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Nerves of Steel? Stress, Work Performance and Elite Athletes

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Abstract:

There is a notable shortage of empirical research directed at measuring the magnitude and direction of stress effects on performance in a controlled environment. One reason for this is the inherent difficulties in identifying and isolating direct performance measures for individuals. Additionally most traditional work environments contain a multitude of exogenous factors impacting individual performance, but controlling for all such factors is generally unfeasible (omitted variable bias). Moreover, instead of asking individuals about their self-reported stress levels we observe workers' behavior in situations that can be classified as stressful. For this reason we have stepped outside the traditional workplace in an attempt to gain greater controllability of these factors using the sports environment as our experimental space. We empirically investigate the relationship between stress and performance, in an extreme pressure situation (football penalty kicks) in a winner take all sporting environment (FIFA World Cup and UEFA European Cup competitions). Specifically, we examine all the penalty shootouts between 1976 and 2008 covering in total 16 events. The results indicate that extreme stressors can have a positive or negative impact on individuals' performance. On the other hand, more commonly experienced stressors do not affect professionals' performances.

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I. INTRODUCTION

On July 17 1994, at the Los Angeles Rose Bowl, Brazil attempted to secure its 4th FIFA World Cup trophy, in probably one of the most memorable shootouts in World Cup history. One of Italy's greatest ever players and a shining light of the tournament, Robert Baggio, took what was to be the final shot of the U.S. World Cup. Baggio placed the ball on the spot, while Taffarel, the Brazilian goal keeper, took his position on the line in front of 94,000 spectators. The fascinating aspect of such a "high pressure" situation is the fact that after 4 years of preparation, several matches before this final, 120 minutes of game time, and 8 prior penalty attempts, one single shot held the match outcome in the balance. If Baggio misses then Italy loses the greatest prize of all in football, namely the World Cup; if he is successful Italy still can retain a glimmer of hope of being world champions. As many readers may know Baggio shot not only missed but it soared meters over the crossbar which meant that Italy lost the tournament and Brazil became the 1994 World Cup champions. Did the pressure of the situation contribute to Baggio making such a mistake? What factors influenced such an outcome? Was it the crowd, the pressure of losing or just simple bad luck or in other words a random event? If it is a random result, there is no reason to conduct an analysis of the determinants of penalty success. In this case, an empirical analysis should also indicate that there are no major driving forces that affect the outcome. On the other hand, it is commonly reported that a team has been able to succeed by managing to "hold its nerve together". Such a statement would suggest that a penalty process is not a lottery.

In this paper we will explore penalty shootout kicks taken in the knock-out phase of the two major international events, the FIFA World Cup and the UEFA Euro Cup competitions, working with a large data set that covers the period between 1978 and 2008 (16 events). The "Baggio example" used above, shows that elite sports are so highly competitive that a single poor choice can be the margin between victory and defeat (Driskell, Johnston, & Salas, 2001). In other words, this is a winner-take-all situation. Football games, as opposed to many other sports, provide the interesting characteristic of low scoring games. This often results in penalty kicks playing decisive roles in determining the success of a team in important international competitions like the World or Euro Cups, for example, not only the 1994 World Cup final was decided by penalties but also, for example, the most recent one in 2006. Anecdotal evidence based on autobiographies suggests that the stress associated with performing these kicks in such major international tournaments is immense (Jordet, Hartman, Visscher, & Koen, 2007), but surprisingly, many coaches do not include specific penalty drills in their training routines as they believe the shot success to be an entirely random process (Bonizzoni, 1988). This lack of specific training reduces players' ability to use strategies that help to reduce the effects of stress on performance.

The 'inverted U' theory of stress indicates that at levels of stress greater than an individual's threshold, or ability to effectively cope, inefficient and poor choices are being made. It is these 'bad' decisions which can be very costly in terms of work performance and individual or team success (Driskell et al., 2001; Epstein & Katz, 1992). In many sports disciplines considerable effort is being devoted to the development and

implementation of methods in an attempt to minimize or overcome such negative effects. These methods include "Stress Inoculation Training" (SIT) and "Decision Training" (DT). SIT is based upon the disease inoculation concept: by exposing the athlete's to a milder form of stress it can improve the coping mechanism. Either making the athlete immune to or reduce the effect of possible future stressors (Meichenbaum, 2007). DT is a training regime that attempts to remove the decision element from athletic motor skill functions via repetitive training programs. DT is derived from the "gestalt concept" where the whole is greater than the sum of its parts. Such that training needs to include environmental and situational stressors as part of the system (Vickers, Livingston, Umeris-Bohnert, & Holden, 1998). Research shows that by using this pedagogy it takes longer to acquire initial skill sets but display higher skill levels under stress conditions. This training concept has also been applied to areas outside sport, such as training of medical practitioners on procedures and medical equipment. The research has shown improvements in both skill retention and greater ability under real stress conditions whilst using the specialist equipment (Thuraisingam, Levine, & Anderson, 2006).

One of the problems plaguing the empirical analysis of the stress/performance relationship arises because of the difficulty of measuring work performance well. In many occasions performance can be seen as a "fuzzy" concept that is not fully comparable among workers. If two workers get the same work performance score, the performance should really be the same on the underlying characteristic, otherwise the effectiveness of the statistical analysis deteriorates (Allison 1999). Another criticism is the use of field data in a multiple regression context instead of non-random experimental

data. Multiple regressions are not fully able to estimate without noise the single estimate for the effect of stress on performance as it is impossible to measure all the variables that might conceivably affect performance. Allison (1999, p. 20) nicely points out "No matter how many variables we include in a regression equation, someone can always come along and say, "Yes, but you neglected to control for variable X and I feel certain that your results would have been different if you had done so". The question now arises whether we are able to find work environments that are close to an experimental setting. Several researchers stress that sports events come close to an experimental environment. For example, Goff and Tollison (1990, pp. 6-7) state: "Sports events take place in a controlled environment, and generate outcomes that come very close to holding "other things equal." In other words, athletic fields supply real-world laboratories for testing economic theories. The data supplied in these labs have some advantages over the data normally used in economic research (…) The economist can perform controlled experiments similar to those performed by the physical and life scientists. Sports data afford a similar opportunity. Although the laboratory is a playing field, the data generated are very "clean." Most external influences are regularly controlled by the rules of the game".

Thus, sporting events can be seen as "quasi-natural field experiments" where subjects are acting in the natural environment instead of an artificial laboratory environment (natural incentives to perform). It has been shown that experiments performed in an environment where the test subjects are keenly aware that their behavior is being monitored are prone to change their normal behavior such that it is difficult to generalize the results (Levitt & List, 2008). Moreover, selection effects are also visible

when recruiting subjects for (lab) experiments (e.g., "scientific do-gooders" interested in research). In addition, real field events such as penalty kicks are numerous and are driven by large financial incentives. Football players compete in an actual high stake contest such as the World Cup, but in a very controlled environment (Goff & Tollison, 1990). This realism provides researchers with a clear advantage over laboratory, self-reporting and other forms of experiments while maintaining the randomness of natural data (Reiley & List, 2007). The sporting events are also relatively controlled events where all participants encounter the same environmental variables. This allows for a large number of the exogenous (external) factors to be controlled when exploring the relationship between stress and performance. In addition, one should note that penalty shootouts are even more controlled than the regular game period as team interactions (individual performance is affected by teammates' performance directly (e.g., assists etc.),) for example, are no longer that relevant.

Thus, in this paper we are going to explore the impact of a set of different stress factors on players' performance. Our hypothesis is that less predictable, anticipated and experienced stress factors have a stronger impact on performance than routinely experienced stress determinants. In addition, athletes react to incentives. A large difference between individual/team expected benefits of success and the expected costs of failure leads to behavioral consequences. A large positive difference promotes performance (*positive stress*) while a negative difference reduces performance (*negative stress*).

II. THEORETICAL CONSIDERATIONS

The last few decades has seen a major expansion into the exploration of causes and consequences of stress or the perception of stress in the work environment (see, e.g., Holt, 1993). As well as the physical and mental health issues, an additional consequence of stress is the breakdown in judgment and rational decision making and the generation of mistakes. Research into the medical profession has shown that doctors report making serious mistakes in patient care, directly due to the effect of working under high levels of stress (Reason, 1990; Rosenthal, 1995) and not because of incompetence, lack of skill or training (Firth-Cozens & Greenhalgh, 1997). Furthermore, other experiments have shown a clear tendency for individuals working under stressful conditions to incorrectly weight options (Wright, 1974). Early studies explored the emergency decision making process and found that time and pressure seemed to be major determinants of hyper-vigilance (Schultz, 1966; Janis & Mann, 1977). The inability to scan alternative options and the incorrect weighting of payoffs creates a problem within traditional choice models by leading to inefficient or poor outcomes (Keinan, 1987). As stress levels increase individuals are less able to make rational choices, leading to larger choice impairment (Meichenbaum, 2007). In these situations individuals may fall back on other non-rational methods of making decisions. Political psychology literature has shown that under stress individuals act as "satisfiers" instead of the expected "optimizers". In the case of policymakers it has been found that they rely on ideological or operations principles as decision guides rather than a detailed analysis of any particular policy issue (George, 1980). Thus, individuals under stress have been shown to make poor or bad decisions,

however explaining how little or how much stress is required to affect decision making has been in contention (Jamal, 1984).

The literature describing the relationship between stress and performance has generated many contradictory models (Edwards, Guppy, & Cockerton, 1992). Sullivan and Bhagat (1992) illustrated four of the more common models which included: 1) higher levels of performance require at least some moderate level of stress; 2) a positively correlated relationship such that only through high stress could high performance be achieved; 3) a negatively correlated relationship where high stress results in low performance levels; 4) and finally that stress and performance are totally unrelated. Instead of a linear model, psychology has worked with a curvilinear (the inverted-U) model (see Allen, Hitt, & Greer 1982; Meglino, 1977; Yerkes & Dodson, 1908), where low levels of stress spur individual performance upwards but after a threshold point additional stress becomes detrimental to performance. Within the inverted-U model, two post threshold stages of performance degradation have been well discussed within psychological and sports literature (see e.g. Baumeister, 1984; Baumeister & Showers, 1986). These have been identified as the 'choking' and 'panicking' stages (Beilock & Carr, 2001; Bourne & Yaroush, 2003; Lehner, Seyed-Solorforough, O'Connor, Sak, & Mullin, 1997). Choking behavior occurs with a shift from the normal automatic and reactive response behavior, to the more laborious and time consuming step-by-step thought process. Athletes begin to "second guess" the automatic response of the highly practiced and well-learned repetitive skills. The over-thinking of actions result in slowed reaction times and degraded performance. The panic stage response results in further

degrading of reactions and performance. An individual's behavior reverts to primitive maladaptive instinctive thinking (Epstein & Katz, 1992). Here the panicked individual obsessively focuses on singular aspects or tasks to the neglect of all else, resulting in an inability to respond to any changes outside the panic focus. It was this behavioral reaction that was, for example, perceived to be responsible for a catastrophic and tragic event 1988, which saw the USS Vincennes mistakenly shoot down an Iran Air passenger flight. The investigation found that the US officer in charge of target identification was exhibiting the panicked obsessive state triggered by excessive levels of stressed (Collyer & Malecki, 1998).

Two distinct subsets of stressors that influence the decision making process has been identified: "task-related" and "ambient stressors" (Cannon-Bowers & Salas, 1998). The task related stressors include: workload and time pressures, uncertainty and ambiguity, or auditory overload. Ambient stressors include: auditory interference, performance pressure, or fatigue and sustained operations. Workload pressures specifically relate to number of tasks an individual is able to successfully handle simultaneously (by increasing the number of task the levels of stress increases). Whereas time pressure stressors is directly related to the amount of perceived time remaining to complete a task, as the perceived window shortens stress levels increase. When the number of tasks exceeds the individual's ability to process or the time remaining to complete a task is less than the amount of time perceived to be required, individual performances begins to wane and more mistakes are made. Uncertainty and ambiguity stresses are generated when intent or information is lacking. For example role ambiguity

stress occurs when the individual is unsure of the role they are supposed to fulfill or perform (this stressor type is not expected to be observed in this setting). Finally auditory overload occurs when too much information is being passed to an individual, through auditory means, to be coherently received and understood. Such as receiving instructions or auditory cues in a noisy work environment with many other auditory distracters present. In general we would expect to observe in the penalty shoot out process that ambient stressors are more dominant than task related. Task related stressors are more present during normal match play.

This is quite different and separate from the 'ambient stressor' of auditory interference, whereby excessive noise levels interfere with normal thought processes, such as crowd noises or military personnel operating under gunfire. Work performance pressure has been well documented within the sports field (see, e.g., Beilock & Carr, 2001), where a heightened sense of self-consciousness creates high stress levels and degraded performance. Famous examples of this can be observed in the 1996 Masters Golf Tournament, with Greg Norman's final round collapse. In this stressor players 'know' a large audience is watching their move and awaiting possible mistakes, causing players to choke and over think what should be natural sporting movements and actions. Although Cannon-Bowers and Salas (1998) investigation was done with a military focus, the stress factors are consistent with Bourne and Yaroush (2003). They performed a review of stress factors for the National Aeronautics and Space Administration (N.A.S.A.), an equally high stress non-military setting. The extended set of stress factors included: extremes of temperature, extreme heavy or prolonged workloads, and social

pressures. As discussed in the first section, one of the advantages of using the sporting arena as the investigation ground is the chance to control many exogenous factors (hold them constant) which is generally less possible in other environments. In the case of the extended stress factors within a penalty shoot-out situation we observe that all players are subjected to identical environmental conditions. Thus extremes of temperature and prolonged workloads are the same for all players which helps to isolate the influence of other factors, namely, for example, auditory, work performance, and social stressors.

Research has shown that auditory stressors, which are the noise effect from large crowds, are known to have an impact on both players and referees alike (Greer, 1983; Nevill, Balmer, & Williams, 2002; Pollard, 1986; Schwartz & Barsky, 1977). Recent studies into the effects of noise on performance have found that noise levels appear to have a significant effect on both decision making and reaction times (Kjellberg, 1990; Kjellberg, Landstrom, Tesarz, Soderberg, & Akerlund, 1996; Larsson, 1989). The noise effect is driven by audience volume of attendance at matches, for this reason we use absolute crowd size as a proxy measurement for auditory stress. Additionally we have used the absolute crowd size divided by the stadium capacity as a proxy for the relative crowd size. This allows for control of the perceived crowd size. The sound generated in massive stadiums with a seating capacity of 100,000 only containing a crowd of 40,000 are perceived much different to a smaller stadium filled to close to capacity with the same 40,000 individuals. In addition, the performance is not only done in front of a large crowd at the games but also being aware of a large television audience. It has been shown that that audience presence promotes task disruption which can lead to negative performance

externalities due to self-consciousness (Baumeister, 1984; Beilock & Carr, 2001). This effect could be exacerbated in context of World and Euro Cups as the viewer audience can exceed 700 million in the finals. This would also indicate that international events like the Olympics and World Cups are some of the most stressful environments endured by elite athletes, due in part to the large viewing audience.

Additionally, the virtue of competitive sport and the standing of the competition itself create further work related stressors that is intrinsically linked to the very nature/design of the work. In drawn/tied matches the penalty shootout rules are initiated, creating a sudden death win/lose scenario. Penalty shots are comparable to a winner-take-all situation, where the outcome of any single kick to either win or lose, places much greater stress upon players (Jordet et al., 2007). The more comfortable situation for a kicker is the case where his team can win the game if he is able to achieve a goal. A successful kick will lead to large individual and team benefits. On the other hand, missing the opportunity means that the game is open again ("nothing is lost"). In other words, the expected costs of missing are substantially lower than the expected benefits of success. If individuals react positively to such incentives, one would predict that player performance would be better in this situation (positive stress effect). On the other hand, the kicker is confronted with a high expected costs in a situation of a relative disadvantage (when missing means losing), while the expected benefits are much smaller (team has not won yet and player has not made it happen). This can be defined as a negative stress situation. One may predict that in such a circumstance players may be more vulnerable to mistakes and underperformance due to stress. Thus, we would predict a higher probability of not

making a goal. The positive or negative effects are even large once we also consider the goalkeeper's incentives that work in the opposite direction. The literature on football has disregarded such a potential positive or negative effect. McGarry and Franks (2000) report with their simulation calculating scoring percentages that later kicks are more important than early kicks. Anxiety increases with kick importance leading to fewer goals. They stressed that the goal probability follows an inverted-U curve (least successful kicks early and late). On the other hand, Jordet et al. (2007) suggest a negatively linear curve with higher anxiety progressively resulting in a poorer outcome. Our predicted positive effect in case of a relative advantage would smooth out a non-linear relationship at the right hand side of the function, e.g., making the right hand side more linear. To investigate kick importance or in other words positive stress (expected benefits are substantially larger than expected costs) and negative stress (expected costs are substantially larger than expected benefits) we have included two dummy variables, namely a single kick that can result in an overall game win or loss (PRESSURE TO WIN and PRESSURE TO LOSE).

In addition, the relative importance of success and the level of perceived stress vary with the game level. As the finals series unfold and teams progress through the varying stages, e.g. round of 16, semi-finals, finals, the opportunity costs of losing increase. The perceived costs are higher for losing in the finals compared to the quarter-finals, given the closer proximity to the ultimate success of winning the competition. In this way we have encoded the varying levels in order of importance from 1 to 4, the higher the value the greater the importance of the match. Thus the round of 16 = 1,

quarter finals = 2, semi-finals = 3 and the final = 4, the normal round matches are not included as the penalty process is only used in the knockout stages. Both game level and shot outcome can be considered as work pressure stressors, as both are inherent factors of the tournament and rules structure. Thus we have created a proxy measures for game level.

As a robustness test we also consider social stressors. Football tradition may induce further pressure to players in the penalty shootout. Players of nations with a stronger football tradition bear the additional burden of expectation pressure. Nations that have long national football traditions and especially those national teams with outstanding national success could have a greater expectation of success, thus increasing the pressure upon players to perform. However, such players may have also a better ability to succeed. Thus, to control for such a social stressor, we control in this case also for players' ability.

III. METHOD

Design and Procedure

Explored in this paper are the penalty shootout kicks taken in the knock-out phase of the FIFA World Cup and the UEFA Euro Cup competitions. The rules pertaining to elimination games when after normal game time and a period of extra time has expired and team scores remain tied, penalty kicks are used to determine a winner (FIFA, 2008). The penalty shootout process is as follows: 5 players from each team are selected to take a penalty shot, in alternating succession each player will attempt to score from the

penalty spot opposed by only the opposition goalkeeper; the result is a best out of 5, a team wins by being the one to score the most goals out of the 5 shots; if at the end of the 5 shots the score is still a draw then the penalty shootout continues one pair at a time, where a single shooter from each team attempts to score until the tie is broken and one team wins; players are only allowed to shoot once until every member of the team has shot at least once. Such process places the full weight of game's outcome upon the shoulders of each kicker and goalkeeper in turn, determining the stresses placed upon these players will give a clearer picture of its effects on the success of penalty shots (isolation of an individual performance in a team sport). A penalty shootout is therefore much more controlled than performances during the main game.

The data for this analysis has been gathered through various method and sources including: FIFA game footage, the official FIFA web archives and other football databases. The data included player, game, tournament and historical data such as player statistics (e.g., age and years of international experience before the start of a particular tournament), game statistics (scores, outcomes, crowd sizes), tournament statistics (competition, game stage, etc) and historical statistics (e.g., FIFA association, world rank). We have calculated players' years of international experience, as the number of years since their first international debut. We identify all the kickers' and goalkeepers from the penalty shootout process in World and Euro Cup tournaments cover a large time period of over 30 years (1976-2008), resulting in 326 individual observations. This period covers 9 Euro cups but only 7 World Cups, due to the early adoption of the penalty shootout process in the UEFA tournaments. This results in about 43% of the observations

being taken from the UEFA tournament and the remaining 57% coming from the FIFA World Cups. A complete list of the descriptive statistics can be seen in Table 1. The average age of players varies depending on the role; we observe a clear age difference (-3.3 years) with goalkeepers on average 3 years older than the kickers (30 years and 27 years respectively). In line with this age difference we observe that goalkeepers have more international experience (6.2 years) than the opposing kickers (4.96 years). There is very little difference in the world rank position (-0.126) where the average world rank of the national teams for kickers is (40.02) and goalkeepers is (40.15). However, we do observe a large difference in the club ranking (-31.37) between kickers (77.6) and goalkeepers (109.06), indicating that kickers play for clubs of much higher rank (lower number is higher rank). Moreover, we observe very little differences in regards to FIFA membership (-0.683 years). Finally, we observe that 28% of all penalty shot are pressure shots, to either win (12.9%) or lose (15.1%).

The world ranking for national teams in this respect has not utilized the current FIFA Coca-Cola world ranking system, as this system was not in place until 1993. Therefore we have utilized the points system already in place for World Cups, in the variable NATIONAL WORLD RANK. Points are allocated such: 3 points for wins, 1 point for draws and nothing for losing, however prior to 1994 wins were allocated 2 points and a draw 1 point. We have accumulated this point's allocation over all the World Cups. Thus, teams with higher point accumulation at that period of time were ranked higher. The ranking of each team was determined by points immediately prior to commencement of each tournament. This ranking system was implemented for every

team over the duration of the analysis period, such that a continually evolving world ranking system has been used. This system allows us to demonstrate the effect of prior success in World Cups, as all matches won or drawn have an accumulation effect on the ranking. In this way our NATIONAL WORLD RANK variable, is also a proxy for the social pressure due to expectations. We have also included players' club world ranking at the time of the penalty process, utilizing the IFFHS world club ranking tables such that the lower the value the higher the club ranking position (IFFHS, 2009). As well as ranking statistics, we have included the variable for duration of national FIFA membership (years). This variable is a proxy that measures the level of football tradition within a country (see Torgler 2006, 2008).

Our data variables include not only the absolute values of variables like age, experience, world rank and FIFA membership but we also investigate the difference of these variables (e.g., DIFF.EXP.: kicker's experience – goalkeepers' experience).

Used Statistical Analysis

We use a multivariate regression analysis or specifically a probit model due to the non-linear and binary nature of the dependant variable. The dependant variable in this analysis is a dummy variable used to indicate either success or failure of a particular penalty shot (failure/miss = 0; success/goal = 1). Failure of a penalty shot encompasses all eventualities where the kicker was not successful in scoring a goal. This includes the goalkeeper saving/stopping the shot, the shot hitting the uprights or cross-bar and deflecting outwards, or the kickers shot being off target and missing the goals entirely. In

other words, our dependent outcome variable has two values, goal or miss. We therefore use a probit model instead of a linear regression mode. As a linear regression model is unbounded, the model can produce negative predictions and predictions exceeding unity and therefore unrealistic probabilities. It is also not possible to arbitrarily constrain the point predictions outside the unit interval to either 0 or 1 as the error term would not satisfy the assumption of homoskedasticity (Baum, 2006). A probit model allows us to solve these problems implementing a non-linear function that takes on values strictly between zero and one. Alternatively, one could also estimate a logit model as variations of these nonlinear functions have been suggested, but we prefer to use a model where such a function is the standard normal cumulative distribution function.

As the estimated probit coefficients are based on a non-linear estimation technique, we cannot interpret the coefficients readily in terms of the quantitative sizes of the effects. We therefore calculate the marginal effects to find the quantitative effect of an independent variable. The marginal effect indicates the penalty success rate or the probability of success when the independent variable increases by one unit. We compute the marginal effects at the multivariate point of means exploring therefore a marginal change of the variable x from the average x.

To isolate the effect of stress and performance, we control for individual factors (age, experience, position, ability), team factors (team strength and tradition) and tournament (dummy variables for all the events, but also in some regressions a dummy variable between EURO and World Cup to see tournament differences). Age and

acclimation training have been found to be valid mechanisms for displacing stress effects (Johnston, Poirer, & Smith-Jentsch, 1998). Acclimation can be achieved through experience, as individuals become more familiar with the working environment and skills are less impacted by stressors and make better decisions (Cannon-Bowers & Salas, 1998; Wright, 1974). However, as we are not privy to the training regimes of teams we are unable to construct any direct proxies in relation to any stress reduction activity like SIT or DT directly. However, we checked the robustness of our results using team dummy variables to take into account unobserved team effects or we control for example, for the quality of the team through their current international ranking position in further regressions. These team dummy variables have included every team for the two competitions, e.g., a dummy was created for Brazil for each of the matches in which they participated in the dataset, in this manner we control for team effects.

IV. RESULTS

Table 2 presents the results. As can be seen, we add the stress factors sequentially in the specification starting in equation (1) with the dummy variables PRESSURE SHOT TO WIN and PRESSURE SHOT TO LOSE, and exploring in the next also the absolute (LOG CROWD SIZE) and the relative crowd size (CROWD SIZE/STADIUM CAPACITY) and then also the game level situation within the tournament. In all estimations we also use time dummies to control for unobserved time effects. To take into account a player's characteristic we control in a first step for kicker's and goalies' age. The results indicate that the two variables PRESSURE SHOT TO WIN and PRESSURE SHOT TO LOSE have strong impact on the success of a penalty shot. Being

in situation of a relative advantage having the chance of winning the game with a successful penalty increases the probability of a goal by around 17%. On the other hand, being in relative disadvantaged situation (pressure to lose) leads to a decrease of success by around 45%. Thus, this is a quite significant effect and it is interesting to observe that the marginal effects are stronger in case of a relative disadvantage compared to relative advantage. Negative stress has therefore a stronger impact on performance than positive stress. Looking at all the other proxies for stress (relative and absolute crowd size, game level) we observe that these factors have no statistically significant impact on the probability of a penalty performance. Based on our hypothesis, this is not a surprise. Such international professional players are used to play in front of a large absolute and relative audience. In addition, we observe a selection effect. The process to become an elite athlete would include demonstration of individual ability to handle such a stress and those unsuccessful individuals would have left the sport prior to reaching this level. On the other hand, players might be less used to semi-finals or final in such big international tournaments which suggest that the stress level increases and that such an increase is correlated with a performance. However, they may experience similar important international games at the club level (e.g., Champions League). Many of the best international players work for Spanish, Italian, English or German clubs. Maguire and Pearton (2000) reported that European clubs employed 62 percent of the players participating in the 1998 World Cup in France. Moreover, players can adapt to the situation insofar as they know in advance when they are going to play the game. In other words, they can prepare themselves mentally and physically for that event. This is different for penalty shootouts. The trainer may have some favorites, but the process

throughout the game also affects trainer's choice and player's willingness to shoot the penalty (e.g., fatigue, still part of the team, injuries, bad day etc.). Studying the videos during the break before the penalty shootout clearly indicates that the trainers are preparing or finalizing the list of penalty kickers and the strategy to conduct at that time. In addition, in many of the cases a player does not know in advance whether he will be in a situation of "pressure to win" or "pressure to lose". Such a higher level of uncertainty reduces individuals' mental and physical preparation for such an event. In addition, we have stressed in the introduction that athletes react to incentives. This is confirmed with our analysis. A large difference between individual/team expected benefits of success and the expected costs of failure seemed to affect players' stress levels and therefore their performance. A large positive difference promotes performance (positive stress) while a negative difference reduces performance (negative stress). We also observe that age is a significant factor on performance stress of kickers, such that as the age of the kicker increases so does the probability of being unsuccessful thus increasing the stress levels, however the age effect does not appear to be statistically significant for goalkeepers.

We conduct several robustness tests. A summary of the results are reported in Table 3. For simplicity, we only report the results of our key independent variables, namely our stress factors. The results obtained with these additional variables are discussed in the main text. The continuous age variable has been re-coded in line with Jordet et al. (2007) into categories (22 and below: young; between 23 and 28: medium; 28 and older (older)). The results show that even after splitting the age variable for both kickers and goalkeepers into these three categories we observe little variation within the

stress factors (see specification 6). However, we do observe that middle age kickers are significantly less likely to be successful (-13.7%) than their younger counterparts (statistically significant at a 10% level). Furthermore, we do not observe any significant change for goalkeepers across the three age groupings. We also control for kickers' and goalkeepers' experience using the number of years playing at the international level as a proxy for experience (specification 7). Moreover, instead of adding the single goalkeeper and kicker factors we also build the differences in experiences. The results show that the single factor of experience does not have a significant effect on the outcome of the penalty process). However, the difference in experience is statistically significant at 10% level, having noticeable effect on the outcome. A marginal decrease in a kicker's relative experience advantage by one year (from the average) reduces probability of success by around 1%. One should note that these two specifications indicate that the quantitative effects for PRESSURE SHOT TO WIN and PRESSURE SHOT TO LOSE don't change substantially. The coefficients remain statistically significant. On the other hand, the other stressor factors are still not statistically significant.

Next, one can stress that goal-scoring skills are derived from positional roles (Jordet et al., 2007). Players with the primary task of scoring goals may perform differently than other players in the penalty kick. We therefore control in specification 8 for players' position within the game with dummy variables (forward, midfield, and defender). The results indicate that the position of a player has ceteris paribus no influence on the penalty success. In the same specification we also control for the dominant foot of players (dummy, right=1). Research into the kick selection process of

players has shown that foot dominance is reflected in positional bias of the kick. A right-footed kicker is much more successful shooting to their natural side (which is to the right from the perspective of the goalkeeper), resulting in better rates of success (Chiappori, Levitt & Groseclose, 2002). However, this does not ensure kick direction as if the placement becomes predictable the goalkeeper will have a much better probability of successfully stopping/catching the ball (Leela & Comissiong, 2009). Our results show that there are no differences in success between right- and left-footed kickers.

Furthermore, we extend the previous estimations controlling in a better manner for players' ability. One can argue that experience, measured as the years of international experience, may already help to control for players' ability and skills. This allows to better isolate the impact of stress on performance otherwise one can criticize that observed performance differences are driven by ability or skills. Thus, to further control for ability or skills we also control in which club the player is active (club world ranking). The club ranking should be strongly correlated with players' skills and abilities. Also here we run estimations with the absolute values and the differences between the players. As shown in specification (9) we observe little change in our main stress factors. Interestingly, both ability/skill proxies (and the differences between kicker and goalkeeper) have no statistically significant effect on players' shot success. That might be a reason why many trainers believe as discussed previously that penalty shots are a random process that does not require substantial training and preparation. Additionally the difference between club ranks of kicker and goalkeeper is not significant. These results may also be caused in part by the fact that a vast majority of the players are

playing in elite European competitions (low quality difference). Table 3 indicates that the results in regards to our stress factors remain robust.

To measure also team quality in further estimations, we explore a variety of different cases: a World Cup ranking based on past performances in World Cups (NATIONAL WORLD RANK, see previous discussion), the number of World Cup wins in the past before the competition started, and the duration of FIFA association. In line with previous estimations we explore first single averages and then differences. Besides competence, these variables may also relate to social stress. Players are national representatives and as such bear the additional burden of expectation pressure, driven by national pride and tradition. Nations that have long national football traditions and especially those national teams with outstanding national success could have a greater expectation of success, thus increasing the pressure upon players to perform (Torgler, 2004). However, as a player from such a team may also be better, it is useful to control for players' ability in such regressions. As can be seen we control in these specifications for international experience and club affiliation (club ranking). The results indicate that even when controlling for team quality the quantitative effect of our main stress factors don't change substantially. On the other hand, the proxies we have used to measure social stress (expectation and tradition) are mostly not statistically significant. Such a result is consistent with our hypothesis and can also be explained using the Stress Inoculation Training (SIT) process. The high expectations are not instantaneous in nature, but build over periods of time. Players were raised within such a football culture where expectations are high and are in a sense used to it (socialization process).

We also run estimations with team dummy variables to take into account for unobserved team heterogeneity of team effects (see specifications 10 to 12). This may cover issues such as training intensity or training programs, trainer's strength, social cohesion, talent pool etc. It is also a proxy for historical strength or football culture.

In sum, previously obtained findings are robust, even after subjecting the stress factors to numerous robustness tests controlling for aspects such as individual factors (position, skill and ability) or team factors (e.g., team strength, football tradition). The marginal effects for our two key variables (PRESSURE SHOT TO WIN and PRESSURE SHOT TO LOSE) hardly change and coefficients remain in all cases statistically significant. On the other hand, the other stressors are consistently not statistically significant. Thus, the previous results obtained in Table 2 remain robust confirming our hypothesis that less predictable, anticipated and experienced stressors have a stronger impact on performance than routinely experienced or predictable stress determinants. Moreover, players react to positive and negative stressors, while the effect for a negative stressor on performance is substantially larger.

V. CONCLUSIONS

This study builds upon prior research investigating the relationships between work stressors and performance, through the examination of a high pressure situation in the working environment of elite athletes. It explore penalty shootout kicks taken in the knock-out phase of the two major international events, the FIFA World Cup and the

UEFA Euro Cup competitions, working with a large data set that covers the period between 1978 and 2008 (16 events). Penalty shootouts are so highly competitive that a single poor choice can be the margin between victory and defeat (winner-take-all situation).

We explore different stress factors and find that predicable, anticipated and experienced stress factors (routinely experienced stress determinants) have no impact on performance. On the other hand, less predictable anticipated stressors (individual final shot stressors), appear to be very important in understanding performance success. In addition, athletes react to incentives. A large difference between individual/team expected benefits of success and the expected costs of failure leads to behavioral consequences. A large positive difference promotes performance (*positive stress*) while a negative difference reduces performance (*negative stress*). Being in situation of a relative advantage having the chance of winning the game with a successful penalty increases the probability of a goal by around 17%. On the other hand, being in relative disadvantaged situation (pressure to lose) leads to a decrease of success by around 45%. Thus, this is a quite significant effect and it is interesting to observe that the marginal effects are stronger in case of a relative disadvantage compared to relative advantage. Negative stress has therefore a stronger impact on performance than positive stress.

Thus, the effect of high stress on the performance of elite athletes is empirically observable in this sporting environment. Here a poor decision can result in the elimination of a national team from an international sporting event in the real world the

result could be much worse. A poor decision made by emergency workers, doctors, military leaders or the CEO of multinational corporations could result in the loss of lives, jobs or billions of dollars.

The present study has limitations that need to be acknowledged and suggest possible avenues of future research in this area. A central concern to the future study of stress and performance is that of measurement, successful testing of stress impacts on individuals requires good and comparable measures of individual performance. The use of the sporting environment to examine the stress/performance relationship has both limitations and advantages. In the introduction we have discussed in the detail the advantages. The sports environment provides the ability to observe behavioral consequences in a control environment that allows isolation the potential impact of stress on performance in a better manner. One limitation of adopting a non-standard work environment is that translating the results back into the traditional work environment may be difficult. In other words one should be care in generalizing from the results of research working with sports data to the population as a whole. For example, players' average salary is far above the median earnings of full-time, full-year equivalent workers. However, it has been shown that sports athletes are motivated by similar forces that affect workers in general and sports labor markets can been seen as a laboratory for observing whether some theoretical propositions have a chance of being correct (Kahn, 2000). Given the importance of stress in the workplace we hope that the use of the sports environment opens future studies to a wider scope of possible research questions.

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TABLES

Table 1: Descriptive Statistics.

Variable	Obs.	Mean	Min	Max
KICKER AGE	325	26.917	16	35
KICKER INTERNATIONAL EXPERIENCE	325	4.96	0	16
KICKER CLUB RANK	325	77.637	1	250
KICKER NATION WORLD RANK	325	40.028	1	130
KICKER FIFA MEMBER	325	88.797	15	143
KICKER WORLD CUP WINS	325	0.7938	0	4
GOALIE AGE	325	30.218	21	41
GOALIE INTERNATIONAL EXPERIENCE	325	6.2	0	20
GOALIE CLUB RANK	325	109.006	1	250
GOALIE NATION WORLD RANK	325	40.154	1	130
GOALIE FIFA MEMBER	325	89.48	15	143
GOALIE WORLD CUP WINS	325	0.8031	0	4
LOG CROWD SIZE	325	10.835	9.796	11.453
CROWD SIZE/STADIUM CAPACITY	325	0.945	0.333	1.538
PRESSURE SHOT TO WIN	325	0.129	0	1
PRESSURE SHOT TO LOSE	325	0.151	0	1
DIFFERENCE AGE	325	-3.302	-18	12
DIFFERENCE INTERNATIONAL EXPERIENCE	325	-1.24	-18	13
DIFFERENCE CLUB RANK	325	-31.37	-249	247
DIFFERENCE WORLD RANK	325	-0.1262	-83	83
DIFFERENCE FIFA MEMBER	325	-0.683	-97	97
DIFFERENCE WORLD CUP WINS	325	-0.009	-4	4

Table 2: Stress determinants

Probit	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
PRESSURE SHOT TO	0.817**	0.814**	0.794**	0.800**	0.796**
WIN	*2.41*	*2.40*	*2.36*	*2.37*	*2.32*
	0.174	**0.174**	**0.170**	**0.171**	**0.168**
PRESSURE SHOT TO	-1.26***	-1.26***	-1.284***	-1.276***	-1.31***
LOSE	*-5.73*	*-5.74*	*-5.81*	*-5.77*	*-5.84*
	-0.441	**-0.442**	**-0.450**	**-0.447**	**-0.456**
LOG CROWD SIZE		0.186	0.256	0.059	-0.034
		0.53	*0.72*	*0.14*	*-0.08*
		0.053	**0.073**	**0.017**	**-0.010**
CROWD			-2.62	-1.89	-1.578
SIZE/STADIUM			*-1.46*	*-0.93*	*-0.77*
CAPACITY			**-0.742**	**-0.535**	**-0.442**
GAME LEVEL				0.121	0.201
				0.77	*1.23*
				0.034	**0.056**
KICKERS AGE					-0.041*
					-1.74
					-0.011
GOALIES AGE					0.039
					1.54
					0.011
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Obs.	325	325	325	325	325
Prob.>chi2	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo R2	.1774	.1782	.1841	.1857	.2003

Notes: z- values in italics, marginal effects in bold. The symbols *, **, *** represent statistical significance at the 10% ($p < .10$), 5% ($p < .05$) and 1% ($p < .01$) levels, respectively.

Table 3: Robustness Tests

Probit	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
PRESSURE SHOT TO WIN	0.852**	0.857**	0.855**	0.850**	0.861**	0.852**	0.849**
	2.43	*2.46*	*2.43*	*2.40*	*2.36*	*2.31*	*2.29*
	0.176	**0.176**	**0.176**	**0.174**	**0.168**	**0.163**	**0.163**
PRESSURE SHOT TO LOSE	-	-	-	-	-	-	-1.348**
	-5.73	*-5.79*	*-5.72*	*-5.48*	*-5.72*	*-5.56*	*-5.55*
	-0.445	**-0.455**	**-0.453**	**-0.438**	**-0.474**	**-0.461**	**-0.460**
LOG CROWD SIZE	0.0887	0.036	0.034	-0.051	3.245	7.101	6.130
	0.20	*0.08*	*0.08*	*-0.11*	*-0.40*	*0.71*	*0.75*
	0.025	**0.010**	**0.010**	**-0.014**	**0.873**	**1.881**	**1.621**
CROWD SIZE / STADIUM CAPACITY	-2.20	-2.478	-2.48	-1.918	1.638	-	-29.18***
	-1.07	*-1.20*	*-1.18*	*-0.89*	*0.46*	*-3.94*	*-4.06*
	-0.616	**-0.693**	**-0.693**	**-0.535**	**0.441**	**-6.014**	**-7.718**
GAME LEVEL	0.151	0.149	0.150	0.169	0.855*	-	10.669***
	0.92	*0.90*	*0.90*	*1.00*	*1.91*	*-2.93*	*-3.32*
	0.042	**0.042**	**0.042**	**0.047**	**0.230**	**-2.240**	**-2.822**
AGE GROUPING	Yes	Yes	Yes	Yes	Yes	Yes	Yes
INT. EXP.		Yes	Yes	Yes	Yes	Yes	Yes
DIFF. EXP.		Yes	Yes	Yes	Yes	Yes	Yes
PLAYER			Yes	Yes	Yes	Yes	Yes
DOMINANT			Yes	Yes	Yes	Yes	Yes
CLUB WORLD				Yes	Yes	Yes	Yes
DIFF CLUB				Yes	Yes	Yes*	Yes
WORLD RANK					Yes	Yes	Yes
DIFF. WORLD					Yes	Yes	Yes
FIFA MEMBER						Yes*	Yes
DIFF. FIFA						Yes*	Yes
WORLD CUP							Yes
DIFF. WORLD CUP WINS							Yes
Team Dummies					Yes	Yes	Yes
Time Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	325	325	325	325	325	325	325
Prob.>chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
Pseudo R2	0.1964	0.2019	0.2021	0.2070	0.2579	0.2676	0.2689

Notes: z- values in italics, marginal effects in bold. The symbols *, **, *** represent statistical significance at the 10% ($p < .10$), 5% ($p < .05$) and 1% ($p < .01$) levels, respectively (see also added factors) such as DIFFERENCE WORLD RANK.