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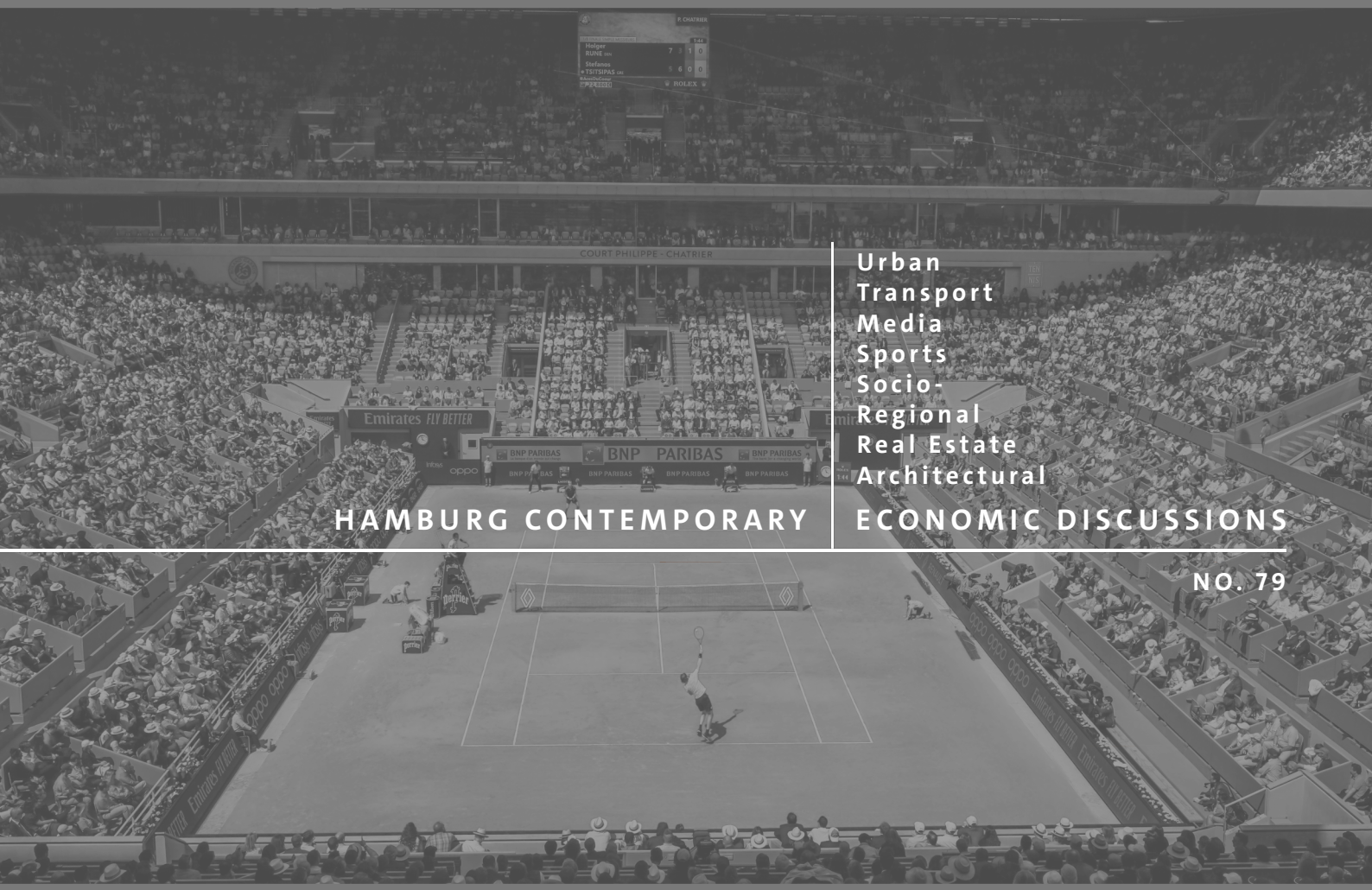
THE SUPERSTAR EFFECT IN TENNIS – A WITHIN-MATCH ANALYSIS



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The Superstar Effect in Tennis – A within-match analysis

Abstract: This study is the first to investigate the superstar effect on professional men's tennis players' situational performance, employing novel serve and return ratings. We innovate by examining the impact of superstars on the performance of both higher-ranked (HR) and lower-ranked (LR) players. We provide evidence that HR players deliberately increase/decrease their performance in (non)dominant match situations based on their rank and the timing of facing a superstar in subsequent matches. Similarly, there are differences in the extent of performance shifts induced by superstars among different rank groups for LR players; however, the differences do not extend to different within-match situations.

***Keywords**: Superstar effect, tournaments, professionals, productivity*
***JEL:** J44, L83, Z21, Z22*
***Version:** September 2024*

1 Introduction

Peers' performance in tournament settings may be impacted by a contestant's superior ability (MacDonald, 1988; Rosen, 1981) or popularity (Adler, 1985). This "superstar effect" is frequently observed in sports competitions. For example, underdog alpine skiing athletes enjoy positive peer effects in the case of superstar presence, decreasing their race time (Babington et al., 2020). Similarly, the data suggest that the presence of Usain Bolt improves other contestants' running time (Hill, 2014). However, (Meissner et al., 2021) provide evidence of a negative effect of gymnastics superstar Simone Biles on her peers' performance. Similarly, the findings of (Tanaka & Ishino, 2012) indicate that the presence of superstar players on the Japan Golf Tour has a significant negative effect on the performance of other players. In addition, (J. Brown, 2011) exploits the adverse participation effect of Tiger Woods on other top-ranked PGA golfers' general performance (strokes relative to par).

(McFall & Rotthoff, 2020) challenge the setup of (J. Brown, 2011) and similar studies regarding the superstar effect on athletes' general performance. In contrast, their results

point to the necessity of employing detailed performance indicators to model players' in-game performance dynamics and strategic behavior induced by the presence of superstars. Using the second shot on par five holes, (McFall & Rotthoff, 2020) provide evidence that the participation of Woods influences other golfers' within-game performance, such as in critical situations, and shifts in risk-taking behavior.

Recent findings provided by (Deutscher et al., 2023), who analyze professional men's tennis tournaments, indicate a negative effect of superstars on top-performing players' winning probabilities. However, considering the remarks regarding indicators for players' general performance by (McFall & Rotthoff, 2020), winning probabilities merely offer a binary view of a match's outcome and do not directly capture aspects of a player's within-match performance. For example, induced by the superstar effect, a player may lose [win] a match but perform better [worse] in certain match situations.

This is the first study to investigate the superstar effect on professional tennis players' performance in different within-match situations. Using data from men's tennis from 2004 to 2019, our study provides two contributions to the literature. First, we complement the discussion in (Deutscher et al., 2023) by leveraging novel serve and return performance rating data provided by the Association of Tennis Professionals (ATP) to proxy performance in (non)dominant game situations. Due to the organizational aspects inherent to tennis, both players are assigned to either be the server or the returner at any given time. Hence, a natural starting point to assess the superstar effect on performance beyond the winning probabilities in tennis is to evaluate situations in which a competitor acts as the server and returning player. Second, we innovate by assessing the superstar effect on higher-ranked (HR) and lower-ranked (LR) tennis players simultaneously, allowing coefficients to vary across players' pre-match status (HR vs. LR) (Sunde, 2009).

We affirm previous findings that superstar-induced shifts in HR players' performance differ across rank categories and that HR players adjust their performance according to the timing of potentially facing a superstar in a tournament (Deutscher et al., 2023). As

central results, we uncover that, unless there is an immediate threat of facing a superstar, HR players only adjust performance in match situations in which they have the upper hand (dominant positions). Our findings suggest that performance in nondominant game situations is affected, if at all, only when an HR player potentially encounters a superstar in the subsequent round. This underscores a strategic dimension in HR players' competitive play: the players are not only reactive to immediate circumstances but also engaged in strategic planning, such as by adjusting their performance to preserve their physical state. Similar to HR players, our results indicate that there are differences in the extent of performance alterations induced by superstars among different rank groups for LR players. However, these discrepancies do not extend to different match scenarios. Finally, while smaller for HR players in absolute terms, the main effect of superstar participation on LR players' situational performance is greater than, for example, the impact of surface familiarity.

This study connects to the literature on players' strategic decision-making in tournament settings (J. Brown & Minor, 2014; Ely et al., 2017; McFall & Rotthoff, 2020; Walker & Wooders, 2001). Tennis provides a natural framework in which asymmetric individuals with different skill sets compete. We contribute to previous studies on heterogeneous agents' effort exertion (Lazear & Rosen, 1981; Rosen, 1986), especially in the context of professional sports (e.g., Ehrenberg & Bognanno, 1990). Finally, our work connects to a vast body of literature using tennis data (A. Brown, 2014; Klaassen & Magnus, 2001; Malueg & Yates, 2010).

2 Empirical strategy

As a starting point for our analysis, we use the framework of (Deutscher et al., 2023), who evaluate the superstar effect on players' winning probability as a natural measure of player performance. Equation (1) refers to the linear fixed effect model in which the dependent variable is dichotomous, i.e., $HR\,won_{hlm}$ equals one if HR player h won against LR player l in match m and zero otherwise. The players' ranking positions are mutually exclusive; every match features an HR and an LR player.

$$HR\,won_{hlm} = \sum_{k=1}^{K}(\alpha_k Star_m \times Cat_{khm} + \beta_k Next_m \times Cat_{khm} + \gamma_k \Delta Rank_{hlm} \times Cat_{khm} + \delta_k \Delta^2 Rank_{hlm} \times Cat_{khm}) + \epsilon_1 HA_{hm} + \epsilon_2 HA_{lm} + HR_{hm} + R_m + T_m + u_{hlm} \quad (1)$$

(Deutscher et al., 2023) employ the following variables. The binary variable $Star_m$ indicates whether a match m is played while at least one superstar still competes in a given tournament during a season of dominance (Novak Djokovic 2007-2019, Roger Federer 2004-2019, Rafael Nadal 2005-2019, and Andy Murray 2008-2016). Similarly, $Next_m$ equals one if the match's winner potentially faces a superstar in the subsequent tournament round. $Star_m$ (=1) is a necessary condition for $Next_m$ (=1). Hence, the main effect $Star_m$ is moderated by $Next_m$. Besides this, a player's ranking remains constant throughout a tournament.

Equation (1) features a set of covariates: Cat_{khm} indicates whether the (in game) HR player is ranked in one of $K = 3$ distinct rank categories ($k = 1$: ranks 1-20; $k = 2$: ranks 21-50; $k = 3$: ranks > 50). The difference in ranking positions between players ($\Delta Rank_{hlm}$) accounts for their heterogeneous abilities. Including a squared term ($\Delta^2 Rank_{hlm}$) accounts for a nonlinear relationship. If a player has a home advantage (HA) in match m, the binary variable HA equals one; a player is considered to have a HA if a match is hosted in the player's home country (cf., Creutzburg et al., 2024). While player-season fixed effects (HR_{hm}) capture players' season-specific forms, R_m and T_m are round and tournament fixed effects.

A shortcoming of a binary outcome variable (i.e., a match outcome) is that it does not provide comprehensive information on players' in-match performance. For example, a player may lose a match but perform better in certain match situations (or vice versa). To gain a nuanced understanding of how the superstar effect alters players' performance in different match situations, alternative performance measures may be needed. The organization of the game of tennis inherently entails the assignment of players to specific roles: a severing and a returning player. A natural starting point for assessing

the impact of the superstar effect in tennis beyond the probability of winning is to evaluate situations in which a competitor serves and returns.

The server has a greater probability of winning the point if his serve is strong (Albert & Kovalchik, 2017), implying that the serving player is usually in a dominant position. To evaluate a player's serving performance, the ATP offers a serve rating that measures the efficiency and quality of a player's serve at the match level. The rating is determined by adding four service metric percentages as well as the number of aces and subtracting the number of double faults per match. A high serve rating signals that the tennis player consistently executes powerful and accurate serves.

$$\begin{aligned} Serve\ rating\ =\ & \%\ 1st\ serve\ in + \%\ 1st\ serve\ points\ won \\ & + \%\ 2nd\ serve\ points\ won + \%\ service\ games\ won + Aces \\ & - Double\ faults \end{aligned} \tag{2}$$

The returning player plays a nondominant position. The ATP measures the returning player's performance through a return rating, which reflects the ability to read the serve and respond appropriately. A high return rating therefore suggests that a player can adeptly read and respond to the serves of his opponent.

$$\begin{aligned} & Return\ rating \\ & = \%\ 1st\ serve\ return\ points\ won \\ & + \%\ 2nd\ serve\ return\ points\ won + \%\ Return\ games\ won \\ & + \%\ Break\ points\ converted \end{aligned} \tag{3}$$

Equation (4) shows the model we use for our analysis of a player's performance in dominant (nondominant) situations:

$$\begin{aligned} & HR{:}\ serve\ [HR{:}\ return]_{hlm} \\ & = \sum_{k}^{K} (\alpha_k Star_m \times Cat_{khm} + \beta_k Next_m \times Cat_{khm} \\ & + \gamma_k \Delta Rank_{hlm} \times Cat_{khm} + \delta_k \Delta^2 Rank_{hlm} \times Cat_{khm}) + \epsilon_1 HA_{hm} \\ & + \epsilon_2 HA_{lm} + \zeta \boldsymbol{F}_{hlm} + HR_{hm} + R_m + T_m + u_{hlm} \end{aligned} \tag{4}$$

We adopt key elements of the framework of (Deutscher et al., 2023) but diverge in two key areas. First, we substitute their binary dependent variable by the HR player's performance in (non)dominant match situations using the continuous serve and return rating ($HR: serve\ [HR: return]_{hlm}$). Second, $\boldsymbol{F}_{hlm}$ captures additional match-specific characteristics relevant for players' performance beyond the HA effect. In particular, players' jet lag and surface-familiarity effects mitigate against an omitted variable bias regarding players' HA effects (Creutzburg et al., 2024). Two variables are included in the analysis to control for the number of time zones traversed by both players between tournaments; two dichotomous variable indicate whether the tournament surface matches the surface utilized predominantly in the HR and LR player's home country (cf., Creutzburg et al., 2024). Similarly, the match's duration (in minutes) decreases with the rank difference between HR and LR players (Jane, 2020) and most likely affects players' serve and return performance. Hence, including the duration rules out a potential omitted variable bias concerning the effects of $\Delta Rank_{hlm}$ and $\Delta^2 Rank_{hlm}$.

(Deutscher et al., 2023) highlight the possibility of a correlation between the idiosyncratic error term u_{hlm} within a specific season for HR players and within a specific tournament in that season. Consequently, we present cluster-robust standard errors at the level of the HR player-season and tournament-season. In linear regression settings, reported standard errors may be erroneously small due to the presence of "singleton groups," which are situations where a single observation is directly captured by a fixed effect (Correia, 2015). We employ the estimator suggested by (Correia, 2017), which entails the iterative removal of "singletons" and modifies the variance-covariance matrix according to (Correia, 2015) in all the following specifications.[1]

[1] The removal of singleton groups of fixed effects that are non-nested within clusters results in an increase in error terms; in contrast, the removal of singletons of non-nested fixed effects has the effect of reducing standard errors, thereby reinforcing the bias (Correia, 2015). In this study, only HR_{hm} is nested within clusters, while tournament and round fixed effects are not nested within clusters.

3 Data

We enrich the data of (Deutscher et al., 2023) for the purpose of better isolating the superstar effect on player performance in specific match situations. To collect data pertaining to tournaments, matches, and individual players, we use a web-scraping algorithm. First, our algorithm retrieves basic information on ATP singles tournaments for the 2004-2019 seasons from www.atptour.com. Second, by looping over each tournament in the provided seasons, we systematically obtain match information such as a unique player identifier, the match-level performance ratings of both contestants (HR and LR), the match round, and the final score. Third, we utilize the player identifiers to collect personal contestants' information, e.g., a player's current world ranking position and country of origin. We link each match with both participants using the individual player identifiers.

Our analysis is confined to singles matches. Team and doubles competitions (World Team Championship and ATP Cup) are excluded because it is not possible to identify HR and LR players at the match level. Furthermore, events that do not generate world ranking points (Olympics, Laver Cup, and Next Gen ATP Finals) are not considered, as such tournaments are only accessible to a selected group of players. We discard 4,384 matches in which a player received a bye and exclude 1,728 matches due to irregularities in the outcome (e.g., injury, disqualification, or walkover).[2] In addition, detailed match information or player ranks are unavailable for 1,711 matches. Moreover, as they deviate from the conventional elimination structure of tennis tournaments (cf., Gilsdorf & Sukhatme, 2008), we exclude round-robin competitions (216 matches), such as the ATP World Tour Finals.

The data cleaning process is conducted in accordance with (Deutscher et al., 2023). First, 3,295 matches involving tennis superstars during their most dominant seasons are omitted (Novak Djokovic, 2007-2019; Roger Federer, 2004-2019; Rafael Nadal, 2005-2019;

[2] In a tennis tournament, a player who receives a bye is automatically advanced to the subsequent round, bypassing the necessity for a match in the current round.

Andy Murray, 2008-2016). Second, the Grand Slams (Australian Open, French Open, Wimbledon, and U.S. Open) and the two annual ATP Masters 1000 events in Indian Wells and Miami (9,236 matches) are excluded due to concerns regarding self-selection and structural differences in the competitions. Third, since it is not possible to examine whether a superstar impacts a player's performance in the next round if the match is a final or if all the superstars are eliminated from the tournament, we discard 943 matches. The final dataset features 936 tournaments on the ATP World Tour, resulting in a total of 27,366 observations identified at the match level. Each observation contains information on competing HR and LR players. A total of 920 players are included in the dataset. Table 1 presents a comprehensive summary of the selected variables in our dataset.

Table 1 Summary statistics

	Mean	Sd	Min	Max
HR: won	0.63		0	1
HR: serve	272.23	36.71	90	392
HR: return	149.42	51.93	6	343
LR: serve	255.17	39.24	86	384
LR: return	128.56	52.34	5	356
HR: 1-20	0.29		0	1
HR: 21-50	0.38		0	1
HR: > 50	0.34		0	1
LR: 1-20	0.02		0	1
LR: 21-50	0.19		0	1
LR: > 50	0.79		0	1
Star	0.33		0	1
Next	0.06		0	1
HR: HA	0.13		0	1
LR: HA	0.19		0	1
HR: time zones	3.16	4.07	0	19
HR: surface match	0.51		0	1
LR: time zones	2.72	3.78	0	19
LR: surface match	0.54		0	1
Duration	97.56	29.93	29	290

Note: Data include 27,366 main draw ATP singles matches played in 936 tournaments between the 2004 and 2019 seasons. Every match is played by a higher- (HR) and lower-ranked (LR) player. The dataset features a total of 920 players.

4 Results

We start with a replication of the key results of (Deutscher et al., 2023). Column (2.1) in Table 2 shows the results of estimating Equation (1).

Table 2 Superstar effect on higher-ranked players' winning probabilities

	(2.1) HR: won		(2.2) HR: won	
Star x HR: 1-20	-0.034**	(0.014)	-0.032**	(0.014)
Next x HR: 1-20	-0.047***	(0.018)	-0.043**	(0.018)
Star x HR: 21-50	-0.023*	(0.014)	-0.025*	(0.013)
Next x HR: 21-50	-0.017	(0.024)	-0.015	(0.024)
Star x HR: > 50	0.040**	(0.016)	0.039**	(0.016)
Next x HR: > 50	0.002	(0.033)	0.003	(0.033)
HR: HA	0.059***	(0.010)	0.042***	(0.011)
LR: HA	-0.007	(0.008)	0.004	(0.009)
HR: time zones			-0.003**	(0.001)
LR: time zones			0.003***	(0.001)
HR: surface match			0.062***	(0.008)
LR: surface match			-0.028***	(0.007)
Duration			-0.001***	(0.000)
N	26,901		26,901	
r2	0.143		0.152	
r2_within	0.016		0.027	

Note: The dependent variable (HR: won) equals one if the higher-ranked (HR) player won against the lower-ranked (LR) player and zero otherwise. Every match is played by an HR and LR player. A player has a home advantage (HA) if the match is played in his home country. The standard errors in parentheses are clustered at the HR player-season and tournament-season levels. All estimations include rank difference interactions, round FEs, tournament FEs, and HR player-season FEs. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

We affirm the previous results, validating our data. We find a significant adverse main effect of a superstar presence of 3.4 percentage points on the winning probabilities of HR players ranked in the top 20 (Star x HR: 1-20). In addition, we observe that this effect is even more pronounced when the player potentially faces a superstar in the next round (Next x HR: 1-20).[3] In contrast, there is a positive effect of superstar presence on the winning probability of HR players ranked outside of the top 50 (Star x HR: > 50). The probability of a player winning the match increases by 4.1 percentage points. However, the main effect does not significantly depend on a potential match against a superstar in

[3] Potentially facing a superstar in the next round is a sufficient condition for a superstar to still participate at the tournament.

the subsequent round (Next x HR: > 50). Our results suggest that the main effect of superstar presence on a mediocre HR player's winning probability (Star x HR: 21-50) is significantly negative; the potential for competition with a superstar in the subsequent round does not alter the observed effect. Finally, there is a significant positive HA effect (approximately 6 percentage points).

Column (2.2) presents the results of using the predictors shown in Equation (4) and the dependent variable of (Deutscher et al., 2023), i.e., the binary match outcome, which equals one if the HR player won the match. Coefficients related to the presence of (and potential matches against) superstars remain unchanged. However, we observe that the HA effect of HR players (HR: HA) decreases by almost 30% when adding other match- and player-specific characteristics, implying the risk of an omitted variable bias. In particular, there is a significant positive effect of an HR player playing on a familiar surface (HR: surface match): the player's winning probability increases by 6.3 percentage points. The effect is (in absolute terms) superior to the main effect of superstar presence. Moreover, we observe a small but significant negative jet lag effect (HR: time zones). Finally, the longer the match lasts, the lower the HR player's chances of winning. This is likely because HR players are driven by a desire to conclude the match as swiftly as possible to conserve resources.

Our main within-match performance analysis is as follows. We report the results obtained from estimating Equation (4) in Table 3. The dependent variables are HR players' serve (HR: serve) and return (HR: return) ratings.

Table 3 Superstar effect on higher-ranked players' in-game performance

	(3.1) HR: serve		(3.2) HR: return	
Star x HR: 1-20	-2.358**	(1.118)	-1.904	(1.571)
Next x HR: 1-20	-2.124*	(1.160)	-3.655*	(2.128)
Star x HR: 21-50	-2.913***	(1.084)	-1.883	(1.389)
Next x HR: 21-50	0.857	(1.457)	-0.406	(2.156)
Star x HR: > 50	2.577**	(1.263)	0.228	(1.803)
Next x HR: > 50	0.068	(2.391)	7.011**	(3.457)
HR: HA	2.742***	(0.727)	4.980***	(1.085)
LR: HA	1.007*	(0.603)	-0.529	(0.891)
HR: time zones	-0.353***	(0.082)	-0.167	(0.112)
LR: time zones	0.143*	(0.077)	0.204*	(0.106)
HR: surface match	2.930***	(0.578)	6.228***	(0.810)
LR: surface match	-1.943***	(0.495)	-1.354*	(0.716)
Duration	-0.096***	(0.008)	-0.358***	(0.012)
N	26,901		26,901	
r2	0.266		0.221	
r2_within	0.023		0.059	

Note: The dependent variables refer to the higher-ranked (HR) player's serve (HR: serve) and return rating (HR: return) on a match level. Every match is played by an HR and a lower-ranked (LR) player. A player has a home advantage (HA) if the match is played in his home country. The standard errors in parentheses are clustered at the HR player-season and tournament-season levels. All estimations include rank difference interactions, round FEs, tournament FEs, and HR player-season FEs. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Our analysis reveals several superstar effects. For the group of top 20 players, there is an adverse main effect of superstar presence (Star x HR: 1-20) on players' performance in dominant match situations; in column (3.1), a (top 20) HR player's serve rating is approximately 2 points lower than when no superstar is present. This effect is further accentuated when the player is likely pitted against a superstar competitor in the next round (Next x HR: 1-20). In such constellations, a top 20 HR player's performance in dominant match situations is reduced by approximately 2 points. In contrast, in nondominant match situations (Column 3.2), the estimated main effect (Star x HR: 1-20) is not significantly different from zero. However, the moderator effect (Next x HR: 1-20) is marginally significant, suggesting that the return performance (nondominant match situation) of the top 20 HR players decreases by approximately 4 points only if the next match may be against a superstar.

HR players ranked between positions 21-50 experience a 3-point decline in their serve rating when a superstar is present (Star x HR: 21-50). The main effect is not significantly

contingent on the possibility for a match with a superstar in the subsequent round (Next x HR: 21-50. Proxied by the player's return rating, the player's performance in nondominant match situations is not significantly affected by the superstar effect.

HR players ranked outside of the top 50 enjoy an increase of 3 points in their serve rating in the case of superstar presence, the main effect (Star x HR: > 50). It is estimated that competing against a superstar in the subsequent round (Next x HR: > 50) will not result in a notable alteration in the player's serve performance. However, it does increase performance in nondominant positions, proxied by the player's return rating.

Finally, we find that an HR player increases his performance in both dominant and nondominant match situations if he competes on his most familiar surface (HR: surface match). In addition, the estimated coefficients regarding surface familiarity are (in absolute terms) greater than the main effect of superstar presence, suggesting that the superstar effect is not the primary driver of HR players' within-game performance.

The second part of our analyses examines the superstar effect on situational LR players' performance. We rewrite Equation (4) such that we model the performance of LR player l competing against an HR player h in match m. In particular, we now use the LR player's serve and return ratings as dependent variables. Moreover, we exchange the LR player season fixed effects (LR_{lm}) and the player's ranking category (Cat_{klm}) accordingly. The results are presented in Table 4.

Table 4 Superstar effect on lower-ranked players' in-game performance

	(4.1) LR: serve		(4.2) LR: return	
Star x LR: 1-20	-0.930	(4.018)	-5.184	(5.757)
Next x LR: 1-20	-1.425	(3.695)	2.355	(5.393)
Star x LR: 21-50	-6.850***	(1.286)	-4.538**	(1.856)
Next x LR: 21-50	6.699***	(1.705)	4.556*	(2.382)
Star x LR: > 50	-0.785	(1.045)	-0.039	(1.372)
Next x LR: > 50	-1.000	(1.491)	1.548	(1.985)
HR: HA	-1.452*	(0.781)	-5.702***	(1.079)
LR: HA	3.868***	(0.841)	1.894	(1.167)
HR: time zones	0.172*	(0.088)	0.020	(0.127)
LR: time zones	-0.257***	(0.091)	-0.051	(0.128)
HR: surface match	-2.864***	(0.586)	-2.336***	(0.770)
LR: surface match	2.677***	(0.674)	4.802***	(0.935)
Duration	0.244***	(0.009)	0.144***	(0.012)
N	26,307		26,307	
r2	0.309		0.209	
r2_within	0.054		0.020	

Note: The dependent variables refer to the lower-ranked (LR) player's serve (LR: serve) and return rating (LR: return) on a match level. Every match is played by a higher-ranked (HR) and LR player. A player has a home advantage (HA) if the match is played in his home country. The standard errors in parentheses are clustered at the LR player-season and tournament-season levels. All estimations include rank difference interactions, round FEs, and LR player-season FEs. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The single most surprising finding to emerge from Table 4 relates to an asymmetric effect of the timing of potentially facing a superstar on the performance of LR players ranked between positions 21-50. In particular, there is a significant negative superstar effect on both the player's serve performance and return performance (Star x LR: 21-50). Interestingly, we find that potentially facing a superstar in the subsequent round (Next x LR: 21-50) approximately absorbs the estimated main effect; the player's serve [return] performance increases by 7 [5] points. Like HR players, LR players appear to benefit on both their serve and return if playing on the most familiar surface, suggesting a performance-enhancing effect of competing in a known environment. In contrast, those effects are smaller than the main effect of superstar participation in a tournament round.

Similar to (Deutscher et al., 2023), we perform robustness checks using an expanded sample comprising Grand Slam events and both Master 1000 events (Miami and Indian

Wells). In addition, we rerun the core results and report standard errors clustered at different levels. The corresponding results are presented in the Appendix (Section 2) and corroborate our findings.

5 Conclusion

This study investigates the superstar-induced performance shifts of players in different within-match situations using data from men's professional tennis from 2004 to 2019. Given the distinctive attributes of tennis, we innovate by examining the influence of tennis superstars on both HR and LR players' serve and return ratings to proxy players' performance in dominant and nondominant match situations.

We provide evidence that HR players deliberately adjust their performance given specific (non)dominant match situations due to superstar participation in a tournament rather than dispersing effort across all match situations indiscriminately. In contrast, while we observe that superstar-induced changes in LR players' performance vary across rank groups, their shifts in performance are not different across match situations. Finally, while superior for LR players in absolute terms, the main effect of superstar participation on HR players' situational performance is inferior to, for example, the impact of surface familiarity.

We reaffirm previous results by (Deutscher et al., 2023) for HR players, suggesting that the three rank groups experience different superstar-induced performance shifts. However, we find that HR players only modify their performance in match situations in which they are in dominant positions if there is no direct threat of facing a superstar in the subsequent round. Our findings suggest that performance in nondominant game scenarios is impacted, if at all, when a HR player might face a superstar in the next round. This highlights the strategic behavior of HR players: the players are strategically planning, such as modifying their actions to maintain their physical condition. Finally, while our results indicate that LR players' various rank groupings differ in the degree to which superstars affect their performance, we do not find that these differences extend to different match scenarios.

The general discrepancy regarding the superstar-induced performance shifts of HR and LR players is likely explained by the fact that HR players have more experience than their LR opponents do. The HR player is usually perceived as the favorite in a match. Compared with LR players, it is reasonable to assume that HR players possess a more qualified understanding of match dynamics and have instruments that allow them to consciously dispense situational performance based on match situations.

We acknowledge that the use of the ATP serve and return ratings, while innovative, presents inherent limitations that warrant careful consideration. The ratings are tennis-specific indicators and extrapolating these findings to other sports and tournament settings must be approached with caution to avoid overgeneralization and misinterpretation. Despite its limitations, this study certainly adds to our understanding of superstar-induced changes in situational performance, connecting to, e.g., (Lackner, 2023; McFall & Rotthoff, 2020). Finally, the nuanced ATP serve and return performance ratings (and similar in-match indicators from other sports) may lay the foundation for further research regarding sports economic phenomena such as panicking and chocking (e.g., (Böheim et al., 2019; Cohen-Zada et al., 2017, 2018)).

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The Superstar Effect in Tennis – A within-match analysis

Appendix

1 Introduction

The Appendix contains additional robustness tests that were not included in the main text.

2 Robustness tests

2.1 Including additional tournaments

The Grand Slam tournaments and the two annual ATP Masters 1000 events in Indian Wells and Miami were excluded from the study due to concerns regarding self-selection and structural differences in the competitions. In particular, the three tournaments feature seven rounds of competition. Furthermore, at least one superstar participated in every Grand Slam tournament during the period between 2004 and 2019.

Table A1 presents the results corresponding to Table 3 in the main text. The majority of the coefficient estimates exhibit minimal change, thereby reinforcing the findings presented in Table 3 (main text). However, we observe that the coefficient estimates for higher-ranked (HR) players ranked outside the top 50 become statistically insignificant when additional tournaments are incorporated.

Table A2 shows the results corresponding to Table 4 in the main text. A comparison of the two tables reveals that some coefficient estimates in Table A2 differ in size. However, the general pattern aligns with our discussion presented in the main text.

Table A1 Superstar effect on higher-ranked players' in-game performance, including additional tournaments

	(1) HR: serve		(2) HR: return	
Star x HR: 1-20	-1.962**	(0.989)	-1.075	(1.344)
Next x HR: 1-20	-2.231**	(0.937)	-4.566***	(1.611)
Star x HR: 21-50	-2.621***	(0.935)	-1.517	(1.266)
Next x HR: 21-50	1.027	(1.001)	-0.598	(1.573)
Star x HR: > 50	0.730	(1.025)	1.450	(1.532)
Next x HR: > 50	-0.334	(1.669)	2.678	(2.456)
HR: HA	2.962***	(0.639)	5.602***	(0.914)
LR: HA	0.891	(0.542)	-1.320*	(0.779)
HR: time zones	-0.340***	(0.069)	-0.155	(0.099)
LR: time zones	0.152**	(0.067)	0.202**	(0.089)
HR: surface match	3.256***	(0.483)	5.047***	(0.699)
LR: surface match	-1.973***	(0.411)	-1.539***	(0.589)
Duration	-0.096***	(0.007)	-0.318***	(0.010)
N	36,083		36,083	
r2	0.271		0.211	
r2_within	0.025		0.062	

Note: The dependent variables refer to the higher-ranked (HR) player's serve (HR: serve) and return rating (HR: return) on a match level. Every match is played by an HR and a lower-ranked (LR) player. A player has a home advantage (HA) if the match is played in his home country. The standard errors in parentheses are clustered at the HR player-season and tournament-season levels. All estimations include rank difference interactions, round FEs, tournament FEs, and HR player-season FEs. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A2 Superstar effect on lower-ranked players' in-game performance, including additional tournaments

	(1) LR: serve		(2) LR: return	
Star x LR: 1-20	-3.107	(3.299)	-6.473	(4.444)
Next x LR: 1-20	0.131	(2.833)	2.032	(3.935)
Star x LR: 21-50	-6.443***	(1.203)	-3.760**	(1.679)
Next x LR: 21-50	3.815***	(1.385)	4.261**	(1.846)
Star x LR: > 50	-1.399	(0.993)	-0.368	(1.250)
Next x LR: > 50	1.177	(0.978)	2.447*	(1.307)
HR: HA	-0.413	(0.681)	-6.092***	(0.921)
LR: HA	3.684***	(0.703)	2.582***	(0.991)
HR: time zones	0.137*	(0.077)	0.024	(0.109)
LR: time zones	-0.187**	(0.076)	-0.107	(0.107)
HR: surface match	-2.156***	(0.489)	-2.853***	(0.612)
LR: surface match	2.870***	(0.554)	4.521***	(0.724)
Duration	0.230***	(0.007)	0.157***	(0.009)
N	35,492		35,492	
r2	0.295		0.189	
r2_within	0.061		0.025	

Note: The dependent variables refer to the lower-ranked (LR) player's serve (LR: serve) and return rating (LR: return) on a match level. Every match is played by a higher-ranked (HR) and LR player. A player has a home advantage (HA) if the match is played in his home country. The standard errors in parentheses are clustered at the LR player-season and tournament-season levels. All estimations include rank difference interactions, round FEs, and LR player-season FEs.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

2.2 Standard errors clustered at different levels

Tables A3 and A4 present the results corresponding to Table 3 and Table 4 in the main text. The results remain unchanged when different error term structures are assumed and the standard errors are clustered accordingly.

Table A3 Superstar effect on higher-ranked players' in-game performance, clustering standard errors at different levels

	(1) HR: serve	(2) HR: serve	(3) HR: serve	(4) HR: return	(5) HR: return	(6) HR: return
Star x HR: 1-20	-2.358**	-2.358**	-2.358**	-1.904	-1.904	-1.904
	(1.035)	(1.079)	(1.129)	(1.568)	(1.492)	(1.570)
Next x HR: 1-20	-2.124*	-2.124*	-2.124*	-3.655*	-3.655*	-3.655*
	(1.242)	(1.248)	(1.221)	(2.130)	(2.117)	(2.125)
Star x HR: 21-50	-2.913***	-2.913***	-2.913***	-1.883	-1.883	-1.883
	(1.082)	(1.018)	(1.095)	(1.395)	(1.426)	(1.356)
Next x HR: 21-50	0.857	0.857	0.857	-0.406	-0.406	-0.406
	(1.504)	(1.445)	(1.443)	(2.133)	(2.246)	(2.137)
Star x HR: > 50	2.577**	2.577**	2.577**	0.228	0.228	0.228
	(1.236)	(1.232)	(1.259)	(1.815)	(1.824)	(1.791)
Next x HR: > 50	0.068	0.068	0.068	7.011*	7.011**	7.011**
	(2.407)	(2.389)	(2.344)	(3.633)	(3.523)	(3.459)
HR: HA	2.742***	2.742***	2.742***	4.980***	4.980***	4.980***
	(0.739)	(0.724)	(0.745)	(1.090)	(1.071)	(1.099)
LR: HA	1.007*	1.007*	1.007	-0.529	-0.529	-0.529
	(0.610)	(0.586)	(0.635)	(0.867)	(0.896)	(0.936)
HR: time zones	-0.353***	-0.353***	-0.353***	-0.167	-0.167	-0.167
	(0.081)	(0.080)	(0.081)	(0.112)	(0.112)	(0.112)
LR: time zones	0.143*	0.143**	0.143*	0.204**	0.204*	0.204*
	(0.077)	(0.072)	(0.077)	(0.103)	(0.107)	(0.108)
HR: surface match	2.930***	2.930***	2.930***	6.228***	6.228***	6.228***
	(0.560)	(0.557)	(0.574)	(0.800)	(0.789)	(0.813)
LR: surface match	-1.943***	-1.943***	-1.943***	-1.354**	-1.354*	-1.354*
	(0.512)	(0.482)	(0.531)	(0.682)	(0.749)	(0.757)
Duration	-0.096***	-0.096***	-0.096***	-0.358***	-0.358***	-0.358***
	(0.007)	(0.008)	(0.008)	(0.012)	(0.011)	(0.012)
Clustering levels:						
HR player-season	Yes	No	Yes	Yes	No	Yes
LR player-season	No	Yes	Yes	No	Yes	Yes
Tournament-season	No	No	Yes	No	No	Yes
N	26,901	26,901	26,901	26,901	26,901	26,901
r2	0.266	0.266	0.266	0.221	0.221	0.221
r2_within	0.023	0.023	0.023	0.059	0.059	0.059

Note: The dependent variables refer to the higher-ranked (HR) player's serve (HR: serve) and return rating (HR: return) on a match level. Every match is played by an HR and a lower-ranked (LR) player. A player has a home advantage (HA) if the match is played in his home country. The standard errors are in parentheses. All estimations include rank difference interactions, round FEs, tournament FEs, and HR player-season FEs. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A4 Superstar effect on lower-ranked players' in-game performance, clustering standard errors at different levels

	(1) LR: serve	(2) LR: serve	(3) LR: serve	(4) LR: return	(5) LR: return	(6) LR: return
Star x LR: 1-20	-0.930	-0.930	-0.930	-5.184	-5.184	-5.184
	(4.026)	(3.814)	(4.318)	(5.539)	(5.496)	(5.842)
Next x LR: 1-20	-1.425	-1.425	-1.425	2.355	2.355	2.355
	(3.757)	(3.589)	(3.771)	(5.268)	(5.130)	(5.726)
Star x LR: 21-50	-6.850***	-6.850***	-6.850***	-4.538**	-4.538**	-4.538**
	(1.288)	(1.332)	(1.299)	(1.881)	(1.872)	(1.873)
Next x LR: 21-50	6.699***	6.699***	6.699***	4.556*	4.556*	4.556*
	(1.651)	(1.824)	(1.824)	(2.367)	(2.457)	(2.431)
Star x LR: > 50	-0.785	-0.785	-0.785	-0.039	-0.039	-0.039
	(0.991)	(1.020)	(1.015)	(1.408)	(1.308)	(1.356)
Next x LR: > 50	-1.000	-1.000	-1.000	1.548	1.548	1.548
	(1.450)	(1.498)	(1.522)	(1.962)	(2.034)	(1.988)
HR: HA	-1.452*	-1.452*	-1.452*	-5.702***	-5.702***	-5.702***
	(0.742)	(0.789)	(0.830)	(1.074)	(1.100)	(1.156)
LR: HA	3.868***	3.868***	3.868***	1.894	1.894*	1.894
	(0.812)	(0.803)	(0.840)	(1.158)	(1.100)	(1.156)
HR: time zones	0.172**	0.172*	0.172**	0.020	0.020	0.020
	(0.086)	(0.089)	(0.087)	(0.122)	(0.128)	(0.128)
LR: time zones	-0.257***	-0.257***	-0.257***	-0.051	-0.051	-0.051
	(0.089)	(0.087)	(0.092)	(0.127)	(0.121)	(0.128)
HR: surface match	-2.864***	-2.864***	-2.864***	-2.336***	-2.336***	-2.336***
	(0.543)	(0.591)	(0.621)	(0.776)	(0.775)	(0.795)
LR: surface match	2.677***	2.677***	2.677***	4.802***	4.802***	4.802***
	(0.662)	(0.630)	(0.661)	(0.942)	(0.867)	(0.911)
Duration	0.244***	0.244***	0.244***	0.144***	0.144***	0.144***
	(0.009)	(0.008)	(0.009)	(0.012)	(0.012)	(0.013)
Clustering levels:						
HR player-season	No	No	Yes	No	No	Yes
LR player-season	Yes	No	Yes	Yes	No	Yes
Tournament-season	No	Yes	Yes	No	Yes	Yes
N	26,307	26,307	26,307	26,307	26,307	26,307
r2	0.309	0.309	0.309	0.209	0.209	0.209
r2_within	0.054	0.054	0.054	0.020	0.020	0.020

Note: The dependent variables refer to the lower-ranked (LR) player's serve (LR: serve) and return rating (LR: return) on a match level. Every match is played by a higher-ranked (HR) and LR player. A player has a home advantage (HA) if the match is played in his home country. The standard errors are in parentheses. All estimations include rank difference interactions, round FEs, and LR player-season FEs. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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