



# Performance Under Pressure in the NBA

Zheng Cao<sup>1</sup>, Joseph Price<sup>2</sup>, and Daniel F. Stone<sup>1</sup>

## Abstract

The authors analyze the effects of psychological pressure on performance using National Basketball Association (NBA) free throw data from the 2002-2003 through 2009-2010 seasons. The authors find evidence that players choke under pressure—they shoot on average 5–10 percentage points worse than normal in the final seconds of very close games. Choking is more likely for players who are worse overall free throw shooters, and on the second shot of a pair after the first shot is missed. In general, performance declines as pressure increases (as game time remaining decreases, and as the score margin decreases, whether the shooter's team is winning or losing). However, the authors find no evidence of choking when games are tied in the final 15 seconds. The authors also fail to find evidence of performance under pressure being affected by home status, attendance, and whether or not the game is in the playoffs.

## Keywords

choking, anxiety, pressure, clutch, NBA

## Introduction

Neoclassical economic theory predicts that individuals exert the most effort, and consequently produce their best performances, when the returns to effort are highest. Folk wisdom and common sense suggest something different: when performance matters most, individuals feel psychological pressure, and as a result often make

---

<sup>1</sup> Department of Economics, Oregon State University, Corvallis, OR, USA

<sup>2</sup> Department of Economics, Brigham Young University, Provo, UT, USA

## Corresponding Author:

Daniel F. Stone, Department of Economics, Oregon State University, 303 Ballard Extension Hall, Corvallis, OR 97331, USA

Email: [dan.stone@oregonstate.edu](mailto:dan.stone@oregonstate.edu)

uncharacteristic mistakes (i.e., “choke”), but sometimes rise to the occasion in the clutch. The degree to which experienced professionals choke or perform well in the clutch and the factors causing or mitigating either type of behavior are empirical issues that are still not fully understood.<sup>1</sup>

In this paper, we analyze performance under pressure using free throw data from the National Basketball Association (NBA). Pressure and the potential for choking arise in all sports and many contexts outside of sports as well.<sup>2</sup> The basketball variable free throw percentage is a measure of performance that is especially well suited for the empirical analysis of choking for several reasons. First, each free throw attempt is taken from the same distance and location, so the physical difficulty of each shot is constant (as opposed to basketball field goal attempts or say, golf putts, which are taken from varying locations). Second, free throws are undefended, and so observed changes in performance are not confounded by simultaneous changes in offensive and defensive player behavior (in contrast to, e.g., soccer penalty kicks). Third, free throws occur very frequently—most players shoot over 100 in each season. This allows us to control carefully for the substantial heterogeneity across players in free throw shooting ability. Fourth, since most close games involve at least a few free throws being shot in the final seconds or minute, we have access to the sample size necessary to obtain reasonably precise estimates of how performance changes as a function of time remaining in the game and score difference. Finally, shooting a free throw is a fairly easy, but still nontrivial, task for most NBA players (as opposed to, say, the trivial task of kicking an extra point in American football), so *a priori* it seems highly plausible that psychological factors may affect performance.

We find that NBA players do indeed choke, but not too badly. In fact, they are fairly immune to factors that we hypothesized may cause anxiety throughout games. In the first three quarters of games, being the home team has a statistically significant but very small (less than half a percentage point) positive effect, playoff status has no effect, and attendance has a significant, but also small effect (free throw percentage decreases by just over 1 percentage point when attendance increases by 10,000) for both home and away players. The score difference and time of shot have small and usually insignificant effects.

When the shot is taken at the very end of a close game, and thus is much more likely to change the game's outcome, the story is different. We find that expected free throw percentage declines by around 4 percentage points when the shooter's team is down by 1 or 2 points and the shot is taken in a game's final minute. The magnitude of the decline increases to 6.3 and 8.8 in the last 15 seconds, when down 2 and 1 points, respectively. There are also significant choking effects for players whose teams are up by 1 or 2 points, but they are substantially stronger for the second shot, when pressure is likely higher.<sup>3</sup> Surprisingly, given these other results, we find that performance does not decline at all in the last 15 seconds when the score is tied.

We find that these choking effects are considerably larger for players who are worse free throw shooters in general. Since it is natural to think that these shooters are less confident in their abilities, we interpret this result to support the theory that

self-confidence moderates and potentially eliminates anxiety and choking. This result may also simply be due to the magnitude of choking being an increasing function of the variance of the outcome variable. We also find that choking declines when the previous free throw was made and increases when the previous shot was missed, which provides further support for the importance of confidence, since making the first free throw likely improves confidence.<sup>4</sup> We find that the effects of other variables that may be thought to affect the degree of choking in games' final seconds (experience, home and playoff status, and attendance) are minimal and mostly insignificant.

## Theory and Related Literature

The topic of choking under pressure has received substantial attention from the psychology literature. Hilla, Hantonb, Matthews, and Fleming (2010), a recent review, say that most of the literature defines choking (at least implicitly) as "any inferior performance under pressure."<sup>5</sup> We attempt to use this basic definition, which raises two questions: (a) What causes pressure? (b) Inferior performance as compared to what? Regarding the former, it is natural to think that pressure increases as the probability that the performance will affect which team wins the game increases, which occurs as both the score difference and the time remaining in the game decrease. Hilla et al. also discuss what they refer to as possible moderators of choking, including presence of an audience, whether that audience is supportive or not, self-confidence, and skill level.<sup>6</sup> The answer to the second question is less straightforward, since it is not clear that pressure and performance have even a monotone relationship. Hilla et al. discuss the upside-down U curve theory of this relation: that increasing pressure first causes performance to improve, then decline. We take this into consideration in our empirical analysis.

Many of the papers cited by Hilla et al. (2010) use experimental data from controlled settings; one advantage of our paper is that we use nonexperimental data.<sup>7</sup> The size of our data set (discussed further below) also provides us with greater statistical power than that of many experimental studies. One especially closely related psychology paper is Worthy, Markman, and Maddox (2009), which also analyzes NBA free throw performance and uses a fairly large data set. Their results are fairly similar to some of ours, in that we both find performance worsens when the shooter's team is down by 1 or 2 points, or up 1 point with less than 1 minute remaining, but not when tied. However, there are numerous differences between our papers. We use a sample from eight seasons, while their sample only comes from one season, and we use a different empirical strategy. We also examine several issues outside of their scope, including pressure effects throughout the game, how the effects change as time remaining decreases during the last minute and depending on whether the shot is the first or last of the set, and how the effects vary for players with different characteristics.

There is a limited but growing economics literature on choking. Ariely, Gneezy, Loewenstein, and Mazar (2009) analyze experiments showing that individuals perform worse when stakes are higher, and Bannier and Feess (2010) and Ruah and Seccia (2010) study theoretical models that incorporate anxiety and choking. Dohmen (2008) is one of the few economics papers that uses nonexperimental data to study choking.<sup>8</sup> Dohmen uses penalty kick data from the German Premier football league over 40 seasons. He finds that while being the home team is associated with an approximately two conversion percentage point decline, neither the score difference at the time of the shot nor attendance has significant effect on performance. Our results differ in that we find that being the home team has a very small *positive* effect on performance, while score differences can have negative effects of larger magnitude. One reason being the home team may be more of an advantage in the free throw setting is that home fans may be able to distract shooters from the away team more in basketball than soccer. One reason Dohmen may not have found that choking increased when the score was closer was that his data set may not have included a sufficient number of observations from the very final seconds of games. On the other hand, each penalty kick is much more important than most individual free throws, since scoring occurs much less frequently in soccer than basketball, which should mitigate the importance of time remaining on pressure.

## Data and Empirical Strategy

We use play-by-play data from the 2002-2003 through 2009-2010 seasons obtained from ESPN.com. We use a play-level, rather than game-level, data set because it allows us to observe the time in the game at which the various shots were taken and the score difference at the time of the shots. We convert the play-by-play data to a free throw attempt-level data set with nearly 500,000 observations; however, the vast majority are shots taken throughout the game that are unlikely to directly cause the shooter's team to win or lose, and so pressure likely does not vary substantially across most of the observations. Summary statistics are presented in Table 1 and graphically in Figure 1 (all variables referred to are defined below).<sup>9</sup> We have over 700 and over 900 observations with the shooter's team losing by less than 5 points with 16–30 and 0–15 seconds remaining in the fourth quarter or overtime, respectively.<sup>10</sup> The table and figure also provide a preview of our econometric results, as they both show performance clearly declines as the score margin and game time remaining decrease in the final minute of games. Both indicate that choking is greater when teams are losing rather than winning (by the same margin), and Figure 1 indicates a lack of choking in the second to last minute of games, and that choking does not occur when the score is tied in the final 15 seconds.

There are two more subtle observations we can make from Figure 1. One is that since the major decline in “Actual” performance from “Normal” occurs only when the score is very close and in the last 30 seconds, this indicates that fatigue cannot be

**Table 1. Summary Statistics**

	$t > 60$			$30 < t \leq 60$			$15 < t \leq 30$			$t \leq 15$		
	M	SE	N	M	SE	N	M	SE	N	M	SE	N
	A: Summary statistics for <i>FreeThrowMade</i>											
<i>Home = 1</i>												
<i>Down_4</i>	0.750	0.002	35,323	0.769	0.017	585	0.739	0.024	341	0.729	0.021	468
<i>Up0_4</i>	0.750	0.002	48,831	0.755	0.015	867	0.774	0.011	1,524	0.778	0.008	3,007
<i>Other</i>	0.752	0.001	135,517	0.774	0.006	4,423	0.779	0.007	3,298	0.780	0.008	2,431
<i>Home = 0</i>												
<i>Down_4</i>	0.751	0.002	36,632	0.738	0.017	682	0.756	0.022	386	0.722	0.021	454
<i>Up0_4</i>	0.751	0.002	42,503	0.728	0.016	767	0.776	0.012	1,128	0.791	0.008	2,498
<i>Other</i>	0.750	0.001	131,434	0.760	0.006	4,546	0.779	0.008	2,876	0.771	0.009	2,079
<i>Playoff = 1</i>												
<i>Down_4</i>	0.742	0.007	4,447	0.816	0.042	87	0.830	0.052	53	0.687	0.057	67
<i>Up0_4</i>	0.744	0.006	5,741	0.738	0.047	88	0.735	0.035	162	0.755	0.022	376
<i>Other</i>	0.753	0.003	17,357	0.765	0.016	686	0.770	0.023	330	0.728	0.026	301
B: Summary statistics for other variables												
<i>FTPct</i>												
<i>Down_4</i>	0.752	0.000	76,402	0.771	0.002	1,354	0.772	0.003	780	0.779	0.003	989
<i>Up0_4</i>	0.751	0.000	97,075	0.765	0.002	1,722	0.793	0.001	2,814	0.795	0.001	5,881
<i>Other</i>	0.751	0.000	284,308	0.762	0.001	9,655	0.778	0.001	6,504	0.782	0.001	4,811
<i>Exper</i>												
<i>Down_4</i>	5.201	0.013	76,402	5.375	0.094	1,354	5.031	0.123	780	5.332	0.114	989
<i>Up0_4</i>	5.234	0.012	97,075	5.382	0.085	1,722	5.550	0.066	2,814	5.473	0.047	5,881
<i>Other</i>	4.997	0.007	284,308	4.758	0.037	9,655	4.908	0.045	6,504	4.928	0.052	4,811
<i>Atts</i>												
<i>Down_4</i>	3.763	0.009	76,402	4.281	0.070	1,354	4.139	0.087	780	4.182	0.086	989
<i>Up0_4</i>	3.808	0.008	97,075	3.926	0.061	1,722	3.702	0.045	2,814	3.648	0.031	5,881
<i>Other</i>	3.586	0.005	284,308	3.193	0.025	9,655	3.098	0.028	6,504	3.159	0.033	4,811
<i>PAtts</i>												
<i>Down_4</i>	2.822	0.013	76,402	5.756	0.108	1,354	5.609	0.136	780	5.657	0.125	989
<i>Up0_4</i>	2.816	0.011	97,075	3.686	0.097	1,722	3.460	0.074	2,814	3.243	0.049	5,881
<i>Other</i>	2.625	0.006	284,308	2.517	0.035	9,655	2.514	0.041	6,504	2.592	0.053	4,811

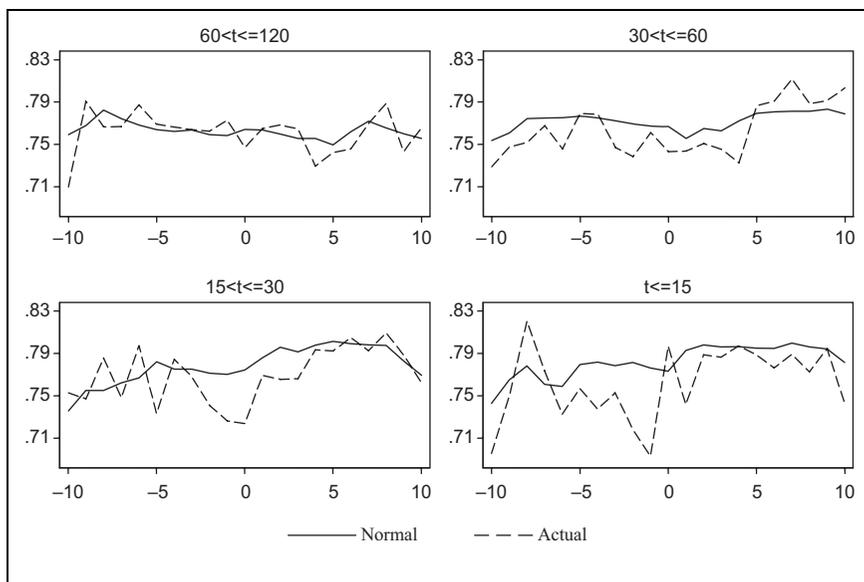
Note. The first two sections of panel A (*Home = 1* and *Home = 0*) give the statistics for regular season games only. Observations for *OneShot*, second and third shot with team losing by 2 or 3 points and time remaining is less than 6 seconds are dropped. *t* = seconds remaining in fourth quarter or overtime.

the main factor driving the decline. It is implausible that the players' physical condition changes substantially in the final 30 seconds, as compared to the previous 30 seconds. The second observation in the figure shows better overall shooters are more likely to be selected to shoot when the shooter's team is winning by at least 1 point, as compared to when his team is tied or losing, in the last 30 seconds. The "Normal" plot for the bottom figures, which represents the overall free throw percentage of players shooting for each score difference, is approximately flat for score differences between  $-5$  and  $0$ , and also for score differences between  $1$  and  $5$ . But the plot jumps when the difference increases from  $0$  to  $1$  (the jump is less pronounced when there are 16–30 seconds remaining). This likely reflects the fact that teams that are winning in the final seconds know they are likely to be fouled, and as a result attempt to give the ball to their players known to be relatively good shooters, and perhaps even players thought to perform especially well under pressure. This may bias our estimates of choking toward zero for situations in which the shooter's team is winning in the final 30 seconds.

Our empirical strategy is to use linear probability models to estimate the effects of several variables that may be associated with pressure on a binary dependent variable that equals 1 if the free throw is made (*FreeThrowMade*). We use player-season fixed effects, which means our estimates should be interpreted as deviations from player-season means and should eliminate many possible selection biases (as discussed just above, shooters who are better—or worse—on average may be more likely to get fouled in certain situations).<sup>11</sup> However, our results may still be affected by changes in the composition of shooters in different situations. We discuss this further below in this section. We also include quarter dummies and dummies for whether the shot was from a one-shot set (*OneShot*, which usually occurs when the player was fouled during a successful field goal attempt), and whether the previous free throw was made (*PrevMade*) and whether it was missed (*PrevMiss*) for the second or third free throw of a set, as controls (see Arkes, 2010).

We use linear models rather than logit or probit because most of our estimates of interest are coefficients on interaction terms, which are difficult to interpret for non-linear models (Ai and Norton, 2003). It is well known that the linear probability model generally yields results that are very similar to those of logit and probit, especially for dependent variables whose means are not too close to 0 or 1 (see, e.g., Angrist & Pischke, 2009), and we have confirmed that results are very similar when we use logit and calculate marginal effects using the methods of Ai and Norton (2003) and Cornelissen and Sonderhof (2009).<sup>12</sup>

We first estimate the effects of several variables, including home/playoff status (*Home* and *Playoff*); attendance (*Attend*), and score differences (*Up1*, *Down1*, *Up2*, ...) on performance in the first three quarters of games, to examine the effects of factors that may affect anxiety throughout games. We drop the fourth quarter to ensure that our results are not affected by end-of-game effects. The theoretical effect of home status on performance here is ambiguous, as players may benefit from the support of fans at home and be harmed by distractions created by fans on the road,



**Figure 1.** Comparison of free throw percentage in high (“Actual”) and low (“Normal”) pressure situations.

*Note.*  $t$  = seconds remaining in fourth quarter or overtime; X-axis = score difference (shooter’s team’s score minus opponent’s score, prior to shot); Normal = mean *FTPct* (free throw percentage for the shooter in nonpressure situations); Actual = mean *FreeThrowMade* (percentage of shots made for given pressure situation—score difference/time remaining).

but may also feel more pressure to please home fans. Clearly, playoff games and games with higher attendance levels should involve higher pressure, even in the first three quarters. Smaller score differences should involve higher pressure, but the differences may not be substantial, since in the first three quarters of a game it is highly unlikely that any single free throw will affect the game’s outcome (and it is almost certain that fans and analysts will not attribute the game’s outcome to a free throw taken before the fourth quarter).

We then analyze how the effects of the score difference variables may change in the final seconds when the game’s outcome is on the line. To do this, we interact dummies for various score differences with dummy variables for whether there is less than 60/30/15 seconds (*Last60*, *Last30*, and *Last15*) left in the game (fourth quarter or overtime). We use interactions so that we can include the *Last* variables separately to control for fatigue and other changes that may result at the end of games for reasons other than pressure. We use dummy variables for different amounts of time remaining to transparently allow for a nonlinear relation between score difference and pressure. We focus on the last minute since, as shown in Figure 1, there is little evidence of choking with greater than one minute remaining.

We also estimate coefficients on a number of triple-interaction terms involving score difference, the *Last* variables, and other variables. This allows us to gain insight into the importance of various factors that may affect responses to pressure, both internal (i.e., inside a player's head) and external. First, we look at interactions with *FinalShot*, a dummy for whether the free throw is the last of its set (usually second of two). In many situations, the pressure will be higher when the shooter is down to his last shot. For example, if the shooter's team is up 1 point, then there is a large benefit to hitting one shot, since that puts his team up by a field goal.

We also examine interactions with shooter characteristics: free throw percentage for the season for shots taken with more than 1 minute remaining in the fourth quarter or overtime (*FTPct*<sup>13</sup>), years of experience (*Exper*), number of attempts per game for the season (*Atts*), and number of attempts for the season in pressure situations (*PrAtts*), defined as attempts in the final minute when the shooter's team is tied or losing by up to 4 points. These interactions allow us to analyze the types of players who are more or less likely to choke. The natural hypothesis is that free throw shooting ability, years of experience, and free throw shooting experience are internal factors that would be positively associated with "mental strength" and thus better performance under pressure.<sup>14</sup>

The estimate for *PrAtts* may be most difficult to interpret. The variable is intended to proxy experience shooting free throws in high pressure situations. If its coefficient is positive, this could be caused by selection (players known to be better in the clutch may be given the ball more often in pressure situations) or could indicate that greater experience in the clutch causes clutch performance to improve. Thus, if we find the estimate is positive, it is not clear which of these factors would be responsible. On the other hand, if we find the estimate is insignificant, we could view this as evidence that selection does not substantially affect our overall results, at least for situations in which the shooter's team is losing or tied. When constructing our measure of previous shots, we exclude situations in which the shooter's team is winning by a small number of points because selection effects are likely more severe in those situations, since the shot is much more likely to be due to a strategically committed foul.

We use interactions with *Home*, *Playoff*, and *Attend*, which all would be positively associated with pressure, to examine the importance of these external factors. We also look at interactions with *PrevMade* and *PrevMiss*, which are likely more appropriately classified as internal factors, since conditional on other variables (score, time remaining, etc.) they primarily affect a player's mind-set. If we find performance improves when *PrevMade* = 1, and declines when *PrevMiss* = 1 (in high pressure situations, relative to regular situations), this would indicate confidence is affected by the outcome of the initial shots, which in turn affects performance on the later shots.

To elaborate on the potential sample selection issue alluded to just above—that teams may feed the ball to players thought to perform best in the clutch—this may not be too serious a concern since basketball teams tend to just give the ball to their

best shooters in the most crucial situations and not necessarily the players thought to be best in the clutch relative to their regular performance. However, if selection affects our results, it would likely bias our estimates of performance under pressure upward, since the shooting team usually has more control over the foul shooter than the defending team. We should thus view our estimates as conservative estimates of the amount of choking that occurs.<sup>15</sup>

The coefficient on each score dummy can be interpreted as the difference between expected free throw percentage when that dummy equals 1, and the expectation conditional on the score difference being in the omitted category. Thus, the definition of the omitted category affects the interpretation of the results. To make results as transparent as possible, we present results with two “baselines” (omitted categories): (a) down or up by 11+ points (11+ baseline) and (b) down or up by 5 to 10 points (5–10 baseline). The 11+ baseline is intended to capture the lowest pressure situations and the 5–10 baseline represents medium pressure situations. We combine situations in which a team is either winning or losing by the same range of points for each baseline because pressure, as determined by the expected effect of the shot on game outcome, should be similar in both cases. This approach enables us to easily allow for a nonlinear (e.g., inverse-U) relation between pressure and performance. The approach also allows us to test whether performance changes significantly when the score is very close as compared to both baselines (if we just used the 11+ baseline, we would have to use *F* tests to test the difference between estimates for small score margins and margins of 5–10 points) and to check that our results are not driven by changes in the composition of players that occur when the score difference takes different values.<sup>16</sup>

## Results

Table 2 presents results for the analysis of the first three quarters. This analysis roughly parallels that of Dohmen (2008), who focused on the determinants of choking throughout games. The magnitude of the coefficients on the score difference are less than or equal to 1% and mostly insignificant, so we do not report them. There is a small positive effect to being the home team and small negative effect of higher attendance, both of which are only significant when the data from all three quarters are pooled. The attendance effect is not significantly different for home or away teams, and playoff status does not have an economically or statistically significant effect. The estimates are generally similar for each of the first three quarters. Almost all of the effects are not significantly affected by player characteristics, but there is some evidence that the playoff effect is increasing in overall shooting percentage, but decreasing in player experience (the coefficient on *Playoff* × *FTPct* is positive and significant at 10%, and on *Playoff* × *Exper* is negative and significant). The former is consistent with more confident players choking less in higher pressure situations, but the latter result is difficult to explain.

**Table 2.** Analysis of Quarters 1–3

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Quarter 1	Quarter 2	Quarter 3	Quarter 1–3	Quarter 1	Quarter 2	Quarter 3	Quarter 1–3
Home	0.002 (0.003)	0.004 (0.003)	0.005 (0.003)	0.004*** (0.002)	-0.034 (0.027)	0.026 (0.024)	0.003 (0.024)	0.001 (0.014)
Home × FTPct					0.052 (0.035)	-0.039 (0.032)	0.016 (0.031)	0.007 (0.019)
Home × Exper					0.000 (0.001)	-0.000 (0.001)	-0.001* (0.001)	-0.001 (0.000)
Home × Atts					-0.001 (0.001)	0.003** (0.001)	-0.001 (0.001)	0.000 (0.001)
Attend	-0.013 (0.009)	-0.012 (0.008)	-0.008 (0.008)	-0.012*** (0.005)	-0.008 (0.072)	-0.016 (0.063)	-0.099 (0.060)	-0.044 (0.038)
Attend × FTPct					0.023 (0.096)	-0.024 (0.084)	0.133* (0.080)	0.045 (0.050)
Attend × Exper					-0.003 (0.002)	0.004* (0.002)	-0.002 (0.002)	-0.000 (0.001)
Attend × Atts					-0.002 (0.004)	-0.000 (0.003)	-0.000 (0.003)	-0.001 (0.002)
Home × Attend	-0.005 (0.013)	0.018 (0.012)	-0.016 (0.012)	-0.001 (0.007)	0.058 (0.097)	-0.025 (0.086)	-0.025 (0.084)	-0.002 (0.052)
Home × Attend × FTPct					-0.085 (0.129)	0.084 (0.115)	0.012 (0.111)	0.015 (0.069)
Home × Attend × Exper					0.002 (0.003)	-0.003 (0.003)	0.001 (0.003)	-0.000 (0.002)
Home × Attend × Atts					-0.001 (0.005)	-0.002 (0.005)	0.001 (0.005)	-0.001 (0.003)
Playoff	0.006 (0.007)	-0.006 (0.006)	0.008 (0.006)	0.004 (0.004)	-0.019 (0.052)	-0.047 (0.048)	0.011 (0.045)	-0.020 (0.028)
Playoff × FTPct					0.096 (0.065)	0.087 (0.060)	0.000 (0.058)	0.060* (0.036)
Playoff × Exper					-0.006*** (0.002)	-0.004** (0.002)	-0.000 (0.002)	-0.003*** (0.001)
Playoff × Atts					-0.003 (0.002)	-0.000 (0.002)	-0.001 (0.002)	-0.001 (0.001)
N	67,585	87,472	89,413	244,470	67,585	87,472	89,413	244,470
R <sup>2</sup>	0.003	0.003	0.002	0.003	0.043	0.042	0.045	0.043

Note. All models include *OneShot*, *PrevMade*, *PrevMiss*, *Up5\_10*, *Up4*, *Up3*, *Up2*, *Up1*, *Tied*, *Down1*, *Down2*, *Down3*, *Down4*, and *Down5\_10*. Models 4 and 8 also include dummies for quarter. *Attend* is measured in ten thousands. Models 1–4 include player-season fixed effects, and Models 5–8 include *FTPct*, *Exper*, and *Atts* as separate regressors. Robust standard errors given in parentheses. \*, \*\*, \*\*\* denote 10%, 5%, and 1% significance.

The paper's main results are presented in Tables 3 and 4. Both present estimated coefficients for interactions of the various score differences with the *Last* variables and, in separate specifications, whether the shot was the final shot from the set. In Table 3, the omitted score category is winning or losing by 11 or more points, and in Table 4 the omitted score difference is 5–10 points. The main effects for the score difference and *Last* variables are included in all of the regressions. Their coefficients are almost always less than 0.01 and insignificant.

The results indicate that during the last 15 seconds of the game, players shoot 8.8 percentage points worse than their season average when down 1 point, and 6.3 percentage points worse when down by 2, as compared to when up or down 11 or more points, in the last 15 seconds. When we expand our window of pressure situations to the last 30 seconds or the last minute, we see the estimated effects are slightly smaller but continue to be statistically significant at the 5% level.

Players shoot around 5 percentage points worse when up one or two in the last 15 seconds on the final shot of a set, as compared to other shots in the same set. This is consistent with the choking hypothesis, since pressure should be higher on the final shot. On the other hand, players perform better on the initial shot of a set, as compared to the final shot, when down by 1 point, which is puzzling, but the effect is insignificant so we should not put much weight on it. The estimates for interactions of dummies for down three and down four with *Last30* and *Last15* range from –1% to –5%, but are statistically insignificant and unreported.

Table 4 shows that players shoot 3.7 and 5.5 percentage points worse when down one and two in the last 30 seconds, respectively, as compared to when the score difference is 5–10. The numbers are 4.5 and 6.5, respectively, in the last 15 seconds, though only the latter is significant. Players again shoot around 5 percentage points worse on the final shot in the last 15 seconds when winning by one or two. These effects are smaller than those reported in Table 3 because players shoot 1–2 percentage points worse in the last 30 seconds, as compared to the rest of the game, when the score difference is 5–10, indicating there are small pressure effects for these moderate score differences. The estimates tend to be of much lower magnitude and insignificant for the *Last60* models, and for terms involving the variable representing the score being tied.<sup>17</sup>

Table 5 presents estimates of interaction terms involving player characteristics, for the +11 baseline.<sup>18</sup> To improve statistical power, we combine some of the individual score difference groups into broader categories and report the coefficients for a dummy variable equal to 1 when the shooter's team is down by 1–4 points, *Down1\_4*. We look at both the effect of shots taken during the last 30 seconds of the game (Panel A) and during the last 15 seconds (Panel B).

In columns 2–5, we examine whether the basic choking effect (Column 1) differs based on player characteristics such as ability and previous experience. We find that players with higher shooting ability experience a smaller change in performance in high pressure situations. A 10 percentage point increase in a player's past free throw percentage is associated with a decrease in the choking effect of 5.6 percentage

**Table 3.** Analysis of Last Minute Pressure Effects, I + Baseline

	(1) X = 60	(2) X = 30	(3) X = 15	(4) X = 60	(5) X = 30	(6) X = 15
<i>LastX</i> × <i>Down2</i>	-0.037** (0.017)	-0.045** (0.023)	-0.063** (0.032)	-0.021 (0.024)	-0.034 (0.031)	-0.060 (0.042)
<i>LastX</i> × <i>Down1</i>	-0.041** (0.016)	-0.066*** (0.022)	-0.088*** (0.030)	-0.062** (0.024)	-0.097*** (0.032)	-0.108** (0.043)
<i>LastX</i> × <i>Tied</i>	-0.015 (0.017)	-0.008 (0.022)	0.018 (0.029)	-0.011 (0.025)	-0.010 (0.032)	0.023 (0.040)
<i>LastX</i> × <i>Up1</i>	-0.026** (0.012)	-0.029** (0.015)	-0.042** (0.020)	-0.009 (0.015)	-0.015 (0.017)	-0.016 (0.023)
<i>LastX</i> × <i>Up2</i>	-0.018* (0.011)	-0.019 (0.013)	-0.018 (0.019)	0.001 (0.014)	0.002 (0.017)	0.008 (0.022)
<i>FinalShot</i> × <i>LastX</i> × <i>Down2</i>				-0.029 (0.032)	-0.020 (0.042)	0.001 (0.057)
<i>FinalShot</i> × <i>LastX</i> × <i>Down1</i>				0.043 (0.031)	0.060 (0.041)	0.042 (0.053)
<i>FinalShot</i> × <i>LastX</i> × <i>Tied</i>				-0.006 (0.032)	0.005 (0.041)	-0.009 (0.050)
<i>FinalShot</i> × <i>LastX</i> × <i>Up1</i>				-0.036 (0.023)	-0.031 (0.026)	-0.063** (0.032)
<i>FinalShot</i> × <i>LastX</i> × <i>Up2</i>				-0.034* (0.019)	-0.039** (0.020)	-0.046** (0.023)
N	436,898	424,167	414,069	436,898	424,167	414,069
R <sup>2</sup>	0.003	0.003	0.003	0.003	0.003	0.003

Note. All models include *Up5\_10*, *Up4*, *Up3*, *Up2*, *Up1*, *Tied*, *Down1*, *Down2*, *Down3*, *Down4*, *Down5\_10*, *Last60/30/15*, *PrevMade*, *PrevMiss*, *Home*, *Playoff*, interaction of *Last60/30/15* and score dummies, dummies for quarter. Models 1–3 also include *OneShot*. Models 4–6 also include *FinalShot* and its separate interactions with *Last60/30/15* and score dummies. Observations with *FinalShot* = 1 and less than 6 seconds remaining (in fourth quarter or overtime) are dropped, as are observations with *LastX* = 0 with less than 5 minutes remaining (this is why N varies from model to model). All models include player-season fixed effect and use robust standard errors that are given in parentheses. \*, \*\*, \*\*\* denote 10%, 5%, and 1% significance.

**Table 4.** Analysis of Last Minute Pressure Effects, 5–10 Baseline

	(1) X = 60	(2) X = 30	(3) X = 15	(4) X = 60	(5) X = 30	(6) X = 15
<i>LastX</i> × <i>Down2</i>	-0.033*** (0.016)	-0.035 (0.021)	-0.041 (0.029)	-0.018 (0.024)	-0.025 (0.030)	-0.039 (0.039)
<i>LastX</i> × <i>Down1</i>	-0.037*** (0.016)	-0.055*** (0.020)	-0.065*** (0.027)	-0.059*** (0.024)	-0.087*** (0.031)	-0.087*** (0.040)
<i>LastX</i> × <i>Tied</i>	-0.010 (0.016)	0.003 (0.021)	0.040 (0.026)	-0.008 (0.024)	-0.000 (0.031)	0.045 (0.037)
<i>LastX</i> × <i>Up1</i>	-0.022* (0.011)	-0.019 (0.012)	-0.019 (0.015)	-0.005 (0.014)	-0.005 (0.015)	0.005 (0.018)
<i>LastX</i> × <i>Up2</i>	-0.013 (0.010)	-0.008 (0.010)	0.005 (0.013)	0.004 (0.014)	0.012 (0.015)	0.029 (0.018)
<i>FinalShot</i> × <i>LastX</i> × <i>Down2</i>				-0.029 (0.032)	-0.019 (0.042)	0.002 (0.057)
<i>FinalShot</i> × <i>LastX</i> × <i>Down1</i>				0.042 (0.031)	0.060 (0.041)	0.043 (0.053)
<i>FinalShot</i> × <i>LastX</i> × <i>Tied</i>				-0.007 (0.032)	0.005 (0.041)	-0.008 (0.050)
<i>FinalShot</i> × <i>LastX</i> × <i>Up1</i>				-0.036 (0.023)	-0.031 (0.026)	-0.062*** (0.032)
<i>FinalShot</i> × <i>LastX</i> × <i>Up2</i>				-0.034* (0.019)	-0.039* (0.020)	-0.046* (0.023)
N	436,898	424,167	414,069	436,898	424,167	414,069
R <sup>2</sup>	0.003	0.003	0.003	0.003	0.003	0.003

Note. All models include *Up5\_10*, *Up4*, *Up3*, *Up2*, *Up1*, *Tied*, *Down1*, *Down2*, *Down3*, *Down4*, *Down5\_10*, *Last60/30/15*, *PrevMade*, *PrevMiss*, *Home*, *Playoff*, interaction of *Last60/30/15* and score dummies, dummies for quarter. Models 1–3 also include *OneShot*. Models 4–6 also include *FinalShot* and its separate interactions with *Last60/30/15* and score dummies. Observations with *FinalShot* = 1 and less than 6 seconds remaining (in fourth quarter or overtime) are dropped, as are observations with *LastX* = 0 with less than 5 minutes remaining (this is why N varies from model to model). All models include player-season fixed effect and use robust standard errors that are given in parentheses. \*, \*\*, \*\*\* denote 10%, 5%, and 1% significance.

**Table 5. Player Characteristics Interactions**

	(1)	(2)	(3)	(4)	(5)	(6)
A: Last30 interactions						
Last30 × Downl_4	-0.038*** (0.014)	-0.453*** (0.121)	-0.075*** (0.025)	-0.057*** (0.023)	-0.071*** (0.021)	-0.475*** (0.122)
FTPct × Last30 × Downl_4		0.557*** (0.155)				0.547*** (0.159)
Atts × Last30 × Downl_4			0.008 (0.006)			-0.002 (0.008)
Exper × Last30 × Downl_4				0.004 (0.004)		0.001 (0.004)
PrAtts × Last30 × Downl_4					0.007 (0.004)	0.003 (0.006)
N	424,167	424,167	424,167	424,167	424,167	424,167
R <sup>2</sup>	0.003	0.04	0.003	0.003	0.003	0.04
B: Last15 interactions						
Last15 × Downl_4	-0.058*** (0.021)	-0.511*** (0.189)	-0.093*** (0.035)	-0.045 (0.034)	-0.086*** (0.031)	-0.546*** (0.193)
FTPct × Last15 × Downl_4		0.611*** (0.243)				0.648*** (0.250)
Atts × Last15 × Downl_4			0.008 (0.009)			0.008 (0.013)
Exper × Last15 × Downl_4				-0.004 (0.006)		-0.007 (0.006)
PrAtts × Last15 × Downl_4					0.002 (0.007)	-0.008 (0.010)
N	414,069	414,069	414,069	414,069	414,069	414,069
R <sup>2</sup>	0.003	0.04	0.003	0.003	0.003	0.04

Note. All models include *Up5\_10*, *Up0\_4*, *Down5\_10*, *Last30/15*, *Oneshot*, *PrevMade*, *PrevMiss*, *Home*, *Playoff*, interaction of *Last30/15* and score dummies, dummies for quarter. Models with *FTPct*, *Atts*, *Exper*, and *PrAtts* interactions include separate interactions of these variables with *Last30/15* and score dummies. Observations with *FinalShot* = 1 and less than 6 seconds remaining (in fourth quarter or overtime) are dropped, as are observations with *LastX* = 0 with less than 5 minutes remaining (this is why *N* varies from model to model). All models except 2 and 6 include player-season fixed effects; 2 and 6 include *FTPct* as non-interacted regressor. Robust standard errors are given in parentheses. \*, \*\*, \*\*\* denote 10%, 5%, and 1% significance.

points in the last 30 seconds. However, we find that none of our measures of player experience were associated with lower choking effects. Our results are also similar when we include all of the interactions at the same time and when we narrow our analysis to look at the effect of the last 15 seconds. A very poor shooter who averages 60% (e.g., Shaquille O'Neal) would have an estimated choking effect for those situations of around 15 percentage points (from Column 2 of Panel b,  $-0.51 + 0.61 \times 0.6$ ).

Table 6 presents results for additional interactions with *Down1\_4*. The most striking result is that performance in the final 30 seconds when the shooter's team is down up to 4 points improves by around 5 percentage points when the previous free throw was made, and declines by an even greater magnitude when the previous shot was missed, though these effects are not estimated precisely. As discussed above, this likely indicates the importance of a player's mind-set, and how it can be influenced by success on the first shot. Although performance on the first/second shot may be correlated for other reasons, we control for this possible general correlation by including *PrevMade* and *PrevMiss* as noninteracted terms in the models.

Home status and attendance have no significant interaction effects (the direction of the home effect is positive but its magnitude is always less than 4%). Playoff status does not interact significantly with *Down1\_4* and *Last*, and the magnitudes of the effects are close to 0 for Models 3 and 4. We are somewhat surprised by this, and while it may be due to the relatively small playoff sample, we thought this may also be due to players gaining experience throughout the season, and consequently becoming less prone to choke later in the season, which could nullify increased choking in the playoffs. This does not appear to be the case, however, as when we include an interaction with a variable equal to month of season, which is highest in playoff months and should thus pick up the effect of declining within-season choking, results are similar (results not reported).

Pressure may also be relatively high for games that occur late in the regular season that are likely to affect playoff seeds. To account for this, we estimate the models on a subsample without regular season games played in the final month (April); this should accentuate the difference in pressure between playoff and regular season games. Doing this does not substantially change the *Playoff* results, but does weaken the *PrevMade* and *PrevMiss* estimates (results unreported). Perhaps, the lack of an observed increase in choking in the playoffs is caused by selection biases being exacerbated in the playoffs, which would occur if teams make more of an effort to get the ball to their best free throw shooters and/or clutch players in the playoffs, as compared to the regular season. Perhaps, teams experiment more in the regular season, giving various players chances in clutch situations.

## Discussion and Conclusion

The results of this paper indicate that NBA players do choke at the very end of games when their team is winning or losing by a small margin. Choking is more severe for

**Table 6.** Other Interactions

	(1) X = 30	(2) X = 15	(3) X = 30	(4) X = 15
<i>PrevMade</i> × <i>LastX</i> × <i>DownI_4</i>	0.042 (0.026)	0.058 (0.036)	0.049** (0.023)	0.045 (0.031)
<i>PrevMiss</i> × <i>LastX</i> × <i>DownI_4</i>	-0.036 (0.041)	-0.046 (0.053)	-0.069* (0.035)	-0.096** (0.047)
<i>Home</i> × <i>LastX</i> × <i>DownI_4</i>	0.016 (0.025)	0.032 (0.034)	0.004 (0.022)	0.022 (0.029)
<i>Playoff</i> × <i>LastX</i> × <i>DownI_4</i>	-0.046 (0.053)	-0.108 (0.072)	0.036 (0.043)	-0.003 (0.060)
<i>Attend</i> × <i>LastX</i> × <i>DownI_4</i>	0.012* (0.007)	0.005 (0.009)		
<i>Home</i> × <i>Attend</i> × <i>LastX</i> × <i>DownI_4</i>	-0.008 (0.009)	-0.004 (0.013)		
N	308,176	300,664	424,167	414,069
R <sup>2</sup>	0.003	0.003	0.003	0.003

Note. All models include *Up5\_10*, *Up0\_4*, *Close*, *Down5\_10*, *Last30/15*, *Oneshot*, *PrevMade*, *PrevMiss*, *Home*, *Playoff*, interaction of *Last30/15* and score dummies, dummies for quarter, separate interaction of *Home* and *Playoff* with *Last30/15* and score dummies. Models 1 and 2 also include *Attend* and *Home* × *Attend* and their separate interactions with *Last30/15* and score dummies. Only observations from 2002-2003 to 2007-2008 season are used for Models 1 and 2, as *Attend* is only available for those seasons. Observations with *FinalShot* = 1 and less than 6 seconds remaining (in fourth quarter or overtime) are dropped, as are observations with *LastX* = 0 with less than 5 minutes remaining (this is why N varies from model to model). All models include player-season fixed effect and use robust standard errors that are given in parentheses. \*, \*\*, \*\*\* denote 10%, 5%, and 1% significance.

players who are worse overall free throw shooters, and on the second shot if the first was missed. Choking effects are stronger for players whose teams are losing, which is unsurprising since the marginal effect of a foul shot on the probability of winning the game is likely greater for shooters whose teams are losing rather than winning. However, the choking estimates for players on winning teams may be biased slightly downward, as the shooters in those situations are slightly better than average.

In contrast, we find that players do not choke when the score is tied in the last 15 seconds, which is consistent with the findings of Worth et al. (2009). In these situations, players may perceive that even if the shot is missed the shooter cannot be held directly responsible for the game outcome—the shooter's opponent still needs to score in the final seconds to win, and if the opponent scores by making a 2- or 3-point field goal (as scoring usually occurs), a single free throw would not make a difference to the game outcome anyway. On the other hand, when the shooter's team is up by 1 or 2, a single free throw could be the difference between a 2- or 3-point shot by the opponent leading to a win or overtime. However, these perceptions would be at odds with the empirical reality. We find that when games are tied in the last 15 seconds, after a made free throw, the shooter's team has a 69.5% chance of winning in the current period, and only a 35.0% chance of winning after a miss. When up 1 point, the percentages are 71.1% and 67.7%, respectively. The numbers are similar for teams up 2 points. This indicates that the shot is very important to the team's outcome when the game is tied, but is less likely to matter when the shooter's team is winning by a small margin.<sup>19</sup>

Another possible explanation for the lack of a decline in performance in the last 15 seconds when the score is tied is that players are especially focused in those situations, while players do not exert full effort, that is, they shirk, when there is more time left because they think there will be time to recover from missed shots. It is possible shirking, rather than choking, explains the negative performance effects we do observe in the last minute of games. See Berri and Krautmann (2006) for a recent study of shirking in the NBA. We do not think shirking can plausibly explain our results since we find for all scores other than ties, performance declines as time remaining decreases, and the decline is sharper when the score is closer. While this pattern is consistent with the choking hypothesis, we would expect shirking to cause the opposite pattern—for performance to be worst in the situations where it matters least.

We are also somewhat surprised that home and playoff status do not have substantial effects on choking (despite the ambiguous theory regarding home status, discussed above). Perhaps, the lack of a home effect is due to players knowing their teammates, coach, and the vast majority of fans, will be aware of or learn about the performance (good or bad) whether it takes place at home or on the road, and so the effects of choking on the player's reputation are independent of home status. The lack of a home effect (in the first three quarters and end-of-game choking) may also be due to competing forces; players may feel more pressure playing at home, but be more distracted by fans on the road, as they typically make extra noise and even

wave objects to attempt to distract shooters from the opposing team. The lack of a playoff effect may be due to small sample size; although our data set is large, the number of observations for very high pressure situations that occurred in the playoffs is still highly limited.

NBA players are highly paid professionals, most of whom have substantial experience performing in front of thousands watching in person, and millions watching on television. Our findings that even NBA players choke lead us to believe that athletes across all sports, and workers in general, are likely subject to anxiety in pressure situations that cause them to perform less than optimally. An important topic for future sports economics research is the relation between performance under pressure and earnings. The most immediate questions to investigate are whether players who consistently choke more than average have lower pay or if playing time is affected by choking, and if so (for either), to what extent. Deutscher, Frick, and Prinz (2010) take a step in this direction; they find that players who perform better than normal in the last 5 minutes of close games do receive substantially higher pay. A more difficult question to answer would be whether monetary compensation for choking/clutch performance is optimal from a profit-maximization perspective. One plausible alternative hypothesis is that pay may respond excessively to recent, salient performance under pressure. For example, if a player hits a last-minute winning shot in an important playoff game, that player may obtain greater pay as a free agent in the next off-season. But a single shot may provide almost no information about the player's ability as a clutch performer in the future. Anecdotal evidence of this occurring in American football is Larry Brown, a previously unheralded player who had a very good performance in Super Bowl XXX causing him to win the game's MVP award and then one month later signed a relatively lucrative contract with the Oakland Raiders. He was released just two seasons after that due to poor performance (Kroichick, 1998).

### **Acknowledgments**

We thank Rob Simmons and two anonymous referees for helpful comments, and Henry Tappen for providing excellent research assistance.

### **Declaration of Conflicting Interests**

The author(s) declared no potential conflicts of interests with respect to the authorship and/or publication of this article.

### **Funding**

The author(s) received no financial support for the research and/or authorship of this article.

### **Notes**

1. See Hilla et al. (2010) for a recent literature review.

2. See Dohmen (2008) and Ariely (2010) for discussions of the relevance of choking in labor market contexts outside sports. One context particularly worth noting is finance, and perhaps day-trading in particular, since, like basketball players, traders sometimes have to make split-second decisions and the degree of pressure can be very high.
3. Most free throws are shot in pairs.
4. Arkes (2010) showed that free throw shooters perform better after making their previous free throw, as compared to after a missed free throw, which he interpreted as evidence of the hot hand. We find similar results, and find that the effect is exacerbated considerably in the final seconds of close games. It is also worth noting (estimates not reported) that players perform substantially (3–4 percentage points) better on the second shot than the first even when the first was missed, indicating that even seasoned professionals benefit from a warm-up shot.
5. Hilla et al. (2010) provide a detailed discussion of alternative theories for exactly why, and how, anxiety may arise and worsen performance in pressure situations. Two primary classes of theories are distraction (that performers are distracted from their task when pressure is high) and self-focus (that performers become self-conscious under pressure). Distinguishing between these theories is beyond the scope of this paper; we refer the reader to their paper for more detail on those topics.
6. Wallace, Baumeister, and Vohs (2005) provides a review of the literature on the effects of performing in front of supportive and hostile audiences. They discuss the theory of how supportive audiences should improve performance for effort-based tasks, but increase pressure and worsen performance for skill-based tasks. Evidence of supportive audiences causing choking has been found in multiple contexts, such as golf and baseball. Free throw performance is likely more affected by skill than effort; however, basketball audiences can distract players from the opposing team, especially free throw shooters, more than audiences in other sports (such as golf), so the net theoretical effect of home status on performance in basketball is ambiguous.
7. For example, Wang, Marchant, and Morris (2004) examine choking using free throw data obtained from a controlled setting. Levitt and List (2007) provide a discussion of the advantages of data “from the field.”
8. Ariely (2010) refers to research on clutch performance using NBA data currently in progress; see also Deutscher et al. (2010). There are also sabermetric studies on clutch performance, but they focus on the question of whether individual players are consistently good clutch performers; see, for example, Neyer (1999). Two other very recent papers that use soccer data and study a somewhat different form of psychological pressure are Apesteguia and Palacios-Huerta (2010) (who find substantial pressure effects) and Kocher et al. (2010) (who find weak and insignificant pressure effects).
9. Attendance data are only available for the 2002-2003 through 2007-2008 seasons. We began this project during the 2009-2010 season and added in all observations for the regular season as we proceeded, but exclude all observations from that season’s playoffs.
10. We drop observations for the last shot of a set (usually the second shot of two) with the shooter’s team losing by 2 or 3 points with five or fewer seconds remaining, as players sometimes intentionally miss their shot in those situations in the hope that their team will rebound the missed shot and make a field goal, which is necessary to tie the game or take

the lead. We examined the data closely and found no evidence of these intentional misses for shots taken with greater than 5 seconds remaining.

11. We experimented with alternative controls, including player fixed effects, and player 60–120 day moving averages, to allow for players' free throw percentage to vary less/more frequently than season to season, and obtained similar results.
12. Results are not reported, but available on request. Another reason that we prefer linear models is that due to our large sample size and player-season fixed effect specification it is computationally extremely demanding to use the Ai and Norton (2003) approach.
13. We exclude the current observation in the calculation of this variable.
14. In all specifications with interaction terms, we include all variables used in the interaction terms as separate regressors. We drop the player-season fixed effects in specifications involving *FTPct* to avoid perfect multicollinearity. The variable *FTPct* still provides a good control for overall free throw shooting ability.
15. We considered examining shots caused by technical fouls separately. Teams can directly choose the shooter (i.e., the free throw shooter is not just the player who was fouled) for these shots, so positive selection bias should be most severe for these shots. However, we only have seven and three observations for technical shots take in the last 30 and 15 seconds, respectively, with the shooter's team down 1–4 points.
16. It is well known that teams are more likely to play "scrubs" when losing or winning by a substantial margin at the end of the game. Scrubs may actually feel even less pressure than normal players in these situations (since they likely know they are not being evaluated by their coach and others as closely as they are evaluated in the middle of games), and will not be as fatigued, which could bias the estimates on the *Last* variables upward, and consequently the estimate on *Last* interacted with other score variables to be biased downward. We are confident our results are robust to this issue since results are similar when we use the 5–10 baseline, and we also found results are similar for the 11+ baseline when we drop scrubs (players who took most of their free throw attempts in the last minute when winning or losing by 11+ points).
17. Figure 1 indicates that players perform worse when the score is tied when there are 16–30 seconds remaining; however, we find even these effects are insignificant when we test for them using this framework.
18. In the interest of brevity, we do not present results for the alternate 5–10 baseline for the remaining tables, as they are largely similar. We also do not report results for other score difference category interactions, although many are significant. It is worth noting in particular that the interaction of the category representing situations in which a team is tied or winning by a small margin with *FTPct* is also significant, but of a lower magnitude than the *Down1\_4* estimate, which is consistent with choking being more likely when teams are losing by a small margin rather than winning for players of all abilities.
19. The percentages are 28.7% and 5.5% when down 1 point, respectively.

## References

- Ai, C., & Norton, E. C. (2003). Interaction terms in logit and probit models. *Economics Letters*, 80, 123-129.

- Angrist, J. D., & Pischke, J. S. (2009). *Mostly harmless econometrics*. Princeton, NJ: Princeton University Press.
- Apestequia, J., & Palacios-Huerta, I. (2010). Psychological Pressure in Competitive Environments: Evidence from a Randomized Natural Experiment. *American Economic Review*, *100*, 2548-2564.
- Ariely, D. (2010). The irrational side of corporate bonuses. Retrieved May 27, 2010, from [www.huffingtonpost.com](http://www.huffingtonpost.com)
- Ariely, D., Gneezy, U., Loewenstein, G., & Mazar, N. (2009). Large stakes and big mistakes. *Review of Economic Studies*, *76*, 451-469.
- Arkes, J. (2010). Revisiting the Hot Hand Theory with free throw data in a multivariate framework. *Journal of the Quantitative Analysis in Sports*, *6*, 2.
- Banner, C. E., & Feess, E. (2010). When high-powered incentive contracts reduce performance: Choking under pressure as a screening device. *Frankfurt School-Working Paper Series*.
- Berri, D. J., & Krautmann, A. C. (2006). Shirking on the court: Testing for the incentive effects of guaranteed pay. *Economic Inquiry*, *44*, 536-546.
- Cornelissen, T., & Sonderhof, K. (2009). Partial effects in probit and logit models with a triple dummy variable interaction term. *The Stata Journal*, *9*, 571-583.
- Deutscher, C., Frick, B., & Prinz, J. (2010). *Performance under pressure: Estimating the returns to mental strength in professional basketball*. Working paper.
- Dohmen, T. J. (2008). Do professionals choke under pressure? *Journal of Economic Behavior and Organization*, *65*, 636-653.
- Hilla, D. M., Hanton, S., Matthews, N., & Fleming, S. (2010). Choking in sport: A review. *International Review of Sports and Exercise Psychology*, *3*, 24-39.
- Kocher, M. G., Lenz, M. V., & Sutter, M. (2010). Psychological Pressure in Competitive Environments: Evidence from a Randomized Natural Experiment: Comment IZA DP No. 484.
- Kroichick, R. (1998). Raiders 'recommend' that Larry Brown leave. Retrieved April 25, 1998. *The San Francisco Chronicle*.
- Levitt, S. D., & List, J. A. (2007). What do laboratory experiments measuring social preferences reveal about the real world? *The Journal of Economic Perspectives*, *21*, 153-174.
- Neyer, R. (1999). Clutch hitting. Retrieved December 17, 1999, from [www.espn.com](http://www.espn.com)
- Ruah, M. T., & Seccia, G. (2010). Agency and anxiety. *Journal of Economics and Management Strategy*, *19*, 87-116.
- Wallace, H. M., Baumeister, R. F., & Vohs, K. D. (2005). Audience support and choking under pressure: A home disadvantage? *Journal of Sports Sciences*, *23*, 429-438.
- Wang, J., Marchant, D., & Morris, T. (2004). Coping styles and susceptibility to choking. *Journal of Sport Behavior*, *27*, 75-92.
- Worthy, D. A., Markman, A. B., & Maddox, W. T. (2009). Choking and excelling at the free throw line. *The International Journal of Creativity and Problem Solving*, *19*, 53-58.

## Bios

**Zheng Cao** is a Ph.D. candidate in Economics at Oregon State University. He also works as Marketing Strategy Analyst II for HSBC Card Services.

**Joseph Price** is Assistant Professor of Economics at Brigham Young University. His current research focuses on the economics of the family, sports economics, health economics, and discrimination.

**Daniel F. Stone** is Assistant Professor of Economics at Oregon State University. His research interests are information economics, behavioral economics, political economy and industrial organization, in addition to sports.