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CAREER DURATION IN THE NHL: PUSHING AND PULLING ON EUROPEANS?

Craig A. Depken, II
Johnny Ducking
Peter A. Groothuis

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THE UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE
BELK COLLEGE OF BUSINESS
DEPARTMENT OF ECONOMICS
9201 University City Blvd
Charlotte, NC 28223-0001
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ABSTRACT

Using a panel of National Hockey League players from 2000 through 2013, we analyze the determinants of career length in the league. In our analysis, we include both performance variables and nationality of origin to determine their importance in determining career length. We find that European-born players have shorter careers than North American-born players holding performance constant and Russian-born players have even shorter careers than other Europeans. We further find that Russian-born players have even shorter careers than other players after the 2005 lockout. These shorter careers are consistent with exit discrimination against European and Russian players pushing them out of the league and voluntary exit by European and Russian players due to opportunities in their home countries pulling them out of the league. Ironically, voluntary exit by European and Russian players provides teams with a financial incentive to discriminate against European players.

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Craig A. Depken, II
Professor
Department of Economics
University of North Carolina – Charlotte
Charlotte, NC

Johnny Ducking
Assistant Professor
Department of Economics
North Carolina A&T State University
Greensboro, NC

Peter A. Groothuis
Professor
Department of Economics
Appalachian State University
Boone, NC

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Abstract

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JEL Classifications: Z22, L83

Keywords: Exit discrimination, competing leagues, professional sports, return migration

"In fact, the other side of the water is the one thing the Wings can't offer. This is about geography, upbringing and pride. Datsyuk said he wants to play a last season in Russia while his skills are still mostly intact, and not "be broken down," performing a victory lap that isn't warranted."

Mitch Albom, Detroit Free Press

Introduction

The improvement in human capital and the reduction in transportation costs, coupled with increasing returns to quality, has caused many labor markets to become international. For instance, in the United States in the health care profession 27% of surgeons are foreign born while in the education profession 40% of engineering professors are foreign born. Aslanbeigui and Montecinos (1998) estimated that in the 1990s approximately 30% of US economics professors were foreign born. The internationalization of labor markets has led to many questions such as are foreign workers more productive because of self-selection on the part of immigrants (Borjas and Bratsberg, 1996) or less productive due to language and cultural differences than native born workers (Dustmann and Soest, 2002)? Do foreign born workers experience negative discrimination (Aslund, 2014)? Do foreign workers return to their native country after some amount of time or money earned (Galor and Stark, 1990, and Dustmann, 1997)?

Because sport is most clearly a meritocracy which drives sports teams to find the most talented players, all sports leagues have international labor markets. For instance, in 2014 twenty percent of the players in the National Basketball Association were foreign born, while twenty-five percent of Major League Baseball were foreign born, and in the National Hockey League fifty-one percent of the players were born in Canada, twenty-four percent born in the United States, and twenty-five percent born in Europe.[1]

[1] From the 2000-2013 period, players also hailed from Indonesia (1), Japan (2), Kazakhstan (7), Nigeria (1), and Tanzania (1). These players are not included in the empirical analysis below.

Sports leagues provide a fertile ground for research on immigration due to the increasing degree of internationalization of sports leagues. For instance, Kahane, Longley, and Simmons (2013) find that NHL teams who employ a higher proportion of Europeans perform better if the Europeans are from the same country than teams with fewer Europeans or Europeans from many different countries. This productivity increase appears to arise because of the communication and cultural consistencies that a critical mass of foreign players from the same country attains. Such improvements to productivity would seem to extend a player's career, on the margin. However, previous studies suggest that there is discrimination against certain foreign players which might, in turn, reduce a player's career length. The purpose of this paper is to investigate how nationality influences career length in the National Hockey League.

In sports leagues career length might be influenced by nationality because of institutional factors of the league. For instance, many European soccer leagues limit the number of foreign-born players on a team. In the Kontinental Hockey League, Russian teams are not allowed more than 5 foreign players. In these cases, a player might be pushed out of the league if their productivity falls below that of the sixth foreign player available. This would correspond with a reduced career length for foreign nationals.[2]

A different source of reduced career length might be an increase in lucrative opportunities in the native country of a foreign worker or a sufficient amount of savings on the part of a foreign worker so that the worker finds it more attractive to return to their native country rather than remain in the host country. In the case of professional sports athletes, this would lead to their native country pulling them back home. This too would correspond with a reduced career length.

[2] Although no U.S. league explicitly limits the number of foreign born players, teams might still discriminate against foreign players due to fan, player, or management preferences.

Our empirical results suggest that European-born and Russian-born players have shorter careers in the NHL, all else equal. After the end of the 2004-2005 lockout, Russian-born players seem to have even shorter careers compared to other European and North American-born players. While these results might be consistent with exit discrimination, the greatest effects correspond with increasing opportunities outside of the NHL, most notably the Kontinental Hockey League in Russia which has many players paid at or near the mean of NHL players.

Literature Review

Exit discrimination has a long history in sports economics. Johnson and Marple (1973) pioneered this branch of discrimination research when they found evidence from 1970-71 NBA data that marginal white players had longer careers than marginal black players. Hoang and Rascher (1999) more formally developed a model to explore the concept of racially-based retention barriers in the NBA. They, too, found evidence that, performance being equal; there was exit discrimination in the NBA. Groothuis and Hill (2004) failed to confirm Hoang and Rascher's results using more recent data, adding height as an added explanatory variable, and using a duration model that allows for both stock and flow samples. Jiobu (1988) found evidence that race decreased career length, *ceteris paribus*, for black players but not Hispanics in Major League Baseball from 1971-1985. Again, Groothuis and Hill (2008) failed to find exit discrimination in MLB using more recent data from 1990-2004 and a model that better accounted for performance decay. Lastly, Ducking, Groothuis, and Hill (2013) find no exit discrimination in the NFL.

Discrimination in the NHL against foreign born players

In hockey most of the discrimination literature has focused on discrimination against French Canadians. For instance, both Grenier and Lavoie (1988) and Jones and Walsh (1988) find significant pay discrimination against French-Canadian defensemen using 1977-78 data. In addition, Lavoie (1989) finds evidence of positional stacking involving minority (French-Canadian) hockey players. Mongeon and Longley (2015) find referees in hockey exhibit discrimination with French Canadian referees showing a bias by calling more penalties against English Canadian players than against French Canadian Players, *ceteris paribus*. Lastly Christie and Lavoie (2015) find that there is entry discrimination against European players and particularly Russian players. They further suggest a bias against hiring players from the KHL. Overall we know of no studies that have examined career length of foreign born players in hockey. To analyze career duration in the NHL we use a panel describing all North American, European and Russian non-goalies who played for only one team in a given year from 2000 to 2013 and non-parametric and semiparametric duration techniques.

Non-parametric Analysis of Career Duration in the NHL

To help understand career duration in the NHL, we calculate yearly hazard functions as:

(1) $$h_t = d_t / n_t ,$$

where d_t is the number of players who end their career in year t and n_t is the number of players at risk of ending their career in year t. The hazard rate can be interpreted as the proportion of players who exited the NHL given they have survived up to some level of tenure. In Table 1, we report the hazard rate for non-Russian European-born NHL players, for Russian-born players, and for North American-players who were either born in Canada or the United States. We also report the longest career for each group.

In Figure 1 we plot the hazard functions for each group of players based upon the tenure of the player. We find that compared to North American-born players, the hazard rate for non-Russian

European-born players is higher for the first four years of tenure and the hazard rate for Russian-born players is higher for the first seven years of tenure. Not surprisingly, we find that the North American-born, the Russian-born, and the non-Russian European-born hazard rates increase over time. The increase suggests that the wear and tear from playing hockey as player's age increases the likelihood of exit. Interpreting the differences in hazard rates as discrimination, however, is potentially misleading because there is no control for productivity differences across players. Figure 2 depicts the hazard rates for the three sets of players over time. As can be seen, the Russian players have a notably higher hazard rate after the end of the 2004-05 lockout.

Semi-parametric Analysis of Career Duration in the NHL

Methodology

We estimate semi-parametric hazard functions following Berger and Black (1998) and Groothuis and Hill (2004). Because the data are reported at the season level we calculate the hazard rate as a discrete random variable. As with Groothuis and Hill (2004) we model the durations of a single spell and assume a homogeneous environment so that the length of a particular spell is uncorrelated with the calendar time at which the spell begins. This assumption lets us treat all the players' tenure as the same regardless of when it occurred in the panel study. For instance, all fourth-year players are considered to have the same baseline hazard regardless of calendar time, so a fourth-year player in 2000 has the same baseline hazard as a fourth-year player in 2009.

To understand how stock data influence a likelihood function we follow the notation of Groothuis and Hill (2004). Suppose the probability mass function (pmf) of durations is defined as $f(t, x, \beta)$, where t is the duration of the career, x is a vector of performance and personal characteristics, and β is a vector of parameters. Denote $F(t,x,\beta)$ as the cumulative distribution function; the probability that a career lasts at least t° years is then 1 - F(t°,x,β). Defining the hazard function as h(t,x,β) ≡ f(t,x,β) / S(t,x,β) and applying the definition of conditional probabilities, the pmf can be expressed as

$$f(t_i, x_i, \beta) = \prod_{j=0}^{t_i - 1} [1 - h(j, x_i, \beta)] h(t_i, x_i, \beta). \quad (2)$$

If we have a sample of n observations, $\{t_1, t_2, \ldots, t_n\}$, the likelihood function of the sample is

$$L(\beta) = \prod_{i=1}^{n} f(t_i, x_i, \beta) = \prod_{i=1}^{n} \left(\prod_{j=1}^{t_i - 1} [1 - h(j, x_i, \beta)] h(t_i, x_i, \beta) \right). \quad (3)$$

Often it is not possible to observe all careers until they end, hence careers are often right-censored. Let the set A be all observations where careers are completed during the sample period and the set B be all observations where careers are right censored. For the set B, all we know is that the actual length of the career is greater than t_i, the observed length of the career up through the last year. Because we know that the actual length of the career is longer than we observe then the contribution of these observations to the likelihood function is just the survivor function,

$$S(t, x, \beta) = \prod_{i=1}^{t-1} [1 - h(i, x, \beta)].$$

To introduce stock sampling, let the set C be the careers that were in progress when data collection began. For these observations, we know that the career for player *i* has lasted for *r* years before the panel begins so the likelihood must be adjusted by the conditional probability of the career having length *r*. Of course, some stock-sampled observations may be right-hand censored. Let the set D be all observations that are both right and left censored. An example of a career that is both right and left censored would be a player who starts his career prior to 2000 and ends his career after 2013. Taking into account all four sets: A, B, C, and D the likelihood function becomes

$$L(\beta)=\prod_{i\in A}\left(\prod_{j=1}^{t_i-1}[1-h(j,x_i,\beta)]h(t_i,x_i,\beta)\right)\times\prod_{i\in B}\left(\prod_{j=1}^{t_i-1}[1-h(j,x_i,\beta)]\right)$$

(4)

$$\times\prod_{i\in C}\left(\prod_{j=r_i}^{t_i-1}[1-h(j,x_i,\beta)]\right)h(t_i,x_i,\beta)\times\prod_{i\in D}\left(\prod_{j=r_i}^{t_i-1}[1-h(j,x_i,\beta)]\right)$$

In equation (4), the contribution of censored, stock-sampled observations to the likelihood function is strictly from the last two terms; such observations simply provide information about the survivor function between (r,t).

Thus we, as Groothuis and Hill (2004), have expressed the likelihood function as a function of the hazard functions. All that remains is to specify the form of a hazard function and estimate by means of maximum likelihood estimation. As the hazard function is the conditional probability of exiting the NHL given that the NHL career lasted until the previous season, the hazard function must have a range from zero to one. In principle, any mapping with a range from zero to one will work. Cox (1972) recommends

(5) $$\frac{h(t,x,\beta)}{1-h(t,x,\beta)}=\frac{h_t}{1-h_t}e^{x\beta}=\exp(\gamma_t+x\beta),$$

which is simply the logit model with intercepts that differ by time periods. The term h_t is a baseline hazard function, which is common to all observations. The $x\beta$ term, determined by the player's personal and productivity characteristics, shifts the baseline hazard function, but it affects the baseline hazard function in exactly the same way in each period. Berger and Black (1998) consider other hazard functions and find that their results are relatively robust across various specifications of the hazard function. As the logit model is available in many software packages, we follow Cox and use the logit model.

The intuition behind equation (5), when using the logit model for the hazard function, is relatively simple. For each year during the survey in which the player is in the NHL, the player either comes back for another season or ends his career. If the career ends, the dependent variable takes on a value of one; otherwise, the dependent variable is zero. The player remains in the panel until the player exits the NHL or the panel ends. If the panel ends, we say the worker's spell is right censored. Thus a player who begins his NHL career during the panel and plays for 6 years will enter the data set 6 times: the value of his dependent variable will be zero for the first 5 years (tenure one through five) and be equal to one for the sixth year.

To illustrate a stock observation, consider another player who enters the panel with 7 years of NHL job tenure prior to 2000 the first year of the panel, then plays for an additional 3 years for a 10-year career. For this player, we ignore his first 7 years of tenure because he is left censored. As the equation of the likelihood function with stock data indicates, the duration of a NHL career prior to the beginning of the panel makes no contribution to the value of the likelihood function. Therefore, only years 8 through 10 will enter the data set with the dependent variable taking on the value zero for year 8 and 9 and in the 10^{th} year it takes on a value of one, this player appears in the data set a total of 3 times. Note for all players who are right censored, we do not know when their career ends so their dependent variables are always coded as zero.

Because the players in the panel have varying degrees of job tenure prior to the beginning of the panel, we identify the hazard function for both long and short careers. The disadvantage to this approach is that the vector γ_t of equation (5) can be very large. In our study it would require 25 dummy variables. We also run into problems with the Cox technique because we have too few players who have long careers. To simplify the computation of the likelihood function and to be able to keep the long careers, we approximate the γ_t vector with a 5^{th} order polynomial of player's tenure, which reduces the number of parameters to be estimated from 25 to 5. Thus, the hazard function becomes

(6) $$\frac{h(t,x,\beta)}{1-h(t,x,\beta)} = \Phi(t)\, e^{x\beta} = \exp(\phi(t) + x\beta),$$

where ϕ(t) is a 5th order polynomial in the worker's tenure. We choose the Taylor series approximation technique over using tenure dummies due to the small number of observations for high tenures. This method provides a very flexible specification of the baseline hazard, but does impose more restrictions than Cox's model.[3]

Estimation Results

In Table 2, we report the means of the variables used in the analysis. We find that both non-Russian Europeans and Russians have a higher exit rate than North Americans. North Americans have fewer games played, assists, and goals than non-Russian Europeans and Russians indicating that they are less skilled than their European counterparts. North Americans have more penalty minutes than non-Russian Europeans and Russians. Both Russian and non-Russian Europeans have a better plus minus than North Americans indicating that teams are better in terms of scoring differential when North Americans are not on the ice. Both non-Russian Europeans and Russians are taller than North Americans. Russians weigh more than North Americans and North Americans weigh more than non-Russian Europeans. The average age for all three groups is between 26.5 and 27 years of age. Approximately 70% of all the observations occur after the lockout but only 51% of the Russian observations occur after the lockout. Only 4% of the sample is Russian and 21% is non-Russian European.

[3] When higher order polynomials of the sixth and seventh power are included the results do not change, suggesting that a fifth order polynomial is flexible enough to capture the influence of the baseline hazard.

In table 3 we report the percentage of non-Russian European and Russian players by year. In 2000, the percentage of non-Russian European players in the league was 22.3% and the percentage of Russian players was 6.9%. Over the course of the sample period the percentage of non-Russian European players fell to 15% and the percentage of Russian players fell to 2.2%. Table 3 reveals that there has been a steady decline in the percentage of non-Russian European and Russian players over time.

In Table 4 we report the results of estimating equation 6 for two specifications. The first controls for the post-lockout period alone and the second controls for differences across non-Russian European and Russian-born players in the post-lockout period, with North American-born players being the reference category. In both cases, better performance decreases the likelihood of exit with the coefficients on games played, goals, assists, penalty minutes, and plus minus[4] all being negative and statistically significant. In addition, we find that the coefficient on age is positive and significant suggesting that older players are more likely to exit than younger players. We also find that the coefficient on the year the player played is negative and statistically significant suggesting that recent players are less likely to exit than past players. We also find that heavier players are less likely to exit and taller players are more likely to exit the league.

As in other studies that find differential treatment of hockey players based on nationality, we also find that country of origin influences whether a player exits the league. Using North American-born players as the reference category, both Russian-born and non-Russian European-born hockey players have a higher probability of exit in a given year, *ceteris paribus* on

[4] The "plus-minus" statistic is calculated as a points differential. When an even-strength or shorthanded goal is scored, every player on the ice for the scoring team is credited with a "plus." Every player on the ice for the team scored against gets a "minus." A player's overall plus-minus is calculated by subtracting the minuses from the pluses. A high plus-minus is taken to mean the player is a good offensive or defensive player.

productivity and age. Our results could be consistent with customer-based discrimination if fan preference for North American-born players is sufficiently high or with co-worker discrimination that might arise with possible language or cultural differences (see Kahane et al., 2013). However, there appears to be little empirical evidence of wide-spread discrimination against European (both Russian and non-Russian) players in other dimensions of hockey such as salaries. Therefore, it is not immediately obvious that the evidence points to aspects of the NHL pushing European and Russian players away. However, the increased likelihood of Europeans and Russians leaving coincides with increasingly lucrative opportunities to play hockey in Europe, most notably in the KHL in Russia.

To get a feel for the magnitude of exit likelihood, we convert the coefficients into a percentage change by using 100(exp(β)-1) for each dummy variable. We find that a non-Russian European-born player has a 125% higher likelihood of exiting than a North American-born player, holding performance constant, while Russian-born players have a 184% higher likelihood of exiting their career than a North American-born player prior to the NHL lockout that climbs to 423% after the NHL lockout, holding performance constant. Our results suggest that although there has been a large influx of foreign players from Europe into the NHL, there is something pushing and/or pulling that reduces career duration of players from Europe below what performance would suggest.

Nonlinear Decompositions of Career Length Differences

To further explore the effect of being foreign born on exit in the NHL we use the Blinder-Oaxaca nonlinear decomposition technique (Sinning, Hahn and Bauer 2008). Like the linear Blinder (1973) and Oaxaca (1973) method the nonlinear method decomposes the difference between groups into differences across individual characteristics and differences across coefficients. In the linear case the decomposition is:

$$(7) \qquad \bar{Y}_A - \bar{Y}_B = (X_A - X_B)\beta^* + X_A(\beta_A - \beta^*) + X_B(\beta_B - \beta^*),$$

where $\bar{Y}_A - \bar{Y}_B$ is the total difference between two groups, $(X_A - X_B)\beta^*$ is the difference due to different individual characteristics, $X_A(\beta_A - \beta^*)$ is the advantage of being in group A, $X_B(\beta_B - \beta^*)$ is the disadvantage in being in group B, and β^* is a weighted average of the coefficient vectors β_A and β_B. In the simple Blinder and Oaxaca (1973) decomposition method, β^* is either set to β_A or to β_B. Two alternative methods to determine β^* are the Cotton (1988) and the Neumark (1988) methods where Cotton uses a weighted average technique and Neumark (1988) uses a pooled model to derive β^* (Sinning, Hahn and Bauer 2008). The non-linear technique follows the same pattern decomposing the logit equations into the percentage determined by characteristics in our case performance and the percentage determined by differences in coefficients.

In our case, we estimate separate logit models for North American-born players, for non-Russian European-born players, and for Russian-born players. We then perform two sets of decompositions, one for North American-born players compared to non-Russian European-born players and one for North American-born players compared to Russian-born players. The results for the separate logit models are reported in Table 5. We report the decomposition results in Tables 6A and 6B.

In Table 6A we report the results of the non-linear decompositions between North American-born and non-Russian-born Europeans using the simple Blinder and Oaxaca technique, the Cotton technique, and the Neumark technique. We find that the raw difference is .0217. We convert the coefficients into a percentage change of the raw difference by using 100(exp(β)-1) and find that non-Russian European players have only two percent higher likelihood of exit than North

American-born players on average when not controlling for productivity differences. Using the decomposition technique however, we find that differences in productivity, however, lower the likelihood of exit. The effect ranges from -193 to -237 percent depending upon what decomposition technique is performed. These results suggest that if only productivity determined career length Europeans should have a six percent lower probability of exit and thus longer careers than North Americans. But when focusing on differences in coefficients we find that this difference counts from 297% to 337% of the differential showing that on average non-Russian-born Europeans are more likely to exit than North American-born players. These results suggest that European-born players have an eight percent higher likelihood of exit, when controlling for performance.

In Table 6B, we report the results of the non-linear decompositions between North American-born and Russian-born players using the simple Blinder and Oaxaca technique, the Cotton technique, and the Neumark technique. We find that the raw difference is .066. We convert the coefficients into a percentage change of the raw difference by using 100(exp(β)-1) and find that Russian players have a seven percent higher likelihood of exit than North American-born players on average. Using the decomposition, we find that differences in productivity, however, lowers the likelihood of exit. The effect ranges from -169% to -72% percent depending upon what decomposition technique is performed. These results suggest that if only productivity determined career length Russians should have a five percent to twelve percent lower probability of exit and longer careers than North Americans. But when focusing on differences in coefficients we find that this difference counts from a 29% to 246% of the differential showing that on average Russian-born players are more likely to exit than North American-born players.

Our decomposition results further suggest that although there has been a large influx of foreign players from Europe, something is pushing and/or pulling European players from the NHL and making their careers shorter than their productivity would suggest. Either exit discrimination or voluntary exit due to other factors determines why European players have a higher likelihood of exit. One potential explanation is that Europeans return to their native countries to end their careers in professional hockey leagues there (Albom, 2016).

The NHL Lockout's Influence on NHL Exit

The 2004-2005 NHL season was cancelled because of a lockout against the players. The lost season provided an opportunity for many players, especially European-born players, to seek employment in other hockey leagues around the world. After the end of the lockout, brought about by a collective bargaining agreement which dramatically altered the market price for hockey talents by introducing an individual and team salary cap, reducing the average salaries to year-2000 levels, and introducing greater minimum wages (see Depken and Lureman, 2014, for further analysis of how the market for hockey talents changed after the lockout).

These changes in the market for NHL talents might have provided European-born players a greater incentive to leave the NHL early to play in European leagues that might be more competitive in salaries. This appears to have been the case with the KHL which started paying higher salaries starting in 2008 and thereby recruiting heavily from NHL players.

To test for changes in exit patterns after the collective bargaining agreement, we interact the dummy variables describing country of birth with a dummy variable that takes a value of one after the lockout ended and zero otherwise. The results including these interactions are reported in Column 2 of Table 4. To better interpret the magnitude of the likelihood of exit in both the preand post-lockout period, we convert the coefficients into a percentage by using 100(exp(β)-1) for each country-of-origin dummy variable and post-lockout interaction. We find that a non-Russian European-born player had a 125% higher likelihood of exiting in a given year than a North American-born players prior to the lockout, holding performance constant. After the lockout this likelihood increased an additional 15 percentage points although the post-lockout effect is statistically insignificant. Russian-born players have a 184% higher likelihood of exiting their career than North American-born players prior to the lockout and this likelihood increases by an additional 239 percentage points after the lockout for a total 423% higher likelihood of exit than North American-born players.

Conclusion

We find that European-born hockey players have shorter careers than their performance statistics would suggest. In particular, Russian-born hockey players have the highest likelihood of exit during the period 2000-2013 and this likelihood increased dramatically after the end of the 2004-2005 lockout in the NHL which also corresponded to increased salaries in the Russian Kontinental Hockey League. Our statistical evidence suggests that there is something pushing and/or pulling European players in the NHL into exiting earlier than North American-born players. While customer-based, coworker-based, or employer-based exit discrimination might be pushing these players to leave the league, more lucrative opportunities to play hockey in their native countries might be pulling players to leave the NHL earlier than otherwise predicted. There is anecdotal evidence that many players choose to retire from the NHL early to wind down their careers in leagues in their native countries with shorter seasons and fewer injuries, although with lower salaries. Future research would do well to focus on these options to foreign-born NHL players.

Although it is difficult to determine from our analysis whether the increase in the exit of European players is determined by exit discrimination by the team or voluntary exit by the player, it is likely that a portion of the higher probability of exit by European players is due to exit discrimination. In the case of European players being pulled back to their native countries (Albom, 2016), exit discrimination is a plausible response by teams. This is because European players that exit the league voluntarily to return to their home countries have the ability to leave their team with salary cap and roster issues that impose additional costs on the team. These additional costs provide teams with an incentive to release European players from the team sooner than they would release a North American-born player without an incentive to leave the team and return to his native country. Even if there would be no discriminatory behavior towards European players in the absence of voluntary exits, the presence of voluntary exits by European players provide teams with an incentive to discriminate against European players.

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Table 1: Hazard Rates

Tenure	Full Sample	North American	European (Non-Russian)	Russian
1	.163 n=1447	.150 n=1053	.205 n=335	.169 n=59
2	.105 n=1095	.071 n=787	.192 n=255	.207 n=53
3	.114 n=1092	.104 n=823	.132 n=227	.214 n=42
4	.135 n=1035	.109 n=783	.201 n=208	.272 n=44
5	.144 n=877	.144 n=672	.122 n=171	.264 n=34
6	.131 n=800	.142 n=605	.088 n=170	.160 n=25
7	.141 n=733	.132 n=545	.152 n=157	.225 n=31
8	.138 n=643	.133 n=478	.158 n=139	.115 n=26
9	.128 n=561	.122 n=399	.148 n=128	.117 n=34
10	.143 n=467	.141 n=333	.134 n=97	.189 n=37
11	.152 n=458	.147 n=326	.127 n=102	.300 n=30
12	.176 n=379	.196 n=275	.108 n=83	.190 n=21
13	.201 n=332	.218 n=247	.157 n=70	.133 n=15
14	.184 n=271	.186 n=193	.125 n=64	.428 n=14
15	.264 n=227	.229 n=170	.367 n=49	.375 n=8
16	.206 n=179	.210 n=138	.222 n=36	.000 n=5
17	.405 n=148	.400 n=110	.438 n=32	.333 n=6
18	.263 n=95	.315 n=76	.066 n=15	.000 n=4
19	.448 n=78	.442 n=61	.461 n=13	.500 n=4
20	.285 n=42	.285 n=35	.333 n=6	.000 n=1
Longest Career	27 years	27 years	24 years	21 years

Table 2: Descriptive Statistics of the Sample

Variable	Full Sample	North American	European (Non-Russian)	Russian
Exit NHL	0.15 (0.36)	0.14 (0.35)	0.17 (0.37)	0.21 (0.40)
Games played	47.44 (28.42)	45.92 (28.67)	51.78 (27.37)	51.72 (26.67)
Assists	12.51 (13.15)	11.26 (12.41)	15.74 (14.25)	17.54 (15.59)
Goals	7.32 (8.96)	6.69 (8.45)	8.81 (9.61)	10.60 (11.92)
Penalty Minutes	35.18 (35.61)	36.98 (38.30)	29.92 (25.74)	30.75 (26.22)
Plus Minus	-0.25 (9.34)	-0.52 (8.94)	0.67 (10.36)	-0.26 (10.21)
Weight (Pounds)	203.20 (15.69)	203.29 (15.62)	202.46 (15.66)	205.41 (16.74)
Height (Inches)	73.14 (2.05)	73.10 (2.06)	73.25 (2.00)	73.21 (2.18)
Age (Years)	26.87 (4.56)	26.90 (4.51)	26.84 (4.63)	26.52 (5.01)
Post Lockout (1=Yes)	.68	0.69	0.65	0.51
European-born (1=Yes)	.21	-	-	-
Russian-born (1=Yes)	.04	-	-	-
Post Lockout (1=Yes) * European-born	.14	-	-	-
Post Lockout (1=Yes) * Russian-born	.02	-	-	-
Sample Size	11,029	8,170	2,365	494

(Standard deviation in parentheses)

Table 3: Percentage of Non-Russian European and Russian Players by Year

Year	Proportion European (Non-Russian)	Proportion Russian
2000	22.3	6.9
2001	23.8	6.4
2002	24.2	6.1
2003	23.4	6.1
2004	Lockout	Lockout
2005	22	4.5
2006	22.9	3.9
2007	22.7	3.4
2008	21.4	3.2
2009	20.8	3.3
2010	19.6	3
2011	19.3	2.7
2012	17.6	2.3
2013	15	2.2

Table 4: Determinants of NHL Exit: Logit Model

	Model (1)	Model (2)
Games Played	-0.021***	-0.021***
	(0.003)	(0.003)
Assists	-0.094***	-0.094***
	(0.011)	(0.011)
Goals	-0.045***	-0.044***
	(0.012)	(0.013)
Penalty Minutes	-0.010***	-0.010***
	(0.002)	(0.002)
Plus Minus	-0.028***	-0.028***
	(0.005)	(0.005)
Weight	-0.011***	-0.011***
	(0.003)	(0.003)
Height	0.037*	0.037*
	(0.021)	(0.021)
Age	0.233***	0.236***
	(0.015)	(0.015)
Year	-0.036**	-0.035**
	(0.014)	(0.014)
Post Lockout	0.133	0.059
	(0.129)	(0.135)
European	0.754***	0.652***
	(0.078)	(0.126)
Russian	1.361***	1.044***
	(0.149)	(0.212)
European x Post Lockout		0.153
		(0.159)
Russian x Post Lockout		0.611*
		(0.318)
Constant	63.980**	62.914**
	(28.510)	(28.575)
Observations	11,029	11,029
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1		

Table 5: Determinants of NHL Exit: Separate Logit Models for Decompositions

	(1)	(2)	(3)
	North American	European (Non-Russian)	Russian
Games Played	-0.030***	-0.005	-0.006
	(0.003)	(0.005)	(0.008)
Assists	-0.074***	-0.122***	-0.129***
	(0.014)	(0.019)	(0.032)
Goals	-0.064***	-0.040*	0.025
	(0.017)	(0.020)	(0.025)
Penalty Minutes	-0.008***	-0.020***	-0.010
	(0.002)	(0.004)	(0.009)
Plus Minus Goals	-0.038***	-0.012	-0.005
	(0.007)	(0.009)	(0.020)
Weight	-0.009***	-0.015***	-0.012
	(0.003)	(0.006)	(0.012)
Height	0.038	0.036	-0.045
	(0.025)	(0.045)	(0.092)
Age	0.235***	0.253***	0.220***
	(0.018)	(0.030)	(0.057)
Year	-0.010	-0.091***	-0.050
	(0.017)	(0.030)	(0.068)
Post CBA	-0.114	0.657**	0.889
	(0.155)	(0.260)	(0.543)
Constant	13.477	175.402***	98.383
	(33.867)	(59.632)	(137.385)
Observations	8,170	2,365	494
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1			

Table 6A: Nonlinear Decompositions of Exit Logits: European-born

Omega =1	Coefficient	Standard Error[1]	Percentage
Characteristics	-.0514***	.0062	-237%
Coefficients	.0731***	.0089	337%
Omega =0			
Characteristics	-.0428***	.0034	-197%
Coefficients	.0645***	.0074	297%
Cotton Technique			
Productivity	-.0498***	.0051	-229%
Advantage	.0181***	.0021	83%
Disadvantage	.0536***	.0067	247%
Neumark Technique			
Productivity	-.0419***	.0033	-193%
Advantage	.0494***	.0055	227%
Disadvantage	.0143***	.0015	66%
Raw Difference	.0217	.0079	100%

Number of Observations in European-born Group 2365
Number of Observations in North American-born Group 8170
[1]Standard Errors calculate by 50 Bootstrap Replications using STATA

Table 6B: Nonlinear Decompositions of Exit Logits: Russian-born

Omega =1	Coefficient	Standard Error[1]	Pct of Raw Difference
Characteristics	-.1116***	.0276	-169%
Coefficients	.1777***	.0342	29%
Omega =0			
Characteristics	-.0488***	.0069	-74%
Coefficients	.1148***	.0176	174%
Cotton Technique			
Productivity	-.1073***	.0257	-163%
Advantage	.0103***	.0017	16%
Disadvantage	.1630***	.0317	246%
Neumark Technique			
Productivity	-.0475***	.0065	-72%
Advantage	.1070***	.0161	162%
Disadvantage	.0064***	.0001	10%
Raw Difference	.0660	.0172	100%

Number of Observations in Russian-born Group 494
Number of Observations in North American-born Group 8170
[1]Standard Errors calculated by 50 Bootstrap Replications

Figure 1: Hazard Rates for Career Ending by Years of Tenure

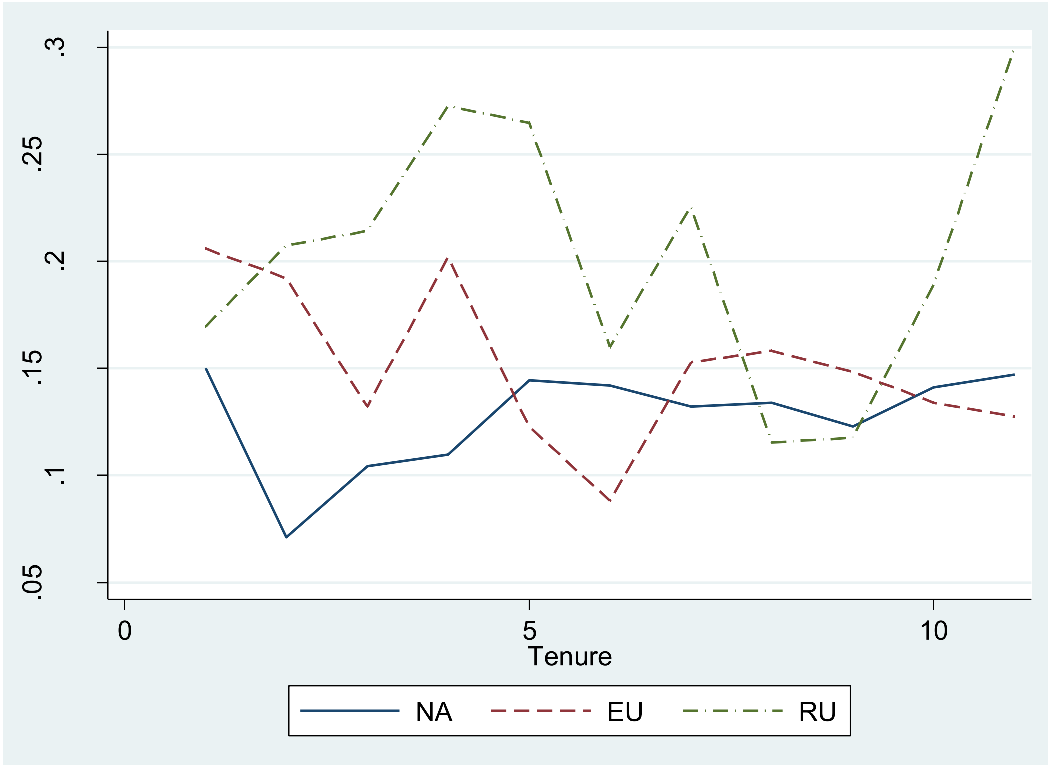

Figure 2: Hazard Rates for Career Ending by Year (2000-2013)