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## Article

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## Determinants of Online Food Delivery(OFD) Sales during COVID-19

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### ABSTRACT

**Purpose:** The outbreak of COVID-19 in early 2020 compelled consumers to abstain from dining out and instead use online food delivery (OFD) services. This study aims to examine the determinants of OFD sales in a restaurant during the COVID-19 crisis.

**Design/methodology/approach:** We analyzed 139,812 restaurant-level credit card OFD transaction data from January 2019 to June 2020 in Seoul, South Korea.

**Findings:** During COVID-19, many restaurants participated and experienced sales growth through the OFD platforms. On the demand side, the composition of customers using OFD services has changed, replacing the demand for dining out. Our estimation results show that the food category, customer composition ratio, and past performance significantly affected restaurants' OFD revenue during the pandemic.

**Research limitations/implications:** The results suggest implications for the restaurant industry responding to changing customer needs on OFD platforms. Restaurants with high-performing OFDs before the pandemic experienced higher sales during the pandemic period. The results imply that experiences to fit customers' needs toward OFD are likely to help restaurants overcome the losses incurred due to the COVID-19 outbreak.

**Originality/value:** This study empirically revealed the effect of store category, past performance, demographic, and geographical customer profile on OFD demand for external shocks such as COVID-19.

*Keywords: online food delivery (OFD) service, food delivery app, consumer behavior in the pandemic*

## I. Introduction

The ongoing COVID-19 pandemic has made non-face-to-face consumption the "new normal" worldwide, fueling digital transformation in many areas. The New York Times reported the pandemic's negative impact in 1Q20 in the U.S., especially in the travel, shopping, transportation, entertainment, and restaurant sectors. With social distancing becoming the norm,

most restaurants across the country have been ordered to stop dine-in services. Consequently, fine and casual dining sales plunged by half compared to the previous year (Leatherby & Gelles, 2020). Moreover, significant changes in consumer behavior have emerged, in which people avoid physical contact to prevent the possibility of transmission (Sheth, 2020). Mobile technology has helped meet these consumer needs and provide a formidable solution for restaurants to reach potential customers. Consumers can complete food delivery orders and payments with mobile applications and receive ready-to-eat food at their doorstep without face-to-face contact. Online food delivery (OFD) services

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have contributed to meeting customers' technical and stability needs related to the consumption of ready-to-eat food in the COVID-19 situation, while mitigating the impact on stores from a sharp drop in visitors (Zhao & Bacao, 2020).

Food delivery apps are an emerging offline-to-online (O2O) mobile platform that connect restaurants and consumers most efficiently through real-time location tracking and shortest distance calculation. OFD platforms provide consumers with a variety of food options and are also convenient to use. Food delivery apps have been increasingly used in many countries even before the outbreak of COVID-19 (Statista, 2018). However, most restaurants had focused their limited resources on offline services and were hesitant to use the OFD platform because of the high commission (Li et al., 2020). Following the COVID-19 outbreak, restaurants had no choice but to utilize the OFD platform in response to the rapidly declining offline demand. Raj et al. (2020) documented that OFD platforms such as Uber Eats played a significant role in mitigating the adverse effects of the negative economic shock arising from COVID-19. In addition, they verified whether there is a "long tail" effect that increases sales of relatively low-profile stores.

Small restaurants can partner with food delivery apps to reach existing customers and leverage their partners' complementary resources to expand their customer base. How local restaurants and small businesses respond to a crisis when demand plummets is an important research topic (Pantano et al., 2020). To shed light on this research stream, we examined the determinants of OFD sales of a restaurant in Seoul, South Korea, from January 2019 to June 2020. We used the Shinhan Card Co., Ltd. data, which aggregates card transactions paid through food delivery apps at the restaurant level<sup>1)</sup>. Specifically, this study investigates the effect of user profile and past performance of the restaurant on OFD sales and discusses managerial implications for mitigating the pandemic risk in the restaurant industry.

Our primary research questions are as follows:

**RQ1:** How does a restaurant's customer composition affect OFD sales during the COVID-19 pandemic?

**RQ2:** How does past OFD sales performance affect sales during the COVID-19 pandemic?

Our study is related to a stream of literature investigating the economic value of online platforms during the COVID-19 pandemic (Dannenberg et al., 2020; Ellison et al., 2021; Van Droogenbroeck & Van Hove, 2021). Using store-level OFD payment information provides a unique opportunity to examine how consumers' online platform usage behavior has changed and how the shift helped restaurants relieve the crisis triggered by the pandemic.

This study contributes to existing research in two ways. First, the use of OFD platforms is increasing worldwide, and its importance as a non-face-to-face channel has further grown after the pandemic. Therefore, it is meaningful to shed light on the value of non-face-to-face channels that connect supply and demand in a crisis situation. Understanding changes in consumer behavior on OFD platforms after the pandemic will make a theoretical contribution to the existing literature on the effects of COVID-19 on digital transformation. Second, most studies on OFD have focused on identifying consumers' motives using a small sample survey method (Ali et al., 2021; Ellison et al., 2021; Mehroli et al., 2020; Zhao & Bacao, 2020). However, previous studies using surveys were limited in analyzing the effect of restaurant-level attributes on OFD sales. To address such limitations, we analyzed store-level OFD sales and customer profile data, which were previously difficult to obtain. The findings of this study provide important information for managers to make decisions regarding OFD platform utilization in an environment of changing demands.

The remainder of this paper is organized as follows. The subsequent section discusses the research background, focusing on the growth of OFD services and the effect of COVID-19 on online and offline food consumption behavior. We then present our data,

1) This data is supported by the Korea Data Agency's data voucher project in 2020 for research related to COVID-19.

the proposed methodology, and empirical results. In conclusion, we discuss the managerial implications, limitations, and potential extensions of our research.

## II. Background

### A. Consumer Behavior Related to OFD

O2O commerce has emerged as a new business model that uses mobile Internet infrastructure and smartphones. O2O refers to consuming products or services in an offline business through online purchases (Cho et al., 2019; Kang & Namkung, 2019; Yang et al., 2021). In the restaurant and the food service industry, OFD services have flourished with the use of mobile applications such as Delivery Hero, Foodpanda, and UberEats. According to Statista Reports (2021)<sup>2</sup>, the revenue of the U.S. The OFD sector is expected to reach \$28 billion by 2021 (35.3% user penetration in the overall market). The market size is expected to grow to \$32 billion by 2024, at an annual growth rate of 4.30%. In the global market, China's OFD division's revenue is expected to be the largest at \$56 billion by 2021.

South Korea's OFD industry has experienced rapid growth, driven by the growing popularity of OFD applications such as BAEMIN, Yogiyo, and Coupang Eats (Lee, 2020). According to the National Statistical Office, the number of online transactions in 2019 reached \$114.06 billion, up 18.3% from 2018. The popularity of OFD in South Korea can be attributed to technological, demographic, and social environmental factors. First, mobile technology development enables a connection between demand and supply for food more efficiently. The second is the growth of young and single-person households who prefer eating out and purchasing a ready-made meal. Third, with an increasing number of women working full-time, the need to save time for meal preparation proportionally rises. China has also experienced similar demographic

shifts and a rapid growth in the OFD industry (Cho et al., 2019).

Prior studies have examined consumer attitudes toward OFD services. Various food choices, prices, and trustworthiness affect the intention to use OFD applications, especially for single-person households (Cho et al., 2019). Young generations who live in single-person homes trigger a higher demand for OFD services. Consequently, the menu and promotion are targeted at the young and tech-savvy market segments (Yeung & Cheung, 2015). Prior studies have examined consumer motivations for the use of OFD services. Yeo et al. (2017) found that convenience motivation is critical for experienced users for OFD. In addition, they confirmed that the time-saving element facilitates the use of OFD services. Ray et al., (2019) found that customer experience, ease of use, and restaurant listings were vital factors influencing the intention to use food delivery apps. Roh and Park (2019) demonstrated that married people may seem more reluctant to adopt OFD than single people because of their high moral obligations. Kang and Namkung (2019) found that perceived usefulness and perceived ease of use have been shown to affect customer confidence in O2O food commerce. This finding indicates that customers tend to believe that O2O food commerce has sufficient capacity to make successful transactions when built on a valuable and convenient system.

### B. Usage of the O2O Platform during the COVID-19 Pandemic

COVID-19 had a greater external impact on business. Business organizations rely on online platforms and digital-based transactions to survive (Hamsal et al., 2022). Recent studies have confirmed that the pandemic has caused many people worldwide to use O2O services for the first time or make existing users more dependent on them (Dannenberg et al., 2020; Ellison et al., 2021; Van Droogenbroeck & Van Hove, 2021). For example, online U.S. grocery sales were expected to grow by 40% in 2020, while e-commerce sales at Walmart rose 74% in April 2020,

2) <https://www.statista.com/outlook/dmo/eservices/online-food-delivery/united-states>

despite declining in-store visits (Nassauer, 2020). In addition, Baker, Farrokhnia, Meyer, et al. (2020) reported a significant increase in OFD spending as it replaced dining at restaurants with meals at home. Online food shopping in China and Europe has also increased significantly since the pandemic (Cheng, 2020).

Chang and Meyerhoefer (2021) investigated how COVID-19 affected online food shopping services using data from the agri-food e-commerce platform in Taiwan. They found that an additional confirmed case of COVID-19 increased the demand for online food shopping by 5.7%, which benefited small firms. Dannenberg et al. (2020) examined how and why online grocery retail expanded during the "stay-at-home" lockdown in Germany. They found that since the onset of the crisis, online food transactions have increased significantly, witnessing high growth rates. Nevertheless, the spatial spread of online food groceries has been limited because both large and small businesses have tried to address increasing demand rather than expanding catchment areas.

### C. Customer Response to OFD during the COVID-19 Pandemic

The COVID-19 crisis caused by the novel coronavirus has drastically changed the restaurant industry due to stay-at-home orders (Jang, 2021). Prior studies have examined customers' willingness to adopt OFD services during the pandemic. Mehrolia et al. (2020) investigated the characteristics of customers who used OFD during the COVID-19 outbreak in India. They found that customers with high perceived threat, reduced product involvement, less perceived benefit on OFDs, and a lower frequency of OFD are less likely to order through OFD. Similarly, Ali et al. (2021) found that optimism and innovation positively affected acceptance intentions, while anxiety and discomfort hurt OFD acceptance intentions. Ellison, McFadden et al. (2021) surveyed consumer panels in the U.S. from mid-March to the end of April 2020. They found that while consumer expenditure on dining out slumped, increased takeaway orders

offset this decline. Finally, Zhao and Bacao (2020) showed that user satisfaction, perceived task-technology fit, trust, performance expectancy, social influence, and confirmation directly or indirectly influence users' intention to continue using the OFD platform during COVID-19.

Yang et al. (2021) elucidated how five-star hotels have survived through O2O food delivery platforms during the pandemic. Analyzing the customer reviews of five-star hotels on the largest OFD platform in China, they found that packaging and delivery quality and hygiene emerged as critical quality dimensions due to COVID-19. They argue that a luxury restaurant can meet customers' expectations by ensuring the superb taste of foods without undermining their luxury image on OFD platforms.

## III. Empirical Analysis

### A. Data

We used store-level OFD transaction data from Shinhan Card cooperation, a leading credit card company, accounting for around 22% of the market share in South Korea (Financial Supervisory Service, 2020). The company aggregated transactions through OFD platforms such as BAEMIN, Yogiyo, and Coupang Eats, on a three-month basis for each store. Location and subcategory information for restaurants was available. Meanwhile, in order to protect the privacy of individual customers, demographic and purchasing behavior information was provided as proportions. Customer composition ratio includes demographic (gender, age group, and life stage) and behavioral (order time, order day, and order radius) characteristics of OFD orders for a restaurant.

Table 1 shows the descriptive statistics of the 139,812 restaurant-level OFD credit card transaction data. During the sample period, the number of merchants participating in OFD platforms continued to increase and doubled from 15,590 to 30,911. The average OFD sales of stores declined between 1Q19 and 3Q19,

but increased again in 4Q19. In 1Q20, when social distancing was implemented, it increased by 10.67% compared to the previous quarter and 10.56% year-on-year. For 18 months, the total market size of OFD grew about 2.15 times, when estimated by multiplying the number of stores and average OFD sales per store.

Concerning the consumer age composition of OFD, before COVID, those in their 20s and 30s accounted for 89% of all orders. These results are consistent with prior studies on user intention for OFD, which revealed that younger generations embrace innovative technologies more quickly (Kang & Namkung, 2019; Yeung & Cheung, 2015). During COVID-19, those

in their 20s and 30s comprised the leading segment for OFD, but the proportion declined to 71%. Conversely, the proportion of those in their 40s was about 15% before COVID-19 but rose to 20% during COVID-19. This suggests that O2O in the upper age group was activated as the pandemic placed restrictions on dining out. These results indicate that middle-aged people can also overcome inhibitions and adopt new technologies (Pantano, Pizzi, Scarpi, & Dennis, 2020). This phenomenon also appears in the classification of life-family cycles of OFD usage. Before COVID-19, the primary target of OFD was single-person households (64%), but it can be seen that the share of OFD by multi-person households

**Table 1.** Descriptive statistics of restaurant-level OFD transactions

Year		2019				2020	
Quarter		Q1	Q2	Q3	Q4	Q1	Q2
<i>Total # of restaurants</i>		15,590	17,428	22,305	24,770	28,808	30,911
<i>Café&amp;Bakery</i>		358	491	989	1,372	1,634	1,774
<i>Chinese</i>		862	947	1,166	1,352	1,622	1,716
<i>Fastfood</i>		774	818	955	1,087	1,186	1,247
<i>General food</i>		6,116	6,766	8,519	9,353	10,772	11,415
<i>Japanese</i>		748	859	1,095	1,200	1,398	1,470
<i>Korean</i>		6,187	6,927	8,815	9,595	11,229	12,209
<i>Western</i>		545	620	766	811	967	1,080
<i>Monthly OFD revenue (\$)</i>		3,331	3,177	2,910	3,328	3,683	3,616
<i>Monthly OFD transactions</i>		178	173	158	184	195	191
<i>OFD customer composition ratio</i>							
<i>Age group</i>	<i>20s</i>	0.38	0.38	0.38	0.39	0.34	0.34
	<i>30s</i>	0.41	0.40	0.39	0.38	0.39	0.37
	<i>40s</i>	0.15	0.16	0.16	0.17	0.20	0.20
	<i>over 50s</i>	0.06	0.07	0.07	0.07	0.08	0.08
<i>Household</i>	<i>single-person</i>	0.64	0.63	0.62	0.62	0.60	0.59
	<i>multi-person</i>	0.36	0.37	0.38	0.38	0.40	0.41
<i>Order time</i>	<i>lunch</i>	0.42	0.41	0.43	0.43	0.45	0.46
	<i>dinner</i>	0.44	0.43	0.42	0.41	0.41	0.40
	<i>other</i>	0.15	0.15	0.15	0.15	0.14	0.14
<i>Order day</i>	<i>weekday</i>	0.56	0.59	0.62	0.61	0.64	0.61
	<i>weekend</i>	0.44	0.41	0.38	0.39	0.36	0.39
<i>Order distance</i>	<i>within 1km</i>	0.33	0.33	0.33	0.32	0.32	0.32
	<i>1~3km</i>	0.33	0.33	0.34	0.34	0.35	0.35
	<i>over 3km</i>	0.34	0.34	0.33	0.33	0.33	0.33

increased from 32% to 41% during COVID-19.

Regarding behavioral characteristics, the proportion of OFD orders for lunch gradually increased, while orders for dinner decreased. During the week, the share of OFDs on weekdays increased, and decreased on weekends. Such a pattern can be attributed to the increasing demand for OFD during weekdays and lunch hours due to telecommuting and home education. Regarding the OFD radius, the proportion of orders from customers located at a medium distance (1-3 km) from a restaurant marginally increased. Specifically, the O2O platform helps stores reach customers over medium distances beyond very close distances.

Figure 1 shows the total OFD monthly transactions over the sample period by category. The most popular categories for OFD in Korea are general food (including chicken specialty stores) and Korean food. The OFDs for these two categories have been on the rise even before COVID-19. In particular, after implementing social distancing, it can be seen that category orders more than doubled compared to the same quarter in 2019. This suggests that the two categories are the categories specialized in online delivery in Korea. Chinese and fastfood were ranked third and fourth among OFD orders, respectively. Meanwhile, cafes and bakeries had the lowest number of online delivery orders throughout the sample period, indicating that these are less suitable for online delivery.

We used store monthly average OFD sales information as a performance variable to investigate the determinants of OFD performance in a restaurant. This study

compares the first two quarters of 2019 and 2020 to examine changes in OFD demand before and after COVID-19. We considered the seasonality of food demand by comparing data from the same quarter rather than from the previous quarter. Using data from the first and second quarters of 2019, we calculated sales performance quintiles (top20, top40, middle, bottom40, and bottom20) for each region and category. We also identified restaurants that launched OFD services after the COVID-19 outbreak.

Table 2 shows the monthly average OFD revenue for each restaurant. For example, in 1Q19, the average OFD sales of restaurants in the top 20 totaled \$11,255, 29 times the stores' sales in the bottom20 (\$392). However, after staying at home, the sales performance of the two groups narrowed the gap by about ten times (bottom20 - \$1,339, top20 - \$14,057 in 1Q20) as overall demand for OFD restaurants increased. Table 2 demonstrates that all performance quintiles experienced a rise in revenue during the lockdown period. Notably, even new OFD restaurants experienced substantial growth in sales. However, the performance of new OFD services varied among different restaurant categories. For instance, new entrants in the Chinese and Fast Food categories performed moderately, while those in the Bakery category performed below expectations. These results highlight that during a socially distanced disaster situation, entry into the online platform in food categories considered staple foods and easily deliverable leads to favorable outcomes.

Figure 2 illustrates the actual and percent changes in the monthly average OFD revenue after COVID-19, depending on their past performance. The sales increase differed for each industry. Concerning the dollar amount increase, it appears that Chinese and fast food sales increased more than twice compared to other categories across all performance quintile groups. It is relatively easy to maintain food quality in these two categories until delivery after food is cooked. The experience of developing and using packaging containers optimized for delivery would have enabled them to respond more actively to the growing demand for delivery. In addition, as a result of analyzing the sales growth rate by quintile, the

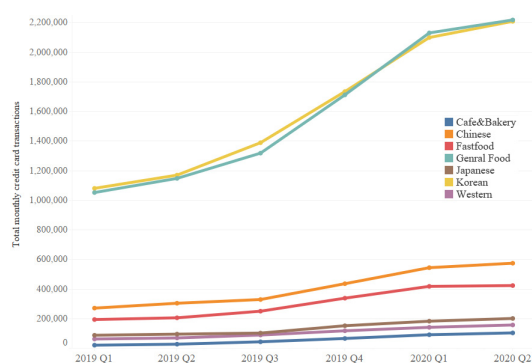


Figure 1. Total OFD Monthly Transactions by Category

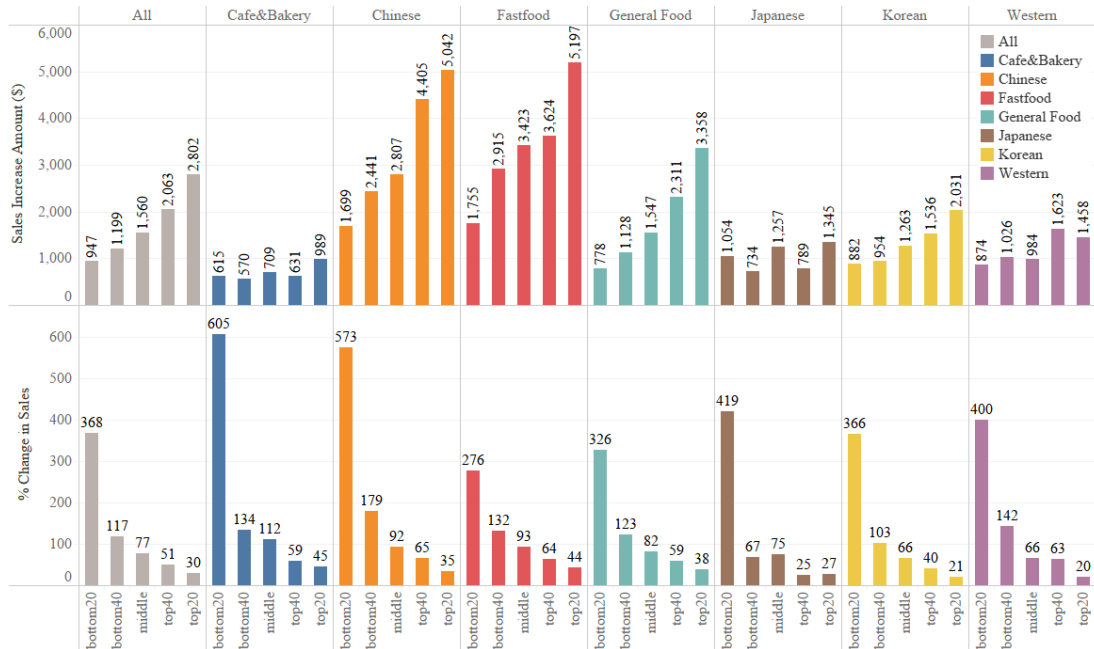
increase rate was high in the bottom20 groups across all categories. These results imply that stores that experienced low OFD revenue before COVID-19

experienced a sharp increase in sales from 275% (Fastfood) to 605% (Café&Bakery).

In the subsequent section, we construct an explanatory

**Table 2.** Monthly average OFD revenue per restaurant (\$)

Category	Year (Q1)	newOFD	bottom20	bottom40	middle	top40	top20
Café&Bakery	2019		205	410	734	1,379	2,979
	2020	795	820	980	1,443	2,010	3,968
Chinese	2019		575	1,609	3,510	6,992	17,355
	2020	4,030	2,274	4,050	6,317	11,398	22,397
Fastfood	2019		822	2,205	4,002	6,518	13,630
	2020	4,893	2,577	5,120	7,425	10,142	18,827
General food	2019		348	993	2,048	3,962	10,612
	2020	2,708	1,126	2,121	3,596	6,273	13,970
Japanese	2019		414	979	1,903	3,671	9,402
	2020	2,696	1,468	1,713	3,160	4,460	10,747
Korean	2019		354	1,003	2,052	4,054	11,791
	2020	3,001	1,236	1,958	3,315	5,590	13,822
Western	2019		348	943	1,789	3,314	7,152
	2020	2,665	1,222	1,970	2,773	4,937	8,610
All	2019		392	1,083	2,197	4,208	11,255
	2020	2,792	1,339	2,282	3,758	6,271	14,057



**Figure 2.** Changes in OFD Revenue Per Restaurant (1Q19 vs. 1Q20)



model for OFD revenue after the COVID-19 outbreak based on an analysis of the customer composition ratio of stores and previous OFD sales performance while controlling for the restaurant category effect.

## B. Model Specification

We estimated the effect of the customer composition ratio and past performance on OFD sales during COVID-19. We modeled the logarithm of monthly sales during COVID-19 regression on the restaurant category, customer composition, regional characteristics, and past performance variables as follows:

$$\begin{aligned} \log(msales_{it(q)}) = & \beta_0 + \sum_{k=1}^K \beta_{1k} category_{ik} \\ & + \beta_2 psingle_{it(q)} + \beta_3 psingle_{it(q)}^2 \\ & + \beta_4 pdinner_{it(q)} + \beta_5 pweekend_{it(q)} \\ & + \beta_6 pdist01k_{it(q)} + \beta_7 pdist13k_{it(q)} \\ & + \beta_8 rpop_{it(q)} + \beta_9 rcomm_{it(q)} \\ & + \beta_{10} top20_{it-1(q)} + \beta_{11} top40_{it-1(q)} \\ & + \beta_{12} bottom40_{it-1(q)} \\ & + \beta_{13} bottom20_{it-1(q)} \\ & + \beta_{14} newOFD_{it(q)} + \epsilon_{it(q)} \end{aligned} \quad (1)$$

where  $msales_{it(q)}$  is the average monthly OFD revenue for restaurant  $i$  for quarter  $q$  of year  $t$ . The restaurant category (Cafe&Bakery, Chinese, Fastfood, General Food, Japanese, and Korean) was dummy coded using Western as the baseline.  $psingle_{it(q)}$  is the proportion of single-person households. We included the quadratic term of  $psingle_{it(q)}$  to capture the nonlinear relationship between the single-person household proportion and OFD revenue. This model excluded age composition variables because they lead to multicollinearity issues with household composition variables.  $pdinner_{it(q)}$  is the proportion of OFD orders during dinner time.  $pweekend_{it(q)}$  is the proportion of OFD orders during weekends.  $pdist01k_{it(q)}$  and  $pdist13k_{it(q)}$  represent the proportion of OFD orders within 1 km and 1-3 km radius, respectively.

We included the regional population and the

number of commuters to control for the effect of regional characteristics, which may affect OFD demand. Information related to the population of the administrative district was obtained from the Statistics Korea website (<https://kostat.go.kr>). Subsequently, regional characteristic information was merged with the OFD transaction data by the administrative district.  $rpdp_{it(q)}$  measures the regional population of the administrative district where the restaurant is located.  $rcomm_{it(q)}$  is the number of commuters in the area, which is a proxy measure of the business district.

Using quarterly data for 2019, we calculated quintiles for each region and category to measure the OFD revenue performance before COVID-19. We then created four dummy variables for each quintile using the middle quintile as a baseline.  $top20_{it-1(q)}$  refers to a restaurant with OFD revenue performance quintile of the top 20% in the same category within the administrative district where they belong in the year  $t-1$  at quarter  $q$ . Correspondingly,  $top40_{it-1(q)}$  is a restaurant belonging to the quintile of the top 20-40%,  $bottom40_{it-1(q)}$  is a restaurant belonging to quintile in the bottom 20-40%, and  $bottom20_{it-1(q)}$  is a restaurant belonging to quintile in the bottom 20%. Lastly,  $newOFD_{it(q)}$  is a dummy variable for a restaurant that starts OFD service from year  $t$  quarter  $q$ . It measures the relative sales performance effect of new entrants compared to middle-performing incumbent restaurants on food delivery platforms.

## C. Results

Table 3 shows the estimation results for explaining restaurant revenue from OFD during the first and second quarters of 2020 in South Korea. In this study, we only consider Q1 and Q2 data as restaurant-level credit card data is available from Q1 2019 to Q2 2020. M1a, M2a, and M3a show the estimation results for the log(sales) model for 1Q20, and M1b, M2b, and M3b illustrate the estimation results for the log(sales) model for 2Q20. M1a and M1b represent the log(sales) model with customer composition ratio

**Table 3.** Effect of past performance on OFD revenue during COVID-19

	Dependent variable:					
	log(s20q1)			log(s20q2)		
	M1a	M2a	M3a	M1b	M2b	M3b
<i>General food</i>	0.074 (0.047)	0.065 (0.041)	0.042 (0.035)	0.073 (0.046)	0.031 (0.039)	0.018 (0.034)
<i>Japanese</i>	0.014 (0.059)	0.025 (0.051)	0.044 (0.044)	0.081 (0.058)	0.049 (0.049)	0.070 (0.043)
<i>Chinese</i>	0.590*** (0.058)	0.545*** (0.049)	0.557*** (0.042)	0.661*** (0.056)	0.548*** (0.048)	0.565*** (0.042)
<i>Café&amp;Bakery</i>	-0.967*** (0.058)	-0.849*** (0.049)	-0.727*** (0.043)	-0.925*** (0.056)	-0.827*** (0.048)	-0.723*** (0.042)
<i>Fastfood</i>	0.866*** (0.061)	0.709*** (0.052)	0.680*** (0.045)	0.796*** (0.060)	0.609*** (0.051)	0.594*** (0.045)
<i>Korean</i>	0.124*** (0.047)	0.108*** (0.040)	0.099*** (0.035)	0.110** (0.046)	0.071* (0.039)	0.073** (0.034)
<i>psingle</i>	0.474*** (0.039)	11.287*** (0.110)	9.416*** (0.098)	0.217*** (0.038)	11.260*** (0.106)	9.359*** (0.095)
<i>psingle2</i>		-10.146*** (0.099)	-8.578*** (0.087)		-10.329*** (0.095)	-8.688*** (0.085)
<i>pdinner</i>	0.342*** (0.038)	0.252*** (0.032)	0.164*** (0.028)	0.298*** (0.037)	0.232*** (0.032)	0.128*** (0.028)
<i>pweekend</i>	0.883*** (0.044)	0.659*** (0.038)	0.477*** (0.033)	0.753*** (0.042)	0.586*** (0.036)	0.435*** (0.031)
<i>pdist0_1k</i>	-0.352*** (0.046)	-0.441*** (0.040)	-0.356*** (0.034)	-0.338*** (0.045)	-0.385*** (0.038)	-0.317*** (0.034)
<i>pdist1_3k</i>	0.476*** (0.049)	0.155*** (0.042)	0.081** (0.036)	0.518*** (0.047)	0.195*** (0.040)	0.130*** (0.035)
<i>rpop</i>	0.022*** (0.005)	0.028*** (0.004)	0.027*** (0.004)	0.023*** (0.005)	0.030*** (0.004)	0.027*** (0.004)
<i>rcomm</i>	-0.0004*** (0.00004)	-0.0002*** (0.00003)	-0.0001*** (0.00003)	-0.0003*** (0.00004)	-0.0002*** (0.00003)	-0.0001*** (0.00003)
<i>top20</i>			1.323*** (0.028)			1.344*** (0.028)
<i>top40</i>			0.542*** (0.028)			0.532*** (0.028)
<i>bottom40</i>			-0.502*** (0.028)			-0.482*** (0.029)
<i>bottom20</i>			-0.980*** (0.029)			-0.979*** (0.030)
<i>newOFD</i>			-0.506*** (0.022)			-0.470*** (0.022)
<i>Constant</i>	6.174*** (0.104)	3.971*** (0.092)	4.794*** (0.082)	6.275*** (0.102)	4.006*** (0.089)	4.807*** (0.081)
<i>Observations</i>	28,808	28,808	28,808	30,908	30,908	30,908
<i>R<sup>2</sup></i>	0.095	0.338	0.507	0.079	0.335	0.495
<i>Adjusted R<sup>2</sup></i>	0.095	0.338	0.507	0.079	0.335	0.494
<i>F Statistic</i>	233.032***	1,049.560***	1,559.495***	203.676***	1,113.273***	1,592.235***

Note: \*p&lt;0.1; \*\*p&lt;0.05; \*\*\*p&lt;0.01

and regional characteristics. In M2a and M2b, we added the quadratic term of the percentage of a single-person household, and the model fit was improved (Adjusted-R square: 0.095 in M1a, 0.338 in M2a, 0.079 in M1b, and 0.335 in M2b). These results suggest that stores that target multiple customer segments are more advantageous for OFD sales than those with a high percentage of a specific market segment. Lastly, the full models include the past OFD sales performance quintile variables and yield improved explanatory power (Adjusted-R square: 0.507 in M3a and 0.494 in M3b).

The Chinese and fastfood categories showed positive coefficients in all models, indicating that their average monthly sales through the OFD platform were higher than those in other categories during the COVID-19 period. In contrast, the negative coefficients for café and bakery indicate that it underperforms other categories. As shown in Table 2, the average monthly OFD sales in the Chinese and fastfood categories were higher than in other categories even before the pandemic. Specifically, Chinese and fast food restaurants have adjusted to increasing demand through the food O2O platform. Accordingly, they can achieve better sales performance through the OFD platform after staying home orders. Meanwhile, the categories specialized in dine-in services (e.g., café and bakery, Korean, Japanese, and Western) have experienced relatively lower sales increases.

Next, we examined the effect of the customer composition ratio of a restaurant on sales from the OFD platform. The higher the composition ratio in single-person households, the more positive the OFD sales ( $\hat{\beta}_2 = 0.474$ ,  $p < 0.01$  in M1a;  $\hat{\beta}_2 = 0.217$ ,  $p < 0.01$  in M1b). The results imply that single-person households have been a substantial consumer segment for OFD services. Further, M2a and M2b include the quadratic term of  $p_{single}$  yield, which improves the explanatory power. The coefficients of  $p_{single}^2$  are both negative and significant ( $\hat{\beta}_3 = -10.146$ ,  $p < 0.01$  in M2a;  $\hat{\beta}_3 = -10.329$ ,  $p < 0.01$  in M2b), suggesting an inverted U relationship between single-person household composition and OFD sales.

Accordingly, we applied the M2a (M2b) model to the 1Q19 (2Q19) dataset to examine the optimal proportion of single-person household changes. Figure 3 illustrates the predicted monthly OFD revenue with respect to the single-person household composition ratio when the category is fixed as fastfood. Our estimation results suggest that the optimal single-person household proportion in 2019 was 60% when the others were all equal. As the single-person household was the primary user of OFD service in the growth stage, the restaurant targeting a single-person household could expect higher revenue than other fast food restaurants. However, when multi-person households increasingly use the OFD platform owing to the pandemic, targeting both single and multi-person households could be helpful in maximizing revenue.

Regarding the effect of OFD order timing, we found that restaurants with a high ratio of dinner orders had higher OFD sales compared to stores with a high percentage of orders at other times of the day. In addition, restaurants with a high proportion of orders on weekends showed higher sales than those with a high proportion of weekdays. These results suggest that OFD sales for restaurants with a high proportion of dinners and weekend dining may be higher during the pandemic, as demand for dinner or weekend dining shifts to OFD. As for the OFD order radius, the higher the proportion of orders within 1 km, the lower the OFD sales compared to stores with orders over 3 km. Meanwhile, restaurants with an order radius ratio within 1-3 km showed higher OFD sales. These results demonstrate that the demand

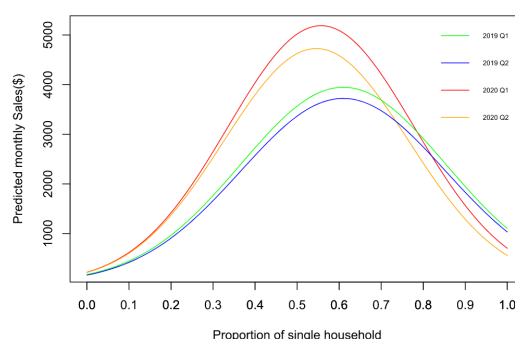


Figure 3. Optimal Proportion of Single-person Household

for OFD is highly likely to occur within a 10-minute drive, considering both the need for quality food and the maintenance of food quality through delivery.

We tested the effect of regional demand and competition on OFD sales. We collected information on the number of populations and commuters given the administrative region from the government's public data website and combined it with our data. The number of background population living in the administrative area where the store is located has a positive effect on OFD sales. In contrast, the number of commuters negatively affects the OFD sales of restaurants. These results suggest that stores located in commercial areas with large floating populations have relatively low OFD. To measure the extent of competition, we calculated the number of stores within the same category and the same regional area. As expected, higher competition negatively affected online food delivery. Conversely, when the number of competitors in the same category within the same region is low, a restaurant can benefit from OFD.

Finally, we examined whether previous performance affects OFD sales during COVID-19. With the middle OFD sales performance quintile of 2019 as a baseline, stores that were in the top20 in the past registered the highest OFD sales compared to other stores ( $\hat{\beta}_{10} = 1.323$ ,  $p < 0.01$  in M3a;  $\hat{\beta}_{10} = 1.344$ ,  $p < 0.01$  in M3b). The absolute magnitude of the positive effect of the top20 on OFD sales is greater than the negative effect of the bottom20. Specifically, restaurants with high sales through food delivery apps could obtain a greater sales increase when OFD demand expanded. These restaurants can enjoy the effect of repurchasing from existing customers. Furthermore, they have accumulated many user reviews, thereby having more advantage to attract new customers by remaining at the top of the list through an algorithm of the OFD platform. In addition, new entrants to the O2O platform showed similar OFD sales performance to the existing bottom40 quintile.

## IV. Conclusion

### A. Summary

The COVID-19 outbreak significantly increased the need for non-contact method of food delivery services. Using a large-scale of restaurant-level credit card transaction data, we examined the changes in consumer behavior related to the use of OFD platforms during the pandemic. From the supply side, we found that the number of restaurants participating in OFD services had increased. Further, we determined a significant increase in OFD sales of restaurants across all food categories. The descriptive analysis provides evidence that the OFD platform enables a restaurant to make up for reduced sales during the stay-at-home order. COVID-19 broadens the segments that use OFD platforms and replaces the prior demand for dine-in services from the demand side. Not only single-person but also multi-person households have started to consider using food delivery apps. Our estimation result supports that as the consumer base expands with the stay-at-home order, the importance of single-person households in OFD sales is attenuated compared to the period before the pandemic. The results suggest that restaurants that target both single-person and multi-person households can be better off during the pandemic. Furthermore, restaurants with high-performing OFDs before the pandemic experienced higher sales during the pandemic period. The results imply that experiences to fit customers' needs toward OFD are likely to help restaurants overcome the losses incurred due to the COVID-19 outbreak.

### B. Theoretical and Managerial Implications

This study supplements the value of O2O platform literature during COVID-19 by investigating the determinants of OFD revenue. Recent studies have documented the economic impact of COVID-19 and the expansion of online platforms (Baker et al., 2020; Chang & Meyerhoefer, 2021; Cheng, 2020; Nassauer, 2020). Focusing on food O2O commerce, we also

provided empirical evidence of an increase in O2O platform participants in supply and demand. Subsequently, we demonstrated that the OFD sales increase during the pandemic differs across restaurant categories. Further, using the explanatory model, we showed that a restaurant's customer composition ratio and its past OFD performance affected OFD sales during COVID-19.

Prior literature on OFD platforms investigated the determinants of the adoption intention of food delivery platforms using questionnaire-based experiments (Ali et al., 2021; Cho et al., 2019; Kang & Namkung, 2019; Mehroli et al., 2020; Roh & Park, 2020; Yeo et al., 2017; Zhao and Bacao, 2020). We contributed to the existing literature by uncovering consumer behavior toward OFD based on real-world transaction data. This study first attempts to provide empirical evidence that stores (food category, past performance), demographic (family type), occasional (order time, order day), and geographic (distance, regional population, commercial district) characteristics significantly influence demand for OFD. Furthermore, we demonstrated how to build the segmentation and targeting strategy to maximize OFD revenue by considering the demographic shift during COVID-19.

This research also provides meaningful managerial implications for the restaurant industry on how to use OFD services. First, restaurants need to monitor changes in their customer composition. Before the pandemic, an increase in young single households who are tech-savvy and intend to save time for food preparation was the main driving force behind the growth of the OFD platform (Yeung & Cheung, 2015). Restaurants that provide OFD services have made efforts to meet the needs of this primary segment, such as diversifying one-person menus. However, after the COVID-19 outbreak, as it became challenging to dine out due to social distancing, the proportion of multi-person households using OFD increased. Therefore, restaurants need to consider selling food through the O2O platform to mitigate the sales shock caused by the decrease in in-store visits and develop customized menus and packaging for multi-person households, a new customer base.

The bottom20 OFD performance group restaurants

before the pandemic showed the highest growth rate during COVID-19. In addition, restaurants that newly launched OFD services due to stay-at-home orders also showed sales performance equivalent to the bottom40 of stores that had provided OFD services. Accordingly, when the demand for OFD increases, it is necessary to make an extra effort to continuously retain the influx of customers. For example, restaurants with low OFD performance need to analyze customer reviews of their competitors with high OFD performance in the same food category. By analyzing a large volume of customer feedback, they can obtain ideas for OFD service improvement. Prior studies on OFD suggest that restaurants need to control customer satisfaction in three ways. First, they need to improve food quality because it is the most critical factor in customer satisfaction with OFD services (Kang & Namkung, 2019; Yang et al., 2021). Else, customer complaints regarding the restaurant will be posted on the OFD platform, and there is a risk of damaging its reputation. Second, restaurants need to communicate with the O2O platform to deliver food safely at the expected time (Yeo et al., 2017) because delivery conditions affect food temperature and presentation. Third, restaurants can deliver their store personality and partial dine-in experience by utilizing food presentation images on OFD platforms or delivery packages (Yang et al., 2021).

### C. Limitation and Future Research

Despite its implications, we will discuss certain limitations of our study, which should be addressed in future studies. First, this study focused on identifying the factors influencing OFD sales post-pandemic using restaurant-level data from Q1 2019 to Q2 2020. Including data from Q1 2018 and Q4 2020 will give a more comprehensive view to understand the net impact of COVID-19 on sales growth. For a more precise analysis, future research should consider a broader timeframe to account for seasonal fluctuations and evolving trends in the OFD market.

Second, we used OFD transaction data generated

in a single country, South Korea. Food preferences vary by country and culture, which can be an essential factor in OFD sales. In addition, depending on the country's mobile technology and transportation infrastructure, there may be differences in perceived customer satisfaction with the OFD service, leading to differences in performance after COVID-19. Therefore, there may be limitations in generalizing the results of this study to all countries. Future researchers can apply our model to other cultures to establish the generalizability of the implications identified in this study.

Third, we find that restaurants that launched OFD service after the COVID-19 pandemic experienced moderate OFD sales performance. After 2022, the pandemic has eased, and restaurants are resuming normal operations. Will the customer segment using OFD for the first time during COVID-19 be willing to continue using it? How can restaurants effectively manage the two segments of dining-in customers and delivery customers? Changes in consumer attitudes toward OFD during the endemic period and the strategic response of the restaurant industry to this change are the future research agenda.

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