Master Thesis

Diversity in teams: The effect of cultural heterogeneity on team and player performance in the NHL

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Abstract

To compete in today's economy, many organizations are broadening their workforce by establishing culturally diverse teams to leverage the distinct skill sets of workers from different geographic backgrounds. This study makes use of an extensive dataset on the National Hockey League to examine the extent to which companies benefit from culturally diversified teams. By running multi-way fixed effect regressions, significant effects of team diversity on various team and player performance measures are demonstrated on a game level. The study finds that NHL teams that employ a higher number of foreign players perform better offensively, and that this cultural diversification process should be concentrated to a core of outside countries. Notably, the positive effects are only existent for offensive activities implying that the extent of the impact is dependent on the distinct characteristics of an activity. On a player level, the results show that individual performance is enhanced when playing together with a player of a culturally heterogeneous background. This effect is stronger for North American players compared to Europeans while playing exclusively with culturally homogeneous teammates decreases the offensive performance of all players. Overall, the study provides a profound evidence base to inform organizations that culturally diversifying teams can significantly improve their performance. However, the success of the diversification process depends on the distinct characteristics of the activities and must be carefully executed such that the impact is not diminished by communication barriers between workers.

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List of Abbreviations

APG	Assists per Game
CAN	Canada
CZE	Czech Republic
DACH	Acronym for Germany, Austria, and Switzerland
FIN	Finland
GPG	Goals per Game
HHI Index	Herfindahl-Hirschman Index
MLB	Major League Baseball
MVP	Most Valuable Player
NA	North America
NBA	National Basketball Association
NHL	National Hockey League
NFL	National Football League
OLS	Ordinary Least Square
PPG	Points per Game
RUS	Russia
SVK	Slovakia
SWE	Sweden
US	United States of America

1 Introduction

The role of teams in organizations has evolved significantly in the last decades. Many companies today see team formations as economically desirable (Lazear, 1999b) and have introduced team-type incentive schemes to decisively extract specific characteristics of every member (Hamilton et al., 2003). A development that goes along with increasing team formation is the internationalization of companies, largely driven by globalization (Lazear, 1999b). For global businesses, internalization offers opportunities to complement existing teams with members of other countries and cultures and thus improve their organizational performance.

Existing literature in the field of organizational behavior has addressed team dynamics in relative detail. But only in recent years has special emphasis been placed on cultural diversity and performance. Papers such as Stahl et al. (2009) have shown that cultural diversity in teams leads to ambiguous changes in efficiency. On the one hand, cultural diversity broadens the diversity in capabilities and skills among team members (Lazear, 1999b). This can positively influence the performance of the whole team by raising overall productivity and pushing less productive workers to be better (Hamilton et al., 2003). The different skills brought to the team by culturally heterogeneous workers can also lead to learning effects for the incumbent workers, which additionally raises individual and cumulative performance (Lazear, 1999b). On the negative side, culturally heterogeneous teams can imply lower social integration of foreign team members which can lead to efficiency losses (Basadur et al., 2001). Additionally, communication barriers can hinder the positive learning effects among workers, which can potentially make culturally heterogeneous teams ineffective (Lazear, 1999b). Thus, it is critical to address potential hurdles and opportunities when connecting diversity to team performance. Particularly, the focus needs to be placed on process gains and losses stemming from skill and communication differences (Troyer, 2002).

This study provides an extension of the study by Kahane et al. (2013) by estimating the effect of cultural heterogeneity on team performance using an extensive dataset from the 2008/2009 to 2018/2019 season of the National Hockey League (NHL). On a team- and player-game level a multi-way fixed effect regression model is used to estimate if the effect is significant. The research question of this study aims to answer is: *Does the degree of cultural heterogeneity among members of a team significantly affect the performance of its players and the whole team?* To fully answer this question, sub-questions will be considered. First, what is the effect of cultural heterogeneity on team performance on a game level? Then, is there an effect of playing with culturally heterogeneous teammates on the offensive performance of individual players? Finally, is there heterogeneity in the effect among players from different cultural backgrounds?

The results of the analysis suggest that team performance is affected by the integration of foreign workers. However, the effect is not consistent for all measures of team performance. Using various offensive measures, the study finds that foreign workers positively affect performance. This is not the case for offensive and defensive combining performance measures, which implies that the effect is dependent on the type of task. While the result provides support for the composition of culturally heterogeneous teams, the research also demonstrates that foreign workers should be hired from a concentrated number of countries. This provides further proof that cultural diversity can positively impact performance but that communication barriers can diminish these effects when becoming too severe. On the performance of individual players, the study shows similar results. Playing with players of the same cultural background can significantly diminish a player's performance. This effect is even stronger when playing exclusively with players that are culturally homogeneous. Again, this result provides support for the positive effect of higher skill diversity in culturally heterogeneous teams. There are, however, significant differences in the effect among players from different cultural backgrounds. Players from North America are much more negatively affected by playing with one culturally similar player compared to players from Europe. Still, playing with only culturally similar players is negatively correlated to player performance for all cultural groups.

The remainder of this study is organized as follows. Section 2 provides a summary of the existing literature regarding cultural diversity and its effect on the performance of teams. The methodology, dataset, and variables used in the analysis are described in section 3. The results of the regression analyses are presented in section 4. Section 5 summarizes the results and places them in the context of the existing literature, while section 6 touches upon some limitations and potential for future research.

2 Literature review

2.1 Culturally diverse teams and performance – a review of existing frameworks

Many researchers have aimed to develop generic theories that explain the productivity of teams with respect to diversity. One of the first was Lazear (1999b), who asserted that it takes three key factors for diverse teams to be more productive than culturally homogeneous teams. First, team members must bring skills and knowledge that diversify the existing ones and complement the knowledge of others. Second, the skills and information that members are contributing must be relevant for the purpose of the team. Finally, team members must necessarily be capable of communicating with each other. Even if the information of a new team member is distinct and relevant, it is useless if communication barriers prohibit the transfer of knowledge, described by Lazear as costs of communication (Lazear, 1999b). In total, the framework by Lazear (1999b) implies that diverse teams can significantly benefit in terms of diverse skills but only if the cost of communication does not diminish this through culture and language barriers

Another important framework is provided by Hamilton et al. (2003). The authors attempt to build upon the framework by Lazear (1999b) to estimate the effect of diversity on actual team performance. They emphasize the importance of two aspects of this relationship: learning and bargaining. Mutual learning can be a benefit for heterogeneous teams if the members of the team differ in terms of their technical abilities or knowledge. Berg et al. (1996) supported this hypothesis stating that informal training is almost universal in organizations. This means that initially heterogeneous teams have a higher possibility of learning effects which will not only benefit the workers individually but also create a higher level of common knowledge within the team (Hamilton et al., 2003).

The second important factor is the formation of a team norm, which Hamilton et al. (2003) coin as “intrateam bargaining”. It describes the employment options of a worker as being dependent on their ability or skill. The heterogeneity in outside options of all workers determines the work pace and level of the team. This bargaining process will lead the highest-ability workers to opt out unless the other workers agree to a higher team norm. The authors draw the conclusion that more heterogeneous teams in terms of skills or information will have a higher cross-team productivity which will result in higher performance.

Another framework aiming to explain cross-cultural productivity and the cost of diversity is provided by Kandel et al. (1992). Many firms find free riders to be a significant issue in teams performing towards common goals (Hamilton et al., 2012). The authors hypothesize that it requires a system of incentives for team members to interact and work together efficiently. Additionally, a common sense of belonging within a workgroup can diminish the issue and enhance productivity within the group. For the authors, homogenous groups share certain norms or values and are more likely to form social ties outside of work. Partnerships in such circumstances can be characterized by mutual monitoring and social sanctions, which disincentivize workers to free ride. The importance of such social ties is also emphasized and supported by later empirical studies (Spagnolo, 1999; Reagans et al., 2001; Towry, 2003).

Timmerman (2000) largely aligns with the previous authors, while adding that the effect of cultural diversity on team performance also depends on the nature of the tasks. A distinction must be made, for example, between cognitive and physical tasks. While physical work is mostly dependent on coordination between the team members, cognitive tasks rely more on conceptual teamwork. Tasks like generating ideas or conceptualizing workflows can benefit from heterogeneous perspectives (Pelled et al., 1999; Timmerman, 2000). Physical tasks on the other hand are more about implementing ideas, which are dependent on a smooth coordination of team members, whereas heterogeneous team members could be more hindering.

Finally, Timmerman advocates for distinguishing teams based on the extent of interaction between the team members. He bases his theory on previous studies such as the one by Pelled et al. (1999). The study found that the relationship between cultural heterogeneity and emotional conflicts between team members was larger when the tasks of the team were nonroutine. Timmerman concludes that nonroutine tasks require a larger rate of communication, coordination, and interdependence between members. The relationship between cultural diversity and performance must be significantly moderated by the interdependences of the workers. Tasks that require more interdependences have a greater necessity for communication and coordination, which would favor the selection of a more homogeneous group (Timmerman, 2000).

The presented theoretical frameworks suggest that team diversity can impact firm productivity through various mechanisms. Positive aspects of diversity stem from complementary information or skills (Lazear, 1999b), partnerships (Kandal et al., 1992), or the learning and bargaining within teams (Hamilton et al., 2003). Potential challenges arise through communication costs (Lazear, 1999b) and are especially apparent in physical and high interdependence tasks (Timmerman, 2000). In the next paragraphs, studies that aimed to empirically test these hypotheses are investigated in close detail.

2.2 Recent empirical studies

For the past decades, many studies have attempted to measure the relationship between cultural heterogeneity and team performance. These studies provide varying results, which give further reason to believe that there is contradicting dynamics at play when forming diverse teams (Hamilton et al., 2012; Trax, 2012). On the positive side, culturally diverse teams have proven to be more diverse in terms of capabilities, skills, and information, which can lead to learning effects among existing workers. On the other hand, diversity in culture increases barriers of communication among team members which can significantly diminish the positive effects. For this reason, diversity has been coined a “double-edged sword” and requires a case-specific examination in different situations (Horowitz et al., 2007).

Lazear's (1999b) research established conditions that must be met for heterogeneous groups to be more successful than homogeneous teams. The most straightforward ones he calls “knowing the ropes” and “best practices”. They can be summarized by stating that heterogeneous groups hold an advantage if they allow for more diverse sets of skills and knowledge. An exemplary Dutch firm operating in many markets would therefore profit from a team consisting of members of different ethnic backgrounds who speak many languages. It is cheaper to hire foreign workers instead of sending Dutch expatriates to foreign countries and teach them individually the language, knowing the ropes. It is also highly likely that these foreign workers have higher knowledge about customs, laws, and people of the foreign country, indicating that they are more aware of the local best practices (Lazear, 1999b).

A micro-level study on this relationship was conducted by Hamilton et al. (2012). The paper used proprietary data to empirically test the effect of cultural diversity on performance in an intra-firm setting. The study examined data from a Californian garment maker and found that diversity in skills and knowledge lead to higher overall team productivity. This demonstrated the existence of bargaining effects within teams. High-ability workers enforced a higher team norm by leveraging their larger employment options. These results also indicated that there are learning effects among team members. Lower skilled team members were willing and incentivized to adapt techniques from higher skilled workers (Hamilton et al., 2003). Holding the skill level constant, however, the study found that cultural homogeneity was more favorable for team productivity than cultural heterogeneity (Hamilton et al., 2012). The authors demonstrated the countervailing effects created by cultural heterogeneity. On the one hand, knowledge and skill exchange may be possible, whereas, on the other hand, cultural barriers might also play a decisive role.

The effect of cultural diversity on productivity and performance was also empirically studied by Trax (2012) who examined German manufacturing firms. The study did not find direct evidence for a positive influence on team performance just by employing more foreign workers. However, plant productivity appeared to be more favorable when the composition of teams was more fractionalized in terms of cultural background. In relative terms, productivity increased by around 10% when the regional fragmentation increased by a point. The authors based their findings on potential learning effects in their workforce which also support Lazear’s framework on spillover effects stemming from cultural diversity (1999b).

That cultural diversity also affects the performance and working style of teams in sports is shown by a recent empirical study by Amodio et al. (2022). The authors used an extensive dataset of the NHL spanning over 50 seasons to show that the working styles of foreign workers can diffuse that of existing employees. The authors found that American hockey players adapted their styles of hockey to that of Russian hockey players after they joined the league following the collapse of the Soviet Union in the 1990s. In the following years, American players were collecting systematically fewer penalties than before, and this effect was further enhanced when they shared the ice with Russian players. These results indicate that the arrival of new workers to the existing teams can significantly affect the working style of the incumbent workers and that those experience learning effects (Amodio et al., 2022).

Kahane et al. (2013) used similar multiple-year data from the NHL to examine the effect of cultural and language diversity on team performance. On a season-team level, the authors were able to prove existing theories that cultural heterogeneity can have a positive impact on performance. Teams with a higher proportion of European players performed better compared to teams with a lower proportion. While the addition of foreign players increased the performance of NHL teams, this effect was largest for homogeneous groups of European players. The paper also found that the individual statistics of European players were better when playing with other European players. In general, the authors suggest that diversity through different cultures can have a positive impact on performance but that these positive contributions may be overshadowed by the integration costs of language and cultural differences in alignment with the theoretical frameworks by Lazear (1999b) and Timmerman (2000).

The costs of intercultural coordination and communication barriers were empirically shown in a study conducted by Prinz et al. (2016). Using data from the famous bicycle racing event Tour de France, the study found that heterogeneity in skills can negatively affect performance. In circumstances where similar tasks must be performed simultaneously, the homogeneity of performance is a necessity for success. The authors concluded that teams should only be composed of team members with different skill levels if learning effects can have an impact (Prinz et al., 2016). In activities like cycling, such learning effects are less of importance than the coordination of similar tasks. Hamilton et al. (2003) demonstrated similar results on the costs of communication in culturally heterogeneous teams. He proved the existence of learning effects within teams but also showed that cultural heterogeneities can make these effects less effective (Hamilton et al., 2003).

Timmerman further examined these two contradictory dynamics of learning effects and communication barriers for different types of work (Timmerman, 2000). The paper examined the effect for two different types of sports: basketball, and baseball. This allowed for a comparison between work characterized by different levels of team member interdependence. The study found that cultural diversity was significantly negatively correlated to team performance for basketball, a sport requiring strong communication and coordination. For baseball, where performance is rather a sum of individual performance, the study found no significant effect of cultural diversity on performance. Interestingly, a follow-up study by Sakuda (2012) did find a negative relationship using data on the Japanese baseball league. This shows that there are also cross-cultural differences in the role of team interdependence for the relationship between benefits of learning effects and costs of communication barriers in culturally heterogeneous teams (Sakuda, 2012; Timmerman, 2000).

While many studies find significant effects of cultural heterogeneity on team performance, a consensus on the direction of the impact is not apparent. Previous papers have especially strengthened the positive impact of knowledge spillovers (Hamilton et al., 2012; Trax, 2012), improved customer relationships (Leonard et al., 2003), and skill diversity (Amodio et al., 2022). However, those are opposed by the negative effects which stem from higher communication costs among the workforce (Zenger et al., 1989), a strong dependence on team interdependence (Jackson et al., 2009), or less need for skill diversity within the team (Prinz et al., 2016).

2.3 Culture and diversity

2.3.1 Culture

An understanding of culture is useful to this study because it examines whether group-specific traits influence integration into a team and hence its performance. (Oonk, 2002). Sociologists and anthropologists define the term culture in ambiguous ways, but one commonality between all definitions is that culture is shared with people of a similar environment (Hofstede, 1992). Often, one’s culture is linked to socioeconomic class, religious affiliation, heritage, age, or gender (Choi, 2002; Ji et al., 2001). It is learned, not innate, and is derived from the social environment rather than someone’s genes (Hofstede, 1992). Typically, people of one culture commonly share some notion of shared beliefs, expectations, customs, jargon, and rituals (Lazear, 1999a)

One key approach to estimating the relationship is the use of surveys to assess mean levels of individual-held cultural values (Kirkman et al., 2016), such as *power distance* (the extent to which team members accept power inequalities) or *individualism-collectivism* (the degree to which people integrate into groups) from Hofstede’s cultural dimensions (Hofstede, 2003). Mean levels of cultural indicators can influence team dynamics directly and indirectly (Kirkman et al., 2016). For example, various studies have found that groups consisting of members with higher levels of collectivism experience higher rates of corporations than groups with more individualistic members (Cox et al., 1991; Eby et al., 1997).

This study focuses on the cultural differences between members of a team. Understanding that culture is learned by growing up with a certain group of people (Hofstede, 1992) can shed light on coordination difficulties in teams. The upbringing of an individual can determine one’s cultural values, which means that one would expect cultural diversity to have an impact on the dynamics of a team. Especially when it comes to collaboration and communication, differences in languages and/or cultural dimensions, such as collectivism, can be critical to collective team success (Hofstede, 2003; Kirkman et al., 2016).

2.3.2 Diversity

Diversity is used to describe the distribution of individual characteristics among independent members of a group (Jackson et al., 2003). Existing literature reflects diversity from various perspectives, such as a configurational perspective (Moynihan et al., 2001) or a compositional one (Tsui et al., 1989). Configurational studies examine differences among members of one defined group, such as a team or a culture in order to give reason to certain dynamics (Moynihan et al., 2001). Compositional studies aim to identify the numerical or proportional representation of various cultures among groups. The goal of such studies is to identify whether the estimated effect stems from the differences among the team members based on certain characteristics, such as language or educational background (Riordan, 2000), similar to this paper.

The terms culture and diversity are often used interchangeably as synonyms. Yet both terms stand for different things (Choi, 2002; Ji et al., 2001). Diversity highlights differences between individuals in the sense that people of the same culture can be diverse in certain characteristics, such as education level, age, or gender (Jackson et al., 2003). A way to describe the connection between culture and diversity is that diversity can exist in groups that are characterized by their unique culture. Culture can therefore connect diverse individuals and unite them through similar lifestyles, norms, and rules.

2.3.3 Development of theories on team diversity

Organizational research from the early 1900s mostly placed individual behavior in the center of organizational units (Haslam, 2004). Mayo (1949) was one of the first organizational researchers to recognize that group or organizational behavior is more than an aggregation of the behavior of individuals. In line with this, social identity theory argues that individuals have a psychology of their own but may define their social identity as different, when in a group setting (Haslam, 2004). This in return means that groups are not just a passible context for the behavior of individuals, but that their behavior is a product of group dynamics (Haslam, 2004). The results of subsequent studies in the field of social identity theory shaped organizational research over the next decades and continue to have significant influence on how we view organizations and team composition today (Turner, 1975; Esler, 2000).

Social categorization theory is an extension of social identity theory, which takes a closer look at the background of social identity salience of individuals. It aims to understand why and how social identities become salient, how it affects the perception of other team members, and what the consequences are for teams and their members (Ely, 1994). This means that past experiences and expectations of any social or ethnic classification can determine how one feels as part of a group. Such differences in perception of self and group are often superficial demographic characteristics. These lead individuals to divide other group members into hierarchies or classes that are not performance-related (Jehn et al., 1999). Conclusions from such comparisons can be dichotomous. If one sees their group as more similar to each other than others, this often leads to in-group favoritism or ethnocentrism (Tajfel, 2004). However, if the group identity is more diverse or if one person feels different from other group members, intra-group polarization may result.

Organizational demography is the third and most recent key organizational theory. Pfeffer (1985) coined the term organizational theory as ”the study of the composition of a social entity in terms of its member’s attributes” (Pfeffer, 1985). It is the compositional component of this theory that distinguishes it from the previous ones. It assumes that the effects of demographic diversity stem from differences in aggregate level variables, which are uninfluenced by individual ones (Lawrence, 1997). In its core argument, organizational demography argues that more homogeneous work groups share more similarities which benefits processes in the workplace (Pfeffer, 1985; Mannix et al., 2005). Demographic differences are perceived by group members as signals for individual differences, which negatively influence group performance through less frequent and qualitative communication (Kirkman et al., 2001). Today, organizational demography is the most frequently used theory as it allows for a practical measurement of intact workgroup diversity on performance (Mannix et al., 2005).

2.3.4 Peer effects and co-working experience

What the above-mentioned frameworks on group identity infer is that communication and social interaction play a strong role in determining individual, co-worker, and overall team performance. A way teams benefit from peer effects is through productivity spillovers. Working with highly productive co-workers increases the chance of learning from one another and raises the productivity of lower productivity workers (Mas et al., 2006; Herbst et al., 2015; Menzel, 2021). Jackson et al. (2009) studied spillover effects using data on elementary school teachers. The authors found that co-worker spillovers were persistent over time and strongest for least experienced peers (Jackson et al., 2009). Another integral factor determining the extent of peer effects is the underlying incentive to improve one’s performance (Bandiera et al., 2005).

Overall productivity is much higher in teams where the performance of one worker influences the outcome of others. Bandiera et al. (2005) found that the productivity of workers rises by up to 50% when the individual effort of workers can impose negative externalities on their peers.

Sports economics, where co-workers are complements or substitutes in the workplace production function, also provides a fitting example to show how peer effects exist, (Herbst et al., 2015). Peer effects do not have to be pushed through peer pressure, social norms, or monitoring, but can stem from profit maximization considerations (Gould et al., 2009). Using an extensive basketball dataset, Gould et al. showed that in teams, where individual goals are complementary, co-workers influenced their peer's performance. This effect is positive when co-workers are complements in the production function but negative for peers that are substitutes. This result is supported by a later basketball study by Arcidiacono et al. (2017). The effort of one worker had a significant effect on the productivity of his peers, enforced by the fact that the goal of each player on the team is a common success (Arcidiacono et al., 2017).

2.4 Hockey and the NHL

2.4.1 Sports Economics for organizational research

As already seen, sports economics can be a unique and useful medium for researchers in business and organizational research (Kahn, 2000). Various studies have examined causalities in professional sports which could be applied to business-related research. Organizational issues have been researched with regards to team turnover (Kahane et al., 1997), leadership (Audas et al., 1997), the adaption of working styles (Amodio et al., 2022) or diversity (Regoli, 1991; Timmerman, 2000; Kahane et al., 2013).

First, professional sports are a major industry. The four major North American sports leagues, the National Football League (NFL), Major League Baseball (MLB), National Basketball Association (NBA), and the National Hockey League (NHL), finished 2020 with a combined revenue of around $40b (BizVibe, 2020). Several of these teams are publicly traded on the national stock exchange markets and therefore subject to regulations and regular shareholder reviews (Sakuda, 2012). Furthermore, professional sports are intertwined with several other industries, such as fashion, health, fitness, and electronic entertainment (Sakuda, 2012).

A second important advantage of professional sports research is the availability of broad performance data (Timmerman, 2000; Kahn, 2000). Quantitative databases are maintained by teams and outside analysts at both the player and team levels. A team's winning percentage, for example, provides an objective representation of a team's performance and can be easily compared to other teams. At the player level, each league yearly recognizes leading players in various categories, which allow this through their exclusive and objective measure of performance (Sakuda, 2012).

Finally, sports data also provides detailed information on the team structure and the individual players (Timmerman, 2000). Team rosters are publicly available and contain personal characteristics of all players, such as height, ethnicity, or age (Kahn, 2000). Furthermore, the public display of the performance in games provides researchers with information on who interacts with whom on the playing field (Kahane et al., 2013). The availability of player information makes it possible to conduct research on performance effects based on data not available in traditional organizational teams (Sakuda, 2012).

2.4.2 Hockey and the NHL as an outlet for research

The first advantage stems from the nature of the game of hockey. In full strength, each team has six players on the ice: three forwards, two defensemen, and a goalkeeper. Players usually play together in one line throughout a game and substitutions are usually executed in full lines. For organizational research, this allocation offers an optimal opportunity to attribute differences in performance to differences in team composition. Additionally, the game of hockey is characterized by a high necessity for member interaction. Previous studies found that professional sports differ in their level of required interdependence (Timmerman, 2000; Sakuda, 2012). Some of these studies have shown that hockey is reliant on strong communication and that those patterns are quantifiable (Timmerman, 2000).

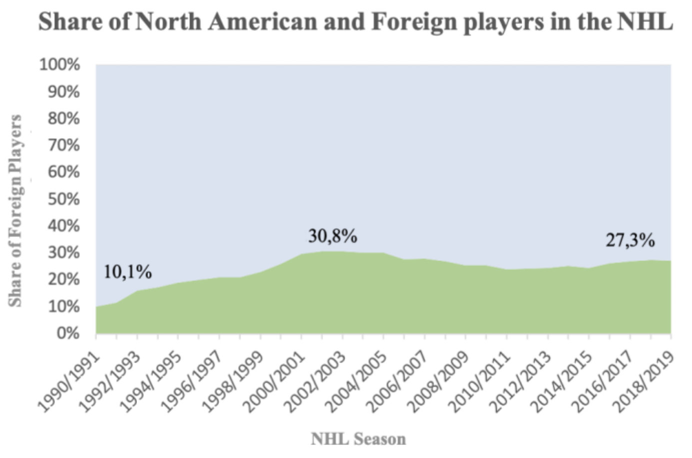
In addition to the sport of hockey, the NHL also offers suitable conditions relevant to this study. The league collects detailed data on every player and game which offers a great base for empirical research (Kahane et al., 2013). Player information is publicly available (Kahane et al., 2013) and additional data on the time team members play together on the ice is provided for each game (Sakuda, 2012). Next to informational data, the NHL also keeps precise team and player performance measures. Data is collected on offensive measures such as the number of goals scored, or defensive measures like the number of penalty minutes received. Team performance is measured through a variety of measures, such as winning percentage or the difference between goals scored and conceived (Kahane et al., 2013).

2.4.3 Team Diversification in the NHL

A final trend that makes the NHL fitting for this paper is the increasing internationalization of the NHL in the past decades (Amodio et al., 2022). Prior to the collapse of the Soviet Union in 1992, playing in the NHL was forbidden for hockey players coming from that part of the world. At that time, the NHL was assembled by almost 90% of only players from the United States (US) and Canada (CAN; Kahane et al., 2013; Amodio et al., 2022). The other 10% were European players mainly from Sweden and Finland that had started to find their way into the North American hockey league in the 1970s and 1980s (Kahane et al., 2013). Figure 1 shows that, in the most recent season, almost 3 of 10 NHL players stem from a country outside North America, with 18 nationalities in total (QuantHockey.com, 2022). That makes the NHL one of the most diverse professional sports leagues in North America (Kahane et al., 2013).

It shows that NHL teams can be considered global firms with workers (players) from a variety of foreign countries. These individual players must be efficiently assembled into a workgroup (team) for the organization to be successful (Kahane et al., 2013). Coordination and communication are already important factors in a game of high member interaction. The existence of a diverse worker group adds to this challenge and makes the knowledge of heterogeneity effects on performance even more important. Based on the critical mass of players in six countries, the NHL provides the perfect tool to empirically test this effect and allow for inferences for business and organizational research.

Figure 1: Share of North American and European players in the NHL



Notes. Figure 1 shows the development of the share of North American players in the NHL compared to players outside of the NHL from the 1990/1991 to the 2018/2019 season. It shows that the number of foreign players has increased in the past decades and that almost every third player is foreign today.

2.5 Hypotheses development

According to Lazear (1999b), the addition of culturally heterogeneous workers must be defined by specific characteristics to be of value for a team. Foreign workers need to add knowledge previously unknown to incumbent workers. This knowledge must contribute to the success of the team and finally, the communication barriers cannot be too severe to transfer the information to the existing team members (Lazear, 1999b). In such scenarios, diversity in skill can initiate learning effects through which existing team members can benefit from this new knowledge (Hamilton, 2003). Positive peer effects can also appear when new workers raise the average performance among teams, also raising the performance of less productive workers (Hamilton et al., 2003; Mas et al., 2006). The potential risk of adding culturally foreign workers stems from an increase in the variety of languages, cultural norms, and practices (Lazear, 1999b). Managers may risk creating large communication barriers among the workers which will diminish the amount of information that can be transferred among them and can hinder the formation of outside bonds (van Vianen et al., 2004).

Some empirical research has demonstrated the negative aspects of culturally diversifying a team. Prinz et al. (2016) estimated the effect on teams cycling in the Tour de France. The study showed that in this setting, homogeneity among team members was more beneficial than diversity in culture or skill. Further studies support the fact that when communication and coordination are critical, cultural heterogeneity can overshadow the benefits of skill diversity (Timmerman, 2000; Sakuda, 2012). Other research demonstrates the positive side of the relationship between cultural heterogeneity and team performance as shown by Hamilton et al. (2012). The authors found that culturally heterogeneous teams showed a higher variety in skill and knowledge compared to more homogenous teams, which raised average productivity within a team and increases the performance of previously less productive workers. The existence of such learning effects in sports was also demonstrated by Amodio et al. (2022) showing that North American hockey players proved to adapt their playing style to that of incoming Russian players. Finally, Kahane et al. (2013) proved that NHL organizations that hire foreign players to their teams benefit from their skill through learning effects of existing players as well as a higher skill diversity of the entire team.

These existing studies reflect the ambivalence of the two opposing dynamics, the "double-edged sword" of assembling culturally heterogeneous teams (Horowitz et al., 2007). Still, cultural diversity has increased significantly in the NHL in the past decades (Kahane et al., 2013). Given that this study closely follows the settings of Kahane et al. (2013) and that similar studies have found significant learning and adapting effects in hockey (Amodio et al, 2022), the positive aspects of cultural and skill diversity in the NHL seem to prove beneficial for these teams. This leads to the first hypothesis of this study:

H1: Cultural heterogeneity among members of a team has a positive effect on team performance compared to more culturally homogenous teams.

Secondly, this paper investigates the composition of teams to consider the effect of playing with culturally similar players on the performance of individual players. Using the hockey-specific offensive lines, the effect of cultural heterogeneity on team performance is tested for teams that pair culturally heterogeneous players in a group against teams forming homogeneous groups. Considering the positive effect of cultural diversity on team performance (Kahane et al., 2013) and the fact that learning effects have been shown in the NHL by Amodio et al. (2022), this paper expects the positive effect of skill diversity to dominate the burden of communication barriers. The hypothesis is as follows:

H2: Playing with culturally similar peers has a negative effect on the offensive performance of a player compared to playing with culturally heterogeneous peers.

Finally, this study aims to test the effect of playing in culturally homogenous offensive lines for heterogeneities between players from different cultures. Amodio (2022) demonstrated that the playing styles of North American NHL players significantly differ from that of foreign players. North American players also learned from the varying skills of foreign players and adapted to them. Additionally, Kahane et al. (2013) showed that the average skill level of European players is higher than that of North Americans. European players directly improved NHL teams through their skill level and additionally enhanced the performance of North American players by broadening the skill set of the entire pair group. Based on the fact that this effect was non-existent for North American players on a season-team level, this paper expects to find similar heterogeneity effects between North American and European players on a game level:

H3: The negative effect of playing with culturally homogeneous peers is stronger for players from North America compared to players from Europe.

3 Methodology

3.1 Data

To test both hypotheses, this paper uses data from a large dataset containing extensive information on player and team statistics of the NHL from the 2008/2009 season to the 2018/2019 season. Table 1 shows descriptive statistics for all offensive players including the mean values of all variables.

Table 1: Descriptive statistics of all variables for offensive players in the NHL

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Goals per Game	312,873	0.19	0.45	0.00	5.00
Assists per Game	312,873	0.27	0.54	0.00	5.00
Points per Game	312,873	0.46	0.72	0.00	8.00
Player Age	312,873	26.99	4.52	18.00	45.00
Player Position	312,873	2.82	1.78	1.00	5.00
Time on Ice	312,873	894.66	260.38	1.00	1945.00
Cap Hit (in %)	312,873	4.17	0.72	1.40	6.62
Peer Cap Hit (in %)	263,763	1.27	0.85	0.16	5.16

Notes. Table 1 presents the descriptive statistics of various performance measures on a player-game level for all offensive players in the NHL from the 2008/2009 to the 2018/2019 season. The depicted measures include offensive statistics such as goals, assists and points per game. Further, player information is listed including average age, position, time on ice, cap hit (in %) and the average cap hit (in %) of the players favorite offensive peers.

Table 2 provides performance statistics on the different playing styles of players among different geographical groups. This heterogeneity in performance goes along with Lazear (1999b) who stated that the main benefit of cultural diversity in teams stems from differences in working styles. North American players make up the majority of players in this dataset during the time period with around 74% of all observations, followed by Swedish players with 8%. The smallest nationality group is from Germany/Switzerland/Austria with around 3%.

It is found that most goals are scored by players from Russia. Russian players also provide the most assists and accordingly collect the most overall points. Most penalty minutes are collected by players from North America. These findings are in accordance with the paper by Amodio et al. (2022). Behind Russia, European players with the highest average points, assists, and points stem from the Czech Republic/Slovakia. Players from those countries also collect the second most penalty minutes. German/Austrian/Swiss players show a strong offensive goal-scoring ability as well, while Swedish players shine mostly through assists.

Overall, it allows to conclude that there are significant differences in the playing styles between players of different national backgrounds. This provides a fitting basis, as described by Lazear (1999b), to expect effects on performance stemming from skill diversity within teams.

Table 2: Descriptive statistics on performance measures for NHL players of all nationality groups

Descriptive Statistics

Goals	Obs	Mean	Std. Dev.	Min	Max
United States/Canada	380,261	0.13	0.38	0.00	4.00
Czech Republic/Slovakia	32,046	0.14	0.39	0.00	4.00
Sweden	42,415	0.13	0.38	0.00	5.00
Finland	21,080	0.12	0.37	0.00	5.00
Russia	23,652	0.17	0.44	0.00	4.00
Germany/Switzerland/Austria	12,697	0.15	0.40	0.00	4.00

Assists	Obs	Mean	Std. Dev.	Min	Max
United States/Canada	380,261	0.22	0.50	0.00	5.00
Czech Republic/Slovakia	32,046	0.26	0.53	0.00	4.00
Sweden	42,415	0.26	0.54	0.00	4.00
Finland	21,080	0.22	0.50	0.00	5.00
Russia	23,652	0.28	0.56	0.00	5.00
Germany/Switzerland/Austria	12,697	0.23	0.50	0.00	5.00

Points	Obs	Mean	Std. Dev.	Min	Max
United States/Canada	380,261	0.36	0.65	0.00	8.00
Czech Republic/Slovakia	32,046	0.40	0.68	0.00	5.00
Sweden	42,415	0.39	0.68	0.00	5.00
Finland	21,080	0.34	0.65	0.00	5.00
Russia	23,652	0.45	0.75	0.00	5.00
Germany/Switzerland/Austria	12,697	0.38	0.66	0.00	5.00

Penalty Minutes	Obs	Mean	Std. Dev.	Min	Max
United States/Canada	380,261	0.57	1.63	0.00	39.00
Czech Republic/Slovakia	32,046	0.45	1.23	0.00	23.00
Sweden	42,415	0.37	1.00	0.00	25.00
Finland	21,080	0.32	1.00	0.00	22.00
Russia	23,652	0.44	1.19	0.00	20.00
Germany/Switzerland/Austria	12,697	0.34	1.07	0.00	32.00

Plus/Minus	Obs	Mean	Std. Dev.	Min	Max
United States/Canada	380,261	-0.01	1.04	-7.00	6.00
Czech Republic/Slovakia	32,046	0.00	1.06	-5.00	6.00
Sweden	42,415	0.01	1.07	-6.00	6.00
Finland	21,080	-0.00	0.95	-5.00	5.00
Russia	23,652	0.01	1.06	-6.00	5.00
Germany/Switzerland/Austria	12,697	-0.00	1.03	-6.00	6.00

Notes. Table 2 presents the descriptive statistics of five performance measures on a player-game level for offensive players across all nationality groups in the NHL from the 2008/2009 to the 2018/2019 season. The first category presents the summary statistics for goals, the second for assists and the third for points scored in a game. Category four shows summary statistics on the penalty minutes of players and category five the average plus/minus score of players when on ice.

3.2 Dependent variables

As dependent variables for H1, this paper uses various team performance measures also used in previous papers of sports literature (Kahane et al., 2013). For this purpose, the data set was adapted to a game level providing performance measures for every team in a game. The main dependent variables are the number of goals scored by a team in a game (*GPG*) and the difference between goals scored and conceived (*Goal Diff*). Robustness tests are conducted using the number of team points (*PPG*), the sum of all assists and goals, and a team's winning percentage (win %).

For H2, the dependent variable is the performance of individual players in a game. The focus lies on offensive players in all models as the goal is to test the predicted effect using unique performance measures, which are more evident for offensive variables. The offensive measurement used is the most complete offensive measurement in the game of hockey, the number of points scored (*Points*). The average points scored in a game by offensive players is 0.46 as can be seen in table 1. To determine the estimated effect on a player level, the number of observations is significantly higher when measuring H2.

3.3 Explanatory variables

For H1, this paper estimates the effect of cultural heterogeneity on performance using an Herfindahl-Hirschman Index (HHI Index), which represents the first of the two main independent variables. Following Kahane et al. (2013), all players were sorted into different major geographic groups. The first group is made of North American (NA) players from the United States and Canada. Further ones are Czech Republic/Slovakia (CZE/SVK), Sweden (SWE), Finland (FIN), and Russia (RUS). In addition to these five groups identified by Kahane et al. (2013), this paper also adds a sixth group called the DACH group consisting of Germany, Switzerland, and Austria. DACH stands for Deutschland, the domestic name of Germany, Austria, and Switzerland's official Latin name Confœderatio Helvetica. Table 3 provides information on the number of players from each region. Since the 2008/2009 season, the number of players from the DACH region has increased from 17 to 25. During the latest season, the NHL had more players from the DACH region than from Russia. This and the fact that the DACH region has provided one Most Valuable Player (MVP) and Rookie of the Season in the past two seasons justifies the inclusion of this nationality group into the HHI Index.

Table 3: The number of NHL players from each nationality group throughout all seasons

season	Nationalities across all seasons						
	NA	CZE/SVK	SWE	FIN	RUS	DACH	Total
2008/2009	719	75	53	42	45	17	951
2009/2010	718	66	52	38	46	16	936
2010/2011	736	56	62	30	44	19	947
2011/2012	743	55	66	29	40	19	952
2012/2013	690	54	61	29	37	20	891
2013/2014	736	50	72	31	36	20	945
2014/2015	729	49	74	34	39	28	952
2015/2016	728	49	83	36	44	28	968
2016/2017	717	49	87	37	44	26	960
2017/2018	715	48	93	40	39	27	962
2018/2019	722	50	93	47	40	25	977
Total	**7952**	**601**	**796**	**393**	**454**	**245**	**10441**

Notes. Table 3 shows the absolute number of players across all nationality groups in each of the season included in the models, from 2008/2009 to 2018/2019. NA stands for North America, CZE/SVK includes players from the Czech Republic and Slovakia. SWE stands for Sweden, FIN for Finland and RUS for Russia. DACH includes players from the German speaking countries Germany, Austria, and Switzerland.

One challenge the HHI Index is facing is the large share of NHL players stemming from the US or Canada region. Around 77% of all players in the dataset belong to the North American group of players. The way of measuring the HHI Index makes this situation complicated as the share of all geographical groups is squared and then added together. That leads the HHI Index to be quite dominating when a team has a high percentage of North American players. Importantly, there is also a second way that a team's HHI Index can be high. This can happen when a team has relatively fewer North Americans, but many players are concentrated among few European groups. In this case, a lesser dominant North American share can also lead to a high HHI Index. The difficulty is that both effects could be opposing each other in the following regression models. For this purpose, this study follows Kahane et al. (2013) in creating an additional variable *Share of Europeans* which indicates the share of players from European countries in a team relative to players from North America. Including this variable in each regression makes the HHI Index conditional on the proportion of players coming from Europe. It benefits this study in that it excludes one of the two ways teams can have a high HHI Index. Controlling for the share of European players in a team, it is now possible to specifically measure the concentration of non-European players in a team and its effect on the team performance.

In H2, the aim is to estimate the effect of playing with peers of the same nationality on individual player performance. The explanatory variable is categorical (*PeerNat)* indicating if a player's two offensive peers are of the same nationality group. In a line of three offensive players, one player can have zero to two peers of the same nationality. The effect is estimated using only offensive players as performance measurements of defensive players, such as the number of penalty minutes received, are much less clear-cut compared to offensive measurements, such as points scored. Each offensive player has two peers whom he shares the most time on ice with in a game. The explanatory variable *PeerNat, therefore,* indicates how many of a player's main peers in a game are of the same nationality group with a minimum of 0 and a maximum of 2. An example of the latter would be the case for a North American player, who played the most time in a game with two other peers from North America.

3.4 Control variables

This study includes a variety of control variables. For H1, the model includes the average player Cap Hit (in %) in a team as a measure of team skill. A player's cap hit is the average relative annual value of his current contract under the team's cost cap. It is calculated by dividing the total salary plus singing bonuses by the contract's length. The mean of all player cap hits indicates a team's focus on highly valued players in that season. This measure follows Gerhards et al. (2016), who found that a team's market value is a good indicator of the skill and success level of that team. The expectation is that teams with a higher average cap hit perform better than teams with a lower average cap hit. To control not only for the skill of the examined team but also that of the opposing team, the same measure of team value for the opposing team is included. Another control variable is a measure of the average age of a team's players. Further, a variable is included that controls if a team played a home or away game. In combination, these measures should provide a fitting control for the skill differences between the teams. Table 4 presents the summary statistics of all variables included in the H1 models.

Similar control variables are included in all H2 models. The skill level of players is measured by the individual cap hit (in %) for their respective team in that season. Here, the model also includes the average cap hits of their peers with whom they spend the most time on ice with. This measure controls for the skill level of the entire line. Another individual measure is included with the time (in seconds) the players spent on the ice (*toi*) in that game. Additionally, the H2 models include the age of the player (*playerage*) and the offensive position of the player (*playerpos*). The three offensive positions are Center, Left-Wing, and Right-Wing.

Table 4: Descriptive statistics of all variables on a team level

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Goals per Game	13,097	2.78	1.66	0.00	10.00
Goal Difference	13,097	0.04	2.37	-10.00	9.00
Assists per Game	13,097	4.75	2.95	0.00	19.00
Points per Game	13,097	7.53	4.56	0.00	29.00
Win %	13,097	0.50	0.50	0.00	1.00
Penalty Minutes	13,097	-0.01	0.53	-2.50	2.00
Team Cap Hit (in %)	13,097	3.77	0.74	1.00	5.74
Opp. Team Cap Hit (in %)	13,097	4.81	0.82	3.18	6.40
Average Team Age	13,097	27.27	1.12	23.80	32.73
HHI Index	13,097	0.56	0.12	0.22	1.00
Share of Europeans	13,097	27.12	9.84	0.00	60.00

Notes. Table 4 presents the descriptive statistics of various performance measures on a team-game level for all games played in the NHL from the 2008/2009 to the 2018/2019 season. The depicted measures include offensive statistics such as goals, assists and points per game. Further, overall performance measures like the difference between goals scored and conceived and the win % is listed. Information on the number of penalty minutes, average team, and opponent cap size (in %), team age is included. Finally, descriptive statistics on the two main explanatory variables HHI Index and Share of Europeans are shown.

3.5 Model

The following empirical strategy is designed to test whether (1) teams with a culturally more heterogeneous workforce perform better compared to culturally homogeneous teams and (2) working with a team member of the same culture increases the performance of individual workers. It is also important to consider potential threats to the internal validity of the estimation. A full description of each threat to the validity of the models in this study is presented in appendix 1.

To test the effect of cultural heterogeneity on team performance, a multi-way fixed effects model is used. This choice was made to enable the inclusion of two levels of fixed effects into the model. Y_{kgt} is the variable of interest – a variety of performance measures by team k in game g in season t. The dependent variables are $\mathrm{HHI}_{\mathrm{kgt}}$ and $\mathrm{ShareEuropeans}_{\mathrm{kgt}}$, which indicate the cultural concentration and relative share of European players within team k in game g in season t. $\mathrm{X}_{\mathrm{gkt}}$ and Z_{gk} are vectors of time-variant and time-variant control variables. Additionally, the regression models include season fixed effects (μ_{t}) to account for the effect of unobserved time-varying characteristics. Team fixed effects (ω_{k}) are added to account for and net out unobserved team-specific factors. The formula for H1 is the following:

$$Y_{kgt} = \propto \ + ß_1 HHI_{kgt} + ß_2 ShareEuropeans_{gkt} + ß_3 X_{gkt} + ß_4 Z_{gk} + \mu_g \ + \ \omega_k \ + \ \varepsilon_{gkt} \quad (1)$$

The estimation of the effect of playing with peers of the same nationalities on the performance of individual players follows a similar multi-way fixed effects model. The main difference between the two models is that the variables of interest are now on a player i level. The dependent variable $\mathrm{PeerNat}_{kgt}$ is a categorical variable indicating the number of peers of the same nationality that a player shared the most time on ice with in a game. The model focuses exclusively on offensive lines consisting of three players indicating that the explanatory variable can take the values 0,1 or 2. X_{ikt} and Z_{ik} remain vectors of time-variant and time-invariant control variables. In H2 the models account for season (μ_g) and individual player (ω_i) fixed the effects. The estimation is first conducted on all offensive players in our dataset and subsequently on North American and European players separately. The final formula is the following:

$$Y_{igt} = \propto + ß_1 \mathrm{PeerNat}_{igt} + ß_2 X_{gkt} + ß_3 Z_{gk} + \mu_g + \omega_i + \varepsilon_{gkt} \quad (2)$$

4 Results

4.1 Cultural heterogeneity and team performance

Table 5 presents the results for Hypothesis 1 using the offensive performance measure of goals scored per game (*GPG*) and the difference of goals scored and conceived in a game (*Goal Diff*). In specifications (1) and (5), the dependent variables *GPG* and *Goal Diff* are regressed through a simple ordinary least square (OLS) method using only the two main explanatory variables *HHI Index* and *Share of Europeans* without any control variables or fixed effects. Next, columns (2) and (6) augment this specification by controlling for season fixed effects (μ_t) and team fixed effects. Specifications (3) and (7) add the control variables *Average Team Age*, *Team Cap Size (in %), Opp. Team Cap Size (in %)* as well as *Home Game* while maintaining the previous fixed effects. Finally, columns (4) and (8) estimate the regression using the same control variables but replacing both season and (μ_t) team fixed effects (ω_k) with team x season fixed effects, to account for potential team differences at the season level.

Table 5: Regression results on GPG and Goal Diff on a team-game level

	(1) GPG	(2) GPG	(3) GPG	(4) GPG	(5) Goal Diff	(6) Goal Diff	(7) Goal Diff	(8) Goal Diff
HHI Index	1.324***	1.665***	1.628***	1.284*	0.178	0.268	0.355	-1.527
	(0.4995)	(0.5656)	(0.5627)	(0.7264)	(0.7357)	(0.8428)	(0.8356)	(1.0964)
Share of Europeans	0.020***	0.023***	0.021***	0.015	0.007	0.010	0.009	-0.018
	(0.0065)	(0.0076)	(0.0076)	(0.0098)	(0.0095)	(0.0114)	(0.0113)	(0.0149)
Average Team Age			-0.025	-0.088***			-0.033	-0.096**
			(0.0181)	(0.0314)			(0.0262)	(0.0455)
Team Cap Size (in %)			0.163***	0.196***			0.256***	0.273***
			(0.0265)	(0.0451)			(0.0385)	(0.0653)
Opp. Team Cap Size (in %)			-0.003	-0.003			0.028	0.028
			(0.0171)	(0.0171)			(0.0248)	(0.0248)
Home Game			0.296***	0.299***			0.579***	0.585***
			(0.0282)	(0.0282)			(0.0409)	(0.0409)
_cons	3.432***	3.483***	3.228***	4.597***	0.809***	1.030***	0.242	1.239
	(0.2081)	(0.2586)	(0.5384)	(0.8731)	(0.2960)	(0.3768)	(0.7817)	(1.2654)
Season Fixed Effects	No	Yes	Yes	n.a.	No	Yes	Yes	n.a.
Team Fixed Effects	No	Yes	Yes	n.a.	No	Yes	Yes	n.a.
Team x Season Fixed Effects	No	No	No	Yes	No	No	No	Yes
Observations	13,097	13,097	13,097	13,097	13,097	13,097	13,097	13,097
R-squared	0.001	0.020	0.031	0.060	0.001	0.015	0.034	0.066

Notes. Standard errors are in parentheses *** p<.01, ** p<.05, * p<0.1. Multi-way fixed effects regression at the level of team and game. The dependent variables are goals per game (GPG) in specifications (1) to (4) and the difference between the number of goals scored and conceived (Goal Diff) in specifications (5) to (8). The sample consist of all teams and spans across the seasons 2008/2009 to 2018/2019. The main explanatory variables are HHI Index and Share of Europeans. Column (1) and (5) estimate the effect of the concentration of nationalities (HHI Index) and the relative share of European players (Share of Europeans) on the team performance measures. Column (2) and (6) include season and team fixed effects. Columns (3) and (7) add various control variables to the equation and represent the preferred specifications. Columns (4) and (8) replace both fixed effects with a combination of both, team x season fixed effects.

Of strongest interest in table 5 are the main explanatory variables *HHI Index* and *Share of Europeans*. Because the *HHI Index* is conditional on the *Share of Europeans*, the latter is examined first. The variable *Share of Europeans* represents the relative proportion of European players in a team compared to North American players and shows a positive correlation to the number of goals scored. This result is significant at a 1% significance level for the first three specifications. Specification (3) implies that a 1% increase in Europeans in a team increases the number of team goals scored per game by 0.021 goals, ceteris paribus. While the coefficient remains positive, it becomes insignificant in specification (4) using team x season fixed effects. The coefficient demonstrates an interesting result in that the significance changes when the model accounts for a team's time-invariant characteristics within a season. It appears that the share of European players is a significant factor when controlling for season and team fixed effects individually but is captured by the team season fixed effects. Based on this, it can be noted that specifications (4) and (8) may be too restrictive on fixed effects given that changes in the HHI index of teams mainly occur between seasons. This in turn implicates that, conditional on the fixed effects, specifications (3) and (7) are the most informative for our research question and represent our preferred specifications. They are also the most comparable to the season-level analysis by Kahane et al. (2013), which exploited the variation between seasons rather than within seasons.

Next, a close look is taken at the results for *HHI Index.* In the simplest regression specification (1), the effect of a more concentrated cultural team force is positive and significant at a 1% significance level. This result holds when season and team fixed effects are added in (2) as well as control variables in (3). Looking at specification (4), which includes all control variables and team x season fixed effects, a positive and significant effect can be found. Again, the variance increases but the coefficient does not lose its significance. Using the preferred specification (7), an increase in the HHI Index by one point raises the average team goals scored in a game by 1.628, ceteris paribus. This result is significant at a 1% significance level.

The regression results using the second team performance measure *Goal Diff* show a different picture compared to the number of goals scored. A higher share of European players in a team is uncorrelated to team performance. Models (5) to (7) present positive coefficients which are all statistically insignificant. The last speciation indicates a negative result but is also not significant. A higher concentration of players from one cultural background (*HHI Index*) has equally no significant impact on the difference between goals scored and conceived. Models (5) to (7) present positive yet insignificant coefficients for *HHI Index*. For model (8), the coefficient is negative and insignificant.

Next, the control variables are examined, which are part of the respective last two specifications. A team consisting of players with a higher average age performs worse compared to a relatively younger team, ceteris paribus. This result is, however, only significant at a 1% significance level in specifications (4) and (8) using team x season fixed effects. It is found that an additional year of team age leads to an average of 0.088 fewer goals scored while the difference between goals scored and conceived decreases by 0.096 goals, ceteris paribus. Next, team value is measured using the average cap hit (in %) of a team's players to the organization. The result is clear; a larger average cap size, indicating a higher team value, has a positive and significant effect on both performance measures. A 1% increase in the team cap size increases the average goals scored by 0.196 goals and enhances the average goal difference by 0.273 goals, ceteris paribus. This result is significant at a 1% significance level for all specifications. A quite different picture is presented for the average player cap size (in %) of a team's opponent. The coefficients are negative for *GPG* and positive for *Goal Diff*. However, neither of the coefficients is significant. This result implies that a team's on-ice performance is not significantly affected by the quality of the opposing team. Finally, the effect of playing at home is put into comparison with playing away games. Playing at home proves to have a highly significant positive effect on both performance measures. Using the most fitting specifications

(4) and (8), home teams score an average of 0.299 more goals, and the difference between goals scored and conceived increases by 0.585 goals compared to playing away, ceteris paribus. Overall, the control variables show consistency between the two performance measures providing a first indication that the estimated effects are robust against a variety of performance measures.

The findings provide three interesting implications. First, teams with the same HHI Index score more goals when employing more European players in their team compared to teams with fewer Europeans. This result is in accordance with the summary statistics which indicated higher offensive scoring potential for players from Europe. Second, teams score more goals when the team is culturally more concentrated to fewer foreign nationality groups compared to teams with a culturally more dispersed team. This implies that teams should not arbitrarily pick players from Europe but rather choose players from the same nationality groups in order to perform better offensively. Finally, it can be concluded that the estimated results are only robust to offensive performance measures. Teams seem to score more overall goals when the team structure is culturally more homogenous. When the same model is run on an overall performance measure this effect does not hold. Based on these findings, the first hypothesis cannot be rejected. Even though a team's overall performance is unaffected by its cultural heterogeneity, the effect is positive on offensive team performance measures.

It is also of interest to examine the economic significance of the results. The preferred specification (3) demonstrates that an increase in the *HHI Index* by one point raises the average number of goals scored by 1.628. This must be put in context, however, in that the standard deviation of *HHI Index* is 0.12 and the maximum is 1, which implies that a one-point increase in *HHI Index* is not realistic. Instead, the economic relevance can be demonstrated using the change of one standard deviation. An increase in *HHI Index* of one standard deviation raises the average number of goals scored by 0.195. Comparing this effect to the mean of goals scored by a team in a game of 2.78 and the maximum of 10 goals, the results indicate economic significance.

4.2 Cultural heterogeneity and player performance

Table 6 shows the results for Hypothesis 2, which aims to measure the effect of playing with peers of the same cultural background on the performance of players. The main dependent variable for this estimation is the most complete offensive performance measure, the number of points scored (*Points*) by a player in a game. The explanatory variable is a categorical variable indicating the number of peers of the same nationality a player spends the most time on the ice with. Playing with one or two players of the same nationality group is compared to the reference category of playing with no teammates of the same cultural background. Specification (1) estimates the effect on *Points* using a simple OLS regression without any control variables or fixed effects. Specifications (2) and (3) add first season (μ_t), then team fixed effects (ω_k). Model (4) augments the specification with both season and team fixed effects. Specifications (5) and (6) run the same models as the prior two but replace team fixed effects with player fixed effects to account for potential player-specific time-invariant unobservables.

In the main explanatory variable, the focus lays on the number of offensive peers of the same nationality group that a player shares the most time on ice within a game. *2 Peers* indicates that both main peers are of the same cultural background, while the reference category *0 Peers* means that neither of the peers has the same cultural background. Specification (1) examines the effect without any control variable or fixed effects. The coefficient of *1 Peer* is negative and significant at a 1% significance level. Playing with two peers is equally negative and significantly correlated to player performance. These coefficients demonstrate that, for all players, playing with one player of the same nationality group decreases the average points scored in a game by 0.027, while playing in a fully culturally homogeneous line even decreases the performance by 0.1 goals, ceteris paribus. This result does not significantly change with the addition of season and team fixed effects in models (2) and (3) respectively. Both *1 Peer* and *2 Peers* remain negative and significant at a 1% significance level while the size of the coefficient stays nearly the same. These results change, however, when control variables are added in specification (4). Neither playing with *1 Peer* nor *2 Peers* of the same nationality show a significant effect on the number of points scored. The coefficients become negative and significant at a 1% level again when team fixed effects are replaced with player fixed effects. This result also holds when the control variables are included in specification (6). It shows that playing with one peer of the same nationality group decreases offensive performance by 0.011 points per game. Playing in a fully homogeneous line decreases the number of points scored in a game by 0.016, ceteris paribus. These results are significant at a 10% and 1% significance level, respectively. Since the aim is to demonstrate the effect of cultural heterogeneity, irrespective of a player's skill level, specification (6) is the preferred one in this model.

Next, the results of the control variables are examined. The age of a player shows a significant negative effect on the number of points scored in a game. This result coincides with the effect that was presented on the average age of players on team performance. Aging by one year leads to an average of 0.011 fewer points scored, ceteris paribus. This result is significant at a 1% significance level with season and team fixed effects. This result, however, does not hold when team fixed effects are replaced by player fixed effects This shows that the effect of player age, which changes at a constant rate, is absorbed by the player fixed effects. The position of an offensive player, which can change throughout his career, can also significantly determine the number of points scored. Using specification (6), it can be seen that playing the Left-Wing position increases the average number of points scored by 0.039 per game compared to the reference position Center. This result is significant at a 10% significance level. Playing Right-Wing has a significant effect on the points scored only when team fixed effects are included. It shows that playing Right-Wing increases the average number of points scored by 0.018 compared to playing Center. While this effect is significant at a 1% significance level for specification (4), it does not hold when the model controls for player fixed effects in specification (6). A positive effect on the number of points scored is also apparent for the time a player spends on the ice. An additional second of ice-time leads to an increase in the average number of points scored of 0.001. While this result arguably lacks economic significance, it is statistically significant at a 1% level for both specifications. Finally, it is found that a player's monetary value for the team also significantly affects his offensive performance. Using specification (6), an additional 1% in a player's cap hit to the team increases his points scored by an average of 0.014 points, ceteris paribus. This result is significant at a 1% significance level. Additionally, a player's points scored is also significantly influenced by the average cap value of his two offensive peers. Using the preferred specification (6), an additional 1% increase in the cap hit of a player's peers increases his performance by 0.025 points, ceteris paribus.

The results demonstrate that, for all players combined, playing with players of the same nationality group is non-beneficial to their offensive performance. In all but one specification did the model provide significant negative relationships. Additionally, it seems that playing in a fully homogeneous line is more detrimental to a player's performance than sharing the ice with only one player with the same cultural background. It can be concluded that hypothesis 2 cannot be rejected. Sharing the ice with culturally similar peers deteriorates the performance of a player compared to playing with culturally heterogeneous players. This effect is even stronger for culturally completely heterogeneous lines.

Table 6: Regression results on Points per Game on a player-game level

	(1) Points	(2) Points	(3) Points	(4) Points	(5) Points	(6) Points
Number of Peers of the same Nationality						
1 Peer	-0.027***	-0.027***	-0.026***	0.003	-0.014***	-0.011*
	(0.004)	(0.003)	(0.003)	(0.004)	(0.005)	(0.006)
2 Peers	-0.100***	-0.099***	-0.102***	-0.004	-0.031***	-0.016***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)	(0.006)
Player Age				-0.011***		-0.000
				(0.000)		(0.002)
Player Position						
Left-Wing				-0.000		0.039*
				(0.004)		(0.021)
Right-Wing				0.018***		0.036
				(0.004)		(0.023)
Time on Ice				0.001***		0.000***
				(0.000)		(0.000)
Cap Hit (%)				0.030***		0.014***
				(0.001)		(0.001)
Peer Cap Hit (%)				0.040***		0.025***
				(0.002)		(0.002)
_cons	0.518***	0.518***	0.519***	0.097***	0.485***	0.031
	(0.003)	(0.002)	(0.002)	(0.012)	(0.004)	(0.053)
Season Fixed Effects	No	Yes	Yes	Yes	Yes	Yes
Team Fixed Effects	No	No	Yes	Yes	No	No
Player Fixed Effects	No	No	No	No	Yes	Yes
Observations	312,873	312,873	312,873	243,144	312,828	243,111
R-squared	0.004	0.004	0.006	0.098	0.106	0.116

Notes. Standard errors are in parentheses *** p<.01, ** p<.05, * p<0.1. Multi-way fixed effects regression at the level of player and game. The dependent variables are points per game (Points). The sample consist of all players from the six nationality groups and spans across the seasons 2008/2009 to 2018/2019. The main explanatory variable is the number of peers of the same nationality that a player shared most time with on ice in a game. Column (1) estimates the effect of the number of culturally similar players on the number of goals scored in a game. Columns (2) and (3) include first season then team fixed effects. Column (4) adds various control variables to the equation. In columns (5) and (6), team fixed effects are replaced by player fixed effects.

As shown earlier, the number of North American players in the NHL is much higher than that of players from Europe. Additionally, the offensive performances of players from each region are different. The next step of this study is to test the results for heterogeneities between nationality groups to see whether the effect of North American players overshadows potential differing effects among European players. The last four specifications of the previous model (3) to (6) are run for North American and European players separately and presented in table 7.

Table 7: Regression results on Points per Game comparing players from North America and Europe

	European Players				North American Players			
	(1) Points	(2) Points	(3) Points	(4) Points	(5) Points	(6) Points	(7) Points	(8) Points
Number of Peers of the same Nationality								
1 Peer	0.062***	0.020**	0.007	0.000	-0.067***	-0.014**	-0.024***	-0.013**
	(0.008)	(0.009)	(0.009)	(0.010)	(0.006)	(0.007)	(0.006)	(0.007)
2 Peers	-0.007	-0.049*	-0.077***	-0.094***	-0.129***	-0.018***	-0.038***	-0.017***
	(0.027)	(0.029)	(0.028)	(0.031)	(0.006)	(0.006)	(0.006)	(0.007)
Player Age		-0.011***		0.002		-0.011***		-0.000
		(0.001)		(0.005)		(0.000)		(0.002)
Player Position								
Left-Wing		0.006		0.043		-0.003		0.031
		(0.007)		(0.036)		(0.004)		(0.027)
Right-Wing		0.054***		0.026		0.006		0.048*
		(0.008)		(0.046)		(0.004)		(0.027)
Time on Ice		0.001***		0.000***		0.001***		0.000***
		(0.000)		(0.000)		(0.000)		(0.000)
Cap Hit (%)		0.030***		0.016***		0.029***		0.012***
		(0.001)		(0.002)		(0.001)		(0.001)
Peer Cap Hit (%)		0.042***		0.026***		0.038***		0.025***
		(0.004)		(0.004)		(0.002)		(0.002)
_cons	0.519***	0.080***	0.527***	-0.011	0.544***	0.120***	0.477***	0.038
	(0.003)	(0.024)	(0.003)	(0.125)	(0.005)	(0.014)	(0.005)	(0.058)
Season Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Team Fixed Effects	Yes	Yes	No	No	Yes	Yes	No	No
Player Fixed Effects	No	No	Yes	Yes	No	No	Yes	Yes
Observations	82,219	64,961	82,204	64,953	230,654	178,183	230,623	178,158
R-squared	0.015	0.086	0.094	0.103	0.008	0.102	0.108	0.119

Notes. Standard errors are in parentheses *** p<.01, ** p<.05, * p<0.1. Multi-way fixed effects regression at the level of player and game. The dependent variables are points per game (Points). The sample differentiates between players the five European country groups in specifications (1) to (4) and North American players in columns (5) to (8). It spans across the seasons 2008/2009 to 2018/2019. The main explanatory variable is the number of peers of the same nationality that a player shared most time with on ice in a game. Columns (1) and (5) estimates the effect of the number of culturally similar players on the number of goals scored in a game and includes season and team fixed effects. Columns (2) and (6) add various control variables to the equation. Columns (3), (4), (7) and (8) run the same equations as the ones before but replace team fixed effects with player fixed effects.

Models (1) to (4) present the results for players from Europe, which include all nationality groups apart from the North American one. Models (5) to (8) provide the results for players from the US and Canada as part of the North American group. Interesting heterogeneous effects become apparent. Playing with one peer of the same nationality is significant and positive in the first two specifications for European players but significantly negative for North American players. For European players, playing with another player of the same nationality group enhances offensive performance by 0.020 (2) points per game, ceteris paribus. For North Americans, the effect is a decrease in points scored by 0.014 (6). The difference of *Peer* 1 between the effect for European players and all players combined demonstrates the above-mentioned quantitative dominance of North American players in the league. While the effect of *1 Peer* remains negative throughout all specifications for North Americans, the effect becomes insignificant for Europeans when player fixed effects are added. For North American players, the preferred specification (6) implies that playing with another North American decreases a player's points scored by 0.013, ceteris paribus. This result is significant at a 5% significance level. Further heterogeneities in the effect among European players are also apparent (appendix 4).

Throughout all but one specification, fully homogenous lineups do not benefit the performance of any individual players. Models (2) to (8) show a negative and significant relationship between *2 Peers* and the number of *Points* scored for Europeans and North Americans, while the effect is even stronger for Europeans. In the preferred specifications (4) and (8), sharing time on ice with only players of the same cultural background decreases the average number of points scored for Europeans by 0.094 and for North Americans by 0.017 points, ceteris paribus. The effects are significant at a 5% and 1% significance level, respectively.

In summary, it can be concluded that the results for playing with culturally similar players partially differ between European and North American players. Controlling for time-invariant player season characteristics, a negative effect of sharing time on ice with one player of the same cultural background can only be found for North American players. Most interestingly, however, is the finding that culturally fully homogeneous lines do not benefit the offensive performance of any individual players, neither from Europe nor from North America. This result is in line with the effect that was measured earlier on the performance of teams. It is beneficial to culturally diversify lines (and entire teams) to extract the most performance out of individual players and achieve positive offensive results. Considering that playing with one culturally similar peer only has a negative effect for North American players but playing in fully homogenous lines is more detrimental to European players, hypothesis 3 cannot be fully rejected.

4.3 Robustness checks

The results of the main hypotheses of this paper have provided interesting results, some of which differ from existing studies. For this reason, all models were subjected to a variety of robustness checks. The first model finds that a higher concentration of players from a few nations within a team positively affects a team's average points scored per game. This effect is significant for all models using purely offensive measures. Interestingly, this effect was not to be found when the dependent variable was replaced by a team's goal difference where the model provided consecutive insignificant coefficients. These results are confirmed by the first robustness check (appendix 5) which estimates the same models with two different dependent variables: *Points per Game* acts as another purely offensive measure and a team's *Win %* reflects a team's overall performance. For the number of points scored, positive and significant results are found for the first three specifications. Model (3) indicates that a 1-point increase in the HHI Index increases the average number of points scored by 3.660, ceteris paribus. All coefficients are significant at a 5% significance level. The only difference to the main model is that specification (4) is insignificant while still being positive. The results for a team's win percentage show a similar picture to the goal difference variable in H1. The coefficients are positive but insignificant for all four specifications. Interesting is also the similarity of both models for the second variable of interest, the *Share of Europeans* in a team. Similar to the effect on the number of goals scored, *Points Per Game* is also significantly positively affected by a higher number of Europeans. Using model (3), the estimation shows that an increase of 1% in the share of Europeans increases the average number of points scored in a game by 0.048, ceteris paribus. This result is significant at a 5% significance level. Like the main model in H1, this result does not hold when both fixed effects in model (4) are interacted. The same resemblance is also found when comparing the results of *win %* to *Goal Diff*. While the model shows negative coefficients, neither of these is statistically significant. In summary, the results of the first robustness check largely support the findings and provide confidence in the estimated effects.

Earlier, the characteristic of the HHI Index was described in that it can be relatively high in two ways. One is that a team has a high concentration of North American players. Secondly, teams can have relatively more players from Europe, but they are dispersed among few European countries. One of these two effects was excluded by integrating the *Share of Europeans* variable into the model that made the effect of the HHI Index conditional on the relative share of Europeans in a team. To test if this assumption was reasonable, *Share of Europeans* is excluded from the H1 model in the next robustness check (appendix 6). As expected, all previously significant models lose their significance completely. This result supports the expectation that when *HHI Index* is unconditional on the number of players from Europe, it includes two opposing effects which cancel each other out. The result of the main regression in the first model demonstrated a case where the influence on performance stemmed from a low number of European players. By excluding *Share of Europeans*, the model captures a second, opposing, effect that comes from the concentration level within the European nationality groups. This effect is also significant as can be seen in the drastic change of significance in the robustness model.

As an additional robustness check, the H1 model is estimated using a different measure of team skill. Previous papers have shown that the team value measured in cap size can effectively capture the skill level of a team. However, the NHL uses a draft system in which young players must sign entry-level contracts which include a maximum salary these players can earn for up to three years. This implies that a team's relative cap hit does not have to represent the relative skill of their team. Therefore, the H1 model is run using two different measures of skill in replacement of the relative cap hit of a team. First, the model replaces the relative *Team Cap Hit (in %) with* the number of goals scored by the currently active players of a team in the previous season (*Goals Pre-Season;* appendix 7). The effect of the goals scored by the players is positive and significant for all specifications of the model. An additional goal of the team's players in the previous season increases the team goals this season by 0.045 and the goal difference by 0.051 goals per game, ceteris paribus. The coefficients of the main dependent variables *HHI Index* and *Share of Europeans* on the goals per game become smaller in size but remain significant for three of four specifications. The coefficients for the Goal Difference specifications remain essentially unchanged in size and significance. The effect of the *Share of Europeans* is equally unchanged for all specifications on *GPG* and *Goal Diff.* The same estimation is also conducted using the total absolute *salary* of a team and their opponent in millions which paints a similar picture (appendix 8). The salary of the own team is positive but only partly significant for this specification. The value of the opponent team has no significant effect on any of the dependent variables. In terms of size, the coefficients of *HHI Index* and *Share of Europeans* are in between the H1 model and the first robustness check while showing less significance. A significant effect of the concentration of nationalities on the number of goals scored can be found for the first three specifications but not for the last one. A higher share of European players is correlated to better offensive performance for all specifications. The coefficients of both dependent variables in the Goal Difference specifications are essentially unchanged in size and significance. Overall, the model is robust to different variables of team value.

Next, the robustness checks for the second hypothesis are conducted. The main finding of the first model of H2 was that playing with one peer of the same nationality only had a partially significant effect on the number of points scored by a player. Playing in a line of only players from the same nationality group on the other hand was consistently negatively correlated to individual performance. This result for robustness is tested by using a different measure of performance, the number of goals scored (appendix 9). The results are similar. Playing with one peer of the same nationality is negative and significant for five specifications. Playing in a culturally homogeneous line is significantly negatively correlated to the number of goals scored for all models. Using specification (6), it is possible to say that playing with a culturally homogenous line-up decreases the average goals scored by a player by 0.01 goals, ceteris paribus. This model is subjected to another robustness check by also running it with the number of assists scored by a player (appendix 10). The results are comparable to the previous two models even though specification (6) is the only one that shows no significant effect.

The second model of H2 provided interesting results regarding the heterogeneity of results between European and North American players. To see if this heterogeneity is also the case for the number of goals scored by a player, a further robustness check (appendix 11) is conducted. For the number of goals scored, the results show a greater heterogeneity between players of Europe and North America compared to the number of points scored. The coefficients for playing with one culturally similar peer and for fully homogeneous lines are only significant for one specification for European players. For North American players, however, all four specifications are significant, two at a 1% significance level. Overall, the negative effects of playing in a culturally homogeneous line are more apparent for North American players compared to European players, and this dominance is represented in the model which combines both cultural groups. Nevertheless, the results confirm the findings of the main model in H2 in those fully homogenous offensive lines do not benefit the performance of individual players. Overall, playing with two players of the same nationality significantly decreases the average number of goals scored by individual players, ceteris paribus. Running the same robustness check on the number of assists scored in a game further supports the findings by being comparable to the main regression (appendix 12).

5 Discussion

This study aimed to answer the research question to what extent culturally heterogeneous team composition influences the performance of teams and individual players in comparison to teams that are more culturally uniform. It finds that adding culturally diverse players to a team, in this study Europeans in the NHL, improves the offensive performance of teams. The models demonstrate that this cultural diversification is existent but must be done carefully and should be concentrated to a core of outside countries. Notably, the positive effect is only existent for offensive activities of an NHL team, which implies that the effect is conditional on the distinct characteristics of an activity. On an individual player level, the results provide support for the findings on teams. The performance of individual players is enhanced when they play together with players of culturally heterogeneous backgrounds. Players in a culturally fully homogeneous line perform consistently worse compared to players that play with culturally heterogenous teammates. The combination of these results allows for a substantiated answer to the posed research question by showing that cultural diversity within a team improves the performance of its players and benefits the offensive performance of a whole team.

The first main finding of this study is that teams consisting of a higher share of European players score on average more goals compared to teams with more North American players. This effect is attributable to two aspects. First, players from European countries are in various offensive categories higher skilled compared to North American players as seen by their higher average offensive performance statistics. Second, the addition of Europeans leads to diversity in skill among all players of a team. This conclusion can be drawn from the consistent negative effect of playing in culturally homogenous lines for all players, including Europeans. Considering that even European players, who on average score more offensive points, perform better when sharing the ice with culturally heterogeneous players demonstrates the existence of benefits from varying skills. A team's cultural diversification leads to a broader range of capabilities, and knowledge, among its team members. This variety is beneficial to the offensive performance of players and teams in hockey as these skills are complementary to each other and relevant to the success of the team (Lazear, 1999b). This finding provides support for the study by Hamilton et al. (2012) which found diversity in skill to be positively related to firm productivity and Kahane et al. (2013) who demonstrated similar synergies in the NHL on a season level.

Building on this observation, this study reveals that the fragmentation of countries in the cultural diversification process is another essential factor. A culturally diversified team performs better when the foreign team members stem from a more concentrated number of countries. It implies that foreign players should not be purely hired based on having different skills from current employees but rather relevant skills to the team and that a certain cultural homogeneity among the foreign players should be preserved. This can be attributed to the fact that diversification in skill through foreign hires is often confronted by increasing barriers of communication. It becomes clear that these two dynamics oppose each other in the composition of culturally diverse teams and should be carefully considered as Lazear (1999b) already identified. The findings also imply that in offensive activities of hockey, a variety of skill is still of more value than the cost of communication it imposes. These findings are in accordance with the study by Kahane et al. (2013) but oppose more general frameworks that assume cost of communication to be dominant in physical and high-interaction tasks (Sakuda, 2012). This study illustrates that there is a certain interplay between these two dynamics and that, as a result, cultural team diversification must be carried out diligently.

It is important to address this significant difference in the effect between offensive and overall team performance in more detail. The results show that neither a higher share of European players nor a higher cultural concentration among team members significantly increases the chance of winning a game. This result can be attributed to two possible effects. First, the insignificance of the impact of European players on the overall team performance may suggest that North American players are superior in defense compared to Europeans. This conclusion would follow Amodio et al. (2022) in that the North American style of hockey has always been a physically intense one, beneficial to defensive performance. This is also represented in the higher average number of penalty minutes that the average North American player receives per game. Perhaps more importantly though, the combination of both explanatory variables suggests that requirements for defensive activities significantly differ from that of offensive activities. Communication barriers seem to play a much larger role in defensive performance, which offsets the positive skill diversity effects observable in the offense. This provides support to existing papers, such as that of Timmerman (2000), who considers the different requirements of activities as a prerequisite for a positive effect of cultural diversity. These results, however, put the results by Kahane et al. (2013) into question which found the effect of cultural heterogeneity to also be significant for overall team performance on a season level.

On an individual player level, comparable results were found. The key finding is that it is not beneficial for neither North American nor European players to play in culturally fully homogeneous offensive lines. This means that players score significantly fewer offensive points when playing in lines that only consist of players of their nationality group compared to playing in a fully heterogeneous line. This is clear support for the main finding that, in the case of offensive activities in the NHL, the benefits of skill diversity within a team outweigh the costs of communication and coordination of culturally diverse team members. In addition, it draws comparisons to existing studies by Berg et al. (1996) and Hamilton et al. (2012) that have emphasized the existence of learning effects among teams. The fact that playing with foreign players not only improves the team performance but also that of individual teammates shows that peer effects exist, and players take note of the varying abilities of their counterparts.

The final key observation of this study is the existence of bargaining effects among team members. The study shows that NHL teams profit from hiring highly skilled European players which raises offensive team and player performance. Additionally, North American players perform worse when sharing the ice with one player of the same cultural background which is not the case for European players, who partially even perform better when playing with a culturally equal player. This demonstrates the existence of a bargaining effect indicating that highly skilled workers, in this case European players, leverage their strong outside options to determine a new “work pace” among the team. This in return results in higher cross-team performance and leads to less productive players, North Americans, raising their performance as well. This proves previous studies by Hamilton et al. (2003; 2012) and leaves to conclude that the addition of foreign players to a team can have significantly positive direct effects on team performance through their high skill level while also indirectly enhancing the performance of their team members through learning and bargaining effects.

For companies, this study can be of value, especially in times when organizations are becoming more and more international. The team composition can have a significant impact on the performance of individual workers and an entire company. Altogether, firms can profit from having a diversity of skills in the organization, which can be achieved through the integration of culturally diverse employees. This effect can be valid, contrary to some existing literature, also for some activities that are characterized by physical activities with a high degree of coordination. However, this is not the case for all activities. The study proves that the characteristics of an activity are what determine the effect of cultural diversity on performance and must therefore be carefully identified. Nevertheless, it remains important to maintain a certain homogeneity when recruiting foreign workers, so that the hurdles of communication within the workforce do not become too high. Even in smaller teams, organizations can benefit from hiring foreign colleagues. Not only do these teams improve their overall performance, but the cultural and skill diversity also has a positive effect on the performance of the individual workers. Here, all parts of the team can benefit from high-performing newcomers raising the average performance level of everyone. In addition, team members can learn skills from others that they did not have before. Overall, it becomes evident that the benefits of cultural diversity can outweigh the costs of higher communication for organizations when the characteristics of the activities allow for it.

6 Limitations and empirical value

First, it is of value to evaluate the nature of the relationship between the explanatory and the dependent variables in our model using four criteria for causality (DeCarlo, 2018). Positive and statistically significant relationships were found between the cultural heterogeneity of teams and the offensive performance of players and teams showing that our variables covary. This effect is in line with existing literature frameworks on team diversity and matches the outcome of previous quantitative studies, which indicates plausibility of the results. Next, the criterion of temporality must be fulfilled meaning that there is no reason to believe that the estimated effect is reversed. In this case, the chance that offensive performance measures lead to a cultural diversification of teams seems highly unlikely. The inclusion of various controls and fixed effects in the models, through which the estimated relationship remained statistically significant leads to the assumption that the effect was also not due to a third variable. Therefore, it can be assumed that this study established nonspuriousness. Based on the fulfillment of these criteria, supported by the internal validity analysis in appendix 1, it is possible to state that this study achieved a nomothetic causal explanation for the relationship between cultural heterogeneity and team and player performance. This leads to believe that this study allows making claims about this relationship for organizations outside of the NHL.

Despite the best effort to estimate accurate and causal effects, it must be acknowledged that the results come with limitations. First, the measure of cultural heterogeneity follows the structure of Kahane et al. (2013) in that culturally similar nations were sorted into six groups and used to estimate the effect on performance. In doing so, this study already extended Kahane et al.'s (2013) HHI Index to include one additional important nationality group, players from the DACH region. Nevertheless, it is necessary to acknowledge that inhabitants of one country, especially large ones like Canada, at times do not share the same culture, language, or style of hockey. For the US and Canada, the playing styles of Canadian and U.S. players have been similarly shaped over the years, as noted by Amodio (2022). Similarly, close ties also exist between the Czech Republic and Slovakia as well as the three DACH states. While this form of measuring the concentration of cultures has this potential drawback, it stands out overall for its practicality and ability to present the nature of the cultural structure within a team.

To follow up on this, another limitation to mention is the fact that some of the foreign players may have spent already some time in North America prior to joining the NHL. This may especially be the case for young, talented European players that made their way to the league through the North American college system. This would imply that these players have spent a significant amount of time in a culture, different from their nationality, which could diminish cultural and language barriers. Additionally, the playing style of such players may have adapted to one of North Americans. If foreign players' cultural backgrounds do not represent the cultural distance to North American culture, it could lead to a misrepresentation of the effect of cultural diversity on performance.

Third, selection bias could be a potential concern to this study. Selection bias occurs when data is not selected randomly or completely (Heckman, 1979). In such a situation, the observed sample is not representative of the population intended to be analyzed (Economou et al., 2021). The player selection process in the NHL could be seen as a potential base for a selection bias. Not all players eligible for the NHL draft have the same chance of being drafted based on their physical characteristics or skill level (Economou et al., 2021). This also includes the selection of European players for North American teams. European players are not assigned to teams randomly but chosen in the NHL draft system in that they must fit the physical and performance criteria of certain teams. This indicates that our sample might not be completely random which potentially overstates the effect of European players on NHL teams compared to the population it intends to represent. Future research could make use of weighted distributions, as developed by Economou et al. (2021) to test the estimated results for this potential bias.

Further, the H1 models found significant differences in the effect of cultural heterogeneity on purely offensive and whole team measures. The significance of the estimated effect on offensive performance was also supported by the findings on a player level. Unfortunately, the database and the game of hockey, in general, provide much clearer offensive compared to defensive statistics. Therefore, a deeper insight into the effect of cultural heterogeneity on defensive performance statistics was not possible in this study. Nevertheless, the findings speak for relevant differences in offensive and defensive collaboration requirements. While this paper could not examine this effect in more detail, this structural difference should be examined further in future research.

While this paper used an extensive database containing information on the NHL for over 10 years, there is some information that could have been of value for the estimated models and could imply a potential omitted variable bias. One issue described earlier stems from the incomplete caption of a team's actual skill level using its percentage cap hit, absolute value, or previous performance. Data on high-value draft picks could take some of the issues away from the percentage cap hit. It would control for the lower entry contracts that might smaller a team's cap value but not its actual skill level. In addition, Kahane et al. (2013) show that top draft picks alone significantly affect team performance. Further, information on the skill level of coaches could be included in all models. Next to their career win percentage, it would also be interesting to examine the effect of their cultural background on the performance of the team and individual players. Other control variables that could help explain the examined relationship are performance values of players in college, other European leagues and players' experience from playoff runs or even championship wins.

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8 Appendix

Appendix 1: Validity of the model

This paper uses a fixed effects regression method to estimate the effect between cultural heterogeneity and performance. This section focuses on the validity of the fixed effect model and hence, the validity of the estimated results.

1.1 Omitted variable bias

Two criteria must be met for the risk of an omitted variable bias. The omitted variable must be 1) correlated with the dependent variable and 2) connected with at least one of the independent variables. The challenge of an omitted variable bias is the inconsistency of the estimator. The independent and control variables included in these models are either taken from the provided database or added based on existing empirical studies (Hamilton et al., 2003; Kahane et al., 2013). Attention was paid to the balance between not enough and too many control variables, which would increase the variance of the estimator and decrease the degrees of freedom. However, not all control variables could be included, which might give the model a stronger explanatory power. These include data on high-value draft picks, the skill level of coaches, or the performance of players outside the NHL.

1.2 Selection bias

The second challenge that a fixed effect model must withstand is that of selection bias. According to Heckman (1979), selection bias occurs when data is not selected randomly or completely but based on the availability of data. The result of a selection bias, similar to the omitted variable bias, is that the estimator is inconsistent (Heckman, 1979). In our case, the risk of selection bias might potentially exist because players are not randomly assigned to teams but based on their specific criteria. On the other hand, no data is systematically omitted for any player or team, which is due to the fact that the data is objectively collected by the league and not the teams. This means that the results from our data represent exactly what happened in the NHL during the period from 2008/2009 to 2018/2019. Overall, a selection bias is a potential challenge to this study, and the randomness of the sample should not be taken as given.

1.3 Large outliers

The third assumption of the fixed effect model is that large outliers are unlikely. The definition of an outlier is not clear, but it could be characterized by the fact that it is clearly distinguishable from other values or that the addition of an outlier can change the estimation results. Naturally, such outliers can be a legitimate part of the data. Other possibilities are that decimal points were moved during input, digits were added or omitted by mistake or that whole entries were forgotten. In the context of this work, the challenge of possible outliers is shown in tables 1 and 4. These show that none of the included variables show maximum or minimum values that are clearly distinguishable from the others. Also, the standard deviation of none of the variables is significantly larger than its mean, which also indicates that this is not a problem of the data set.

1.4 Multicollinearity

The final main criterion for a fixed effects regression is that there is no multicollinearity in the data. Perfect multicollinearity refers to a situation where two variables have a perfect relationship, a rather rare situation. A more frequent challenge is imperfect multicollinearity, or near perfect multicollinearity, between two variables indicating that there is a strong relationship between variables. This can lead to the model becoming strong in its explanatory power or sensitive to including and dropping variables (Brooks, 2019). Appendices 2 and 3 present the correlations between all variables included in the models for H1 and H2. It is apparent that there is a strong relationship in the first model between the two main explanatory variables *HHI Index* and *Share of Europeans*. A higher share of Europeans is strongly correlated to the cultural concentration in a team. This high correlation is not surprising since the HHI Index is conditional on the share of European players after its inclusion in the model. The next highest correlation is between the *Team Cap Hit (in %)* and *Team Age* which lies at 0.46. In the H2 models, the variables most correlated are also *Cap Hit (in %)* and *Player Age* with a score of 0.36. Following Brooks (2019), neither of these correlations are high enough to suspect issues of multicollinearity in the data.

1.5 Serial correlation

Serial correlation, or autocorrelation, means that the error terms must be uncorrelated over time. A situation that is quite likely to occur in time-series data as the unit heterogeneity is an unobserved effect that likely appears in all observations of a unit. Autocorrelation does not lead to estimators being biased but it affects their efficiency (Brooks, 2019). There is a high chance that the error terms are serially correlated over time in this study as well. This opinion stems from the fact that some unobserved error of one observation is correlated with the unobserved error of another observation because they belong to the same unit. An example could be the offensive performance of players, which can influence the playing time of the next year which in return is likely to increase the performance again. Therefore, it is to conclude, that there is a high chance that these unobserved observations in the error term are correlated with each other over time when they belong to the same unit.

1.6 Measurement error

Measurement errors can appear if data is collected falsely or if the collected information is entered into the database incorrectly. Such measurement errors can influence the outcome of the regressions in a similar matter as large outliers. The data used in this study has been previously used in other studies and is collected from official databases of the National Hockey League. It is, of course, not possible to rule out any potential errors in measuring or entering the data into the database. However, there is no plausible reason to believe that systematic measurement errors by the objective data gatherer, the NHL, or other errors of inclusion are at play in the available database.

1.7 Reverse/simultaneous causality

The final criterion for internal validity is reverse causality, which occurs when the dependent variable Y causes the explanatory variable X to change. If the cause-and-effect direction is both ways between X and Y, then it is described as simultaneous causality. Such a misdirection of cause and effect can lead coefficient estimates to be biased and not representative of the actual relationship. In our case, this would imply that, for H1, the offensive and overall team influence the cultural concentration and share of Europeans. In H2, the number of individual goals scored would influence the time a player shares on ice with culturally homogenous players. Both scenarios do not make logical sense, which allows for the statement that reverse or simultaneous causality is not a problem for this study.

Appendix 2: Correlation matrix of all variables included in model 1

Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) GPG	1.00								
(2) HHI	-0.02	1.00							
(3) Share of Europeans	0.01	-0.98	1.00						
(4) Average Team Age	-0.01	-0.11	0.14	1.00					
(5) Team Cap Hit (in %)	0.08	-0.11	0.13	0.46	1.00				
(6) Opp. Cap Hit (in %)	0.00	0.02	-0.02	-0.03	-0.02	1.00			
(7) Home	0.08	-0.02	0.02	0.01	0.01	0.00	1.00		
(8) Team Name	0.05	0.03	-0.03	0.01	0.08	-0.01	-0.01	1.00	
(9) Season	0.03	-0.09	0.09	-0.24	-0.08	-0.01	-0.00	0.01	1.00

Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Goal Difference	1.00								
(2) HHI	-0.02	1.00							
(3) Share of Europeans	0.02	-0.98	1.00						
(4) Average Team Age	0.02	-0.11	0.14	1.00					
(5) Team Cap Hit (in %)	0.09	-0.11	0.13	0.46	1.00				
(6) Opp. Cap Hit (in %)	0.01	0.02	-0.02	-0.03	-0.02	1.00			
(7) Home	0.12	-0.02	0.02	0.01	0.01	0.00	1.00		
(8) Team Name	0.05	0.03	-0.03	0.01	0.08	-0.01	-0.01	1.00	
(9) Season	0.01	-0.09	0.09	-0.24	-0.08	-0.01	-0.00	0.01	1.00

Notes. Appendix 2 presents the correlation matrix between all variables included in the model of hypothesis 1 on a team level. The first matrix is for the estimation on the number of goals scored, the second on the difference between goals scored and conceived. A strong relationship can be seen between the two main explanatory variables HHI Index and Share of Europeans. This strong correlation is expected as the concentration of nationality groups (HHI Index) is conditional on the share of European players. The next highest correlation is between the Team Cap Hit (in %) and Team Age at 0.46. Neither of the correlations are high enough to suspect issues of multicollinearity in the data.

Appendix 3: Correlation matrix of all variables included in models 2 and 3

Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Points per Game	1.00								
(2) Offensive Peers	-0.06	1.00							
(3) Player Age	-0.00	0.04	1.00						
(4) Player Position	-0.02	-0.05	0.10	1.00					
(5) Time on Ice	0.28	-0.14	0.04	-0.10	1.00				
(6) Cap Hit (in %)	0.24	-0.12	0.36	-0.03	0.54	1.00			
(7) Peer Cap Hit (in %)	0.17	-0.16	0.01	0.02	0.43	0.29	1.00		
(8) Player Name	0.01	-0.07	-0.00	-0.06	0.03	0.02	-0.00	1.00	
(9) Season	-0.02	-0.08	-0.01	-0.10	-0.04	-0.02	0.02	0.01	1.00

Notes. Appendix 3 presents the correlation matrix between all variables included in the model of hypothesis 2 and 3 on a player level. The strongest correlation can be seen between the Cap Hit (in %) and Player Age with a score of 0.36 Neither of the correlations are high enough to suspect issues of multicollinearity in the data.

Appendix 4: Regression results on PPG comparing players from all nationality groups

	(1) NA	(2) CZE/SVK	(3) SWE	(4) FIN	(5) RUS	(6) DACH
Number of Peers of The same Nationality						
1 Peer	-0.013**	0.022	-0.006	0.010	-0.031	-0.115*
	(0.007)	(0.021)	(0.014)	(0.026)	(0.046)	(0.067)
2 Peers	-0.017***	-0.129**	-0.062*	-0.030	-0.273	0.006
	(0.007)	(0.054)	(0.042)	(0.108)	(0.374)	(0.012)
Player Age	-0.000	0.003	-0.000	-0.006	0.000	0.006
	(0.002)	(0.013)	(0.011)	(0.011)	(0.058)	(0.012)
Player Position						
Left-Wing	0.031	-0.095	0.085*			
	(0.027)	(0.062)	(0.050)			
Right-Wing	0.048*	0.055	0.280	0.570		
	(0.027)	(0.054)	(0.186)	(0.419)		
Time on Ice	0.000***	0.000***	0.000***	0.000***	0.000***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cap Hit (%)	0.012***	0.024***	0.011***	0.018***	0.021**	0.010**
	(0.001)	(0.004)	(0.004)	(0.006)	(0.008)	(0.004)
Peer Cap Hit (%)	0.025***	0.023***	0.032***	0.021*	0.042**	0.023*
	(0.002)	(0.008)	(0.007)	(0.011)	(0.017)	(0.013)
_cons	0.038	-0.095	0.034	-0.007	0.071	-0.173
	(0.058)	(0.367)	(0.283)	(0.318)	(1.323)	(0.309)
Season Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Team Fixed Effects	No	No	No	No	No	No
Player Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	178,158	14,618	18,742	8,353	3,607	5,714
R-squared	0.119	0.072	0.107	0.089	0.155	0.092

Notes. Standard errors are in parentheses *** p<.01, ** p<05, * p<0.1. Multi-way fixed effects regression at the level of player and game. The dependent variables are points per game (Points). The sample differentiates between players of all six nationality groups and spans across the seasons 2008/2009 to 2018/2019. The main explanatory variable is the number of peers of the same nationality that a player shared most time with on ice in a game. Each column estimates the model including various control variables as well as season and player fixed effects. NA stands for North America, CZE/SVK includes players from the Czech Republic and Slovakia. SWE stands for Sweden, FIN for Finland and RUS for Russia. DACH includes players from the German speaking countries Germany, Austria, and Switzerland.

Appendix 5: Regression results on PPG and Win % on a team-game level

	(1) PPG	(2) PPG	(3) PPG	(4) PPG	(5) Win %	(6) Win %	(7) Win %	(8) Win %
HHI Index	2.895**	3.660**	3.520**	2.986	0.143	0.108	0.100	0.066
	(1.379)	(1.578.)	(1.577)	(2.023)	(0.157)	(0.177)	(0.176)	(0.230)
Share of Europeans	0.047***	0.054**	0.048**	0.045	0.003	0.002	0.001	-0.001
	(0.018)	(0.021)	(0.021)	(0.028)	(0.002)	(0.003)	(0.002)	(0.003)
Average Team Age			-0.113**	-0.303***			-0.016***	-0.035***
			(0.050)	(0.085)			(0.006)	(0.010)
Team Cap Size (in %)			0.473***	0.592***			0.051***	0.058***
			(0.073)	(0.123)			(0.008)	(0.014)
Opp. Team Cap Size (in %)			-0.123	0.014			0.005	0.006
			(0.047)	(0.047)			(0.005)	(0.005)
Home Game			0.894***	0.908***			0.094***	0.095***
			(0.077)	(0.077)			(0.009)	(0.009)
_cons	9.189***	9.265***	9.530***	14.288***	0.687***	0.662***	0.786***	1.196***
	(0.576)	(0.718)	(1.473)	(2.376)	(0.065)	(0.080)	(0.165)	(0.266)
Season Fixed Effects	No	Yes	Yes	n.a.	No	Yes	Yes	n.a.
Team Fixed Effects	No	Yes	Yes	n.a.	No	Yes	Yes	n.a.
Team x Season Fixed Effects	No	No	No	Yes	No	No	No	Yes
Observations	13,097	13,097	13,097	13,097	13,097	13,097	13,097	13,097
R-squared	0.001	0.020	0.033	0.064	0.001	0.012	0.024	0.056

Notes. Standard errors are in parentheses *** p<.01, ** p<.05, * p<0.1. Multi-way fixed effects regression at the level of team and game. The dependent variables are points per game (PPG) in specifications (1) to (4) and a teams' win percentage (Win %) in specifications (5) to (8). The sample consist of all teams and spans across the seasons 2008/2009 to 2018/2019. The main explanatory variables are HHI Index and Share of Europeans. Column (1) and (5) estimate the effect of the concentration of nationalities (HHI Index) and the relative share of European players (Share of Europeans) on the team performance measures. Column (2) and (6) include season and team fixed effects. Columns (3) and (7) add various control variables to the equation and represent the preferred specifications. Columns (4) and (8) replace both fixed effects with a combination of both, team x season fixed effects.

Appendix 6: Regression results on GPG and Goal Difference on a team-game level excluding Share of Europeans

	(1) GPG	(2) GPG	(3) GPG	(4) GPG	(5) Goal Diff	(6) Goal Diff	(7) Goal Diff	(8) Goal Diff
HHI Index	-0.047	-0.001	0.030	-0.044	-0.087	-0.173	-0.122	-0.224
	(0.057)	(0.066)	(0.066)	(0.123)	(0.083)	(0.096)	(0.095)	(0.177)
Average Team Age			-0.048***	-0.100***			-0.061**	-0.125***
			(0.018)	(0.032)			(0.026)	(0.046)
Team Cap Size (in %)			0.153***	0.164***			0.235***	0.214***
			(0.027)	(0.046)			(0.038)	(0.066)
Opp. Team Cap Size (in %)			-0.021	-0.019			0.002	0.005
			(0.017)	(0.017)			(0.025)	(0.025)
Home Game			0.303***	0.300***			0.572***	0.565***
			(0.028)	(0.029)			(0.041)	(0.041)
_cons	2.817***	2.765***	3.359***	4.795***	0.109	0.205*	0.527	2.466**
	(0.065)	(0.076)	(0.475)	(0.813)	(0.095)	(0.109)	(0.684)	(1.167)
Season Fixed Effects	No	Yes	Yes	n.a.	No	Yes	Yes	n.a.
Team Fixed Effects	No	Yes	Yes	n.a.	No	Yes	Yes	n.a.
Team x Season Fixed Effects	No	No	No	Yes	No	No	No	Yes
Observations	13,097	13,097	13,097	13,097	13,097	13,097	13,097	13,097
R-squared	0.000	0.017	0.028	0.056	0.000	0.016	0.033	0.064

Notes. Standard errors are in parentheses *** p<.01, ** p<.05, * p<0.1. Multi-way fixed effects regression at the level of team and game. The dependent variables are goals per game (PPG) in specifications (1) to (4) and the difference between goals scored and conceived (Goal Diff) in specifications (5) to (8). The sample consist of all teams and spans across the seasons 2008/2009 to 2018/2019. The main explanatory variable is only HHI Index. Column (1) and (5) estimate the effect of the concentration of nationalities (HHI Index) and the relative share of European players (Share of Europeans) on the team performance measures. Column (2) and (6) include season and team fixed effects. Columns (3) and (7) add various control variables to the equation and represent the preferred specifications. Columns (4) and (8) replace both fixed effects with a combination of both, team x season fixed effects.

Appendix 7: Regression results on GPG and Goal Difference with pre-season performance as a measure of team performance

	(1) GPG	(2) GPG	(3) GPG	(4) GPG	(5) Goal Diff	(6) Goal Diff	(7) Goal Diff	(8) Goal Diff
HHI Index	0.660***	0.621**	0.593**	0.143	0.435	0.419	0.335	0.109
	(0.252)	(0.290)	(0.289)	(0.371)	(0.363)	(0.420)	(0.415)	(0.533)
Share of Europeans	-0.019***	-0.017**	-0.016**	-0.005	-0.013	-0.014	-0.011	-0.004
	(0.006)	(0.008)	(0.008)	(0.010)	(0.009)	(0.011)	(0.011)	(0.014)
Average Team Age			0.008	-0.010			0.018	0.011
			(0.016)	(0.027)			(0.023)	(0.039)
Goals Pre-Season			0.027***	0.045***			0.043***	0.051***
			(0.004)	(0.008)			(0.006)	(0.011)
Opp. Goals Pre-Season			-0.001	-0.001			0.000	-0.000
			(0.001)	(0.001)			(0.002)	(0.002)
Home Game			0.321***	0.314***			0.571***	0.567***
			(0.028)	(0.028)			(0.041)	(0.041)
_cons	3.366***	3.273***	3.568***	3.767***	0.433	0.520	2.200***	2.130*
	(0.206)	(0.258)	(0.554)	(0.856)	(0.296)	(0.373)	(0.796)	(1.230)
Season Fixed Effects	No	Yes	Yes	n.a.	No	Yes	Yes	n.a.
Team Fixed Effects	No	Yes	Yes	n.a.	No	Yes	Yes	n.a.
Team x Season Fixed Effects	No	No	No	Yes	No	No	No	Yes
Observations	13,097	13,097	13,097	13,097	13,097	13,097	13,097	13,097
R-squared	0.001	0.014	0.025	0.062	0.001	0.014	0.035	0.073

Notes. Standard errors are in parentheses *** p<.01, ** p<.05, * p<0.1. Multi-way fixed effects regression at the level of team and game. The dependent variables are goals per game (GPG) in specifications (1) to (4) and the difference between the number of goals scored and conceived (Goal Diff) in specifications (5) to (8). The sample consist of all teams and spans across the seasons 2008/2009 to 2018/2019. The main explanatory variables are HHI Index and Share of Europeans. Column (1) and (5) estimate the effect of the concentration of nationalities (HHI Index) and the relative share of European players (Share of Europeans) on the team performance measures. Column (2) and (6) include season and team fixed effects. Columns (3) and (7) add various control variables to the equation and represent the preferred specifications. The difference to the main models is that team skill is estimated using the goals and opponent goals scored in the previous season which replaces the average team cap hit (in %). Columns (4) and (8) replace both fixed effects with a combination of both, team x season fixed effects.

Appendix 8: Regression results on GPG and Goal Difference with average team salary as a measure of team performance

	(1) GPG	(2) GPG	(3) GPG	(4) GPG	(5) Goal Diff	(6) Goal Diff	(7) Goal Diff	(8) Goal Diff
HHI Index	0.378**	0.427**	0.367*	0.392	0.320	0.284	0.338	0.288
	(0.170)	(0.194)	(0.203)	(0.262)	(0.240)	(0.279)	(0.291)	(0.375)
Share of Europeans	0.016**	0.018**	0.015*	0.018*	-0.015*	-0.017	-0.017	-0.015
	(0.007)	(0.008)	(0.008)	(0.011)	(0.009)	(0.011)	(0.012)	(0.015)
Average Team Age			0.022	-0.024			0.035	-0.019
			(0.017)	(0.030)			(0.025)	(0.042)
Average Team Salary			0.013**	0.009			0.011	0.005
			(0.007)	(0.007)			(0.010)	(0.010)
Average Opponent Salary			-0.019	-0.019			0.001	0.004
			(0.040)	(0.040)			(0.058)	(0.058)
Home Game			0.291***	0.294***			0.578***	0.575***
			(0.030)	(0.030)			(0.043)	(0.043)
_cons	3.291***	3.356***	2.476***	3.979***	0.617**	0.760**	-0.550	0.864
	(0.211)	(0.260)	(0.567)	(0.926)	(0.291)	(0.375)	(0.814)	(1.326)
Season Fixed Effects	No	Yes	Yes	n.a.	No	Yes	Yes	n.a.
Team Fixed Effects	No	Yes	Yes	n.a.	No	Yes	Yes	n.a.
Team x Season Fixed Effects	No	No	No	Yes	No	No	No	Yes
Observations	13,097	13,097	13,097	13,097	13,097	13,097	13,097	13,097
R-squared	0.000	0.015	0.024	0.054	0.000	0.016	0.031	0.065

Notes. Standard errors are in parentheses *** p<.01, ** p<.05, * p<0.1. Multi-way fixed effects regression at the level of team and game. The dependent variables are goals per game (GPG) in specifications (1) to (4) and the difference between the number of goals scored and conceived (Goal Diff) in specifications (5) to (8). The sample consist of all teams and spans across the seasons 2008/2009 to 2018/2019. The main explanatory variables are HHI Index and Share of Europeans. Column (1) and (5) estimate the effect of the concentration of nationalities (HHI Index) and the relative share of European players (Share of Europeans) on the team performance measures. Column (2) and (6) include season and team fixed effects. Columns (3) and (7) add various control variables to the equation and represent the preferred specifications. The difference to the main models is that team skill is estimated using the absolute average team and opponent salary which replaces the average team cap hit (in %). Columns (4) and (8) replace both fixed effects with a combination of both, team x season fixed effects.

Appendix 9: Regression results on GPG on a player-game level

	(1) Goals	(2) Goals	(3) Goals	(4) Goals	(5) Goals	(6) Goals
Number of Peers of the same nationality						
1 Peer	-0.011***	-0.010***	-0.010***	0.004	-0.010***	-0.007**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)
2 Peers	-0.037***	-0.036***	-0.037***	-0.005**	-0.017***	-0.010**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)
Player Age				-0.006***		-0.001
				(0.000)		(0.001)
Player Position						
Left-Wing				0.021***		0.027*
				(0.002)		(0.014)
Right-Wing				0.027***		0.039***
				(0.002)		(0.015)
Time on Ice				0.000***		0.000***
				(0.000)		(0.000)
Cap Hit (%)				0.012***		0.005***
				(0.000)		(0.001)
Peer Cap Hit (%)				0.017***		0.012***
				(0.001)		(0.001)
_cons	0.215***	0.215***	0.215***	0.064***	0.206***	0.030
	(0.002)	(0.002)	(0.002)	(0.008)	(0.002)	(0.034)
Season Fixed Effects	No	Yes	Yes	Yes	Yes	Yes
Team Fixed Effects	No	No	Yes	Yes	No	No
Player Fixed Effects	No	No	No	No	Yes	Yes
Observations	312,873	312,873	312,873	243,144	312,873	243,111
R-squared	0.001	0.002	0.003	0.041	0.049	0.054

Notes. Standard errors are in parentheses *** p<.01, ** p<.05, * p<0.1. Multi-way fixed effects regression at the level of player and game. The dependent variables are goals per game (Goals). The sample consist of all players from the six nationality groups and spans across the seasons 2008/2009 to 2018/2019. The main explanatory variable is the number of peers of the same nationality that a player shared most time with on ice in a game. Column (1) estimates the effect of the number of culturally similar players on the number of goals scored in a game. Columns (2) and (3) include first season then team fixed effects. Column (4) adds various control variables to the equation. In columns (5) and (6), team fixed effects are replaced by player fixed effects.

Appendix 10: Regression results on APG on a player-game level

	(1) Assists	(2) Assists	(3) Assists	(4) Assists	(5) Assists	(6) Assists
Number of Peers of the same Nationality						
1 Peer	-0.017*** (0.003)	-0.017*** (0.003)	-0.016*** (0.003)	-0.001 (0.003)	-0.004 (0.004)	-0.003 (0.004)
2 Peers	-0.063*** (0.002)	-0.063*** (0.002)	-0.065*** (0.002)	-0.009*** (0.003)	-0.014*** (0.004)	-0.007 (0.005)
Player Age				-0.005*** (0.000)		0.001 (0.001)
Player Position						
Left-Wing				-0.021*** (0.003)		0.012 (0.016)
Right-Wing				-0.009*** (0.003)		-0.003 (0.018)
Time on Ice				0.000*** (0.000)		0.000*** (0.000)
Cap Hit (%)				0.019*** (0.000)		0.009*** (0.001)
Peer Cap Hit (%)				0.023*** (0.001)		0.013*** (0.002)
_cons	0.303*** (0.002)	0.303*** (0.002)	0.304*** (0.002)	0.033*** (0.009)	0.279*** (0.003)	0.002 (0.040)
Observations	312873	312873	312873	243144	312828	243111
R-squared	0.003	0.003	0.004	0.063	0.075	0.082
Season Fixed Effects	No	Yes	Yes	Yes	Yes	Yes
Team Fixed Effects	No	No	Yes	Yes	No	No
Player Fixed Effects	No	No	No	No	Yes	Yes

Notes. Standard errors are in parentheses *** p<.01, ** p<.05, * p<0.1. Multi-way fixed effects regression at the level of player and game. The dependent variables are assists per game (Assists). The sample consist of all players from the six nationality groups and spans across the seasons 2008/2009 to 2018/2019. The main explanatory variable is the number of peers of the same nationality that a player shared most time with on ice in a game. Column (1) estimates the effect of the number of culturally similar players on the number of goals scored in a game. Columns (2) and (3) include first season then team fixed effects. Column (4) adds various control variables to the equation. In columns (5) and (6), team fixed effects are replaced by player fixed effects.

Appendix 11: Regression results on GPG for players from North America and Europe

	European Players				**North American Players**			
	(1) Goals	(2) Goals	(3) Goals	(4) Goals	(5) Goals	(6) Goals	(7) Goals	(8) Goals
Number of Peers of the same Nationality								
1 Peer	0.008	-0.010*	-0.001	-0.003	-0.032***	-0.008*	-0.015***	-0.009**
	(0.005)	(0.006)	(0.006)	(0.007)	(0.004)	(0.004)	(0.004)	(0.004)
2 Peers	-0.009	-0.022	-0.029*	-0.031	-0.057***	-0.009**	-0.021***	-0.011**
	(0.017)	(0.019)	(0.018)	(0.020)	(0.004)	(0.004)	(0.004)	(0.004)
Player Age		-0.006***		-0.001		-0.005***		-0.001
		(0.001)		(0.003)		(0.000)		(0.001)
Player Positions								
Left-Wing		0.036***		0.053**		0.016***		0.005
		(0.005)		(0.023)		(0.003)		(0.018)
Right-Wing		0.053***		0.002		0.017***		0.055***
		(0.005)		(0.030)		(0.003)		(0.018)
Time on Ice		0.000***		0.000***		0.000***		0.000***
		(0.000)		(0.000)		(0.000)		(0.000)
Cap Hit (%)		0.013***		0.006***		0.011***		0.004***
		(0.001)		(0.001)		(0.000)		(0.001)
Peer Cap Hit (%)		0.017***		0.013***		0.017***		0.011***
		(0.002)		(0.003)		(0.001)		(0.002)
_cons	0.213***	0.065***	0.214***	0.001	0.234***	0.074***	0.207***	0.038
	(0.002)	(0.015)	(0.002)	(0.080)	(0.003)	(0.009)	(0.003)	(0.038)
Season Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Team Fixed Effects	Yes	Yes	No	No	Yes	Yes	No	No
Player Fixed Effects	No	No	Yes	Yes	No	No	Yes	Yes
Observations	82219	64961	82204	64953	230654	178183	230623	178158
R-squared	0.005	0.036	0.045	0.049	0.004	0.043	0.051	0.055

Notes. Standard errors are in parentheses *** p<.01, ** p<.05, * p<0.1. Multi-way fixed effects regression at the level of player and game. The dependent variables are goals per game (Goals). The sample differentiates between players the five European country groups in specifications (1) to (4) and North American players in columns (5) to (8). It spans across the seasons 2008/2009 to 2018/2019. The main explanatory variable is the number of peers of the same nationality that a player shared most time with on ice in a game. Columns (1) and (5) estimates the effect of the number of culturally similar players on the number of goals scored in a game and includes season and team fixed effects. Columns (2) and (6) add various control variables to the equation. Columns (3), (4), (7) and (8) run the same equations as the ones before but replace team fixed effects with player fixed effects.

Appendix 12: Regression results on APG for players from North America and Europe

	European Players				North American Players			
	(1) Assists	(2) Assists	(3) Assists	(4) Assists	(5) Assists	(6) Assists	(7) Assists	(8) Assists
Number of Peers of the same Nationality								
1 Peer	0.054***	0.030***	0.008	0.003	-0.035***	-0.006	-0.009**	-0.004
	(0.006)	(0.007)	(0.007)	(0.008)	(0.004)	(0.005)	(0.004)	(0.005)
2 Peers	0.002	-0.027	-0.048**	-0.063***	-0.072***	-0.009*	-0.017***	-0.007
	(0.021)	(0.023)	(0.021)	(0.024)	(0.004)	(0.005)	(0.004)	(0.005)
Player Age		-0.004***		0.002		-0.005***		0.001
		(0.001)		(0.004)		(0.000)		(0.002)
Player Position								
Left-Wing		-0.030***		-0.010		-0.019***		0.026
		(0.006)		(0.028)		(0.003)		(0.021)
Right-Wing		0.000		0.023		-0.011***		-0.008
		(0.006)		(0.036)		(0.003)		(0.020)
Time on Ice		0.000***		0.000***		0.000***		0.000***
		(0.000)		(0.000)		(0.000)		(0.000)
Cap Hit (%)		0.018***		0.010***		0.018***		0.008***
		(0.001)		(0.001)		(0.000)		(0.001)
Peer Cap Hit (%)		0.025***		0.012***		0.020***		0.013***
		(0.003)		(0.003)		(0.002)		(0.002)
_cons	0.306***	0.014	0.313***	-0.012	0.310***	0.046***	0.270***	0.000
	(0.002)	(0.019)	(0.002)	(0.097)	(0.004)	(0.011)	(0.004)	(0.044)
Season Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Team Fixed Effects	Yes	Yes	No	No	Yes	Yes	No	No
Player Fixed Effects	No	No	Yes	Yes	No	No	Yes	Yes
Observations	82,219	64,961	82,219	64,961	230,654	178,183	230,654	178,183
R-squared	0.013	0.058	0.070	0.075	0.006	0.065	0.074	0.083

Notes. Standard errors are in parentheses *** p<.01, ** p<.05, * p<0.1. Multi-way fixed effects regression at the level of player and game. The dependent variables are assists per game (Assists). The sample differentiates between players the five European country groups in specifications (1) to (4) and North American players in columns (5) to (8). It spans across the seasons 2008/2009 to 2018/2019. The main explanatory variable is the number of peers of the same nationality that a player shared most time with on ice in a game. Columns (1) and (5) estimates the effect of the number of culturally similar players on the number of goals scored in a game and includes season and team fixed effects. Columns (2) and (6) add various control variables to the equation. Columns (3), (4), (7) and (8) run the same equations as the ones before but replace team fixed effects with player fixed effects.