium. In the data, we observe that all three types of restaurants exist: 12.5% exclusive on Deliveroo, 13.2% exclusive on Foodpanda, and the rest multi-homing in the last month of our data period. We want our demand model to be able to allow for such an equilibrium without depending too much on random shocks and heterogeneities in preference and supply-side costs, for better robustness.

To develop the idea, we first conduct a simulation experiment: N identical consumers choosing M identical restaurants from two platforms A and B. On either platform, r delivers utility ϵ_{ir} if it is not exclusive, and $\ln \delta + \epsilon_{ir}$ if it is. ϵ_{ir} is i.i.d. EV1. WLOG, we assume consumers have an exogenous and constant probability, $p >= 0.5$, to order from platform A, i.e., platform A is "stronger" for exogenous reasons. Restaurants deterministically choose the exclusive type (A, B, or Both) that on expectation delivers the highest order volume. In this case, for any p, there only exists a very narrow interval for the value of δ — which exists mostly likely due to the integer constraint — where all three types have at least one restaurant. If the exclusive effect δ is above the interval, restaurants would either be exclusive on A or B, but none is multi-homing; if it's below the interval, restaurants would either be multi-homing or exclusive on the stronger platform, A, but never choose to be exclusive on B.

Therefore, in this setting, it is almost impossible to have an equilibrium where all three types of restaurants exist; the exclusive effect has to hit the tiny interval. A negative exclusive spillover (i.e., diminishing), would solve the problem. Intuitively, it's helpful to think of an extreme case where all

restaurants but one are exclusive either on A or B. The remaining multi-homing restaurant, when the exclusive effect is constant and big enough, would still choose to go exclusive; however, if there is a negative exclusive spillover, this last multi-homing restaurant would likely stay on both platforms as the exclusive share on both platforms is close to 1. Once this extreme case is taken care of, we can easily see how the desired equilibrium can be potentially salvaged. Although the spillover term doesn't guarantee to solve the issue entirely — the signs and magnitudes of some of the coefficients have to align well (e.g., we need to have a negative spillover on the stronger platform) — this term provides us an additional and much more flexible channel to achieve the observed equilibrium. See the Appendix for detailed discussions and calculations.

7 Estimation

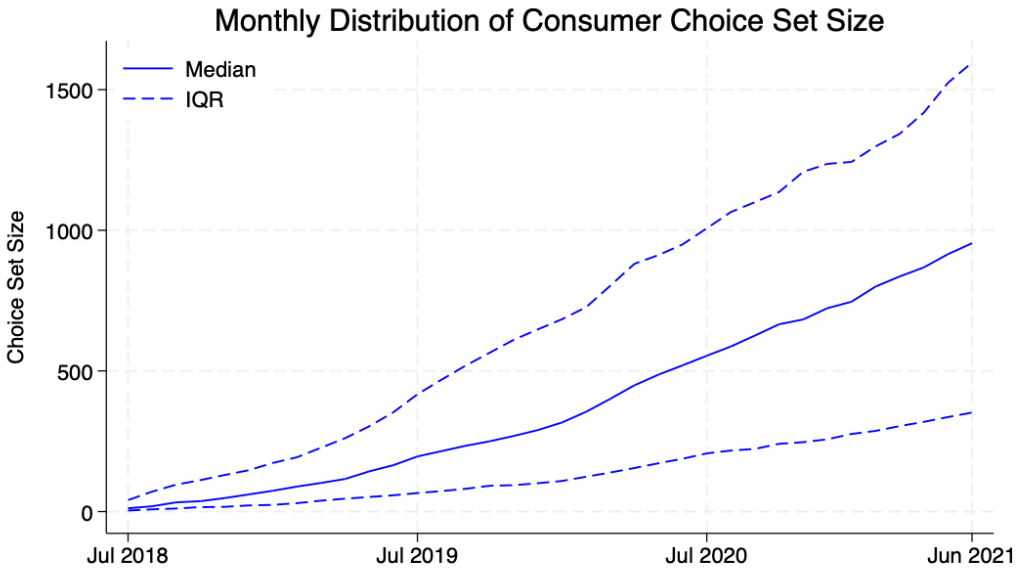
7.1 Sample Construction

To define potential consumers, we take all consumers in our sample who had at least one order from any food delivery platform or HKTVmall — a popular online shopping and entertainment platform in Hong Kong. Samples who had purchases on HKTVmall, but didn't have any food delivery orders in our data period, are included in the estimation and serve as the source of market expansion at the extensive margin.

As described in Section 6.1, we assume each consumer's choice condition stays the same within a month. So, in the data, for consumers who ordered from multiple locations in the same month, we only keep orders from her modal location in that month. In the end, we dropped 2,169 out of 19,881 (10.9%) of food delivery orders observed in the three-year data period. As for restaurants, since the data on the universe of Hong Kong restaurants are not available, we construct the restaurant pool using the actual orders on a monthly basis: all restaurants being ordered on any day in month X are assumed to exist throughout month X and onward, and we assume restaurants never exit.

We observe the geographical coordinates of all consumers and restaurants in our data. For each consumer-month, we define her choice set, $\mathcal{C}_{ijt}$, as restaurants available on platform j within 3 km (1.86 miles) to i's location in month t. Figure 5 plots the distribution of consumer choice set size over time.

Figure 5



We impute whether the consumer-month has a platform premium membership by the delivery fee in her orders — in most cases, premium members have free delivery. We proxy each consumer's characteristics by the demographics of her modal constituency in the data. There are 431 constituencies covering all 18 districts of Hong Kong in our sample. We scraped restaurant characteristics and exclusive status from OpenRice, a popular dining guide website, and platform websites around Jan 2021. See Section 5 for more details on our data.

In the end, our final estimation sample consists of 1,425 unique consumers, 5,455 unique restaurants, and 17,712 online orders on Deliveroo and Foodpanda across a 36-month window from July 2018 to June 2021.

7.2 Demand

We estimate the demand side parameters in one step by a maximum likelihood, using a single likelihood function that combines order frequency and platform-restaurant decisions.

For consumer i, let $\overrightarrow{N_i}$ denote the number of delivery orders i has in each month, so $\overrightarrow{N_i}$ is a vector over month $t = 1 \dots T$. Let $\overrightarrow{y_{it}}$ denote the vector of order numbers of i in month t, where each component of $\overrightarrow{y_{it}}$ is a platform-restaurant combination, and $\overrightarrow{y_{it}}$ only includes $r - j$'s that exist in i's choice set in month t.

Given demand side parameter θ, the likelihood of observing i's records is

$$P_i(N_i, \overrightarrow{y_{it}}, \ldots, \overrightarrow{y_{iT}}|\theta) \tag{18}$$

$$= P_i(N_i|\theta) \prod_{t=1}^{T} \prod_{j \in \mathcal{J}} \prod_{r \in \mathcal{C}_{ijt}} (P_{irjt}^{y_{irjt}}|\theta) \tag{19}$$

The log-likelihood in turn is

$$\ln L_i(N_i, \overrightarrow{y_{it}}, \ldots, \overrightarrow{y_{iT}}|\theta) \tag{20}$$

$$= \ln P_i(N_i|\theta) + \sum_{t=1}^{T} \sum_{j \in \mathcal{J}} \sum_{r \in \mathcal{C}_{ijt}} y_{irjt}(\ln P_{irjt}|\theta). \tag{21}$$

The first term corresponds to the standard log-likelihood function for a random effect Poisson model; the second term corresponds to the standard log-likelihood function of nested-logit.

We use MLE to find the values of demand coefficients that maximize the log-likelihood

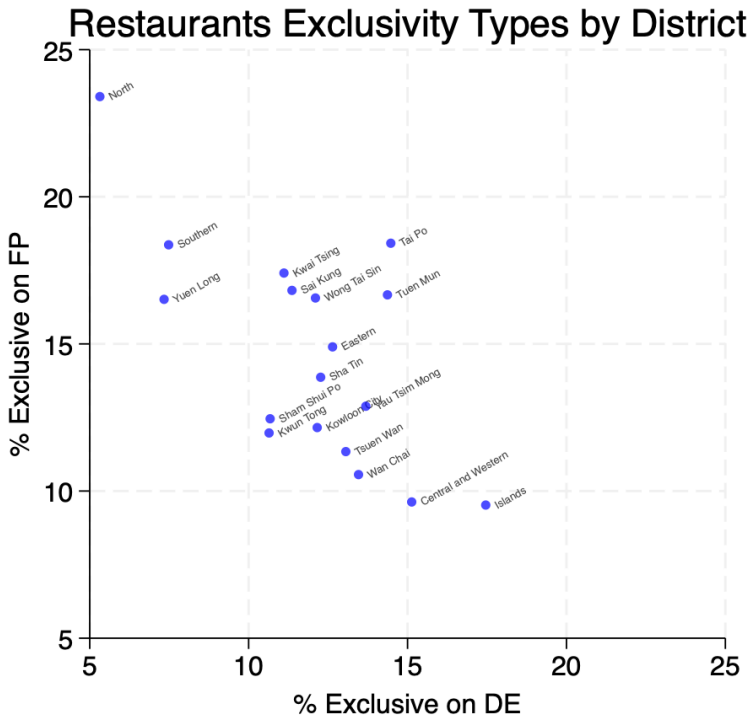
$$\theta^* = \max_{\theta} \sum_{i \in \mathcal{I}} \ln L_i(N_i, \overrightarrow{y_{it}}, \ldots, \overrightarrow{y_{iT}}|\theta) \tag{22}$$

We include a rich set of restaurant characteristics: price level, rating star, number of reviews, cuisine types, etc., and let consumers' distance elasticity vary by their platform premium status. We allow for heterogeneities in platform preference and monthly order frequency. As for the exclusive effect, we allow chain and independent restaurants to vary on their levels (i.e., the coefficient on e_{rjt}) but have the same size of spillover effects (i.e., the coefficient on ϕ_{ijt}).

7.3 Supply

We then estimate the costs of exclusive options, which are used to match restaurants' exclusive decisions in the data. We use all consumers and restaurants in our data to estimate the simultaneous game, so the time subscript is dropped in the following paragraphs. We specify four types of cost: chain Deliveroo exclusive, chain Foodpanda exclusive, independent Deliveroo exclusive, and independent Foodpanda exclusive, and let each of them vary by the 18 districts. This is motiveated by Figure 6, where we see big geographic variations in restaurants' exclusive decisions. In total, we have 72 cost parameters. We denote these costs as $\mathbf{C}$.

Figure 6



We estimate **C** using a two-step generalized method of moments (GMM) estimator, similar to Sullivan (2024). In the first step, we estimate restaurants' common beliefs on all restaurants' conditional choice probability (CCP) using a multinomial logit model via maximum likelihood. We use observed market conditions as covariates, which include the number of consumers and premium consumers on each platform; log number of reviews, price level, star rating, chain indicator, total number of restaurant competitors, district dummies, and cuisine type of each restaurant. Let $\widehat{q}_{r,xj}$ denote the estimated CCP of r being exclusive on j, and $\widehat{q}_{r,MH}$ the probability of being multi-homing. Let $\overrightarrow{Q}$ denote the vector of all these CCPs.

With each restaurant's CCP estimated, the probability of r being on platform $j \in \{DE, FP\}$ is

$$\widehat{p}_{rj} = \widehat{q}_{r,xj} + \widehat{q}_{r,MH} \tag{23}$$

And conditional on being on platform j, the utility i gains from r on platform j is

$$u_{ijr} = x_{ijr} + \Psi_{ijr}(\widehat{x}_r) + z_{ijt} + (1-\rho_j)\xi_{ijt} + \epsilon_{irjt}. \tag{24}$$

where

$$\Psi_{ijrt}(\widehat{x}_r) = \theta_i' \left[\frac{\widehat{q}_{r,xj}}{\widehat{p}_{rj}}, \frac{\sum_{k\in\mathcal{R}_{ijt}} \widehat{q}_{r,xj}}{\sum_{k\in\mathcal{R}_{ijt}} \widehat{p}_{rj}} \right], \tag{25}$$

i.e., we replace the exclusive dummy in the utility function by the probability of r being exclusive on j conditional on being on j. When calculating the denominators or the inclusive values in P_{irjt}, we ignore Jensen's inequality and simply sum up $p_{rj}\exp(u_{ijr}/\rho_j)$ for computational feasibility.

This process allows us to calculate implied choice probabilities, $G(\mathbf{C}|\widehat{\theta}, \overrightarrow{Q})$ of each restaurant for any given guess on $\mathbf{C}$. Our GMM estimator in the end matches $G(\mathbf{C}|\widehat{\theta}, \overrightarrow{Q})$ to data, by minimizing the sum of squares of the difference between $G(\mathbf{C}|\widehat{\theta}, \overrightarrow{Q})$ and restaurants' actual choices.

8 Estimation Results

8.1 Demand

Table 1 shows our demand estimates. At the restaurant level, consumers prefer closer restaurants, while the elasticity is much lower when they have a premium membership on the platform, because the delivery fee is waived. Consumers also derive higher utility from chain-owned, less expensive, high-review, and high-star restaurants. At the platform level, Foodpanda seems to be the stronger platform of the two, while Deliveroo tends to be more attractive to consumers with higher incomes, which is consistent with the fact that Deliveroo focuses more on the high-end market. The two nest parameters are estimated as 1, which means there is little correlation in the demand shock at the platform level; the consumer ordering decision is therefore reduced to directly choosing a restaurant-platform pair, as modeled in Sullivan (2024). At the order frequency level, consumers purchase more often when the expected utility from online ordering is higher, and high-income people tend to order less delivery, potentially because they are more flexible in their meal selection (home-cook, dine-in, etc.)

Table 1: Demand Estimates

Demand Estimates							
Restaurant Level	Estimate	SE	p-value	**Platform Level**	Estimate	SE	p-value
Distance				Log Monthly Income × DE	2.138	0.099	0.00
Distance (non-premium, FP)	-2.794	0.027	0.00	Median Age × DE	-0.020	0.006	0.00
Distance (premium, FP)	-1.361	0.026	0.00	Male to Female Ratio × DE	2.270	0.260	0.00
Distance (non-premium, DE)	-2.440	0.031	0.00	Percentage of Working Population × DE	-0.019	0.004	0.00
Distance (premium, DE)	-0.720	0.022	0.00	DE	-21.476	1.100	0.00
Exclusive				Nest parameter (FP)	1.000	0.000	0.00
Exclusive (FP)	1.150	0.085	0.00	Nest parameter (DE)	1.000	0.000	0.00
Chain × Exclusive (FP)	0.109	0.056	0.05				
Exclusive Ratio × Exclusive (FP)	-3.265	0.484	0.00	**Monthly Order Frequency**	Estimate	SE	p-value
Exclusive (DE)	0.825	0.101	0.00	Log Monthly Income	-0.218	0.121	0.07
Chain × Exclusive (DE)	-0.362	0.056	0.00	Median Age	-0.002	0.016	0.91
Exclusive Ratio × Exclusive (DE)	1.276	0.506	0.01	Male to Female Ratio	0.041	0.650	0.95
Restaurant Characteristics				Percentage of Working Population	-0.021	0.013	0.10
Chain	0.281	0.020	0.00	Expected Utility of Online Order	0.634	0.009	0.00
Price Range 50 – 100	0.006	0.019	0.74	Gamma Variance	3.812	0.155	0.00
Price Range above 100	-0.291	0.026	0.00				
ln(1+Num.Review)	0.046	0.006	0.00				
Star Rating	0.034	0.018	0.06				
Cuisine FEs	Yes						

We now discuss the exclusive effects. First, being exclusive significantly boosts the probability of a restaurant being chosen on the platform. At the observed level — where 14% of restaurants on Deliveroo and 15% of restaurants on Foodpanda are exclusive — the odds ratios of the exclusive effect are 2.7 (1.9) and 1.9 (2.2) for independent (chain) restaurants on Deliveroo and Foodpanda, respectively. In other words, becoming exclusive approximately doubles the expected order volume on that platform. If we consider a one-size deviation when all restaurants are multi-homing (i.e., the exclusive shares on both platforms are zeros), the odds ratios are 3.2 (3.5) and 2.3 (1.6) for independent (chain) restaurants on Deliveroo and Foodpanda, respectively.

Moreover, our results indicate that the two platforms' exclusive status works differently: Deliveroo is *Reinforcing* while Foodpanda is *diminishing*. As more restaurants on the platform become exclusive, the exclusive effect on Deliveroo gets stronger, while the exclusive effect on Foodpanda wanes down. As discussed in Section 6.2.3, we don't aim to explore the exact mechanism of why this happens. Intuitively, this matches the brand images of the two platforms: Deliveroo targets higher-end consumers, who potentially value quality more; as a result, as more restaurants they observe are exclusive, they may discount the value of the restaurants that don't wear this badge. On the other hand, Foodpanda focuses more on big-chain, less expensive, and popular restaurants, whose consumers may care less about quality and more about time efficiency; too many promoted restaurants

therefore may make the exclusivity look "cheaper" and consumers more likely to scroll through.

Finally, as discussed in Section 6.2.3, the diminishing exclusive effect on FP, which happens to be the stronger one of the two, may be compressing the market size (i.e., total order volumes in the market) at the equilibrium that leads to inefficiency. We will further explore this in the counterfactual analysis.

8.2 Supply

Figure 7 shows the match of district-level exclusive shares with the cost estimates. Since we have costs for four types of restaurants in each district, the match is very good. However, the magnitude of the estimated costs, as shown in Table 2 with the unit of 1,000 orders, is big. Remember that we normalize the order volume in the restaurants' reward function to the monthly level, and the mean of a restaurant's monthly order is around 300. So the estimates indicate that the perceived cost of being exclusive ranges from 5 – 9 times its monthly order. In other words, although the reward for being exclusive is high as indicated by our demand estimates, restaurants are still reluctant to go exclusive. These estimated costs may include lots of factors that we don't consider in the simple supply model: one being restaurants' risk aversion — restaurants may want to stay on both platforms just in case the business of one of them goes south; or restaurants simply underestimate the return for being exclusive. Either way, these cost estimates are still consistent with our demand estimates and match well with restaurants' actual decisions, therefore we believe the implications from this in the counterfactual analysis are still valuable.

Figure 7

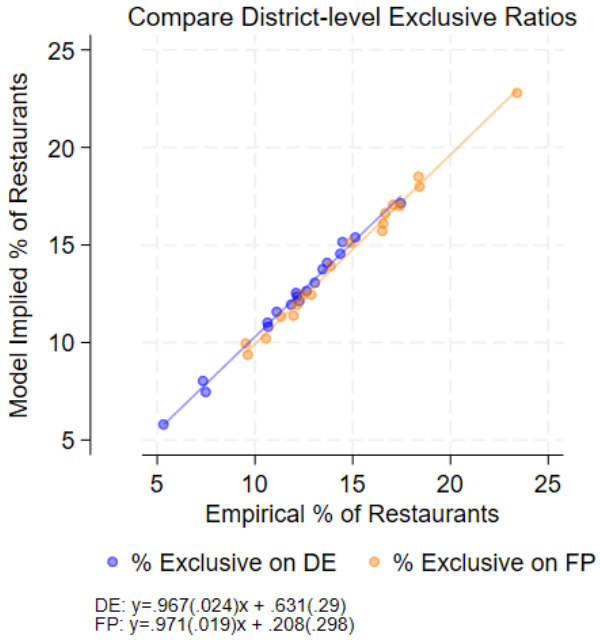


Table 2: Supply Estimates

Supply Estimates		
District Level Exclusive Costs	Mean	STD
Chain Exclusive on DE	1.534	0.303
Chain Exclusive on FP	1.781	0.310
Independent Exclusive on DE	2.183	0.441
Independent Exclusive on FP	2.614	0.439

Note: In the unit of 1,000 orders, with total order volume in the reward function normalized to monthly order volumes.

9 Counterfactuals

In this section, we use our model estimates to evaluate several counterfactual policies. We also explore the size and mechanism of the loss in consumer welfare due to the prisoner's dilemma faced by restaurants.

9.1 Solving Equilirbium

Counterfactual analysis requires us to solve for new market equilibrium under different policy environments. We use a contraction mapping in our algorithm for faster computation. For any input of parameters and policy environments (e.g., instead of choosing from Deliveroo-exclusive, Foodpanda-exclusive, and multi-homing, only allow restaurants to choose between the latter two), we run the algorithm below following similar notations as in Section 6.2.2 and calculations in Equation (25):

1. Guess any vectors for $\overrightarrow{W}$ and $\overrightarrow{\phi}$.
2. Calculate each restaurant's choice probabilities of each exclusive option, $\overrightarrow{q} := \{q_{rx} \; \forall \; r \in \mathcal{R}, x \in \mathcal{X}\}$, conditional on $\overrightarrow{C}$, $\widehat{\theta}$, $\overrightarrow{W}$, and $\overrightarrow{\phi}$.

3. Calculated $\overrightarrow{W}'$ and $\overrightarrow{\phi}'$ implied by $\overrightarrow{q}$.

4. Update $\overrightarrow{W} = \overrightarrow{W}'$ and $\overrightarrow{\phi} = \overrightarrow{\phi}'$. Repeat steps (2) – (4), until they converge.

In the end, the converged vector $\overrightarrow{\phi}$ gives us all restaurants' choice probabilities at the equilibrium.[11] We can then use these choice probabilities to easily back out other market outcomes.

9.2 Alternative Policies

The Hong Kong government had been worrying about exclusive contracts being anti-competitive and went back and forth with Deliveroo and Foodpanda to negotiate a new regulation commitment. In December 2023, the Competition Commission accepted the proposed regulation that allows Deliveroo and Foodpanda to enforce exclusive contracts only against competitor platforms with a market share lower than 10%, in the hope of promoting competition.

Since there are not many active small platforms in our data sample — the third largest platform in our data period, UberEat, had been having less than 5% of the market share and ended up quitting Hong Kong at the end of 2021 — we instead focus on the dynamics between the two big platforms and experiment with three different counterfactual policies: 1. Only allow Deliveroo to sign exclusive contracts; 2. Only allow Foodpanda to sign exclusive contracts, and; 3. Ban both platforms from signing exclusive contracts.

First, we look at how restaurants choose their exclusive status in counterfactual scenarios. Figure 8 shows the share of restaurants choosing each option under each policy. The first group shows the status quo, which indicates that our model matches the empirical shares well. The result of "Ban Both" is trivial: when banning both from signing exclusive contracts, all restaurants have to be multi-homing. The group "Only Allow DE" show the shares when we only allow Deliveroo to sign exclusive contracts. We see that more, but only by a little, restaurants choose to be exclusive on Deliveroo; similar results for the "Only Allow FP" group where we only allow Foodpanda to sign exclusive contracts. These results are not surprising due to the high costs of going exclusive. However, even though the exclusive shares don't change much, the results in market shares and volumes reveal interesting lessons.

[11] Proof of the contraction is pending. We experimented with different initial guesses and the algorithm always converges to the same vector very fast.

Figure 8

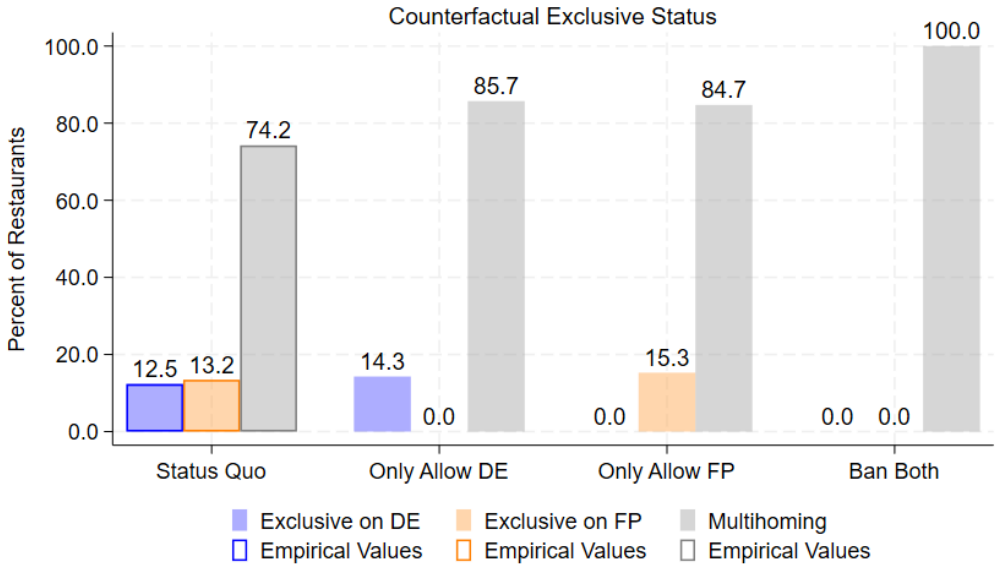
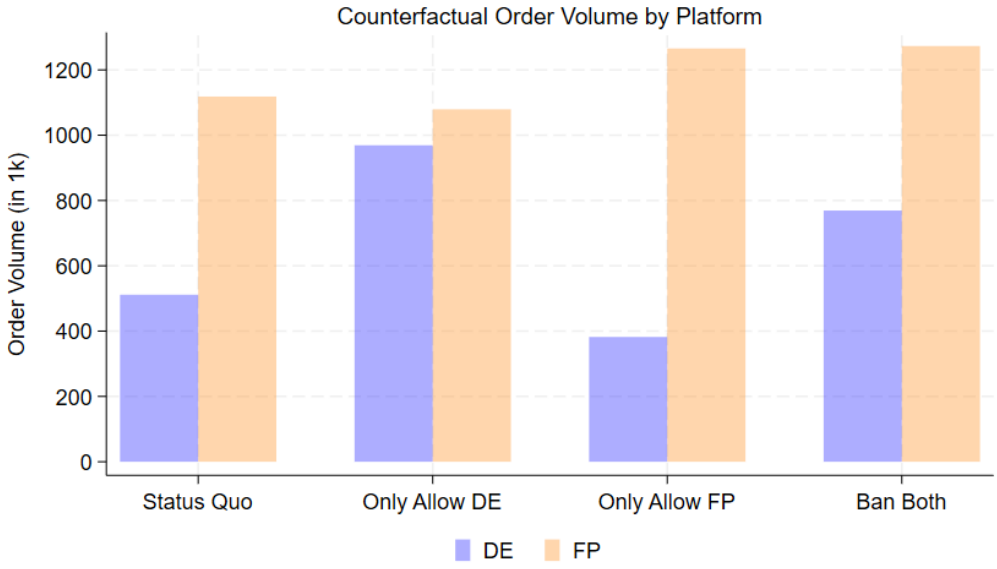


Figure 9 shows the total order volumes of two platforms under different policies. When we only allow Deliveroo to sign exclusive contracts, its order volume is more than doubled, while Foodpanda's only decreased a little. There are three main channels for this to happen: 1) more (in fact, all) restaurants are now on Deliveroo; 2) since Deliveroo's exclusive effect is Reinforcing, the higher exclusive percentage further boosts the utility of restaurants on Deliveroo; 3) consumers' total expected utility also increases, which makes consumers order more often, expanding the market demand.

The opposite story happens when we only allow Foodpanda to sign exclusive contracts. The increase in Foodpanda's order volume doesn't increase as much as Deliveroo does in "Only Allow DE", mainly because Foodpanda's exclusive effect is diminishing — higher exclusive share leads to a lower utility for all exclusive restaurants. For the same reason, we also don't see much market expansion effect, while the increase in Foodpanda's market share is offset by the decrease for Deliveroo. Lastly, banning exclusive entirely benefit both platforms. Both see an increase in their market shares compared to the status quo, where no exclusive contracts are allowed.

Figure 9



We write platforms' payoffs from Figure 9 into Table 3, where we can immediately see the prisoner's dilemma: suppose platforms can choose whether to sign exclusive contracts. Starting from no exclusive contract, $(FP, DE) = (0,0)$, Deliveroo would happily deviate to $(1,0)$. However, at $(1,0)$, Foodpanda has to deviate to have exclusive contracts as well to gain more orders. In the end, the market settles on the status quo, $(1,1)$, where both players are worse off compared to when exclusive contracts are not available, $(0,0)$. The main channel, still, is market expansion originating from Foodpanda's diminishing exclusive effect. In the next section, we will play with the exclusive effect parameters and make this channel clearer.

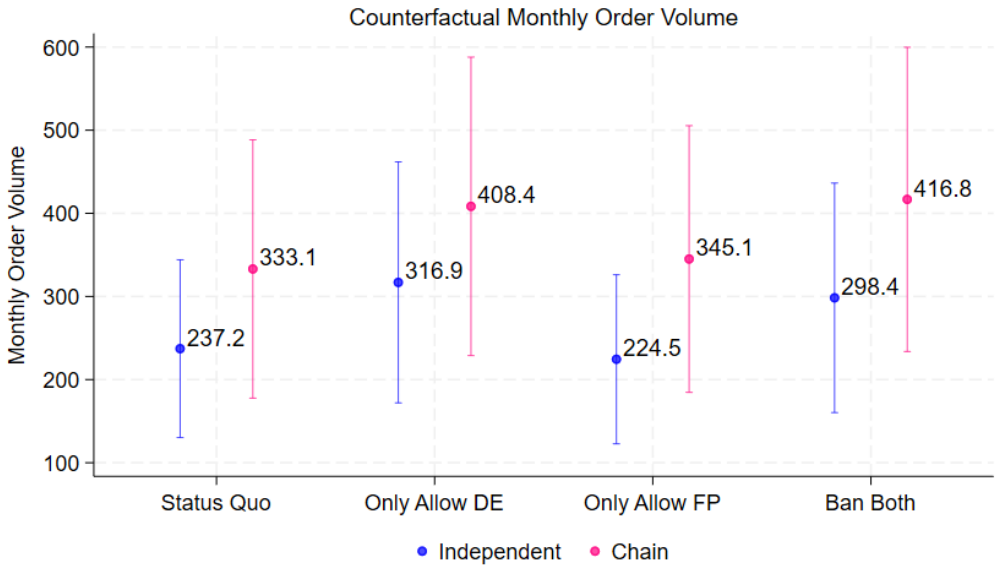
Table 3: Platform Payoff Table

		Deliveroo	
(Sign Exclusive Contracts?)		0	1
Foodpanda	0	1273\769	1079\969
	1	1266\382	1118\511

Note: In the unit of 1,000 orders, with total order volume in the reward function normalized to monthly order volumes.

We can see the same stories happen at the restaurant level. Figure 10 shows the distribution of restaurant order volumes under each counterfactual policy. Banning exclusive contracts entirely benefits both chain and independent restaurants on average. Only allow Deliveroo to sign exclusive contracts benefits both types, but helps independent restaurants more, because they are likely to be preferred by Deliveroo. Only allowing Foodpanda to sign exclusive contracts barely changes much: there should've been a gain from having more restaurants on the more popular platform, but it's offset by the smaller exclusive effects. The prisoner's dilemma for restaurants, therefore, is that at "Ban Both", the exclusive effect on both platforms are stong, so some restaurants would want to deviate. This leads to a drop in orders for non-exclusive restaurants, which would further consider going exclusive. In the end, restaurants settle on the status quo group, where restaurants on average are worse off than when the exclusive is banned.

Figure 10



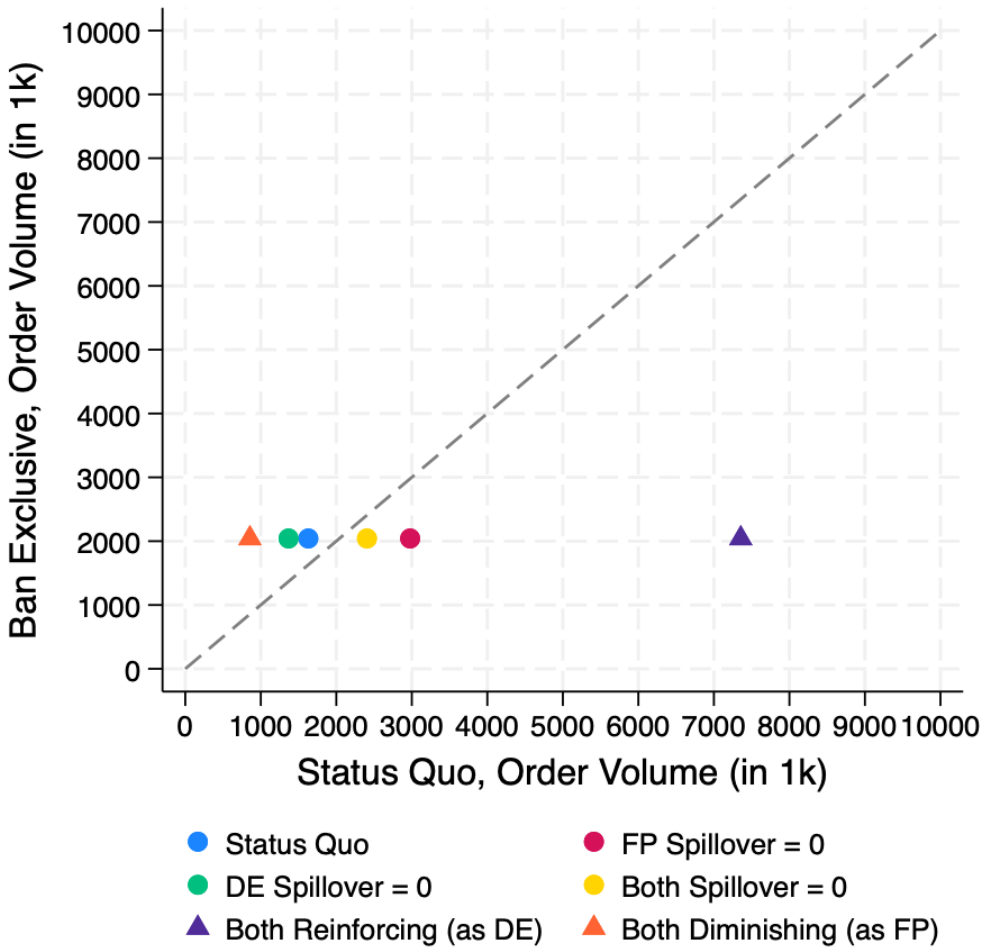
9.3 Consumer Welfare and Mechanism for Prisoner's Dilemma

Since our outside option for consumers, not ordering food delivery, is normalized to have utility zero, the total order volume in the market can be regarded as our measure of total consumer surplus — consumers order more only when they like to. Then, as we've already seen in Figure 9, consumer

welfare can be increased if exclusive contracts are banned. Thus, in this section, we focus more on understanding the mechanism of the current welfare loss at status quo. Again, "status quo" here indicates the status quo *policy*, i.e., letting both platforms freely sign exclusive contracts.

The welfare loss at status quo comes from the compression of market size caused by the diminishing exclusive effect of Foodpanda. To see this more clearly, at the four dots in Figure 11, we turn off Deliveroo and/or Foodpanda's exclusive spillover, and see the comparison between the total market size (i.e., consumer welfare) under status quo (x-axis) and when exclusive contracts are banned (y-axis), while keeping all other parameters unchanged. If the dot is above the 45-degree dashed line, it means moving from status quo to banning exclusive contracts improves consumer welfare, and vice versa. As we can see, once the spillover for Foodpanda is turned off, banning exclusive contracts is no longer welfare-improving. On the other hand, since Deliveroo's exclusive effect is reinforcing, shutting it down in fact decreases the welfare at status quo. At the other two triangles in the figure, we replace Deliveroo's spillover size with Foodpanda's, and vice versa. When both platforms have diminishing exclusive effect, the prisoners delimma gets sharper, and banning exclusive contracts are more benefitial to consumers. On the other hand, if both platform have reinforcing exclusive effects, banning exclusive contracts reduces consumer welfare. In this case, the game among restaurants goes from a prisoner's delimma to a coordination game, where everyone's incentives are aligned and autonomously meets at an equilibrium with a higher payoff.

Figure 11: Exclusive Spillover and Consumer Welfare



10 Conclusions

We study the duopoly in Hong Kong food delivery from 2018 to 2021, and analyze various apspects of government's plan on regulating exclusive contracts between platforms and restaurants. We document that being exclusive significantly increase restaurants' probability of being chosen on the platform, while its dynamics differ across two platforms. On Deliveroo, the exclusive effect is *reinforcing*, where as more restaurants become exclusive on the platform, the reward for being exclusive increases; on Foodpanda, the exclusive effect is *diminishing*, where a larger exclusive share reduces the exclusive effect. We hypothesize that the difference comes from how platforms manage the exclusive advertizing and how consumers perceive the exclusive status on the platform.

The dichotomy of such exclusive spillover directly leads to different policy implications. When platforms have diminishing exclusive effects, banning exclusive contracts improves consumer welfare, and possibly improve welfare for platforms and restaurants as well due to market expansion. When platforms have reinforcing exclusive effects, banning exclusive contracts recudes consumer welfare, likely so for platforms and restaurants. Therefore, the welfare implication of banning exclusive contracts depends on the composition and megnitude of the exclusive effect types of platforms in the market. In our setting, since Foodpanda has diminishing exclusive effect and is the more popular platform, banning exclusive contracts benefit consumers and platforms, and on average, restaurants as well. The ban prevents restaurants and platforms falling into a prisoner's delimma, which generates welfare loss at the equilibrium.

11 Discussions

[In progress]

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