Gendered Consequences of COVID-19 Among Professional Tennis Players

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Abstract
The COVID-19 pandemic increased the risk of travelling, working, and participating in public events. To test whether there were gendered differences in the response to COVID-19, we examine the behavior of male and female professional tennis players. We use data from major tennis tournaments which included a rather large number of athletes withdrawing from play. After controlling for past performance, wealth, and other relevant player attributes, we find that female tennis players were more likely to withdraw. This suggests that high-earning women may have greater risk aversion, especially related to COVID-19, than their male counterparts. Importantly, women were more risk-averse when it comes to international travel.

Keywords
COVID-19, gender, risk aversion, tennis

Introduction
The COVID-19 pandemic and the rapid spread of the virus meant that leaving the house to travel, work, or interact with others contained risk of infection. At the same time, shutdown orders and remote/online schooling, meant that staying at home presented its own set of stresses.

As people juggled their personal and professional responsibilities, women left the workforce at higher rates than men in the COVID era in 2020 (Farré et al., 2020).
This is partially due to the fact that women more frequently serve as the primary caregiver in their home (Gausman & Langer, 2020; Langer et al., 2015). Women are also predominantly responsible for household management, even when they are the primary income earner (Chesley, 2017). Perhaps as part of the role of caregiver, women are more likely to worry about the health of others and, as a result, women are more likely than men to have experienced stress related to the pandemic (Liu et al., 2020).

Women are also more likely than men to make decisions to protect their own health and to follow virus-protection protocols, like wearing masks (Moran & Del Valle, 2016). In fact, in general, men are more likely to engage in behavior that has health risks than women (Harris & Jenkins, 2006) and some attribute this to gender attitudes regarding masculinity (Reny, 2020). Despite this, there is some evidence that men may have worse health outcomes from getting the COVID-19 virus than women (Jin et al., 2020). Although, other researchers caution that more research is needed to understand this, women may actually be as likely to get as seriously ill as men (Kopel et al., 2020).

Another possible explanation for the differences in the labor force and mitigation behaviors between men and women may be due to the fact that women have generally been found to be more risk averse than men (Bernasek & Shwiff, 2001; Jianakoplos & Bernasek, 1998; Nofsinger et al., 2018; Power, 2020; Sapienza et al., 2009). Women are also disproportionately represented in the industries hit the hardest by the pandemic, e.g., hospitality (Alon et al., 2020).

To understand these gendered differences, several studies have used survey data to consider the employment decisions due to COVID-19 of typical workers, e.g., (Brynjolfsson et al., 2020). However, very little is known about the impact of COVID-19 on labor force participation among exceptionally high-income earners or those who have to travel for work, and how COVID-19 might have differentially affected men versus women in these occupations.

To address this, we use data on professional tennis players and whether or not they competed in the first major professional tennis tournaments held after the resumption of play in fall 2020. After controlling for a number of other factors including player attributes and spatial heterogeneity in COVID-19 related policies, such as travel policies, we find that women were less likely to compete in these major tennis tournaments than men. This suggests that women remain more risk averse than men, even in the setting of highly skilled, high income earners. Given the extensive international travel in professional tennis, our results also offer insight into how business leaders might approach the tradeoffs between travel and remote conferencing during the pandemic.

**Tennis During COVID-19**

Professional tennis is managed by separate associations for women and men. For women it is the Women’s Tennis Association (WTA), and for men it is the...
Association of Tennis Professionals (ATP). In 2020, both associations temporarily stopped their seasons in March before ultimately resuming play shortly before the US Open in August. During the stretch from March to August 2020, most scheduled tournaments were cancelled, though one notable tournament opted to postpone and reschedule for after the US Open: the French Open.

The US Open and the French Open are two of the four most prestigious tournaments in professional tennis, part of a set of four tournaments collectively called the “Grand Slams.” In addition to prestige, these tournaments have the largest winnings (monetary payouts) and greatest impact on player rankings (Boulier & Stekler, 1999). One level below the Grand Slam events are those tournaments considered among the “Premier 5” tournaments by the WTA and as a “Master’s 5000” event by the ATP. Tournaments belonging to these categories have lower prestige, prize money, and impact on player rankings. In our analysis, we include both the US Open and the French Open Grand Slam tournaments as well as the Italian Open which is considered a Premier 5 and Master’s 5000 event. We include it because it took place between the US Open and the French Open and was effectively a warm-up tournament for the French Open as both featured clay courts (while the US Open is played on hard courts).

A majority of the entrances to all of these tournaments are filled through invitation, with the remaining entrances awarded via competition to the winners of play-in tournaments, called “Wildcards.” Invitations are typically extended based upon a player’s international ranking and are awarded to the highest ranked players in the world. A few invitations may also be extended to other players in special circumstances, e.g., a player who was highly ranked prior to an injury from which they have just recovered. If an invited player declines to attend a tournament, invitations are then offered to alternative players until the draw is filled. These replacement players are typically, though not exclusively, players who performed well in the play-in tournaments, though not quite well enough to earn an entry as a Wildcard. Additional players may also be asked to compete as replacements after the qualifying rounds have begun when an athlete is unable to compete in a subsequent round of the tournament, a group referred to as “Lucky Losers.” In our analysis we distinguish between Wildcards, initially invited players, and all subsequently invited players (including Lucky Losers). While the subsequently invited players may be more likely to play if this is their only chance at playing in a major tournament, we are unable to model their decision about whether or not to compete as we only observe those individuals if they accepted an invitation to compete (thus they are excluded from our analysis). There are no press releases about a potential subsequently invited player who declined an invitation to compete. Players who earned entry as a Wildcard may be more likely to play as having already played in a play-in tournament has revealed that they are willing to accept some risks of contracting COVID-19. However, it is still possible that a Wildcard player could decline to compete in a tournament.

An additional and important feature about these tournaments is that they are comprised of more than just individual competitions. Doubles tennis is exactly what the name indicates, a competition between teams of two players. Presumably, having an
invitation for doubles tennis will affect the decision to participate in a given tournament, as withdrawing would potentially let the partner in doubles play down. Even though we focus on the decision of singles players to compete in tournaments, many of these players also played doubles tennis at the same event. Thus, in our analysis, we control for whether a player is competing only in singles tennis, or if they are competing in both singles and doubles tennis.

Data and Model

Observations in this study are at the player-tournament level. The tournaments included are the US Open, the Italian Open, and the French Open, all played in 2020. The US Open and the French Open both have 128 entries for each gender. The Italian Open typically has 56 entries per gender, but only 55 athletes ultimately competed in the 2020 Italian Open. Again we mention that we only include those players for whom we can observe a decision to compete, hence Lucky Losers are omitted from the sample.

Data on the attributes of the athletes came from the WTA and the ATP. We exclude from our analysis any athletes who tested positive for COVID-19, were on suspension, or were injured as these athletes had no choice on whether or not they would compete. As noted above, subsequently invited players were dropped from the data as we can only observe those athletes who chose to compete in a tournament (not those who turned the opportunity down). For all other players, data on which players declined invitations to compete in these tournaments was pulled from press releases. Tables 1 and 2 contain the descriptive statistics for the data used in our

| Statistic                             | Mean    | St. Dev. | Min  | Max  |
|---------------------------------------|---------|----------|------|------|
| Competed                              | 0.824   | 0.382    | 0    | 1    |
| Doubles                               | 0.365   | 0.482    | 0    | 1    |
| Ranking                               | 72.99   | 85.65    | 1    | 785  |
| Age                                   | 26.11   | 4.72     | 15   | 40   |
| Career Winnings                       | 7,241,242 | 11,774,262 | 8,493 | 92,742,122 |
| 2020 Winnings                         | 260,864 | 377,803  | 0    | 3,031,173 |
| Titles                                | 4,417   | 9,743    | 0    | 73   |
| Majors                                | 0.494   | 2.396    | 0    | 23   |
| Majors (Binary)                       | 0.141   | 0.349    | 0    | 1    |
| Current Tournament Wins               | 0.099   | 0.513    | 0    | 6    |
| Current (Binary)                      | 0.084   | 0.234    | 0    | 1    |
| Competed Previous Tournament          | 0.481   | 0.500    | 0    | 1    |
| Intercontinental Travel Required      | 0.878   | 0.328    | 0    | 1    |
| Twitter Followers                     | 301,580 | 1,280,234 | 158  | 10,700,000 |
analysis for women and men, respectively. In all, we observed a decision for 304 men and 312 women. There are more observations for women than men due to differences in injuries, suspensions, and COVID-19 testing outcomes (either a positive test or contact with a person who tested positive for COVID-19 excluded them from competing). It is worth mentioning that, since those players who did not compete for reasons such as injury, positive COVID tests, or COVID exposure are omitted from our regressions on the basis that no true decision to compete during COVID was observed, and since these athletes were mostly men, if anything we may underestimate the true difference in risk aversion between women and men.

We next look at the decision to play at the two Grand Slam events (the US Open and the French Open) for only those players who were invited to both events. Given that the French Open was held after the US Open, playing in the French Open but not the US Open is a more risk averse decision than the opposite, in part because players learned from the US Open that COVID was not easily spread at tournaments. We see some evidence of potential COVID-19 related risk aversion among all players as more players chose to compete only in the French Open than the US Open. We also see some evidence that women exhibited more risk aversion across the board, with fewer women than men attending both events and more women than men attending neither event. These results are then extended to include the Italian Open which has a smaller sample size and twice as many possible decisions for those athletes invited to all three tournaments. In addition to the same pattern observed for the two Grand Slam events, there is a clear trend to attend only the Grand Slam events, avoiding the less prestigious Italian Open (Tables 3 and 4).

Table 5 breaks down the different reasons athletes did not compete in a tournament to which they were invited by gender and tournament. Individual choice was
the most common reason for not competing, with injury also occurring with some frequency. Only one player tested positive for COVID after accepting an invitation to compete and was replaced before the tournament began.

To consider the impact of gender on the probability of competing in the first tennis tournaments in the COVID-19 era, we estimate models where the dependent variable is a dichotomous variable indicating whether or not an athlete competed in a given tournament; this variable is equal to one if the athlete competed and is equal to zero if the athlete did not compete in the tournament after either being invited or

Table 3. A Breakdown by Gender of the Number of Players who Opted to Attend the Grand Slam events Conditional on being Invited to Attend both the US Open and the French Open.

| Decision                  | Men | Women |
|---------------------------|-----|-------|
| Attended Both             | 91  | 77    |
| Attended US Open Only     | 2   | 3     |
| Attended French Open Only | 7   | 13    |
| Attended Neither          | 2   | 12    |

Table 4. A Breakdown by Gender of the Number of Players who Opted to Attend any of the Three Events Conditional on Being Invited to Attend all Three Events.

| Decision                  | Men | Women |
|---------------------------|-----|-------|
| Attended All Three        | 38  | 32    |
| Attended US Open Only     | 0   | 0     |
| Attended Italian Open Only| 0   | 1     |
| Attended French Open Only | 0   | 0     |
| Attended US and Italian   | 0   | 0     |
| Attended US and French    | 12  | 8     |
| Attended Italian and French| 0  | 0     |
| Attended No Tournament    | 0   | 3     |

Table 5. A Breakdown by Gender and Tournament of the Reasons why Invited Athletes Opted not to Compete.

| Reason       | US Open | Italian Open | French Open |
|--------------|---------|--------------|-------------|
|              | Men     | Women        | Men         | Women       | Men | Women |
| Choice       | 10      | 28           | 5           | 12          | 4   | 15    |
| COVID        | 1       | 0            | 0           | 0           | 0   | 0     |
| Injury       | 3       | 2            | 0           | 0           | 3   | 1     |
| Suspension   | 1       | 0            | 0           | 0           | 0   | 0     |
winning a play-in tournament. We use a logistic regression (Equation 1) to consider the probability that an athlete competed in a given tournament based on gender (Male) and a vector \((X_i)\) of other factors that may be important to the decision of whether or not to compete, including age, financial winnings from competing in previous tennis tournaments, current and historical athlete ability, and properties of the tournaments themselves. Since there were no competitions for roughly five months prior to the return of professional tennis, all earnings from previous tennis competitions may be viewed as wealth rather than as income.

\[
Pr(\text{competing } = 1) = G(z) = \frac{e^z}{1+e^z}
\]

where:

\[
z_i = \alpha + \beta \text{Male} + \gamma x_i + \epsilon
\]

(1)

Since the coefficients from a logistic regression are difficult to interpret (telling us the change in the log-odds ratio of the dependent variable), we calculate the average of the marginal effects and present those in the results below. The marginal effects tell us how the impact of a change in a given attribute affects the probability that an individual athlete would choose to compete in a given tournament.

To control for financial winnings, we include two variables: career winnings and year-to-date winnings. Career winnings act as an indication of wealth, while year-to-date winnings are an indication of recent athlete performance; athletes with a higher level of recent performance might believe that they are more likely to perform well in one of these tournaments, thereby increasing their expected utility and earnings from competing in the tournament. In both cases we use the natural logarithm of the winnings variable, but add $1 to each before we transform it to ensure that the natural logarithm function is well defined for those players with no past earnings. While this paper is framed as a study of high income earners, we do acknowledge that not all professional tennis players are necessarily high income earners. However, we can say that professional tennis players have a high expected income i.e., all athletes in this study certainly have the potential to be high income earners. Caveat aside, 75% of the players in our sample had earned at least $1,000,000 in career winnings at the time of the stoppage in play due to COVID. Moreover, competitors in the 2020 US Open who did not win a single match still earned $61,000 even without revenues from ticket sales. This figure increased to $75,000 the following year (Perfect Tennis, 2021).

We also include several non-financial tennis-related attributes. First, we control for athlete rankings. Major tournaments such as the US Open and French Open are a significant source of points used to determine the rankings. Since rankings are used to determine access to tournaments and seeding within tournaments (Boulier & Stekler, 1999), there is a direct tennis-related incentive for athletes to compete in these tournaments as it will affect their ability to compete or seeding in future tournaments. In tennis, a ranking of 100 is worse than a ranking 1, thus an athlete with a numerically higher ranking is a less elite tennis player. Thus, there may be greater potential gains for less elite athletes or those with a numerically
higher ranking, as competing may improve their chances in the future via improved draws in future tournaments. In addition to ranking, we control for the number of tournaments previously won, the number of major tournaments previously won, and the number of previous titles at each tournament in our study (the US Open, the French Open, and the Italian Open). Athletes who have previously won a specific tournament may either be more likely to compete (thinking they can win again) or less likely, as they already have received that honor. We also control for whether or not an athlete competed in the most recent tournament since the resumption in play during the COVID-19 era, as this is a potential indicator of individual levels of risk aversion regarding COVID-19 and tennis tournaments. The first tournament during the COVID-19 era for men was the ATP Master’s 1000 Cincinnati, which was the only tournament played before the US Open. The US Open was followed by the Italian Open (a.k.a. the ATP Master’s 1000 Rome), and then the French Open. For women, the Western & Southern Open was the first tournament held during the COVID-19 era. Like the ATP Master’s 1000 Cincinnati, this was a precur- sor for the US Open. After the US Open was the Italian Open followed by the French Open. We also control for the type of entry earned by an athlete, and whether or not an athlete is competing in doubles tennis.

To address potential spatial heterogeneity in COVID concerns, policies, and travel restrictions, we include fixed effects for the nationality of each athlete and interact them with tournament fixed effects. Nationality fixed effects control for COVID cases and policies in an athlete’s home nation, and tournament fixed effects control for COVID cases and policies in the tournament host nation. Finally, by interacting these fixed effects, we also control for any travel restrictions/policies between tournament host nations and athlete’s home nations. However, to explore further the international travel component, we also estimate models with a tournament fixed effect and a variable indicating whether an athlete had to travel to another continent to compete.

An important factor in an athlete’s decision to compete in a tournament could be to increase sponsorship revenues. While, to the authors’ best knowledge, no public data set exists detailing revenues and other pertinent sponsorship data for professional tennis players, a proxy for sponsorship revenues was used to address this concern. By a source with access to the private data, it has previously been demonstrated that social media follower counts correlate with sponsorship revenues. This source suggests that beyond the few male tennis players who have all achieved historic success at major tournaments, sponsorship revenues exhibit a “healthy split across genders”. They also suggest that social media follower counts serve as a viable proxy for sponsorship data. To control for this, we use Twitter followers for each athlete to proxy for sponsorship. Figures 1 and 2 provide further evidence of the correlations between Twitter followers and sponsorship. It should be noted that Twitter accounts were only identified for roughly 60% of the sample.

As can be seen in Figures 1 and 2, the relationships between career winnings and Twitter followers and career titles won and Twitter followers is consistent across
gender. Given the greater level of parity that has existed over recent decades in women’s tennis, it is perhaps not surprising that the data for women has a somewhat narrower distribution. Overall, however, we provide evidence that controlling for Twitter followers should help address any issues related to sponsorship.

**Results and Discussion**

**Main Model**

First we present results from estimating Equation 1 on our full sample, considering whether or not an athlete invited to a tournament competes in that tournament. In Table 6 we present the average marginal effects based on the logit estimation. The
full set of logit results and corresponding results using OLS are shown in Appendix Tables A and B, respectively.

The coefficient we are most interested in is the coefficient for gender. As shown in Table 6 there is a positive and statistically significant increase in the probability of competing for men, indicating that all else equal, men were approximately 7-12% more likely to compete in these COVID-19 era tournaments than women. Given the increased risk associated with competing during COVID-19, and before vaccines were available, this result is consistent with the literature on risk aversion and gender which has shown that women are generally more risk averse than men, and that men are more likely to opt to compete than women, even when it is not necessary (Niederle & Vesterlund, 2007). It also further supports the notion that women have taken the COVID-19 pandemic more seriously than men (Galasso et al., 2020).
Table 6. Understanding the Probability of Competing for Women and Men Combined (marginal effects).

|                  | (1)       | (2)       | (3)       | (4)       | (5)       | (6)       | (7)       | (8)       |
|------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Male             | 0.1138*** | 0.1199*** | 0.1119*** | 0.1176*** | 0.1067*** | 0.0715*** | 0.1063*** | 0.0903**  |
| Age              | -0.0062** | 0.0045    | -0.0063** | 0.0048    | 0.0044    | 0.0082**  | 0.0041    |           |
| log(Career Winnings) | -2.374e-08*** | -2.52e-08*** | -1.585e-08*** | -1.294e-08*** | -1.515e-08*** |
| log(2020 Winnings) | 6.801e-08 | 1.076e-07** | 1.531e-08 | 3.273e-09 | 1.297e-08 |           |           |           |
| Doubles          | 1.933***  | 1.326***  | 1.816***  |           |           |           |           |           |
| Qualifier        | 0.9411*** | 1.205***  |           |           |           |           |           |           |
| Ranking          | 0.0003*   | 0.0010    | -0.0000   | 0.0006**  |           |           |           |           |
| Career Titles    |           |           |           |           |           |           |           |           |
| Ever Won a Major | 0.0647*   | 0.0552    | 0.0977**  |           |           |           |           |           |
| Ever Won Current Tournament | 0.0413  | -0.0660  | 0.0220    |           |           |           |           |           |
| Competed in Previous Tournament | 0.1003*** | 0.1553*** | 0.1254*** |           |           |           |           |           |
| Intercontinental Travel Required |           |           |           |           | -0.0914*** |           |           |           |
| log(Followers)   |           |           |           |           |           |           |           |           |
| Nationality×Tournament Interaction | ✓        |           | ✓         |           |           |           |           |           |
| Tournament Fixed Effect Only | ✓        |           | ✓         |           |           |           |           |           |
| Observations     | 616       | 616       | 616       | 616       | 616       | 615       | 615       | 361       |
| Log Likelihood   | -216.374  | -213.749  | -201.218  | -213.483  | -199.639  | -101.849  | -135.900  | -60.078   |
| Akaike Inf. Crit. | 436.748  | 433.499   | 410.436   | 434.966   | 409.279   | 335.698   | 301.800   | 366.155   |

Note: *p<0.1; **p<0.05; ***p<0.01
Models (6) and (7) do not include one female player who was not ranked because she had not competed in a tournament recently enough to earn points towards being ranked due to maternity leave. Model (8) has fewer observations than the other models because many players were not found on Twitter.
Supporting our claim that the gender difference is attributable to the pandemic, Krumer et al. (2016) found that, after controlling for player attributes, within-match competitiveness was similar for men and women. Additionally, Lallemand et al. (2008) found that female tennis players respond to increased prize money; thus since the tournaments in our sample are the highest paying of all tennis tournaments, any distinction must be due to some other conditions (such as the pandemic). We also recognize, however, that it is possible that the greater celebrity status given to the highest performing male athletes could be a factor influencing more men to compete (Binder et al., 2020; Humphreys, 2000).

We also find that there is some evidence that both male and female tennis players respond to tennis-related incentives when deciding whether or not to compete in a tournament. For instance, higher career winnings from playing tennis leads to a slight decrease in the likelihood that a player will compete in a tournament. This indicates a decreasing marginal utility of wealth, and is consistent with Geyer (2010).

Interestingly, neither in our main model nor in any other model do we find evidence of sponsorship income being a statistically significant factor in athlete decision making (proxied by our measure of Twitter followers). This result should not be too surprising considering that we just saw that better athletes were less likely to compete. Furthermore, athletes with greater levels of support from sponsors have less need to compete and may even be contractually guaranteed income without having to compete. However, given that sponsorship revenues for tennis players are skewed heavily towards the very top of the rankings, for the majority of players, sponsorship revenues are not large enough to justify staying home, given a specific level of COVID-19 related risk aversion. In fact, sponsorships at the low end may not even cover the cost of international travel and extended stays for an athlete and their team (coaches, trainers, etc.). In fact, in robustness checks in which we estimate separate regressions for each gender, we found that there was no effect for women, but that sponsorship revenue actually had a negative effect for men, indicating that it may be seen as effectively an additional wealth effect (Tables 8 and 9, below).

Our results also show that higher ranked (i.e., relatively better) players (those with numerically smaller rankings), were less likely to compete. This result is again expected since the points used to determine player rankings, which accumulate over the past twelve months, were frozen. That is, if a player had performed well in, say, the 2019 US Open, the points they earned from this performance would continue to count towards their ranking, even if they did not play in the 2020 US Open. If they did compete in the 2020 US Open, only their best performance from the 2019 and 2020 iterations of the US Open would count towards their ranking. This is in contrast to the standard policy (in non-COVID times) where points earned from performance in the 2019 US Open would no longer count after the completion of the 2020 US Open. This is important since better rankings impact seeding in tournaments, with higher ranked players getting better draws and having a greater likelihood of advancing. So, there is less risk for previously higher ranked players to sit out these tournaments.
Players who also had an invitation to compete in doubles tennis were more likely to choose to compete. While this may be due to the fact that they do not want to let their partner down, it also could be that an athlete competing in doubles tennis is already risking exposure to COVID-19 and, therefore, has already indicated a lower level of risk aversion. Similarly, we also see that having competed in the previous tournament significantly increased the probability that an athlete would choose to compete in the next event (in other words, they have already been potentially exposed). Those players who earned a Wildcard entry were also significantly more likely to compete than their invited counterparts. These athletes had also already risked COVID-19 exposure by competing in the qualifying event.

We also found that the type of tournament and prestige matters. Our results indicate that the two Grand Slam events were much more appealing to athletes, and there was a significant decrease in the probability that a given athlete would accept an invitation to the lower-tier Italian Open. Further supporting this result is the fact that, during the period of time during which these tournaments occurred, Italy had the smallest number of new infection per million people of the three nations which hosted the tennis tournaments included in this study (Our World in Data, 2021).

In Model 7, we drop the interacted fixed effect between nationality and tournament, and instead use a tournament fixed effect and the indicator variable for intercontinental travel. The indicator for intercontinental travel is statistically significant and negative in the combined model, indicating that large travel distances and/or travel to a region of the world that might have different approaches to COVID (both political and cultural) significantly decrease the probability of competing in an event. However, as shown in Tables 8 and 9 when we estimate models for women and men separately, this effect is being driven by women; i.e., men were not any less likely to attend an event that was held on a different continent, while women were significantly less likely to attend such an event.

Lastly, our results could support an alternative hypothesis - that the men in this sample are inherently more likely to be COVID skeptics than the women. That is, rather than being more risk seeking than women, perhaps (more of) the men simply do not believe that COVID is either as transmissible or as severe as it actually is.

As an example of potential gender-based differences in attitudes toward COVID, consider the saga of Novak Djokovic at the 2022 Australian Open. Djokovic, who is not vaccinated against COVID-19, went through a tumultuous legal battle to stay in Australia, despite his unvaccinated status, before he was ultimately deported, unable to compete in the tournament. However, throughout the pandemic, Djokovic himself has provided evidence in his behavior and in interviews that suggest that gender-based differences in attitudes toward COVID could be a consequence of more fundamental gender-based differences in risk aversion. For example, Djokovic knowingly attended an interview after testing positive for COVID-19, during which he removed his mask for a photoshoot (Yahoo! Sports, 2022). Afterwards
he released a statement regarding his behavior noting that “On reflection, that was an error of judgment” (Yahoo! Sports, 2022).

One way to control for the impacts of COVID-skepticism would be to control for vaccination status of individuals, but, unfortunately, such data are not publicly available. However, further casting doubt on this alternate hypothesis, Sports Travel Magazine (2022) reported that an equal number of WTA and ATP players were vaccinated as of the 2021 US Open, and, despite Djokovic’s resistance to get vaccinated, by early 2022, Djokovic was the only unvaccinated ATP player ranked in the top 100\(^{10}\) (Sports Travel Magazine, 2022). Many of those players who were initially skeptical towards vaccines, including Stefanos Tsitsipas, Alexander Zverev, and Daniil Medvedev, have since received the vaccine, suggesting that players do respond to the incentives arising from tournament vaccine requirements.

**Robustness Checks**

To test the sensitivity of our main results, we conducted a series of robustness checks. We first considered the decision to compete in each tournament individually. We also excluded the top 10 men and women by career winnings and by ranking from our data set, and estimated the same models as shown in Table 6. Finally, we examined the decision to compete separately for men and women. Results across all the models were extremely consistent, but some important outcomes are worth mentioning here.

Turning our attention to the individual tournaments, Table 7 illustrates that there was a large difference in the likelihood of competing between men and women (about 15%) at the US Open, but less evidence of a difference in the other tournaments. This is important because it shows that, in an absence of information on how likely professional tennis players were to contract COVID-19 at a professional tournament, women were significantly more risk averse than men. However, once more information was available to the athletes, i.e., at least one major tournament had been held, this gender gap began to close. This further supports a fundamental difference in risk aversion across gender.

| Competed                          | US Open | Italian Open | French Open | Top 10 Dropped | No Previous Tournament |
|----------------------------------|---------|--------------|-------------|----------------|------------------------|
| Male                             | 0.1381*** | 0.1234*      | 0.0852**    | 0.1079***      | 0.1138***              |
| Male + Controls                  | 0.1462*** | 0.0854      | 0.0863**    | 0.0753***      | 0.1232***              |
| Male + Controls + Followers      | 0.1592*** | 0.0733      | 0.0080      | 0.0506*        | 0.1310***              |

*Note: *p<0.1; **p<0.05; ***p<0.01*
|                          | (1)          | (2)          | (3)          | (4)          | (5)          | (6)          | (7)          |
|--------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Age                      | -0.005\,(0.005) | 0.008\,(0.006) | -0.005\,(0.005) | 0.009\,(0.006) | 0.114***\,(0.042) | 0.112***\,(0.040) | 0.108*\,(0.055) |
| Age Squared              |              |              |              |              | -0.002**\,(0.001) | -0.002**\,(0.001) | -0.002**\,(0.001) |
| log(Career Winnings)     |              |              | -0.063***\,(0.018) | -0.074***\,(0.018) | -0.078***\,(0.028) | -0.068***\,(0.025) | -0.093\,(0.060) |
| log(2020 Winnings)       | 0.012\,(0.018) | 0.026*\,(0.014) |              |              | 0.021\,(0.013) | 0.003\,(0.012) | 0.020\,(0.024) |
| Doubles                  |              |              |              |              | 0.229***\,(0.040) | 0.227***\,(0.036) | 0.238***\,(0.051) |
| Qualifier                |              |              |              |              | 0.106**\,(0.050) | 0.118**\,(0.047) | 0.126\,(0.078) |
| Ranking                  |              |              |              |              | 0.001***\,(0.0003) | 0.001***\,(0.0002) | 0.001***\,(0.0003) |
| Career Titles            | 0.004\,(0.005) | 0.007\,(0.004) | 0.003\,(0.005) |              |              |              |              |
| Ever Won a Major         |              |              |              |              | 0.033\,(0.091) | -0.015\,(0.084) | 0.078\,(0.108) |
| Ever Won Current Tournament |              |              |              |              | 0.025\,(0.093) | -0.036\,(0.105) | 0.073\,(0.089) |
| Competed in Previous Tournament |              |              |              |              | 0.224***\,(0.041) | 0.255***\,(0.039) | 0.233***\,(0.058) |

(continued)
Table 8. (continued)

|                          | (1)  | (2)  | (3)  | (4)  | (5)  | (6)  | (7)  |
|--------------------------|------|------|------|------|------|------|------|
| Competed                 |      |      |      |      |      |      |      |
| Intercontinental Travel Required | $-0.121^{***}$ |      |      |      |      |      |      |
|                          |      |      |      |      |      |      |      |
| log(Followers)           |      |      |      |      |      |      |      |
|                          |      |      |      |      |      |      |      |
| Nationality×Tournament Interaction | ✓   |      |      |      | ✓   |      |      |
| Tournament Fixed Effect Only | ✓   |      | ✓   |      | ✓   |      |      |
| Observations             | 312  | 312  | 312  | 312  | 311  | 311  | 187  |
| Adjusted $R^2$           | 0.0003 | 0.031 | $-0.0002$ | 0.040 | 0.348 | 0.266 | 0.301 |

Note: *p<0.1; **p<0.05; ***p<0.01
Table 9. Understanding the Probability of Competing for Men Only (OLS).

|                  | (1)      | (2)      | (3)      | (4)      | (5)      | (6)      | (7)      |
|------------------|----------|----------|----------|----------|----------|----------|----------|
| Age              | -0.008** | 0.0002   | -0.008** | 0.001    | 0.024    | -0.025   | -0.031   |
|                  | (0.004)  | (0.004)  | (0.004)  | (0.005)  | (0.039)  | (0.039)  | (0.065)  |
| Age Squared      |          |          |          | -0.0003  | -0.0003  | 0.001    |          |
|                  |          |          |          | (0.001)  | (0.001)  | (0.001)  |          |
| log(Career Winnings) | -0.043***| -0.049***| -0.077***| -0.076***| -0.040   |          |          |
|                  | (0.013)  | (0.016)  | (0.021)  | (0.022)  | (0.027)  |          |          |
| log(2020 Winnings) |          |          |          | 0.001    | 0.012    | 0.009    | 0.009    |
|                  |          |          |          | (0.017)  | (0.018)  | (0.020)  | (0.020)  |
| Doubles          | 0.078**  | 0.078**  | 0.105**  |          |          |          |          |
|                  | (0.034)  | (0.034)  | (0.050)  |          |          |          |          |
| Qualifier        |          |          |          | -0.031   | -0.031   | 0.003    |          |
|                  |          |          |          | (0.043)  | (0.043)  | (0.075)  |          |
| Ranking          | 0.0001   | 0.0001   | -0.0002  |          |          |          |          |
|                  | (0.0003) | (0.0001) | (0.001)  |          |          |          |          |
| Career Titles    | 0.005    | 0.005    | 0.009*   |          |          |          |          |
|                  | (0.004)  | (0.004)  | (0.005)  |          |          |          |          |
| Ever Won a Major | 0.040    | 0.038    | 0.111    |          |          |          |          |
|                  | (0.206)  | (0.205)  | (0.237)  |          |          |          |          |
| Ever Won Current Tournament | -0.384* | -0.382* | -0.448** |          |          |          |          |
|                  | (0.204)  | (0.205)  | (0.186)  |          |          |          |          |
| Competed in Previous Tournament | 0.073** | 0.072** | 0.096*   |          |          |          |          |
|                  | (0.035)  | (0.036)  | (0.055)  |          |          |          |          |
| Intercontinental Travel Required |          |          |          |          | -0.009   |          |          |
|                  |          |          |          |          | (0.031)  |          |          |
Table 9. (continued)

|                          | (1)  | (2)  | (3)  | (4)  | (5)  | (6)  | (7)  |
|--------------------------|------|------|------|------|------|------|------|
| log(Followers)           |      |      |      |      |      | $-0.055^{***}$ |      |
| Nationality×Tournament Interaction | ✓    | ✓    | ✓    | ✓    | ✓    | ✓    | ✓    |
| Tournament Fixed Effect Only | ✓    | ✓    | ✓    | ✓    | ✓    | ✓    | ✓    |
| Observations             | 304  | 304  | 304  | 304  | 304  | 304  | 174  |
| Adjusted $R^2$           | 0.021| 0.062| 0.018| 0.064| 0.081| 0.077| 0.008|

Note: "p<0.1; "p<0.05; ""p<0.01
Average marginal effects on the probability of competing for additional regressions. The first three columns show results by tournament. The fourth column shows results for the full sample but with the top 10 men and women by career winnings and by current ranking. The fifth column shows results for the full sample, including the top ranked players and top earners, but omits the control for having competed in the previous tournament. The first row shows results with only Male as an explanatory variable (Model (1) in the main results). The second row shows results with all controls except the number of Twitter followers (Model (6) in the main results) to increase the sample size. The third row shows results with the full set of controls including Twitter followers (Model (8) in the main results) but has a reduced sample size.

Furthermore, COVID-19 cases were higher during the US Open and French Open than during the Italian Open (Dong et al., 2020). Figure 3 shows the 14-day moving average of new cases per million people in each of the three host nations throughout

![COVID Cases in Host Nations](image)

**Figure 3.** Time series for the 14-day moving average of new cases per million people in the three host nations. The first vertical line indicates the first day of the US Open. The second vertical line indicates the first day of the Italian Open. The third vertical line indicates the first day of the French Open. Data comes from (Dong et al., 2020).
August and September 2020. While this value was slightly higher at the French Open that at the US Open, going into the French Open the players were aware of how the first two tournaments were held and had a better idea of how likely they were to contract COVID at the French Open.

To ensure our results are not being driven by the highest performing athletes, in the fourth column of Table 7 the top ten men and women by ranking and career winnings are dropped from the sample. We find similar results suggesting that the effects we observe are not driven by the choices of these top athletes. Finally, we drop the control for having competed in the previous tournament, and again our results are robust.

Finally, we further explore the differences between gender by presenting separate sets of regressions for each gender in Tables 8 and 9. We present results using OLS in place of logit average marginal effects so that we can observe the effects of the Age and Age-Squared variables separately; i.e. in order to see whether there is a nonlinear relationship between age and attendance with respect to gender.

Regarding age, we see that age has no significant effect for men, but for women, younger and older women (relative to “prime age” tennis players) are less likely to compete. The age at which the probability of competing is maximized for women, when holding all else equal, is at about 30 years old.

There also appears to be an interesting gender-based difference in the choices of the top performing players in our sample. Ranking had a positive and statistically significant increase in the probability of competing for women, and was insignificant for men. This suggests that top performing women were less likely to compete than women with numerically higher rankings (less elite tennis players). This gendered difference in the behavior of top performing tennis players is quite striking. Geyer (2010) had previously shown that in tennis, player ranking and the number of tournaments won each correlate with the likelihood that a player quits. If foregoing a tournament to which a player has been invited is viewed as analogous to quitting, then our results align with Geyer (2010) only for men. However, prioritizing health during a global pandemic does not need to be viewed as quitting. In fact, Krum et al. (2016) found that, after controlling for player attributes, within-match competitiveness was similar for men and women. Supporting the distinction brought on by the pandemic, Lallemand et al. (2008) found that female tennis players respond to increased prize money; the tournaments in our sample are the highest paying of all tennis tournaments.

Finally, as mentioned above, there is a clear difference in the effect of intercontinental travel on participation for women versus men, with female athletes less likely to play if such travel is involved. Given the additional risks associated with travel, this is further evidence of increased risk aversion.

Conclusion

The COVID-19 pandemic caused many disruptions to the world economy and to day-to-day life. Previous studies have suggested that there are gendered differences
in risk, in the willingness to comply with pandemic-restrictions, and in the effect of the pandemic on household responsibilities and work. Other research has also supported gendered differences in risk aversion more generally.

Using data on professional tennis players, we examine whether there were differences by gender in the willingness of top athletes to accept the risks of competing in major professional tennis tournaments during a global pandemic. We find that women were, all else equal, less likely than men to compete in a tournament. The differential outcomes based on gender also appear among the top performing tennis players, with higher (numerically lower) ranked women less likely to compete, while ranking was not a significant factor for men.

Overall, these results suggest that women may be more risk averse and their lives may be more disrupted by the COVID-19 crisis, despite evidence that women face potentially less severe health consequences from the virus. It appears that COVID-19 has had differential effects on the employment decisions of men and women. Extending this literature, we find evidence that COVID-19 exhibits differential effects across gender in the case of high income earners with extremely unique skill sets (professional tennis players).

But perhaps the most salient characteristic of professional tennis players is the substantial amount of travel required. While many skilled, high income earning positions can now be performed remotely, others still have incentives for face-to-face interaction, e.g., to build professional relationships. Our results offer some insight into what other professionals whose jobs required frequent travel might decide to do during more severe phases of the pandemic. Our results indicate that men are likely to opt for more travel than women. Thus we might expect the impacts of the pandemic on companies which require or otherwise can benefit from travel to be distributed differently across corporate structure conditional on the gender composition of leadership. Moreover, gender gaps in professional opportunities, career advancement, and wages may very well grow as a consequence of this gender-based difference in travel preferences.

Declaration of Conflicting Interests
The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Notes
1. Professional tennis was halted worldwide in March 2020 due to the COVID-19 pandemic.
2. The US Open was held in New York, New York, USA, from August 31 to September 13. The Italian Open was held in Rome, Italy, from September 14 to September 21. The French Open was held in Paris, France, from September 27 to October 11.
3. https://www.wtatennis.com/players
4. https://www.atptour.com/en/players
5. https://www.wtatennis.com/rankings/singles
6. https://www.atptour.com/en/rankings/rankings-faq
7. See: https://www.sportcal.com/Insight/Features/126844
8. Again, see: https://www.sportcal.com/Insight/Features/126844.
9. At the time of the writing of this paper.
10. This is in part because explicitly anti-vaccine players like Tennys Sandgren have fallen out of the top 100 since the 2021 season.

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### Table A. Coefficients from the Main Logit Results Corresponding to the Average Marginal Effects in Table 4

|                  | (1)      | (2)      | (3)      | (4)      | (5)      | (6)      | (7)      | (8)      |
|------------------|----------|----------|----------|----------|----------|----------|----------|----------|
| Competed         |          |          |          |          |          |          |          |          |
| Male             | 1.166*** | 1.236*** | 1.213*** | 1.215*** | 1.169*** | 1.361*** | 1.472*** | 1.634**  |
|                  | (0.280)  | (0.276)  | (0.280)  | (0.278)  | (0.283)  | (0.455)  | (0.334)  | (0.660)  |
| Age              | −0.061** | 0.047    | −0.063** | 0.050    | 0.084    | 0.119    | 0.075    |          |
|                  | (0.028)  | (0.037)  | (0.027)  | (0.036)  | (0.056)  | (0.048)  | (0.071)  |          |
| log(Career Winnings) | −0.608*** | −0.646*** | −0.953*** | −1.057*** | −1.000*  |          |          |          |
|                  | (0.122)  | (0.121)  | (0.254)  | (0.236)  | (0.451)  |          |          |          |
| log(2020 Winnings) | 0.052    | 0.106**  | 0.049    | −0.048   | 0.011    |          |          |          |
|                  | (0.101)  | (0.051)  | (0.098)  | (0.081)  | (0.109)  |          |          |          |
| Doubles          | 37.197***| 19.220***| 33.372***|          |          |          |          |          |
|                  | (3.004)  | (0.524)  | (1.322)  |          |          |          |          |          |
| Qualifier        | 18.114***| 17.462***| 17.033***|          |          |          |          |          |
|                  | (0.690)  | (0.510)  | (1.435)  |          |          |          |          |          |
| Ranking          | 0.007*   | −0.0003  | 0.012*   |          |          |          |          |          |
|                  | (0.004)  | (0.0003) | (0.006)  |          |          |          |          |          |
| Career Titles    | 0.020    | 0.030*   | 0.008    |          |          |          |          |          |
|                  | (0.021)  | (0.018)  | (0.024)  |          |          |          |          |          |
| Ever Won a Major | 1.245*   | 0.800    | 1.796**  |          |          |          |          |          |
|                  | (0.718)  | (0.614)  | (0.882)  |          |          |          |          |          |
| Ever Won Current Tournament | −0.794 | −0.957 | −0.405 |          |          |          |          |          |
|                  | (0.792)  | (0.753)  | (1.150)  |          |          |          |          |          |
| Competed in Previous Tournament | 1.931*** | 2.252*** | 2.305*** |          |          |          |          |          |
|                  | (0.430)  | (0.411)  | (0.566)  |          |          |          |          |          |
| Intercontinental Travel Required | −1.325 |          |          |          |          |          |          |          |
|                  |          |          |          |          |          |          |          |          |
| log(Followers)   |          |          |          |          |          |          | 0.079    |          |
|                  |          |          |          |          |          |          | (0.231)  |          |
| Nationality×Tournament Interaction | ✓ |          |          |          |          |          |          |          |
| Tournament Fixed Effect Only | ✓ |          |          |          |          |          |          |          |
| Observations     | 616      | 616      | 616      | 616      | 616      | 615      | 615      | 361      |
| Log Likelihood   | −216.374 | −213.749 | −201.218 | −213.483 | −199.639 | −101.849 | −135.900 | −60.078  |
| Akaike Inf. Crit. | 436.748  | 433.499  | 410.436  | 434.966  | 409.279  | 335.698  | 301.800  | 366.155  |

Note: *p<0.1; **p<0.05; ***p<0.01
Table B. Coefficients from the OLS Results Comparable to the Average Marginal Effects in Table 4

|                  | (1)       | (2)       | (3)       | (4)       | (5)       | (6)       | (7)       | (8)       |
|------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Male             | 0.114***  | 0.120***  | 0.110***  | 0.118***  | 0.100***  | 0.072**   | 0.114***  | 0.097**   |
|                  | (0.026)   | (0.025)   | (0.025)   | (0.026)   | (0.026)   | (0.027)   | (0.026)   | (0.040)   |
| Age              | −0.006**  | 0.004     | −0.007**  | 0.005     | 0.011***  | 0.009**   | 0.009**   | 0.004**   |
|                  | (0.003)   | (0.004)   | (0.003)   | (0.004)   | (0.004)   | (0.004)   | (0.004)   | (0.004)   |
| log(Career Winnings) | −0.052*** | −0.062*** | −0.065*** | −0.070*** | −0.077*** |
|                  | (0.011)   | (0.013)   | (0.015)   | (0.017)   | (0.023)   |
| log(2020 Winnings) | 0.006     | 0.020*    | 0.012     | 0.003     | 0.017     |
|                  | (0.013)   | (0.012)   | (0.012)   | (0.012)   | (0.012)   |
| Doubles          | 0.138***  | 0.165***  | 0.135***  |
|                  | (0.027)   | (0.025)   | (0.031)   |
| Qualifier        | 0.037     | 0.072***  | 0.0002    |
|                  | (0.035)   | (0.033)   | (0.057)   |
| Ranking          | 0.0002    | −0.0001   | 0.001***  |
|                  | (0.0002)  | (0.0003)  | (0.0002)  |
| Career Titles    | 0.002     | 0.003*    | 0.002     |
|                  | (0.002)   | (0.002)   | (0.002)   |
| Ever Won a Major | −0.007    | −0.025    | 0.016     |
|                  | (0.075)   | (0.078)   | (0.078)   |
| Ever Won Current Tournament | −0.068    | −0.105    | −0.045    |
|                  | (0.109)   | (0.109)   | (0.110)   |
| Competed in Previous Tournament | 0.173***  | 0.162***  | 0.196***  |
|                  | (0.028)   | (0.027)   | (0.040)   |
| Intercontinental Travel Required | −0.087*** |
|                  | (0.025)   | (0.025)   | (0.025)   |

(continued)
|                          | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| log(Followers)           |     |     |     |     |     |     |     | −0.001 (0.014) |
| Nationality x Tournament |     |     |     |     |     |     |     | ✓ ✓ |
| Interaction              |     |     |     |     |     |     |     | ✓ ✓ |
| Tournament Fixed Effect Only | 616 | 616 | 616 | 616 | 616 | 615 | 615 | 397 |
| Observations             |     |     |     |     |     |     |     |     |
| Adjusted R²              | 0.029 | 0.036 | 0.069 | 0.035 | 0.076 | 0.270 | 0.207 | 0.190 |

Note: *p<0.1; **p<0.05; ***p<0.01