An Empirical Examination of Multidimensional Effort in Tournaments

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Abstract

We provide explicit empirical tests of worker-incentive models in which individuals can devote costly effort to increasing their own output and to decreasing their opponents' output. The predictions of incentive theory on this dimension have previously remained untested because systematic evidence of 'sabotage' activities by workers is, by nature, difficult to obtain. In this investigation we exploit an incentive change that took place in European soccer league tournaments and various forms of sabotage activities that are systematically recorded. Moreover, we also use the fact that the same teams were simultaneously playing a different tournament in which there was no change in the reward spread between winners and losers. The evidence we uncover from this unique dataset is consistent with the predictions of the sabotage-based theory of tournaments. In particular, we find that the increase in the spread between winning and losing led to a significant increase in both sabotage effort and creative effort; that this increase did not increase total production; and that the increase in sabotage was larger in stronger teams, which normally engage in less sabotage activities, while the increase in creative effort was larger for weaker teams, which normally engage less in creative effort. These results suggest that multidimensional effort models hold a great deal of promise for enhancing our understanding of the incentive effects of these reward systems.

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1 Introduction

Tournaments are distinguished from other incentive devices by the fact that an agent’s payment in a tournament depends only on his performance relative to that of other agents covered by the same incentive system. In the simplest possible case, the rank-order tournament, the agent’s payoff depends only on the rank of his performance relative to that of other agents in the system. Tournaments are pervasive. For example, tournaments have been found to describe the compensation structures applicable to managers, corporate executives, salespeople (whose bonuses typically depend on their sales relative to those of other salespeople in the firm), assistant professors (who compete for a limited number of tenured positions), professional sports players, and many other occupations.

Over the last few years an important theoretical literature has studied the properties of tournaments as incentive devices. The classical framework of analysis assumes that agents’ efforts are unidimensional, in particular that workers can allocate their time and attention only in the direction of productive activities (see Lazear and Rosen (1981), Green and Stokey (1983), Nalebuff and Stiglitz (1983), and Prendergast (1999) for a review). Testing the implications of the theory, however, has proven extremely difficult, primarily because many of the predictions hinge on properties of utility functions and the values of the rewards used. Even when only productive efforts are considered in the model, data on these parameters are seldom available. Moreover, there is often great difficulty in measuring both individuals’ effort levels and the incentive structures competitors face. Indeed, among the few readable testable propositions are those concerned with the size and distribution of prizes in sport match-play tournaments (see Rosen (1986) and Ehrenberg and Bognanno (1990)). Also, in view of the substantial problems with testing the theory of tournaments using natural data, some authors have been compelled to test it in experimental settings (Bull, Schotter and Weigelt (1987)).

Recent theoretical developments in the literature have also recognized that interactions among workers are an important aspect of the work environment and that workers can affect the productivity of other workers with whom they are compared. This fundamental idea has been incorporated into the analysis by assuming that agents’ efforts can be multidimensional. In particular, the relative comparisons that
take place in a tournament imply that individuals can improve their relative position in two ways: through increased “creative” effort, which has a positive effect on output (the initial idea in Lazear and Rosen (1981) and in most of the literature that followed), and through “destructive” effort or “sabotage,” that is through actions that can adversely affect the output of other workers, such as blocking cooperation and erecting barriers so that coworkers cannot obtain useful information.\(^1\)

Lazear (1989) provides the fundamental theoretical framework for the analysis of tournaments when agents can devote costly time and effort in these two directions (see also Rob and Zemsky (1997)). Each agent selects two types of effort: productive effort, which directly increases his or her own measured contribution to output, and sabotage effort, which decreases the measured contribution of the other agent. Among other results, the model predicts that the larger the spread between the winner and the loser the more important are each of these effects. It also predicts that the productive incentive effects will not tend to offset the lost output that results from increased sabotage behavior.

If testing the implications of tournament theory with unidimensional efforts has proven difficult in the literature, the empirical study of tournaments with multidimensional efforts, in particular with sabotage activities, has been impossible. Sabotage is, by its nature, unobservable except perhaps anecdotally. Workers engaging in sabotaging their fellow workers’ performance will certainly go to great efforts to conceal these activities. It is thus almost impossible to find any direct, objective evidence of sabotage activities.

Consequently, recent work in general incentive theory (not only tournament related) that stresses the multidimensional nature of agents’ efforts has been exclusively theoretical.\(^2\) Although the ability of a sabotage-based theory to explain the diversity of individual behavior in the work environment has significant practical and theoretical implications, notably for the choice of incentive systems, essentially no research has been devoted to testing the major predictions of this theory.

We aim to overcome these difficulties in this paper. Our analysis offers explicit

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\(^1\) We adopt Lazear’s naming convention and call effort that is intended to reduce the rival’s performance in the tournament ‘sabotage.’ It is worth noting, however, that although sabotage may connote an illegal action, in the technical sense we use it refers broadly to all actions (legal or illegal) that reduce rivals’ output. This use of the term is consistent with the common definition: “an act or process tending to hamper or hurt” (Merriam Webster Dictionary, Collegiate edition, 1993).

empirical evidence on sabotage-based agency problems and thus on some of the major predictions of the theory of tournaments. The empirical findings that we will present provide support for the implications of the model in Lazear (1989) and also point out various directions for further theoretical work.

We exploit a unique data set that permits us to take various objective measures of both productive efforts and sabotage efforts, as well as obtain information on the incentive structure and measures of output. Our empirical strategy focuses on a case where sabotage efforts are “legally” allowed in the tournament, and where such activities are officially recorded. We then test the main implications of the theory when an initial reward system experiences an exogenous change.

The exogenous change we examine is an increase in the spread of the rewards between winners and losers in soccer league tournaments. The data come from 750 professional soccer games in league competitions where a variety of measures of productive effort and sabotage effort within a game (a tournament) are available. In addition, data are available to control for factors other than the incentive structure that should affect output (e.g., team qualities). We also use data on a second class of games that were played simultaneously by the same teams but in a different tournament, in particular one in which no changes in rewards took place. We use these data to test for the main implications of a theory of tournaments that includes sabotage efforts.

To summarize some of the main results, we find that a greater reward spread leads to more productive effort and to more sabotage effort, that total output does not increase when the spread of rewards increases, and that weaker agents engage in relatively more sabotage activities than agents in a more favorable position. These results are consistent with the implications of a sabotage-based theory of tournaments and suggest that these models hold promise for enhancing our understanding of payment systems and their incentive effects.

The rest of the paper is organized as follows. The next section describes briefly the framework of analysis and major results of the positive theory of tournaments as developed in Lazear (1989) and in some detail the precise propositions that will be examined empirically. Section III describes the data. Section IV provides a description of our identification strategies. Section V is devoted to the empirical analysis, and Section VI contains some conclusions and suggestions for further research.
2 Sabotage in Tournaments: Theory

Consider the basic model of relative competition. To make it simple we adhere to the competitive structure and notation developed by Lazear (1989). The game consists of two players, $j$ and $k$, with output $q_j$ and $q_k$. Let output produced by these two players be given as

$$Q = Q(q_j, q_k),$$

where

$$q_j = f(\mu_j, \theta_k) + \epsilon_j,$$
$$q_k = f(\mu_k, \theta_j) + \epsilon_k,$$

$\mu_j$, $\mu_k$ is effort by $j$, $k$; $\theta_k$ is $k$’s “sabotage” inflicted on player $j$; $\theta_j$ is $j$’s “sabotage” inflicted on player $k$; and $\epsilon_j$ and $\epsilon_k$ are random terms such that $E(\epsilon) = 0$. These random components can be thought of as luck or unobserved and uncontrollable market forces. The term “sabotage” includes all legal and illegal costly actions that one worker takes to adversely affect the output of another, such as blocking cooperation, erecting barriers so that coworkers cannot obtain useful information, stealing valuable resources, or inflicting injuries.

The production functions are such that $f_1 > 0$ and $f_2 < 0$. This captures the idea that $\mu$ is productive effort and $\theta$ is counterproductive activity. Clearly, the direct effect of $\theta > 0$ is output reduction; however, the final effect need not be output reduction given that $\mu_j$ and $\mu_k$ may be sufficiently large as to make up for the lost output.

In a firm the identities of the players should not matter so $Q$ must be symmetric:

$$Q = Q(q_j, q_k) = Q(q_k, q_j).$$

When only relative performance matters, what is crucial is the difference between the reward that the winner receives, $W_1$, and the one that the loser receives, $W_2$. To see this note that individual $j$ solves the following problem:

$$\max_{\mu_j, \theta_j} W_1 P(\mu_j, \theta_j; \mu_k, \theta_k) + W_2 \left[ 1 - P(\mu_j, \theta_j; \mu_k, \theta_k) \right] - C(\mu_j, \theta_j),$$

where $P(\mu_j, \theta_j; \mu_k, \theta_k)$ is the probability that he wins the tournament conditional on his choice of $\mu_j$ and $\theta_j$, and he produces $\mu_j$ and $\theta_j$ according to the cost function $C^j(\mu_j, \theta_j)$. Player $j$ wins if $q_i > q_j$. In a Nash equilibrium, $\mu_k$ and $\theta_k$ are taken as given by $j$. Note that

$$P(\mu_j, \theta_j; \mu_k, \theta_k) = \prob(q_j > q_k)$$
$$= \prob(f(\mu_j, \theta_k) - f(\mu_k, \theta_j) > \epsilon_k - \epsilon_j)$$
$$= G \left[ f(\mu_j, \theta_k) - f(\mu_k, \theta_j) \right],$$
where $G(.)$ is the distribution function of the random variable $\epsilon_j - \epsilon_k$. The first order conditions for player $j$ are:

\[
(W_1 - W_2) \cdot \frac{\partial P}{\partial \mu_j} = C^j_1 (\mu_j, \theta_j)
\]

\[
(W_1 - W_2) \cdot \frac{\partial P}{\partial \theta_j} = C^j_2 (\mu_j, \theta_j)
\]

or

\[
(W_1 - W_2) \cdot g [f(\mu_j, \theta_k) - f(\mu_k, \theta_j)] f_1(\mu_j, \theta_k) = C^j_1 (\mu_j, \theta_j)
\]

\[
(W_1 - W_2) \cdot g [f(\mu_j, \theta_k) - f(\mu_k, \theta_j)] f_2(\mu_k, \theta_j) = -C^j_2 (\mu_j, \theta_j).
\]

In the special case in which we have identical players, in equilibrium $\mu_j = \mu_k$ and $\theta_j = \theta_k$, so the solution is characterized by

\[
(W_1 - W_2) \cdot g (0) = \frac{C^j_1 (\mu_j, \theta_j)}{f_1(\mu_j, \theta_k)}
\]

\[
(W_1 - W_2) \cdot g (0) = -\frac{C^j_2 (\mu_j, \theta_j)}{f_2(\mu_k, \theta_j)}
\]

\[
(W_1 - W_2) \cdot g (0) = \frac{C^j_1 (\mu_k, \theta_k)}{f_1(\mu_k, \theta_j)}
\]

\[
(W_1 - W_2) \cdot g (0) = -\frac{C^j_2 (\mu_k, \theta_k)}{f_2(\mu_j, \theta_k)}.
\]

These conditions imply two initial results. As long as $C_{12}$ is not sufficiently negative, then:

**Result 1.** Increasing the reward spread $W_1 - W_2$ increases the levels of both sabotage and productive effort.

**Result 2.** Increasing the reward spread $W_1 - W_2$ lowers expected net output per worker, defined as $E(Q/2) - C(\mu, \theta)$.

Lazear (1989) shows how, unless $C_{12}$ is sufficiently negative, productive effort $\mu$ is lower when the possibility of sabotage exists. He also shows how the optimal reward spread is larger when sabotage is not possible. This result may also be noted in another way. Workers would like to minimize the cost of producing their generalized effort: $\sigma \equiv \mu + \theta$, for given $\sigma$. Firms prefer that effort take the form of $\mu$ rather than $\theta$. Then at the wage differential that induces the optimal level of productive effort $\mu^*$
for the firm when sabotage is zero, workers will engage in sabotage \( \theta > 0 \). Using the envelope theorem, there is a first-order gain from reducing \( \theta \) but no first-order gains from changing \( \mu \). As a result, the optimal reward spread should be reduced. Clearly, this argument in favor of reward equality is strictly based on efficiency.

Consider now that players are different. Suppose that there are two types of workers: \( H \) ("hawks") and \( D \) ("doves"). They produce \( \mu \) and \( \theta \) according to the cost functions

\[
\begin{align*}
\text{cost} &= C^H (\mu, \theta), \\
\text{cost} &= C^D (\mu, \theta).
\end{align*}
\]

Hawks have a lower marginal cost of sabotage for given \( \mu, \theta : C^H_2 (\mu, \theta) < C^D_2 (\mu, \theta) \). Consider now tournaments in which workers are paired against the same type and the production function is linear: \( f(\mu, \theta) = \mu - \theta \). The first order conditions found above apply for each type:

\[
\begin{align*}
(W_1 - W_2) \cdot g (0) &= C^D_1 (\mu, \theta) \\
(W_1 - W_2) \cdot g (0) &= C^D_2 (\mu, \theta)
\end{align*}
\]

for doves, and

\[
\begin{align*}
(W_1 - W_2) \cdot g (0) &= C^H_1 (\mu, \theta) \\
(W_1 - W_2) \cdot g (0) &= C^H_2 (\mu, \theta)
\end{align*}
\]

for hawks. Therefore,

**Result 3.** For a given reward spread, hawks engage in more sabotage activities than doves.

Note also that the optimal reward differential is lower in tournaments among hawks than in tournaments among doves.

If instead workers are paired against the opposite type, then the first order conditions for doves become

\[
\begin{align*}
(W_1 - W_2) \cdot g (\mu^D - \mu^H + \theta^D - \theta^H) &= \tilde{C}^D_1 (\mu, \theta) \\
(W_1 - W_2) \cdot g (\mu^D - \mu^H + \theta^D - \theta^H) &= \tilde{C}^D_2 (\mu, \theta)
\end{align*}
\]
and for hawks become

\[(W_1 - W_2) \cdot g(\mu^H - \mu^D + \theta^H - \theta^D) = \tilde{C}^H_1(\mu, \theta)\]

\[(W_1 - W_2) \cdot g(\mu^H - \mu^D + \theta^H - \theta^D) = \tilde{C}^H_2(\mu, \theta).\]

Comparing the equilibrium conditions when agents are paired against their own type versus when they are paired against a different type, then for given reward differential, since \(g(X)\) attains its maximum at \(X = 0\), the marginal cost of either type of effort for either type of player is lower when playing against a different type than when playing against his own type:

\[\tilde{C}^J_i(\mu, \theta) < C^J_i(\mu, \theta).\]

This implication is difficult to test because player types are difficult to identify. However, we discuss some evidence on the determinants of productive and destructive effort that may shed some light on this matter, at least within the specific context of our empirical analysis.

3 Data

3.1 Soccer Tournaments and Tournament Theory

Soccer tournaments are regulated by the Fédération Internationale de Football Association (FIFA), the world governing body of soccer. In setting up the rules of the game, the main concern of this body is increasing the popularity of soccer. Of the many factors that affect the popularity of the game, FIFA has repeatedly stated its belief that, at current (low) levels of scoring, the crucial determinant of spectator interest is the amount of scoring in the game.\(^3\) Recent changes in rules have explicitly aimed to increase the incentives for scoring.

From FIFA’s viewpoint then, at current levels of scoring, it is legitimate to take output \((Q)\) to be approximated by the number of goals. Thus from the viewpoint of our principal, forward players specialize in productive effort while defensive players specialize in sabotage in Lazear’s sense of “effort that aims to reduce the output of the rival in the tournament.” Both types of players can simultaneously increase their effort if the residual, the number of midfielders, decreases. This interpretation of the

\(^3\)See, for example, “FIFA officials’ goal: Encourage attacking, high-scoring matches”, USA TODAY March 17, 1994, and “FIFA Approves scoring changes” LA Times, December 17, 1993.
midfielders’ role does not imply that they do nothing. It means that, at the margin, a
midfielder has greater skills to hold the ball and wait for time to pass than a forward
or a defender. A particularly costly type of sabotage is intentional or dangerous fouls
which are punished by yellow cards or, when very egregious, red cards.\footnote{The actions
that lead to these cards are a clear form of sabotage. In soccer every aspect of the
game is governed by the \textit{Laws of the Game} (FIFA (2000)). Law XII is concerned with \textit{Fouls
and Misconduct}. It establishes that “a player is cautioned and shown the yellow card if he is guilty
of unsporting behavior.” This includes “rough kicks, trips, tackles, strikes or attempts to kick,
trip, tackle or strike an opponent; rough jumps, charges or pushes at an opponent, and deliberately
holding an opponent.” A player is sent off and shown the red card “if he is guilty of serious foul
play or violent conduct that endangers the safety of an opponent; if he spits at an opponent or any
other person; uses offensive, insulting or abusive language, or if he receives a second caution (yellow
card) in the same match.”}

As the principal does not care about the identity of the agents, $Q = Q(q_j, q_k) =
Q(q_k, q_j)$. Goals of team $j$ are produced by the productive effort of team $j$, $\mu_j$ and by
the amount of sabotage received from team $k$, $\theta_k: q_j = f(\mu_j, \theta_k) + \epsilon_j$.

In a league tournament the incentives of the teams engaged in a match are
determined by the points they obtain. Throughout this century league tournaments in
Europe and around the world have awarded two points per win, one per tie and zero
per loss. With the explicit aim of encouraging an increase in scoring and in attacking
play, FIFA modified the rules of the game for the 1994 World Cup, introducing a
change in the structure of the rewards.\footnote{The change was largely the result of pressure by the US organizers of the 1994 World Cup,
who feared that low scoring similar to the one observed in the 1990 World Cup would leave US
stadiums empty. As the LA Times of December 17, 1993 put it commenting on the rule change: ‘An
underlying reason for FIFA’s action, and for World Cup Chairman Alan Rothenberg of the United
States pushing hard for it, was the feeling that American fans, used to higher-scoring American
games, would be much less tolerant and much more quickly turned off than a more traditional
soccer audience by an early parade of 0-0 and 1-1 results.” Citing experts of the game, The New
FIFA last June to reward teams three points for a first-round victory instead of two has increased
optimism that teams will emphasize offense and produce a scoring spectacle in the World Cup.”}
This change was the introduction of three
points for a win, while one point was still awarded per tie and zero per loss. This new
measure became part of the \textit{Laws of the Game} and “it was applied after 1995 to
all league competitions worldwide.”\footnote{Professional soccer leagues in England already implemented this change in the reward schedule
in the season 1982-83.} We refer to the new reward scheme as the 3-1-0
scheme and to the old one as the 2-1-0 scheme.
3.2 Spanish Soccer League and Cup Data

The data in this paper come from the professional soccer leagues in Spain. We use data from the 1994-95 full season (370 games), the last one with the 2-1-0 scheme, and from the 1998-99 full season (380 games) with the new 3-1-0 scheme. We exploit this *exogenous* shock in the reward system to evaluate the hypothesis outlined in the previous section. We also use the data to explore the determinants of both types of effort. In particular, we seek to understand whether sabotage activities and positive effort respond to the same kind of considerations. Using data that are four seasons apart is particularly convenient because it does not require us to assume that teams were able to immediately adjust their behavior to the new situation. It also means that we will have to account for any possible year effects in the data. Below we describe how data from a second tournament, one that did not experience any change in rewards and that was played by the *same* teams, will be used toward this end.

The data collected include very detailed observations of both productive effort and costly actions that players (teams in our case) take to adversely affect the output of one another. All the data come from *Marca*, the best selling newspaper in Spain, and *www.sportec.es*.

As Table 1 shows, the data include information on the number of goals and on the 11 players in the line-ups before and after the change in the reward scheme. On average about 2.6 goals per game are scored with a 1.2 standard deviation. The home team scores about 1.6 goals per game. Players other than the goalkeeper can be of three possible types: defenders (D), midfielders (M) or forwards (F). Defenders are interpreted as players specialized in “sabotage” activities and forwards as players specialized in “productive effort.” We use the official definitions of players’ types as published by *Marca* and *www.sportec.es*. It may be observed that all teams choose to play with more defenders than midfielders, and with more midfielders than forwards. Also, visitors choose to play with fewer forwards than home teams.

The data also include the sanctions in the form of yellow and red cards received by the players described in n.4 above. Players who receive a red card are expelled from the game. Those with one yellow card may continue playing but a second yellow card results in expulsion. Red cards are to a large extent random and unplanned. They are qualitatively different from yellow cards because they involve conduct that is beyond the bounds of the game, such as insulting the referees or intentionally provoking a very dangerous foul. Empirically, they are extremely rare. There are only about
0.07-0.09 per team per game, whereas on average 2.15-2.90 yellow cards are given per team per game.

Among the other determinants of productive and sabotage effort that we include in the analysis are the budgets of the team and whether the team plays at home or as a visitor. These variables are important as controls in our analysis of the impact of the increase in the point spread on effort provision. Moreover, they are of interest in themselves, as they allow us to understand the determinants of both types of effort.

Finally, we use data on games from the Spanish Cup competition as controls in our analysis. This competition is an elimination tournament in which teams are paired together, no points are awarded, and the winner survives to the next round. All changes in rules and regulations that took place during the period of analysis apply equally to League and Cup games except, of course, the change in rewards. As a result, the behavior of the teams in this tournament should be largely unaffected by the change in the reward scheme in the league tournament. Therefore, these data should help separate any possible year effects from the actual effects of the incentive change.

4 Identification

Our primary aim is to study the effect of the change in the reward structure on both productive and counterproductive effort. The theory presented in Section 2 predicts that increasing the spread of rewards between losing and winning a match should increase both types of effort. Thus the change in reward schemes we study should affect several variables, including the composition of teams, the number of yellow and red cards received, and possibly the scores.

Our estimation strategy relies on using the control group of cup tournament matches to control for any trend effects that may appear in before-after estimates. To understand the need for this method, consider first the before-after estimator. It consists simply of estimating the effect of the change as the difference between the behavior of the relevant variables before and after the change took place. Suppose that we are interested in estimating the effect of this new reward schedule on the

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7 We imputed the budgets of a few low-budget teams for which budgets were not available. This affected only 31 observations out of 1718 game-team observations. Our results are unaffected by this imputation.

8 In what follows, we rely for the exposition of our identification strategies on Angrist and Krueger (1999).
team’s choice of variable $y_i$ when it is confronting team $j$. Assume that this choice is governed by the following relations:

\[ y_{ij0} = X_i \beta + Z_j \gamma + \varepsilon_i \]  
\[ y_{ij1} = X_i \beta + Z_j \gamma + \delta + \varepsilon_i, \]  

where 0 stands for the choice under the old system and 1 for the choice under the new system, and the vectors $X_i$ and $Z_j$ represent the characteristics of the own ($i$) and rival ($j$) team. Then we can write the before-after regression model in the following way:

\[ y_{ij} = X_i \beta + Z_j \gamma + N_i \delta + \varepsilon_i, \]  

where $N_i$ reflects whether the choice of $y$ is made under the old scheme or the new one. The effect $\delta$ is:

\[
E[y_{ij}|X_i, Z_j, N_i = 1] - E[y_{ij}|X_i, Z_j, N_i = 0] = \\
\delta + \{E[\varepsilon_i|X_i, Z_j, N_i = 1] - \{E[\varepsilon_i|X_i, Z_j, N_i = 0]\},
\]

and this effect is identified to the extent that no change in the unobservables takes place at the same time as the new scheme is introduced. This means that, conditional on the observables,

\[
\{E[\varepsilon_i|X_i, Z_j, N_i = 1] - \{E[\varepsilon_i|X_i, Z_j, N_i = 0]\} = 0.
\]

Unlike in most non-experimental settings, note that no selection bias is present here, since individual teams cannot select which reward schemes they want to play by. Thus the change affects all teams. It is reasonable to expect that, to the extent that the vectors $X$ and $Z$ pick up the important systematic variation in the observables, the estimator is unbiased.

A potential pitfall of the before-after approach is the possibility that other variables, not in the vectors $X_i$ and $Z_j$, changed at the same time as the new scheme was introduced, thereby confounding the effects of the new reward structure. We deal with this potential problem by using cup tournament matches as a control group. This solves the problem as long as other unobservable changes affect the behavior in league and cup games similarly. The reason is that the cup tournament is an elimination system in which only one team survives. The change in the number of points
awarded for winning has no direct effect. It may, however, have some indirect effects which we will discuss later.

Suppose that there exist common trends different from the change in rewards. Then the equations (1) above should be written

\[
y_{ij0} = X_i \beta + Z_j \gamma + C + \beta_t + \varepsilon_i \\
y_{ij1} = X_i \beta + Z_j \gamma + C + \beta_t + N_i \delta + \varepsilon_i,
\]

where \( C \) is a dummy that equals 1 if the match is a cup match and \( \beta_t \) is a time trend common to league and cup, \( N_i \) is now a dummy variable that is 1 only when the choice is actually affected by the change in incentives, i.e. when it is made in the context of a league match that takes place after the change took place. In other words \( N_i \) is an interaction term that is the product of the league dummy and the year effect. Taking first differences on the equation above and substracting the cup effect from the league effect in order to take into account the year effect we have:

\[
\{ E[y_{ij}|X_i, Z_j, C = \text{league}, \beta_t = \text{after}] - E[y_{ij}|X_i, Z_j, C = \text{cup}, \beta_t = \text{after}] \} - \\
\{ E[y_{ij}|X_i, Z_j, C = \text{league}, \beta_t = \text{before}] - E[y_{ij}|X_i, Z_j, C = \text{cup}, \beta_t = \text{before}] \} = \delta.
\]

This equation can be estimated using a regression approach:

\[
y_{ij} = X_i \beta + Z_j \gamma + C + \beta_t + N_i \delta + \varepsilon_i. \tag{5}
\]

The key identifying assumption here is that, absent the change in rewards, the league and cup should evolve in the same way. This is plausible as the same teams are involved. If, for example, for some exogenous reasons strategies have become more aggressive or certain regulations change, the cup matches will allow us to account for that impact.

However, this difference-in-differences estimator may create a downward bias, possibly leading us to underestimate the impact of the changes we analyze. When we talk about control groups we usually have in mind a different individual. Here we observe the same individual engaged in a different activity. It is possible that the changes the teams make as a consequence of the new incentive system ‘contaminate’ the way they play both kinds of matches. Suppose that teams adapt their play to a more aggressive style as a result of the change in the point spread. When playing cup
matches the new, more aggressive style will likely still be present. As a result, taking differences in differences may cause the entire result to vanish into the year effect. For this reason we interpret the differences-in-differences estimators as lower bounds on the effect of the change. We present both the before-after and the differences-in-differences estimators when the differences-in-differences results are suggestive but not conclusive.

5 Empirical Results

5.1 Effect of the larger point spread

5.1.1 Team Structure

[Table 2 Here]

Table 2 presents the impact of the new incentive scheme on the offensive effort of each team, given by the number of forwards used. As in all the results we will present, the differences-in-differences estimators in this table include the cup matches (playoff format) as the control group, since in these matches the increase in the spread does not have any direct effect. As previously argued in the identification section, the incentive change dummy represents the effect that the new reward schedule has on the league net of any common changes in playing style, which are controlled for by the cup matches.

The first row presents the basic differences-in-differences results. They show that the increase in the mean number of forwards used by each team was statistically significantly different from 0. The increase in the number of forwards during this period in matches affected by the incentive change relative to unaffected matches was 0.41. Considering that 2.08 forwards were used before the change, the effect of a roughly 20% increase is in fact sizable. In our second specification, adding a dummy variable for whether the team played at home or was a visitor shows an almost identical result. The result still holds when we consider a specification with team fixed effects, though the effect becomes a bit smaller. The size of the estimate with team fixed effects is 0.23. The specifications in rows 4-6 include controls for the budgets of both the team making the choice and its rival. The results are essentially identical to the ones in which we do not control for the team’s budgets. Row 6, which includes both the budgets and the team fixed effect, does not include the visitor dummy since it cannot be estimated jointly with the team dummies.
The evidence from all of these specifications is unambiguous: teams significantly increase, by roughly between 0.24 and 0.4 players per team, the number of attackers they use as a result of the new reward scheme. The effect remains unchanged when we include a dummy to control for whether the team is playing at home or as a visitor, and also when we control for the budget of the teams.

Table 3 shows the change in the number of midfielders after the incentive change. Again, the result is unambiguous and precisely estimated. The number of midfielders used by each team clearly decreases, by between 0.44 and 0.60 players per team, as a result of the increase in the reward spread. The stability of these coefficients across the different specifications is quite remarkable. Again, the table follows the same methodology as Table 2, presenting the results of the differences-in-differences estimators, both conditionally and unconditionally.

These two tables give us some initial indirect evidence that the number of defenders, our first proxy for the amount of ‘destructive’ effort employed by the team, must be increasing, since in all cases the drop in the number of midfielders is larger than the increase in the number of forwards. This indirect evidence suggests that the number of defenders must have increased by between 0.07 and 0.25 players per team.

Table 4 presents some direct evidence of the changes in the number of defenders. This table is presented for clarity, since these numbers are simply the residuals of the numbers on the previous two tables. Indeed, the estimates we obtain are all positive and the sizes vary between 0.07 and 0.25, which is entirely consistent with what the previous tables imply. However, given the size of the standard errors, these estimates are statistically significant only when we include the team fixed effects. In this case, the estimates we obtain suggest a significant increase in the number of defenders used as a consequence of the change in reward schemes.

Thus, the composition of teams in matches affected by the change in rewards reflects an increase in both their creative effort (as given by the number of attackers) and their destructive effort (as given by the number of defenders), relative to the composition of teams in matches unaffected by the change. These results are consistent with the first hypothesis we derived from the theory, namely that creative effort
and sabotage activities both increase as a result of an increase in the spread between the value of winning and the value of losing. Next we examine detailed evidence on the change in the amount of sabotage activities in the form of yellow and red cards.

5.1.2 Number of Cards Received

[Tables 5 and 6 Here]

The differences-in-differences estimates of the effect of the scheme change on the number of yellow cards received by the teams is shown in Table 5. The estimates we obtain using the different specifications are all of the same magnitude, suggesting that the number of yellow cards received increased by between 0.21 and 0.27 per match as a result of the incentive change. These results, suggesting an increase in ‘sabotage’ effort, lend support to the theory. Table 6 repeats the analysis relying on a Poisson model. The results are again statistically significant, and extremely consistent with each other.

However, the results in both Tables 5 and 6 are only marginally significant or marginally insignificant by usual standards. Previously, we have suggested that the differences-in-differences estimates are a lower bound for the true effect of the incentive change, since there is a possibility that, if the teams changed their style of play in the league, this could contaminate the play in the cup and bias our results downwards. To get a further sense of what the data are showing, we also undertake the before-after analysis of the yellow cards change.

[Table 7 Here]

The before-after analysis of yellow cards shows a clear increase in the number of yellow cards awarded after the incentive change in league matches. The estimates obtained by this method are in all instances but one statistically significant, and are almost identical in size to the estimates we obtained from the differences-in-differences procedure. The unconditional change in the number of yellow cards was 0.33, or one extra card per three matches, and statistically significantly different from 0. Controlling for whether the team was a visitor and adding team effects leaves the result roughly unchanged, and so does controlling for the relative strengths of the

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9 A Poisson model may be the most appropriate to the card data given its temporal nature. This model, however, could not be estimated using team fixed effects as it was not computable; for this reason, we also present OLS results.
teams, as given by their budgets. Only when we simultaneously control for both team fixed effects and budgets does the size of the increase become smaller, but leaving it at the same level as the differences-in-differences estimates suggested.

We take the evidence from Tables 5, 6 and 7 to be consistent with the theory presented here, in the sense that they strongly suggest that an increase in sabotage actually took place. The size of the increase in the number of yellow cards awarded, somewhere from 0.17 to 0.33 (that is, an increase of about one card per team per three to five matches starting from a baseline of around 2.3 cards per team), is consistent between specifications, and seems like a large but reasonable change.

Table 8 presents the red cards analysis. The change, though small, seems to go in the ‘right’ direction, although it is clearly not statistically significant. The average number of cards per match, around 0.09, is basically 0 both before and after the change, and its variation appears random. Players usually get red cards as a result of a temper tantrum or a hot disagreement with the referee. The change in incentives had little, if any, effect on the frequency with which they were awarded. As with yellow cards, we also obtained the before-after estimates of the change, and have not obtained any effect significantly different from zero. For this reason, we do not report that analysis here.

![Table 8 Here]

We conclude from our analysis of the amount of cards that the number of yellow cards went up by around 10 percent, a significant amount. We take this change as evidence of an increase in sabotage activities as a result of the change in the point spread introduced to the system. The number of red cards, which may have been positively affected by the new incentive scheme (none of the coefficients we obtained was negative), did not change in a significant manner. We interpret this finding as due to the extreme randomness and rarity of a red card in these tournaments.

5.1.3 Scoring

![Table 9 Here]

The analyses in this table evaluate whether total gross output (total number of goals) changed as a result of the change in rewards and also provide some additional, indirect evidence that sabotage has increased. To the possible surprise of FIFA,
perhaps unaware of Lazear’s (1989) theoretical results, the change in the reward of the winners did not have the intended effect on the number of goals scored. None of the specifications we use shows an increase in the number of goals scored. In fact, most of the signs are negative, suggesting that the number of goals scored may have decreased as a result of the increase in both constructive and destructive effort. This negative result is the same in the before-after estimates, which we do not present here for brevity. Therefore, these results lend support to Lazear’s (1989) second result discussed in section 2. Output does not increase, even when we ignore the effects of increased costs $C(\mu, \theta)$.

The lack of change in scoring even after a substantive increase in the number of forwards for both teams must necessarily mean that the defensive effort rose at least as much as the offensive effort. This is a strong piece of evidence supporting the theoretical hypothesis that the change in the spread between winning and losing led to the teams increasing both their constructive and destructive effort.

All three pieces of evidence presented here—team composition, cards, and goals—are consistent with each other and point unambiguously in the same direction. Table 10 summarizes their implications for the theory.

The increase in the reward spread between winning and losing led to an increase in the value of winning, and induced teams to supply more productive effort. The incentive change did not lead to an increase in gross output. The reason is that the increase in the spread also provided a larger incentive for teams to increase their ‘sabotage’ of rival teams’ offensive effort. The evidence presented here provides support for the hypotheses derived from incentive theory that an increase in the reward spread increases both creative effort and destructive effort and will generally not increase net output. We examine next the possibility that the incentive change affected different teams in different ways.

5.2 Differential Effects of the Rule Change

Now we weaken the assumption that the effect of the rule change is the same for all teams, and explore the possibility that the rule change affects teams with different budgets differently.\(^\text{10}\) Table 11 presents the results of these analyses for all four of

\(^{10}\) A similar analysis was undertaken with an interaction with rival teams’ budgets, but this interaction was not found to be significant.
the main variables of interest.\textsuperscript{11}

[Table 11 Here]

The first set of regressions in Table 11 is concerned with the number of forwards, and should be read in parallel to the analysis in Table 2. As we know from that table, the rule change led to an increase in the number of forwards in each team. Table 11 confirms that this is still true for teams of all budgets, but shows that there is a negative and significant interaction effect. The effect of the rule change can be envisioned as a line with an intercept of 0.5411 (the increase in forwards for a team with a very small budget) and a negative intercept of 0.02: a 1 billion Pesetas (Pta) increase in budget leads to a 0.02 smaller increase in forwards as a result of the rule change. Given that the budgets of teams in our data set have a range from Pta 0.325bn. to Pta 14.9bn., with a mean of Pta. 3.3bn., the negative slope never leads to a decrease in the number of forwards for budgets in the relevant range. This means that (i) all teams were made more offensive as a result of the rule change; and (ii) the teams that were made most offensive were the poorest teams, which are generally the least offensive. Conversely, the increase in the offensiveness of the richer teams as a result of the rule change was substantially smaller.

The second set of analyses in Table 11 is concerned with the number of midfielders. Again, the interaction effect is negative, while the intercept is now also negative. A team with small budget decreases the number of midfielders used as a result of the incentive change. Moreover, the richer the team, the larger the decrease in the number of midfielders. The effect on larger teams is a substantial drop in the average number of midfielders in the line-up.

The third set of analyses in Table 11 answers the question: where did the midfielders of richer teams go? The intercept of the number of defenders becomes negative now but insignificantly different from 0. The key interaction effect is now positive, large and significant. This means that the richer the team, the more defensive it became as a result of the change in rewards. A Pta 1bn. increase in the budget of the team led to a 0.07 larger increase in the number of defenders aligned.

The effects on the number of yellow cards are suggestive and consistent with the increase in the number of defenders. The increase in this form of sabotage was larger

\textsuperscript{11}The second specification for each dependent variable includes team fixed effects. This made it impossible to estimate the effects of rival’s budget and the visitor dummy coefficient for computational reasons. The results obtained, however, are consistent across specifications and do not depend on some control variables being excluded or included, as Tables 1-7 show.
for richer teams: the richer the team, the larger the increase in the number of yellow cards as a result of the rule change. This increase is significant in the fixed-effect specifications, and suggests that a Pta 1bn. increase in the budget of the team led to an increase of 0.04 in the number of yellow cards received.

Overall, the results we obtained are statistically significant, economically important and internally consistent. They lead us to modulate our conclusion about the impact of incentive changes on creative effort and sabotage. As a result of the incentive change, all teams engaged in more offensive effort and more defensive effort. The change, however, had a differential impact on different teams. On the one hand, richer teams, which were the ones playing more offensively before, experienced proportionally greater increases in sabotage effort relative to creative effort. On the other hand, poorer teams, which were before the most engaged in destructive effort, saw a relatively more important increase in their creative effort.

What are the implications of these results in terms of the model by Lazear outlined in Section 2? Suppose that hawks are characterized by both a lower marginal cost of sabotage and a greater marginal cost of productive effort. Hawks will then engage more in counterproductive effort and less in productive effort than doves. An increase in the reward spread will then increase both types of effort for both types if $C_{12}$ is not negative enough. In addition, such a change in rewards will induce for both hawks and doves a relatively greater increase in the type of effort in which they initially engaged less if the elasticity of the marginal cost curve ($\mathcal{E}$) of that effort is lower for the type that engaged in a lower production of that effort. Formally, necessary and sufficient conditions for the empirical results in Table 11 to obtain from the model are that

$$\mathcal{E}_H^H < \mathcal{E}_D^D$$

and

$$\mathcal{E}_D^D < \mathcal{E}_H^H.$$

We next summarize our finding on the other determinants (apart from the incentive change) of these two types of effort, some of which we have hinted at already here.

## 5.3 Other Determinants of Creative and Destructive Effort

A last hypothesis we derived from the theory concerns the relationship between the relative payoffs of the different efforts and the level of each effort. We study briefly
the relevant evidence here with regard to the effects of playing as a visitor, having a larger budget and confronting a stronger rival:

1. The impact of not playing at home

The weak position resulting from being a visitor leads to a significant increase in defensive effort and a decrease in offensive effort. From Tables 2-4 we can see that, with remarkable consistency, visitors are shown to significantly decrease the number of forwards in the team, by 0.18 on average, compensated by an increase of 0.10 in the number of midfielders and of 0.08 in the number of defenders. Moreover, the number of yellow cards is substantially and significantly larger for a visitor (Table 5), by about 0.4 per match. This effect is larger than the effect that resulted from the change in the reward schedule. A result of this lower offensive effort is a substantially smaller number of goals scored by visitor teams. As Table 9 shows, visitors scored, on average, 0.54 fewer goals per match than home teams. This difference is statistically significant and consistent across specifications.

2. The value of having a large budget

As we pointed out in the previous subsection, a lower own budget appears to lead to a statistically significant (but small in magnitude) decrease in the number of forwards and midfielders, and correspondingly to a significant increase in the number of defenders. That is, a lower budget has similar effects to being a visitor. However, the effect is not precisely estimated when we include fixed effects in the regressions that estimate the changes in the number of forwards (Table 2), as the sign flips in this case. This is not entirely unexpected, as most of the individual budgetary variation is already accounted for in the team fixed effects.

3. Confronting a stronger rival

Rival’s budget does not appear to affect significantly the number of forwards. Confronting a richer team, however, does lead to a decrease in the number of midfielders, although this effect is not always significant (Table 3) and clearly leads to a statistically significant increase in the number of defenders (Table 4). Contrary to the case for higher own budget, an increase in the rival’s budget results in a substantial increase in sabotage, as measured by the number of yellow and red cards that the teams received.

To conclude, poorer teams and teams in a weaker position (those not playing at home), and those confronting stronger teams, rely more on sabotage and destructive
effort and less on offensive effort. Conversely, home teams, richer teams, and those confronting a poorer rival, rely less on destroying their rival’s productive efforts and more on creating their own opportunities.
6 Summary and Concluding Remarks

This paper has provided the first explicit tests of worker-incentive models where individuals can devote costly effort to improving their own output and to decreasing opponents’ outputs. Although theoretical research warns us about the possible detrimental incentive effects of increasing the spread between the reward for winning and losing in a tournament when workers can engage in sabotage, the theory has remained untested up to now. Workers engaged in promotion tournaments may indeed bad-mouth their colleagues and actively prevent them from achieving good results by withholding information and many other means, but they will do their best to conceal their efforts. For this reason, evidence on sabotage activities is, by its nature, at best anecdotal.

We exploit an incentive change that took place in a specific sports tournament and the availability of detailed data on productive efforts and sabotage activities to obtain evidence on the implications of the theory. We are able to control for possible year effects or trends by relying on the fact that the same teams are simultaneously playing a different tournament in which there was no change in rewards.

The results on the effects of the increase in the spread of the tournament are conclusive and very consistent across specifications. First, both creative effort, as given by the proportion of offensive players specialized, and sabotage effort, as measured by the proportion of defensive players and the number of yellow cards received by teams, increased for all teams as a result of the increase in the spread between winning and losing. Our estimates suggest that the number of yellow cards received per team increased by 10–15 percent. Second, the largest increase in offensive effort resulting from the incentive change took place on the teams that were initially least offensive (the poorer teams), while the largest increase in sabotage effort took place on the teams that were originally least engaging in it (richer teams). Third, the number of goals scored by teams did not change at all as a result of the change in rewards. This suggests that the increased creative effort and the increased destructive effort largely canceled each other out.

Our data also allowed us to study other determinants of creative and destructive effort. We found that poorer teams and teams in a weaker relative position (those playing as a visitor and those confronting richer teams) engaged relatively more in
sabotage and less in creative effort.

The results are thus consistent with the implications of a sabotage-based theory and suggest that multidimensional effort models hold a great deal of promise for enhancing our understanding of the incentive effects of reward systems. Our findings raise relevant questions that merit consideration in future research, both theoretical and empirical. Theoretically, it is important to explore under what conditions it is technologically the case that “weaker” players have a comparative advantage in sabotage or destructive effort. It seems intuitively plausible that a “worse” player’s only chance to succeed in a tournament is making sure the better player does not produce his best effort. Empirically, it will be relevant to study whether the determinants of productive and destructive efforts and other empirical regularities we have uncovered in our analysis apply to other fields.
REFERENCES


Rob, Rafael, and Zemsky, Peter. “Cooperation, Corporate Culture and Incentive Intensity.” Mimeo, University of Pennsylvania.

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**Table 2. Initial Team Composition: Number of Forwards**  
(Differences-in-Differences, using cup matches as control)

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<th>Own Budget</th>
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* Significant at 10% level; ** Significant at 1% level.
### Table 3. Initial Team Composition: Number of Midfielders

(Differences-in-Differences, using cup matches as control)

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<td>(0.007)</td>
<td>(0.1121)</td>
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* Significant at 10% level; ** Significant at 1% level.
### Table 4. Initial Team Composition: Number of Defenders
(Differences-in-Differences, using cup matches as control)

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<th>Independent Variables</th>
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<th>Visitor Dummy</th>
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<th>Own Budget</th>
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<th>Team Fixed Effects</th>
<th>Intercept</th>
<th>R. Square</th>
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<td>-0.0986* (0.0511)</td>
<td>4.15** (0.0594)</td>
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<td>-0.0986* (0.0511)</td>
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<td>0.0124** (0.006)</td>
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* Significant at 10% level; ** Significant at 1% level.
**Table 5. Yellow Cards**  
(Differences-in-Differences, Linear Regression)

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<th>Own Budget</th>
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<th>Team Fixed Effects</th>
<th>Intercept</th>
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* Significant at 10% level; ** Significant at 1% level.
### Table 6. Yellow Cards
(Differences-in-Differences, Poisson Regression)

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<th>Own Budget</th>
<th>Rival’s Budget</th>
<th>Team Fixed Effects</th>
<th>Intercept</th>
<th>Pseudo R. Square (n)</th>
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* Significant at 10% level; ** Significant at 1% level.
**Table 7. Yellow Cards**  
(Before-After Estimates)

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<th>Rival’s Budget</th>
<th>Team Fixed Effects</th>
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* Significant at 10% level; ** Significant at 1% level.
### TABLE 8. RED CARDS
(Differences-in-Differences, using cup matches as control)

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<th>Independent Variables</th>
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<th>Own Budget</th>
<th>Rival’s Budget</th>
<th>Team Fixed Effects</th>
<th>Intercept</th>
<th>R. Square (n)</th>
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* Significant at 10% level; ** Significant at 1% level.
TABLE 9. GOALS SCORED  
(Differences-in-Differences, using cup matches as control)

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<th>Independent Variables</th>
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<th>Cup Dummy</th>
<th>Year Effect</th>
<th>Own Budget</th>
<th>Rival's Budget</th>
<th>Intercept</th>
<th>R. Square</th>
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* Significant at 5% level; ** Significant at 1% level.
### Table 10. Summary Table: Effects of Incentive Change
(Differences-in-Differences, with team fixed effects and controls for budget)

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<td>Decreased by 15%</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of Defenders</td>
<td>Sabotage</td>
<td>Increased by 6%</td>
<td>Yes</td>
</tr>
<tr>
<td>Yellow Cards</td>
<td>Sabotage</td>
<td>Increased by 10%</td>
<td>Yes</td>
</tr>
<tr>
<td>Red Cards</td>
<td>Sabotage</td>
<td>No change/Positive Change</td>
<td>Uncertain</td>
</tr>
<tr>
<td>Goals Scored</td>
<td>Gross Output</td>
<td>No change</td>
<td>Yes</td>
</tr>
<tr>
<td>Dependent Variables</td>
<td>Independent Variables</td>
<td>Intercept</td>
<td>R. Square</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------------------------</td>
<td>------------</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td>Incentive Change</td>
<td>Visitor Dummy</td>
<td>Cup Dummy</td>
</tr>
<tr>
<td>Number of Forwards</td>
<td>0.5411**&lt;br&gt;(0.1177)</td>
<td>-0.1895**&lt;br&gt;(0.0333)</td>
<td>0.1105*&lt;br&gt;(0.0745)</td>
</tr>
<tr>
<td></td>
<td>0.468**&lt;br&gt;(0.1193)</td>
<td>0.1242*&lt;br&gt;(0.0762)</td>
<td>-0.2616**&lt;br&gt;(0.1038)</td>
</tr>
<tr>
<td>Number of Midfielders</td>
<td>-0.3497**&lt;br&gt;(0.1693)</td>
<td>0.1097**&lt;br&gt;(0.0479)</td>
<td>-0.3632**&lt;br&gt;(0.1072)</td>
</tr>
<tr>
<td></td>
<td>-0.3519**&lt;br&gt;(0.1691)</td>
<td>-0.4016**&lt;br&gt;(0.108)</td>
<td>0.2882**&lt;br&gt;(0.147)</td>
</tr>
<tr>
<td>Number of Defenders</td>
<td>-0.1881*&lt;br&gt;(0.1377)</td>
<td>0.0774**&lt;br&gt;(0.039)</td>
<td>0.2554**&lt;br&gt;(0.0872)</td>
</tr>
<tr>
<td></td>
<td>-0.1118&lt;br&gt;(0.138)</td>
<td>0.2811**&lt;br&gt;(0.0882)</td>
<td>-0.027&lt;br&gt;(0.12)</td>
</tr>
<tr>
<td>Number of Yellow Cards</td>
<td>0.1349&lt;br&gt;(0.2494)</td>
<td>0.4071**&lt;br&gt;(0.0732)</td>
<td>0.3261**&lt;br&gt;(0.1576)</td>
</tr>
<tr>
<td></td>
<td>0.083&lt;br&gt;(0.2591)</td>
<td>0.3898**&lt;br&gt;(0.1663)</td>
<td>0.1666&lt;br&gt;(0.2238)</td>
</tr>
</tbody>
</table>

* Significant at 10% level; ** Significant at 1% level.