The Moneyball Effect: Incentives and Output in the NBA Three Point Shootout

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Abstract

The purpose of this study is to empirically test whether skilled professionals are susceptible to "choking under pressure." Prior research of this phenomenon has been largely limited to laboratory environments and real world settings that feature direct strategic interaction. Our research examines a real-world setting in which highly-trained professionals compete amidst varying incentives and without direct strategic interaction. This paper utilizes a novel data set that includes performance metrics from highly skilled professional basketball players participating in the *NBA Three Point Shootout* from 2001-2010 (which is a non-strategic setting). The resulting data set includes data on 2,150 three point shots attempted by a collection of 33 contestants. The goal of each contestant was to maximize their total points scored each round given twenty shots worth 1 point each and 5 shots worth 2 points each. The shots worth 2 points each are called *moneyballs*. Traditional economic theory suggests that players would expend relatively more time/effort on the moneyballs and hence perform better on moneyball shots compared to regular shots. However, our findings suggest the opposite, as players fared relatively *worse* on moneyballs. This result was statistically significant and robust to several econometric models. Our findings call into question the orthodox economic model that performance hinges primarily (and predictably) on incentives.

I. Introduction

A body of experimental evidence suggests that performance incentives can increase task pressure and, in so doing, decrease performance level. Such a process—typically referred to in the literature as "choking under pressure" or "performance decrements under pressure"—runs counter to standard economic theory. The efficiency wage hypothesis, for example, holds that stronger wage incentives induce greater effort levels and increased worker output. There is a great deal of experimental evidence that such relationships may not hold in performance settings, however. The notion that higher stakes may lead to decreased performance has long been noted in the psychology literature (see, e.g., Baumeister (1984), Lewis and Linder (1997), Beilock and Carr (2001)). In an important paper, Ariely et al. (2009) conducted a series of experiments in the U.S. and rural India. In the experiments, participants were given the opportunity to win substantial sums of money relative to income. Payouts were directly linked to performance in several games. As stakes increased, performance level often fell. The authors attribute this outcome to counterproductive processes that occur as an involuntary response to increasing stakes (performance pressure). These processes include distraction and self-monitoring of overlearned skills. Sanders and Walia (2012) demonstrate within a contest-theoretic environment that distraction and self-monitoring can erode not only performance but also efforts under stakes-based pressure.

Despite the empirical credibility of "choking under pressure" in experimental settings, there have been relatively few real world tests of the phenomenon. This is partly due to the difficulty of obtaining real world data that reveals the relationship between incentives and performance. Dohmen (2008) notes, "It is generally difficult to obtain the kind of real world data that are required to test whether choking matters in real world working conditions." As another obstacle, the amount of pressure associated with a real-world action is typically difficult to measure. This is because multiple processes involving pressure (e.g., stakes, difficulty of task) may change at the same time. Real world tests of "choking under pressure" are also valuable in that they (often) allow us to study professionals behaving in professional environments. Economist Gary Becker has suggested that while some people might choke under certain circumstances, paid professionals might not be susceptible to choking (see Becker's interview with Stewart in 2005). To address this concern, several papers have studied professional athletes. It is important to ascertain whether professionals are largely immune to the processes that cause performance decrements under pressure (either by self-selection or through experience). If this is the case, then perhaps "choking under pressure" does not have large ramifications upon labor market incentives.

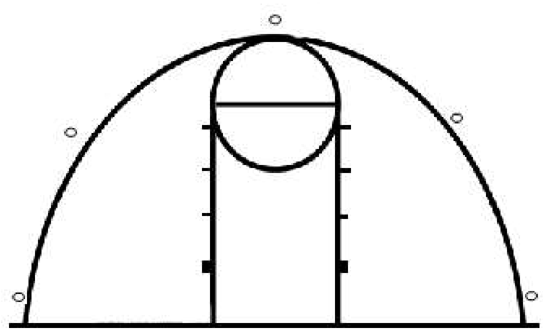
In real world tests that have been conducted, evidence of "choking under pressure" is mixed. It is clear that the necessary and sufficient conditions for performance decrements under pressure can be motivated within an experimental laboratory. The extent to which said conditions apply in real-world settings remains unclear, however. Worthy et al. (2009) provide a real-world test of "choking under pressure." They find evidence that NBA players are typically less proficient in free throw shooting when a game's outcome hangs in the balance. In an analysis of penalty kicks in soccer, however, Dohmen (2008) finds no evidence that higher stakes penalty kicks (i.e., ones that decide the game or are crucial to the team's season) induce performance decrements. In fact, he finds that "choking rates tend to fall when more is at stake." Paserman (2007) finds that professional tennis players perform worse (have an elevated error rate) as the importance of a point increases. Kamenika (2012) argues that the relationship between incentives and performance may be confounded in strategic settings.

Thus, prior research has been limited largely to laboratory environments and real world settings that feature direct strategic interaction. Our research examines a real-world setting in which highly-trained professionals compete amidst varying incentives and without direct strategic interaction. Namely, the present study tests for the existence of counterproductive incentives by analyzing ten years of *NBA Three Point Shootout* data (2001-2010; prior to rules changes that diluted individual incentives in the contest). This contest is an ideal setting in which to test the relationship between incentives (stakes-driven pressure) and performance in that it features variable shot values (clear incentive variation), no direct strategic interaction, and an objective metric for success.

II. Data and Description of *Shootout*

This study is based on an analysis of ten years of *NBA Three Point Shootout* data (2001-2010). The *Shootout* is an annual event within *NBA All-Star Weekend*. Among the set of active players, the NBA chooses six or more proficient three point shooters each year to participate in the contest. Players have one minute to navigate the three point arc and attempt 25 three-point shots. Specifically, players shoot five shots from each of five locations. Figure 1 below provides an approximate depiction of these shooting locations.

Figure 1: An Approximate Depiction of Shot Locations



At each location, four balls are standard in color and are worth one point if made. The remaining ball or "moneyball" is red, white, and blue in color and is worth two points if made. Contestants can shoot the five balls on a given rack in any chosen order (i.e., may order the "moneyball" shot such that it will have the most impact). The top three scoring contestants in round one of the contest advance to a second and final round that is identical in structure. The winning shooter receives $35,000, a trophy, and an awards ceremony. Thus, there is a clear incentive for a shooter to maximize his number of points and therefore a higher reward to making the marginal "moneyball" shot as compared to the marginal standard shot.

As Dohmen (2008) notes, economists generally agree that stronger incentives will lead to harder work and more output. [1] Thus, the standard economic model would predict shooters to exhibit increased accuracy for "moneyball" shots as compared to regular shots. However, research has shown that incentives do not always change behavior in the way that the standard economic model would suggest. Ariely et al (2009) note that "increased incentives can cause people, involuntarily, to consciously think about the task, shifting control of behavior from "automatic" to "controlled" mental processes even

[1] Worthy et al (2009) avoid any problems involving strategic interactions by investigating free throw percentages by professional basketball players at the end of close games. They find evidence that players do worse than their career average when the point differential is -2, -1, 1 and 3. However, players perform at their career average when the score is tied or when their team is winning by 2 points. However, it is not clear which situations give a player an incentive to shoot better. Thus, the incentive structure is not clearly defined.

though it is well documented that controlled processes are less effective for tasks that are highly practiced and automated (Langer and Imber, 1979; Camerer, Loewenstein and Drazen, 2005)."

The unique data set for this study was developed by watching video footage of each *Shootout* between 2001 and 2010 (National Basketball Association, 2001-2010) and recording each observation manually. The resulting data set includes data on 2,150 three point shots attempted by a collection of 33 contestants.

III. Model and Results

In our analysis, we compare "moneyball" shots to one-point shots not taken as the first shot on a rack. Such a reference group was chosen because players are much less proficient when transitioning to a new location, *ceteris paribus*. Within the sample, "moneyball" shots were never taken as the first shot on a rack. This stands to reason, as players wish to use their valuable shot for a given rack when they are not shooting relatively poorly. Moreover, "moneyball" shots did not always come as the last shot on a rack. Below are summaries as to the relationship between proficiency and ball type.

Table 1: Summary Data in Regards to Performance

	Non-Moneyballs	Regular Balls (excepting 1st on rack)	Moneyballs
% made	0.535	0.567	0.512
Observations	1720	1290	430

Table 1 demonstrates that contestants are less proficient within the sample on "moneyball" shots. Figures 2a and 2b demonstrate this point visually.

Figure 2a: Box Plots of Predicted Shot Proficiency for Non-Moneyball and Moneyball Shots

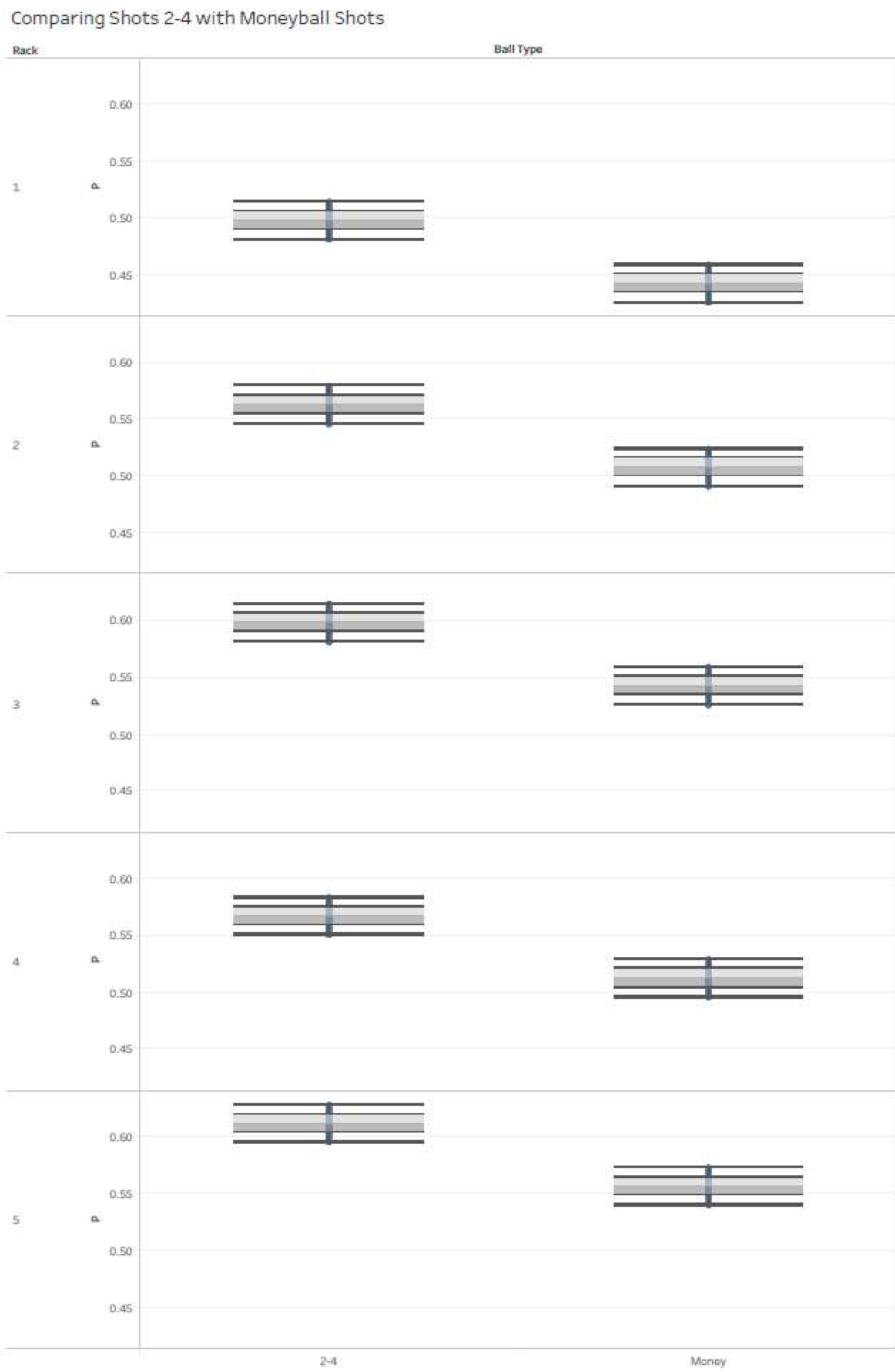
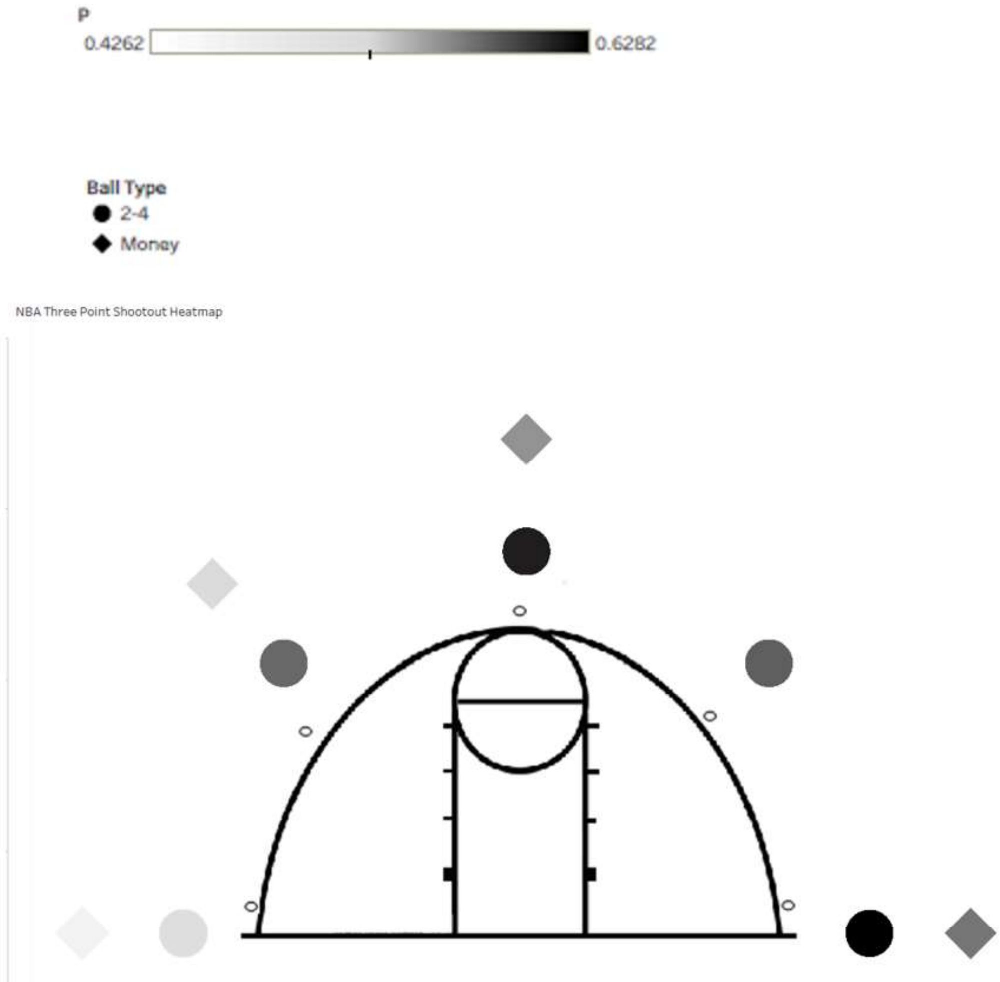


Figure 2b: A Texture-Coded Map of Predicted Shot Proficiency for Moneyball and Non-Moneyball Shots



We use regression analysis to determine whether this difference is statistically significant. Specifically, we employ logistic regression, which is appropriate when there is a binary dependent variable; in this case, the dependent variable is *made* and is equal to 1 when the shot is made and equal to 0 when the shot is missed. The independent variable of interest is *moneyball* which is equal to 1 when the shooter shoots a moneyball and equal to 0 when the shooter shoots a 'regular' ball. In order to isolate the "moneyball effect," we employ the following controls.

Ball 1 is a dummy variable that controls for when the shooter is shooting the first ball from a given rack; we use this variable to account for the relatively difficult task the shooter has of taking the first shot from a new location. One reason that the first shot is relatively more difficult is the shot's distance may fluctuate from station to station; for example, moving from rack 1 to rack 2, the shot's distance changes from 22 feet to 23 feet 9 inches while moving from rack 4 to rack 5 the distance changes from 23 feet 9 inches back to 22 feet. These changes in distance make the first shot of a given rack more difficult since the shooter is forced to adjust to these changes in distance. Another point of note is that each time a shooter shoots the first ball from a given rack, the shot's angle is different from that of the previous shot-- this also serves to increase the difficulty of the first shot from each rack.

Next, we have a categorical variable that accounts for the rack the shooter is shooting from. With *rack 1* serving as the reference group, we use variables *rack 2*, *rack 3*, *rack 4*, and *rack 5* to account for any relative differences in difficulty from shooting from the various racks on the floor. The variable 'year' is a time trend treats time in a chronological manner. This controls for the possibility that shooters got better over time. We use the variable *round* to control for any differences in the ability of a shooter to make shots in the second round compared to the first round. One reason that there may be a difference is a learning effect where players learn from their experiences from the first round in order to improve their performance in the second round.

Finally, we use the dummy variable *guard* that is equal to 1 when the player is a guard and equal to 0 when the player is a forward or center. Traditionally, guards are more frequently used as three point specialists while forwards and centers typically play closer to the basket (although there are exceptions to this rule). Thus, the *guard* variable attempts to pick up any differences in shooting ability between players from these different positions.[2]

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[2] We would like to thank an anonymous referee for inquiring about the difference in three point shooting ability and attempts between guards and forwards. To test for such a difference, we first looked at the top 100 guards (who played at least 41 games) by three point attempt rate for the 2010-2011 season (where three point attempt rate is defined by the percentage of total field goal attempts from three point range). From these 100 guards, the average number of three point attempts per game was 3.1. We then looked at the top 100 forwards (who played at least 41 games) by three point attempt rate for the 2010-2011 season. From these 100 forwards, the average three point attempts per game was 1.6. From this sample, guards shot nearly twice as many 3pt shots as forwards. In another test from the same sample, the average guard shot made 35.5

Table 2: Regression results[3]

Variable	Logit (1)	Logit (2)	FE (3)	FE (4)	RE (5)	RE (6)
moneyball	-0.225** (0.048)	-0.223** (0.048)	-0.229** (0.044)	-0.229** (0.044)	-0.229** (0.044)	-0.229** (0.044)
Ball 1	-0.518*** (0.000)	-0.515*** (0.000)	-0.527*** (0.000)	-0.527*** (0.000)	-0.527*** (0.000)	-0.527*** (0.000)
Rack 2	0.265* (0.054)	0.264* (0.055)	0.270* (0.052)	0.270* (0.052)	0.270* (0.052)	0.270* (0.052)
Rack 3	0.408*** (0.003)	0.406*** (0.003)	0.416*** (0.003)	0.416*** (0.003)	0.415*** (0.003)	0.415*** (0.003)
Rack 4	0.284** (0.039)	0.283** (0.040)	0.289** (0.038)	0.289** (0.038)	0.289** (0.038)	0.289** (0.038)
Rack 5	0.466*** (0.001)	0.464*** (0.001)	0.475*** (0.001)	0.475*** (0.001)	0.474*** (0.001)	0.474*** (0.001)
year	0.004 (0.786)	0.006 (0.727)	0.009 (0.769)	0.011 (0.715)	0.018 (0.413)	0.021 (0.348)
round	0.241*** (0.002)	----	0.065 (0.449)	----	0.160* (0.058)	----
guard	-0.122 (0.166)	-0.152* (0.083)	----	----	-0.003 (0.983)	0.001 (0.996)
constant	-9.280 (0.779)	-11.478 (0.728)	----	----	-35.488 (0.409)	-41.625 (0.347)
Obs.	2150	2150	2150	2150	2150	2150
Chi-squared p-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

To ensure that our results are robust, we utilize three different types of logistic models: logit with robust standard errors, (contestant) fixed effects logit, and (contestant) random effects logit. In each of these models, the dependent variable is *made* and is equal to 1 if the shot is made and equal to 0 if the shot is missed. Each shot counts as an observation in each of our three econometric models and we employ the same set of controls in each model as well. Since each contestant has at least 25 observations, our data allow us to use panel data models (i.e. fixed effects logit and random effects logit) in addition to the standard logit model. We use the fixed effects models because the fixed effects model tends to be less vulnerable to omitted variable bias by having individuals serve as their own controls (see Williams 2013). However, since fixed effects models can suffer from high standard errors, we also use a random effects logit model in order alleviate any

percent of their three point attempts while the average forward made percent. This is further evidence that guards are more specialized than forwards at shooting three point shots.

[3] Where *made* is the dependent variable and is equal to 1 if the shot is made and equal to 0 if the shot is missed.

concerns over efficiency. On the other hand, although random effects logit models tend to have smaller errors, they are also prone to having biased estimates (see Williams 2013). Thus, using both the random effects and fixed effects models allow us to eliminate any concerns relating to efficiency *and* biasedness. For completeness, we report regression results from each of the three models; as seen in table 2, results across models are nearly identical.

The primary independent variable of interest is called *moneyball*, and is equal to 1 if the observation includes a shot where the moneyball is used and is equal to 0 if a regular ball used. Recall that moneyballs are worth 2 points if made while regular balls are worth 1 point if made (and the object of the contest is to score as many points as possible). Table 2 reveals that contestants are significantly less proficient (at the .05 level) in shooting the "moneyball" compared to regular balls, *ceteris paribus*. This result holds across different models and model specifications. To put this into context, we calculate that a player shooting a moneyball has 4/5th the estimated odds of making the shot a player shooting a regular ball. In other words, a player shooting a regular ball is 1.2 times more likely to make the shot than a player shooting a moneyball.[4] We conclude evidence of "choking under pressure" herein.

One potential concern of trying to isolate a "moneyball effect" is that the money ball is differently colored (red, white, and blue) than the other balls, which are orange in color. We think this concern is not relevant because players are trained to look at the rim when shooting. In other words, when a player shoots, they are looking at the rim and not the ball. For example, Stephen Curry (current NBA 3 point shooting specialist) encourages shooters to look at the hooks in front of the rim while shooting.[5] For this reason, we are not concerned that the "moneyball" has a different color.

We employ a robust set of controls in order to isolate the effect that *moneyball* has on the likelihood of making a shot. Our first control variable is called *Ball 1* and is a dummy variable equal to 1 if the ball is the first shot taken from the rack and is employed to control for the

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[4] We would like to thank an anonymous referee for suggesting that give an interpretation on the magnitude of the moneyball effect. We calculated this effect as follows: $\frac{odds\ when\ moneyball=1}{odds\ when\ moneyball=0} = e^{-0.229} = 0.795$. We rounded to 0.8 in the explanation above to 4/5.

[5] https://www.forbes.com/sites/hunteratkins/2014/08/26/shooting-tips-from-n-b-a-all-star-stephen-curry-2/2/#3e3cad345af4

relative difficulty of the first shot on a rack (there are 5 racks and each rack has 5 balls); the reason for this being that players likely use the first ball to help calibrate their expectation of the distance and shooting angle to the basket. Thus, the coefficient of *Ball 1* has the expected negative sign and is statistically significant.

Next, we use dummy variables to control for the rack from which a shot is taken; in this case, we have four dummy variables (*Rack 2*, *Rack 3*, *Rack 4*, *Rack 5*); shots taken from the first rack therefore serves as the reference group. We expected rack 1 to be the most difficult rack to shoot from, since it is likely that players need time to warm up (and hone) their shot when beginning a round. As expected, the coefficients for racks 2-5 are all statistically significant and positive-- thereby providing evidence that the first rack is indeed the most difficult to shoot from.

We also control for the year in which a shot took place. This serves to control for any factors that differed by year (e.g. shooting backdrop, fan attendance, etc.) that could potentially affect shooting percentages. However, the coefficient for *year* was not statistically significant in any of the specifications.

Round is a dummy variable equal to 1 for shots taken in the second round and equal to 0 for shots taken in the first round. The *round* variable was used in order to control for any differences between shooting in the first round versus the second round. For instance, shooters could learn from round 1 in order to increase their performance from round 2. However, in some model specifications, the *round* variable is not featured. This omission was made due to concern that characteristics allowing a contestant to reach round 2 might be related to characteristics that cause the individual to perform differently on "moneyball" shots. The *round* coefficient was typically positive and statistically significant, although the *moneyball* coefficient (or any other coefficient) did not appreciably change based on the inclusion or exclusion of the *round* variable.

The *guard* variable was included to control for differences in shot making ability between guards (who are typically shorter) and forwards/centers (who are typically taller). Guards are typically thought to have better 3 point accuracy since they are more likely to specialize in long distance shots. However, the results show that the *guard* coefficient is typically statistically insignificant.[6]

[6] The *guard* variable is not included in the fixed effect (FE) specifications because such models—by design—do not include any characteristics that are invariant for a given

IV. Conclusion

Although previous research has explored the link between incentive variation and performance in the laboratory or sports setting, this type of research has typically suffered because research participants have either been 1) unskilled novices playing unfamiliar skill games or 2) professional athletes in strategic situations (i.e. facing an opponent). Conversely, this paper utilizes a novel data set that includes performance metrics from highly skilled professional basketball players participating in the *NBA Three Point Shootout* from 2001-2010 (which is a non-strategic setting). The goal of each contestant was to maximize their total points scored each round given twenty shots worth 1 point each and 5 shots worth 2 points each. The shots worth 2 points each are called moneyballs. Traditional economic theory suggests that players would expend relatively more time/effort on the moneyballs and hence perform better on moneyball shots compared to regular shots. However, our findings suggest the opposite as players fared relatively *worse* on moneyballs. This result was statistically significant and robust to several econometric models. Our findings call into question the orthodox economic thought that performance hinges primarily (and predictably) on incentives. In fact, our results suggest that performance—even by highly skilled professionals—can actually *decrease* in the face of positive incentives.

Relatedly, CEO Nathan Kontny writes in a Forbes article that he choked under pressure during his role as the CEO of Highrise. He draws a parallel to his experience to that of golfer Jordan Spieth

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individual/contestant. An anonymous referee was also curious in regards to players at the '3' position (e.g. a player that could be listed as a guard or forward depending on the offensive system of their team). This was a very good point. When coding the data, we relied on the position classification from nba.com. However, there were some players in our sample (like Kyle Korver) that do not fit the classic guard/forward classification. This is a limitation of the data. It should be noted that our fixed effects model does account for this issue.

choking in the Masters.[7] Meanwhile, in a study on performance pressure and math performance, Beilock and Carr (2005) find that "performance pressure harms individuals most qualified to succeed by consuming the working memory capacity that they rely on for their superior performance." In a theoretical study, Bannier and Feess (2010) presume that "high ability workers choose steeply-incentivized contracts" even though these workers anticipate a choking effect; they do this to avoid "being mistaken for (and paid like) low ability employees." Given these findings, we believe empirical research should be extended to investigate the link between pressure and the performance of skilled business professionals. If bonuses do indeed tend to increase the pressure faced by high ability business professionals, then choking under pressure might also be relevant.

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