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

June 2011

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Acknowledgements: The authors thank Rachel Ridler and Angus Holford for their research assistance. The authors also thank two anonymous referees and the Editor for their helpful comments on earlier drafts of the paper. Any errors are ours.

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Review of Economics and Statistics Just Accepted MS.
doi:10.1162/REST_a_00221

Abstract

The paper uses data from the National Hockey League (NHL) to consider the potential gains to firms from employing culturally-diverse work teams. It finds that the presence of foreign workers does increase firm-level performance – NHL teams that employed a higher proportion of European players performed better. However, the results also indicate that teams perform better when their European players come from the same country, rather than being spread across many European countries – when teams have players from a wide array of European countries, integration costs associated with language and cultural differences may start to override any gains from diversity.

JEL Codes: J240; L830

Review of Economics and Statistics Just Accepted MS.
doi:10.1162/REST_a_00221

"I've got Americans. I've got Canadians. I've got Finns and Swedes and Czechs. If I ever get fired, I can always get a job at the United Nations."

Herb Brooks, as the N.Y. Rangers' coach

I. 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

Review of Economics and Statistics Just Accepted MS.
doi:10.1162/REST_a_00221

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?

II. 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 that this international mixing of employees can create difficulties for a firm that would otherwise not be

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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.[2]

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

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doi:10.1162/REST_a_00221

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 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 our testing ground, 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 were 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.

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doi:10.1162/REST_a_00221

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) and Leonard and Levine (2004) use proprietary data sets to measure the impacts of worker diversity – including cultural diversity – on intra-firm performance.[3] Hamilton et. al, using data from a California garment maker, find that work teams (of sewers) 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. 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 pertain 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

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doi:10.1162/REST_a_00221

organizations that generally employ low-skilled labor. It is likely that foreign workers in these organizations did not emigrate to take these jobs, or were internationally recruited in any way – they were individuals who were presumably already in the country and simply happened to find employment with this firm. 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,

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doi:10.1162/REST_a_00221

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.

III. 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

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doi:10.1162/REST_a_00221

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], and during that decade 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, and to a lesser extent, Finland, 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]

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. 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. 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. 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%

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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.

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doi:10.1162/REST_a_00221

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.

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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 examined 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, 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

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talk easily to each other". Similarly, the article also noted that Detroit employed 16% of the Swedes in the League, and quoted Detroit's GM as saying "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".

IV. Model and Data

Production Functions in Sport

To test for the possible effects of worker diversity on firm-level production in the NHL, we employ the following general model:

$$Firm\ performance_{it} = f(worker\ skills_{it}, managerial\ ability_{it}, worker\ diversity_{it}) \quad (1)$$

where the subscripts *i* and *t* refer to team *i* and season *t*, respectively. In essence, firm (i.e. team) performance in any given season is a function of the collective skills of the team's workers (i.e. players), the abilities of the firm's management (i.e. coaches) to effectively organize and direct the workers, and the degree of cultural diversity amongst the workers. The first two factors – worker skills and managerial ability – are control mechanisms which allow us to then isolate on our focus variable, the level of player diversity on a team.[6]

This approach we take to specifying the production function is consistent with the general approach found in the literature pertaining to the economics of sport. This literature is now quite vast, and spans over 50 years, dating back to Rottenburg's (1956) seminal article on the economics of baseball labor markets. Sport-related research can now be found in numerous sub-disciplines within economics, including industrial organization, labor economics, and public finance. While there are many reasons for the growth in this literature, one important factor is

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that the sport industry provides a level of data availability not typically seen in other sectors, thus allowing economists to empirically test theories in a manner not possible in most other industries.

The use of production functions within the sport context is well developed, and Dobson and Goddard (2001) provide a comprehensive overview of the literature in this area. They note, at the most basic and fundamental level, players and managers/coaches are the primary factor inputs, with on-field team performance being the measure of output. The first to formally estimate a sport production function was Scully (1974), who modeled the win percent of baseball clubs as a function of various player, management, and team characteristics. Scully's ultimate goal was to measure the marginal revenue product of baseball players, thus allowing him to determine the degree of monopsonistic exploitation that baseball players were suffering in that era. His general approach became the norm in the literature for these types of studies, with his methodology adopted by many subsequent researchers.[7]

Dependent Variable

As is standard in the sport literature, we measure team/firm performance by the team's sporting (i.e. on-ice) success during a given regular season. With the NHL, the issue is complicated somewhat by a 2005 rule change that altered the way in which points were awarded. Up until the 2003-04 season, if a game was tied at the end of regulation time, each team would receive a point in the standings and a five-minute 'sudden death' overtime period was then played.[8] 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. However, beginning with the 2005-

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06 season (the 2004-05 season was cancelled due to a labor dispute), 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 – thus, games could no longer end in a tie.[9] With the implementation of the shoot-out, the end-of-season point totals between the pre- and post-lockout periods are not strictly comparable.

Our data set spans these two different periods, thus in order to account for any potential effects that this rule change might have, 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.[10]

Control Variables: Team Skill Levels and Coaching

Two approaches are used in this paper to measure team skills. One uses team-averaged career skill vectors.[11] For example, we compute team-averaged values for (NHL) 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

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points-per-game values by their share of minutes played during the current season.[12] 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.[13] 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 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.[14] 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 the payroll 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

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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.[15] A further disadvantage of using payroll is the potential for reverse causation effects – whereby a team's payroll reflects, in part, what it is willing to pay for anticipated *future* performance.[16]

Our final team skill measure is a variable equal to the number of top draft picks playing on a team.[17] 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.[18] Other things equal, it is expected that better coaches should be able to increase a team's performance.

Focus Variable: 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.[19]

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 American

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group. As a means of dealing with this issue we simultaneously include a variable measuring the share of a team's players that are not from North America (denoted as *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.

Data

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.

Table 4 provides further details on the data, and shows the mean values for each independent player performance variable, disaggregated by nationality. As discussed in Section II, Lazear argues that the more disjoint the skill sets of the various worker groups, the greater the benefits of diversity. Table 4 does reveal substantial differences between North Americans and Europeans, and also differences within the European group. First, North American players have higher levels of penalty minutes, supporting the notion that Europeans employ a less-aggressive playing style than North Americans. Simultaneously, North Americans seem to be less-skilled in the offensive aspects of the game, as evidenced by their lower-than-average values for goals, assists, and points. Within the European group, players from the both the Czech Republic/Slovakia and Russia have higher levels of goals, assists, and points per-game than do

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doi:10.1162/REST_a_00221

other players, indicating particularly high offensive skills for players from these countries. Also, while players from Sweden produce more assists than the sample mean (at the 10% level of significance), they do not produce more goals, possibly indicating the Swedes are specialists in "setting-up" others to score goals, rather than scoring themselves. Finally, players from the Czech Republic/Slovakia have higher plus/minus values, indicating these players not only possess offensive skills (which earn 'pluses'), but also possess a corresponding attention to playing sound defense (which helps avoid "minuses").

In general, then, the data in Table 4 establishes quite clearly that players from different nationalities do, in fact, possess different skill attributes, supporting Lazear's notions that skill disjointedness across groups is necessary if firms are to be benefit from diversifying their workforce. What remains to be determined, and what is tested in the following section, is whether such diversity ultimately increases firm-level output. To do so, any benefits that accrue from this broadening of the range of skills within the organization must more than offset the corresponding increased integration costs that will be incurred.

V. Results

The results are reported in Table 5, 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 %*. The variables *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. 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

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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 %.*

Our focus in the results is on team diversity, and we find that both *HHI* and *Relative European Share* have positive coefficients and are significant at 5% or better in all regressions except specification (2), where they are significant at the 10% 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 5. Overall, then, teams that are made up of mostly homogeneous European players appear to gain an advantage in team performance.[20]

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.

Although the coefficient on *HHI* is statistically significant, we should consider its economic relevance. For example, is the coefficient of 0.566 in Regression 1 plausible? With

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HHI ranging in our data set from 0.265 to 0.792, this difference results in a 0.30 difference in Win Percent between the top and bottom teams by this measure, which does not appear plausible. However, when we control for *Relative European Share* in the models, changes in *HHI* reflect changes in the concentration *within* the European group. The relevant range of *HHI* then becomes much smaller as the following example shows. Assuming a 20 player roster and 14 North Americans on the team (about the average in the league), if all 6 Europeans are from a different country, then the *HHI* is 0.505. At the other extreme, if all 6 are from the same country, the *HHI* is 0.58. Thus, the range of HHIs is much tighter (at 0.075) than it is if we do not hold the number of Europeans constant. Thus, with a coefficient on *HHI* of 0.566, the top-to-bottom difference in *HHI* (attributable to differences within the European group) results in a difference in Win Percent of 0.04245, or about 3.5 games over an 82 game season, which does appear to be more plausible than 0.30 in the naïve interpretation above.

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 this finding with the earlier positive and significant coefficient on *Relative European Share*? [21] 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*.

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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*.[22]

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 inclusion of payroll inequality, we added an intra-team Gini coefficient to our model. We find first, that the effects of *HHI* and *Relative European Share* remain positive and significant when the team Gini coefficient is an additional covariate. Also, the coefficient on the Gini measure of pay dispersion is itself insignificant.[23]

As an additional robustness check, we included measures designed to capture players' skill levels prior to joining the NHL. Specifically, we included in our basic regressions players' points-per-game for their performances in either North American college or junior leagues, or in European leagues. In all cases the coefficients of these added variables were not statistically significant, singly or jointly, and the coefficients of the remaining variables, including *Relative European Share* and *HHI*, were essentially unchanged in terms of size and significance.[24]

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VI. An Extension: Diversity Effects at the Individual Level

The above results suggest that there are two separate diversity effects in the NHL. More diversity is better, in the sense that teams that employ more foreign workers (i.e. Europeans, as designated by *Relative European Share*), relative to local (North American) workers, will tend to perform better. However, *within* this foreign worker group, diversity reduces team performance (as given by *HHI*) – i.e. when hiring foreign workers, it is better to have a higher concentration of workers from the *same* foreign country, rather than to have these foreign workers originating from many different countries. This latter result is likely due to integration costs. The more languages and cultures represented in a firm's workforce, the greater the communication costs, and the more difficult it will be to develop a harmonized and cohesive workforce.

While *Relative European Share* was included in the Table 5 regressions largely as a control variable (to ensure HHI measured concentration within the *European* group only), its consistently positive and significant coefficient across the various specifications raises a related question as to what is driving this effect. The reasons are not entirely straightforward, and warrant further investigation. Initially, one might be inclined to explain the finding by the fact that Europeans are generally more productive players than North Americans – recall that Table 4 shows Europeans outperform North Americans across a wide range of performance measures (goals, assists, points, plus/minus). However, these impacts are already controlled-for in our model – teams that employ more Europeans will already tend to have higher (beginning-of-season) team-averaged values for *Points per Game* in Table 5. Thus, the consistently positive and significant coefficient on *Relative European Share* is due to something beyond the fact that the measureable skills of Europeans tend to be greater than that of North Americans. A second possible explanation may relate to specialization: teams with more European players

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(particularly Czechs/Slovaks and Russians) may be better able to divide their labor, with European players specializing in scoring and North American specializing in physical play.[25]

A third possible explanation, and our focus in this section, is that the presence of Europeans on a team increases the productivities of North American players on that team. This question of positive productivity spillovers from foreign workers to local workers was addressed at an aggregated level in the aforementioned work of Ottaviano and Peri (2006), who found that the productivity of US-born citizens was higher in those US cities in which there were a higher percentage of foreign-born residents, implying that the productivity of the native population rises as the workforce become more culturally diverse. In the NHL case, these spillovers could be due to direct on-ice production complementarities between European and North American players (for example, a North American winger scores more goals when playing with a highly-creative Swedish center) or could be due to more indirect effects. With the latter, the presence of European teammates may, for example, expose North American players to new training methods, to different psychological approaches to games, to different off-ice lifestyles and routines, etc. Whatever the specific source of these complementarities, the presence of Europeans could increase the productivities of North Americans beyond what was expected from the latter's career performance to date (i.e. beyond what we have already controlled-for in our Table 5 regressions). Statistically, this complementarity effects would then be picked-up in the *Relative European Share* variable.

To further explore these possible complementarity effects, we turn our focus to the individual player level, rather than the team level. We regress the performance of individual players (as measured, alternatively, by points, goals, and assists) in a given season on both the past performance of the player[26], and on the number of Europeans (*Relative European Share*) on

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the team for which he plays during that season. Table 6(a) provides the results for individual North American players, and shows that *Relative European Share* is not significant in any of the six regressions. Thus, the complementarity hypothesis – whereby the increased presence of Europeans on a team increases the productivity of their North American teammates – is not supported. North Americans, with their lower offensive-skill levels and more physical style-of-play (see Table 4) are apparently unable to take advantage of playing with more offensively-skilled European players.

However, as a further test, we perform the exact same analysis for individual European players. These results are reported in Table 6(b), and show that in three of the six specifications, *Relative European Share* is significant, albeit at the 10% level. This would indicate that the productivity of individual European players is positively related to the number of European teammates that the player has (and, conversely, to the fewer the North American teammates he has).

Thus teams that add more European players to their roster benefit in two ways, one direct and one indirect. The direct benefit is that the European players added to the roster tend to be more highly skilled than the North American players they are replacing. The indirect benefit is that by adding more European players, the productivity of *existing* Europeans is increased beyond what it would be otherwise.[27] This latter effect may be due to Europeans having greater on-ice compatibility with other Europeans (compared to their compatibility with North Americans)[28], or may be due to broader off-ice factors – for example, it may be that a greater number of Europeans on the team reduces the cultural dominance of the domestic (i.e. North American) group, thus allowing Europeans to more easily integrate, and to have less feelings of isolation and/or of being an "outsider".

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These results in Table 6(b) would seem to indicate, then, that there is in fact a complementarity effect at work on teams. However, rather than the effect being Europeans with North Americans, as was originally speculated, it is actually Europeans with other Europeans. From a statistics perspective, this effect at the individual level would explain the positive coefficient on *Relative European Share* found in Table 5 – the presence of more European teammates increases the productivities of any given European player beyond what was expected given that player's career performance to date (i.e. beyond what is controlled for in *Points per Game*). This additional complementarity effect reveals itself in the *Relative European Share* variable.

Importantly, the significance of *Relative European Share* in Table 6(b) is obtained holding HHI constant. Thus, the mere adding of European players, even if this does not change the concentration (HHI) level on the team, will increase the performance of existing Europeans on the team. However, HHI is itself also positive in three of the six regressions, indicating that individual European players perform better when they are on teams where the European players have a greater homogeneity in their countries of origin. This result at the individual level for HHI supports our findings at the team-level, as reported in Table 5.

We further refine our analysis by running a second set of player-level regressions similar to those shown in Tables 6(a) and 6(b), but with *Relative European Share* now being replaced by *Percent Same*, which is defined as the proportion of the player's teammates who are from the same country as the player. Given a player's past performance, a positive and significant coefficient on *Percent Same* would indicate that less teammate diversity would increase individual performance. These regressions were estimated by group (Table 7(a)), and then jointly with interaction effects with player country dummies (Table 7(b)). As shown in Table

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7(a), the *Percent Same* variable has a statistically significant coefficient in the points and goals regressions for European players, but not for North American players. Table 7(b) further demonstrates that some European players tend to perform better when they play with teammates from the same country. Specifically, Swedish players have significantly better points and assists performances (at the 5 percent level or better) when playing with a greater share of compatriots on a roster, for given levels of past performance. Russian players have significantly better goals records when playing with a greater share of fellow Russians on their roster, all else equal. We view these player-level results as further evidence that reduced diversity within the European group may enhance team performance, by raising the productivity of individual European players.

VII. Summary and Conclusions

The results of the paper 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.

The paper found that NHL teams that add more European players to their roster benefit in two ways. First, there is a direct benefit, in that these players are generally more highly-skilled than the North Americans they are replacing. However, there is also an indirect benefit, in that adding more Europeans increases the productivity of the team's *existing* Europeans beyond what it otherwise would be.

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

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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.

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Table 1

Europeans Drafted by NHL Teams

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

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

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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)

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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

(Source: All data are from NHL.com, apart from relative payroll which were found at USATODAY.com)

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Table 4

Difference in Means, by Nationality

Player Productivity Means, by Country of Origin*

Country of Origin	**Performance Measure**				
	Goals	*Assists*	*Points*	*Penalty Minutes*	*Plus/Minus*
USA/Canada (n = 2187)					
Mean	**0.150**	**0.246**	**0.396**	**0.895**	**-0.016**
Difference in Mean (p-value)	**-0.026 (0.000)**	**-0.049 (0.000)**	**-0.074 (0.000)**	**0.288 (0.000)**	**-0.019 (0.002)**
Czech Rep./Slovakia (n = 383)					
Mean	**0.185**	**0.302**	**0.485**	**0.608**	**0.022**
Difference in Mean (p-value)	**0.031 (0.000)**	**0.046 (0.000)**	**0.074 (0.000)**	**-0.220 (0.000)**	**0.036 (0.000)**
Sweden (n = 214)					
Mean	0.152	0.281	0.432	**0.512**	-0.009
Difference in Mean (p-value)	-0.006 (0.442)	0.021 (0.077)	0.013 (0.461)	**-0.311 (0.000)**	0.001 (0.902)
Finland (n = 124)					
Mean	0.151	0.278	0.429	**0.570**	0.001
Difference in Mean (p-value)	-0.007 (0.497)	0.017 (0.175)	0.009 (0.667)	**-0.241 (0.000)**	0.011 (0.366)
Russia (n = 187)					
Mean	**0.211**	**0.337**	**0.549**	**0.606**	0.002
Difference in Mean (p-value)	**0.056 (0.000)**	**0.080 (0.000)**	**0.138 (0.000)**	**-0.207 (0.000)**	0.012 (0.389)
Other (n = 145)					
Mean	0.158	0.255	0.416	0.781	-0.027
Difference in Mean (p-value)	-0.000 (0.994)	-0.007 (0.562)	-0.004 (0.845)	-0.022 (0.590)	-0.017 (0.181)

* Mean values are pooled across players for all seasons and are for career per game performance. The difference in means reprsents the d between the group identified and all other observations in the data set. The p-values are computed assuming unequal variances. Bolded show a difference in means that is statistically significant at the 5 percent level.

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Table 5

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

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doi:10.1162/REST_a_00221

Table 6(a)

Individual Productivity, North American Players

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	points	goals	assists	points	goals	assists
lag of dependent variable				0.208***	0.0345	0.146***
				(0.0448)	(0.0484)	(0.0469)
Relative European Share	-0.0229	0.00223	-0.0251	-0.0163	0.0128	-0.0279
	(0.0719)	(0.0317)	(0.0502)	(0.0888)	(0.0448)	(0.0589)
HHI	-0.0924	-0.00583	-0.0866	-0.0466	0.0356	-0.0702
	(0.185)	(0.0829)	(0.130)	(0.228)	(0.116)	(0.154)
Post-lockout	0.0154	0.000774	0.0147**	-0.0218*	-0.00803	-0.00901
	(0.0101)	(0.00443)	(0.00703)	(0.0126)	(0.00615)	(0.00910)
Constant	0.468***	0.149**	0.319***	0.386*	0.123	0.299**
	(0.164)	(0.0727)	(0.115)	(0.205)	(0.101)	(0.136)
Observations	2,187	2,187	2,187	1,150	1,150	1,150
R-squared	0.004	0.000	0.006	0.045	0.004	0.024
Number of Players	693	693	693	490	490	490
*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. All regressions pla						

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doi:10.1162/REST_a_00221

Table 6(b)

Individual Productivity, European Players

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	points	goals	assists	points	goals	assists
lag of dependent variable				0.277***	0.0721	0.231***
				(0.0657)	(0.0778)	(0.0646)
Relative European Share	0.163*	0.0678*	0.0951	0.151	0.0106	0.149*
	(0.0866)	(0.0402)	(0.0624)	(0.109)	(0.0501)	(0.0853)
HHI	0.451*	0.185	0.266	0.580*	0.0891	0.499**
	(0.247)	(0.115)	(0.179)	(0.306)	(0.147)	(0.234)
Post-lockout	0.0152	-0.00486	0.0201*	-0.0235	-0.0104	-0.00957
	(0.0158)	(0.00703)	(0.0114)	(0.0179)	(0.00937)	(0.0121)
Constant	0.0881	0.0176	0.0705	-0.0691	0.124	-0.153
	(0.208)	(0.0970)	(0.150)	(0.260)	(0.126)	(0.201)
Observations	1,053	1,053	1,053	568	568	568
R-squared	0.017	0.005	0.024	0.089	0.015	0.082
Number of Players	311	311	311	229	229	229

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. All regressions have player fixed ef

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doi:10.1162/REST_a_00221

Table 7(a)

Individual Productivity, Impact of Teammates from Same Country

		All Players			**North Americans**			**Europeans**	
VARIABLES	points	goals	assists	points	goals	assists	points	goals	assists
lag of dependent variable	0.231***	0.0460	0.179***	0.208***	0.0351	0.146***	0.280***	0.0657	0.238***
	(0.0378)	(0.0420)	(0.0383)	(0.0447)	(0.0482)	(0.0469)	(0.0657)	(0.0770)	(0.0648)
Percent Same	0.0469	0.0221	0.0286	-0.00491	-0.00218	0.00582	0.232**	0.105**	0.118
	(0.0555)	(0.0273)	(0.0388)	(0.0635)	(0.0318)	(0.0429)	(0.109)	(0.0493)	(0.0886)
Post-lockout	-0.0175*	-0.00787*	-0.00506	-0.0229**	-0.00716	-0.0109	-0.0110	-0.00971	0.00281
	(0.00917)	(0.00465)	(0.00650)	(0.0112)	(0.00547)	(0.00808)	(0.0156)	(0.00834)	(0.0109)
Constant	0.328***	0.150***	0.222***	0.350***	0.155***	0.232***	0.305***	0.152***	0.209***
	(0.0330)	(0.0160)	(0.0219)	(0.0442)	(0.0218)	(0.0282)	(0.0442)	(0.0213)	(0.0320)
Observations	1,718	1,718	1,718	1,150	1,150	1,150	568	568	568
R-squared	0.054	0.006	0.035	0.045	0.004	0.024	0.085	0.020	0.070
Number of Players	719	719	719	490	490	490	229	229	229
*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Player fixed-effects included.									

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Table 7(b)

Individual Productivity, with Country Interaction Effects

VARIABLES	points	goals	assists	points	goals	assists
lag of dependent variable				0.233***	0.0476	0.180***
				(0.0379)	(0.0423)	(0.0384)
Percent Same	-0.0303	-0.0122	-0.0181	-0.00782	-0.00237	0.00254
	(0.0406)	(0.0183)	(0.0285)	(0.0628)	(0.0317)	(0.0422)
Percent Same x Czech/Slovak	0.0679	0.0272	0.0407	0.161	0.0448	0.106
	(0.167)	(0.0562)	(0.130)	(0.206)	(0.101)	(0.158)
Percent Same x Swedish	0.546***	0.246**	0.300**	0.432***	0.120	0.356***
	(0.182)	(0.114)	(0.129)	(0.141)	(0.0995)	(0.134)
Percent Same x Finnish	-0.313	0.0516	-0.364	-0.688	-0.334	-0.428
	(0.566)	(0.297)	(0.341)	(0.570)	(0.281)	(0.401)
Percent Same x Russian	-0.110	0.0121	-0.122	0.276	0.195**	0.0300
	(0.162)	(0.0663)	(0.120)	(0.225)	(0.0771)	(0.186)
Percent Same x Other	0.0606	0.0999	-0.0393	0.335	0.190	0.104
	(0.159)	(0.0837)	(0.0968)	(0.338)	(0.144)	(0.244)
Post-lockout	0.0179**	0.000120	0.0178***	-0.0180**	-0.00786*	-0.00549
	(0.00793)	(0.00346)	(0.00553)	(0.00913)	(0.00469)	(0.00643)
Constant	0.439***	0.160***	0.279***	0.334***	0.150***	0.229***
	(0.0199)	(0.00892)	(0.0139)	(0.0343)	(0.0165)	(0.0223)
Observations	3,240	3,240	3,240	1,718	1,718	1,718
R-squared	0.010	0.005	0.014	0.063	0.015	0.042
Number of Players	1,003	1,003	1,003	719	719	719
*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Player fixed-effects included.						

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Footnotes

[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.

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

[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

[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.

[6] As a referee points out, an alternative way to describe our research approach is that we are determining how diversity affects the Solow residual in a firm-level regression.

[7] Out of this general stream of research a somewhat new direction emerged, one that focused more specifically on the particular role of management within the production process. As Dobson and Goddard note, the basic Scully approach is an "average" production function, as opposed to a production frontier, and hence implicitly assumes the team production occurs at maximum efficiency. In contrast, a production frontier approach acknowledges that, across teams, different

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managers/coaches will have different abilities to convert inputs (players) into a given output. In other words some managers will be more competent than others – whether due to training methods, on-field strategic decisions, motivational techniques, etc. Thus, while the production frontier identifies the technologically efficient use of inputs, in practice, varying degrees of management ability across teams means that not all teams will be on this frontier. Numerous sport-related studies have employed the production frontier approach to investigate managerial inefficiency. For example, Hofler and Payne (1996, 2006) use stochastic frontier estimation to examine the NFL and NBA, as do Dawson, Dobson, and Gerrard (2000) for English soccer; Ruggerio, Hadley, and Gustafson (1996) and Frick and Simmons (2008) employ both deterministic and stochastic frontiers to examine Major League Baseball and German soccer, respectively, while Kahane (2005) uses a stochastic frontier analysis to analyze the NHL. Kahane also employs a transcendental logarithmic production function, in addition to the Cobb Douglas function that is more typically found in the sport literature.

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

[9] The shoot-out consists of each team taking turns in a 'one-on-one' contest 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.

[10] 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.

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

[12] 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.

[13] 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.

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

[15] For example, players who have not achieved free agency may be underpaid, given their skills. See Krautmann et al (2009) for empirical evidence of this monopsony exploitation result across all four major North American sports leagues (baseball, basketball, football and hockey).

[16] Our concern here, however, is lessened in light of the work on Granger causality by Szymanski, Hall and Zimbalist (2002) that shows payroll causes performance, rather than the opposite.

[17] 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

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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.

[18] 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.

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

[20] Because the Detroit Red Wings were very successful over our sample period, and because they tended to employ a disproportionate number of Swedish players, as a robustness check we re-ran our regressions with Detroit excluded and found that HHI continued to be positive and significant in all six regressions.

[21] If there was a high degree of collinearity between *HHI* and *Relative European Share* then one or both of these variables would have statistically insignificant coefficients. But this is not the case so the two diversity variables each contribute explanatory power to the regression.

[22] As a robustness check, the regressions shown in Table 5 were re-estimated to include the interaction between *HHI* and *Relative European Share*. These new regressions produced estimated coefficients with approximately the same size and significance as the ones shown in Table 5. Furthermore the coefficient to the interaction effect was statistically insignificant in all specifications, (results available upon request).

[23] Results available upon request.

[24] Results available upon request.

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[25] This issue will be a topic for future research, since we are primarily concerned with interaction effects in this paper.

[26] We run specifications both with lagged dependent variables and without.

[27] Since our results show that NHL teams benefit both directly and indirectly from employing more Europeans, one might ask whether NHL teams comprised of *only* Europeans would perform better than teams that are a mix of Europeans and North Americans, thus eventually leading to North Americans no longer being present in the League. However, there are at least two limiting factors that would make such an extreme outcome improbable. First, on the demand side, there is likely some type of fixed-proportion production technology at work here, where teams require a minimum number of the more physical-oriented North Americans to the allow the more-skilled European players to perform unfettered – i.e. teams comprised of exclusively Europeans could be vulnerable to intimidation tactics of teams that continued to employ North Americans. Second, on the supply side, with the game of hockey being generally of less prominence in Europe than in North America (particularly Canada), the talent pool in Europe is much less deep, and eventually the supply of NHL-caliber Europeans would be exhausted.

[28] If it is assumed that high-quality players perform better when they play with other high-quality players, and with Table 4 showing Europeans tending to be of higher-quality than North Americans, then it would seem that a typical European player should perform better when he plays with other Europeans, rather than with North Americans.