The Effect of Seasonal Parking Fees on Disc Golfing

Jimena González-Ramírez[*], Kenneth Liao[†], Kevin Meyer[‡], and Victoria Adams[§]

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Abstract

This study investigates the impact of price changes on the behavior of disc golf players using a natural experiment involving two nearby courses. One of these courses enforces a seasonal parking fee, while the other remains free all year. By integrating data from a popular disc golf scorekeeping app, state park fee schedules, and weather conditions, we assess the fee's effect on the visitation dynamics between the two courses. Our results indicate that introducing a parking fee can lead to a drop of up to 30 percent in daily visits to the course with the fee, compared to times when both courses are free. However, considering the potential substitution to the free course, the daily share of visits to the fee-charging course diminishes by about 6 percent, and the average monthly visits per player decrease by around 7 percent. This research sheds light on how pricing affects participation in recreational activities, offering insights that can inform decisions related to course management, pricing strategies, and the promotion of disc golf.

Keywords: Disc golf, frisbee golf, recreation demand, congestion pricing, demand estimation, substitutability, public parks, user fees

JEL Codes: Z2, Z20, Q50

[*]Manhattan College
[†]Farmingdale State College
[‡]Saginaw Valley State University
[§]Manhattan College

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1 Introduction

In recent years, outdoor recreational activities have witnessed a surge in popularity as individuals increasingly pursue opportunities to connect with nature. Lockdowns and social distancing due to the Covid-19 pandemic motivated people to explore unique ways to recreate outdoors, as evidenced by recent empirical studies (**???**). Disc golf, which bears similarities to traditional golf but with distinctive features, has been one such activity that has grown in popularity. The game tasks players with landing a disc into a basket using the fewest possible throws, typically spanning an 18-hole course located within a public park. Unlike traditional frisbees, disc golf discs are more compact and crafted from denser plastic, allowing them to be thrown faster and farther. Distinct from its traditional counterpart, disc golf thrives on varied terrains and natural barriers like trees, ensuring an environmentally sustainable yet challenging experience for players.

While the majority of disc golf courses are free to access, a subset of courses implement a variety of fee structures, ranging from usage fees for the course itself to entry fees for the encompassing park, as well as per-vehicle parking charges. This study probes the repercussions of such fees on disc golfer choices, with an emphasis on course preference. We spotlight two closely located, comparable courses, one of which imposes a vehicle entry fee during certain timeframes, while its counterpart remains fee-free. We use the latter as both a control and an imperfect substitute to analyze how the fee affects visits to both courses.

Initially, we compare the attendance of the fee-charging course against a hypothetical fee-free scenario, using the free course as the reference point. Using a panel data regression, we find that the introduction of a $10 parking fee at FDR State Park reduces the visits by disc golfers by around 30 percent, compared to periods when both courses are free of charge. However, this approach only provides an upper-bound estimate of the fee's influence due to its omission of inter-course substitution effects. Specifically, during favorable weather or peak times like summer weekends, an observed increase in visits to the free course might not solely be attributed to the favorable conditions, but also to some golfers switching away from the fee-charging course. This potential substitution effect could lead to an overestimation of the negative impact of the fee on attendance.

Thus, while our initial model indicates the potential maximum effect of the fee, it is crucial to acknowledge that course substitution could bias this estimate.

Our subsequent model attempts to directly account for the substitution effect, analyzing how the fee changes the share of visits between the two courses. Since we concentrate on the share of visits to one course relative to the other, we are able to study the way players substitute one course for the other in the presence of the exogenous fee. We find that the share of visits to the fee-charging course goes down by about 6 percent during days when there is a fee.

While our first two approaches use daily-level course data, our third approach utilizes user-level data to account for user fixed effects. Specifically, the third model examines individual user data, focusing on players who have visited both courses during our study. We find that the users who visit both courses tend to visit FDR 7 percent less often when there is a fee. These insights hold significant implications for park officials and course operators crafting optimal pricing strategies and for policymakers and city planners evaluating the development of new disc golf courses.

Our research extends through various literature topics and provides further insights to inform future research. We contribute to the congestion pricing and niche sports literature as we use score-keeping app data from UDisc to examine the impact of a congestion pricing entry fee on disc golfers' course choices. Our partnership with UDisc can also advise future research on the impact of social media and application use on recreational site use and decision making. Additionally, we contribute to recreation demand literature by analyzing the effect of both natural (weather) and controlled (parking fees) factors on disc golfers' decisions to visit a park.

This paper proceeds as follows: Section 2 provides an overview of disc golf and discusses current trends in the sport. Section 3 reviews relevant literature on disc golf, recreation demand, and site choice. Section 4 details the data utilized for this study, including data from a disc golf score-keeping application and information about the specific disc golf courses under study. In Section 5, we detail our econometric models and methodology. The findings from our analysis are then presented in Section 6. Section 7 concludes by discussing our results, examining their implications for park officials, course operators, and policy makers, and suggesting potential avenues for future

research in this domain.

2 Disc Golf

2.1 Overview

Disc golf mirrors the structure of traditional golf; however, it substitutes balls and clubs with specialized discs which players throw into metal baskets. The courses for this sport are typically nested within parks or wooded areas, capitalizing on existing terrains and thus rendering it a considerably lower-impact activity compared to its traditional counterpart. Moreover, disc golf's low cost of entry — requiring only a couple of discs priced between $10 and $25 — significantly undercuts the financial barrier associated with traditional golf.

Scoring in disc golf is similar to its traditional counterpart, counting the number of throws per basket or hole. Many players turn to mobile applications for recording and saving their scores. UDisc is the leading choice in this realm. The application not only offers scorekeeping functionalities but also provides features such as interactive maps for over 14,000 courses, tools for league management, throw measurements, and player progress tracking. UDisc has amassed over 1 million downloads, making it the top application for disc golf enthusiasts. This prominence is further supported by their 2023 Growth Report, which reveals that 1.2 million disc golfers utilized UDisc in the previous year (**?**).

While the majority of disc golf courses operate free of charge, certain premium courses may charge a fee for their superior tee boxes, signage, landscaping, or other amenities. Further, some public parks may introduce congestion fees for parking or entry during certain seasons, despite the absence of an additional cost for using the disc golf course. While these premium courses remain the exception rather than the rule, their existence, along with congestion fees, indicates that despite disc golf's image as a low-cost outdoor recreation activity, the cost of play can be subject to variability based on the course and associated fees.

2.2 Trends in Popularity of Disc Golf

The popularity of disc golf has surged in recent years due to its affordability and its suitability for individuals of various athletic abilities. The COVID-19 pandemic further propelled this interest, as the sport presented an ideal choice for outdoor, socially-distanced activities (**?**). The heightened demand for disc golf, initially spurred by the pandemic, has not only persisted through 2021 and 2022 but has also shown consistent growth. Those who embraced the sport during lockdown periods exhibit the same level of enthusiasm as players before the pandemic, underscoring a sustained and growing interest in the sport. (**?**).

The growth of disc golf is notably reflected in the scoring data from the UDisc app, with the number of rounds scored tripling in 2020. This upward trend continued into the subsequent years, with a 50 percent increase in 2021 and a further 10 percent increase in 2022 (**?**). The rising popularity of the sport is also evident in the expanding membership of the Professional Disc Golf Association, or PDGA, which crossed the 200,000 threshold in 2022. Interestingly, while it took 41 years for the organization to reach the initial 100,000 members, the subsequent 100,000 joined within just four years (**?**). Globally, the installation of new disc golf courses has seen a significant upswing as well, with 64 percent of the current 14,048 courses having been installed since 2012. Of these, a substantial 22 percent were installed after 2020 (**??**). Beyond the benefits to players, disc golf courses also attract tourism and stimulate local business opportunities, thereby contributing to the local economy.

3 Literature Review

While the popularity of disc golf is rapidly growing, there is little academic research on the sport. Generally, the demand for outdoor recreation is impacted by environmental conditions, site conditions, and the intrinsic values people receive from using the space or doing the activity. In this section, we identify and summarize a number of articles that study recreation demand and the impacts of various factors which drive individuals' decision making processes. All of which inform

our approach in the study of congestion pricing and site choices for comparable disc golf courses.

? analyze the literature in the realm of sports to understand monetary valuation research in sports - discussing the methodologies and motivations for such analyses. They acknowledge three types of value obtained from their analyses: direct use value, indirect use value, and option value - all of which are important to finding the total value of a sport/recreational zone. Since our research is focused outdoor recreation choices, not on the value of a recreational activity, we turn to articles that identify factors that influence such choices. **?** directly analyze the impacts of both natural and human-caused environmental disasters (forest fires) on consumers' demand for hiking and biking on national park trails. Their findings suggest that environmental conditions play an important role in hikers/bikers' demand for the trails and suggest that both natural and man-made conditions should be considered in recreational demand surveys. While fires can cause harm and make trails and parks less appealing, the recent environmental/social impacts of the COVID-19 pandemic caused surges in trail use- up to a 200% increase in trail use in 2020 (**?**). This increase was primarily due to the fact that the sport allowed all ages to practice social distancing and enjoy the outdoors (**?**). As suggested by **?**, resource managers should consider the increased demand for resources during unexpected conditions and ideally provide more opportunities for resource use. Similarly, **?** analyzes the impact of the recession on outdoor recreation demand and demonstrates how an economic downturn can have detrimental effects on otherwise low-cost use of outdoor space – primarily through actual travel costs.

? compares six mountain biking trails in a North Carolina region, primarily considering the choice variables which influence visitors decisions to visit. The two key variables that were considered were trail condition and site layout. Similar considerations are likely taken into account when choosing between any two (or more) comparable disc golf courses. Additionally, as with any outdoor activity, weather is often an inhibiting or encouraging factor for individuals. **?** found that temperature has a substantial positive impact on outdoor recreation, which motivates the inclusion of weather variables in our analysis.

The primary focus of our study is congestion pricing, which aims to reduce traffic at/for par-

ticular resources. **?** resolved congestion issues at a forest in an urban region of Turkey, suggesting that resource-enlarging policies would improve overall welfare over restriction policies. Their model included important aspects of the New Environmental Paradigm (NEP) scale - biodiversity, sensitivity to sustainable development, and efficient resource use (**?**). (**?**). **?** analyze an interesting fee policy at a national park in South Africa. Their analysis suggests that the tourists (non-locals) should be responsible for the majority of funds (i.e., higher prices for international tourists) as it encourages locals to be involved and experience the same location, which is in their backyard, and ultimately improves attitudes toward conservation and the environment. In another pricing model, **?** found that they could discourage congestion of sustaining renewable resources by setting the price of a permit at the shadow price of the resource.

Some pricing policies also emphasize the need to effectively generate funds for the amenity by providing the optimal entrance fee. **?** estimate optimal fess and the related welfare implications for entrance to 130 lakes in Iowa and find that fees can be used to cover maintenance costs, but would be regressive in nature. **?** used the contingent valuation method to estimate the willingness to pay a fee to maintain volcanic sites in Italy, and found that a fee system that charged different rates for high visitation and low visitation periods would be optimal. **?** found that 92% of visitors to natural attractions in Iceland would be willing to pay a moderate fee if it were used to maintain the attractions. T

We also look to the literature on niche sports, such as disc golf, to gain a stronger understanding of what the designation entails. According to **?**, niche sports are those not attracting large live audiences or mainstream media. Key factors that are associated with niche sports are affordability and player similarities (to oneself), as compared to mainstream sports which are associated with popularity. While they are becoming more prevalent, research into the world of niche sports is still limited (**?**). While mainstream sports garner larger audiences and have larger funds for advertising (**?**), niche sports primarily rely on social media for attracting attention (**??**). Another key feature of niche sports is the emphasis on travel and experience. **?** investigates the impact of a niche sporting event on the perception of a rural area, as well as how it impacts tourism.

It is becoming increasingly common for studies on outdoor activities to rely on data from cell-phone applications, such as UDisc, and social media. The eBird application is one such example, which allows individuals all over the world to partake in a Citizen Science (CS) project, providing researchers with a constant flow of information regarding birds locations, habits, and interaction with humans (**?**). Data from ebird has been used in several recent economic papers (**???**) According to **?**, social media posts help the goodness of fit for regressions where the outcome is on-site visits and additional controls include weather and calendar date.

4 Data

4.1 Study Area: FDR State Park and Leonard Park Disc Golf Courses

Though the United States boasts over 9,000 disc golf courses, New York City's urban expanse of five boroughs contains zero disc golf courses. According to the Disc Golf Growth Report published in 2023, New York City lacks a single course and its 8.5 million population are missing out on this recreational activity. The absence of disc golf courses poses a noticeable constraint for New York City's residents, who are required to commute to neighboring areas such as Westchester, New Jersey, or Long Island to visit a disc golf course (**?**). Moreover, not having a course within NYC also limits the accessibility of this recreational activity to those with access to cars, as the courses near New York City are not easily reachable through public transportation. New York City's situation distinctly contrasts other major U.S. cities like San Francisco, San Diego, Los Angeles, and New Orleans, which have disc golf courses within their limits.

This study focuses on two disc golf courses, FDR State Park Disc Golf Course and Leonard Park Disc Golf Course, which are situated about 40 miles north of New York City and only 11 miles apart, as depicted in Figure 1. These courses serve as critical recreational venues for disc golf enthusiasts from both the city and surrounding local communities.

In addition to being located closely together, FDR State Park Disc Golf Course and Leonard Park Disc Golf Course offer relatively similar playing experiences. As shown in Figures 2 and

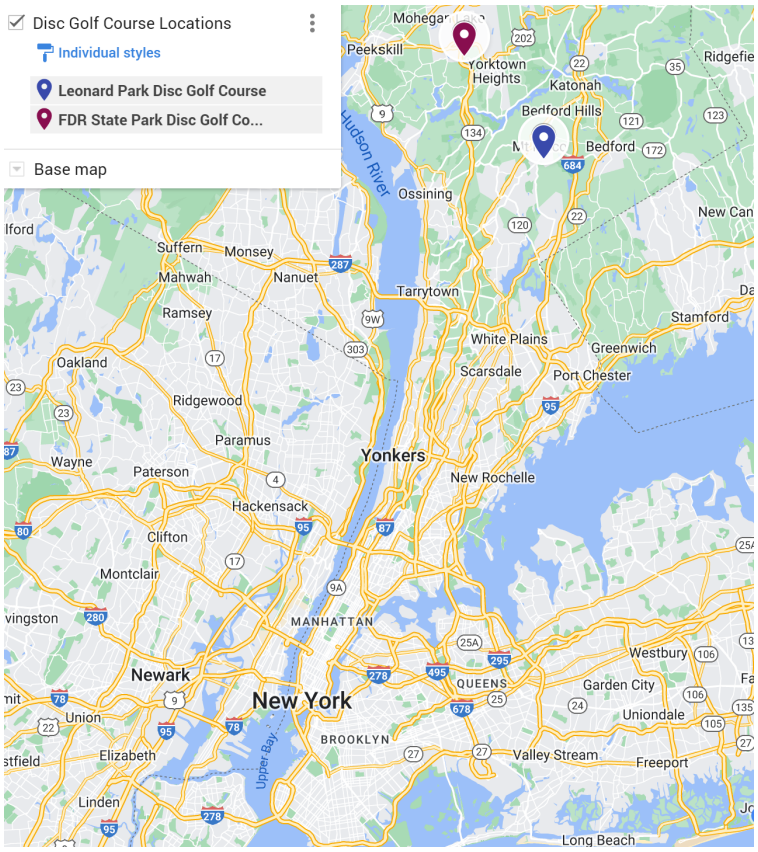

Figure 1: Map showing the location of FDR State Park and Leonard Park Disc Golf Courses

3, each course consists of 18 baskets, exhibits a high standard of maintenance, with well-marked tees, fairways, and baskets, clear course signage, and clean playing environments, reflecting the commitment of the park administrations and user communities.

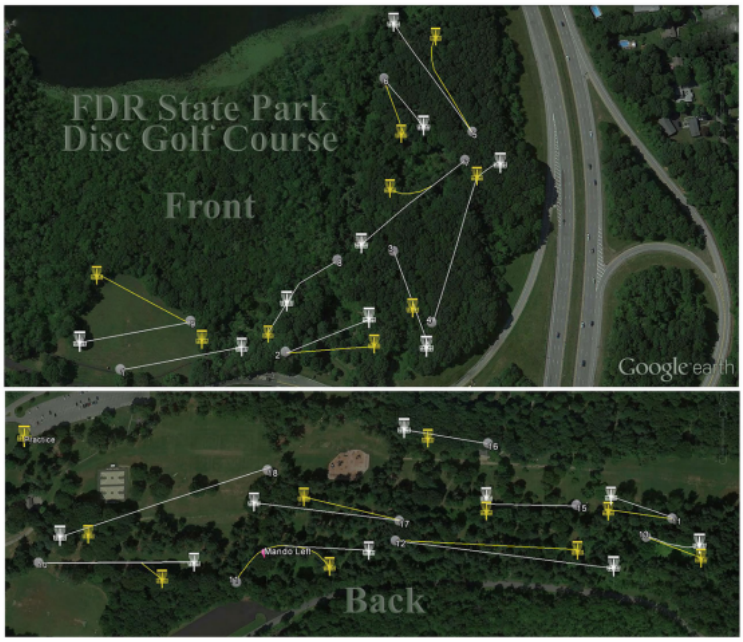

Figure 2: FDR Disc Golf Map provided by WeDGE (**?**)

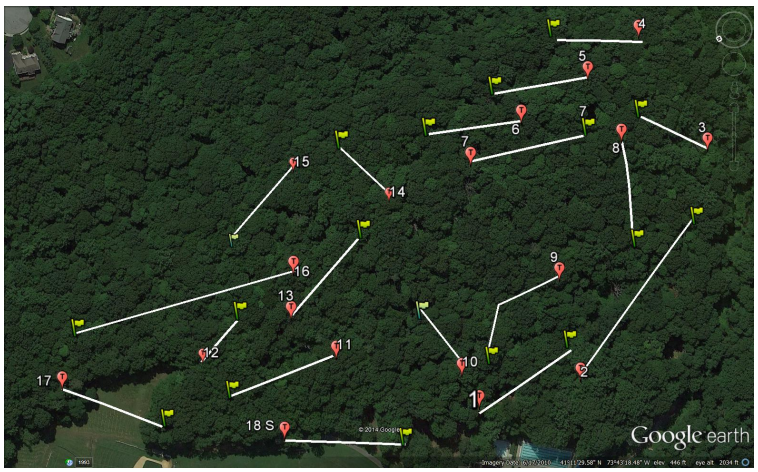

Figure 3: Leonard Park Disc Golf Map provided by PDGA(**?**)

Both courses feature a blend of open spaces and wooded areas, with varying elevations and native woodland serving as strategic obstacles. There are unique characteristics to each course, with some holes notably shaped by the distinctive natural features of the respective parks. Any dif-

ferences in course layout, location, and amenities are controlled for using fixed effects, as detailed in the following section. Both courses are maintained by the Westchester Disc Golf Enthusiasts (WeDGE), which is a non-profit club for disc golfers in Westchester County.

Both courses operate year-round and are free to use, with the exception of the parking fee imposed at FDR during certain times of the year. Regular events and tournaments, often organized by local disc golf clubs such as WeDGE, attract players from across the region, fostering an active community of disc golf enthusiasts. These events provide opportunities for competition and skill development, enhancing the overall disc golf experience at both locations.

One pivotal aspect to emphasize regarding the parking fee at FDR is its critical role in our research design and identification strategy. The fee structure at FDR functions akin to an exogenous variable in our model. The park itself is expansive and offers a myriad of recreational activities ranging from general sports to picnics. It's noteworthy that only a marginal fraction of the visitors to FDR State Park are actually there to partake in disc golf. This dynamic is further illustrated by the fact that many New York state parks, irrespective of whether they offer disc golf facilities or not, follow a similar fee structure for parking. This fee schedule is determined solely by the calendar, taking into account the day of the week and the month of the year, and is not directly influenced by disc golf activities or its attendance patterns. A more in-depth discussion of this fee scheduling, particularly in relation to congestion pricing, will be detailed in subsection **??**. Park visitors who want to avoid paying the congestion fee may purchase the Empire Pass, which allows free access to New York State parks throughout the year.

4.2 The UDisc Scorekeeping App

UDisc is a leading mobile application within the disc golf community that offers a comprehensive suite of features geared towards players of all skill levels. At its core, UDisc offers players a simple and intuitive platform to keep track of their scores. The app allows players to record the number of throws per hole during their rounds and to store this information for future reference. It also offers an in-depth analysis of the player's performance over time, aiding in tracking progress and

identifying areas for improvement. UDisc offers both free and premium versions of the app. The free version provides basic functionalities such as score-keeping and locating courses, while the premium version offers advanced features like statistics tracking and unlimited scoring history.

UDisc also serves as a community platform. First, it allows groups of disc golfers to record their scores simultaneously and to connect their accounts as they play. Second, the app includes an extensive database of disc golf courses worldwide, complete with maps, characteristics, and player reviews. This feature enables players to locate courses near them, discover new ones, and gain insights about specific courses from the player community.

The popularity and widespread usage of UDisc provide a unique dataset for analyzing patterns in disc golf play, such as player preferences and responses to price changes. Through a data agreement, UDisc shared the data for FDR State Park and Leonard Park disc golf courses from January 1st, 2015 until December 31st, 2021. The data has every log/visit to each of the two courses and includes an anonymized user ID, the location, date, time, and holes played by each player.

4.3 Data Considerations

Several potential confounding factors associated with our data deserve attention, particularly given that our dataset originates from UDisc, a score-keeping application. There exists a segment of disc golf players who neither use UDisc nor consistently record their scores. Should the UDisc sample not faithfully represent the entirety of the disc golf community, our derived estimates might carry a bias.

One primary concern relates to the possibility of underestimating the impact of the fee, as our dataset does not encompass behaviors of non-UDisc users. Players who utilize UDisc, given their predilection for score-keeping, are arguably more devoted to the sport. They might possess heightened knowledge about the fee schedule compared to occasional players. Such a distinction hints at the possibility that the comprehensive disc golf community could display a *lesser* responsiveness to the fee, rooted in a broader unawareness about the fee structure.

Furthermore, it is plausible that a substantial fraction of UDisc users in New York are Empire Pass holders. This annual pass costs $75 and provides free access to FDR and other New York State Parks, and its subscribers are presumably regular park visitors, who deemed the pass a worthwhile investment. Given our data's probable bias towards more frequent players, of which a segment might be Empire Pass holders, we might be inadvertently understating the fee's actual deterrent effect. This leads to the inference that the wider disc golf community might be *more* influenced by the fee than our current estimates indicate, as a significant portion of them would bear the direct brunt of the fee, unlike the potentially exempted regular UDisc users.

The question of whether UDisc users accurately reflect the fee responsiveness of the wider disc golf community is outside the scope of this study and is a topic for future research.

4.4 Disc Golf Course Visits

Utilizing UDisc data, we interpret each user's daily scorekeeping log as a 'visit'. However, we adjust for instances where players log more than once in a day, as on rare occasions, they may play the course consecutively. From January 1st, 2015 to December 31st, 2021, we recorded a total of 27,415 visits to FDR State Park and Leonard Park disc golf courses. Of these, 16,927 were to FDR and 10,488 to Leonard. **?** finds that about 20 percent of all rounds of disc golf played are recorded in UDisc. More recent results from an intercept survey at FDR find that 90 percent of disc golfers use a scorekeeping app when playing disc golf. Among them, 82 percent use UDisc as their scorekeeping app. Among UDisc users, they reported using the app an average of 79 percent of the time **?**.

Figure 4 shows the average number of daily visits to each course over time. The popularity of disc golf and/or UDisc is on the rise at both courses, as illustrated by the growing trend. Figure 4 indicates that prior to 2020, both the popularity of the sport and the usage of the UDisc app had been growing slowly. In 2020, there was a noticeable uptick in UDisc logs, which could potentially be attributed to the COVID-19 pandemic. As policies for social distancing and lockdowns were enacted, many indoor activities such as gym workouts and social gatherings at bars were restricted.

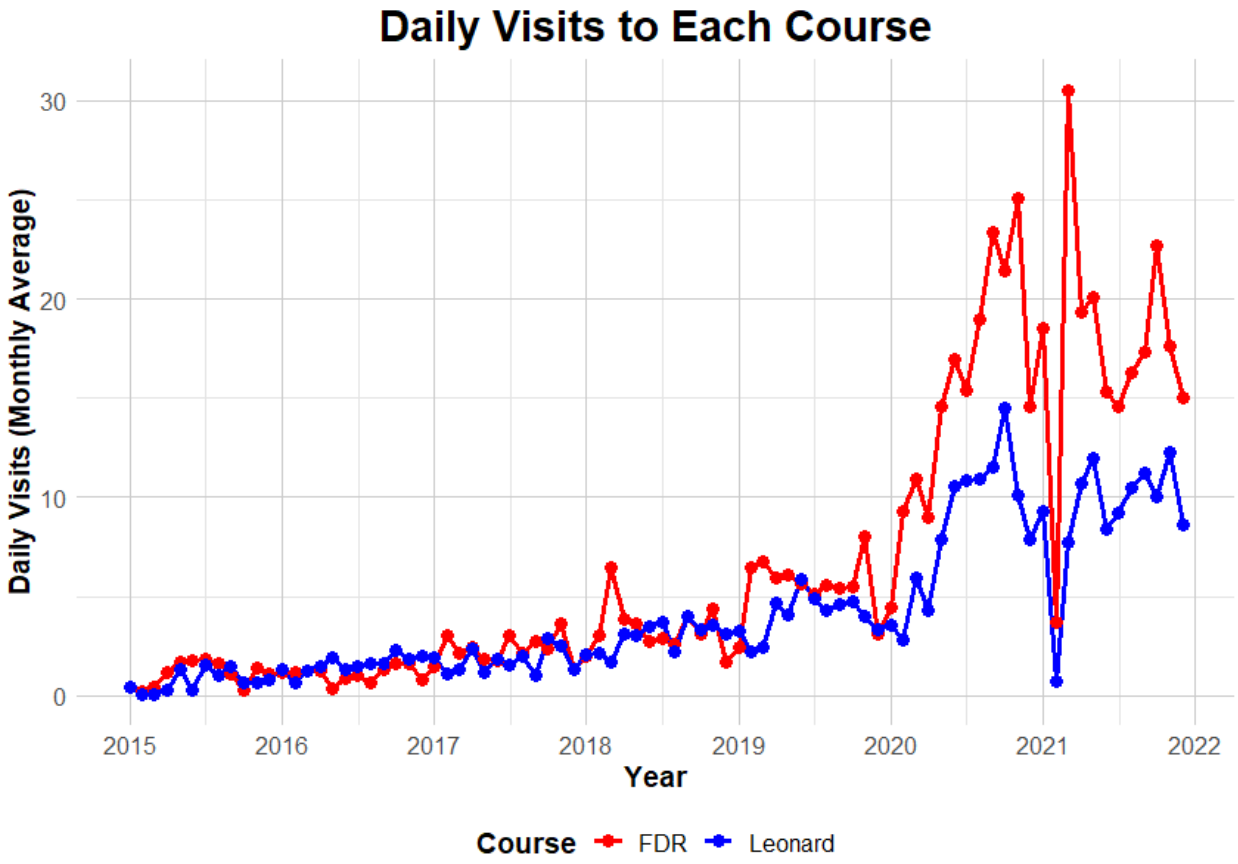

Figure 4: FDR and Leonard Disc Golf Course Daily Visits Over Time

In contrast, disc golf, being an outdoor activity, offered individuals an avenue for recreation that naturally accommodated social distancing guidelines, possibly leading to its increased popularity during this period. After the social distance restrictions were relaxed, we still see positive trend in monthly visits in 2021 and 2022, showing that the sport continued its growth after the pandemic's most critical periods.

Narrowing the attention to each park, Figure 5 shows the growing popularity of the sport at FDR State Park and Leonard. It shows the percentage of days per year with at least one UDisc log.

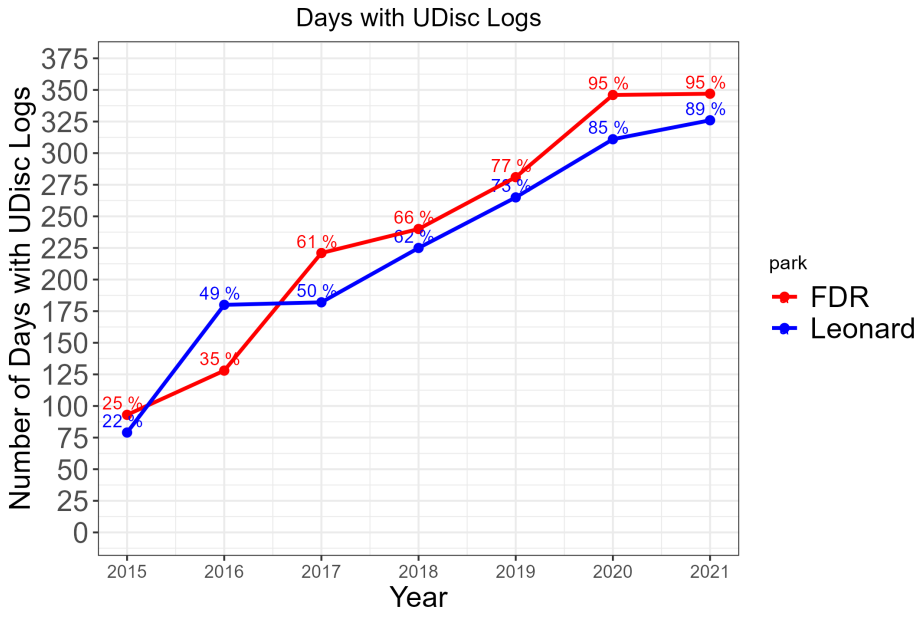

Figure 5: Days with UDisc Logs at FDR

It shows that from 2015 until 2021, the app and the sport have increased in popularity. The very high percentages in 2020 and 2021 may indicate that players are going to both courses despite harsh weather conditions. In general, we see similar trends in the popularity of the sport and the app at both courses.

4.5 Relative Popularity: FDR vs. Leonard

Given the proximity of FDR and Leonard Park 1, we perceive them as imperfect substitutes for each other. This is reflected in the patterns of disc golfer visitation during our study period. Based

on UDisc data, the average and median daily share of visits to FDR relative to Leonard are 0.58 and 0.63, respectively. This suggests a moderate preference among disc golfers for FDR over Leonard.

The change of this share over the course of the study period is captured in Figure 6. Here, one can observe that the monthly average daily share per course fluctuates more noticeably during the earlier years, especially in 2015 and 2016. Conversely, the latter portion of our study period, spanning 2017 to 2021, shows a more stable pattern; the share largely fluctuates within the confines of 0.45 to 0.85. Our primary focus is whether the implementation of a parking fee at FDR State Park reduces its share of total disc golf visits compared to Leonard Park.

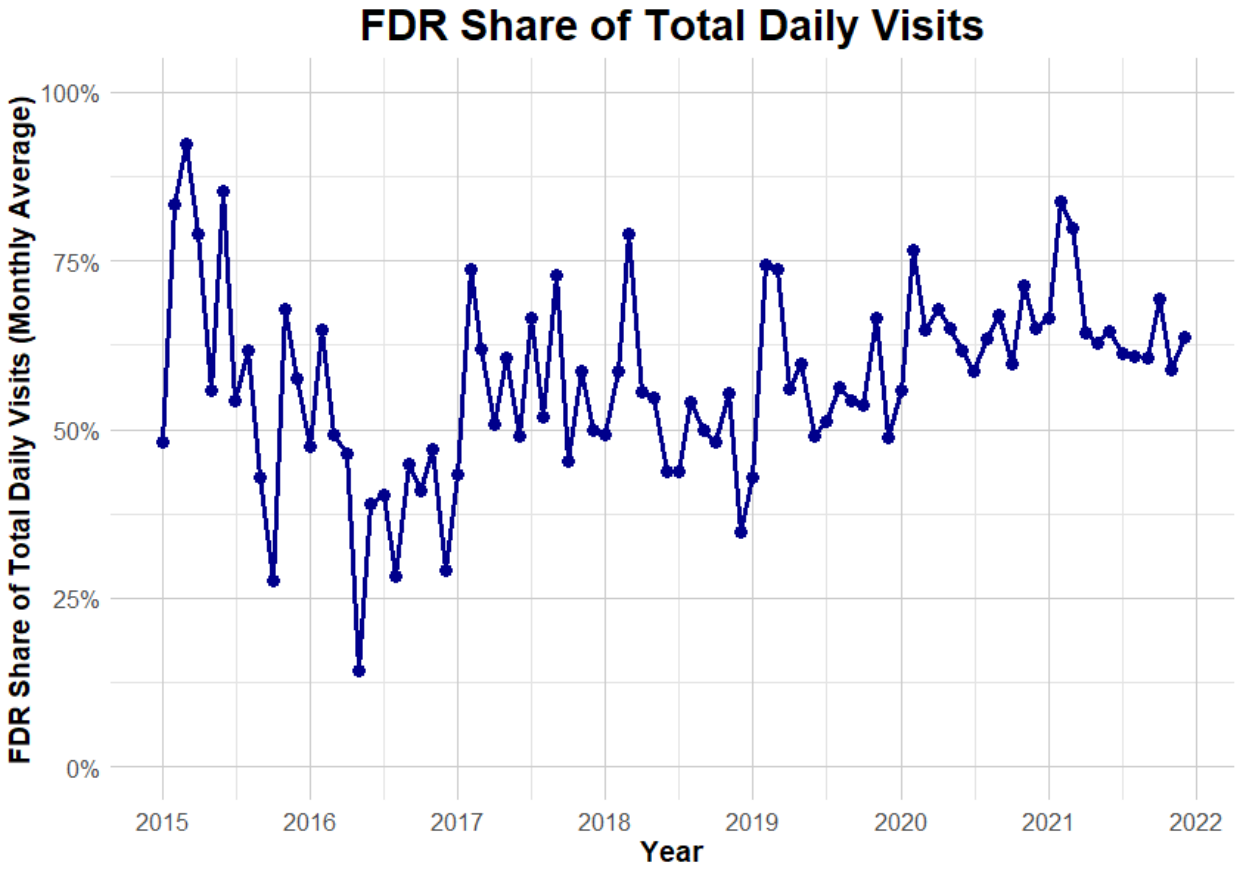

Figure 6: FDR Share of Total Daily Visits

4.6 Seasonal Congestion Pricing

The disc golf course at FDR State Park presents a unique scenario for our analysis due to its parking fee. Unlike many disc golf courses set within parks that offer free access, FDR State Park has a parking fee imposed during certain times of the year. Importantly, this parking fee is exogenous to our study: it isn't influenced by the disc golf course's policies or its management but stands as a broader park policy. As a result, all park visitors are subject to this fee, regardless of their chosen activities within the park. The independent nature of this fee is crucial for our research methodology, ensuring that the fee remains separate from the specific dynamics and utilization of the disc golf course itself.

While the park occasionally refers to this charge as a "congestion fee", it operates distinctly from dynamic congestion pricing models found in some urban settings. Dynamic congestion pricing adjusts fees in real-time based on actual usage or demand, aiming to manage congestion and optimize the user experience. In contrast, the fee at FDR State Park is predetermined based on the calendar, levied on predictable high-demand days such as weekends and during the summer months. Thus, even on these so-called "congestion days", if the disc golf course were scarcely populated or even empty, players would still be required to pay the parking fee. This static approach, essentially functioning as seasonal pricing, does not reflect real-time congestion or course usage. Consequently, while it might regulate the overall park visitors to some extent, its effectiveness in managing actual course congestion remains ambiguous.

We sourced the parking fee structure of FDR State Park from its official website and validated the information through direct correspondence with the park's administrators. The details, as presented in Table 1 for the years spanning 2015 to 2021, outline the park's parking fee regimen, which operates in four distinct seasonal patterns.

During the Winter months, the park provides complimentary parking on a daily basis. In Spring, specifically from mid-May to mid-June, no parking fee is levied on weekdays. However, fees are charged on weekends and holidays, with the booth staffed from 8 am to 4 pm. The Summer season, starting from mid-June and extending to early September, has parking fees every

day, with the booth being operational from 8 am to 6 pm. Lastly, the Fall season, which starts from early September and lasts until mid-October, only has a parking fee on weekends and holidays. The booth during this period is manned from 8 am to 4 pm. Following mid-October, the park resumes its Winter policy of offering complimentary parking for all days.

Table 1: FDR Parking Fee Schedule from 2015 to 2021

	Parking Fee Schedule at FDR Across Years (Parking Fee = $10 per car)				
Year	**Free**	**8 am - 4 pm Weekends & Holidays**	**8 am - 6 pm Daily**	**8 am - 4 pm Weekends & Holidays**	**Free**
2015	Jan 1 - May 15	May 16 - Jun 21	Jun 22 - Sep 7	Sep 8 - Oct 12	Oct 13 - Dec 31
2016	Jan 1 - May 20	May 21 - Jun 12	June 13 -Sep 5	Sep 6 - Oct 10	Oct 11 - Dec 31
2017	Jan 1 - May 19	May 20 - Jun 18	Jun 19 - Sep 4	Sep 5 - Oct 9	Oct 10 - Dec 31
2018	Jan 1 - May 18	May 19 - Jun 17	Jun 18 - Sep 3	Sep 4 - Oct 8	Oct 9 - Dec 31
2019	Jan 1 - May 17	May 18 - Jun 16	Jun 17 - Sep 2	Sep 3 - Oct 14	Oct 15 - Dec 31
2020	Jan 1 - Jun 30	—	Jul 1 - Aug 17	—	Aug 18 - Dec 31
2021	Jan 1 - May 14	May 15 - Jun 20	June 21 - Sep 6	Sep 7 - Oct 11	Oct 12 - Dec 31

Note: 2020 saw deviations from the regular parking fee schedule due to the COVID-19 pandemic.
Total days from 2015-2021: 2,557; FDR levied fees on 658 days.

Following the fee structure, we turn our attention to the visitation numbers. Table 2 shows the visitation figures and congestion pricing specifics for FDR State Park and Leonard Park. The table shows a clear pattern in the distribution of visits between the two parks. On days when there is no parking fee at FDR State Park, it accounts for approximately 63.5% of the total visits between the two parks, underscoring its popularity among disc golf enthusiasts. However, when FDR implements parking fees, its share of the total visits drops to around 57.0%. This relative decline in FDR's attendance on fee days implies that Leonard Park becomes a more attractive alternative for disc golfers when parking fees are in effect at FDR. This shift in visitation suggests that parking fees influence a player's choice between the two parks.

Table 2: Course Information and Congestion Pricing Impact on Visits

Disc Golf Course	Visits		Total Logged Rounds
	During Fee at FDR	No Fee	
FDR State Park	4,238	12,689	16,927
Leonard Park	3,201	7,287	10,488
Total	7,439	19,976	27,415
FDR Share	0.5697	0.6352	0.6174

Note: Total days under study: 2,557; FDR had fees on 658 days.

4.7 Weather Data

To account for the potential impact of weather on disc golfers' decision-making, we integrated temperature and precipitation variables into our analysis. We obtained daily weather data from Oregon State's PRISM dataset, which covers the contiguous United States at over 800,000 grid points, and merged this with a shapefile for U.S. zip codes. We then computed the averages for the zip codes where the two New York disc golf locations under study are situated.

Although the two courses are in close proximity and have comparable daily temperatures, we deemed it necessary to include these variables as even slight differences in temperature and precipitation could influence disc golfers' choice of course.

4.8 Summary Statistics

We combine the UDisc, parking fee schedule, and weather data to examine the effect of the entrance fee on disc golfers' course choices. Table 3 displays the summary statistics for the variables used in this analysis. The dataset comprises of 5,114 total observations corresponding to FDR or Leonard disc golf course between January 1, 2015 and December 31, 2021 (2,557 unique days for each park).

The variable *Daily Visits* is the aggregated number of visits to either FDR or Leonard on any given day, derived from consolidating user-level visits. An average course received roughly 5.36 visits per day. Some days, particularly ones likely hosting events or during peak conditions, saw

as many as 142 visitors. The distinct *Daily Visits* variables for each park — *FDR Daily Visits* and *Leonard Daily Visits* — serve to highlight the unique visitation patterns for the individual parks. On average, the FDR course has about 6.62 visits per day, slightly higher than Leonard's average of 4.10.

As with the drop in total visits seen in table 2, we observe a slight dip in average daily visits at FDR when the fee is imposed (6.44), compared to the overall average of 6.62. This drop indicates the potential deterrent effect of the fee. The drop is fairly small, possibly due to the fee being imposed during dates with better weather (late Spring, Summer, and early Fall) and longer sunlight hours.

We find a contrasting pattern for Leonard Park. On days when FDR levies a fee — and Leonard remains fee-free — Leonard Park experiences an average of 4.86 visits, a substantial increase from the overall average of 4.10. We suggest two possible reasons for this increase. First, the increase in visits to Leonard Park might be due to the general increase in the sport's appeal during favorable weather. Second, we could be observing a course substitution effect. If substitution effects are present, they would dampen the estimated effect of the fee on a player's choice to not visit FDR.

Comparing the data on days with no fee at FDR also suggests substitution effects are at work when the fee is imposed. The average visits at FDR and Leonard without the fee are 6.68 and 3.83, respectively. While FDR's visits remain roughly consistent whether or not a fee is imposed, Leonard's numbers suggest a deeper interplay of factors at hand. The substantial increase in Leonard's visits on fee days at FDR compared to non-fee days could be a course substitution effect at play. If there is not a course substitution effect in action, then these figures suggest a notable impact of the fee. The absence of a similar uptick in visits at FDR, compared to Leonard, underscores the potential magnitude of the fee's deterrent effect. Consequently, this represents the upper bound scenario for gauging the influence of the course fee, especially when no substitution is considered.

FDR's Share of Visits is the share of total visits to the two parks who chose FDR on days when at least one park recorded a visit. Of the 2,557 total days from January 1, 2015 to December 31,

2021, 1,999 days had at least one visit to one of the two courses, and the share of total disc golfers who chose FDR ranged from 0 (on days when there were visits to Leonard but not FDR) to 1 (on days when there were visits to FDR but not Leonard). The average daily share who chose FDR was 0.58, and the median daily share was 0.63, indicating a preference towards FDR among the disc golfers.

Parking Fee Day is a binary variable denoting whether or not a parking fee was charged at a course on a specific day. Of our entire dataset, comprising 5,114 course-day combinations (2,557 days observed at two different courses), 13 percent had a parking fee. Since Leonard Park never charges a fee across its 2,557 observations, it means that out of FDR's 2,557 observations, 26 percent had a parking fee imposed. This percentage reflects the days within our observation period when FDR had a parking fee.

Weather conditions are encapsulated by *High Temp in Celsius*, *Avg Temp in Celsius*, *Low Temp in Celsius*, and *Precipitation*. The average high temperature is 16.43°C, indicating moderately warm days. Precipitation averages at 0.33mm, though the variability is apparent from the maximum value.

Differences in weather conditions between the two parks on any day are captured by *Difference in Avg Temp (FDR-Leonard)*, *Difference in High Temp (FDR-Leonard)*, and *Difference in Low Temp (FDR-Leonard)*. Their averages being close to zero indicate that both parks generally experienced similar weather.

5 Methodology

We use three methodological approaches to assess the impact of a parking fee on the course selection of disc golfers. While the first two approaches rely on daily course-level data, the third harnesses the granularity of user-level data.

Table 3: Summary Statistics

Statistic	Mean	Min	Median	Max	N
Daily Visits	5.36	0	2	142	5,114
FDR Daily Visits	6.62	0	2	142	2,557
Leonard Daily Visits	4.10	0	2	79	2,557
FDR Fee Daily Visits	6.44	0	3	77	658
Leonard Fee (at FDR) Daily Visits	4.87	0	2	44	658
FDR No Fee Daily Visits	6.68	0	2	142	1,899
Leonard No Fee (at FDR) Daily Visits	3.84	0	1	79	1,899
FDR's Share of Visits	0.58	0.00	0.63	1.00	1,999
Parking Fee Day	0.13	0	0	1	5,114
High Temp in Celsius	16.43	−11.50	17.38	35.46	5,114
Avg Temp in Celsius	11.23	−16.02	11.54	29.29	5,114
Low Temp in Celsius	6.03	−21.66	6.07	24.02	5,114
Precipitation in mm	0.33	0.00	0.00	15.17	5,114
Difference in Avg Temp (FDR-Leonard)	−0.25	−1.27	−0.25	1.01	5,114
Difference in High Temp (FDR-Leonard)	0.05	−1.23	0.03	1.47	5,114
Difference in Low Temp (FDR-Leonard)	−0.55	−2.02	−0.52	0.54	5,114
Difference in Precipitation (FDR-Leonard)	−0.01	−1.99	0.00	1.98	5,114

5.1 Approach 1: Estimating the Daily Number of Course Visits

The objective of our first model is to estimate the effect of the parking fee on the number of visits to the disc golf courses. To do this, we use Leonard Park Disc Golf Course as a comparison for FDR State Park Disc Golf Course. By comparing the changes in visits to FDR on days when there is a fee to the concurrent changes in visits to Leonard (which never experienced a fee), we can isolate the impact of the parking fee at FDR.

This first model is similar to a conventional difference-in-differences model; however, due to our data generation process, we only ever observe the parking fee at FDR. Thus, the interaction term between the fee and FDR becomes perfectly collinear with the fee term. This renders us unable to isolate the direct effect of the fee. Instead, we estimate the effect of the fee as it pertains specifically to FDR[1].

[1] In a typical difference-in-difference equation, we have at least three independent variables: $treat_i$, $post_t$ and the interaction between $treat_i$ and $post_t$. In our setting, $treat_i$ is FDR_j and $post_t$ is Fee_{jt}. Moreover, since the parking fee is only levied at FDR, Fee_{jt} and the interaction between Fee_{jt} and FDR_j are perfectly correlated. Thus, we do not include Fee_{jt} as a stand-alone independent variable.

Our model can be formally represented by the following equation:

$$\text{Visits}_{jt} = \beta_1(\text{Fee}_{jt} \times \text{FDR}_j) + \beta_2 \text{FDR}_j + \beta_3 \text{Temperature}_{jt} + \beta_4 \text{Precipitation}_{jt} + \gamma_t + \delta_w + \zeta_h + \phi_y + \epsilon_{jt}$$

Where Visits_{jt} is the total number of UDisc scorekeeping logs or 'visits' to course j on day t. Fee_{jt} is an indicator variable that is set to 1 if there is a fee at course j on day t, and 0 otherwise. FDR_j is a binary variable that is set to 1 if the course is FDR and 0 otherwise. Temperature_{jt} is the temperature in Celsius at course j on day t.

The terms γ_t, δ_w, ζ_h, and ϕ_y capture daily time trends, day-of-the-week fixed effects, holiday fixed effects, and year-wise trends or anomalies, respectively. Finally, ϵ_{jt} is the error term.

We have three regression specifications, each including one of three temperature measures: the daily average, the daily high, and the daily low.

The coefficient of primary interest is β_1. This term quantifies the differential change in visits to FDR in comparison to Leonard after the introduction of the parking fee at FDR. Should the coefficient β_1 be negative, this would indicate that the fee resulted in a relative reduction in the number of visits to FDR. However, it is important to note that this model does not adjust for potential substitution effects. Thus, the estimate of the fee impact from this first model can be perceived as an upper bound; if some disc golfers switch from FDR to Leonard due to the fee, our estimation will overstate the effect of the fee. The outcomes rendered by this methodology represent a baseline approach that can be compared with our subsequent models that attempt to incorporate course substitution effects.

5.2 Approach 2: Estimating the Daily Course Share of Disc Golfers

Our second approach focuses on determining the effect of the parking fee by examining the *share* of the total daily visits who choose FDR. To calculate this, we aggregate daily visits for each course, $FDR.Visits_t$ and $Leonard.Visits_t$, excluding days with no visits to either course. FDR's share of total daily visits, in relation to Leonard, is computed as:

$$Share_t = \frac{FDR.Visits_t}{FDR.Visits_t + Leonard.Visits_t} \tag{1}$$

This share indicates the preference of disc golfers between the two courses on any given day as described in Table 3 and Figure 6.

In this approach, the daily share of total disc golfers who choose FDR relative to Leonard is the dependent variable, while the independent variable of interest is whether or not FDR has a fee that day.

The equation for this model can be written as follows:

$$Share_t = \beta_1 Fee_t + \beta_3 \Delta Temp_t + \beta_4 \Delta Precip_t + \gamma_t + \delta_w + \zeta_h + \phi_y + \epsilon_t$$

where $Share_t$ is the daily share of disc golfers visiting FDR, relative to Leonard, on day t, and where Fee_t is 1 when FDR has a parking fee on date t and 0 otherwise. For weather variables, we control for the difference in temperature and precipitation between the two courses.

Again the terms γ_t, δ_w, ζ_h, and ϕ_y capture daily time trends, day-of-the-week fixed effects, holiday fixed effects, and year-wise trends or anomalies, respectively. And ϵ_t is the error term. The coefficient of interest for this first regression is β_1, which measures the effect of the parking fee on the share of visitors to FDR relative to Leonard. A negative coefficient implies that the parking fee at FDR decreases the share of disc golfers visiting FDR.

5.3 Approach 3: Estimating a User's Monthly Visits

The third approach takes advantage of the rich user-level dataset provided by UDisc. We estimate a regression that examines the way FDR's fee affects course monthly visits per user[2]. We concentrate on the subset of players who visited both courses during our study period. The outcome variable is a user's monthly visits to a course. This outcome ranges from 1 to 20, with a median of 1 and a

[2]We aggregate the individual data at the monthly level such that we could include a course fixed effect in addition to the user fixed effects.

mean of 1.68.

The equation for the third model to estimate a user's monthly visits to a course is:

$$Monthly.Visits_{i,j,m,y} = \beta_1(Fee_{j,m,y} * FDR_j) + \beta_2 FDR_j + \beta_3 Monthly.Temp_{j,m,y} + \beta_4 Monthly.Precip_{j,m,y} + \gamma_t + \eta_i + \mu_m + \phi_y + \epsilon_{i,j,m,y}$$

where $Monthly.Visits_{i,j,m,y}$ is the total visits by user i to course j during month m and year y. Moreover, $Fee_{j,m,y}$ is a binary variable indicating whether course j has a parking fee at any point during month m and year y. FDR_j is an indicator variable that takes the value of 1 when the course j is FDR. This control variable measures the preference of FDR over Leonard, the course fixed effect. The interaction between $Fee_{j,m,y}$ and FDR_j captures the way FDR's fee affects the monthly course visits by player i to FDR. $Monthly.Temp_{j,m,y}$ and $Monthly.Precip_{j,m,y}$ capture the monthly averages of temperature and precipitation at course j during month m and year y. As before, we include a time trend, γ_t. Lastly, we include individual fixed effects of each player η_i, month fixed effects μ_m, year fixed effects ϕ_y, and $\epsilon_{i,j,m,y}$ is a random error term.

The coefficient of interest in this model is β_1, which focuses on the interaction between the parking fee and FDR. A negative coefficient would suggest that the presence of a parking fee decreases a user's monthly visits to FDR, all else equal. Conversely, a positive coefficient would suggest that the fee increases the monthly visits to FDR. Given our prior belief that disc golfers would want to avoid the fee, we expect the coefficient to be negative.

6 Results

6.1 Results from Approach 1: Daily Course Visits

Table 4 presents the estimation results of the daily visitations to FDR and Leonard Park disc golf courses. The table comprises three models that account for different temperature measures: daily

average temperature, daily high temperature, and daily low temperature.

A consistent observation across all three models is the significant effect of the parking fee at FDR. The coefficient estimate suggests that the imposition of the fee leads to a decline of approximately 1.98 daily visits. It's essential to note, however, that even with this fee, FDR continues to be a more popular choice relative to Leonard Park.

The estimate of the FDR course fixed effect is 3.04, which is how many more daily visits FDR would get than Leonard if there were no fee, controlling for differences in weather.

Temperature, regardless of its measure (average, high, or low), exhibits a positive influence on visits. For instance, for every one degree Celsius increase in average temperature, daily visits increase by about 0.085. Similarly, daily visits rise by approximately 0.084 and 0.079 for every unit increase in high and low temperatures, respectively. This suggests that warmer days, whether it is warmer average, high, or low temperatures, tend to attract more players.

Precipitation is also a significant determinant of daily visits to the courses. Specifically, for every millimeter increase in precipitation, we observe a decline of approximately 0.586 in the number of visits. This result underscores the sensitivity of outdoor activities like disc golf to weather conditions.

Finally, there is a slight upward time trend observed across the models, signifying that as time progresses, the popularity of the UDisc scorekeeping app or the propensity to visit these courses has been on the rise.

To account for potential confounding effects, fixed effects for weekdays, holidays, and years were controlled for. These fixed effects help in capturing the variations in visits due to specific days of the week, public holidays, and any broad year-wise trends or anomalies (such as the COVID-19 pandemic).

As an additional investigation and also robustness check, we also estimate the models using only data from 2019 through 2021 instead of the full data spanning from 2015 through 2021. We include the results for this time period in Appendix 7.

In the 2019-2021 subset of the data, we observe 22,011 total visits over 1,096 days. The average

number of daily visits to FDR was 12.84. Our coefficient estimate for the size of the fee effect is -3.12 daily visits, or about 24 percent of the course's daily visits. Overall, the results are consistent with the full data models.

While FDR overall recorded higher visits, the imposition of parking fees at FDR had an evident effect. Our model estimates the effect of the fee to be a decrease of 1.98 daily visits, or roughly 30 percent of FDR's 6.68 average daily visits on non-fee days.

However recall that one factor contributing to this result is that Leonard showed a marked increase in visits during FDR's fee days, while FDR's visits stayed relatively constant. This raises the question of whether players are choosing Leonard as an alternative to avoid FDR's fees, or whether the increase is attributed to the fact that fee days often align with popular summer weekends.

In summary, from the results of Approach 1, the parking fee clearly impacts visitation at FDR, but the influence of other factors, including weather and seasonality, is also evident. In our subsequent approaches, we aim to further understand the nuances of these trends and the potential for course substitutions.

6.2 Results from Approach 2: Daily Course Share

Table 5 shows the results from our second approach that uses the share of visits to FDR as the dependent variable. The results across three specifications suggest that a parking fee decreases the daily share of total disc golf visits to FDR relative to Leonard. Focusing on Model 2.1, the fee decreases the daily share by about 5.6 percentage points (*e.g.*, instead of the daily share being 60 percent of disc golfers choosing FDR instead of Leonard, the daily share would be 60 - 5.6 = 54.4 percent if there were a fee, all else equal). The average daily share of visits to FDR relative to Leonard when there is no fee is 0.60. The fee decreases the daily share and brings it closer to parity. In fact, the average daily share on days when the fee is in place is 0.51. Thus, the fee accounts for most of the reduction in the share and results in disc golfers substituting away from FDR to Leonard due to the entrance fee.

Given that the sport and record-keeping app were not as popular during the first years of our

Table 4: Number of Daily Visits Estimation Results

	Model 1.1	Model 1.2	Model 1.3
Fee * FDR	−1.980***	−1.980***	−1.875***
	(0.403)	(0.401)	(0.404)
FDR	3.045***	3.020***	3.040***
	(0.255)	(0.254)	(0.256)
Avg Temp C	0.085***		
	(0.011)		
High Temp C		0.084***	
		(0.011)	
Low Temp C			0.079***
			(0.011)
Precipitation	−0.586***	−0.552***	−0.614***
	(0.098)	(0.098)	(0.100)
	(0.1960)	(0.1951)	(0.1948)
Time	0.006***	0.006***	0.006***
	(0.001)	(0.001)	(0.001)
Num.Obs.	5114	5114	5114
R2	0.377	0.378	0.376
R2 Adj.	0.375	0.376	0.374
R2 Within	0.051	0.052	0.049
R2 Within Adj.	0.050	0.051	0.048
AIC	35 028.2	35 022.3	35 037.9
BIC	35 152.5	35 146.5	35 162.1
RMSE	7.40	7.40	7.41
Std.Errors	HC1	HC1	HC1
FE: weekday	X	X	X
FE: holiday	X	X	X
FE: year	X	X	X

* p $<$ 0.1, ** p $<$ 0.05, *** p $<$ 0.01

Table 5: Regression Results for Daily Share of Visits - 2015 to 2021

	Model 2.1	Model 2.2	Model 2.3
Fee	−0.056***	−0.055***	−0.054***
	(0.017)	(0.017)	(0.017)
Δ Average Temp C	−0.031		
	(0.033)		
Δ High Temp C		0.008	
		(0.025)	
Δ Low Temp C			−0.033
			(0.021)
Δ Precipitation	−0.008	−0.010	−0.010
	(0.036)	(0.036)	(0.036)
Time	0.000**	0.000**	0.000**
	(0.000)	(0.000)	(0.000)
Num.Obs.	1999	1999	1999
R2	0.092	0.092	0.093
R2 Adj.	0.085	0.084	0.085
R2 Within	0.009	0.009	0.010
R2 Within Adj.	0.007	0.007	0.008
AIC	1286.9	1287.7	1285.5
BIC	1387.7	1388.5	1386.3
RMSE	0.33	0.33	0.33
Std.Errors	HC1	HC1	HC1
FE: weekday	X	X	X
FE: holiday	X	X	X
FE: year	X	X	X

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

study period, we check the results by estimating the same regressions with a subset of the data that only includes 2019, 2020, and 2021. Results from these regressions are in the Appendix. In general, our results are robust and consistent. There are a few differences worth mentioning. The magnitude of the parking fee effect, by itself, goes up to about 8 percentage points, over 2 percentage points higher than the model with all the data. This implies that the fee effect gets larger with time.

The results of this model can help inform park management on the potential impact of parking fees on disc golf visitation patterns and can aid in the development of pricing strategies that maximize revenue while minimizing negative effects on park visitation.

6.3 Results from Approach 3: User's Monthly Visits

The third approach allows us to control for user fixed effects, which are important given that we do not observe demographic characteristics of UDisc users. By including individual fixed effects, we are able to control for all time invariant characteristics of each user. Table 6 summarizes the results from this approach.

Results from Table 6 show that the fee decreases monthly visits to FDR by about .13. While FDR is more popular than Leonard as depicted by the positive coefficient (about .26) of the FDR dummy, FDR experiences a decrease in monthly visits during months where visitors face a parking fee. Given the summary statistics of the monthly visits, a decrease of 0.13 is not small as the median is 1 and the average is 1.68. During months without a parking fee, FDR has about .26 more monthly visits per user relative to Leonard. During months where FDR charges a parking fee, we see that monthly visits to FDR per user are higher by about .13 relative to Leonard[3]. These results are robust when we focus on the three most-recent years of the data: 2019, 2020, and 2021. The Appendix includes the regression results for this subset of the data, showing that while FDR is preferred, the fee decreases the monthly visits to FDR and diminishes the preferences towards

[3]We look at the difference between the coefficient of the FDR course fixed effect (0.26) and the coefficient of the interaction between FDR and the Fee (.13).

Table 6: Regression Results for Monthly Visits per User from 2015 to 2021

	Model 3.1	Model 3.2	Model 3.3
Fee * FDR	−0.1258**	−0.1270**	−0.1253**
	(0.0522)	(0.0523)	(0.0521)
FDR	0.2609***	0.2625***	0.2599***
	(0.0513)	(0.0517)	(0.0509)
Monthly Avg Temp C	−0.0039		
	(0.0027)		
Monthly High Temp C		−0.0032	
		(0.0022)	
Monthly Low Temp C			−0.0035
			(0.0030)
Monthly Precipitation	−0.0415**	−0.0431**	−0.0403**
	(0.0186)	(0.0188)	(0.0186)
Time	0.3147	0.3213	0.2989
	(186 511.2337)	(186 591.6186)	(186 429.2199)
Num.Obs.	10 341	10 341	10 341
R2	0.326	0.326	0.326
R2 Adj.	0.230	0.230	0.230
RMSE	1.14	1.14	1.14
FE: user	X	X	X
FE: month	X	X	X
FE: year	X	X	X

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

that course. We observe similar results to Approach 1.

The results also show that monthly temperature and precipitation have a negative effect on monthly visits, after controlling for month fixed effects. Notably, precipitation has a statistically significant effect, while the three temperature measures do not. This implies that rain is a strong deterrent to disc golfing, while hot days are not. As with the previous approaches, we include the results for the subset of the data from 2019 to 2021 in the Appendix.

Putting the results in context, the average monthly visits per user to FDR when there is no fee is 1.84. Thus, a decrease of 0.13 is not small, as it implies a decrease of about 7 percent[4]. On average, FDR's fee decreases monthly disc golf visits to FDR by 7 percent.

6.4 Combining the Results

Our analysis employs multiple modeling approaches, each offering distinct perspectives on the impact of the fee on disc golfer decisions. While a comprehensive calibration merging these model estimates remains technically elusive, their juxtaposition offers insights that allow us to stitch together a plausible narrative.

The initial model, accounting solely for direct effects, indicates a decline in FDR patronage by 24 to 30 percent following fee introduction. This is a sizable effect, but it is crucial to understand that this model doesn't capture substitution behaviors—hence it might overestimate the net effect on overall participation. Conversely, our second model's share-based approach, as well as the user-level insights from the third model, suggest a more nuanced scenario: the daily share of FDR visits drops by a modest 6 to 8 percentage points.

For clarity, we illustrate this with a hypothetical scenario. On an average fee-free day, 62 out of 100 disc golfers opt for FDR, while 38 choose Leonard, establishing a baseline FDR share of 0.62. Enter the fee, and the landscape shifts: only 50 now choose FDR—a 20 percent decrease—while Leonard's patrons rise to 42, a 10 percent increase. This difference in differences—30 percent

[4]By taking the ratio of the estimated coefficient and the monthly visits during days without fee, we find the decrease in 7 percent.

altogether—is consistent with our first model's findings. Yet, it is worth noting that our first model quantifies daily visits, and this illustrative percentage-based breakdown is merely intended to contextualize its findings.

Importantly, this shift also means 8 golfers abstain from playing altogether in the face of the fee. When calculating subsequent daily shares, these non-participants are inherently excluded.

Thus, among the remaining 92 golfers (50 at FDR and 42 at Leonard), FDR's share drops to $\frac{50}{92}$, or about 0.54—a fall of 8 percentage points from our baseline 0.62. This aligns with the second model's observations.

In sum, the fee does not merely shuffle preferences between FDR and Leonard; it also influences the overall inclination to play. Of the original 62 FDR enthusiasts, 12 alter their choice due to the fee: 4 now lean toward Leonard, and 8 opt out. Recognizing this multi-faceted behavioral shift is paramount in contextualizing the fee's broader impact and streamlining our model results into a cohesive narrative: the fee at FDR results in about a 20 percent decrease in visits, of which two-thirds abstain from disc golf entirely, while the remaining third divert to Leonard.

7 Conclusion

Public parks, such as FDR State Park, often rely on local or state tax revenues for maintenance and enhancements. Some parks introduce seasonal parking fees to generate additional revenue and manage crowd levels. In this study, we used the seasonal fees at FDR State Park as a natural experiment to gauge the demand response among disc golfers.

Our findings from three different models shed light on the behavior of disc golfers in reaction to the parking fee. The first model suggests a 30 percent drop in daily visits to FDR due to the fee. However, this model might overstate the impact because it doesn't factor in potential substitution effects.

The second model, which considers course substitution, shows that FDR's share of total visits decreased by about 5.6 percentage points due to the fee. Our third approach, analyzing individual

disc golfer data, indicates a 7 percent decline in monthly visits to FDR for each golfer.

Combining insights from all three models, we conclude that the fee causes approximately a 20 percent decrease in visits to FDR. Notably, two-thirds of this drop can be attributed to disc golfers choosing not to play, while the rest opt for Leonard instead.

In summary, the $10 seasonal parking fee has a moderate impact on disc golfer behavior, causing a notable but not overwhelming shift from FDR to Leonard. This redistribution of players could help in balancing the load on both courses, addressing potential congestion issues.

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Appendix A: Robustness Check with Recent Data

As a further verification of our findings, we conducted a robustness check, analyzing potential changes in the response to parking fees over time. Specifically, we re-ran our analysis using only data from the years 2019 to 2021, rather than the full span of 2015 to 2021. Although this truncated dataset covers only 3 of the 7 years, reducing the number of observed days from 2,557 to 1096, it encompasses a significant portion of the total visits. The total visits drop only from 27,415 to 22,011, illustrating the increased frequency of visits and the increased popularity of the UDisc scorekeeping mobile application in the more recent years. The details of this robustness check and its findings are presented in Appendix A.

Data and Summary Statistics: 2019-2021

In alignment with our main text, this section utilizes the combination of UDisc, parking fee schedule, and weather data to evaluate the influence of the parking fee on disc golfers' course selection over the narrower window of January 1, 2019, to December 31, 2021. Table 7 outlines the summary statistics for the variables in this truncated dataset. This subset incorporates 2,192 observations, corresponding to either the FDR or Leonard disc golf course, each spanning 1,096 unique days.

Examining the summary statistics for the subset data spanning 2019-2021, several insights emerge. At the forefront is the variable indicating *FDR Daily Visits*. During this period, FDR saw an average of 12.84 visits daily. However, when breaking down these visits into days when a parking fee was implemented versus days without, we notice a nuanced trend. On days with a fee, the daily visits averaged 13.32, slightly higher than the 12.70 on no-fee days. This mild increase in visits during fee days contrasts with our observations from the complete dataset, where we saw a minor decrease.

Turning our attention to Leonard, our comparison park, there's a pronounced uptick in the number of visits on FDR's fee days. Specifically, Leonard's daily visit average jumps from 7.24 to 9.21 on these days. This differential response between the two parks to the fee imposition at FDR is central to our analysis.

Our multifaceted approach attempts to decipher this observed behavior. We aim to determine whether Leonard's rise in visits—paired with FDR's static visitation pattern—can be solely attributed to the imposition of FDR's fee. Furthermore, we investigate whether this differential effect is compounded by a substitution effect wherein disc golfers opt for Leonard over FDR due to cost considerations.

It's essential to underscore that our model does not represent a traditional Difference-in-Differences methodology. The crux of this distinction lies in our observational constraints: while we can estimate the effect of the parking fee at FDR, we cannot directly estimate its effect at Leonard, as we

never observe the fee being implemented there. Thus, while we observe Leonard's uptick in visits, our goal is to parse out the specific impact of FDR's fee on this behavior, acknowledging that other factors could also be in play.

Table 7: Summary Statistics (2019-2021)

Statistic	Mean	Min	Median	Max	N
Daily Visits	10.04	0	6	142	2,192
FDR Daily Visits	12.84	0	9	142	1,096
Leonard Daily Visits	7.24	0	4	79	1,096
FDR Fee Daily Visits	13.32	0	11	77	251
Leonard Fee (at FDR) Daily Visits	9.21	0	7	44	251
FDR No Fee Daily Visits	12.70	0	8	142	845
Leonard No Fee (at FDR) Daily Visits	7.24	0	4	79	845
FDR's Share of Visits	0.63	0.00	0.67	1.00	2,066
Parking Fee Day	0.12	0	0	1	2,192
High Temp in Celsius	16.42	−11.39	17.46	35.46	2,192
Avg Temp in Celsius	11.36	−14.39	11.53	29.29	2,192
Low Temp in Celsius	6.30	−19.03	5.79	24.02	2,192
Precipitation	0.34	0.00	0.00	15.17	2,192
Difference in Avg Temp (FDR-Leonard)	−0.22	−1.00	−0.23	1.01	2,192
Difference in High Temp (FDR-Leonard)	0.09	−1.23	0.06	1.47	2,192
Difference in Low Temp (FDR-Leonard)	−0.53	−1.81	−0.50	0.54	2,192
Difference in Precipitation (FDR-Leonard)	−0.01	−1.83	0.00	1.70	2,192

Results from Approach 1: Daily Course Visits (2019-2021)

The results of the first model approach using the 2019-2021 data subset are shown in Table 8 . The coefficient of interest yields an estimate of -3.116, which is statistically significant. This figure suggests that the implementation of the parking fee leads to 3.116 fewer visits to FDR. To frame this in relative terms: given that FDR typically receives an average of 12.84 visits each day, the fee results in approximately a $\frac{3.116}{12.84} \times 100\% = 24$ percent decline in the number of visits.

Comparing this to our earlier analysis that used the full dataset, we had observed a decline of 1.98 visits from an average of 6.7, translating to roughly a 30 percent decrease. This earlier result served as an upper bound. With the 24 percent reduction gleaned from the recent subset, the figures are broadly in the same ballpark. This slight variation might hint at evolving disc golfer behavior over the years. One plausible interpretation is that disc golfers have, over time, become more accommodating of parking fees or, conversely, have developed a higher willingness to pay. This shift could be indicative of rising popularity, perceived value of the park, or other external

factors influencing players' decisions.

Table 8: Number of Daily Visits Estimation Results 2019-2021

	Model 1.1a	Model 1.2a	Model 1.3a
Fee * FDR	−3.116***	−3.052***	−2.999***
	(0.866)	(0.857)	(0.871)
FDR	6.337***	6.277***	6.353***
	(0.510)	(0.507)	(0.514)
Avg Temp C	0.152***		
	(0.024)		
High Temp C		0.146***	
		(0.023)	
Low Temp C			0.144***
			(0.025)
Precipitation	−0.945***	−0.890***	−0.994***
	(0.195)	(0.192)	(0.199)
Time	0.012***	0.013***	0.013***
	(0.002)	(0.002)	(0.002)
Num.Obs.	2192	2192	2192
R2	0.346	0.347	0.345
R2 Adj.	0.342	0.343	0.340
R2 Within	0.113	0.114	0.110
R2 Within Adj.	0.111	0.112	0.108
AIC	16 337.7	16 334.8	16 343.5
BIC	16 423.1	16 420.2	16 428.9
RMSE	9.98	9.98	10.00
Std.Errors	HC1	HC1	HC1
FE: weekday	X	X	X
FE: holiday	X	X	X
FE: year	X	X	X

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Results from Approach 2: Daily Course Share (2019-2021)

The results of the second model approach using the 2019-2021 data subset are shown in Table 9. The coefficient of interest yields an estimate of -0.076, which is statistically significant and suggests that the fee at FDR causes the daily FDR share to decrease by 7.6 percentage points.

In contrast to this, our prior assessment, which employed the full dataset spanning 2015-2021, estimated a fee-induced reduction of 5.6 percentage points. This difference of 2 percentage points between the two periods might be attributed to various factors, potentially including changes in

player behavior, course modifications, or wider economic conditions over the years. A more granular investigation into these variations is an avenue for future research.

Table 9: Share of Daily Visits Estimation Results 2019-2021

	Model 2.1a	Model 2.2a	Model 2.3a
Fee	−0.076***	−0.075***	−0.075***
	(0.019)	(0.019)	(0.019)
Δ Average Temp C	−0.003		
	(0.032)		
Δ High Temp C		0.010	
		(0.025)	
Δ Low Temp C			−0.010
			(0.020)
Δ Precipitation	−0.051	−0.052	−0.052
	(0.036)	(0.036)	(0.036)
Time	0.000*	0.000*	0.000*
	(0.000)	(0.000)	(0.000)
Num.Obs.	1033	1033	1033
R2	0.084	0.084	0.084
R2 Adj.	0.072	0.072	0.072
R2 Within	0.021	0.021	0.021
R2 Within Adj.	0.017	0.017	0.017
AIC	104.4	104.3	104.2
BIC	173.6	173.4	173.4
RMSE	0.25	0.25	0.25
Std.Errors	HC1	HC1	HC1
FE: weekday	X	X	X
FE: holiday	X	X	X
FE: year	X	X	X

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Results from Approach 3: User's Monthly Visits (2019-2021)

Utilizing the more recent data subset spanning 2019 to 2021, the results presented in Table 10 offer a refined perspective on user behavior. Similar to the findings using the broader dataset from 2015 to 2021, the imposition of a fee at FDR continues to exert a downward pressure on the monthly visits. Specifically, the fee results in a decrease in monthly visits to FDR by approximately 0.128. The magnitude of this effect is slightly larger compared to the full dataset, indicating that the fee might have had a slightly stronger deterrent effect in recent years.

The preference for FDR over Leonard Park still remains evident in the 2019-2021 dataset, as indicated by the positive coefficient (around 0.317) of the FDR dummy. Thus, while FDR consistently draws more users than Leonard, the gap narrows during months when the parking fee is in effect. The difference in coefficients (0.317 versus 0.128) signifies a reduced preference for FDR during fee-charging months, aligning with our previous conclusions.

It is notable that the negative impact of precipitation on visits persists in the 2019-2021 subset. However, the coefficients associated with temperature variables remain statistically insignificant, reiterating the insight that weather, particularly precipitation, plays a more defining role than temperature in influencing disc golfing activities.

In terms of magnitude, considering that the average monthly visits per user to FDR without a fee is approximately 1.84 (as detailed in the main text), the observed decrease of about 0.128 in the 2019-2021 subset translates to a decrease of about 7 percent, which is consistent with the findings from the complete dataset.

In conclusion, the results derived from the 2019-2021 data subset corroborate our primary findings, providing further evidence of the significant role of fees and weather conditions in shaping disc golf player behavior. Additionally, the slight increase in the magnitude of the fee effect might suggest evolving user sensitivities or other unobserved changes in the more recent years.

Table 10: User-Level Monthly Visits Estimation Results 2019-2021

	Model 3.1a	Model 3.2a	Model 3.3a
Fee * FDR	−0.1276**	−0.1278**	−0.1274**
	(0.0544)	(0.0545)	(0.0545)
FDR	0.3170***	0.3172***	0.3168***
	(0.0528)	(0.0530)	(0.0526)
Monthly Avg Temp C	−0.0005		
	(0.0033)		
Monthly High Temp C		−0.0003	
		(0.0027)	
Monthly Low Temp C			−0.0005
			(0.0035)
Monthly Precipitation	−0.0276	−0.0278	−0.0274
	(0.0249)	(0.0250)	(0.0250)
Num.Obs.	8257	8257	8257
R2	0.351	0.351	0.351
R2 Adj.	0.243	0.243	0.243
RMSE	1.15	1.15	1.15
FE: user	X	X	X
FE: month	X	X	X
FE: year	X	X	X

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$