# DEPARTMENT OF ECONOMICS

# WORKING PAPER SERIES

2000-04

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# The National Hockey League Entry Draft, 1969-1995: An Application of a Weighted Pool-Adjacent-Violators Algorithm

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Abstract

We use data on the National hockey League Entry Draft and subsequent performances of the players to predict performance as a function of the player's position, year, and overall rank in the draft. This is done by inequality-constrained least squares using a variation of the pool-adjacent-violators algorithm. The results are used to examine the value of having the $i^{th}$ versus the $j^{th}$ overall pick, the drafting performance of franchises, and the performance of European players. The actual performance of European players drafted in the 1988-1992 period notably exceeded their predicted performance.

## 1. INTRODUCTION

As noted by Neale (1964), professional sports leagues are unique. Although cartel-like activity off the field is optimal from an economic point of view, it is anathema when it comes to activity on the field of play. Attendance and revenue tend to be maximized when game outcomes are uncertain. To facilitate this end, various leagues have instituted a draft system which, ideally, will allow for relatively random outcomes.

It is the aim of this paper to analyze both the performance of groups of players and the relative success of the franchises in drafting players in the National Hockey League. The expected performance of each drafted player is modeled as the function their position on the ice, draft year, and their position in the draft. So as not to create confusion with two uses of the term "position", we will refer to the position in the draft instead as the "pick number".

With these expected performance estimates, we examine three issues:

(1) The expected difference in performance between a player drafted $i^{th}$ overall and a player drafted $j^{th}$ overall for any i, j and position.

(2) The drafting records of franchises, comparing the actual performance of players they drafted with their predicted performance.

(3) The extent to which European players have been undervalued

in the draft, again by comparing their actual performance with their expected performance.

The year and pick number effects are estimated by least squares subject to a monotonic non-increasing pick number effect. These estimates can be obtained by modifying the pool-adjacent-violators algorithm to account for weights.

Section 2 describes the data and section 3 gives some background about the NHL draft. The model is presented in section 4, and the estimator and algorithm are given in section 5. Sections 6, 7 and 8 address the three issues listed above, and section 9 concludes.

## 2. THE DATA

The data have been taken from Tredree and Bontje (1998). For all drafted players we have entered the following, by year:

a. Draft position ("pick number")

b. Drafting franchise

c. Country of team with whom the drafted player had last played when drafted (Canada, United States or Europe)

d. Position (left wing, right wing, centre, defenseman or goaltender)

e. Total regular season games played in the NHL as of the end of the 1997-98 season

For non-goaltenders the following NHL regular season career totals have also been entered:

f. Goals

g. Assists

h. Total Points

i. Penalty Minutes

For goaltenders these four items have been replaced by the following regular season career statistics:

j. Wins

k. Goals against

l. Goals-against average

m. Shutouts

Team data have been consolidated in five cases to allow for team shifts which have occurred over the sample period. (See Tables 1 and 2.) For example, the Kansas City Chiefs, Colorado Rockies and New Jersey Devils are considered to be one drafting unit. These data are available in QuattroPro format from the authors upon request.

## 3. BACKGROUND

The following information is drawn from Tredree and Bontje (1998) and Meagher (1998). The first Amateur Draft conducted by the National Hockey League was held in Montreal on June 5, 1963. Prior to this time there was no organized draft and franchises, on their own initiative, signed young players on a "C-form." This effectively gave the franchise control of the player's hockey-related destiny for his life. Even after retirement, a player had to seek the franchise's permission to look for coaching or administrative positions with other NHL clubs. The Amateur Draft and sponsorship arrangements co-existed until 1969, when sponsorship was terminated. From 1969 on, the vast majority of players entering the NHL went through the Amateur Draft, which was renamed the Entry Draft in 1979. Wayne Gretzky is a notable exception. For this reason, we only consider draft data from 1969 and after.

In 1963, the six league members drafted 21 players. As the league has expanded to 28 teams, so has the number of players drafted. In 1998 (the last year in our data set) 258 players were drafted. The focus of the draft has also expanded from Canadian players to ones playing anywhere in the world.

The rules of the drafting system have changed over time. The age of eligibility has varied from 17 to 20 but has been set at 18 since 1980. The exclusive right of the Montreal Canadiens to draft the best players from Quebec effectively expired in 1969, the last year they exercised it. The order of drafting varied in the early years but it was codified in 1969 - the order of selection is based on the reverse order of standing in the league in the previous year. Since 1995, the first round has been an exception - a weighted lottery system has been introduced for the top 14 picks (Meagher (1998, p.132)). (Teams can, however, improve their drafting position by means of trades.) In 1969 it was decided that the drafting process would continue until every franchise declared that its participation was complete. Currently it consists of nine rounds plus up to one round of compensatory draft selections.

4. THE MODEL

We divide the players into three groups: goaltenders, defensemen and forwards. We use total NHL regular season games played as a performance measure for all three positions. We also use total NHL regular season points as a performance measure for defensemen and forwards. Games played and points are not perfect measures of a player's true value, but we feel that these are the best statistical measures available. Measures such as points per game are misleading for players who have not played many games, and do not reflect longevity, which itself indicates positive characteristics that may not be reflected in the player's scoring totals.

We have the NHL career statistics as of the end of the 1997-98 season for all players drafted from 1963 to 1998. Consequently, we have no NHL statistics for players drafted in 1998, and not many statistics for players drafted in 1996 and 1997. Therefore we will only include players drafted up to and including 1995. We only consider players drafted in 1969 or after, for reasons given in Section 3.

We model the expected value of the performance measure as a function of position, pick number and draft year. The parameters are estimated separately for goaltenders, defensemen and forwards. The following notation then applies separately to each of these three positions. To save notation we do not include a position subscript. Let the performance measure of a player who was drafted $i^{th}$ overall in year t be $p_{it}$. The expected value of $p_{it}$ given i and t is modeled as:

$$E(p_{it}|i,t) = \pi_i \tau_t, \tag{1}$$

where $\pi_i$ is the pick number effect and $\tau_t$ is the year effect. We assume that $\pi_i$ is non-increasing in i. Since $p_{it}$ is either points or games played, one expects that more promising players would be selected earlier in the draft, so that as i increases, expected $p_{it}$ decreases. This creates what could be described as an isotonic regression model with multiplicative fixed (year) effects.

The two most tractable ways to model the year effect are to add it to or multiply it into the pick number effect. We model it as multiplicative since we expect the absolute size of the year effect to be greater for larger $\pi_i$. An additive isotonic regression model has been developed by Bacchetti (1989). Variation in $\tau_t$ over time is expected for the following reasons: players drafted near the end of the 1969-95 period will tend to have a lower $p_{it}$ since their NHL careers as of the end of the 1997-98 season will have been shorter than those of the older players; players entering the NHL earlier in the 1969-95 period were entering a league with fewer teams than those entering later; the number of games in the regular season changed over this period; when $p_{it}$ is career points, it will matter if the player's career was during a low-scoring or a high-scoring period; through chance and other factors, some years had more good players in the draft than other years.

A normalizing restriction is required: we restrict the average of the 27 $\tau_t$'s to equal one. $\pi_i$ is then the expected value of $p_{it}$ for a player drafted $i^{th}$ overall in the average year, when $\tau_t = 1$.

Once $\pi_i$ and $\tau_t$ have been estimated for each position by $\hat{\pi}_i$ and $\hat{\tau}_i$ respectively, the three questions can be addressed. The change in $\hat{\pi}_i$ over i tells us about the average performance of players across different pick numbers. The second and third questions can be explored by computing $\hat{p}_{it} = \hat{\pi}_i\hat{\tau}_t$. $\hat{p}_{it}$ is the expected performance of a player drafted $i^{th}$ overall in year t. The residual, $p_{it} - \hat{p}_{it}$, tells us how that player actually performed compared this prediction. These residuals can be added up within franchises to provide an answer to the second question. The third question can be answered by summing these residuals over European players.

## 5. ESTIMATION OF PICK NUMBER AND YEAR EFFECTS

$\pi_i$ and $\tau_t$ for each position are estimated by least squares, minimizing

$$\sum_t \sum_i I_{it} (p_{it} - \pi_i \tau_t)^2 \qquad (2)$$

subject to the restrictions $\pi_i \geq \pi_{i+1}$, i = 1,..,286. The overall maximum value of i is 286, occurring in 1993 and 1994. $I_{it}$ is an indicator variable which equals one if a player was drafted $i^{th}$ overall in year t who plays at the position whose coefficients are being estimated, and equals zero otherwise.

We consider the estimation of $\hat{\pi}_i$ and $\hat{\tau}_t$ separately, which leads to a zigzag algorithm. $\hat{\tau}_t$ is simpler because it is subject to no restrictions. Given $\hat{\pi}_i$, minimization of (2) with respect to $\tau_t$ yields:

$$\hat{\tau}_t = \sum_i I_{it} p_{it} \hat{\pi}_i / \sum_i I_{it} \hat{\pi}_i^2 \qquad (3)$$

for each t.

To obtain $\hat{\pi}_i$ given $\hat{\tau}_t$, we convert the minimization of (2) with respect to $\pi_i$ into a weighted least squares problem. With the inequality constraints, this is an isotonic regression problem that can be solved by a weighted pool-adjacent-violators (WPAV) estimator. To see this, replace $\tau_t$ with $\hat{\tau}_t$, then expand the square in (2) to give

$$\sum_i \sum_t I_{it} [p_{it}^2 - 2 p_{it} \pi_i \hat{\tau}_t + \pi_i^2 \hat{\tau}_t].$$

We can ignore the first term since it does not involve $\pi_i$. Summing each term over t and dropping the first term gives

$$\sum_i [-2(\sum_t I_{it}\hat{\tau}_t p_{it})\pi_i + (\sum_t I_{it}\hat{\tau}_t^2)\pi_i^2].$$

Factoring out $(\sum_t I_{it}\hat{\tau}_t^2)$ and completing the square gives

$$\sum_i (\sum_t I_{it}\hat{\tau}_t^2)[(\sum_t I_{it}\hat{\tau}_t p_{it}/\sum_t I_{it}\hat{\tau}_t^2) - \pi_i]^2$$

or more compactly,

$$\sum_i w_i (b_i - \pi_i)^2, \tag{4}$$

where $w_i = (\sum_t I_{it}\hat{\tau}_t^2)$ and $b_i = \sum_t I_{it}\hat{\tau}_t p_{it}/\sum_t I_{it}\hat{\tau}_t^2$.

For some intuition about (4), consider a special case. If $I_t = 1$ for all i and t in the summations, and if $\hat{\tau}_t = 1$ for all t, then (4) becomes $T\sum_i(\bar{p}_i - \pi_i)^2$, where $\bar{p}_i = \sum_t p_{it}/T$ is the average performance of players drafted $i^{th}$ overall, and T is the total number of years. The problem then would be least squares fitting of $\pi_i$ to $\bar{p}_i$ subject to the inequality constraints.

Our function (4) replaces $\bar{p}_i$ with $b_i$ as the measure of average performance of players drafted $i^{th}$ overall. $b_i$ is a weighted average, where the weights are $\hat{\tau}_t^2$, of the year-adjusted performances $(p_{it}/\hat{\tau}_t)$ of the players included in the calculation $(I_{it} = 1)$. The variation in the number of players drafted at each pick number, again weighted by $\hat{\tau}_t^2$, also is accounted for by $w_i$ in (4).

The resulting step function could be smoothed further, either by replacing $b_i$ in (4) by a kernel-smoothed $b_i$ prior to WPAV, or by kernel-smoothing the $\hat{\pi}_i$'s after WPAV. In the interest of avoiding further complexities in the exposition, we do not do any further smoothing.

The WPAV algorithm, which we use to obtain estimates of $\pi_i$ in (4), is an extension of the PAV algorithm (Ayer et al. (1955), Barlow et al. (1972), Hanson et al. (1973)). Härdle (1990, pp. 218-223) provides a good discussion of the PAV algorithm. First we describe PAV, and then explain our WPAV algorithm.

The PAV algorithm provides the $\hat{\pi}_i$ values that minimize $\sum_i (b_i - \pi_i)^2$ subject to $\pi_i \geq \pi_{i+1}$ for all i. Picture the $b_i$'s as a vector: $\{b_1, b_2, .., b_{286}\}$. The algorithm, adapting Härdle's description to our notation with the opposite ordering, replaces this vector with a vector of $\hat{\pi}_i$'s as follows:

1. Starting with $b_1$, move to the right and stop if $b_i < b_{i+1}$. Replace both $b_i$ and $b_{i+1}$ by their average $\hat{\pi}_i = \hat{\pi}_{i+1} = (b_i + b_{i+1})/2$.
2. Check that $b_{i-1} > \hat{\pi}_i$. If not, replace each member of the subvector $(b_{i-1}, \hat{\pi}_i, \hat{\pi}_{i+1})$ by their average. Continue to the left in this manner until the monotonicity requirement is satisfied. Then proceed to the right from that point, returning to step 1.

To motivate a solution to the weighted least squares problem, suppose that we multiplied (4) by some $K > 1$ so that the weights, $Kw_i$, all are integers. Then (4) could be minimized by applying the above PAV estimator to the vector: $\{b_1, b_1, .., b_1, b_2, .., b_2, .., b_{286}, .., b_{286}\}$, where each $b_i$ appears in the vector $Kw_i$ times. We do not have to work with this longer vector, however, because it can be seen that the algorithm would never stop within the subvector $\{b_i, .., b_i\}$ in its left and right movements. It may stop only when it moves from a $b_i$ to a $b_{i+1}$ or a $b_{i-1}$. This leads to the following WPAV algorithm, which replaces the original vector $\{b_1, b_2, .., b_{286}\}$ by $\hat{\pi}_i$'s as follows:

1. Starting with $b_1$, move to the right and stop if $b_i < b_{i+1}$. Replace both $b_i$ and $b_{i+1}$ by the weighted average $\hat{\pi}_i = \hat{\pi}_{i+1} = (w_i b_i + w_{i+1} b_{i+1})/(w_i + w_{i+1})$.
2. Check that $b_{i-1} > \hat{\pi}_i$. If not, replace each member of the subvector $(b_{i-1}, \hat{\pi}_i, \hat{\pi}_{i+1})$ by the weighted average $\hat{\pi}_{i-1} = \hat{\pi}_i = \hat{\pi}_{i+1} = (w_{i-1} b_{i-1} + w_i b_i + w_{i+1} b_{i+1})/(w_{i-1} + w_i + w_{i+1})$. Continue to the left in this manner until the monotonicity requirement is satisfied. Then proceed to the right from that point, returning to step 1.

The constant K in the above argument cancels out of the weighted averages and need not be specified.

Our overall zigzag algorithm is:

1. Set the year effects $\hat{\tau}_t = 1$ for all t.
2. Minimize (2) with respect to the $\hat{\pi}_i$'s by minimizing (4)

using the WPAV algorithm.

3. Minimize (2) with respect to the $\hat{\tau}_t$'s using (3).

4. Repeat steps 2 and 3 until convergence.

5. Normalize the $\hat{\tau}_t$'s by dividing by their average, and multiply the $\hat{\pi}_i$'s by the same number.

This algorithm worked quickly and always converged in less than 10 iterations. Each step of the algorithm reduced the sum of squares criterion. (A previous version normalized the $\hat{\tau}_t$'s after each pass through step 3, putting step 5 in the loop, but it converged much more slowly.)

Härdle (1990, p.218) mentions that the PAV algorithm can give a different answer depending on whether it works left-to-right as described above, or right-to-left. We estimated some of them both ways, and found it made no difference.

## 6. PICK NUMBER AND YEAR EFFECTS

Figure 1 plots the year effects ($\hat{\tau}_t$'s) for each position, using games played as the performance measure $p_{it}$. Because fewer goaltenders are drafted than forwards or defensemen, there is more random year-to-year variation, causing the goaltenders' plot to be bumpier. There is a slight increase during the 1970s, a spike in 1979 for forwards and defensemen (1980 for goaltenders), a high period in the early 1980s, and finally a gradual decline from the mid-1980s onward. The spike in 1979 could be due to eligibility of some WHA talent in the entry draft, as the rival

WHA league amalgamated with the NHL that year. The post-1984 decline is explained by some players still being in mid-career by the time the statistics end in 1998. The slightly higher level in the early 1980s compared to the 1970s could be explained by the increase in the number of teams from 17 to 21 in 1979. A similar pattern emerges when the plot uses points as the performance measure for forwards and defensemen, not shown here.

Figure 2 plots the pick number effects on games played for the three positions. The plots for forwards and defensemen are remarkably similar. The goaltenders' plot has longer flat sections, again partly reflecting the smaller sample size for goaltenders. A goaltender drafted very high, say in the top 10, on average plays fewer games than do forwards and defensemen who were drafted that high. However, goaltenders drafted with a pick number in the early 20's play more games on average than the other players. Goaltenders who are late picks, say 150$^{th}$ overall or higher, play fewer games on average than the others. Figure 3 shows these same pick number effects but just for the top 50 overall picks, making some of these differences easier to see.

This pattern for goaltenders is reflected in drafting behaviour. Even though about 10% of all drafted players are goaltenders, they comprise only 3.3% of the players drafted in the top 20 overall.

Figure 4 shows the pick number effect on points rather than games played. Figure 5 shows this same data but just for the top

50 overall picks. There is a large drop in predicted points for forwards moving from first to fifth overall. This pattern, which is not present for defensemen, is more pronounced than the similar drop in Figure 3 for games played. Franchises appear to be pretty good at ranking the top few high-scoring forwards in each draft. A first-overall forward pick is significantly higher-scoring on average than a fifth-overall pick, and this difference is much higher than the difference in their average games played.

There is a flat section in Figure 5 for forwards' points from 23$^{rd}$ to 48$^{th}$. This section is almost flat for games played as well. It suggests that forwards selected in the 40's overall do just as well as forwards selected in the late 20's. In recent years this is roughly a mid-second-round pick vs. a late-first-round pick.

## 7. FRANCHISE DRAFTING PERFORMANCE

Table 1 lists the total number of predicted games played and actual games played of all players drafted during this period by franchise. Franchises are ranked by the absolute difference between actual and predicted games played. The percentage difference between these two totals is also given, as well as the first and last years the franchise has operated during the 1969-95 period. Table 2 has a similar format, but uses points instead of games played as the performance measure, omitting goaltenders.

The results for franchises that began operating in the 1990s must be interpreted with caution. They have drafted a small number of players, and those players have had at most only a short stint in the NHL by 1997-98. Keeping these caveats in mind, San Jose, Florida, and to a lesser extent Ottawa, have drafted well among the new franchises. Anaheim is about average, and Tampa Bay below average. It is possible that the better-than-average overall drafting performance of the new franchises is due to their having had to rush their drafted players into the NHL sooner than have the more established franchises.

Turning to the older franchises, one notable result is the large amount of drafting done by Montreal compared to all other franchises. Montreal's 50 000 predicted games played and 25 740 predicted points are 40.3% and 42.1% greater respectively than the next-highest franchise, Minnesota/Dallas in both cases. Moreover, Montreal's drafted players have performed slightly above their predictions. Montreal, then, has been far and away the greatest supplier of drafted players in terms of career games played and points over this period.

In terms of the absolute differences between actual and predicted performance, the standout franchises are the N.Y. Rangers, Buffalo, Quebec/Colorado, and Winnipeg (now Phoenix), all ranking high in both games played and points. Atlanta/Calgary ranks highest in points, but only 10th in games played. In terms of percentage difference, which favours newer franchises that have drafted well, Quebec/Colorado ranks first in games played and Edmonton ranks first in points.

The only defunct franchise, California/Oakland/Cleveland, has a poor drafting record. Minnesota/Dallas, however, is the franchise with the worst drafting record by far, as measured by games played or points, in both absolute and percentage terms.

Complete year-by-year franchise drafting records are available upon request. To quickly summarize some results for absolute differences in games played, not reported in tables, Detroit goes from having the worst drafting record during 1969-78 to having the best drafting record over the 1979-90 period. The best-drafting franchise during the 1969-78 period was the N.Y. Islanders, which accords with their four consecutive Stanley Cup victories during 1980-83. Minnesota/Dallas had the second-worst drafting record during 1969-78, despite reaching the Stanley Cup finals in 1980, and they had the worst drafting record during 1979-90 despite reaching the Stanley Cup finals in 1991. Even during 1991-95, immediately preceding a period of strong on-ice performance from the Dallas franchise including the 1999 Stanley Cup win, their drafting record was below average. The best drafting record during 1991-95 was Boston's, the worst was Washington's.

## 8. AVERAGE PERFORMANCE OF PLAYERS DRAFTED FROM EUROPEAN TEAMS

For some purposes it would be preferable to divide players into those who were raised in Europe vs. North America. We do not have this information. We know whether the team that the player was with when they were drafted is located in Europe or North America. In the vast majority of cases, this team location will correspond with the player's true origin, so to a large extent the results can be interpreted either way. To save space, we will refer to a player drafted from a European team as European. We should note that in recent drafts there is a small but growing number of European players drafted from Canadian junior teams.

We will not distinguish between Canadian and U.S. players. In work not reported here, the difference in performance of players drafted from Canadian vs. U.S. teams was small compared to the differences between Europeans and North Americans described below. Further, the problem of having to identify the origin of the player based on the location of their most recent team is more pronounced for a Canada-U.S. comparison. Some Canadian players are drafted from U.S. colleges, or play on junior teams located in the U.S. Many players were drafted from high school, with the country not identified. We assumed they were U.S. schools in the unreported work mentioned above.

We consider two questions. First, how many of the drafted players at each position are European? Second, how well have these European players performed compared to their expected performance as defined by our model?

### 8.1 How many European players are drafted?

A simple way to answer this question is with the percentage of players drafted at each position who were from Europe. This would not take into account whether they were selected near the top or the bottom of the draft. Instead, we plot the percentage of the total predicted games played or points of the drafted players at each position who were from European teams in Figures 6 to 10. This amounts to a weighted percentage of players drafted, with a larger weight being placed on players drafted higher. If games played is the performance measure, these weights are the pick number effects for games played shown in Figures 2 and 3. For points, the weights are the pick number effects shown in Figures 4 and 5. Europeans have tended to be picked later in the draft than have been North Americans, so the unweighted percentage of all drafted players who are European is greater than the percentages appearing in the Figures.

Since the predicted games depend only on the estimated pick number effects and actual pick numbers, we can show these percentages right up to the 1998 draft. Not surprisingly, these plots are much higher at the end of the sample period than at the beginning, when they were zero. But it might be surprising that they have not risen since the early 1990s, and in fact appear to have fallen for forwards and defensemen since 1992. Since then, the percentage has settled down at roughly 20%. It is worth repeating here, though, that some European players now are being drafted from North American teams, and hence are counted as North American in this study. The predicted plot for goaltenders is bumpier due to the relatively small number of goaltenders drafted each year. In most years, a lower percentage of goaltenders drafted are European than at other positions.

8.2 How well have European players done?

We compare the predicted plot with a plot of the actual total games played (or points) of the European players as a percentage of total games played of all players drafted that year at that position. This comparison indicates how well the European players have done compared to the model's prediction, which treats them the same as North Americans. If the actual plot lies above the predicted, it indicates that the European players were undervalued; that is, they did better than expected given when they were picked. When the performance measure is career points, such a result could be due to a tendency for defensively-oriented players, who get under-valued by our method when using points as the performance measure, to be North American. Total games played, however, should be less affected by this bias.

Using either performance measure, the European forwards and defensemen drafted in the 1988-92 period have done much better than predicted. This is also a period in which the Europeans' predicted percentages increased rapidly, possibly as franchises tried to catch up to the fact that these players were doing very well. Some of these gaps are extremely large. The European defensemen drafted in 1991, for example, have scored about 64% of all of the points scored in the NHL by defensemen who were drafted in that year as of 1997-98. Based on where they placed in the draft, one would have predicted them to have scored less than 15% of the total! (See Figure 9.) The games-played gaps are a bit smaller, but still very large during this period. Although we do not provide hypothesis tests, the size of these gaps and the fact that they persist for several consecutive years for both forwards and defensemen gives strong evidence that the gaps are statistically significant.

With few exceptions, this gap did not exist prior to 1988. It seems that franchises were not successfully using any special knowledge to draft good European players late in the draft before 1988. Another possibility is that European players drafted pre-1988 may have tended to be older than the North American draftees, reducing their expected career games. The gap has narrowed after 1992, but since these more recently drafted players had not had much NHL experience as of the 1997-98 season, this narrowing may or may not be real.

This surge in Europeans' performances beginnning in the 1988 draft year may be a result of a higher fraction of drafted players coming to North America from Europe than previously, due to political developments in Europe and escalating NHL salaries. As franchises realized that this probability had increased, they started choosing European players higher in the draft, causing the predicted plots in Figures 6 to 9 to increase in the early 1990s.

The 1988-92 period also saw European goaltenders drafted who performed much better (i.e. played more games) than expected, although the year-to-year pattern, shown in Figure 10, is not as consistent as it is for non-goaltenders.

## 9. CONCLUSION

We have modeled the expected performance of hockey players selected in the NHL Entry Draft as the product of a year effect and a "pick number effect", which is a non-increasing function of their pick number, or rank in the draft. A least-squares method is developed that generalizes the pool-adjacent-violators algorithm to multiplicative fixed (year) effects.

Findings include: Franchises can predict the scoring performances of top-ranked forwards much better than the success (as measured by career games played) of top-ranked goalies; Buffalo, Edmonton and Quebec/Colorado have drafted well, Minnesota/Dallas has not; Europeans drafted during 1988-92 performed much better than predicted; and the percentage of drafting "resources" (as measured by expected games) devoted to players from European teams has not increased since 1992.

The estimator is used only as a data-descriptive device, since we have not derived distributional results. Asymptotic results could follow the approach of Hansen et al. (1973) for estimators from PAV, or they could use a large-year assumption, or a combination.

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TABLE 1.
FRANCHISE DRAFTING PERFORMANCE, 1969-95: GAMES PLAYED

| Rank | Franchise | First Year | Last Year | Actual Games | Predicted Games | Difference | Percent Diff. |
|---|---|---|---|---|---|---|---|
| 1 | Buffalo | 70 | 95 | 39 323 | 34 055 | 5268 | 15.5 |
| 2 | N.Y. Rangers | 69 | 95 | 39 621 | 34 949 | 4671 | 13.4 |
| 3 | Quebec/ Colorado | 79 | 95 | 22 365 | 18 264 | 4101 | 22.5 |
| 4 | Montreal | 69 | 95 | 53 019 | 50 000 | 3019 | 6 |
| 5 | Winnipeg | 79 | 95 | 21 683 | 18 894 | 2789 | 14.8 |
| 6 | N.Y. Islanders | 72 | 95 | 33 100 | 31 397 | 1703 | 5.4 |
| 7 | Boston | 69 | 95 | 33 489 | 32 191 | 1298 | 4 |
| 8 | Edmonton | 79 | 95 | 17 475 | 16 420 | 1055 | 6.4 |
| 9 | San Jose | 91 | 95 | 3141 | 2783 | 358 | 12.9 |
| 10 | Atlanta/ Calgary | 72 | 95 | 30 719 | 30 395 | 324 | 1.1 |
| 11 | Detroit | 69 | 95 | 34 568 | 34 397 | 171 | 0.5 |
| 12 | Chicago | 69 | 95 | 33 033 | 32 890 | 143 | 0.4 |
| 13 | Florida | 93 | 95 | 1212 | 1081 | 131 | 12.2 |
| 14 | Ottawa | 92 | 95 | 1769 | 1669 | 100 | 6 |
| 15 | Hartford | 79 | 95 | 17 470 | 17 434 | 36 | 0.2 |
| 16 | Anaheim | 93 | 95 | 1014 | 1051 | -37 | -3.5 |
| 17 | Toronto | 69 | 95 | 34 408 | 34 456 | -48 | -0.1 |
| 18 | Tampa Bay | 92 | 95 | 1662 | 1757 | -95 | -5.4 |
| 19 | Kansas City/ Colorado/ New Jersey | 74 | 95 | 27 064 | 28 185 | -1121 | -4 |
| 20 | Washington | 74 | 95 | 25 448 | 26 905 | -1457 | -5.4 |
| 21 | Los Angeles | 69 | 95 | 24 689 | 26 847 | -2158 | -8 |
| 22 | Pittsburgh | 69 | 95 | 27 323 | 29 505 | -2182 | -7.4 |
| 23 | Vancouver | 70 | 95 | 29 905 | 32 588 | -2683 | -8.2 |
| 24 | California/ Oakland/ Cleveland | 69 | 77 | 9931 | 12 986 | -3055 | -23.5 |
| 25 | Philadelphia | 69 | 95 | 30 019 | 33 450 | -3431 | -10.3 |
| 26 | St. Louis | 69 | 95 | 24 739 | 28 617 | -3878 | -13.6 |
| 27 | Minnesota/ Dallas | 69 | 95 | 25 939 | 35 633 | -9694 | -27.2 |

TABLE 2.
FRANCHISE DRAFTING PERFORMANCE, 1969-95: POINTS

| Rank | Franchise | Actual Points | Predicted Points | Difference | Percent Diff. |
|---|---|---|---|---|---|
| 1 | Atlanta/ Calgary | 17 021 | 13 773 | 3248 | 23.6 |
| 2 | N.Y. Rangers | 19 787 | 16 984 | 2803 | 16.5 |
| 3 | Edmonton | 10 156 | 7389 | 2767 | 37.4 |
| 4 | Buffalo | 19 528 | 16 974 | 2554 | 15 |
| 5 | Quebec/ Colorado | 10 723 | 8775 | 1948 | 22.2 |
| 6 | Winnipeg | 11 253 | 9355 | 1898 | 20.3 |
| 7 | N.Y. Islanders | 17 007 | 15 452 | 1555 | 10.1 |
| 8 | Boston | 17 418 | 16 248 | 1170 | 7.2 |
| 9 | Detroit | 18 405 | 17 614 | 791 | 4.5 |
| 10 | Los Angeles | 13 166 | 12 638 | 528 | 4.2 |
| 11 | Montreal | 26 057 | 25 740 | 317 | 1.2 |
| 12 | Ottawa | 989 | 757 | 232 | 30.6 |
| 13 | San Jose | 1426 | 1221 | 205 | 16.8 |
| 14 | Florida | 447 | 392 | 55 | 14.1 |
| 15 | Anaheim | 488 | 457 | 31 | 6.9 |
| 16 | Tampa Bay | 626 | 674 | -48 | -7.1 |
| 17 | Chicago | 16 464 | 16 637 | -173 | -1 |
| 18 | Hartford | 8353 | 8786 | -433 | -4.9 |
| 19 | Toronto | 16 107 | 17 043 | -936 | -5.5 |
| 20 | Pittsburgh | 14 129 | 15 338 | -1209 | -7.9 |
| 21 | Washington | 12 235 | 13 614 | -1379 | -10.1 |
| 22 | Vancouver | 15 118 | 16 505 | -1387 | -8.4 |
| 23 | Philadelphia | 15 335 | 16 751 | -1416 | -8.5 |
| 24 | California/ Oakland/ Cleveland | 5108 | 6637 | -1529 | -23 |
| 25 | Kansas City/ Colorado/ New Jersey | 12 758 | 14 447 | -1689 | -11.7 |
| 26 | St. Louis | 11 551 | 13 500 | -1949 | -14.4 |
| 27 | Minnesota/ Dallas | 11 127 | 18 115 | -6988 | -38.6 |

**Figure 1**
Year Effects on Games Played

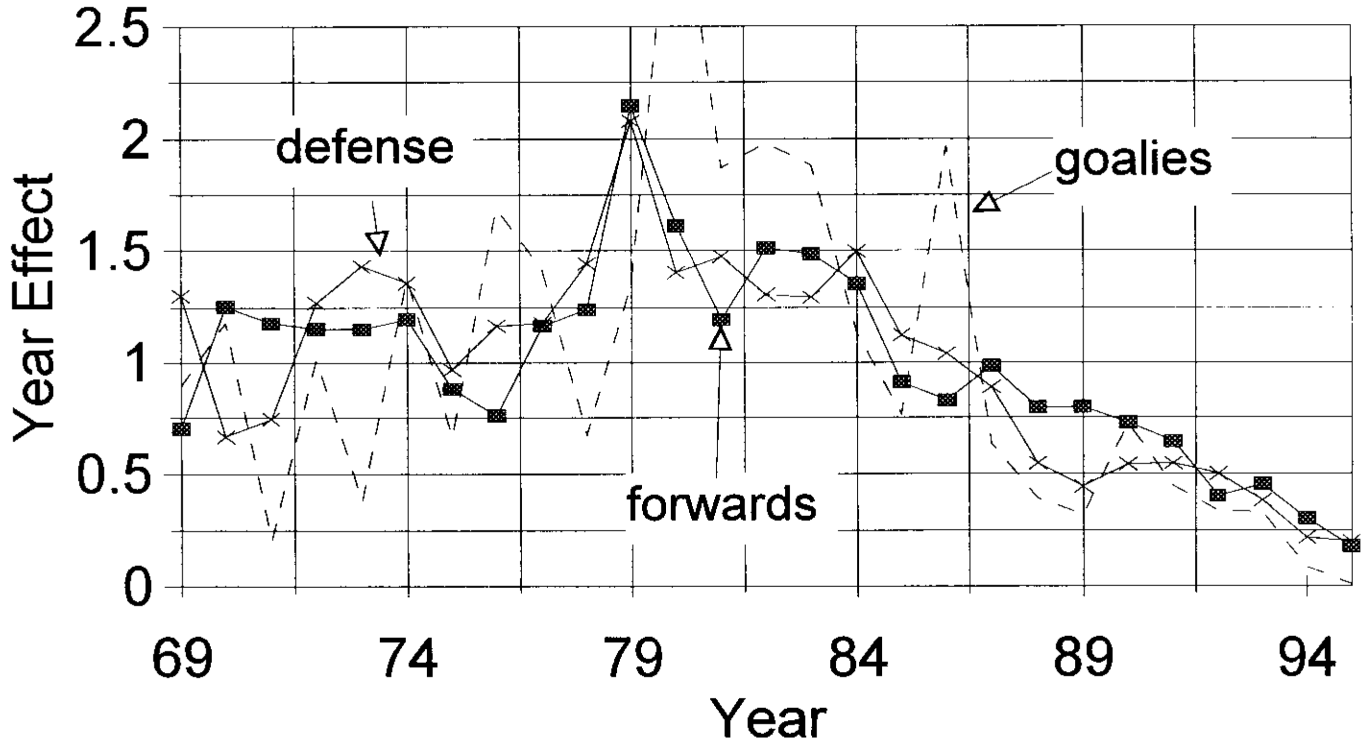
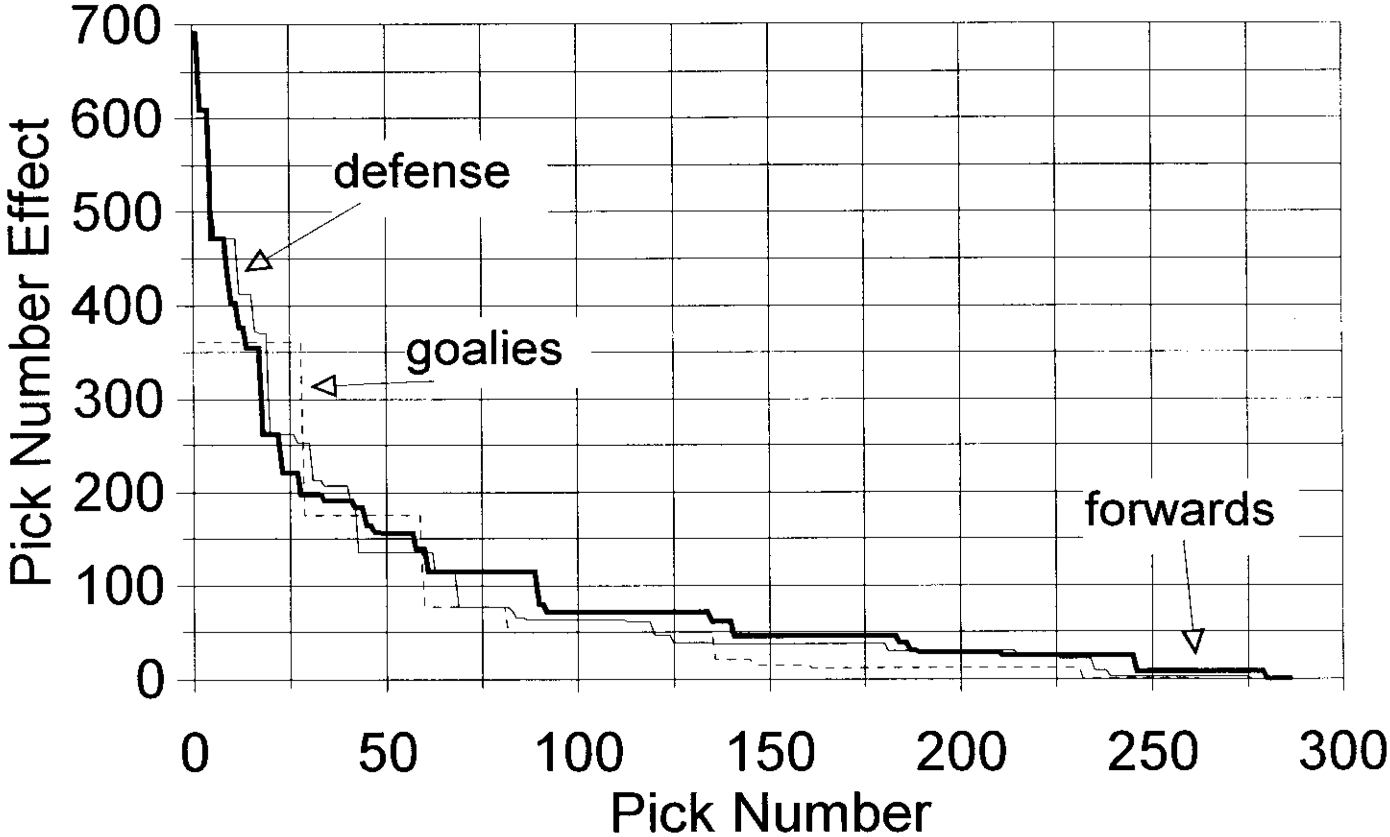


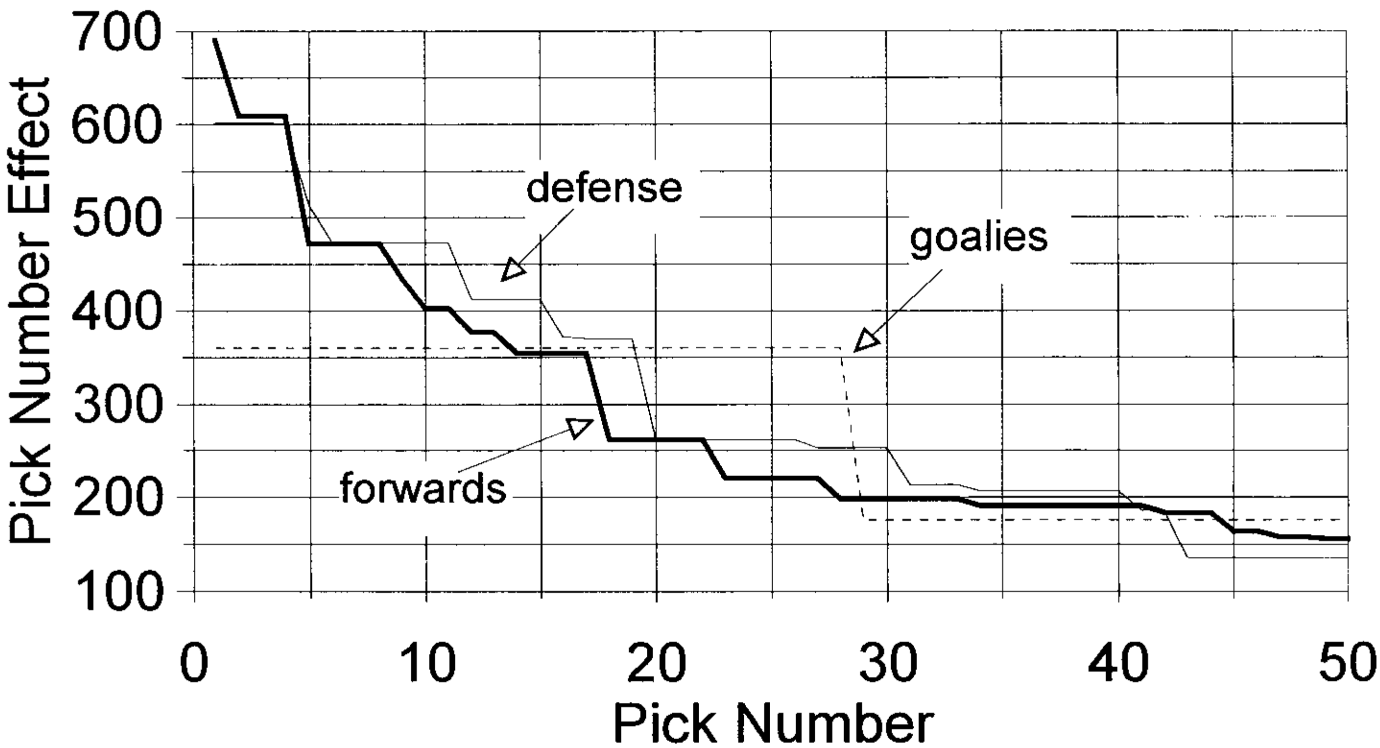
**Figure 2**

Pick Number Effect on Games Played



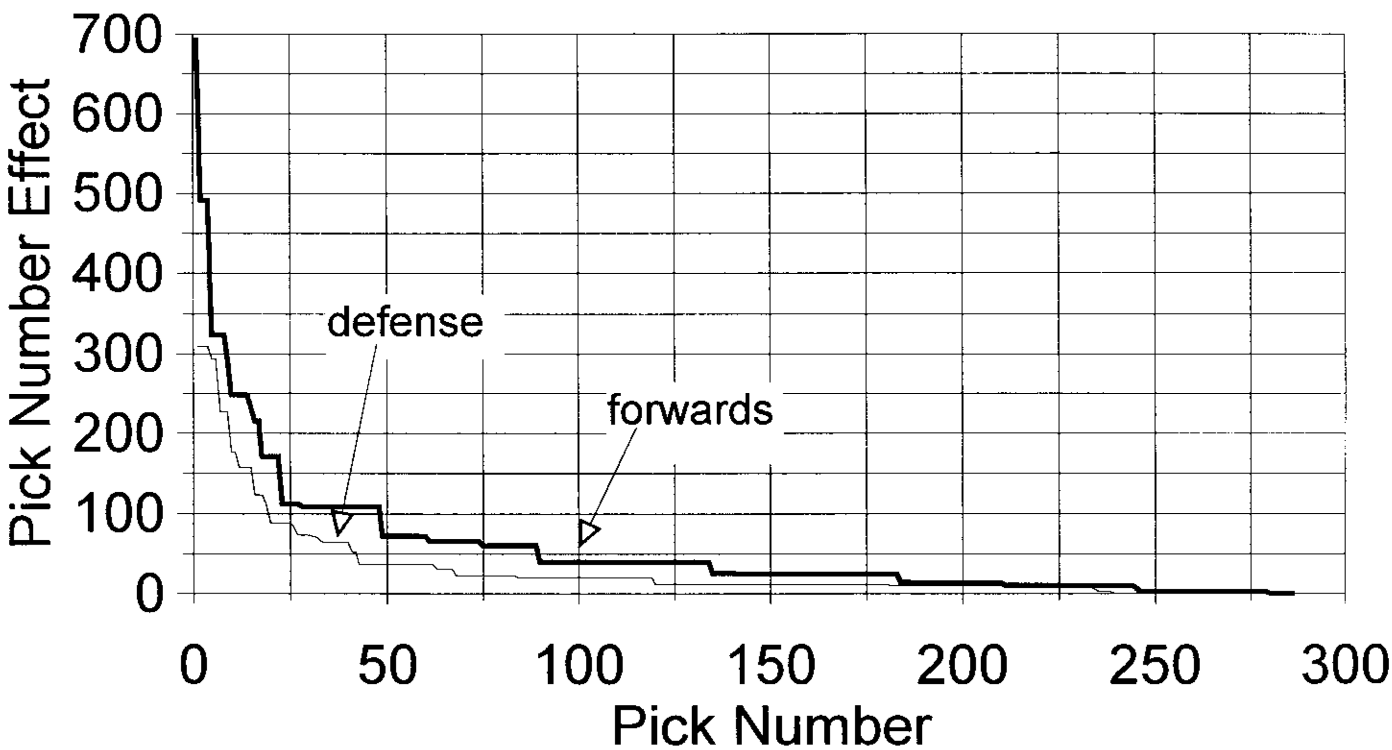
# Figure 3

## Pick Number Effect on Games Played



# Figure 4

## Pick Number Effect on Points



# Figure 5
Pick Number Effect on Points

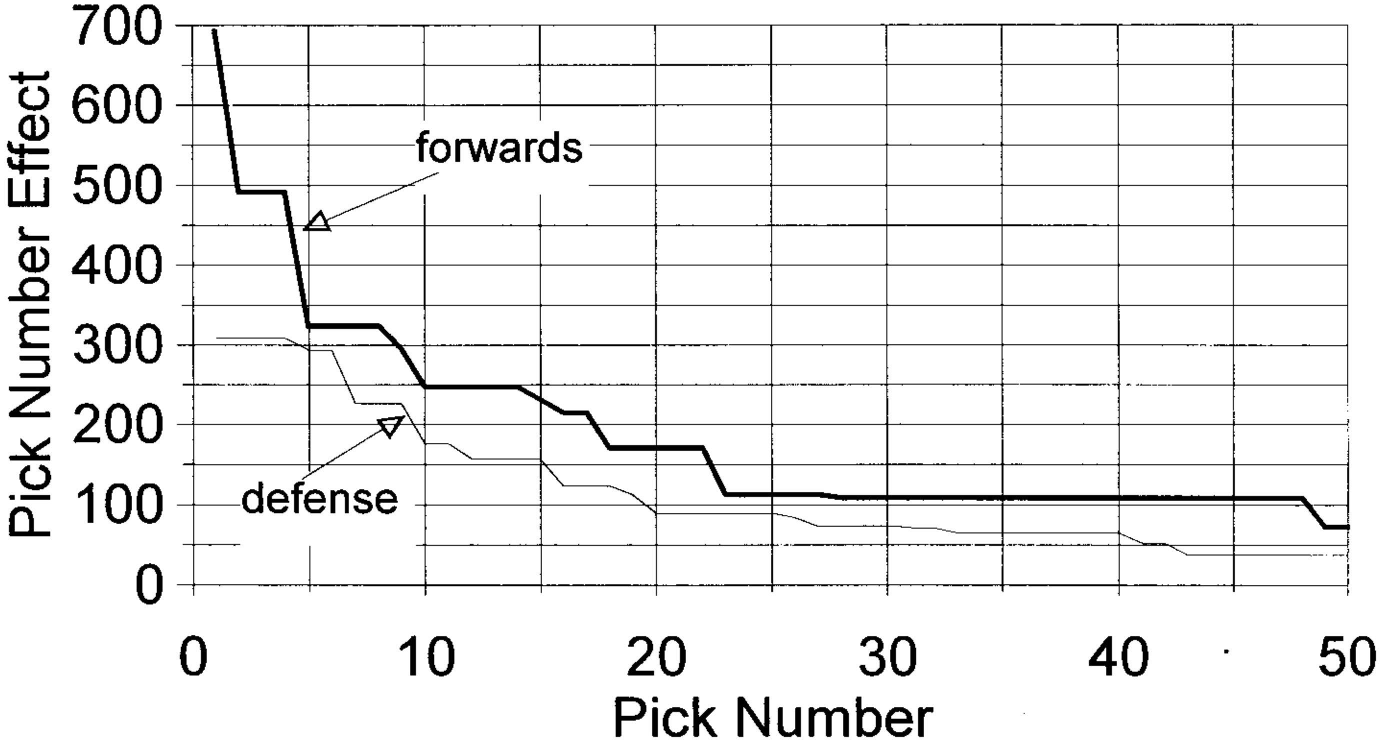


**Figure 6**

European Forwards, Games Played

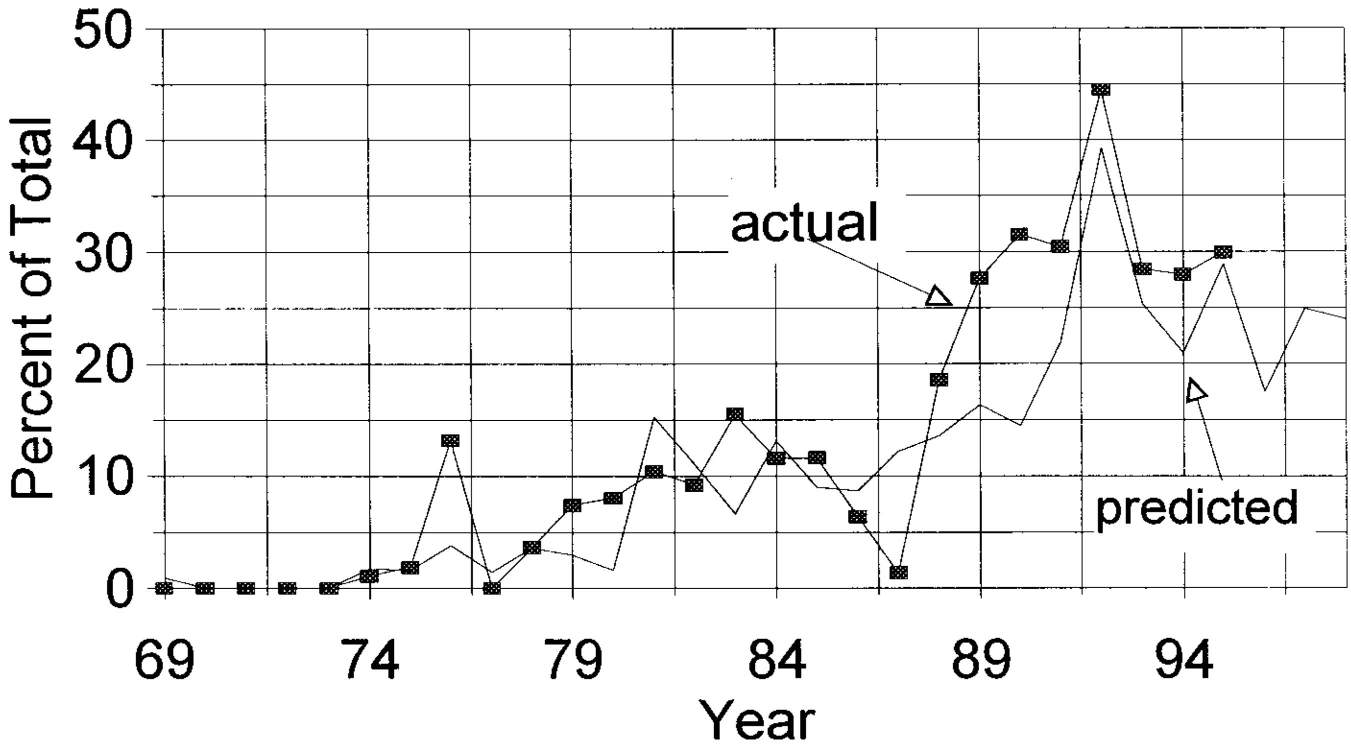
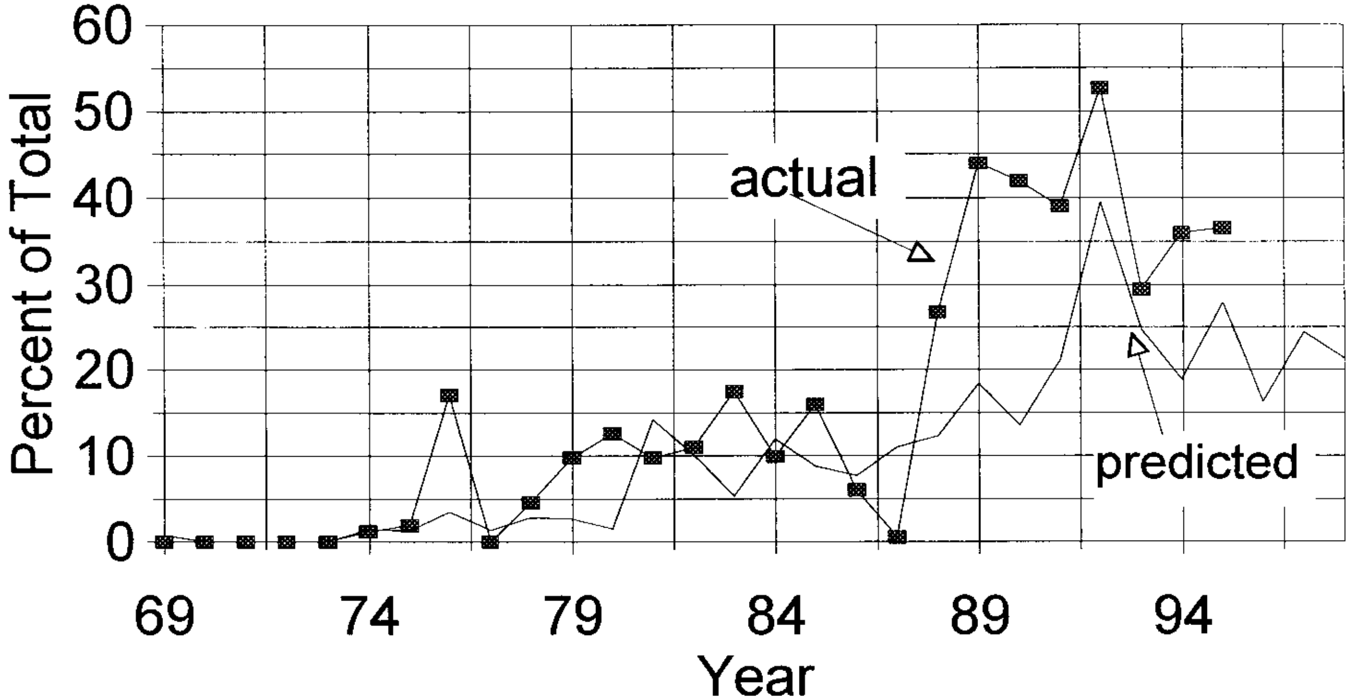


**Figure 7**

European Forwards, Points



## Figure 8
European Defensemen, Games Played

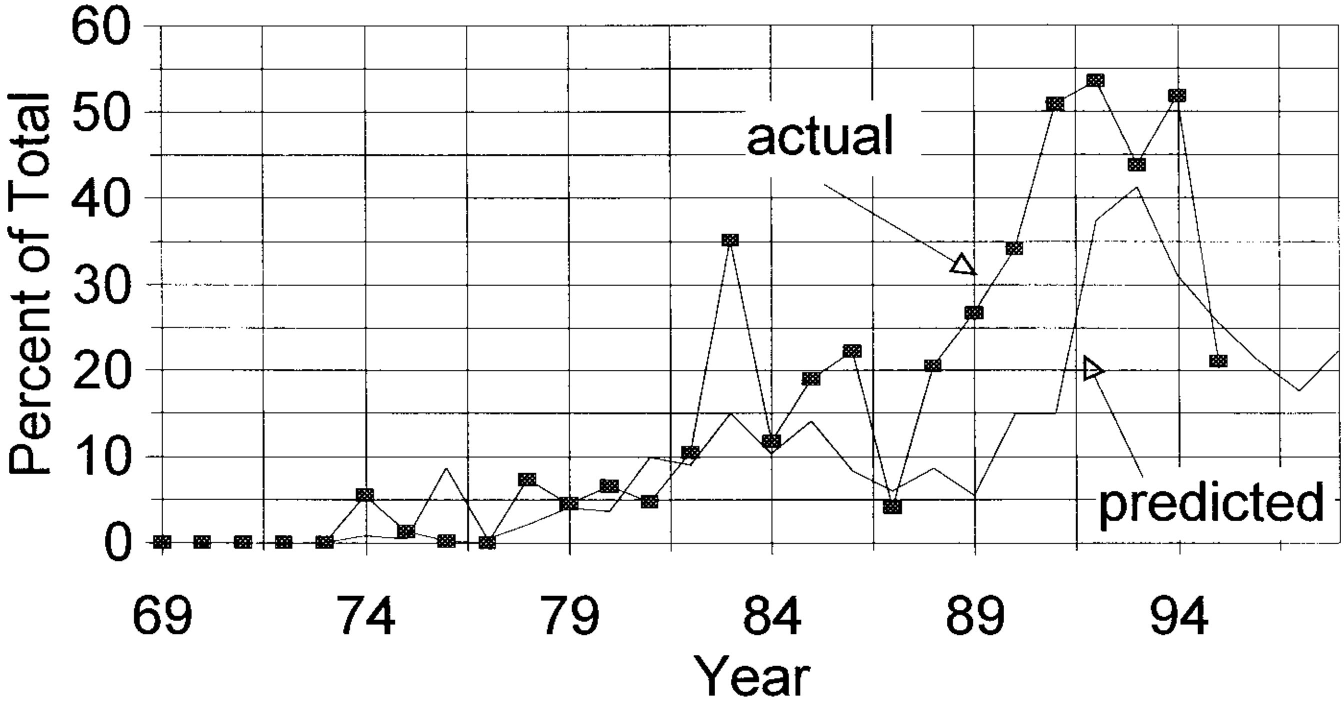


**Figure 9**

European Defensemen, Points

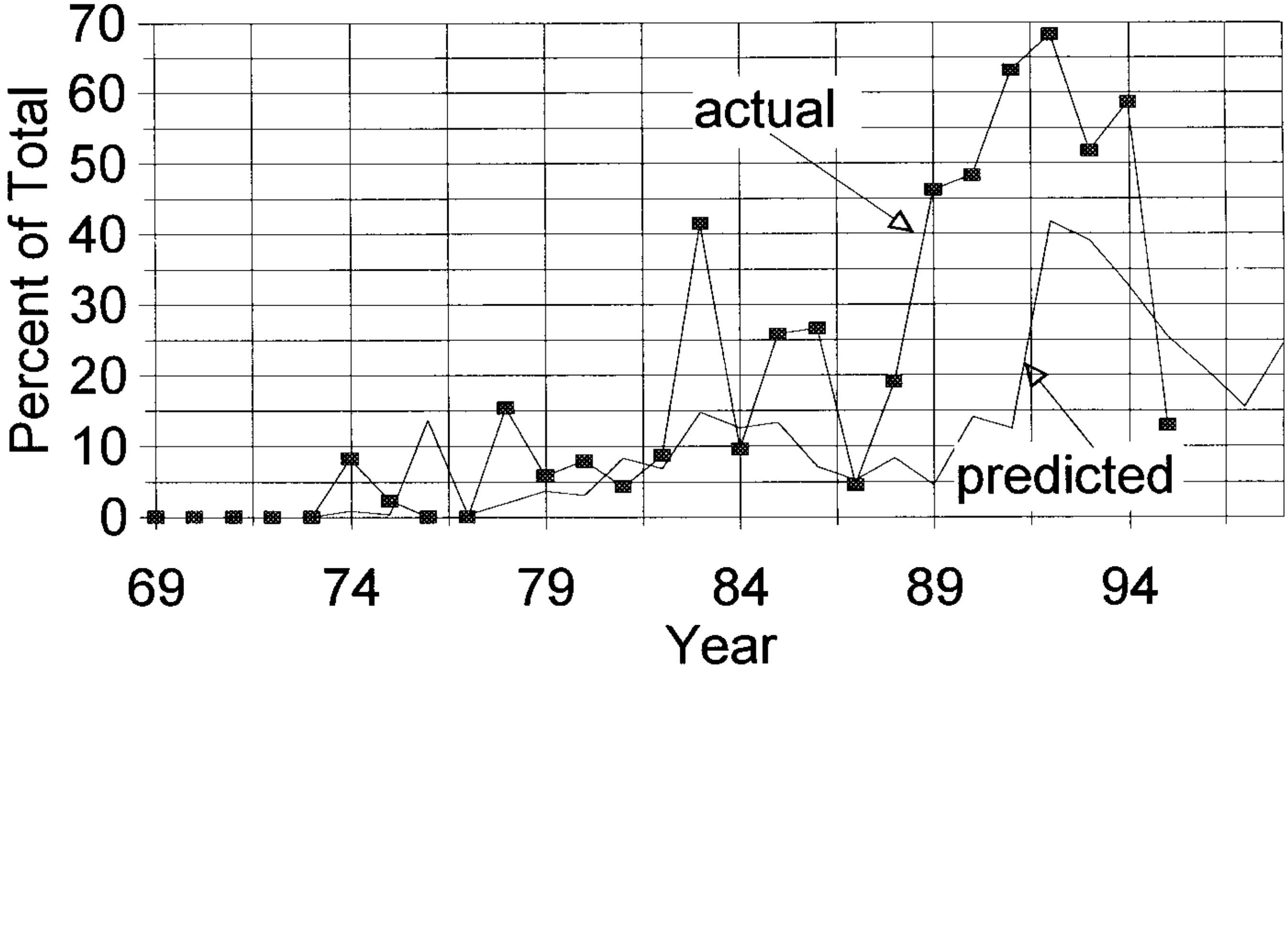
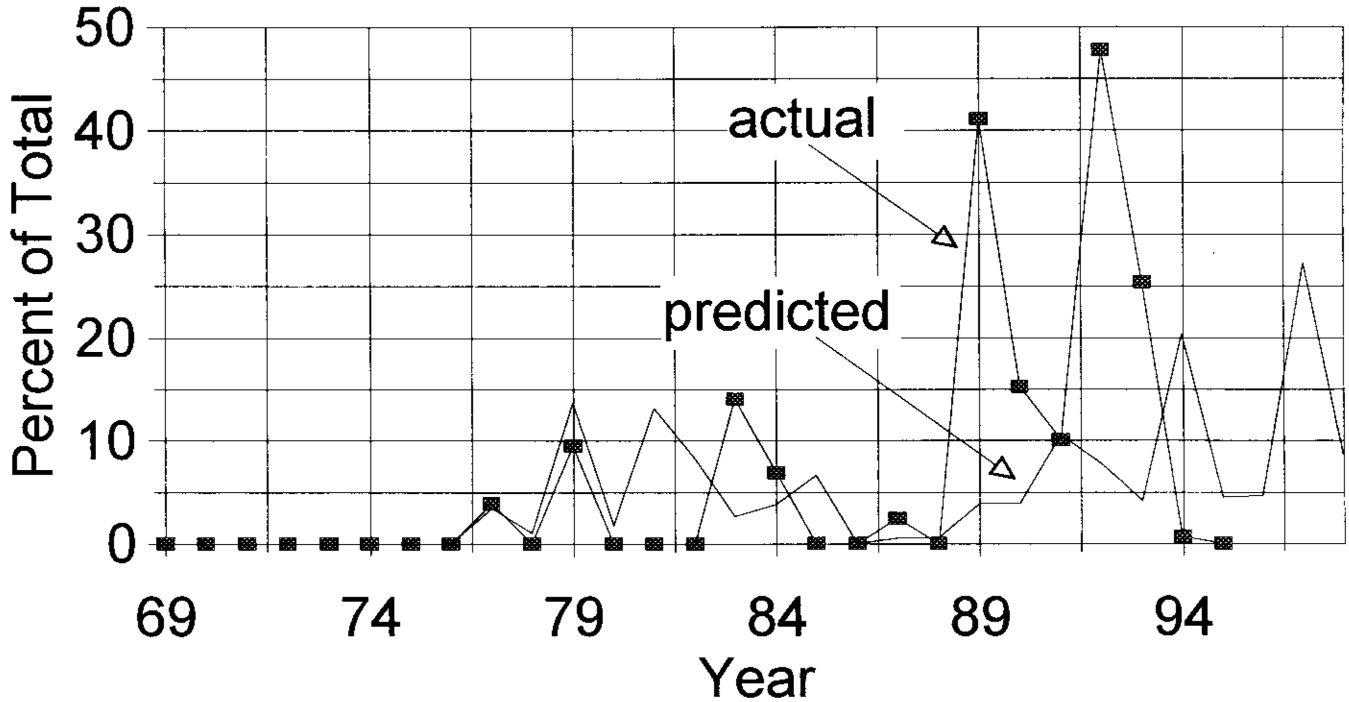


**Figure 10**

European Goalies, Games Played



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