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SUBSTITUTION AND COMPLEMENTARITY BETWEEN MANAGERS AND SUBORDINATES: EVIDENCE FROM BRITISH FOOTBALL*

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Abstract

We use data on British football managers and teams over the 1994-2007 period to study substitution and complementarity between leaders and subordinates. We find for the Premier League (the highest level of competition) that, other things being equal, managers who themselves played at a higher level raise the productivity of less-skilled teams by more than that of highly skilled teams. This is consistent with the hypothesis that one function of a top manager is to communicate to subordinates the skills needed to succeed, since less skilled players have more to learn. However, we also find that managers with more accumulated professional managing experience raise the productivity of talented players by more than that of less-talented players. This is consistent with the hypothesis that a further function of successful managers in high-performance workplaces is to manage the egos of elite workers. Such a function is potentially more important the more accomplished the workers are -- as indicated, in our data, by teams with greater payrolls.

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Introduction

Microeconomic models of the firm typically assume a production function, sometimes with labor inputs disaggregated into managerial and production labor (and perhaps clerical labor as a separate category). Yet little is known about the ways in which managers augment production. For example, do managers directly affect the productivity of their subordinates, and if so, how? Knowledge of such effects is potentially important for studying many issues in economics, including for example wage inequality. Suppose, for instance, that managers are complementary inputs with certain types of labor, such as less skilled workers; for example, less skilled workers may need more supervision or training by managers than more highly skilled workers would. If so, then exogenous increases in the supply of unskilled labor (caused perhaps by immigration from less developed countries) will raise the relative demand for managers, and overall wage inequality will rise by more than one might have thought. Conversely, if the two kinds of labor are substitutes, then the relative demand for managers would fall, reducing the rise in wage inequality. For example, it is possible that unskilled workers could take over some basic monitoring functions from management.

Knowledge about the ways in which managers contribute to organizational success is also crucial in the study of human resource management. Researchers in that field are concerned with the roles of managerial expertise and the motivation of subordinates. The same questions that are of interest to applied microeconomists such as substitutability across factors of production are also important to firms, as they decide on their best strategies for combining managerial and production worker expertise.

The nature of the production relationship between supervisors and subordinates is difficult to study in most settings. Often there are only rather imperfect measures of output, and firm-level data on combinations of various kinds of labor inputs are usually hard to obtain. Data on sports leagues can be ideal in this situation because output is

observable, and we have detailed measures of the qualifications of managers and who their subordinates are.

This paper uses data from British professional football to study the issues of substitution and complementarity between managers and subordinates. We exploit British football data for the 1994-2007 seasons to study whether managers' skills substitute for or complement players' skills. We do this by examining interaction terms in frontier production analyses where team success is the measure of output. Managers' skills are proxied by information on the level at which they played (if they played at all), as well as their degree of experience as managers, while player skills are proxied by the relative payroll (for players) of the team in a given season. Unlike previous research on managerial productivity in soccer (e.g. Dawson, Dobson and Garrard 2000a and b; Dawson and Dobson 2002; Frick and Simmons 2008), we study the interaction between managerial skill and player skill. Unlike earlier work, our approach allows managerial talents to differently affect players of different skill levels and thereby provides additional insights into production relationships.

Our strongest findings are for the Premier League (the highest level of competition). We estimate frontier production functions where output is defined as the team's finishing position relative to other teams in the league in a given season. Our findings indicate that other things being equal, managers who played at a higher level raise the productivity of lesser skilled teams by more than that of more highly skilled teams. This finding is consistent with the hypothesis that one of the functions of a highly skilled manager is to teach subordinates some of the skills needed to succeed. The value of this teaching is, according to our results, greater the less skilled the players are, an intuitively plausible result. An additional finding, however, suggests that other things being equal (including the manager's playing ability), managers with more accumulated professional managing experience raise the productivity of more skilled players by more

than that of less skilled players. This finding is consistent with the idea that another function of successful managers in high pressure, high performance workplaces may be to manage the egos of the workers involved. This function is likely more important the more accomplished the workers are, as indicated in our data by teams with higher relative payroll levels. Our findings, then, suggest that managerial skills are multidimensional, including instruction as well as an ability to coax peak levels of performance from high ability workers. These results may have some relevance to high performance workplaces such as professional law or consulting practices, high tech innovative companies or research universities.

Expectations and Previous Research on Managerial Productivity in Sports

To develop hypotheses about the effect of management, some researchers have attempted to break down into component parts the functions that executives perform. For example, after observing several chief executives, Mintzberg (1973, pp. 54-94) concluded that there were roles common to successful managers. First, an executive serves as a leader and a liaison with those outside the organization. Second, successful managers engage in monitoring the work of subordinates. Finally, the manager must use the information gathered to make decisions. An important aspect of successful leadership is an ability convince employees to act in the best interests of the firm. For example, Loch et al. (2000) emphasize that it is important for managers to create a culture in which individuals submerge their egos for the common good. In this view, managers need to be seen as credible if subordinates are to be willing to accept advice and show humility. Credibility can be attained through several routes, including having expertise as well as having a record of achievement as a manager (Goodall 2009a and b; Kouzes and Posner 2003). In addition, Butler and Waldroop (1999) discuss successful strategies for

motivating and retaining highly skilled employees. The authors stress the importance for managers to learn what really matters to their star employees in order to design their jobs in such a way as to enhance their loyalty to the company.

The roles these authors have emphasized for managers in general also are relevant for team managers in sports. In the sports context, two dimensions of successful management seem especially relevant for our study of the relationship between leader and subordinate in soccer: the teaching function (corresponding to the monitoring role mentioned by Mintzberg, 1973) and convincing players to subordinate their egos for the betterment of the team (a function which draws on all three roles Mintzberg, 1973 mentioned). Of course, a manager's credibility enhances both of these dimensions. First, on the teaching function, in his 1984 ratings of American League baseball managers, James (1984) noted what he believed were each manager's best qualities. Among other attributes, these included an "ability to work with young players, help them develop their skills" (p. 117). Moreover, in the context of English Premier League football, Gilmore and Gilson (2007) study the success of one team during the 2003-5 period, Bolton Wanderers. The authors note that the team successfully implemented a long-run strategy of bringing in low cost, inexperienced players, and using a highly skilled manager, Sam Allardyce, to train them (p. 420). In both of these instances, the teaching function is seen as clearly more valuable for less skilled subordinates, who presumably have more to learn about playing the sport at a high level than established stars do. Allardyce is known for his ability to get the best out of teams of previously under-performing individual players (Bridgewater 2010).

Second, on managing the egos of the highly skilled athletes in professional sports, Phil Jackson, the National Basketball Association coach who has won more league championships (11) than any other coach, is known for taking over teams with established stars who weren't winning. He then managed the strong egos on these teams

and won multiple championships.[1] In the context of English football, in interviews with 22 current managers, one said: "Football managers who have experience are less fazed by difficult players, difficult situations, media attention. They have things with which to compare new challenges and have learned how best to handle situations." This manager thus suggests that experience as a manager contributes to one's ability to handle players with strong egos. Moreover, in English football generally, Bridgewater (2010), based on analysis of the League Managers' Association statistics from 1992 to date and interviews with 45 current and past football managers concludes that skilled managers need to convince great players who might not always be in the starting eleven to accept roles as substitutes even if they could start in another team. This issue seems more salient at the highest levels of the sport and suggests that managerial experience will be especially useful for handling high-level players.

Whether a manager has himself played soccer at a high level can contribute to both of these roles a successful manager plays. For example, managers who were great players may be able to impart skills and insights to the current generation of players, suggesting a positive impact of the manager's prior playing skill on team success. For example, as suggested by Goodall, Kahn and Oswald (forthcoming) in the context of North American professional basketball, this impact may come about through several possible routes:

- Perhaps this is the coach's acquired skill based on the in-depth knowledge of what wins games.
- Perhaps the manager has played for and gained useful skills from great coaches.
- Perhaps some "tenacious personality" factor is at work. What made someone a winner as a player makes him a winner as a coach.
- Maybe this is even something genetic that makes the person a winner.

[1] These included the Chicago Bulls in 1991-3 and 1996-8 with stars Michael Jordan and Scottie Pippen and the Los Angeles Lakers with Kobe Bryant and Shaquille O'Neal during 2000-2 and Kobe Bryant in 2009-10 (as of June 2010).

In football terms, having been a great player might be expected to provide several types of expertise which could be useful to the manager.

- Great players might lead by example.
- As in the case of basketball just discussed, a great player might be able to demonstrate a particular football skill, or to spot a potentially great player.
- A manager who was a great player may have an understanding of how the game should be played at the highest level and often played in the most successful clubs under successful managers and acquiring good training and nutritional habits.
- Players at higher levels may have networks among better clubs. Even if the manager is working at lower level, he might be able to use his name and contacts to attract good players, or to get loans from the second string of higher level clubs.
- Perhaps the reputation and credibility of being a great player impresses the players of today.
- All of these might reasonably help top players create a culture and help the manager to become a visionary and inspirational leader who players want to follow.

While better players may indeed make better managers, going in the opposite direction is the possibility that a manager who was a great player may not be able to identify with journeymen players and understand what motivates them. For example, one manager who had, himself, played at the top but managed in lower leagues complained of his players:

> "They just couldn't do the things that I was used to players being able to do. We would work on something in training, for example how to defend a corner, and everyone would know who they were marking in that situation. The next match someone would not be marking their man and we would concede from a corner in the same silly way. It was very frustrating." (Bridgewater 2010, p. 74).

In addition to affecting the average quality of play, the manager's playing ability may have differing effects on team success depending on the innate abilities of the players. For example, as noted, more highly skilled players may have less to learn than

less skilled players. They might be better able to perform irrespective of the abilities of their leader. Therefore, a manager who was a great player may disproportionately raise the output of lesser skilled players by teaching them. Of course, as in the case of the manager just quoted, in order to teach players to improve, one needs to get through to them. A manager who was a great player may be better able to manage the egos of great players because formerly great players may have credibility with stars of today. Thus, the manager's playing ability has opposing theoretical interactions with the players' ability, with the teaching function implying a negative interaction and the ego management function implying a positive interaction. In the current context, there are a number of examples of great football players who were not great football managers. Famously, World Cup Winner, Sir Bobby Charlton spent a brief period as manager of Preston North End before deciding management was not for him, Maradona has had a mixed record with the Argentinian national team and England international, John Barnes was dismissed after eleven games in charge at Tranmere Rovers in the English League 1. Conversely, top players such as Kenny Dalglish, Mark Hughes and Stuart Pearce have been both great players and great managers. There are also great managers, such as Jose Mourinho, Arsène Wenger and Sven Göran Eriksson who never played at a high level themselves. Thus, anecdotal evidence in this instance is apparently inconclusive.

Our study will use statistical methods to make general conclusions about the impact of managerial playing ability on English soccer outcomes. We draw on previous econometric research on managerial productivity in sports. Early studies in this area documented the existence of managers' fixed effects in influencing team success. For example, Porter and Scully (1982) used frontier production function analysis to document and measure the extent of managerial inefficiency in Major League Baseball. As discussed further below, this framework assumes that there is a maximum level of output (measured in this instance by team victories) a team could achieve given its inputs. More

efficient managers lead to output levels that are closer to this maximum (the frontier of the production set). The authors found considerable variation in the efficiency of baseball managers. Since Porter and Scully's (1982) study, many authors have estimated similar effects in other sports, including Kahane (2005) for the National Hockey League (NHL), Hofler and Payne (2006) for the National Basketball Association (NBA), and most relevant to the current study, Dawson, Dobson and Gerrard (2000a and b), Dawson and Dobson (2002), and Frick and Simmons (2008) for European football.

While establishing the existence of managerial differences in productive efficiency is an important goal, several studies of productivity in sports go beyond this issue to examine the factors that are related to managers' success. For example, Pfeffer and Davis-Blake (1986) find that an NBA new head coach's past record of success is positively related to current team success. In addition, Kahn (1993) found that among Major League Baseball managers, those with higher predicted salaries (with the predictions based on past record and experience) had higher winning percentages (relative to the team's previous winning percentage) and improved players' performance (relative to the players' previous performance levels) by more than managers with lower predicted salaries. Similarly, Hofler and Payne (2006) found that NBA coaches with more experience, higher career winning percentages, and more current tenure are more productively efficient than otherwise. And Kahane (2005) found that NHL head coaches with higher career winning percentages or those who played for their current team were able to bring the team closer to the production function frontier than otherwise. On the other hand, total coaching experience or total playing experience had no apparent effects on efficiency. Moreover, Goodall, Kahn and Oswald (forthcoming) found that in the NBA, coaches who were themselves former all-star players had significantly better regular season and post-season success than coaches who never played in the NBA or

who played but were not all-stars. The authors suggested that managerial expertise as a player led to better performance by current players.[2]

Since the current study concerns British football, we now discuss several studies of European football, and in all cases except one, these studies examined British football. For example, Dawson, Dobson and Gerrard (2000a and b) study various aspects of managerial efficiency in British football over the 1992-98 period, using frontier production function analysis. The authors consider several different issues in estimating productive efficiency, including the measurement of player talent, using fixed effects methods, and whether managerial efficiency is time-varying or invariant. Regarding the measurement of player talent, the authors recommend using ex ante measures. Moreover, Dawson and Dobson (2002) study British football from 1992 to 1998 and find that having played internationally or having previously played or coached for the current team significantly raises a manager's productive efficiency. In addition, the authors find that former forwards make more technically efficient managers. Finally, a recent study of German soccer examines several factors that affect the degree to which managers bring the team closer to productive efficiency (Frick and Simmons 2008). Specifically, head coaches who earn more money and who have better career coaching records lead to significantly more productive efficiency than otherwise.

Our study builds on this previous research in the following ways. First, and most importantly, unlike previous literature, we estimate the degree of substitutability between managerial skill and playing skill in the production process. As discussed in the introduction, substitution/complementarity relationships are fundamental in helping one understand the determinants of relative factor prices as well as from the point of view of managing human resources. Like Dawson and Dobson (2002), Kahane (2005), Hofler

[2] In another context, Goodall (2009a and b) has found that the publication record of university presidents makes them more successful leaders of research universities, providing further evidence that experts make better leaders than nonexperts.

and Payne (2006) and Goodall, Kahn and Oswald (forthcoming), we study different aspects of coaching skill, including playing ability as well as coaching knowledge, as proxied by experience. Second, unlike previous work, we pay some attention to the issue of missing data by estimating in some cases models which use multiple imputation techniques for estimating values of missing data. This procedure contrasts with the more familiar design of omitting observations with missing data, and we discuss this issue further below.

Third, unlike previous research on European football, we provide separate analyses of leagues below the Premier League in addition to the top league itself. Because the level of play is lower in the lesser leagues, it is potentially useful to compare results across leagues, since the large variation in playing ability across leagues allows for a fuller examination of the production function than merely concentrating on top level performers. And production relationships may differ depending on the level of play, implying that one shouldn't pool leagues in estimating production functions and efficiency. Specifically, the teaching and inspiring functions of managers may be more important for lower leagues in which the players have more to learn, while the ego management function is likely more important in the Premier League, where the biggest stars play.

The Setting: English Football

Competition in English football (soccer) is split into four leagues.[3] These are open leagues in that teams can be promoted to the level above or relegated to the level below on the basis of performance over the season. The highest of these leagues, the Premier League, now contains twenty clubs (although in 1992-93 and 1993-94, the first

[3] For further description of English Football, see Bridgewater (2010).

years of its formation, the Premier league contained 22 teams). Among the remaining leagues levels 2 – 4 are known jointly as the Football League. The highest of these, the second league in England, is known as the Championship, the third league is called League 1, and the fourth League 2. Each of these last three contains 24 clubs (although the Championship also contained 22 clubs in 1992-93 and 1993-94 and changed to 24 clubs when the Premier league changed at the beginning of the 1994-95 season.) There are a total of 92 Clubs in the English Professional Football Leagues. Given the changes in name over time, the leagues are not referred to by name but as "Tiers 1 to 4" in this paper. Performance data are split by league – as a high performance in Tier 4 is measured relative to lesser teams than a high performance in Tier 1. Football seasons run from August of one year until early May of the following year. Each club plays every other club twice in the league – once at home and once at the opponent's ground.

Data and Empirical Procedures

The data used in this paper are the official statistics on football manager appointments and dismissals and key trends collected by Warwick Business School on behalf of the League Managers Association (LMA) - the football managers' union. Data from the LMA are supplemented by published statistics on performance from two websites: www.soccerbase.com, for football manager data, such as clubs for which the manager played and management experience, and www.footymad.net (data from these sources are as at February 2009) for league tables and performance data. Data have been collected for the period from the beginning of the 1992-93 English football season through to February 2009, although as explained below, we are only able to use at most the 1994-2007 seasons, due to data availability.

Our aim is to determine whether expert leaders raise the productivity of highly productive workers by more than for less productive workers. In other words, is managers' expertise a substitute for or complement with production workers' expertise? Like several recent papers on the efficiency of management in sports discussed earlier, we take a structural approach which recognizes that the players are the direct input to team success, but where the manager can move the organization toward productive efficiency, when the team achieves its potential output. As discussed, such a design has been termed a frontier production function analysis, and we seek to determine whether expert leaders have larger effects in reducing inefficiency for less productive than for more productive workers.[4]

The data points are each a manager-team-season observation. We use as dependent variable the log of the team's finishing position minus the log of the average team's finishing position for that season, where a larger value means better performance. For example, in a 22 team league, the first finisher gets a 22 and the worst team gets a 1. We then take the logs of these values and subtract the mean of the log of the finishing positions for the given league and year, in order to take into account league size. Giving the best team the largest value (as opposed to the smallest value) transforms the dependent variable into a positive indicator of output. Taking logs of course reduces the differences between extreme observations. We define the manager's playing expertise in a series of dummy variables with four categories:

1. **Those who played internationally and in their top domestic league.** The requirement to have been both an international player **and** to have played in the top domestic league is decided upon because some smaller international teams may take players who are the best of that nationality but are not playing at the highest level. So, for example, Wales and Northern Ireland (and Scotland) have international players who are playing in the second tier of the English game.

[4] For the development of frontier production analysis, see Aigner, Lovell and Schmidt (1977).

2. **Those who played in their top domestic league but not internationally.**
   These last groups of international but not highest league players are also put into this category on the basis of their international caps, even if their league careers would not have put them into this group.

3. **Those who played in leagues below the top level in their country**
   Any manager who played professionally but not in the highest league.

4. **Those who did not play professionally**
   While there are not many managers who fall into this category, there are still some. For example, Jose Mourinho is in this category, as was Stuart Murdoch at MK Dons and Lennie Lawrence at the various clubs he has managed.

An additional measure of managerial quality is the amount of managerial experience. This is the case since there is learning by doing and also because the better managers are asked back for future contracts. In either instance, managerial experience is likely to be positively correlated with managerial quality. Since actual performance may affect teams' decisions to employ managers in future years, experience may be endogenous, and we therefore report some results which do not control for experience. We measure managerial playing ability and experience relative to the league average for the given season, since the dependent variable is also a relative measure for a given season.

We note that several studies of managerial efficiency in sports control for whether the manager previously played for the current team and also current tenure. We do not control for such factors, since they are likely to be endogenous with respect to current performance. For example, teams are likely to keep their successful managers (raising current tenure), especially if they previously played for the team (producing a positive correlation between having played for the team and winning as a manager). By excluding such variables, we in effect estimate a reduced form.

The players' skills are proxied by the log of the team's real payroll for players minus the log of the average team's payroll for the given league and season. We recognize that this measure is an ex ante indicator of playing skill, although it does have the advantage of placing the manager's abilities into a proper context. Specifically, we are interested in comparing the performance of different types of managers when given teams with the same market value of players. As long as the salaries of the players are positively affected by their skill, a reasonable assumption, this variable will be a measure of that skill; however, like any other measure, including transfer values and even past performance levels, payroll may measure skills with error.[5] Our maintained hypothesis is that better quality players earn higher salaries, which can then be used as an indicator of playing skill. Szymanski (2003) provides evidence for all major team sports in North America as well as European football that team relative payroll is positively correlated with team success.[6]

Note that we use team payroll rather than more direct measures of player performance. We follow this procedure in part because these performance measures are potentially affected by the manager, through teaching as well as motivating player performance, and through the manager's substitution patterns, which influence players' opportunities to accumulate playing statistics. In fact, as suggested earlier, more successful managers may make better recruiting decisions, given the level of team payroll, providing an additional avenue through which managerial skill can help teams reach their potential output. Thus, our measure of team skills, payroll, allows the manager to have an effect in evaluating talent. Using player performance statistics

[5] For example, Dawson, Dobson and Gerrard (2000a and b) use transfer values as an indicator of playing skill.

[6] See Szymanski (2000) and Hall, Szymanski and Zimbalist (2002) for further evidence finding a positive correlation between team payroll and performance in sports. There is some question in the literature as to whether causality runs from payroll to team success or vice-versa. Hall, Szymanski and Zimbalist (2002) address this issue by performing Granger causality tests for baseball and English soccer. The authors in fact find (positive) causality from payroll to performance for soccer for 1974-1999 and for baseball from 1995 to 2000, supporting our use of team payroll as an indicator of playing skill.

would not allow this effect to be observed.[7] Payroll as a proxy for quality of players is adopted from the Deloitte and Touche Football Finance reports who take this as the most reliable and verifiable measure. These reports find a correlation between payroll and sporting performance (Deloitte and Touche 2009), and econometric research concludes, we have seen, that higher payroll does indeed cause better performance (Hall Szymanski and Zimbalist 2002).

While our team payroll measure, in our opinion, provides a good proxy for the average quality of the players, we acknowledge that it doesn't measure the productivity of individual players. In soccer, individual performance may be more difficult to measure than in baseball or basketball, where we have an abundance of individual performance measures. Sources such as OPTA (www.optasports.com) or journalists as in the work of Garcia-del-Barrio and Pujol (2004 and 2009) provide ratings of individual players; however, as just mentioned, our payroll measure allows the manager to have effects in making skillful choices within a budget constraint. Thus our maintained hypothesis follows the evidence of Deloitte and Touche (2009) and Hall, Szymanski and Zimbalist (2002) that the players on high payroll teams are on average better than those on low payroll teams. One can interpret the differences between the effects of managers on high and low payroll teams as average treatment effects on high skill vs. low skill players.[8]

To study the issues of complementarity and substitution, we estimate the following frontier production function model of the determinants of the log of the team's finishing position relative to the average for year t and team i:

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[7] Since a player's salary is affected by past performance, some of the payroll variable may have been affected by the manager's skills, like individual player performance statistics. Thus, we may still be underestimating the impact of the manager's skill by controlling for team payroll.

[8] Some studies of soccer players' salaries use individual performance statistics such as goals scored or defensive statistics (e.g. Lehmann and Schulze 2008 or Lucifora and Simmons 2003); an interesting extension of our work would be to examine the performance of individual players under different management.

1) $\ln(\text{place}_{it}) - \text{league average}(\ln(\text{place}))_t = a_0 + a_1 \text{relpay}_{it} + (e_{it} - v_{it})$,

2) $v_{it} = f(\text{experience}_{it}, D_{it}, \text{relpay}_{it}, \text{relpay}_{it} * D_{it}, \text{relpay}_{it} * \text{experience}_{it}, \text{experience}_{it} * D_{it})$

3) $0 <= v_{it}$,

where place is the team's place in the standings in increasing order of success, relpay is the log of the team's payroll for players minus the average log team payroll, experience is the manager's number of years of professional managing experience minus the league average for that year, D is a vector of three dummies summarizing the manager's level of playing minus the league average for that year, with international level (i.e. the top level) as the excluded category. Because the dependent variable is defined relative to other teams in the same league and year, we also define all explanatory variables in the same way. The interaction terms will shed light on the kind of substitution and complementarity relationships we observe among managerial expertise, managerial experience, and players' expertise.

Equation 1) is a structural production function with the players' talent as input. The disturbance consists of two components: e, which is the usual error summarizing omitted factors affecting potential output, and v, which is a measure of productive inefficiency and is constrained to be nonnegative. Equation 2) expresses the idea that this relative inefficiency is potentially a function of manager characteristics and player skills. Since the dependent variable is a positive indicator of output and since the error component v enters into the model with a minus sign, a negative interaction effect in equation 2) means a more positive effect on productive efficiency.

Our earlier theoretical discussion suggested that managerial skill was multidimensional (i.e. it includes activities such as teaching and ego management). Moreover, we argued that the importance of these dimensions differed across levels of subordinates' playing ability. We therefore estimated equations 1) and 2) estimated

separately by the four leagues in British football, although we will refer briefly to some estimates on the pooled sample. Because of the problems of repeat observations on individual managers, we estimated the standard errors by bootstrapping, using 20 replications. We had mostly complete payroll data for 1994-2007 for the top two leagues and 1994-2001 for the two lower level leagues.[9] Thus, these are the years for which we estimate these models, and we now turn to a description of the results.

We recognize that there may be endogenous matching between certain types of teams and managers with particular skills. For example, a team with fans who have a high willingness to pay for winning may recruit star players and a highly skilled manager. The presence of repeat observations raises the possibility that one could control for manager fixed effects and thereby at least partially control for this potential endogeneity problem. This was done by estimating the within-manager effects of the interaction between payroll and manager's playing ability as well as experience interactions with playing ability and payroll. While we attempted such a model and largely obtained qualitatively similar results to those present below, the results were imprecise, perhaps because in each league, there were only 40-95 individual managers who had multiple years of data. In contrast, there were, overall, 84-143 managers in the total samples within each league. Note that even though the manager's level of play remains constant across observations for the same manager, its interactions with payroll and experience can change, allowing for the estimation of within-manager effects.[10]

Of course, even fixed effects analysis may not fully control for endogenous matching if the factors that influence team and manager turnover decisions change over

[9] Our basic models are estimated deleting any observations with missing data during these sample periods. However, as discussed below, we also estimate some models where we keep the missing data and assign values using multiple imputation techniques.

[10] Making the manager fixed effects the focus of the analysis (as in studies such as Porter and Scully's 1982 examination of baseball managers) would be insufficient for our purposes. This is the case, since we have hypothesized that the manager's productivity varies depending on the type of team being managed as well as on the specific dimension of skill being studied.

time. For example, there is evidence that manager turnover in German soccer is affected by such time varying factors as team winning percentage, the team wage bill, and the manager's pay (Barros, Frick and Prinz 2009; Barros, Frick and Passos 2010). Finding suitable instruments to take account of such sorting is difficult. Unfortunately, attempts to use instruments such as lagged payroll or manager's birth year dummies (as in Goodall, Kahn and Oswald's forthcoming study of basketball coaches) for measures of the skill of the manager and their interactions with team type proved unsuccessful. Perhaps this is due to the fact that in our case, managerial skill is comprised of several dimensions that we hypothesize interact with team type. The data evidently can't support a model with several endogenous regressors. Therefore the possibility of endogeneity biases remains, and below, we discuss whether such biases could help explain our results.

Results

Table 1 shows mean values for selected variables by league. There is a clear sorting of higher playing ability among managers, higher payroll for current players, and a larger amount of managerial experience leading a team into the more elite leagues. Specifically, the incidence of playing at Tier 1 (i.e. the Premier League), the number of years of managerial experience, and the average team payroll for players all decline monotonically as the level of the current league declines. Moreover, each successive decline across consecutive league types in the incidence of the manager's having played in the Premier League, years of managerial experience, or team payroll is statistically significant.[11] In the current Premier League, fully 52% of the managers played internationally and in their country's top league, while only 14% of the managers at Tier

[11] This conclusion is based on ordinary least squares (OLS) regressions of the indicated characteristic on dummy variables for current league level, where the standard errors have been clustered at the manager level.

4 did so; managers at Tier 1 have about 9.3 years' of managerial experience, while those at Tier 4 have only been managing for 6.5 years; and payrolls for Tier 1 teams are about 20 times those at Tier 4 in real terms.[12] Finally, as discussed above, the leagues are about the same size, making the dependent variable comparable across leagues.

Tables 2-5 show frontier production function results for equations 1) and 2). Looking first at the Premier League, the first model in Table 2 only allows the manager's level of play to affect productive inefficiency. In this model, the effect of player payroll on output is a highly significant 0.447. Since both the dependent variable and the payroll variable are in logs, this corresponds to an elasticity. An alternative view of the size of this effect is to ask what moving from the 25th to the 75th percentile of the distribution of average team salaries would entail. Using 2000 figures for the 75-25 salary gap for the Premier League (0.697 log points) and a mean finishing position of about 10 and the 0.447 salary coefficient in the first model in Table 2, we find that moving from the 25th to the 75th payroll level improves the team's position at the mean of standings by about 3.7 places. This is a noticeable effect in a 22 team league. The effects of managerial expertise are insignificant individually and jointly in this specification, which of course constrains their effect to be the same at all payroll and managerial experience levels.[13] The next specification adds managerial experience to the factors that potentially influence productive inefficiency; while the coefficient on experience has the expected negative sign (i.e., managerial experience on average lowers productive inefficiency), it is not significant.

[12] The 20:1 payroll ratio is based on the raw means for real payroll.

[13] This insignificance contrasts with the results of Dawson and Dobson (2002) who found that having played at an international level was associated with more managerial efficiency. Their finding was based on a model which pooled various levels of English football. When we pooled the four leagues (results available on request), we indeed found in some models that having played at Tier 2 led to significantly less efficiency than having played at Tier 1, a similar result to Dawson and Dobson (2002). However, the findings shown below suggest that it is inappropriate to pool the different leagues. In addition, when we added a dummy variable for whether the manager played for the current team, we found a significantly positive effect on efficiency, as Dawson and Dobson (2002) did, while the other results were unchanged. However, as argued above, we believe that this variable is endogenous and should not be included.

While the first two specifications for productive inefficiency do not show significant main effects for managerial expertise or experience, the third specification shows that player skill significantly interacts with the manager's expertise in bringing the team closer to its productive potential. Specifically, in affecting productive inefficiency, player payroll has negative interaction effects with the manager's playing ability at levels 2, 3, and 4, all relative to managers who played at the top level (the log relative payroll main inefficiency effect). Moreover, the interactions are monotonically increasing in absolute value, ranging from -0.308 for level 2 to -2.412 for managers who didn't play. And the interactions for levels 3 and 4 are significant at the 0.8% and 3.6% levels respectively, on two tailed tests. The interaction effect for managers who didn't play is large in magnitude. For example, the impact of a 75-25 increase in player pay lowers productive inefficiency by 1.67 log points more for a manager who didn't play versus a manager who played at level 1, or by about 81 percentage points.[14]

The main effect of log payroll in the analysis of productive inefficiency is the impact of payroll for teams managed by former top level players. It also is significantly negative; in conjunction with the negative interactions for each of the lesser playing ability types of managers, we find evidence that in addition to directly affecting potential output, better paid players enable teams to achieve results closer to their potential. Of course this division of the impact of player skills into direct effects on potential output and indirect effects through their impact on productive efficiency is dependent on the production function model being correct. However, the result does shed light on the routes through which worker and manager skills lead to organizational success.

The fourth specification in Table 2 adds an interaction between player payroll and the manager's experience. This effect is negative and significant at the 2.8% level. A

[14] These large predicted increases in efficiency must of course be interpreted cautiously, in light of the fact that the mean efficiency was about .5 for each league. Nonetheless the large implied effects of these substantial payroll changes do suggest that a higher payroll raises the productive efficiency of less expert (with respect to playing ability) managers by substantially more than for more expert managers.

75-25 change in the manager's experience is roughly 9 years (i.e. 13 vs. 4 years' managing experience), implying that the interaction coefficient of -0.100 represents a large effect indeed. Adding the experience-payroll interaction effect does, however, reduce the size of the payroll-manager's playing ability interactions by about a third for Tiers 3 and 4 and by 81% for level 2. The payroll-manager's playing ability interactions still increase monotonically in magnitude as the manager's playing ability decreases from Tier 1 to Tier 4, and remain statistically significant for levels 3 and 4 (at the 2.9% and 4.6% levels respectively). Finally, there do not seem to be any important managerial experience-managerial playing ability interaction effects, although adding these variables raises the standard errors on the payroll-manager's playing ability interactions without affecting their magnitude.[15]

The basic results for the Premier League, then, suggest the following conclusions. First, teams really do receive something in return for a higher payroll, both directly on potential output and indirectly by having a more technically efficient team (i.e., one which achieves at a level closer to its potential). Second, managerial playing skill raises productive efficiency by more for teams with lower quality than higher quality players. And, third, managerial experience raises productive efficiency by more for more highly skilled players. These disparate interaction effects suggest that there are multiple dimensions of managerial skill. On the one hand, the interactions for managerial playing quality and team payroll for players suggest that leaders who are experts at the sport have more to teach lesser skilled than more skilled players. The more highly skilled players, as indicated by a higher payroll, benefit less from a manager who was a great player, since these players already know how to play well. On the other hand, the effects of

[15] The three experience-managerial playing ability interactions were insignificant as a group as well as individually. In Table 2, last column, the three payroll-managerial playing level interactions become steadily more negative as the manager's playing level declines, as in the earlier models in the Table. However, in the fully-specified model, these three interactions are individually and jointly insignificant. Nonetheless, the pattern of point estimates holds up, and they are largely significant in the earlier models.

managerial experience suggest that long time managers know how to manage the egos of star players. More experienced managers bring more highly skilled players closer to their potential than when they manage less highly skilled players. Either such knowledge was obtained through on the job learning or managers who are better at managing big egos are selected by the Premier League teams to have long careers.

While it is possible that endogenous matching could explain these results, it would need to be a very peculiar kind of matching. Specifically, managers who were great players and highly experienced managers must have opposite matching effects with team type to provide a consistent, competing explanation to the one we have emphasized. This is the case, since these two aspects of managerial skill have oppositely-signed interaction effects with player quality.

Tables 3-5 show results for the lower level leagues and are in general weaker than for the Premier League.[16] In each of Tiers 2-4, the direct effect of player payroll on team potential success is positive and is usually significant: better-paid players are associated with a higher level of potential output at each league level. This positive effect of player payroll serves as some validation of payroll as a positive indicator of player skill. The production function parameter for team payroll for the Premier League is larger than for Tiers 2 and 3 and about the same size as the effect for Tier 4. Thus the elasticity of output with respect to player ability is at least as large for the Premier League as for the other leagues. Moreover, since the 75-25 gaps for the 2000 season for Tiers 2-4 are, respectively, 0.700, 0.663, and 0.568, compared to the Premier League's value of 0.697, an increase in payroll of this magnitude would also have effects at least as large for the

[16] When we pooled the leagues and estimated the fully-specified model (i.e. the last model in Tables 2-5), we found that, relative to managers who played in the Premier League, managers who played at level 2 significantly raised the productivity of lower paid teams more than higher paid teams; however, the other manager playing level-current payroll interactions were insignificant and increasing algebraically. But more experienced managers significantly raised the productivity of high payroll teams more than low payroll teams, as in Table 2. As noted, however, the differences in the results across Tables 2-5 suggest that one shouldn't pool the leagues.

Premier League as for the other leagues. In addition to positively affecting potential output, player payroll also appears to raise productive efficiency in Tiers 2-4, as it did for the Premier League, with several of the effects being statistically significant and large in magnitude. Moreover, at Tier 3, there is a large, negative main effect of managerial experience on inefficiency that is statistically significant. Specifically, the second model in Table 4 shows a coefficient on managerial experience of -0.227 with a standard error of 0.109. For the year 2000, the 75-25 gap in experience for Tier 3 is 5.5 years (i.e. 6.5 vs. 1), implying that an increase of this magnitude in experience lowers inefficiency by about 1.1 log points, or 67 percentage points. Finally, again for Tier 3, Table 4 shows that player payroll has a significantly larger effect in lowering inefficiency for managers who played at Tier 2 vs. Tier 1. The direction of this effect is similar to the impact in the Premier League, although for the Tier 3 league, the interactions do not rise monotonically as the manager's playing skill declines.[17] Finally, the payroll-managerial playing level interactions are insignificant individually and as a group in Tiers 2 and 4.

The finding of stronger payroll-manager playing skill and managerial experience-payroll interactions for the Premier League than for the other leagues deserves further comment. Specifically, we have interpreted the positive manager experience-payroll effects in the Premier League as reflecting an experienced manager's ability to manage the egos of highly paid players. It is intuitive that such egos will be more on display at the top levels of the Premier League than in the lower leagues, making it plausible that we would observe this effect to a greater degree at the top level of play. On the other hand, the negative interactions between managerial playing ability and player payroll

[17] As suggested by Dawson, Dobson and Gerrard (2000b), managerial efficiency may not be constant over time. When we reestimated our models adding a time trend for the determination of inefficiency, the results in every case were small and statistically insignificant. In addition, when we included a dummy variable for having played forward professionally, its effects were insignificant, unlike Dawson and Dobson (2002). Moreover, when we used raw points as the dependent variable (draws plus 3 times wins), the results for the interactions between payroll and managerial playing skill and payroll and managerial experience were very similar to those presented above.

suggest, we have argued, that managers who were great players have more to teach lesser players than more accomplished current players. One might have expected such effects to be stronger in the lesser leagues, where the players presumably have more to learn than in the Premier League. Perhaps the answer is in the nature of the instruction that a manager who was a top level player provides to lesser players in the Premier League relative to lesser players in the lower level leagues. In the Premier League, players compete for higher stakes than in the other leagues, and lesser players in the top league may have more to learn about how to compete in such an environment than in the lower leagues.

As noted earlier, in some cases, there were missing data for player payroll, amounting to 6 cases for the Premier League (2% of the observations), 40 cases for level 2 (9%), 27 cases for level 3 (11%), and 71 cases for level 4 (30%). In addition, there was one missing case for the manager's experience level for the Premier League. In Appendix Tables A1-A4, we show frontier production function results where we employ multiple imputation techniques suggested by Rubin (1987) to use the observed data on the explanatory variables to impute values for the missing data. The results in Tables A1)-A4) are quite similar in magnitude to those in Tables 2-5, although they are less statistically significant. Thus, our basic findings do not appear to be an artifact of the sample with complete data.

Conclusions

In this paper, we have used data on British football managers over the 1994-2007 period to study the issue of substitution and complementarity between leaders and subordinates. This setting is a particularly fruitful one for examining such production relationships because we have clear data on each organization's performance (i.e., its

finishing position during the current season) and the type of both production and managerial labor inputs used.

Our strongest results are for the Premier League (the highest level of competition) and show that, other things being equal, managers who played at a higher level raise the productivity of lesser skilled teams by more than they do of more highly skilled teams. This finding is consistent with the hypothesis that one of the functions of a highly skilled manager is to teach subordinates some of the skills needed to succeed. The value of this teaching is, according to our results, greater the less skilled the players are. Such a result, which we believe is a new one, seems intuitively plausible. An additional finding, however, suggests that other things being equal (including the manager's playing ability), managers with more accumulated professional managing experience raise the productivity of more skilled players by more than that of less skilled players. This finding is consistent with the idea that another role of successful managers in high-pressure, high-performance workplaces may be to manage the egos of the workers involved. Such a role is likely to be more critical the more accomplished the workers are, as indicated in our data by teams with higher relative payroll levels. While our results apply to average team skills, as proxied by its relative payroll level, a fruitful topic for future research is to study which players' performance is enhanced most by better managers.

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Table 1: Managers' Mean Values by League

	League			
Variable	Tier One	Tier Two	Tier Three	Tier Four
Manager Played at Level 1	0.523	0.383	0.256	0.143
Manager Played at Level 2	0.078	0.170	0.177	0.220
Manager Played at Level 3	0.351	0.370	0.484	0.500
Manager Never Played	0.048	0.078	0.084	0.137
Manager's Experience (years)	9.413	6.851	4.468	3.141
Log Team Real Payroll for Players	9.292	8.100	7.022	6.494
Sample Size	333	400	215	168

Table 2: Team Success Equations-- Frontier Production Function Analysis for Relative League Position, Tier One (Premier League) Teams

	coef		se	coef		se	coef		se	coef		se	coef		se
Production Function Parameter:															
Log Team Relative Payroll	0.447	**	0.188	0.440	***	0.087	0.223	***	0.067	0.218	***	0.064	0.217	***	0.055
Technical Inefficiency Parameters:															
	coef		se	coef		se	coef		se	coef		se	coef		se
Manager Played at Level 2	2.110		1.777	2.120		1.708	0.391		0.394	0.446		0.561	0.412		0.567
Manager Played at Level 3	-0.551		1.069	-0.271		3.256	-0.358		0.362	-0.283		0.333	-0.085		0.366
Manager Did Not Play	0.476		2.210	0.819		2.604	0.462		0.523	0.623		0.709	0.661		2.355
Manager's Experience				-0.071		0.085	0.008		0.013	-0.015		0.023	-0.007		0.029
Log Relative Payroll							-2.279	***	0.258	-1.615	***	0.567	-1.598	***	0.594
Log Relative Payroll*Played Level 2							-0.308		0.877	-0.058		1.492	-0.102		0.981
Log Relative Payroll*Played Level 3							-1.308	***	0.495	-0.891	**	0.408	-0.829		0.902
Log Relative Payroll*Never Played							-2.414	**	1.153	-1.659	**	0.830	-1.585		1.050
Manager's Experience*Log Team Relative Payroll										-0.100	**	0.045	-0.107	**	0.046
Manager's Experience*Played Level 2													0.001		0.063
Manager's Experience*Played Level 3													-0.020		0.023
Manager's Experience*Never Played													-0.006		0.214
Sample size	333			333			333			333			333		
Wald Test Prob.	0.0175			0.0000			0.0008			0.0007			0.0001		
Log Likelihood	-313.2			-312.5			-268.7			-266.3			-266.1		

Relative position is defined as the difference between the log of team's finishing position and the average of the logs of the finishing positions of the teams in each given year. Finishing position is defined in direct order of success (i.e. a higher value means a better finish). Therefore a negative coefficient in the technical inefficiency analysis actually represents more technical efficiency. Explanatory variables are each defined relative to the league average for each year. Standard errors are bootstrapped using 20 replications. ***, **, and * mean, respectively, that the coefficient is significantly different from zero at the 1%, 5 % or 10% level, two tailed tests.

Table 3: Team Success Equations--Frontier Production Function Analysis for Relative League Position, Tier Two League Teams

	coef		se	coef		se	coef		se	coef		se	coef		se
Production Function Parameter:															
Log Team Relative Payroll	0.320	***	0.079	0.308	***	0.086	0.134	*	0.071	0.133	**	0.062	0.133	***	0.037
Technical Inefficiency Parameters:															
	coef		se	coef		se	coef		se	coef		se	coef		se
Manager Played at Level 2	0.080		0.806	0.036		0.825	-0.173		0.454	-0.173		0.475	-0.162		0.687
Manager Played at Level 3	0.371		0.641	0.447		0.677	0.003		0.397	0.003		0.416	0.282		0.597
Manager Did Not Play	0.688		1.202	0.992		1.291	0.102		0.969	0.102		0.876	0.458		1.113
Manager's Experience				-0.071		0.066	-0.025		0.031	-0.025		0.030	0.002		0.048
Log Relative Payroll							-2.428	***	0.412	-2.425	***	0.874	-2.445	***	0.646
Log Relative Payroll*Played Level 2							-0.498		0.761	-0.498		0.807	-0.400		0.944
Log Relative Payroll*Played Level 3							0.906		0.751	0.907		0.639	1.039		0.707
Log Relative Payroll*Never Played							1.088		1.143	1.092		1.072	1.164		0.942
Manager's Experience*Log Team Relative Payroll										-0.001		0.061	-0.007		0.043
Manager's Experience*Played Level 2													-0.002		0.087
Manager's Experience*Played Level 3													-0.043		0.070
Manager's Experience*Never Played													-0.049		0.084
Sample size	400			400			400			400			400		
Wald Test Prob.	0.0001			0.0003			0.0590			0.0315			0.0003		
Log Likelihood	-411.0			-409.6			-391.0			-391.0			-390.6		

Relative position is defined as the difference between the log of team's finishing position and the average of the logs of the finishing positions of the teams in each given year. Finishing position is defined in direct order of success (i.e. a higher value means a better finish). Therefore a negative coefficient in the technical inefficiency analysis actually represents more technical efficiency. Explanatory variables are each defined relative to the league average for each year. Standard errors are bootstrapped using 20 replications. ***, **, and * mean, respectively, that the coefficient is significantly different from zero at the 1%, 5 % or 10% level, two tailed tests.

Table 4: Team Success Equations-- Frontier Production Function Analysis for Relative League Position, Tier Three League Teams

	coef	se	coef		se	coef		se	coef		se	coef		se
Production Function Parameter:														
Log Team Relative Payroll	0.254		0.222	0.251	***	0.074	0.101		0.063	0.106		0.074	0.113		0.082
Technical Inefficiency Parameters:														
	coef		se	coef		se	coef		se	coef		se	coef		se
Manager Played at Level 2	1.237		1.153	0.752		0.512	-0.095		0.470	-0.068		0.413	-0.844		0.633
Manager Played at Level 3	-0.598		1.007	-0.607		0.682	-0.593		0.313	-0.582		0.395	-1.150	***	0.411
Manager Did Not Play	0.562		1.146	0.403		0.719	-0.289		0.796	-0.363		0.602	-1.018		0.688
Manager's Experience				-0.227	**	0.109	-0.125	***	0.045	-0.115	**	0.047	-0.248	**	0.100
Log Relative Payroll							-1.358		0.914	-1.973	***	0.609	-2.100		1.642
Log Relative Payroll*Played Level 2							-3.604	**	1.501	-3.254	***	1.170	-3.025	**	1.397
Log Relative Payroll*Played Level 3							-1.013		1.150	-0.636		0.749	-0.537		1.244
Log Relative Payroll*Never Played							-1.547		2.063	-1.378		1.532	-1.581		1.740
Manager's Experience*Log Team Relative Payroll										0.110		0.107	0.134		0.147
Manager's Experience*Played Level 2													0.227		0.142
Manager's Experience*Played Level 3													0.151	*	0.090
Manager's Experience*Never Played													0.170		0.294
Sample size	215			215			215			215			215		
Wald Test Prob.	0.2532			0.0007			0.1103			0.1526			0.1655		
Log Likelihood	-211.4			-206.0			-188.0			-187.4			-184.8		

Relative position is defined as the difference between the log of team's finishing position and the average of the logs of the finishing positions of the teams in each given year. Finishing position is defined in direct order of success (i.e. a higher value means a better finish). Therefore a negative coefficient in the technical inefficiency analysis actually represents more technical efficiency. Explanatory variables are each defined relative to the league average for each year. Standard errors are bootstrapped using 20 replications. ***, **, and * mean, respectively, that the coefficient is significantly different from zero at the 1%, 5 % or 10% level, two tailed tests.

Table 5: Team Success Equations-- Frontier Production Function Analysis for Relative League Position, Tier Four League Teams

	coef		se	coef		se	coef		se	coef		se	coef		se
Production Function Parameter:															
Log Team Relative Payroll	0.469	***	0.134	0.446	***	0.143	0.367	***	0.123	0.362	**	0.159	0.364	*	0.194
Technical Inefficiency Parameters:															
	coef		se	coef		se	coef		se	coef		se	coef		se
Manager Played at Level 2	1.311		5.414	1.156		1.716	1.187		0.985	1.295		1.278	0.934		1.491
Manager Played at Level 3	0.447		5.041	0.438		1.441	0.597		0.801	0.714		1.558	-0.792		1.603
Manager Did Not Play	1.198		5.080	1.025		1.236	1.048		0.633	1.111		1.409	0.322		1.935
Manager's Experience				-0.139		0.131	-0.108		0.099	-0.082		0.105	-0.403		0.308
Log Relative Payroll							-5.501		4.798	-4.910		5.512	-4.288		3.122
Log Relative Payroll*Played Level 2							3.420		4.906	3.149		4.278	3.950		3.125
Log Relative Payroll*Played Level 3							5.116		4.889	5.059		5.584	4.542		2.778
Log Relative Payroll*Never Played							3.397		4.811	3.115		5.728	3.020		3.314
Manager's Experience*Log Team Relative Payroll										-0.219		0.381	-0.473		0.333
Manager's Experience*Played Level 2													0.041		0.331
Manager's Experience*Played Level 3													0.500		0.342
Manager's Experience*Never Played													0.206		0.391
Sample size	168			168			168			168			168		
Wald Test Prob.	0.0004			0.0018			0.0029			0.0231			0.0604		
Log Likelihood	-177.9			-177.1			-175.1			-174.9			-172.6		

Relative position is defined as the difference between the log of team's finishing position and the average of the logs of the finishing positions of the teams in each given year. Finishing position is defined in direct order of success (i.e. a higher value means a better finish). Therefore a negative coefficient in the technical inefficiency analysis actually represents more technical efficiency. Explanatory variables are each defined relative to the league average for each year. Standard errors are bootstrapped using 20 replications. ***, **, and * mean, respectively, that the coefficient is significantly different from zero at the 1%, 5 % or 10% level, two tailed tests.

Table A1: Team Success Equations--Frontier Production Function Analysis for Relative League Position With Time Trend for Productive Inefficiency and Multiple Imputations for Missing Data, Tier One (Premier League) Teams

	coef		se	coef		se	coef		se
Production Function Parameter: Log Team Relative Payroll	0.249	***	0.048	0.243	***	0.047	0.240	***	0.047
Technical Inefficiency Parameters:	coef		se	coef		se	coef		se
Manager Played at Level 2	0.362		0.588	0.422		0.574	0.200		0.905
Manager Played at Level 3	-0.231		0.319	-0.162		0.310	0.221		0.498
Manager Did Not Play	1.043	*	0.595	1.198	**	0.589	0.412		1.403
Manager's Experience	0.0005		0.019	-0.021		0.022	-0.009		0.030
Log Relative Payroll	-2.172	***	0.547	-1.500	***	0.572	-1.424	**	0.569
Log Relative Payroll*Played Level 2	-0.483		1.435	-0.203		1.402	-0.387		1.487
Log Relative Payroll*Played Level 3	-1.300	*	0.691	-0.846		0.690	-0.719		0.685
Log Relative Payroll*Never Played	-1.549		1.255	-0.830		1.197	-0.796		1.223
Manager's Experience*Log Team Relative Payroll				-0.104	**	0.051	-0.120	**	0.055
Manager's Experience*Played Level 2							0.017		0.068
Manager's Experience*Played Level 3							-0.039		0.042
Manager's Experience*Never Played							0.056		0.102
Sample size	339			339			339		
Model F-test Prob.	0.0000			0.0000			0.0000		

Relative position is defined as the difference between the log of team's finishing position and the average of the logs of the finishing positions of the teams in each given year. Finishing position is defined in direct order of success (i.e. a higher value means a better finish). Therefore a negative coefficient in the technical inefficiency analysis actually represents more technical efficiency. Explanatory variables are each defined relative to the league average for each year. All variables involving pay and experience imputed. 10 imputations are performed, but only 7 could be used in the second stage equations, due to. convergence problems. All non-imputed explanatory variables are used as predictors in the imputations.
***, **, and * mean, respectively, that the coefficient is significantly different from zero at the 1%, 5 % or 10% level, two tailed tests.

Table A2: Team Success Equations--Frontier Production Function Analysis for Relative League Position With Time Trend for Productive Inefficiency and Multiple Imputations for Missing Data, Tier Two League

	coef		se	coef		se	coef		se
Production Function Parameter: Log Team Relative Payroll	0.151	***	0.046	0.151	***	0.046	0.151	***	0.046
Technical Inefficiency Parameters:	coef		se	coef		se	coef		se
Manager Played at Level 2	-0.235		0.424	-0.233		0.425	-0.286		0.655
Manager Played at Level 3	-0.098		0.358	-0.097		0.358	-0.014		0.545
Manager Did Not Play	-0.064		0.714	-0.065		0.715	-0.006		0.965
Manager's Experience	-0.049	*	0.029	-0.049	*	0.030	-0.043		0.052
Log Relative Payroll	-2.189	***	0.648	-2.187	***	0.726	-2.200	***	0.734
Log Relative Payroll*Played Level 2	-0.315		0.973	-0.312		0.970	-0.282		0.977
Log Relative Payroll*Played Level 3	0.960		0.868	0.962		0.871	0.998		0.901
Log Relative Payroll*Never Played	0.826		1.135	0.826		1.212	0.833		1.228
Manager's Experience*Log Team Relative Payroll				-0.0003		0.061	-0.0004		0.064
Manager's Experience*Played Level 2							0.010		0.096
Manager's Experience*Played Level 3							-0.013		0.067
Manager's Experience*Never Played							-0.010		0.087
Sample size	440			440			440		
Model F-test Prob.	0.0012			0.0012			0.0012		

Relative position is defined as the difference between the log of team's finishing position and the average of the logs of the finishing positions of the teams in each given year. Finishing position is defined in direct order of success (i.e. a higher value means a better finish). Therefore a negative coefficient in the technical inefficiency analysis actually represents more technical efficiency. Explanatory variables are each defined relative to the league average for each year. All variables involving pay and experience imputed. 10 imputations are performed. All non-imputed explanatory variables are used as predictors in the imputations. ***, **, and * mean, respectively, that the coefficient is significantly different from zero at the 1%, 5 % or 10% level, two tailed tests.

Table A3: Team Success Equations--Frontier Production Function Analysis for Relative League Position With Time Trend for Productive Inefficiency and Multiple Imputations for Missing Data, Tier Three League

	coef		se	coef		se	coef		se
Production Function Parameter: Log Team Relative Payroll	0.023		0.065	0.026		0.067	0.028		0.068
Technical Inefficiency Parameters:	coef		se	coef		se	coef		se
Manager Played at Level 2	-0.460		0.448	-0.442		0.444	-1.009	*	0.572
Manager Played at Level 3	-0.892	**	0.393	-0.887	**	0.387	-1.136	**	0.517
Manager Did Not Play	-0.223		0.575	-0.294		0.581	-0.699		0.857
Manager's Experience	-0.117	***	0.045	-0.113	***	0.044	-0.180	**	0.074
Log Relative Payroll	-1.478		0.797	-1.882	*	1.047	-1.991	*	1.023
Log Relative Payroll*Played Level 2	-3.107	**	1.473	-2.870	*	1.504	-2.571	*	1.458
Log Relative Payroll*Played Level 3	-0.676		1.088	-0.439		1.119	-0.316		1.086
Log Relative Payroll*Never Played	-1.130		1.787	-1.075		1.752	-1.213		2.021
Manager's Experience*Log Team Relative Payroll				0.065		0.112	0.081		0.117
Manager's Experience*Played Level 2							0.167	*	0.100
Manager's Experience*Played Level 3							0.063		0.089
Manager's Experience*Never Played							0.092		0.131
Sample size	242			242			242		
Model F-test Prob.	0.7231			0.6970			0.6799		

Relative position is defined as the difference between the log of team's finishing position and the average of the logs of the finishing positions of the teams in each given year. Finishing position is defined in direct order of success (i.e. a higher value means a better finish). Therefore a negative coefficient in the technical inefficiency analysis actually represents more technical efficiency. Explanatory variables are each defined relative to the league average for each year. All variables involving pay and experience imputed. 10 imputations are performed. All non-imputed explanatory variables are used as predictors in the imputations. ***, **, and * mean, respectively, that the coefficient is significantly different from zero at the 1%, 5 % or 10% level, two tailed tests.

Table A4: Team Success Equations--Frontier Production Function Analysis for Relative League Position With Time Trend for Productive Inefficiency and Multiple Imputations for Missing Data, Tier Four League

	coef		se	coef		se	coef		se
Production Function Parameter: Log Team Relative Payroll	0.110	*	0.059	0.110	*	0.059	0.110	*	0.059
Technical Inefficiency Parameters:	coef		se	coef		se	coef		se
Manager Played at Level 2	1.443		0.894	1.465		0.913	0.929		1.135
Manager Played at Level 3	1.009		0.788	1.024		0.816	0.326		1.018
Manager Did Not Play	0.448		0.988	0.469		1.000	-0.316		1.479
Manager's Experience	0.030		0.081	0.033		0.109	-0.139		0.213
Log Relative Payroll	-3.489		4.272	-3.267		4.515	-3.325		4.359
Log Relative Payroll*Played Level 2	2.393		4.800	2.243		4.974	2.535		4.827
Log Relative Payroll*Played Level 3	2.599		4.532	2.500		4.503	2.589		4.383
Log Relative Payroll*Never Played	1.966		5.307	1.826		5.424	1.971		5.209
Manager's Experience*Log Team Relative Payroll				-0.043		0.403	-0.095		0.426
Manager's Experience*Played Level 2							0.156		0.296
Manager's Experience*Played Level 3							0.213		0.245
Manager's Experience*Never Played							0.259		0.433
Sample size	239			239			239		
Model F-test Prob.	0.0653			0.0660			0.0665		

Relative position is defined as the difference between the log of team's finishing position and the average of the logs of the finishing positions of the teams in each given year. Finishing position is defined in direct order of success (i.e. a higher value means a better finish). Therefore a negative coefficient in the technical inefficiency analysis actually represents more technical efficiency. Explanatory variables are each defined relative to the league average for each year. All variables involving pay and experience imputed. 5 imputations are performed. All non-imputed explanatory variables are used as predictors in the imputations. ***, **, and * mean, respectively, that the coefficient is significantly different from zero at the 1%, 5 % or 10% level, two tailed tests.