University of Zurich[UZH]

Center for Research in Sports Administration (CRSA)

Working Paper Series

Working Paper No. 30

Specific Human Capital as a Source of Superior Team Performance

Egon Franck, Stephan Nüesch, Jan Pieper

October 2009

SPECIFIC HUMAN CAPITAL AS A SOURCE OF SUPERIOR TEAM PERFORMANCE

Egon Franck, Stephan Nüesch, Jan Pieper*

ABSTRACT

In this paper, we empirically investigate the performance effect of team-specific human capital in highly interactive teams. Based on the tenets of the resource-based view of the firm and on the ideas of typical learning functions, we hypothesize that team members' shared experience in working together positively impacts team performance, but at diminishing rates. Holding a team's stock of general human capital and other potential drivers constant, we find support for this prediction. Implications concerning investment decisions into human capital as well as the transferability of our findings to other contexts are discussed.

* Corresponding author: Jan Pieper, University of Zürich, Plattenstrasse 14, 8032 Zürich, Email: jan.pieper@isu.uzh.ch, Phone: +41 44 634 29 13.

INTRODUCTION

The resource-based view of the firm proposes that superior performance can be explained by differentials in the endowment of valuable and rare resources. A positive competitive outcome can be sustained as long as both adequate substitutes are not available and isolating mechanisms protect critical resources from imitation (Rumelt 1987; Barney 1991). These resources can be both tangible and intangible assets that a firm controls. However, in dynamic and competitive environments that characterize many markets (Bettis and Hitt 1995), intangible resources are more likely to make a persistent competitive advantage possible (Miller and Shamsie 1996). According to Barney (1986), an effective isolating mechanism of intangible resources often stems from their inability to be transferred through the market mechanism. More generally, Reed and DeFillippi (1990) argue that the height of barriers to imitation is contingent upon the extent to which the critical resource is observable. Unobservable resources are tacit, diffused throughout the organization, or socially embedded. In particular, organizational routines are described by these characteristics (Nelson and Winter 1982; Reed and DeFillippi 1990). As it is impossible to empirically capture an unobservable resource (Godfrey and Hill 1995) strategy researchers are forced to employ proxy variables that may represent the underlying constructs in a more or less appropriate way. The difficulty of finding good proxies for critical resources has hitherto hampered the empirical testing of hypotheses proposed by scholars of the resource-based view (Godfrey and Hill 1995; Hoskisson, Hitt, Wan, and Yiu 1999).

In this paper, we empirically investigate the question of whether a team's shared experience, i.e., its stock of team-specific human capital, as an intangible and unobservable resource, sustainably affects team output. Scholars who have attempted to quantify specific human capital have used measures such as tenure (see, e.g., Sandell and Shapiro 1980; Berman, Down, and Hill 2002) or qualitative survey data about various organizational factors (see, e.g., Hansen and Wernerfelt 1989). We, in contrast, measure team-specific human capital by measuring the actual number of deployments for the current team in a competitive context. We argue that our proxy measure better reflects the members' cumulative experience in cooperating than does pure tenure. Unlike other papers, such as, for example, Berman et al. (2002), we explicitly distinguish between the separate effects of specific and general human capital on performance. As a proxy measure for the team's stock of general human capital, we make use of estimates of the team members' market potential that are primarily

driven by general components of human capital. Using panel data of 26 different teams with a total of 3,672 observations, our empirical analysis is based on a larger sample than that used by any other related paper. Thus, we believe that this paper will make a unique contribution to the empirical literature relating specific human capital to team performance.

CONCEPTUAL FRAMEWORK AND HYPOTHESES

In the following section, we first examine whether team-specific human capital qualifies as a critical resource to constitute a sustained competitive advantage. According to the resource-based view, it must add value to the firm, it must be rare, it must be inimitable and it must not be substitutable by an alternative resource (Barney 1991). Here, we discuss each of the four criteria individually in order. We then make a reference to learning effects and infer our hypothesis about a curvilinear relationship between a team's stock of team-specific human capital and team performance. As team members accumulate experience in working together, the team's stock of team-specific human capital increases. Although this asset is valuable because it improves the team's interaction quality and thus its success, its accumulation is subject to diminishing returns. In order to gain further insight into the relevance of within-team learning processes, we also investigate the effect of the heterogeneity concerning team-specific human capital on team performance. Moreover, we try to shed some light on the moderating effect of the team leader's team-specific human capital.

IS SPECIFIC HUMAN CAPITAL VALUABLE?

Following Becker (1964), the human capital literature often distinguishes between specific and general human capital. Specific human capital refers to skills, experience, and knowledge that are useful only to a single employer or industry, whereas general human capital (such as literacy) is freely transferable because it is useful to several employers. In view of this distinction, it has to be considered that purely general and purely specific human capital merely constitute theoretical poles on a continuum that allows for any mixed form in between (Thurow 1970). Williamson (1985), when remarking on human asset specificity, notes that it generates a quasi-

rent. Generally, a quasi-rent refers to the difference between the productivity in the current deployment and the second-best alternative. Thus, the degree of specificity corresponds to the scale of the quasi-rent. In the case of purely general human capital, there is no quasi-rent at all. According to Williamson (1975), the main reason why the value of specific human capital is lost when the employer changes is because it consists of idiosyncratic skills, experiences and knowledge. Both Becker (1962) and Williamson (1975) emphasize that idiosyncrasies depend on the duration of the transaction relationship because they are acquired in a continuous learning-by-doing process. In a team context, where each member's specific human capital is only valuable to the current team, this implies that, ceteris paribus, the utility of this asset depends on the stability of the workforce, i.e., the team members' tenure (Berman, Down, and Hill 2002). Alchian (1982) considers the perfect immobility of specific human capital to be the main reason for stable employer-employee relationships and even for the existence of firms.

However, the logic of specificity does not necessarily imply a positive net value. The underlying calculus is typically an investment decision. A profit-maximizing decision maker will only invest in the accumulation of specific human capital as long as the expected profits induced by the investment more than compensate for the accompanied costs, discounted to the present value (Franz 1996).

Some work in the area of utility analysis provides both a theoretical foundation and techniques to empirically investigate increases in value due to human capital, but this work does not distinguish between general and specific human capital (Schmidt, Hunter, and Pearlman 1979; Boudreau 1983; Cascio and Ramos 1986). This body of literature strongly argues that higher-quality human resources add value to firms.

A few studies have attempted to measurably distinguish between general and specific human capital in order to isolate their respective effects, despite Blaug's (1976) claim that such a distinction is all but impossible. Sandell and Shapiro (1980) investigated the impact that young women's ex ante preferences for future labor force attachment have on their human capital accumulation and pay. The authors used years of labor market experience as a proxy variable for general human capital and years of tenure with the current employer as a proxy variable for specific human capital. They determined that continuing gender differentials in job tenure and in cumulative work experience explain a large part of the gender differential in earnings and that women's relative earnings increase when their work experience and job tenure in-

crease. Unfortunately, productivity effects were not directly investigated. However, the combined effects of general and specific training as a major determinant of wages and wage growth among young women indicate at least a partial productivity increase, as wage growth cannot be completely explained by seniority.

In their study on the impact of shared experience on the performance of basketball teams, Berman, Down, and Hill (2002) used a similar conceptualization for their independent variable. Tenure, as measured by a weighted average of prior seasons for the current team, is found to be a highly significant determinant of team performance. In order to control for general player quality, the authors use the team members' average draft position.

Hansen and Wernerfelt (1989) investigated the relative explanatory power of economic and organizational factors on inter-firm differences in profit rates. As a proxy for firm-specific resources, they utilized a questionnaire (Survey of Organizations, SOO) that captures dimensions of organizational factors such as the characteristics of communication flow, emphasis on human resources, decision-making practices, organization of work, goal emphasis, and job design. Their findings show that industry explains 19 percent of the variance in profit rates but that organizational characteristics, including specific human capital, are about twice as important. Based on these arguments and findings, specific human capital can reasonably be assumed to be a valuable resource. But is specific human capital also a rare resource?

IS SPECIFIC HUMAN CAPITAL RARE?

Generally, we agree with Wright, McMahan, and McWilliams (1994), who argue that if output depends at least to a certain extent on human capital, which allows for variance in individual contributions, then these skills should be normally distributed in the population. Hence, high-quality human resources should be rare. Moreover, both general and specific human capital are characterized by the fact that their accumulation is costly (at the minimum in terms of time), but only the former is available through the market mechanism. In other words, there is by definition no supply of specific human capital beyond the internal labor market, although there should be demand, as specific human capital adds value to the firm. These properties support the description of specific human capital as rare.

IS SPECIFIC HUMAN CAPITAL INIMITABLE?

Provided that specific human capital is valuable and rare, is it also inimitable? If a competitive advantage that stems from the accumulation of specific human capital is easily imitated, then it is not possible to sustain superior performance. In order to imitate, competitors must first be able to precisely identify the source of competitive advantage. They then must be able to copy both the critical components of the specific human capital and the circumstances under which these work. The specific human capital generated in a continuous learning-by-doing-process is to a large extent implicit (Doeringer and Piore 1971; Franck 1995). Through cumulative experience, certain processes become so internalized that their successful execution happens unconsciously and cannot be verbally explained. The implicit character of specific human capital makes it all but impossible to formalize (Lippman and Rumelt 1982) and thus constitutes an effective mechanism to impede imitation.

This is true for individual employees and even more so for highly interactive teams performing a common task. A team's stock of specific human capital consists of a socially complex interaction of implicit and non-codifiable skills. As this asset increases through a mutual learning-by-doing process, the team improves its ability to coordinate and synchronize individual actions according to each member's responsibility. In this respect, we follow Weick and Robert's (1993) notion of the collective mind representing the specific human capital that is collectively held by a group of individuals. This asset is diffused among the team members, of whom each only has access to a part of the overall stock of the team-specific human capital. Thus, it is impossible to dissect the complexity of interactions in order to isolate individual contributions to team output (Wright, McMahan, and McWilliams 1994). The fact that in team production, the total output typically exceeds the sum of its members' inputs further complicates the problem of identifying critical resources (Alchian and Demsetz 1972). Even in team production processes that are openly observable to externals, there is causal ambiguity, meaning that neither the firm nor its rivals are able to pinpoint what causes superior performance (Reed and DeFillippi 1990; Powell, Lovallo, and Caringal 2006).

At the extreme, hiring away the entire workforce of a competitor seems to be a

possibility to circumvent both the causal ambiguity and the immobility of specific human capital, but this approach neglects that a team's effectiveness may be tightly coupled to other resources of the firm (Wright, McMahan, and McWilliams 1994). A team's effectiveness may further depend on relationships with other teams or on unique historical circumstances (Alchian and Demsetz 1972). Thus, specific human capital is relatively safe from being imitated. In all likelihood, competitors are neither able to identify the source of competitive advantage nor able to copy the critical components of the specific human capital and the circumstances under which these work.

Porter (1985), however, argues that "… barriers to imitation are never insurmountable." If other teams could identify the source of competitive advantage and imitate it, then the barriers to imitation would still be contingent on the cost of imitation. In the case of specific human capital, imitation is costly, especially in terms of time. Therefore, scholars of the resource-based view would propose that high performance could be sustained for some time at least.

IS SPECIFIC HUMAN CAPITAL NON-SUBSTITUTABLE?

Finally, specific human capital must not be substitutable if it is to be the source of sustained competitive advantage. To the extent that other resources are able to offset performance increments attributable to specific human capital, specific human capital does not have the potential to give rise to sustained competitive advantage. In order to address the question of substitutability, it is important to note that the only resources that can substitute for specific human capital are, in their own right, valuable, rare, inimitable and non-substitutable. Accordingly, the benefits from a team's stock of specific human capital can indeed be eroded by other resources such as, for example, a competing team's additional investment in its stock of general human capital or its application of a superior technology. However, such sources of performance improvements can rarely be sustained in the long run. Taking general human capital and superior technology as examples, it becomes obvious that neither is capable of consistently substituting for specific human capital because these resources are available for purchase in the marketplace. Their free imitability prevents them from acting as a source of sustained competitive advantage (Wright, McMahan,

and McWilliams 1994). Hence, a team's stock of specific human capital is unlikely to be substituted because the requirements for a substitutive resource are difficult to meet.

In summary, a team's stock of specific human capital is valuable and rare, cannot be imitated, and is unlikely to be substituted. Based on these observations, we assume a positive relationship between a team's stock of team-specific human capital and team performance.

Hypothesis 1a:

There is a positive relationship between a team's stock of team-specific human capital and team performance.

LEARNING EFFECTS

The learning-curve phenomenon is well known. As an organization gains experience, organizational performance improves at a decreasing rate. Scholars have extensively researched learning curves, and managers have often used learning curves for planning purposes (Argote 1999).

When members of a team accumulate specific human capital in a constant learning process that facilitates their interaction, several theoretical and empirical arguments suggest that these learning effects are subject to diminishing returns (see Yelle (1979) and Dutton and Thomas (1984) for reviews). The main argument is that there is a limit to the returns of team-specific human capital and that this limit is determined by the production technology. Team cooperation cannot infinitely improve as the stock of team-specific human capital increases. Hence, there are typical learning-curve effects. A newly composed team initially possesses a large potential for learning-based improvements, but the attainment of such improvements corresponds to a reduction of the remaining learning potential. Over the last 50 years, the phenomenon of diminishing returns as a consequence of typical learning effects has been well documented empirically. Studying learning effects in 50 R&D teams, Katz (1982) found the relationship between shared team experience and team performance, as hypothesized, to be concave in shape. He concluded that

> *"... the upward slope in performance probably reflects the positive effects of learning and team building as new project members contribute fresh ideas and approaches while also developing a better understanding of each other's capabilities, of the technologies involved, and of their working relationships. Such positive effects, however, appear to taper off for teams whose members have continued to work together for a long period of time."* (Katz 1982: 98).

In line with theoretical arguments and empirical findings, we assume the relationship between a team's stock of team-specific human capital and team performance not to be linear but concave in shape.

Hypothesis 1b:

The relationship between team-specific human capital and team performance is subject to diminishing returns. The positive performance effects of team-specific human capital will decline as shared experience grows.

Although a team's total stock of team-specific human capital is central to our theoretical predictions, the composition of team members concerning their individual working experience with the team may also matter. One viewpoint is that the team's composition requires continuity for mutual learning processes to improve interaction and to induce positive returns, especially if the successful accomplishment of complex team tasks requires complementary skills. In performing conjunctive tasks, one member's lack of certain skills cannot be compensated by other team members' superior skills (Kremer 1993). This argument suggests that a team should be rather homogeneous in terms of their members' tenure. The heterogeneity of team-specific human capital within a team may also create more distant relationships between team members and cause schisms that impair the exchange of information and thus the quality of interaction (Ancona and Caldwell 1992). In some instances, heterogeneity may create distrust and acrimony, as widely dissimilar group members may have different vocabularies, paradigms, and even objectives.

Another viewpoint is that homogeneity may be counterproductive if there are too

many status-seeking members because the team's (implicit) hierarchy is insufficiently differentiated (Overbeck, Correll, and Park 2005). It can be fertile to expose team members to new perspectives. From this viewpoint, the most successful teams may consist of a combination of experienced members who possess a lot of team-specific human capital and new members who supply fresh ideas. Also, the introduction of new team members may circumvent free-riding tendencies and productively increase competition within the team (see, e.g., Alchian and Demsetz 1972; Holmström 1982).

In line with these contradictory perspectives, empirical findings have been mixed. Some studies have shown a negative relationship between tenure heterogeneity and different performance measures, such as innovation (O'Reilly and Flatt 1989), adaptive change in a sample of electronics firms (O'Reilly, Snyder, and Boothe 1993) and informal communication within the team (Smith et al. 1994). Berman, Down, and Hill (2002) found no significant relationship between tenure heterogeneity and team performance in professional basketball. Using data from the airline industry, Hambrick, Cho, and Chen (1996) found evidence for a positive link between tenure heterogeneity and two measures of performance. Due to the inconsistent theoretical predictions and inconclusive empirical results, we propose two opposing hypotheses.

Hypothesis 2a:

The heterogeneity of team-specific human capital decreases team performance.

Hypothesis 2b:

The heterogeneity of team-specific human capital increases team performance.

TEAM LEADER'S TEAM-SPECIFIC HUMAN CAPITAL

Beyond the compositional aspects of the team itself, the most obvious moderators of any team's performance are its leadership and changes in leadership. In their review of executive succession research, Kesner and Sebora note: "*... few if any transitions at other organizational levels have as profound an effect either inside or outside the*

firm." (Kesner and Sebora 1994: 357). Aldrich and Pfeffer (1976) suggest hiring executives from other organizations as a means of facilitating the transfer of skills and technology across organizations. Generally, the effect of leadership (dis-) continuity on organizational performance has been widely researched, but conclusions are mixed. For example, Lieberson and O'Connor (1972) investigated the relationship between changes in the chief executive officer (CEO) position and subsequent developments in company performance indicators such as sales and profits. They found little evidence of any relationship. Weiner and Mahoney (1981) found stronger evidence of a leadership effect. Also, Virany, Tushman, and Romanelli (1992) drew positive conclusions about the performance effects of changes in the CEO position in their study of US computer equipment manufacturers. Denis and Denis (1995) found that forced resignations of top managers tend to be preceded by large declines in operating performance and followed by strong recoveries. Normal retirements tend to be followed by more moderate improvements on average. Carroll (1984), on the contrary, found that a managerial change among U.S. newspaper publishers was typically followed by a decline in performance. However, empirical investigations of the effect of leadership (dis-) continuity on performance face several intricacies. According to Koning (2003), there are three difficulties. The first difficulty is the measurement of performance. The more complex the structure of a firm, the more difficult it is to isolate a single person's impact on performance. Also, the measurement of performance may be complicated because the interests of the firm's decision makers are not necessarily aligned but may, on the contrary, diverge substantially. The second difficulty is observing if and when a manager is fired, as firms usually have no particular interest in publicly disclosing information about internal hiring and firing decisions. The last difficulty is due to the fact that a managerial change is typically accompanied by simultaneous changes, which impede an investigation under the ceteris paribus condition. It is all but impossible to assess what part of the change in performance can be attributed to the change in the leadership position and what part stems from the change in the conditions faced by the old and the new manager, respectively. These obstacles give rise to a strong tradition of research based on team sports data within the empirical literature (see Audas, Dobson, and Goddard 2002 for a review). The position in sports analogous to an executive is a head coach.

Eitzen and Yetman (1972), for example, investigated the impact of changes in the coaching position in college basketball teams. Based on their data, the authors con-

cluded that coaching shifts do not affect performance. However, they found that the relationship between coaching tenure and team performance is suggestive of a learning curve: as coaching tenure increases, team success increases, but at diminishing rates. Porter and Scully (1982) also found a positive correlation between a coach's tenure and team performance in professional baseball that is comparable to that of an individual star player. Scully (1995) provides further evidence of a significantly positive relationship between a coach's tenure and team performance for baseball, basketball and American football.

In line with these findings, we argue that a team leader's team-specific human capital, i.e., his experience in leading the same team, positively affects team performance. However, we also expect teams with a higher stock of team-specific human capital to profit less from a leader with a lot of team-specific human capital than do teams with a lower stock of team-specific human capital. In other words, maintaining continuity of team leadership on teams with low levels of team-specific human capital is important to allow for learning processes to rapidly progress among team members. In sum, we expect a team leader's team-specific human capital to interact non-monotonically with his team's stock of team-specific human capital to affect team performance.

Hypothesis 3:

The team leader's team-specific human capital interacts non-monotonically with his team's team-specific human capital to affect cooperation. The positive effects of a team leader's team-specific human capital on team performance will decline as the team's stock of team-specific human capital grows.

METHODS

In order to test our hypotheses, we studied a large panel of match-level data of teams appearing in the highest German soccer league, *Bundesliga*. We agree with Kahn (2000) that the sports business is an ideal labor market laboratory. Due to the frequency and regularity of athletic events, large and reliable data sets that contain accurate measures of individual and team performance are easily available. Unlike in

many other industries, hypotheses may be tested in relatively controlled field environments. Competing teams in any sport tend to have similar organizational structures and pursue similar or identical objectives, and the production process is clearly defined by a detailed catalogue of rules of the game, which are enforced by independent referees (Koning 2003). We argue that soccer in particular offers an exceptionally well-suited platform for investigating the impact of a team's stock of specific knowledge on team performance.

Unlike sports in which team productivity depends on disjunctive tasks (e.g., baseball), the output of a soccer team is clearly driven by the interaction of its members' conjunctive tasks. An offense player will be unlikely to score if his teammates do not support him with offensive passes. Similarly, a goalkeeper can hardly avoid conceding a goal if his team's defense is not paying attention to the opposition team's attacks (Franck and Nüesch 2008). Also, the different tactical positions are not as narrowly circumscribed as, e.g., in baseball or American football (Katz 2001). This means that in soccer, each player principally acts according to the responsibilities of his tactical position and predominantly interacts with players of adjacent tactical positions. However, depending on the situation, any player can get involved in offense or defense and may interact with any other team member.

The required interaction of specialized but relatively flexible tactical roles in combination with the speed of the game makes team-specific human capital critical in professional soccer. When there is no time to verbally coordinate individual actions, the players' ability to cooperate almost intuitively is required to execute their collaboration with precision. This becomes obvious if one thinks of a player who wants to pass the ball to a teammate. The passing player has to anticipate where the receiving player is going to run, and equally, the latter has to predict where the ball is going to be passed. Simultaneously, both players have to perceive and even anticipate their opponents' actions in order to adapt to them. In a professional soccer match, a countless number of these types of actions must be conducted very quickly in order to be successful, leaving little time for explicit communication. The high interaction level requires that teammates have shared experience in playing as a team. Although in professional soccer, the final team performance occurs before thousands of spectators in the venue and is televised, the implicit character of team-specific human capital still creates causal ambiguity, which means that it is all but impossible for both the team and its rival to determine what exactly causes superior

performance (Reed and DeFillippi 1990; Powell, Lovallo, and Caringal 2006). Furthermore, the pool of potential substitute resources for team-specific human capital is limited because all competing teams use identical technologies, as defined by the precise specification of the production process of a soccer match.

SAMPLE

Our sample consists of a panel of 1,177 players whom we recorded in 50,412 player-match-observations from the 2001/02 season to the 2006/07 season of the highest German soccer league, *Bundesliga*. From the player-match data set, we aggregate the team's average in team-specific human capital and other team composition variables for 3,672 team-match-observations. In each season, which begins in August and runs through May of the following year, each of the league's 18 teams plays each other team in one home and one away match, resulting in 34 matches per team and season. Due to the relegation of the three lowest-ranked teams and the promotion of the three highest-ranked teams of the second *Bundesliga* at the end of the season, our study sample comprises of 25 teams. Most of the data we employ in this study are freely available on the Internet (*www.fussballdaten.de*). The players' market values were collected from special editions of *Kicker,* the most prominent German soccer magazine. All teams and their respective presence in the *Bundesliga* within the timeframe of our data set are listed in Appendix A.

DEPENDENT VARIABLE

Team performance. In a soccer match, team performance is always a relative outcome that reflects the playing quality of one team in comparison to the opposing team. Each team's output is easily measurable because the team that scores more goals than its opponent wins three points, and the losing team gets zero points. If both teams score an equal number of goals, then the game is counted a draw and both teams get one point. Within a league, teams are ranked according to the sum of their points won. In cases where two or more teams possess an equal number of points, their relative positions are determined by the difference between goals scored and goals received. Hence, each team has an incentive not only to win the match but also

to do so with a goal difference that is as large as possible. Because our data set allows investigation on the team-match level, we consider the goal difference the best way to reflect the presence of a competitive advantage.

INDEPENDENT VARIABLES

Team-specific human capital. It is difficult to accurately distinguish between specific and general human capital because both are simultaneously developed and both can be expected to influence a team's performance. However, a player's team-specific human capital is clearly expunged the moment he leaves his team, whereas he continuously gains experience, as a form of general human capital, throughout his entire career, regardless of the number of clubs he plays for. Therefore, we consider the number of previous appearances in league matches played for the current team to be a reasonable proxy of a player's team-specific human capital. On the team-match level, we build the average of this measure over all fielded players. See Appendix B for a sample calculation of this variable.

We also include the squared value of the variable to allow for the hypothesized concave form of the relationship between team-specific human capital and team performance.

Heterogeneity of team-specific human capital. As a proxy variable for a team's heterogeneity in terms of team-specific human capital, we calculate the standard deviation of all fielded players' number of prior appearances for the current team on a team-match level. This variable is needed to test the alternative hypotheses 2a and 2b and to gain further insight into the relationship between the heterogeneity of team-specific human capital and team performance.

The coach's team-specific human capital. Changes in a soccer team's coaching position are not unusual and are well publicized due to the high transparency of the production process and the large public interest in the clubs' choice of coach. Frick (1998) found that in the German *Bundesliga,* a head coach's mean tenure amounts to 12.5 months. However, we do not measure the coach's team-specific human capital in terms of time; rather, analogously to our conceptualization of team-specific human

capital, we measure it by the number of matches coached with the current team before the match in question. We expect a positive correlation between our measures for coaching experience with the team and team performance because leadership continuity allows for learning processes to progress among team members. In order to test hypothesis 3, that the coach's experience with the same team interacts non-monotonically with his players' team-specific human capital to affect team performance, we introduce an interaction term of the coach's team-specific human capital with his team's stock of team-specific human capital.

CONTROL VARIABLES

Difference in general human capital. We control for a team's stock of general human capital because it is open to scrutiny that a newly composed team with virtually no specific human capital at all but with a lot of expensive superstars (i.e., a larger stock of general human capital) is likely to beat a team that has a great deal of experience playing together (i.e., a larger stock of team-specific human capital) but that is comprised of unknown average players. Thus, a team's competitive advantage due to its members' comparatively larger experience in playing with each other can be offset by a competing team's additional investment in its stock of general human capital. However, as discussed above, the benefits gained from additional general human capital are not safe from imitation because the services of higher-quality players can be bought on the transfer market.

Because we have defined general human capital as a rather heterogeneous blend of multiple skills, abilities and experience aspects, we do not try to estimate the influence of each component separately. We argue that a player's general human capital can be approximated by predicted start-of-season market values. In the *Bundesliga* clubs do not have to publish their players' market values. The *Kicker* soccer magazine, however, began to publish respective proxies in the mid-1990s. These proxies are likely to be consistent because the market values have been estimated in a systematic manner for several years by largely unchanged editorial staff. They have already been used in several empirical studies on the German soccer league (see Lehmann and Weigand 1999; Swieter 2000; Forrest and Simmons 2002; Hübl and Swieter 2002; Littkemann and Kleist 2002; Eschweiler and Vieth 2004; Haas, Ko-

cher, and Sutter 2004; Franck and Nüesch 2007).

A player's performance is not only observable and transparent during the match; also training sessions are usually open to the public (Franck 1995). A wide public interest in players' backgrounds and private life works as an additional monitoring mechanism and reduces behavior that could adversely affect performance. With minimal information asymmetries concerning a player's capabilities, we expect predicted market values to adequately comprise all general human capital components. As market values represent the price that another team is prepared to pay for the services of a certain player, market values should accurately reflect that player's transferable general human capital. Team-specific human capital is not incorporated into market values because it is by definition immobile. Forrest and Simmons (2002) show that in European soccer, high market values clearly increase field success.

Following Depken (1999), we use the logarithm of estimated market values as a control variable for the team's stock of general human capital. Market values are expressed in 2003 Euros and are adjusted for inflation. Because the match is our unit of observation, we can easily take the opposing team's stock of general human capital into account to calculate the teams' relative advantage. Subsequently, we first take the logarithm of each team's sum of its fielded players' estimated market values and then calculate the difference between the opposing teams.

Age. We include a variable for the player's age in the regression as a proxy variable for a player's experience and general physical condition. The age of each player is calculated for each team-match observation by taking the difference between the date of the match day and the player's date of birth. For ease of interpretation, we convert this from days to years and then calculate an average for each team-match observation. Although it is impossible to make a definite distinction between young and old players, age is generally connected with greater experience with the game. However, physical abilities such as speed, stamina, and the ability to continuously recover within short intervals from exhausting performances tend to gradually deteriorate from a certain age onwards.[1] Simultaneously, the risk of injury increases. Only about 8 percent of all player careers in the Bundesliga from the 1963/64 season to the

[1] Frick, Pietzner, and Prinz (2007) found a statistically positive influence of player age on the probability of being eliminated from the *Bundesliga* while controlling for a series of individual characteristics, position dummies, region of origin dummies, and institutional characteristics. In our study sample the quantil $Q_{.9}$ in terms of player age is 32.5 years.

2002/03 season lasted for 10 seasons and more (Frick, Pietzner, and Prinz 2007). At the same time, physical abilities constitute a necessary condition for team-specific human capital to induce positive returns. A player's team-specific human capital can only contribute to his team's performance as long as he is at the same fitness level as his younger teammates. If his physical shape drops below a certain threshold level, he will no longer be selected to play in the competition team (Lucifora and Simmons 2003).

As we have argued above, we expect the relationship between a team's average age and its performance to be curvilinear in shape. Therefore, we also include the square of our age variable in the model.

A potential problem with the use of the age variable is that it is likely to co-vary with the players' market values. However, we include it in the model because the simple aging of players could affect performance beyond the market values. In addition, it is important to account for age in the context of our study. Otherwise, the simple aging of players would be difficult to reject as the main reason for diminishing returns in performance at increasing levels of shared team-specific human capital.

Age heterogeneity. To generate a measure of age heterogeneity, we calculate the standard deviation of the fielded player's age on a team-match level. The integration of this control variable is necessary in order to rule out age heterogeneity as an alternative explanation for hypotheses 2a and 2b, in which we predict the heterogeneity of team-specific human capital to affect team performance.

Home advantage. In order to control for potential home field advantage, we include a dummy variable that takes the value 1 in the case of a home match and 0 in the case of an away match. Carmichael and Thomas (2005) showed that home field factors, e.g., a dominant fan base in the stadium and familiarity effects, positively influence the effectiveness of the home team.

Relative suspension time. After receiving a red card, the affected player has to leave the field immediately, leaving the team at a numerical disadvantage for the rest of the

game.[2] This disadvantage is not negligible concerning the outcome of the match, which was shown by Franck and Nüesch (2007), who analyzed the results of 1,530 matches in the *Bundesliga.* The authors found that red cards significantly influence the final score of a match, with a coefficient of -0.287. However, a variable that denotes the mere number of received red cards does not differentiate in terms of the time that the team has to perform in a numerically reduced formation. It makes a difference whether the player is expelled from the field in the 1st or in the 90th minute of the match. Equally, it is important whether the opposing team is numerically reduced because of red cards as well. If two players of opposing teams are simultaneously expelled from the field, then the respective disadvantages should cancel each other. Thus, we build the sum of the fielded players' time on pitch for both opposing teams and then calculate the difference between them.[3]

Difference in number of substitutions. Despite the fact that in a typical soccer match, most teams exploit the maximum of three substitutions,[4] Franck and Nüesch (2008) still found a positive relationship between the number of substitutions during a match and a game's result. Thus, we also control for the difference in the number of substitutions because this measure takes into account that the two teams' potential advantages due to substitutions may offset each other.

ANALYSIS AND RESULTS

It is well known that panel data require special econometric modeling in the form of either pooled regression, random modeling or fixed-effects modeling. An F-test following a fixed-effects regression indicates that there are significant team-level ef-

---

2 Law 12 of the FIFA Laws of the Game lists the categories of misconduct for which a player may be sent off. These are: 1. Serious foul play (a violent foul), 2. Violent conduct (any other act of violence), 3. Spitting at anyone, 4. A deliberate handling offense to deny an obvious goal-scoring opportunity by any player other than a goalkeeper in his own penalty area, 5. Committing an offence that denies an opponent an obvious goal-scoring opportunity, 6. Using offensive, insulting or abusive language or gestures, 7. Receiving a second caution (yellow card) in one game. (see, for example at: www.fifa.com/worldfootball/lawsofthegame.html/).

3 For illustration purposes, consider the following example: Team A plays against team B. In a 90-minute match, none of team A's eleven players receives a red card. This results in a total of 990 minutes on the pitch for team A. One player on team B receives a red card in the 40th minute of the match. This results in a total of 940 minutes on the pitch for team B. The variable takes the value -50 (= 940 - 990) for team A and 50 (= 990 - 940) for team B.

4 In our study sample, teams deploy an average of 13.73 fielded players per match (which corresponds to 2.73 substitutions per match).

fects (F-statistics: 4.48 and 4.67) implying that pooled OLS would be inappropriate. In order to decide whether the team-level effects are random or fixed, we performed the Hausman specification test (Hausman 1978), which compares the fixed-effects model with the random-effects model. The results show that team-level effects would be inadequately modeled by a random-effects model (Chi-square statistics: 6.33 and 109.39). Furthermore, we use an unbalanced panel due to the promotion and relegation of teams in European soccer and the reason for why a team gets promoted or relegated (called attrition) is not random. Instead, it is likely to be correlated with unobserved team playing strength, which may cause biased estimates due to resulting sample selection. This aspect supports the use of a fixed-effects approach because fixed-effects analysis allows for the attrition to be correlated with the constant unobserved effect (Wooldridge 2003).[5]

Table 1 presents descriptive statistics and correlations. The mean values for goal difference, difference in market values and difference in time spent on the pitch have to be zero by definition. A correlation above 0.9 is found for our team-specific human capital measure and its square as well as for our age measure and its square with respective variance inflation factors (VIFs) of above 10.[6] Despite the high correlations, we do not drop the squared terms from our model, as the requirement of unbiased estimates is not necessarily violated. High degrees of correlation between the independent variables are really no different than using a small sample size, as the variance of the coefficient estimates increases in both cases, which may lead to statistical insignificance (Wooldridge 2003). Additionally, we argue that the concerned squared terms should not be dropped from the model because theoretical arguments and empirical evidence support our predictions that the respective relationships will be concave in shape. Ignoring these non-linearities would lead to biased estimates.

---

5 See, e.g., Kyriazidou (1997) for a procedure to also account for non-constant selection effects.

6 A commonly given rule of thumb says that only VIFs above a value of 10 may be a reason of concern (see, Neter et al. 1989).

TABLE 1: DESCRIPTIVE STATISTICS AND CORRELATIONS

	Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9
1	Goal difference	0	1.83									
2	Team-specific HC	61.3	19.15	.13 ***								
3	Team-specific HC squared	4121.8	2638.88	.13 ***	.98 ***							
4	Coach's team-specific HC	70.3	81.58	-.03	.13 ***	.12 ***						
5	Difference in general HC	0	0.6679	.33 ***	.45 ***	.45 ***	.04 *					
6	Age	9946.8	407.34	.01	.14 ***	.13 ***	-.09 ***	-.03 *				
7	Age squared	9.91E+07	8086351	.01	.14 ***	.14 ***	-.09 ***	-.03 *	.99 ***			
8	Home advantage	0.5	0.5	.25 ***	.02	.01	-.00	.02	.02	.02		
9	Relative suspension time	0	15.04	.22 ***	.01	.01	.01	.02	.04 *	.04 *	.14 ***	
10	Difference in number of substitutions	0	0.76	.18 ***	.02	.01	.06 ***	.07 ***	.02	.02	.03	.03

Note: Significance levels: * 5%, *** 0.1%. N = 3672.

Table 2 shows the estimation results from the regression analysis including team fixed effects for both competing teams of a match. Seven out of 11 variables are significant in predicting the relative outcome of a soccer match, as measured by the goal difference. Based on the tenets of the resource-based view of the firm, we predicted in hypothesis 1a that team performance is positively affected by the accumulation of team-specific human capital. We find support for this relationship as our proxy variable for a team's stock of team-specific human capital, measured by the team average of prior appearances for the current team significantly increases team performance ($b = 0.012$, $p < 0.10$). Furthermore, we hypothesized the performance increments to be subject to diminishing returns due to typical learning processes (hypothesis 1b). Our results are suggestive of such a concave relationship between a team's stock of team-specific human capital and team performance, as the squared term of our team-specific human capital measure is significantly negative ($b = -0.0001$, $p < 0.10$). Shared experience in working as a team seems to matter even beyond the positive impacts of general human capital.[7]

[7] Concerning the conceptualization of the variable, one might object that team-specific human capital is developed not only at the competition stage, but also at the preparatory stage, which is seemingly not accounted for in this approach. At the preparatory stage, a continuous process of exercising and training takes place, in which all players of the roster are involved. At the competition stage, however, only a limited number of

TABLE 2: TEAM FIXED EFFECTS REGRESSION RESULTS

Variable	**Coefficient**	
Constant	-5.3883	(11.2412)
Team-specific HC	.0123 †	(0.0082)
Team-specific HC squared	-.00008 †	(0.00006)
Heterogeneity of team-specific HC	-.0064 *	(0.0026)
Coach's team-specific HC	-.0012	(0.0018)
Team-specific HC × coach's team-specific HC	-5.41E-6	(0.00002)
Difference in general HC	.2119 †	(0.1387)
Age	.0008	(0.0023)
Age squared	-3.00E-8	(1.15E-7)
Age heterogeneity	.0001	(0.0001)
Home advantage	.7838 ***	(0.074)
Relative suspension time	-.0216 ***	(0.0024)
Difference in number of substitutions	.4238 ***	(0.049)

Note: The dependent variable is the goal difference of a match. In order to account for potential time effects, the model also includes seasonal dummies, which are not reported in the table. Standard errors in parentheses are heteroskedasticity robust standard errors clustered at the match-level. Significance tests are one-tailed. Significance levels (one-tailed): † 10%, * 5%, ** 1%, *** 0.1%. N = 3672. $R^2 = 0.26$.

Due to contradictory theoretical arguments and empirical findings, hypothesis 2 was split into two alternatives. Hypothesis 2a suggests that the heterogeneity of team-specific human capital would negatively affect team performance. Hypothesis 2b predicts a positive relationship. Our data provide strong support for hypothesis 2a ($b = -0.006$, $p < 0.05$). Seemingly, team-specific human capital must be equally distributed among the team members to achieve its full potential. This finding can be interpreted in line with Kremer (1993), who suggested that in performing conjunctive tasks, a team member's lack of certain skills cannot be compensated by other team members' superior skills. This finding together with the support for hypotheses 1a and 1b implies that, all else being equal, teams whose members are, on average, both experienced in playing for their current team and homogeneous concerning that experience are more successful simply because they are more used to playing together

players, usually those who are currently considered to be most valuable to the team, are selected by their coach to perform for their team. To check our results for robustness, we calculated a model based on the players‘ and the coaches‘ tenure in terms of the number of seasons with the current team. This approach also takes potential learning processes at the preparatory stage into account, but the results are consistent with the findings presented here.

as a team.

Hypothesis 3, suggesting that a team coach's team-specific human capital interacts non-monotonically with his players' team-specific human capital to affect team performance, is not supported by the data. Neither the coach's number of prior games with the current team as a measure for team-specific coaching experience nor the interaction term between this variable and the team's stock of team-specific human capital has a significant effect on team performance.

Looking at the control variables, we find a positive and statistically significant impact of the relative difference between the opposing teams' logarithmic sum of estimated player market values on team-performance ($b = 0.212$, $p < 0.10$). This result confirms our expectation that a team's performance in soccer also depends on a team's relative advantage concerning the stock of general human capital. The variable mean age and its square are not significantly correlated with team performance. A possible explanation is that a player's age is already accounted for in his estimated market value. Also, the coefficient for age heterogeneity is insignificant and does not indicate that the team composition concerning the team members' age is critical in explaining team performance. However, the integration of this control variable was necessary to rule out age heterogeneity as an alternative explanation for hypotheses 2a and 2b.

The coefficient for home advantage is highly significant ($b = 0.784$, $p < 0.01$). This result is in line with Carmichael and Thomas (2005), who showed that home field factors positively influence the effectiveness of the home team. All else being equal, a team scores approximately 0.8 goals more in a home match than in an away match.

Similarly intuitive is the significantly negative coefficient for relative suspension time, controlling for numerical disadvantage due to red cards ($b = -0.022$, $p < 0.01$). A team that plays about 46 minutes with fewer fielded players than the opposing team receives on average one goal more than it scores.

Finally, a significant effect is found for the difference in the number of substitutions. As expected, there is a strong positive correlation between the difference in the number of substitutions and team performance ($b = 0.424$, $p < 0.01$). All else being equal, a team that uses one more substitution than its opponent scores approximately 0.4 more goals. However, as it is unclear whether the association is causative or correlative, this finding does not provide any guidance to coaches regarding how to

make use of their substitutions. Substitutions may allow the coach to replace temporarily bad performers or exhausted or injured players with promising prospects sitting on the bench. Conversely, it is also plausible that the leading team has an incentive to substitute an offensive player with a defender in order to hinder the opponents' attempts to catch up.

DISCUSSION AND CONCLUSION

In this paper, we empirically investigated whether a team's shared experience, i.e., its stock of team-specific human capital, as an intangible and unobservable resource, sustainably affects team output. We employed a large panel data set of professional soccer teams from the German *Bundesliga* as an example of highly interactive teams, and we used this sample to examine how team-specific human capital qualifies as a critical resource to constitute a sustained competitive advantage. According to the resource-based view, such a critical resource must add value to the firm, it must be rare, it must be inimitable and it must not be substitutable by an alternative resource (Barney 1991). Based on these tenets, we hypothesized a positive relationship between a team's stock of team-specific human capital and team performance. Our empirical investigation provides support for this prediction. Furthermore, we are able to show that the relationship between team-specific human capital and team performance is not linear but concave in shape, which can convincingly be explained by learning effects. Concerning the heterogeneity of a team's team-specific human capital, we find a clearly negative impact on team performance, indicating that team members should not only be retained in the team but should also be similarly experienced in playing for their current team. These findings support the notion of team-specific human capital as constituting a critical resource according to the resource-based view of the firm. As an intangible resource, team-specific human capital is able to induce and, at least temporarily, sustain a competitive advantage because it is relatively safe from being imitated by competitors or substituted by another resource.

We also find that team performance in soccer depends on the relative advantage in a team's stock of general human capital. However, general human capital is freely transferable because it is valuable to all teams, whereas the value of team-specific human capital is lost when the team is changed (see Williamson 1984).

Our finding that a player's specific relationships with teammates matter implies that the loss of team-specific human capital in the case of a transfer should be accounted for in any club's investment decision regarding the engagement of new players (Clarke and Madden 1988; Rosen and Sanderson 2000). The failure to consider this aspect may explain the occasional observation that a soccer player turns out to be a flop after a transfer to a new team because he does not live up to expectations. Moreover, the specificity of certain employment relationships and their interdependence give rise to difficulties in evaluating investment decisions (Vrooman 1996).

For coaches, our results are less conclusive, potentially because we did not incorporate information about general coaching ability or information about the coach's involvement in decisions regarding the engagement of new players. The latter aspect may have an impact on the coach's tenure because the more influence a coach has to chose players according to his tactical concepts, the more team-specific his relationship with the club may become. With these relationship-specific (or management-specific) investments, the coach can safeguard his position because his layoff becomes increasingly costly for the club management (see Shleifer and Vishney 1989). The introduction of adequate proxy variables that capture the degree of the coach's general human capital as well as the specificity of his employment relationship would be a sensible extension of this study.

Whenever correlational designs are used, concerns about internal validity such as possible reverse causality may be raised. Our finding that team-specific human capital increases team performance could be spurious if continuity in the team composition was simply a consequence of successful team performance. In order to test for potential reverse causality, we regressed the team's stock of team-specific human capital on team performance, lagged one time period, using the same team fixed effects estimation approach and the same control variables as in the main model. In doing so, we find a positive ($b = 0.05$) but insignificant (p-value = 0.51) influence of previous team performance on specific human capital. Thus, we find no evidence for reverse causality running from team performance to specific human capital.

Furthermore, matching theory (Jovanovic 1979) may provide an alternative explanation for our results. If we assume that in general, unproductive employments will be terminated and productive employments will be prolonged, then we must conclude that tenure should be a good indicator of productivity. Or, as Flinn (1986) put it: "The longer an employment spell continues, the more precise is the estimate

of the match." We are unable to distinguish between the impact of the specificity of the relationships and the impact of the precision of the match estimate because both increase with tenure and both have a positive effect on team performance. However, the fact that we observed team-specific human capital to be positively correlated with team performance in a highly transparent production process with minimal information asymmetries concerning the players' performances and capabilities suggests that performance increments are more likely due to team-specific human capital. We argue that in soccer, precise *ex ante* information with which to estimate a match is publicly available. In non-sports industries, external employers have only limited access to *ex ante* information and must therefore deduce less precise estimates of the real productivities (Barron and Loewenstein 1985; Greenwald 1986). An employer continuously gains information regarding an employee's initially unknown performance-relevant characteristics. However, it is unrealistic to assume that this information will be transferred to a new employer if it can be kept private (Wilde 1977; Johnson 1978). Thus, information asymmetries between the current employer and potential external employers may be a reasonable explanation of the tendency to prolong existing employments, but this argument is hardly applicable to soccer teams.

Another particularity in soccer that may limit the transferability of our results to other industries concerns the issue of moral hazard in teams (see, e.g., Holmström 1982). Almost perfect monitoring in the stadium and on TV induces players to supply proper amounts of productive inputs and impedes collusion between some of the team's players. However, in most other professional contexts, moral hazard problems are more likely to emerge because the employees' actions are less observable.

In further research, it would be interesting to investigate the relationship between the composition of team-specific human capital and team performance in other contexts involving teamwork in order to explore the transferability of our results.

REFERENCES

Alchian, A. A. and Demsetz, H. (1972). Production, information costs, and economic organization. American Economic Review, 62, 777-795.

Alchian, A. A. (1982). Decision sharing and expropriable specific quasi-rents: A theory of First National Maintenance Corporation v. NLRB. Supreme Court Economic Review, 1, 235-247.

Aldrich, H. and Pfeffer, J. (1976). Environments of organizations. In A. Inkeles (Ed.), Annual review of sociology, 2, 79-105- Palo Alto, CA: Annual Reviews.

Ancona, D. G. and Caldwell, D. F. (1992). Demography and design: predictors of new product team performance. Organization Science, 3, 321-341.

Argote, L. (1999). Organizational learning: Creating, retaining, and transferring knowledge. Boston, MA.

Audas R., Dobson S., and Goddard J. (2002). The impact of managerial change on team performance in professional sports. Journal of Economics and Business, 54, 633-650.

Barney, J. (1986). Strategic factor markets: Expectations, luck and business strategy. Management Science, 32, 1231-1241.

Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of Management, 17, 99-120.

Barron, J. and Loewenstein, M. (1985). On employer-specific information and internal labor markets. Southern Economic Journal, 52, 431-44.

Becker, G. S. (1962). Investment in human capital: A theoretical analysis. Journal of Political Economy, 101, 9-49.

Becker, G. S. (1964). Human capital. A theoretical and empirical analysis with special reference to education, New York.

Berman, S. L., Down, J., and Hill, C. W. L. (2002). Tacit knowledge as a source of competitive advantage in the National Basketball Association. Academy of Management Journal, 45, 13-31.

Bettis, R. A. and Hitt, M. A. (1995). The new competitive landscape. Strategic Management Journal, 16 (special issue) 7–19.

Blaug, M. (1976). The empirical status of human capital theory: A slightly jaundiced survey. Journal of Economic Literature, 14, 3, 827-855.

Boudreau, J. (1983). Economic consideration in estimating the utility of human resource productivity improvement programs, Personnel Psychology, 36, 551-575.

Carmichael, F. and Thomas, D. (2005). Home field effect and team performance. Evidence from English Premiership Football. Journal of Sports Economics, 6, 264-281.

Carroll, G. (1984). Dynamics of publisher succession in newspaper organizations. Administrative Science Quarterly, 29, 93-113.

Cascio, W. F. and Ramos, R. A. (1986). Development and application of a new method for assessing job performance in behavioral/economic terms, Journal of Applied Psychology, 71, 20-28.

Clarke, A. and Madden, L. (1988). The limitations of economic analysis: The case of professional football. Leisure Studies, 7, 59-74.

Denis, D. and Denis, D. (1995). Performance changes following top-management dismissals. Journal of Finance, 50, 1029-1055.

Depken, C. A. II (1999). Free-agency and the competitiveness of Major League Baseball. Review of Industrial Organization, 14, 205-217.

Doeringer, P. B. and Piore, M. J. (1971). Internal Labor Markets and Manpower Analysis, Lexington.

Dutton, J. M. and Thomas, A. (1984). Treating progress functions as a managerial opportunity. Academy of Management Review, 9, 235-247.

Eitzen, D. S. and Yetman, N. R. (1972). Managerial change, longevity and organizational effectiveness. Administrative Science Quarterly, 17, 110-116.

Eschweiler, M. and Vieth, M. (2004). Preisdeterminanten bei Spielertransfers in der Fußball-Bundesliga, Zeitschrift für Betriebswirtschaft. 64, 671-692.

Flinn, C. J. (1986). Wages and job mobility of young worker. The Journal of Political Economy, 94, 88-110.

Forrest, D. and Simmons, R. (2002). Team salaries and playing success in sports: A comparative perspective. Zeitschrift für Betriebswirtschaft, Special Issue 72, 221-238.

Franck, E. (1995). Die ökonomischen Institutionen der Teamsportindustrie. Eine Organisationsbetrachtung, Wiesbaden.

Franck, E. and Nüesch, S. (2007). Wage dispersion and team performance - an empirical panel analysis. Working Paper, University of Zurich.

Franck, E. and Nüesch, S. (2008). The effect of talent disparity on team productivity. Working Paper, University of Zurich.

Franz, W. (1996). Arbeitsmarktökonomik, Berlin u.a.

Frick, B. (1998). Management abilities, player salaries and team performance. European Journal for Sport Management, 5, 6-22.

Frick, B., Pietzner, G., and Prinz, J. (2007). Career duration in a competitive environment: The labor market for soccer players in Germany. Eastern Economic Journal, 33, 429-441.

Godfrey, P. and Hill, C. W. L. (1995). The problem of unobservables in strategic management research. Strategic Management Journal, 16, 519-533.

Greenwald, B. C. (1986). Adverse selection in the labor market. Review of Economic Studies, 53, 325-347.

Haas, D., Kocher, M. G., and Sutter, M. (2004). Measuring Efficiency of German Football Teams by Data Envelopment Analysis. Central European Journal of Operation Research. 12, 251-268.

Hambrick, D. C., Cho, T. S., and Chen, M. (1996). The influence of top management team heterogeneity on firms' competitive moves. Administrative Science Quarterly, 41, 659-684.

Hansen, G. S. and B. Wernerfelt (1989). Determinants of firm performance: The relative importance of economic and organizational factors. Strategic Management Journal, 10, 399-411.

Hausman, J. A. (1978). Specification tests in econometrics. Econometrica, 46, 236-255.

Holmström, B. (1982). Moral hazard in teams. The Bell Journal of Economics, 13, 324-40.

Hoskisson, R. E., Hitt, M. A., Wan, W. P., and Yiu, D. (1999). Theory and research in strategic management: Swings of a pendulum. Strategic Management Journal, 25, 417– 456.

Hübl, L. and Swieter, D. (2000). Neue Institutionenökonomik und Fußball-Bundesliga. WISU, 3, 305-308.

Johnson, W. R. (1978). A theory of job shopping. The Quarterly Journal of Economics, 92, 261-278.

Jovanovic, B. (1979). Job matching and the theory of turnover. The Journal of Political Economy, 87, 972-990.

Kahn, M. L. (2000). The sports business as a labor market laboratory. Journal of Economic Perspectives, 14, 75-94.

Katz, R. (1982). The effects of group longevity on project communication and performance. Administrative Science Quarterly, 27, 81-104.

Katz, N. (2001). Sports teams as a model for workplace teams: lessons and liabilities. Academy of Management Executive. 15, 56-67.

Kesner, I. F. and Sebora, T. C. (1994). Executive succession: past, present and future. Journal of Management, 20, 327-372.

Klein, B., Craword, R. G., and Alchian, A. A. (1978). Vertical integration, appropriable rents and the competitive contracting process. Journal of Law and Economics, 21, 297-326.

Koning, R. H. (2003). An econometric evaluation of the effect of firing a coach on team performance. Applied Economics, 35, 555-564.

Kremer, M. (1993). The o-ring theory of economic development. Quarterly Journal of Economics, 108, 551-575.

Kyriazidou, E. (1997). Estimation of a panel data sample selection model. Econometrica, 65, 1335-1364.

Lehmann, E. and Weigand, J. (1999): Determinanten der Entlohnung von Profifußballspielern - Eine empirische Analyse für die deutsche Bundesliga, in: Be-

triebswirtschaftliche Forschung und Praxis, 2, 124-135.

Lieberson, S. and O'Connor, J. (1972). Leadership and organizational performance: A study of large corporations. American Sociological Review, 37, 117-130.

Lippman, S. A. and Rumelt, R. P. (1982). Uncertain imitability: An analysis of inter-firm differences in efficiency under competition. The Bell Journal of Economics, 13, 418-438.

Littkemann, J. and S. Kleist (2002). Sportlicher Erfolg in der Bundesliga: eine Frage der Auf-oder der Einstellung? Zeitschrift für Betriebswirtschaft, 62, 181-201.

Lucifora, C. and Simmons, R. (2003). Superstar effects in sport: Evidence from italian soccer, Journal of Sports Economics. 4, 35-55.

Miller, D. and Shamsie, J. (1996). The resource-based view of the firm in two environments: The Hollywood film studios from 1936 to 1965. Academy of Management Journal, 39, 519-543.

Nelson, P. (1970). Information and consumer behavior. Journal of Political Economy, 78, 311-329.

Nelson, R. and Winter, S. (1982). An evolutional theory of economic change. Cambridge, MA, Harvard University Press.

Neter, J., Wasserman, W., and Kutner, M. H. (1989). Applied regression models. Homewood, IL: Irwin.

O'Reilly, C. A., III and Flatt, S. (1989). Executive team demography, organizational innovation, and firm performance. Working paper, University of California, Berkeley.

O'Reilly, C. A., III, Snyder, R. C., and Boothe, J. N. (1993). Executive team demography and organizational change. In G. P. Huber and W. H. Glick (Eds.), Organizational change and redesign, Beverly Hills, CA: Sage, 147-175.

Overbeck, J. R., Correll, J., and Park, B. (2005). Internal status sorting in groups: The problem of too many stars. In Status and Group (Ed.) M. Thomas-Hunt, Elsevier, Amsterdam, 169-199.

Powell, T. C., Lovallo, D., and Caringal, C. (2006). Causal ambiguity, management, perception, and firm performance. The Academy of Management Review, 31, 175-196.

Porter, M. E. (1985). Competitive advantage: creating and sustaining superior performance. New York, The Free Press.

Porter, P. K. and Scully, G.W. (1982). Measuring managerial efficiency: The case of baseball. Southern Economic Journal 47, 642–650.

Porter, P. K. and Scully, G. S. (1996). The distribution of earnings and the rules of the game. Southern Economic Journal, 63, 149-163.

Rumelt, R. P. (1987). Theory, strategy, and entrepreneurship. In D. Teece, (Ed.), The Competitive Challenge. Ballinger, Cambridge, MA, 137-158.

Reed, R. and DeFillippi, R. (1990), Causal ambiguity, barriers to imitation, and sustainable competitive advantage, Academy of Management Review, 15, 88-102.

Rosen, S. and Sanderson, A. (2000). Labour markets in professional sports. National Bureau of Economic Research, Working Paper, 7573, Cambridge, MA.

Sandell, S. and Shapiro, D. (1980). Work expectations, human capital accumulation, and the wages of young women. The Journal of Human Resources, 15, 335-353.

Schmidt, F., Hunter, J., and Pearlman, K. (1979). Assessing the economic impact of personnel programs on workforce productivity. Personnel Psychology, 35, 333-347.

Scully, G. W. (1995). The Market Structure of Sports, Chicago.

Shleifer, A. and Vishny, R. W. (1989). Management entrenchment. The case of manager-specific investments. Journal of Financial Economics, 25, 123-139.

Smith, K. G., Smith, K. A., Olian, J. D., Sims, H. P., O'Bannon D. P., and Scully, J. A. (1994). Top management team demography and process. The role of social integration and communication. Administrative Science Quarterly, 39, 412-438.

Swieter, D. (2000). Eine ökonomische Analyse der Fußball Bundesliga. Berlin: Duncker & Humblot.

Thurow, L. C. (1970). Investments in Human Capital, Belmont.

Virany, B., Tushman, M. L., and Romanelli, E. (1992). Executive succession and organization outcomes in turbulent environments: An organizational learning approach. Organization Science, 3, 72-91.

Vrooman, J. (1996). The baseball players‘ labor market reconsidered. Southern Economic Journal, 63, 339-360.

Weick, K. E. and Roberts, K. H. (1993). Collective mind in organizations: Heedful interrelating on flight decks. Administrative Science Quarterly, 38. 357-381.

Weiner, N. and Mahoney, T. (1981). A model of corporate performance as a function of environmental, organizational, and leadership influences. Academy of Management Journal, 24, 453-470.

Wilde, L. (1977). An information-theoretic approach to job quits. Social Science Working paper 150, California Institute of Technology.

Williamson, O. E. (1975). Markets and hierarchies: Analysis and antitrust implications, New York.

Williamson, O. E. (1984). The economics of governance: Framework and implications. Journal of Institutional and Theoretical Economics, 140, 195-223.

Williamson, O. E. (1985). The economic institutions of capitalism, firms, markets, relational contracting. New York.

Wooldridge, J. M. (2003). Introductory econometrics: A modern approach. Second edition. South-Western.

Wright, P. M., McMahan, G. C., and McWilliams, A. (1994). Human resources and sustained competitive advantage: A resource-based perspective. International Journal of Human Resource Management, 5, 301-326.

Yelle, L. E. (1979). The learning curve: Historical review and comprehensive survey. Decision Sciences, 10, 302-308.

APPENDIX A

Teams included in the sample

Teams included in the sample, their respective presence in the Bundesliga within the timeframe of the data set and some descriptive statistics are shown below:

Team	Obs	Seasons
Borussia Dortmund	204	2001/02 to 2006/07
Bayern München	204	2001/02 to 2006/07
FC Schalke 04	204	2001/02 to 2006/07
Borussia Mönchengladbach	204	2001/02 to 2006/07
Hamburger SV	204	2001/02 to 2006/07
Hansa Rostock	136	2001/02 to 2004/05
1860 München	102	2001/02 to 2003/04
Werder Bremen	204	2001/02 to 2006/07
VfB Stuttgart	204	2001/02 to 2006/07
SC Freiburg	102	2001/02; 2003/04 to 2004/05
1. FC Köln	102	2001/02; 2003/04; 2005/06
Bayer Leverkusen	204	2001/02 to 2006/07
FC St. Pauli	34	2001/02
1. FC Kaiserslautern	170	2001/03 to 2005/06
Eintracht Frankfurt	102	2003/04; 2005/06 to 2006/07
VfL Bochum	136	2002/03 to 2004/05; 2006/07
MSV Duisburg	34	2005/06
Arminia Bielefeld	136	2002/03; 2004/05 to 2006/07
Hertha BSC Berlin	204	2001/02 to 2006/07
VfL Wolfsburg	204	2001/02 to 2006/07
1. FC Nürnberg	170	2001/02 to 2002/03; 2004/05 to 2006/07
Energie Cottbus	102	2001/02 to 2002/03; 2006/07
Hannover 96	170	2002/03 to 2006/07
FSV Mainz 05	102	2004/05 to 2006/07
Alemannia Aachen	34	2006/07

APPENDIX B

Sample Calculation of our proxy variable for a team's stock of team-specific human capital

Mean of a all fielded team members' team-specific human capital on a team-match level =

$$\frac{\sum_{\text{All fielded players}} (\text{player i's number of pior appearances for team})}{\text{Number of fielded players}}$$

For illustration purposes, consider the following (real) example of Borussia Dortmund on the first match day of the 2001/02 season. The fielded players have the following histories with Borussia Dortmund.

	Player	Appearances for Borussia Dortmund
1.	Jens Lehmann	76
2.	Christian Wörns	50
3.	Jan Derek Sörensen	10
4.	Dede	85
5.	Tomas Rosicky	16
6.	Giuseppe Reina	58
7.	Miroslav Stevic	68
8.	Jörg Heinrich	31
9.	Jan Koller	1
10.	Lars Ricken	187
11.	Marcio Amoroso	1
12.	Jürgen Kohler	170
13.	Stefan Reuter	218
14.	Evanilson	54

Note that "Appearances for Borussia Dortmund" only take into account the period during which the player has continuously stayed with his current team. In the event that a player had already played for the current team in the past, then changed to another team before returning to his current time, only the period following his most

recent transfer is factored in. In our example, Jörg Heinrich played for Borussia Dortmund from the 1995/96 through the 1997/98 season. In the following two season, he played in Italy for AC Florence and returned to Dortmund for the 2000/01 season. According to our conceptualization, we only consider his experience with Borussia Dortmund after his transfer from Florence. Thus, on the first match day of the 2001/02 season, it is his 31st appearance in a league match with Borussia Dortmund.

These data yield the following calculations of Borussia Dortmund's mean of team-specific human capital:

$$\frac{76+50+10+85+16+58+68+31+1+187+1+170+218+54}{14} = 73.21$$

We do not weight the player-team specific human capital with the playing time on the pitch for two reasons: first, the playing times are very similar, as the number of possible substitutions is restricted to three. Second, and even more important, the team's stock of team-specific human capital would be affected by red cards, which reduce the team's sum of playing time and would therefore distort the effect of team-specific human capital.