Lancaster University Management School
Working Paper
2009/015

The Effects of Coworker Heterogeneity on Firm-Level Output: Assessing the Impacts of Cultural and Language Diversity in the National Hockey League

Leo Kahane, Neil Longley and Rob Simmons

The Department of Economics
Lancaster University Management School
Lancaster LA1 4YX
UK

The Effects of Coworker Heterogeneity on Firm-Level Output: Assessing the Impacts of Cultural and Language Diversity in the National Hockey League

February, 2009

Leo Kahane: Department of Economics, California State University, East Bay

Neil Longley: Isenberg School of Management, University of Massachusetts, Amherst

Robert Simmons: Lancaster University Management School, UK

1. Introduction

The trend towards more globalized product and factor markets has relevance for economists across a wide variety of economics sub-fields, including macroeconomic policy analysis, international trade policy, industrial organization, public finance, and labor economics. In studying issues related to globalization, economic analyses have generally taken what could be termed an institutional perspective, in that the unit of analysis is typically at some aggregated level, such as "governments", or the "firm". For example, with the latter, most research has focused on the impersonal interactions of the firm in the market, rather than, say, analyzing any intra-firm impacts of globalization.

As a result, there is a dearth of literature examining such issues as the micro-level effects of culture and language on firm output. This absence is likely due to data limitations. To systematically examine the effects of culture and language within a firm, one would need a host of detailed data – the nationalities of all workers must be identifiable, each worker's skills and output must be measureable, as well as the collective output of the firm, and all other factors of production must be able to be held constant.

In general, it would be very difficult to find examples of organizations where such data are publicly available. There is an exception, however, and that is the professional sport industry in North America. This paper focuses on one particular segment of that industry – the National Hockey League (NHL). The NHL was chosen for three reasons. First, it employs a relatively high (compared to other North American sports leagues) proportion of foreign (i.e. non-North American) players. Second, these foreign players come from a wide range of European countries, thus bringing together on NHL teams a mix

of many cultures and languages. Lastly, the nature of the game of hockey is such that on-ice teammate interaction effects are strong, and much greater, for example, than in a sport like baseball.

Our paper constructs an empirical model that measures the effects of workplace diversity on firm performance. In particular, it examines the extent to which team output in the NHL is impacted by the presence of foreign players on the team – examining both the number of foreign players on a team, and, even more importantly, the composition of the foreign player group. With the latter, the question is this: all else equal, does the specific nationality mix on a team matter? In other words, for a given number of foreign players on a team, is it better to have all foreign players from a single country, or should teams attempt to employ foreign players from a variety of countries?

2. The Market for "Teammates"

The work of Lazear (1999b) provides a theoretical foundation for this paper. In Lazear's seminal work, he notes how the topics of "globalization" and "teamwork" are ever present in today's business media, and proceeds to examine how the intersection of these issues might affect the labor market decisions of the firm.[1]

The trend towards integrated world markets – on both the product and input sides – has led to the rise of what Lazear calls the "global firm". He defines the global firm as one whose employees originate from a variety of different cultures or countries. Lazear argues

[1] In an earlier work, Lazear (1999a) examined the issue of cross-cultural assimilation and language acquisition by immigrants. The basic premise of that work was extended to the firm in his subsequent (1999b) article

that this international mixing of employees can create difficulties for a firm that would otherwise not be present. Because workers within a global firm have different cultures, legal systems, and language, the firm must now incur additional costs to integrate these workers into a cohesive team. Conversely, these integration costs are not incurred by firms whose employees are homogenous.

The question, then, that naturally arises is what benefits do culturally-diverse work teams provide? Any benefits must be sufficiently large so as to overcome the additional integration costs that the firm incurs. Lazear argues that there are a number of factors that determine the magnitude of these gains to a firm. Perhaps most importantly, the more disjoint the skill sets of the worker groups, the greater the benefits of diversity. If Group A has different skills than Group B, there are gains to the firm of hiring some of both workers, rather than hiring exclusively from Group A or exclusively from Group B. In practical terms, some skill and knowledge sets might be culture-specific – one country or culture might be more likely to have certain skills, for whatever reason, than another. Thus, firms whose employees represent a diverse range of cultures will have greater collective knowledge and skill within the organization. Conversely, if the skill and knowledge sets of Group A and Group B overlap, the gains from employing a diverse workforce are diminished.

In the extreme, if Group A and Group B have identical knowledge and skill sets, there are no gains from a diverse workforce. Given the positive integration costs incurred by hiring a diverse workforce, the firm would always choose in this situation to hire from only one of the groups, and not from both. In general, then, combining workers from

diverse cultural groups into a work team will be most beneficial when those groups have complementary skills, rather than substitutable skills.[2]

However, Lazear also argues that the existence of complementary skills is not, in itself, sufficient to hire a diverse workforce. When a diverse workforce is hired, workers must be able to communicate with each other, necessitating that workers speak a common language. Lazear focuses largely on developing a theoretical model, and only minimally examines any empirical evidence. He claims that the question is not really amenable to empirical analysis, stating "At the empirical level, it is difficult, if not impossible, to obtain direct measures of who works with whom. Even if this could be done, it would then be necessary to obtain information on the characteristics, skills, and knowledge of the individuals who are engaged in team production". He then goes on to take what is – by his own admission – a less accurate and less ambitious empirical approach, and examines trading patterns by country, where he finds that countries are more likely to trade with other countries who speak the same language.

We generally agree with Lazear of the near impossibility of obtaining the intra-firm data that would be required to properly test the assertions of the theoretical model. However, there does exist an important exception to this generalization. Certain segments of the professional sports industry in North America – particularly the National Hockey League (NHL) – have characteristics and data availability that allow for empirical testing. NHL teams are, in Lazear's terms, global firms – they employ workers (players) from a variety of non-English-speaking countries, all of whom are integrated into a single work

[2] Other researchers have also shown there to be gains from diversity, although none have done so in the context of Lazear's questions

group (i.e. team). Furthermore, the data needed to properly conduct the empirical tests is available: we know who works with whom, since team rosters are directly observable; team output is unidimensional and easily measureable (i.e. team winning percent); the quality of individual team members is measureable and publicly available, and; the wage rates of all workers are public information. In addition, a wealth of data exists on a host of other control variables necessary to conduct the empirical analysis.

By using the NHL as the focus, we hope to overcome some of the limitations of other empirical work on diversity that has followed Lazear. The general lack of availability of detailed, firm-level, data on workers has led some researchers to examine the issue at a more aggregated level. For example, Ottaviano and Peri (2006) found that the productivity of US-born citizens was higher in those US cities in which there was a higher percentage of foreign-born residents, implying that the productivity of the native population rises as the workforce become more culturally diverse. In a somewhat similar vein, Ottaviano and Peri (2005) find that average wages and employment density were higher in US cities that had greater linguistic diversity, again lending support for the hypothesis that the benefits of cultural diversity exceed the costs. The limitation of these studies, in the context of this paper, is that the unit of analysis is at such a highly aggregated level (i.e. that of "cities") that no insights can be gained into the intra-firm dynamics of cultural diversity, and hence no insights can be gained pertaining to the formation of optimal work teams within a firm.

There have been a few attempts to examine the issue at a more intra-firm level. Both Hamilton, Nickerson and Owan (2004)[3] and Leonard and Levine (2004) use proprietary

[3] Hamilton, Nickerson, Owan (2004) is actually designed very similarly to Hamilton, Nickerson, Owan (2003), but the latter does not explicitly consider the impacts of cultural diversity

data sets to measure the impacts of worker diversity – including cultural diversity – on intra-firm performance . Hamilton et. al, using data from the Koret Company, a garment maker in California, measure worker heterogeneity along a variety of dimensions, including ability, age and ethnicity. They find that work teams that had greater diversity in skills across workers were more productive – hypothesizing that this may be attributable to lower-skill workers learning from higher-skill workers – but that teams that had a greater diversity in age were less productive. With respect to ethnicity, they found that teams comprised of only Hispanic workers were more productive than other teams, all else equal. Leonard and Levine (2004) used data from an undisclosed firm in the retail industry, and examine worker diversity across that firm's more than 800 stores. They find that sales (and sales growth) variations across stores were generally not predicted by the degree of gender or ethnic diversity of those stores, but that sales were negatively affected by age diversity.

While the proprietary data sets of Hamilton et. al and Leonard and Levine allow them to empirically examine intra-firm cultural diversity in ways not otherwise possible, these studies still possess significant limitations; limitations which we believe can be better overcome by using professional sports as a focus.

First, both of the above studies use data that pertains to only a single company, raising questions about whether their findings are simply artifacts of those companies' unique set of characteristics, or whether their findings have more general applicability. Second, both examined organizations that generally employ low-skilled labor. In Hamilton et al., it was sewers in a garment factory, and in Leonard and Levine it was employees of a retail store. Relatedly, these firms, while "global" by Lazear's definition, are a very specific type of global firm. While these firms employ workers born in other countries, it is likely

that these workers did not emigrate to take these jobs, or were internationally recruited in any way – they were individuals who were presumably already in the county and simply happened to find employment with this firm. They would generally not possess any unique or specialized skills or abilities. This again raises questions as to whether the findings are applicable to global firms that employ more high-skilled international workers. Third, there is also a question as to the actual extent of coworker interaction in the firms studied. While the sewers in the garment manufacturer did work in formal teams, the nature of the tasks involved did not require sophisticated interaction processes. In Leonard and Levine's retail stores, there were no work teams as such – all employees of a particular store were simply considered to come from a single team.

In addition to these more general critiques, questions and concerns arise with both papers regarding the specific way in which cultural diversity is measured. In Hamilton et. al., there are nine different ethnic groups represented in the garment factory, but their empirical analyses uses only two dummy variables to capture the ethnicity factor – one to designate all-Hispanic teams, and the other to designate two-thirds Hispanic teams. This parsimonious approach fails to capture the richness and complexity of the issue, since it does not measure the impacts of all ethnicities on all teams, nor does it measure the possible interaction affects amongst the ethnicities.

Leonard and Levine's measure is stronger, as they employ a Herfindahl index to measure the concentration of ethnicities on a team. However, other issues remain. Data limitations necessitate that they use very broad ethnic categories – for example, they use a category of "Asians" to capture individuals from a wide variety of Asia-Pacific countries

(Korea, Vietnam, the Philippines, etc.), despite the obvious cultural and language differences across these countries.

It is our contention that the NHL data set used in this paper is "cleaner" than the ones used in these studies, and will allow for a more detailed and rich analysis of intra-firm cultural integration. Not only is the information content on employees broader and deeper, NHL teams are much more global in the sense that they actively recruit workers from other countries, and are not simply employing US residents who just happen to have family roots in other countries, however long ago that may have been. Furthermore, unlike, say, factory or retail workers, NHL teams employ high-skilled labor, purchased in a world market, whose interactions with each other are essential to team output and success.

There exists very little literature that uses the sports industry to study teammate effects in firms. Idson and Kahane (2000, 2004) are an exception – they examine teammate effects on compensation in the NHL, and find that coworker attributes do affect individual player pay. Their models, however, did not address the specific question examined in this paper – i.e. that relating to the mix and concentration of foreign players on a team, and the corresponding diversity benefits that may accrue to the team.

3. Foreign Players in the NHL

A Trend towards Europeans: 1970 to Present

Of the four major North American professional sports leagues, the NHL has the most ethnically diverse player group. During the 2007-08 season, players from 20 different countries played at least one game in the NHL. North Americans (Canadians and

Americans) still comprise the majority of players in the NHL, but the number of international players has been steadily rising over the past 30 years. In the 2007-08 season, approximately two-thirds of players were North American (Canadian or American), while one-third were European. Within the European group there is also considerable diversity – 4% of all NHL players were from Russia, 6% were from Sweden, 12% were from the Czech Republic, and 4% were from Finland, with the remainder being from a variety of European countries.

The first European players began arriving in the NHL in the early 1970s.[4] The most significant early players were Borje Salming and Inge Hammarstrom from Sweden, who joined the Toronto Maple Leafs in 1973-74. During the 1970s, the number of Europeans grew steadily, albeit slowly. The NHL's interest in Europeans during the 1970s was partially spurred by the presence of the rival World Hockey Association (WHA), which operated from 1972-73 to 1978-79. The rival league viewed Europe, particularly Sweden, as an untapped source of player talent, and saw the importation of such players as a means to more effectively compete with the established NHL.[5]

One team in the WHA – the Winnipeg Jets – was particularly aggressive in its pursuit of Europeans. The Jets were the dominant team in the WHA, appearing in five championship finals during the league's seven-year existence, and winning the championship in three of those years. During the Jet's 1976-77 season, 10 of the team's

[4] During the 1970s and before, there were a few prominent NHL players that were born in Europe (for example, Stan Mikita in Czechoslovakia, Ivan Boldirev in Yugoslavia, Juha Widing in Finland), but emigrated to Canada at a young age. For the purposes of this discussion, players such as these are not considered "European".

[5] This strategy by the WHA is similar to what occurred with rival leagues (to the NFL) in American football, where both the All-American Football Conference in the late 1940s and the American Football League in the 1960s actively recruited an underutilized player group—in both those cases, the underutilized group was African American players.

players were European, an unheard of number at the time. Nine of these players were Swedish, with the other Finnish, illustrative of the fact that most early European imports to the NHL tended to predominantly come from Sweden, with a few from Finland. Throughout most of the 1980s, Swedes and Finns made up the majority of European players in the NHL. Their numbers were supplemented by a small number of Czechoslovakian players, all of whom had defected from the Soviet-bloc country. Perhaps the most high-profile of these defectors were the three Stastny brothers – all of whom left Czechoslovakia in 1980 to join the Quebec Nordiques of the NHL.

Two players who later went on to become stars in the NHL – Alexandre Mogilny and Sergei Federov – were the first Soviets to defect, in 1989 and 1990 respectively. Federov actually defected while with the Soviet hockey team played at the Goodwill Games in Seattle. At about the same time as these defections, the Soviet Union began allowing a select number of veteran players (i.e. those supposedly well past their prime) to play in the NHL. In 1989-90, four star players -- Slava Fetisov, Igor Larionov, Sergei Makarov, and Vladimir Krutov, joined NHL teams. With the collapse of the Soviet Union in 1991, the number of players from Soviet-bloc countries began to increase dramatically during the early 1990s, as players could now voluntarily move to North America.

Table 1 illustrates the increasing prominence of Europeans in the NHL over the past 40 years by examining the NHL player draft. During the 1970s, only 3% of the players drafted were Europeans, a number which rose to 14% during the 1980s, to 27% during the 1990s, and to 32% during the 2000s. Table 2 shows how the distribution of these players across European countries has changed through time. The early dominance of the Swedes during the 1970s and 1980s was gradually eroded by the large-scale entry of Russian and

Czech/Slovak players. For example, during the immediate post-Soviet period of the 1990s, the number of Russians drafted jumped to 37% (of all Europeans drafted), up from only 6% during the 1970s and 13% during the 1980s. During the 2000s, Russia has continued to have the most players drafted of any European country, although their numbers have dropped somewhat from the heights of the 1990s.

In the current NHL, five countries – Russia, the Czech Republic, Slovakia, Sweden and Finland – have a significant critical mass of players in the league. Two other countries, Germany and Switzerland, while still having relatively few players in the league – have seen their numbers steadily grow over the past decade. This diversity across countries, and this critical mass of players in five countries, makes the NHL an attractive outlet to empirically test coworker heterogeneity theories.

The Expected Gains from Diversity in the NHL

In general, and following Lazear's work, one would expect there to be gains to NHL teams from employing an internationally diverse workforce. First, and most obvious, by opening the labor market to include European players (as opposed to relying solely on North American players), teams broaden the pool from which to choose. More importantly, at least for the purposes of this paper, is that European players may, in Lazear's terms, have skills that are somewhat disjoint from North America players. In other words, the skills sets are not completely overlapping. Furthermore, within Europe, players from each country may possess somewhat different skill sets.

In Europe, training methods for youth players are somewhat different than in North America, with a much greater emphasis in Europe on basic skill development, like skating,

stickhandling, passing, and shooting. In North America, greater emphasis is placed on actually playing games, as opposed to practicing fundamentals. Accordingly, many observers view European NHL players as having, on average, higher levels of basic skill development than many North Americans. Conversely, however, there is a perception amongst many, rightly or wrongly, that European players tend to play the game with a less physical presence, including body-checking and fighting. Since the style of play in the NHL tends to be much more oriented towards this physical play than hockey played elsewhere in the world, North American players have a comparative advantage in this area. Adding further complexity to the issue is that Europeans are not a homogenous group. Training methods and styles-of-play do tend to differ across European countries (although not as much as the differences between Europe and North America). For example, Finnish players are often considered to be more physical than, say, Swedish players.

These potential gains to NHL teams from employing a diverse workforce must be then balanced against the increased costs of hiring the diverse workforce. Since European players possess a culture and language that is different from the dominant North American culture, NHL teams incur costs to hiring Europeans. However, not only must NHL teams decide how many Europeans to hire, they must decide which types of Europeans. For example, if a team hires three Europeans, is there any difference, all else equal, between hiring three Swedes, versus one Swede, one Russian, and one Finn? Hiring from multiple European countries potentially increases the diversity benefits, but it also increases the potential communication costs. English is the universal language of the NHL, so a Swede and Russian must communicate in English. This increases the possibility that communication errors may develop. One would suspect the probability of such errors

would be less when two Swedes communicate, even if such communication were in English.

In addition, players from different countries may impose different integration costs on the team. For example, the average Swede might be viewed as having better English skills than, say, an average Russian, and may be also more "North-Americanized", and hence better able to integrate into the new environment. Also, there are considerable cultural and political differences between the European countries, and in some cases, long-standing historical tensions exist. For example, the Swedes come from a very small (in terms of population) country, known for its egalitarianism and socialist governments. The Russian players grew-up largely under communism, as did the Czechs, while the Germans grew up under a capitalist success story of the post World War II era. Europe has a long history, and many underlying tensions still exist, possibly making for integration of various European players more difficult. For example, the effective control of (then) Czechoslovakia by the Soviets in the Iron Curtain era could possibly result in Czech and Slovak players having residual negative feelings towards their Russian counterparts.

The notion that some teams specialize in players from certain countries has received some attention in the sport media, and is echoed in some anecdotal opinions of players and coaches. A 2006 *Sports Illustrated* article focused on the issue, and noted that the New York Rangers had six Czech players on their (20-player) roster, thus devoting 30% of their roster to players from a nation that comprise only 10% of all NHL players. Jaromir Jagr, the (then) star player for the Rangers, and one of the best players in NHL history was quoted as saying "If you want Europeans on your team, you're better to have six from one country

than one from six countries. You know each other's styles. You can talk easily to each other".

The *Sports Illustrated* article goes on to discuss how Dallas and Detroit followed similar strategies: Dallas with Finns, and Detroit with Swedes. Dallas's General Manager was described as being delighted with what was termed the "industrious, low-maintenance" Finns, and employed six of the NHL's thirty-eight Finns that were in the NHL that season. Similarly, Detroit employed 16% of the Swedes in the League, and Detroit's GM commented that "it wasn't a master plan to come up with all these Swedes, but once you do have a certain player, it makes sense to complement him with a similar type of player".

4. Model

In order to test for the possible effects of teammate diversity on team-level production in the NHL we employ the follow general model:

$$\textit{Team performance}_{it} = f(\textit{team skills}_{it}, \textit{coaching skill}_{it}, \textit{team diversity}_{it}, \textit{dummy for post-lockout}_{t}) \quad (1)$$

where the subscripts *i* and *t* refer to team *i* and season *t*, respectively. Our set of performance metrics captures a team's performance in the regular season, measured by win per cent or points percentage (over maximum) or difference between goals scored and goals conceded.

One issue that complicates measurement of regular season performance is the rule change relating to overtime that occurred between the pre- and post-lockout periods. Prior to the 2004-05 lockout, if a game was tied at the end of regulation each team would receive

a point in the standings and a five-minute 'sudden death' overtime period was played.[6] If one team scored in the overtime period it would receive a second point in the standings. If, on the other hand, the teams remained tied after the overtime period, the game was recorded as a tie and no additional points would be awarded. Following the lockout, a new rule was implemented whereby teams that remained tied at the end of the sudden death period would then participate in a 'shoot-out' with the winner of the shoot out receiving the second point in the standings.[7] With the implementation of the shoot-out, the end-of-season point totals between the pre- and post-lockout periods are not strictly comparable. In order to work around this problem we employ several alternative measures for team performance. One is simply the team's win percentage (*Win %*), computed as the number of wins divided by 82 (the number of regular season games). A second measure employed is the percentage of total possible points the team earned in a season (*Points %*). This is computed as the number of points earned in the regular season divided by 164 (the number of points possible). A third measure we use is the difference between the number of goals-scored and goals-allowed during the regular season, (*Goals Difference*). While none of these measures are entirely immune to the change in the way in which points were awarded in the pre- vs. post-lockout periods we believe that they should serve as a reasonable indicator for the regular season performance of teams.[8]

[6] In all seasons covered by this study a team that wins in regulation receives two points in the standings, the loser receiving zero points.

[7] The shoot-out consists of each team taking turns with a 'one-on-one' between a player from one team and the goalie from the other team. The winner in a three-round contest wins the game. If the shoot-out remains tied in the three-round contest, then the shoot-out continues until one teams scores and the other team does not.

[8] Another possible complicating factor may be that the team strategies may have been affected with the implementation of the shootout. It is our hope that such a possibility would not have a bearing on the potential effects of teammate diversity on production.

Team Skill Levels and Coaching

Two approaches are used in this paper to measure team skills. One uses team-averaged career skill vectors.[9] For example, we compute team-averaged values for career points per game (excluding the current season) and use this measure as a proxy for a team's scoring skill at the beginning of the season. In constructing this measure we weight each player's career points per game values by their share of minutes played during the current season.[10] Other things equal, teams with greater scoring ability should perform better. Similar measures are constructed for other team-level inputs such as the plus/minus statistic and penalty minutes per game.[11] We expect that, *ceteris paribus*, teams with larger career plus/minus values should perform better as it may indicate teams with better two-way play. As for penalty minutes per game, this measure has two opposing effects on a team's performance. First, teams that receive many penalties may perform poorly as they find themselves short-handed much of the time. On the hand, teams with higher career penalty minutes per game may be indicative of teams that play aggressively which, in turn, may lead to greater performance. In addition to these skater measures, we include a measure of goalie input equal to the weighted value of the career save percentage for each team's

[9] Others using this approach in sports research include Berri, Schmidt and Brook (2006), Hofler and Payne (1997, 2006), Zak et al (1979).

[10] Two points with regard to the team's lineup. First, player movement after the start of the season may complicate matters. Our approach is to consider the player's team to be the team with which he started the season. This approach seems appropriate given that players that do move during the season tend to do so well after the midpoint of the season. Second, some players move up and down between their NHL team and its minor league affiliate. In order to deal with this matter, we include in our weighted calculations of skill vectors only the top 18 skaters (i.e., non-goalies) in terms of total minutes played during a season.

[11] The plus/minus statistic is a crude attempt to measure the offensive *and* defensive skill of players. It is computed by awarding a player a +1 if he is on the ice when his team scores an even-strength goal. The player is awarded a -1 if he is on the ice when his team allows an even-strength goal.

goalies. All else equal, teams with better goalies (i.e., higher save percentages) should perform better.

A second approach to measuring team skills is to use their relative payroll. Specifically, we compute for each team the ratio of their current season's payroll to the league's average payroll for the current season.[12] The underlying assumption here is that individual player's talents are reflected in their salaries, albeit imperfectly due to the various labor market restrictions that apply in the National Hockey League. By summing these salaries across players on a team we get a measure of the team's overall talent. Thus, teams with greater relative payrolls should have relatively greater skill and, other things equal, would have a relative better performance. We also include the squared value of a team's relative payroll to allow for diminishing returns of performance to payroll, as proposed by Simmons and Forrest (2004). One advantage of this approach over the use of team-averaged skill vectors is that relative payrolls have the potential to include skills that are difficult to measure, such as player leadership skills and mentoring abilities. One possible disadvantage to using relative payrolls, however, is that it may be the case that player salaries do not accurately reflect playing skills. This disconnection between salaries and skills may arise, for example, if there are differences in salary negotiation abilities across players or if there are considerable differences in restrictions to player mobility between teams.[13]

[12] Others using this approach include Kahane (2005), Forrest and Simmons (2004), Szymanski and Longley (2001), Dawson et al (2000) and Szymanski (2000).

[13] For example, players who have not achieved free agency may be underpaid, given their skills. See Krautmann et al (2008) for empirical evidence of this monopsony exploitation result across all four major North American sports leagues (baseball, basketball, football and hockey).

Our final team skill measure is a variable equal to the number of top draft picks playing on a team.[14] The aim here is to better identify the effects of the very high-impact/young 'star' players, for whom salary and/or past career statistics may not be indicative of their value.

Lastly, the measure used to incorporate coaching input is the head coach's career win percent, excluding the current season.[15] Other things equal, it is expected that better coaches should be able to increase a team's performance.

Team Diversity

We employ two measures of team diversity of players. First, based on the country of birth for players, we sort players into five major geographic groups: North America (Canada and USA), Czech Republic/Slovak Republic, Sweden, Finland and Russia. We then compute a Herfindahl-Hirschman index (HHI) based on the shares of a team's players belonging to these groups.[16]

One problem with the HHI measure as described above is that the vast majority of players (approximately 67%) are born in North America. Given the construction of the HHI, with its squaring of the groups' shares, the index becomes dominated by the North

[14] We only consider the draft years from 1994 to 2000 with the assumption these would be relatively younger players whose salary and/or career skill measures may not truly reflect their impact on the team. We also include only players who have not been traded more than once and who played in at least half the team's games that year. The idea here is that players that haven't been in the lineup for at least half the season and/or have been traded more than once in a relatively short career are probably no longer considered "high impact" players.

[15] One issue with this measure is the fact that rookie coaches will have no value for career win percent. In order to avoid losing observations due to missing data on this measure we have assigned rookie coaches the average value of all previously rookie coaches included in our data set. Regressions run that excluded rookie coaches produced virtually the same results for estimated coefficients for the other variables.

[16] We also computed the HHI with the USA and Canada separately. Regressions using either version of these HHI measures produced similar results.

American group. As a means of dealing with this issue we simultaneously include a measure equal to the share of a team's players that are not from North America, (*Relative European Share*). With this added covariate the HHI effect is now conditional on the proportion of a team's players who are European. Taken together, these two measures should tell us which teams have relatively high concentrations of non-North American players and, given those relative concentration measures, which teams have a large share of players coming from a single European country.

The data used to estimate Equation 1 are from the 2001-02 through the 2007-08 NHL seasons for all 30 teams, excluding the 2004-05 season which was lost due to the player lockout. The resulting sample size is 180 observations; descriptive statistics and data sources are reported in Table 3.

5. Results

The results are reported in Table 4, which shows fixed-effects regression results for regular season performance. Across the various team performance metrics as dependent variables, the best fitting equations are for *Win %*. *Points per game* and *Relative payroll* each have significant coefficients in the equations for *Win %* (columns 1 and 2), with little difference in goodness of fit. This suggests that *Relative Payroll* is indeed a useful proxy for team talent in a given season, given a coefficient that is significant at the 1 percent level. We note, though, that the squared term in *Relative Payroll* does not have a significant coefficient and so we do not identify the property of diminishing returns of performance to payroll that Simmons and Forrest (2004) found for other North American major leagues. In addition to *Relative Payroll* or *Points Per Game* we find a statistically significant effect of

Top Draft Players for the full set of team performance dependent variables. A higher number of top draft picks appearing on a team roster does appear to raise team performance, given payroll or points per game. In contrast we find no significant roles for our chosen measure of head coach ability, *Coach Win %* or for the supplementary indicators of player talent, *Penalty Minutes Per Game*, *Plus/Minus Per Game* and *Save %.* In this respect, either *Points Per Game* or *Relative Payroll* are sufficient predictors of team performance, with no additional, significant role for our selected measures.

Our focus in the results is on team diversity, and we find that both *HHI* and Relative *European Share* have positive and significant (at 5% or better) coefficients. In column 2 of Table 4, with *Win %* as dependent variable and *Relative Payroll* as the selected talent proxy, we obtain coefficients that are significant at even the 1% level. There are two main implications of our results on diversity. First, if two teams have the same degree of group concentration shown in its *HHI*, then the team with the greater share of European players performs better. Second, if two teams have the same share of European players then the team with a higher degree of group concentration performs better. These implications follow for any chosen measure of team performance displayed in Table 4. Overall, then, teams that are made up of mostly homogeneous European players appear to gain an advantage in team performance.

Some intuition for our findings on team diversity can be given by an example. Suppose that Team A has 30% North Americans, 20% Czechs, 20% Swedes and 10% each from Finland, Russia and Slovakia. This yields an *HHI* score of 0.20. In contrast, Team B has 20% each of North Americans, Czechs, Swedes, Finns and Russians. This also gives an

HHI score of 0.20. Our results indicate Team B should perform better than Team A (more Europeans for a given HHI).

Now consider a Team C that has 20% North Americans and 40% each of Swedes and Russians. Our model predicts that Team C will perform better than Team B. This is because team C has a higher concentration of Europeans even though it has the same total number of Europeans as Team B.

As an additional point, when we exclude *Relative European Share* but retain *HHI* as a covariate, we find that the coefficient on *HHI* becomes insignificant. How can we reconcile these disparate findings? Note that if collinearity of covariates were a problem then we would expect the coefficients on these two diversity variables to be insignificant. The explanation comes in the fact that our two measures of diversity are related, in that teams that have fewer Europeans will clearly have a lower value of *Relative European Share* but will also have a higher value of *HHI*. This is because *HHI* is picking up the high concentration of North Americans; one minus *Relative European Share* gives the percentage of North Americans on a team roster. Hence, teams can have high scores for *HHI* in different ways: either a team has very few Europeans, or a team may have many Europeans, most of which come from the same country. Teams that have many Europeans who originate from several countries will tend to have the lowest scores for *HHI*.

Thus, if *Relative European Share* is excluded from the regressions, then *HHI* is aggregating the two separate and opposing effects just noted. These confounding influences deliver an insignificant coefficient on *HHI*. When *Relative European Share* is included in the models, we can account for cases where *HHI* is high simply because there are many North Americans (and few Europeans) on a team. Our incorporation of *Relative European*

Share into the model facilitates an influence, found to be statistically significant, for the concentration level within the European group obtained through the now significant effect of *HHI*.

As a final point, some literature has examined a role for measures of payroll inequality to affect team performance in Major League Baseball, given size of relative payroll. For example, both Depken (2000) using a Herfindahl measure of payroll inequality, and Wiseman and Chatterjee (2003), using a Gini coefficient as measure of inequality, found that increased pay inequality was associated with worse team performance. To ensure that our NHL findings our robust to measures of payroll inequality, we thus added a Gini coefficient to our model. We find first, that the effects of *HHI* and *Relative European Share* remain positive and significant when the Gini coefficient is an additional covariate. Also, the coefficient on the Gini coefficient is itself insignificant, suggesting that pay inequality is not a predictor of team performance in the NHL.

6. Summary and Conclusions

The statistical results of our paper show that team output in the NHL does indeed seem to be impacted by measures of player diversity and concentration. Overall, teams that are made up of mostly homogeneous European players appear to gain an advantage in team performance. These results were robust to various definitions of both output and team skills. The findings support the popular conventional wisdom, where the recent successes of teams like Detroit (Swedes), Dallas (Finns) and the New York Rangers (Czechs), have sometimes been attributed, in part, to the high concentration levels on these teams.

The results imply that there can be benefits to a firm in expanding its workforce beyond the local, homogenous, group. The presence of foreign workers, like Europeans in the NHL, allow the firm to broaden its collective sets of skills and abilities, beyond what would be found if it only employed domestic workers.

However, the results also indicate that NHL teams perform better when their European players tend to come from the same country, rather than being spread across many European countries. This would support the notion that communication costs are always a factor when attempting to diversify– when teams have players from multiple European countries, language and cultural barriers my start to override any increase in diversity benefits. More broadly, this implies that firms need to be cognizant of the *way* in which they diversify – our results suggest that the gains from diversity may be greatest when the foreign component of the workforce has, within itself, a higher degree of homogeneity.

Table 1

Europeans Drafted by NHL Teams

Source: Adapted from National Hockey League Official Guide and Record Book 2008

	2000s	***1990s***	***1980s***	***1970s***
Europeans Drafted, as a Percent of All Players Drafted	32	27	14	3

Table 2
Europeans Drafted, by Country, as a Percent of all Europeans Drafted

	2000s	***1990s***	***1980s***	***1970s***
Russia/Soviet Union	30	37	13	6
Sweden	22	20	38	56
Czech/Slovak	22	24	23	6
Finland	18	14	21	25
Germany	3	2	3	4
Switzerland	4	2	0	2
Norway	0	1	1	0
Denmark	0	0	1	0

Source: Adapted from National Hockey League Official Guide and Record Book 2008

Table 3

Descriptive Statistics

(n=180)

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
Win %	0.468	0.100	0.232	0.707
Points %	0.543	0.091	0.329	0.756
Goals Difference	0	41.976	-113	107
Relative Payroll	1.000	0.281	0.390	1.739
Points Per Game	0.444	0.069	0.243	0.675
Penalty Minutes Per Game	0.778	0.134	0.485	1.223
Plus/Minus Per Game	-0.001	0.064	-0.205	0.169
Save %	0.908	0.008	0.886	0.935
Coach Win %	0.533	0.074	0.302	0.800
HHI	0.512	0.127	0.265	0.796
Relative European Share	1.000	0.347	0.331	1.953
Top Draft Players	0.261	0.489	0	2

All data are from NHL.com apart from relative payrolls
which were found at USATODAY.com

Table 4

Fixed-Effects Regressions for Regular Season Performance

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Win %	Win %	Points %	Points %	Goals Difference	Goals Difference
Relative Payroll		0.312*		0.250		145.5*
		(0.178)		(0.166)		(72.59)
Relative Payroll Squared		-0.102		-0.0758		-48.44
		(0.0853)		(0.0785)		(36.30)
Points Per Game	0.415**		0.376***		181.4***	
	(0.153)		(0.127)		(48.38)	
Penalty Minutes Per Game	-0.0203		-0.0136		8.213	
	(0.0666)		(0.0646)		(28.03)	
Plus/Minus Per Game	-0.0703		-0.00969		-24.88	
	(0.144)		(0.124)		(44.14)	
Save %	0.0988		0.726		223.1	
	(0.897)		(0.795)		(317.3)	
Coach Win %	0.120	0.0860	0.0827	0.0700	45.86	35.31
	(0.0949)	(0.0991)	(0.0915)	(0.0965)	(42.68)	(43.57)
HHI	0.566**	0.403*	0.618***	0.489**	315.7***	234.9**
	(0.229)	(0.201)	(0.216)	(0.200)	(89.85)	(90.92)
Relative European Share	0.213**	0.146*	0.224***	0.173**	116.5***	82.28**
	(0.0822)	(0.0718)	(0.0787)	(0.0724)	(33.76)	(34.46)
Post-lockout	0.0475***	0.0372**	0.00637	0.000265	-10.40	-15.41**
	(0.0140)	(0.0172)	(0.0133)	(0.0161)	(6.226)	(7.323)
Top Draft Players	0.0329**	0.0448***	0.0416***	0.0507***	24.57***	29.44***
	(0.0159)	(0.0138)	(0.0137)	(0.0131)	(6.387)	(6.635)
Constant	-0.390	-0.162	-0.872	-0.100	-593.3*	-314.6***
	(0.855)	(0.182)	(0.740)	(0.185)	(293.6)	(83.66)
Observations	180	180	180	180	180	180
Teams	30	30	30	30	30	30
R-squared	0.267	0.273	0.180	0.177	0.194	0.199

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses

References

Berri, David J., Martin B. Schmidt and Stacey Brook, (2006), *The Wages of Wins: Taking Measure of the Many Myths in Modern Sport,*: Stanford University Press.

Dawson, Peter, Stephen Dobson and Bill Gerrard, (2000). "Estimating Coaching Efficiency in Professional Team Sports: Evidence from English Association Football." *Scottish Journal of Political Economy*, v.47, n.4: 399-421.

Forrest, David and Rob Simmons (2004), "Buying Success: Team Salaries and Performance in North American and European Sports Leagues," Chapter 10 of R. Fort and J. Fizel (eds.) *International Sports Economics Comparisons*, p 123-140 (Westport, Connecticut: Praeger).

Hamilton, Barton, Nickerson, Jack and Hideo Owan (2004) "Diversity and Productivity in Production Teams", Working Paper, Social Science Research Network

_____ (2003) "Team Incentives and Worker Heterogeneity: An Empirical Analysis of the Impact of Teams on Productivity and Participation", *Journal of Political Economy* 111(3): 465-497.

Hofler, Richard A. and James E. Payne (2006). "Efficiency in the National Basketball Association: A Stochastic Frontier Approach with Panel Data." *Managerial and Decision Economics*, vol.27, n.4:279-285.

_____ (1997), "Measuring Efficiency in the National Basketball Association." *Economics Letters*, vol.55, no.8: 293-299.

Idson, Todd and Leo Kahane (2004) "Teammate Effects on Pay", *Applied Economic Letters* 12: 731-733.

_____ (2000) "Team Effects on Compensation: An Application to Salary Determination in the National Hockey League", *Economic Inquiry* 2: 345-357.

Kahane, Leo H. (2005). "Production Efficiency and Discriminatory Hiring Practices in the National Hockey League: A Stochastic Frontier Approach," *Review of Industrial Organization*, vol. 27, no. 1: 47-71

Lazear, Edward (1999a) "Culture and Language", *Journal of Political Economy* 107(6): S95-S126

Lazear, Edward (1999b) "Globalisation and the Market for Team-mates", *Economic Journal* 109: C15-C40

Leonard, Jonathan and David Ian Levine (2004) “Diversity, Discrimination, and Performance", Institute of Industrial Relations Working Paper Series, iirwps-091-03. (University of California, Berkeley)

Ottaviano, Gianmarco and Giovanni Peri (2006) “The Economic Value of Cultural Diversity: Evidence from US cities”, *Journal of Economic Geography* 6(1): 9-44.

_____(2005) “Cities and Cultures”, *Journal of Urban Economics* 58(2): 304-337.

Szymanski, Stefan (2000). “A Market Test for Discrimination in the English Professional Soccer Leagues.” *Journal of Political Economy*, v. 108, n. 3:590-603.

Szymanski, Stefan and Neil Longley (2001). “A Market Test for Discrimination in the National Hockey League.” (mimeo).

Wiseman, Frederick and Sangit Chatterjee, (2003) "Team payroll and team performance in major league baseball: 1985-2002," *Economics Bulletin*, Vol. 1 no. 2 pp. 1-10.

Zak, T.A., C.J. Huang and JJ. Siegfried (1979), “Production Efficiency: the Case of Professional Basketball.” *Journal of Business*, vol.52, no.3: 379-392.