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Internal Promotion in Competitive Sports: Evidence from the English Premier League

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Abstract

The analysis of English Premier League clubs' reliance on internal versus external sources for new additions to the first-team is motivated by relevant labor economics literature. We consider two dimensions for analysis: (i) the extensive margin that drives the selection of youth players in the first team, and (ii) the intensive margin that looks at their career lifespan once selected. Two uniquely created data sets are utilized to establish robust results in support of the notion that more reputable youth programs provide greater first-team opportunities through internal hiring. Foreign sourced players become more prevalent in the league after the Bosman ruling, and their probability of selection is positively correlated with club stature. Survival analysis results validate prior results in terms of youth training reputation of certain clubs, and establishes a presence of heterogeneity at youth club level that signals differences in player career prospects generated by their youth training. Further, when the unobserved heterogeneity is modelled using discrete finite mixtures we get new insights into the role unobservables in the analysis. In particular, two types of players are identified in the data, one type that represents 33% is the one that drives the exits of the youth players. In addition, this model shows that the Bosman ruling positively impacts the career duration of youth players, as opposed to its negative effect on first-team selection.

Key Words: internal promotion, external hiring, binary resposnse models, Bosman ruling, duration models;

JEL Classification: J21, J24, J61, C14, C41, C52.

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1 Introduction

Internal promotion or external hiring is a dilemma faced by firms operating in many distinct sectors of the economy. Heavy investment in training exposes firms to the risk of losing the talented employees they trained to competitors without exhausting the full benefits of their investment. External hiring has its own risks and uncertainties surrounding the worker's ability to integrate effectively within the new firm. Unsurprisingly, this economic dilemma is encountered in professional sports around the globe, particularly in European football. The football clubs in Europe make a spectrum of investment decisions that can significantly affect their long-term success and financial stability, but very few are as important as deciding whether to invest heavily in their youth academies or resort to the transfer market to recruit new players. Providing first-team opportunities to players developed in the youth academy can be viewed as promoting from within, while hiring first-team players from other sources can be viewed as external hiring. The increasing importance of this dilemma is evident in the current market where transfer fees for star players are in excess of 100 million euros;[1] Building a team by relying solely on the transfer market is unimaginable even for the wealthiest of clubs. Developing and nurturing of home-grown talent presents an alternative strategy that could be far less costly but possibly more uncertain in terms of attaining sufficiently talented players in the long-run. Most clubs these days, particularly in top European competitions, rely on both streams for bringing in new players but the weighting of investment in these two alternatives varies by club.

There are significant risks associated with both options that vary by club size and stature, which are further complicated by the transfer market for players under contract in Europe. For example, and much like in any other sector of the economy, football clubs may lose the youth players they developed to other clubs, which could be troubling if their goal was to keep them and integrate them in the first-team. On the other hand, clubs can invest in youth academies in order to generate profit from the sale of these players in the transfer market if their focus is on profit maximization in the short-run, rather than on win maximization. Bringing in players from external sources carries the inherent risk of them not being able to fit in to the new team and system, which can

[1] Gareth Bale was sold by Tottenham to Real Madrid for a fee that exceeded 100 million euros. Luis Suarez was transferred from Liverpool to Barcelona for over 80 million euros, while James Rodrigues went from Monaco to Real Madrid for around 90 million euros in the summer of 2014.

stem from their personal characteristics to professional ones. The scale of a club and financial resources available are an important determinant in these decisions as well; Larger clubs have more options available in this regard, while smaller clubs do not have the financial ability to compete for talent in the transfer market, which might dictate their decision to focus on the youth development channel.

The Bosman ruling (December, 1995) in Europe certainly added an additional level of complexity in these decisions faced by clubs. The talent pool available to clubs expanded significantly as a result of the elimination of the foreign player quota for players originating from EU countries. In addition, players that were out of contract at their club were allowed to move for free (without any transfer fees) to another club, which potentially exposed clubs to greater risk in terms of losing the players they developed through the youth system without any compensation. All of these changes brought interesting dynamics to the internal vs external hiring decisions of football clubs. Therefore, examining the hiring patterns (or the extensive margin of the analysis) of top-division clubs presents an analytical question worth exploring, especially in the years surrounding the Bosman ruling.

Certain clubs have built a reputation of youth development and training that emphasizes their focus and investment in this channel. Examples of world renowned football academies include the likes of FC Barcelona and Real Madrid in Spain, Bayern Munich in Germany, Ajax in Holland, Udinese in Italy, Sporting Lisbon in Portugal, Arsenal in England, etc. The focus of this analysis is on the English Premier League, where some of these most reputable youth academies and football clubs reside. Radoman and Voia (2015) analyzed the historical performance of youth players from 16 top-level English clubs in terms of their career duration in top European leagues. This paper uses that information to create a unique index for youth development reputation of the clubs examined in the current study. In addition to this index and the original data set, this paper creates a link between existing internal vs. external hiring labor literature and a club's decision to hire new players externally or resort to their internal resources (their youth system). The index establishes an inherent ranking in terms of reputation of youth programs among English Premier League clubs, and the multi-stage empirical analysis solidifies the theoretical assumptions that more reputable clubs provide more opportunities to their youth players. The behavior of clubs is analyzed in a specific period that accounts for a major institutional change in the sport, the Bosman ruling. The club ordered results are consistent when controlling for the ruling, even though youth sourced players were negatively affected by this change in favor of foreign player hires. Dominant, or more competitive, clubs (in terms of league performance) have a higher probability of selecting foreign players in available first-team slots, which is amplified after the Bosman ruling. This result signals their superior resources in the augmentation of their player-recruitment operations after the institutional changes freed up the EU labor market for players. Furthermore, survival analysis (intensive margin analysis) is performed that validates the index club reputation when it comes to career duration of youth products at the top level of European football. One interesting result suggests that unobserved heterogeneity is not present at player level, while it becomes a significant factor at the youth parent club level. This indicates that there is a unique "schooling" aspect to each youth program that equips players with necessary skills for a lengthy career at the top level.

The remainder of the paper is structured as follows: Section 2 outlines the theoretical motivation for the research task at hand, section 3 provides an overview of the data generating process and an overall summary of the data, section 4 describes the sequential empirical methodology employed, section 5 provides the extensive margin analysis results for the first step independent probit estimation, and of the second step bivariate probit estimation, section 6 describes the intensive margin analysis results of the survival analysis stage of the empirical methodology and section 7 concludes the paper.

2 Motivation

Applying certain labor market theory can aid in explaining the change in the English Premier League competitive environment brought upon by this institutional change, and can explain the different behavior of clubs in these circumstances. One particular angle of labor economics is worth exploring from a sports economics context, particularly European football; Internal promotion versus hiring from external sources. A fundamental question is why do firms invest in training of employees when they might lose them to competitors later on? A similar question can be asked in European football regarding club investments in their youth academies when first-team spaces are very limited and they risk losing quality players that they trained and invested in.[2] Waldman

[2] One recent example is Paul Pogba, a player brought up through Manchester United's youth system but who joined Juventus on a almost free transfer when his youth contract

(2013) provides a survey of economic literature on this issue, focusing on tying economic theory with empirical evidence. Oyer (2007) argues that there is an insider advantage in getting tenure for economic academic positions in universities (outside the top-ten economic institutions), even though external candidates are generally more productive.

DeVaro and Morita (2013) present a theoretical and empirical analysis of internal promotion versus external recruitment for managerial positions, using a cross section of British firms. They argue that a firm's decision to hire managers internally versus externally is influenced by the size and the quality of the talent pool available at the lower ranks, which is inherently determined by the firm's own hiring decisions. They argue that a firm with higher return to managerial capability tries harder to fill the management positions by hiring internally, and such firms hire more subordinates at lower levels and provide them with more general training to increase the number of workers with managerial potential. Therefore, these "bottom-heavy" employers have a greater probability of filling their management positions through an internal hierarchy. According to the authors, their theory potentially explains common empirical findings that large firms are more likely to hire CEOs internally than small firms. This logic is applicable in the sports industry as well, and explains why certain clubs/teams invest more heavily in their youth training programs, as well as coaching and scouting at that level. Clubs that have built-up a reputation and a track record in terms of youth training should have a higher probability of filling first-team spaces via internal sources, particularly from its own youth academy. Hence, this type of labor market theory can be examined through the sports economics perspective, and this paper does just that by examining English Premier League clubs that endogenously determine their own hierarchical structure and weight of investment in youth training.

This paper also builds on the results of Radoman and Voia (2015) and attempts to assess whether clubs with high-performing youth programs maintain their historical reputation and focus on youth players in a narrower time span. What makes this analysis more interesting is that the time span examined encompasses the ever important Bosman ruling, and allows for testing its effects on the hiring behavior of English Premier league clubs. The Bosman ruling represents one of the most significant external shocks in the history of European sports and its effects and implications have been the subject of analysis of many

expired. His current value exceeds 60 million euros, and Manchester United will not benefit at all from his talents or future transfers.

academic studies. The English Premier league is considered to be the richest among top European leagues in terms of club turnover and player salaries, especially after the Bosman ruling.[3] This ensures a highly competitive environment where top players from around the globe compete for first-team spots and clubs that have an abundance of choice in their scouting efforts. The high salaries in the league attract world-class players, and the financial resources available to clubs do not constrain them in their player recruitment efforts as much as in other European leagues.

In essence, the empirical analysis will attempt to address some important questions that are applicable in a wider labor economics context: (i) Do more youth-reputable (or bottom-heavy) clubs give greater opportunities to youth players in their first-team?, (ii) How is their behavior affected by significant external shocks, such as institutional changes brought upon by the Bosman case?, (iii) Are smaller clubs able to compete with larger clubs in acquiring foreign talent, or does the Bosman ruling inherently change the focus on internal versus external promotion for clubs of different scale?

3 Data and Summary Statistics

The data set is composed of 857 players that entered the English Premier League for the first time[4] from the 1992/1993 to the 1999/2000 season. Relevant information was gathered from publicly available internet sources, but mainly from the following sites: http://www.worldfootball.net/, http://www.transfermarkt.co.uk/en, and http://www.soccerbase.com. The beginning of the data collection period coincides with the establishment of the Premier League, and the seasons examined incorporate the effects of the Bosman ruling, which occurred almost midway through the analysis period. Players are distinguished by source of entry within three categories: players coming from a club's youth program ("Youth"), players sourced from lower level[5] domestic leagues ("Domestic"), and players sourced from foreign leagues ("Foreign"). The data collected for each player also in-

[3] Please refer to Radoman (2015) for more details on the growing trends in European football.

[4] In fact, the data consists of all new entrants in the Premier League that made at least one appearance in the first team for the club that hired them. This is particularly important when it comes to youth player because clubs have a number of youth players under contract at any time, but only a few are given opportunities in the first-team so this is a better measure with this regard.

[5] Lower level leagues in England include: The Championship, League One, League Two, etc.

cludes: club/team that hired the player and the team's table position/ranking in the league at that point, transfer fee paid for the player's rights (applicable only if players was sourced externally), player's name, position, age, nationality, whether the player entered before/after the Bosman ruling, international experience of player before entry,[6] experience in top-level leagues outside of England,[7] and the share of foreign players in the Premier League for each season. In addition, an index of youth training reputation is created using the results from Radoman and Voia (2015) in order to examine the consistency of the results and reputations of these clubs during the period affected by the Bosman ruling. Radoman and Voia based their analysis on 16 clubs and the ordinal index applied in this paper is generated as follows: category 1 clubs includes the top five clubs in terms of career duration of the players brought up through their youth system,[8] category 2 clubs includes youth programs ranked from 6-10,[9] category 3 clubs contain the remaining clubs of the ones examined,[10] and category 4 includes all clubs not examined. In addition, a separate youth ranking index is created that includes Manchester United (Man U) in the first category of youth programs.[11] The main reason behind this is that Man U changed their focus on youth development before and during the study period, especially since the arrival of their legendary manager, Sir Alex Ferguson in the late 80s, and their historical ranking is not consistent with the current study period. In fact, Man U's golden generation of youth players entered the market during this particular analysis period, so it could be problematic to group them in a lower-ranked category. Another index is created (Team rank) to rank the clubs by their position in the table to establish a certain grouping and differences in club stature. Clubs ranked in the top 7 positions of the Premier league table are grouped in

[6] Data is recorded if a player represented his country at junior or senior levels. If the player represented his country at all levels, only the senior level is recorded because it is the highest achievement attainable at the international level. Obviously, youth players generally do not represent their countries at the senior level before they make a first-team appearance for their club so their highest attainable level is the junior level at that stage of their career.

[7] Players are differentiated by their experience in a top-level league from Europe versus experience in any other top-level league outside these leagues.

[8] The highest performing five clubs (category 1) in all relevant model specifications in Radoman and Voia (2015) are: Arsenal, Liverpool, Tottenham, Leeds United, and West Ham.

[9] The clubs in this category include: Everton, Chelsea, Newcastle, Nottingham Forrest, and West Brom.

[10] This category includes the lowest ranked from the 16 clubs examined: Manchester United, Manchester City, Sheffield Wednesday, Coventry City, Southampton, and Aston Villa.

[11] The original index created ranks Man U in category 3 youth programs based on historical performance that does not account for this particular study period with sufficient weight. Therefore, the index is modified to include Man U in the top category but as we will see later, the results are not dependent on the index applied.

category 1, while clubs ranked in positions 8-15 are grouped in category 2, and the bottom 5 ranked clubs are considered category 3 clubs. The logic behind the ranking is that the top 7 places in the league lead to places in European competitions, which are generally occupied by the most competitive clubs in the league; the bottom 5 clubs are typically the ones fighting for survival in the league by avoiding relegation, and the rest of the clubs can be considered mid-ranking clubs.

Out of the total of 857 players, 357 entered in the pre-Bosman period, while 500 entered in the post-Bosman period. These entries can be broken down further by player source; In the pre-Bosman period there were a total of 131 Domestic entries, 147 Youth player entries, and 79 player entries from Foreign sources, while in the post-Bosman period there were 110 Domestic entries, 149 Youth entries, and 241 Foreign source entries. Unsurprisingly, the number of foreign player entries increased significantly (more than tripled) as a result of the removal of the foreign player quota and foreign player entries represented nearly half of all new entrants to the Premier League in the post-Bosman period versus close to 25% in the pre-Bosman period. It appears that players sourced from Domestic sources suffered the most as a result of the Bosman ruling in terms of opportunities in the Premier League; they represented 37% of player entries in the pre-Bosman period versus 22% in the post-Bosman period. Players sourced from Youth academies were least affected in terms of absolute entries, but their relative percentage of entries was reduced by around 11% as well. It appears that increased competition resulting from the ruling negatively impacted players sourced domestically and in general, clubs were willing to take on greater risks in terms of giving opportunities to unproven players in the Premier League as the total number of new entrants increased significantly.

Table 1 breaks down the pre and post Bosman entries by player source in more detail. Looking at the youth program ranking index we can see a shift in hiring patterns for clubs in all categories as a result of the Bosman ruling. The availability of foreign talent in the post-Bosman period resulted in a significant shift towards foreign players for all clubs in the study. It appears that experience in foreign leagues outweighs all other factors associated with unproven players in the Premier League. Consistent with the motivating theory, top ranked youth programs (category 1) continued to give the most first-team opportunities to unexperienced youth players, but this percentage went down from 55% to 33% as a result of the Bosman ruling. This percentage went down from 32% to 23% for category 2 clubs, and from 47% to 24% for category 3 clubs. Domestically sourced players suffered the most in terms of first-team opportunities, particularly at top ranked youth programs, who substituted away from them and youth players (to a lesser extent) towards foreign players. The hiring patterns changed at the position level as well; Domestically and Youth sourced players were given more opportunities in the defensive positions in the post-Bosman period, rather than in the midfield and forward positions. It appears that the more technical positions (M and F), where a higher level of ball, dribbling, passing and shooting skills are required, were allocated to players sourced from foreign leagues. This is consistent with certain viewpoints that foreign players are more technically adept than domestic players in the English Premier League. Furthermore, looking at the hiring patters by club ranking we can see that top ranked clubs (in terms of table standings) shifted the most towards foreign players. When we consider teams ranked lower in the table, their reliance on foreign players increased as well but to a lesser extent than for top ranked clubs; This is particularly true for the lowest ranked club category who were fairly consistent in terms of the first-team opportunities given to players from all three sources. This might signal the much larger resources available to higher ranked clubs that allow them to expand their scouting networks without limits that could be constraining lower ranked clubs. Lower ranked clubs are usually unable to compete for top talent with more reputable clubs, and the process of establishing a scouting network for unproven or unknown foreign talent is very time and resource consuming. Therefore, this suggests that larger clubs were able to shift and/or reallocate their internal resources more quickly and efficiently than lower ranked clubs, as a result of the Bosman ruling.

Focusing on players sourced from youth programs, representing a nation at the junior international level (typically at the U21, U19, or U18 levels) becomes more prevalent for new entrants in the post-Bosman era. In the pre-Bosman period of this study, 45 out 147 youth players made international appearances prior to making a first-team appearance in the Premier League, while this is the case for 71 out of 149 youth players in the post-Bosman period. Table 2 breaks this analysis down further by the youth program ranking of the clubs in this study. Category 1 ranked youth programs maintained their reputation in terms of producing and giving first-team opportunities to youth internationals. Being an youth-level international became increasingly important to earn first-team opportunities in lower ranked youth programs as well, which signals an intensified competitive landscape in the Premier League after the Bosman ruling that filters out top youth talent more efficiently.

4 Methodology

The primary objective of this study is to assess whether clubs with more reputable youth programs (in terms of career duration of their graduates) actually provide greater first-team opportunities to their youth trainees, with a focus on the years surrounding the Bosman ruling. The secondary objective is to examine whether the reputation established in Radoman and Voia (2015)[12] upholds using this data set, especially in the wake of a major institutional change in the sport. To achieve this, a methodology that builds on a sequence of steps is developed.

The first step (the extensive margin analysis) uses probability models to identify factors that are important in providing first-team opportunities to youth and foreign players, separately. After doing this, the selection problem is modelled as a choice among three possible alternatives. The second step estimates a multinomial logit model structuring the dependent variable as a choice among three possible alternatives. The third and final step (the intensive margin analysis) involves the use of survival analysis to examine the career duration patterns of youth trainees in this data set and determine the appropriateness of prior studies in this particular time-frame.

4.1 Extensive Margin Analysis

4.1.1 Probit Analysis

The task is to estimate a model that characterizes the probabilities of hiring, or specifically giving first-team opportunities to youth and foreign players. The observation of youth first-team selection is characterized as a binary variable, Y_i, where:

$$Y_i = \begin{cases} 1 & \text{if a youth player is selected.} \\ 0 & \text{otherwise.} \end{cases} \tag{1}$$

The realization of Y_t is used to define a latent utility measure of youth selection, Y_i^*. Given the available data, this latent utility can be modelled as:

$$Y_i^* = \beta X_i + v, \tag{2}$$

[12]It is important to note that there is very little overlap, less than 10%, in this data vs. the data utilized by Radoman and Voia (2015).

where X_i represents a set of variables with player characteristics, club information, and certain macro information that might be relevant for youth selection, which is further explained in the subsequent model specifications estimated. The error term, v, is assumed to be normally distributed with mean zero and constant variance, σ_v^2. Under this assumption of normality, the model becomes a probit model and can be estimated using the reduced form:

$$Y_t = \Phi(\beta X_i) + v \tag{3}$$

where $\Phi(\beta X_i)$ is the cumulative density function (CDF) associated with the normal distribution.

The probability of foreign player selection,F_i, is modelled in a similar fashion:

$$F_i = \begin{cases} 1 & \text{if a foreign player is selected.} \\ 0 & \text{otherwise.} \end{cases} \tag{4}$$

The realization of F_i is used to define a latent utility measure of the probability of foreign player selection by an English Premier League club, F_i^*. Given the available data, the following model is employed:

$$F_i^* = \alpha D_i + u, \tag{5}$$

where D_i represents a set of variables with player characteristics, club information, and certain macro information that might be relevant for youth selection, which is further explained in the subsequent model specifications estimated. The error term, u, is assumed to be normally distributed with mean zero and constant variance, σ_u^2. Under this assumption of normality, the model becomes a probit model and can be estimated using the reduced form:

$$F_i = \Phi(\alpha D_i) + u \tag{6}$$

where $\Phi(\alpha D_i)$ is a CDF associated with the normal distribution.

Three separate probit specifications are estimated for youth players being selected in the first-team by their respective clubs:

- M1: accounts for ranking of player's youth program (Youthranking), share of foreigners in the league (forshare) at the time of entry, player's position, and a constant term.

- M2: M1 plus a dummy variable controlling for entry pre or post the

Bosman ruling (Bosman) and the relevant international experience (Inter. Exp.) of the player at the time of entry.

- M3: essentially M2 with the addition of Manchester United to category 1 youth programs.

Two separate probit specifications are estimated for foreign players being given a first-team opportunity by clubs in the English Premier League during the study period:

- M1: accounts for team ranking (Team ranking) for the club making the first-team selection, the age of the player at entry (Age), player position, dummy variable controlling for entry pre or post the Bosman ruling (Bosman) and a constant term.

- M2: M1 plus a control for a player's market value at the time of transfer/acquisition (Transfer Value), and his relevant experience at the international level (Inter. Exp.) at the time of entry.

Before moving on to the next stage, the models in (1) to (5) are tested for specification error and fit, under the assumption that the two events arise separately. For robustness purposes, the marginal effects of the parameters in estimated models were compared to the ones under a logit representation that assumes a cumulative standard logistic distribution instead; even though the coefficients were different, the marginal effects in the two models were similar as one would expect. The joint significance of the Youthranking category coefficients, as well as the Team ranking coefficients in the foreign selection model, was conducted using the common Wald test.

Furthermore, the threat posed by heteroskedastic error terms in probit estimations has been documented well academia, particularly in Williams (2009). This could be particularly concerning if the basic model is misspecified. While this is a problem that researchers should at least address, there is no consistent remedy that is implemented in practice. Nevertheless, this paper estimates a maximum-likelihood heteroskedastic probit model ala Harvey (1976), which is a generalization of the probit model that relaxes the assumption of the homoskedastic error term in the probit model. The results indicate that there is no evidence of heteroskedasticity in the error terms in the probit models estimated.

4.1.2 Multinomial Logit Analysis

Up until now, the club's selection problem has been modelled as a binary choice of hiring youths (or foreigners) versus players from all other streams. In fact, there are three possible sources for clubs to utilize when selecting unproven newcomers to the English Premier League; internal (youth stream), and an external stream that can be broken down by players sourced from foreign leagues and players sourced from lower-level domestic leagues. The data accounts for all three sources, and allows for estimation where the dependent variable is categorical:

$$y_j = \{^{1 \text{ if } y=j}_{0 \text{ if } y\neq j} \tag{7}$$

The multinomial logit model is typically applied in this type of situation, where the probability that club j selects alternative j is:

$$p_{ij} = p(y_i = y_j) = \frac{\exp(Z_i' \gamma_j)}{\sum\limits_{k=1}^{m} \exp(Z_i' \gamma_k)}, \tag{8}$$

where Z_i represents a set of explanatory variables described below, and γ_j represents a set of coefficients estimated for different alternatives (player sources). One set of coefficients is normalized to zero and coefficients of other alternatives are interpreted in reference to this base outcome, which is represented by domestically sourced players in this paper.[13] The inferences from one model would be identical to the other if the baseline comparison category changes. Two multinomial logit specifications are estimated and reported:

- M1: Includes categorical variables for youth program ranking (Youthranking), club positional ranking (Team ranking), international experience (Int. Exp.), share of foreigners at time of entry (forshare), and dummy variables for the Bosman ruling (Bosman) and player position.

- M2: M1 with the inclusion of Man U in the top ranked Youthranking variable.

A stringent assumption of multinomial logit models is that outcome categories for the model have the property of independence of irrelevant alternatives (IIA). A general implementation of the Hausman specification test is used to

[13] Depending on which alternative is selected as the base category, the estimated coefficients will be different but the marginal effects will be the same regardless of the base category.

test for the validity of IIA, which tests for any systematic differences in the coefficient estimates from the estimated equations. Under the IIA assumption, we would expect no systematic change in the coefficients if we excluded one of the outcomes from the model. Violation of the IIA assumption can lead to inefficient estimates. The parameters are re-estimated by excluding each of the three alternatives, and a Hausman test is performed against the full model. Another aspect worth considering is that the multinomial logit estimates several equations and requires a larger sample size than a binary choice model; given the sample size here, it might be more appropriate to interpret the results from the binary probit estimations.

In addition to the joint significance test for the Youthranking coefficients, a Wald test is performed to test for the equality of these coefficients across the estimated equations.

4.2 Intensive Margin Analysis

4.2.1 Survival Analysis

In addition to the contents described earlier, the data extends to capture the entire career path for the youth players entering the market during the study period. Most of their observable statistics for each season at the top-tier of major European leagues[14] are captured, including: appearances, minutes per game, goals, assists (when available), yellow and red cards, international appearances, international minutes per game, each club that a player represents, the club's ranking, each transfer during the career and fee paid for the player, exit from the league and reason for exit,[15] etc. This type of detail allows for a substantial survival analysis that tests the reliability of prior results by Radoman and Voia (2015) in this narrow time frame that captures the ever-important Bosman ruling. The duration analysis in this paper also serves to reinforce the credibility of the youth ranking index. A dummy variable is created to capture the top 5 ranked youth programs from the prior study (category 1 clubs described in the Data section), and analyze their reputation and ability to produce higher quality players in terms of career duration at the top level of European football, as compared to lower ranked programs. Consistent with the previous section, a second dummy variable is created that includes Man U in the top-rated youth

[14] In addition to the English Premier league, major European leagues are considered to be: Spanish La Liga, German Bundesliga, Italian Serie A, and French Ligue 1.

[15] Players exiting due to injury are excluded from the sample to generate more reliable estimates that are not impacted by health or related issues.

programs for this particular study period to assess if this alters the results and conclusions in any way.

Wilcoxon and Log-rank tests are performed on the data to test for observed subgroup differences in the survivor functions of players arising from the more reputable versus less reputable youth programs, and the results suggest that there are differences. Figure 1 illustrates the sub-group differences in terms of smoothed empirical hazards. The empirical survivor function (the empirical hazard function) is higher (lower) at all times for youth players originating from more reputable youth academies,[16] which lends support to previous studies and provides foundations for a more formal modelling approach.

Survival analysis is based on duration models that are used to estimate the hazard rate. The hazard rate, or the instantaneous probability of exit, is estimated using a semiparametric Cox Proportional Hazards (PH) model.[17] The Cox PH model makes no assumptions about the distribution of survival times and is robust to misspecication of the baseline hazard. A typical semiparametric model is of the form:

$$h_i(t_i|x_i, v_i) = \phi(x_i)\lambda(t_i), \tag{9}$$

where $\phi(x_i) = \exp(x_i\beta)$ is a function of the observable time-invariant covariates, and $\lambda(t_i)$ is the nonparametric baseline hazard for individual player i. The Therneau-Grambsch test for the PH assumption, which is based on scaled Schoenfeld residuals, is applied both globally and at specific covariate level for each specification estimated and the results indicate that there is no evidence the PH assumption is violated. The nonlinearity of covariates is tested for by applying cubic spline functions, and this nonparametric technique does not result in any changes in the assumed linear functional form of the covariates.

The presence of unobserved heterogeneity (frailty) can result in misspecification for several reasons. However, the magnitude of biases in non-frailty models is reduced when we allow for a fully flexible specification for the baseline hazard, like in the Cox model. It is important to note that if the frailty effect is real, the PH model loses its normal proportional hazards property because the hazard ratios are now conditional on the unobserved frailty. Most scholars suggest that interpreting the sign and significance of the coefficients should be the limit

[16] This difference would be even greater if Man U was included in the more reputable group (Youthrank = 1).

[17] For a detailed description of possible models that could be employed and all of the statistical tests mentioned in this subsection, please refer to Radoman and Voia (2015).

for substantive interpretation of frailty models. Nevertheless, frailty models are estimated using the Gamma distribution for unobserved heterogeneity:

$$g(v) = \frac{v^{\frac{1}{\theta}-1}\exp(\frac{-v}{\theta})}{\Gamma(\frac{1}{\theta})\theta^{\frac{1}{\theta}}} \tag{10}$$

Three different specifications are estimated using the Cox model:

- M1: Includes a dummy variable for more reputable youth programs (without Man U), performance measures (appearances (Apps), international appearances (Intapps), average minutes played per game (Mpg), goals scored (Goals), yellow cards obtained (Yellow), per season), dummy control for entering pre or post the Bosman ruling (Bosman), and position played by the player.
- M2: M1 with the inclusion of Man U in the more reputable youth program category.
- M3: M2, additionally accounting for unobserved heterogeneity.

We test the presence of endogeneity bias using the test proposed in Huynh, Petrunia and Voia (2010)[18] by examining the potential correlation between observables and unobservables in our youth career duration analysis. The test is seen as informative and not a test that measures the actual bias, but the existence of bias on a relation that links our observables to a transformed measure of time that models an Accelerated Failure Time (AFT). In other words we test if there are remaining unobservables that are correlated to our observables in an AFT hazard model. The presence of endogeneity in this model may signal the presence of endogeneity in other transformed outcome measures of time, in particular proportional hazard (PH) models that are considered here. The nonlinearity of the functional form of the PH models may alleviate the presence of bias in AFT models. Therefore, we expect if endogeneity is present in an AFT hazard model to have a smaller impact in a PH model. The actual test is based on a split sample test and is summarized as follows: Coefficients are broken into parameters of interest (β_1) and the nuisance parameters (β_2).$\hat{\beta}_1^{(1)}$ denotes the estimate for the parameters of interest from the first sub-sample. The null hypothesis H_0 concerns the parameters of interest and allows the nuisance parameter to remain unknown. In this case, the null hypothesis is $H_0 : \beta_1 = \hat{\beta}_1^{(1)}$

[18] The Details of applying this test are found in Huynh, Petrunia and Voia (2010).

or that the coefficients are the same across the split samples. To test H_0 using the second sample, the estimates from the first sample are considered as being the true parameters. Significant results on parameters estimates in the second sub-sample regression may signal the presence of remaining unobserved heterogeneity in the model that needs to be controlled.

To address the remaining issue we propose to use a discrete finite mixture hazard model that removes the parametrization of the unobserved heterogeneity that was used in the PH models and replaces it with mass points as proposed by Heckman and Singer (1984). In particular we use the Prentice-Gloeckler (1978) discrete finite mixture (DFM) hazard model implemented by Jenkins' STATA program. The model assumes that each observation belongs to one of several types, each type having its own distribution, which is collapsed to a mass point.

Consider the following hazard model:

$$h_i(t_i|x_i, v_i) = 1 - exp(-exp(v_i + b_0 + x_i\beta)), \tag{11}$$

where v is the unobserved heterogeneity. Now, consider the unobserved heterogeneity has K discrete points ($v = \{v_1, v_2, ..., v_K\}$), with probabilities $p = \{p_1, p_2, ..., p_{K-1}, p_K = 1 - p_1 - p_2 - ... - p_{K-1}\}$.

To estimate the parameters of interest $\theta = (p_1, p_2, ..., p_{K-1}, v_1, v_2, \ldots, v_K, \beta, b_0)$, the log-likelihood function for DFM model is used and it is found in Jenkins (1995).

By replacing the unobserved heterogeneity that was modeled as a random effect with and unobserved heterogeneity modelled as mass points we allow for a nonparametric specification of the unobserved heterogeneity, which is more flexible than the parametric specification used in the Cox hazard model. Therefore, with this specification we expect to further reduce the bias if endogenity is present in our original model specification.

5 Extensive Margin Analysis Results:

Separate probit estimation is conducted for the probability of selection of players sourced internally (youth) and from foreign leagues. The main assumption of independent estimation is that the error terms in the two models are not correlated. This notion will be tested in the next section, where these independent specifications are nested in a bivariate probit model that accounts for correlation in the unobservables.

5.1 Youth Selection

Table 3 presents the results of three probit specifications for youth selection. Looking at the log likelihood for each specification, there is a significant improvement when moving from M1 to either M2 or M3. Consequently, the AIC and BIC model fit statistics show a significant improvement when moving from M1 to M2/M3.[19] Controlling for the Bosman ruling and player experience at the international level improves the model specification substantially. Including Man U in the category 1 youth programs (M3) improves the log likelihood only slightly from M2, but the significance of the youth program ranking coefficients is significantly improved to the point that all categories are significant at the 1% level.

The results support the theoretical intuition that youth players arising from better ranked youth programs have a higher probability of being selected in the first-team of their parent club. Panel A of table 6 provides the predicted probabilities associated with arising from the four differently ranked youth programs from M3; the results indicate that category 1 clubs have a 14-15% higher probability of selecting a youth player in their first-team than lower ranked youth programs. These clubs invest more heavily in their youth academies and could be assumed to be more "bottom-heavy", so players arising from their youth programs have a higher probability of being promoted to the first-team. The results lend support to the theory that more "bottom-heavy", or youth oriented in this case, clubs provide greater opportunities for higher-level positions (first-team) to employees from internal sources. The unique youth ranking index created in this paper measures the degree of "bottom-heaviness" by Premier League clubs, and the estimated results are aligned with the index ranking of clubs in terms of opportunities provided to internally sourced players. What could be just as important is that the youth training reputation of these clubs is consistent in the wake of a major institutional change, the Bosman ruling, that presented clubs in Europe with more options in their talent search and strategic/optimization decisions. Even though the overall first-team opportunities to youth players became scarcer in all clubs, the higher ranked youth programs continued to provide more opportunities to internally sourced players relative to lower ranked clubs.

[19] The AIC for M1 is 1098, 867 for M2 and 863 for M3. Similarly, BIC for M1 is 24, -194 for M2 and -198 for M3. Both of these criteria suggest that lower values correspond to better model fit.

Similar results are obtained from M2, except that category 2 youth programs do not have a significant coefficient at a reasonable level of significance.

Looking at the player's position effect on selection, the benchmarking was based on the goaltender position but that position's representation in the data was by far the smallest so one has to be careful with the interpretation of these results. There is only one available slot on the first-team for a goaltender versus other positions that have multiple slots available for rotation, and goaltenders tend to be replaced less often than the other positions. The results indicate that youth players are most often selected in the midfield and defensive positions and least often in the forward position, even though the coefficient for forwards is not significant at any reasonable level. This suggests that foreign (or other) sources are used more often for the most scrutinized and demanding position in European football, the forward position. The effect of the share of foreign players in the league (forshare) changes signs when moving from M1 to M2 or M3, and it increases in significance as well. Controlling for the Bosman ruling alters the sign of this covariate and results indicate there is a positive effect on youth selection with increases in the share of foreigners in the league. The coefficient for the Bosman ruling was negative and significant at the 1% level, as anticipated. This indicates, in general, that youth players have a lower probability of being selected after the ruling, which is not surprising considering the talent pool available for clubs to draw from increased significantly as a result of this institutional change. However, the more important result here is that the more reputable youth clubs provided more opportunities through internal promotion even in the presence of this external shock. There is a significant effect of international experience on youth player selection as well. The negative correlation between international experience at the senior level and youth selection is not surprising because youth player do not have this sort of experience typically at their tender age. However, and more importantly, international experience at the junior levels has a positive and statistically significant effect (at the 1% level) on youth selection that is not too different in M2 and M3. This indicates the youth players with international experience at junior levels provide a strong signal to their employers about their potential and future inclusion in the first-team.

Tables 4 and 5 outline the tests performed on the appropriateness of model specification and a measure of fit. In table 4 fit is measured by comparing the mean and standard deviation of actual youth selection against the corresponding moments implied by the estimated probit model. The results indicate a close match between the two distributions, with the means being almost identical. Table 5 provides the test of misspecification error for the estimated model. The joint significance test for the Youthranking coefficients indicates they are statistically different from zero. The test regresses the link function of the outcome variable (the probability function) on the predicted probability and the predicted probability squared. The intuition is that the predicted probability function should be statistically significant unless the model is misspecified. Proper specification also implies that the squared probability should not have predictive power. The associated link test supports the specification of the model at the 1% level of significance, while indicating that the squared prediction is not significant at any reasonable level.[20] There is no indication that the model is misspecified.

5.2 Foreign Selection

Table 7 presents the results of two probit specifications for foreign source selection of players. In terms of log likelihood, there is a significant improvement when moving to M2 from M1. Correspondingly, the AIC and BIC statistics are both much lower for M2, 648 and -442 respectively, than for M1, 836 and -267, respectively. Model specification is improved when controlling for additional factors, including a player's market (transfer) value and his experience at the international level at the time of entry.

The results indicate that a club's ranking/grouping in the table significantly affects the probability of a foreign player being selected in the first-team. The ordering of the team ranking coefficients suggests that higher ranked clubs, or those fighting for the league title or a place in European competitions, have a tendency to hire and play more foreigners in their first-team than lower-ranked clubs. Panel B of table 6 outlines the predicted probabilities for the team ranking covariate; clubs ranked in the first tier have an 11% greater probability of selecting players from foreign sources than clubs ranked in the second tier, and 15% greater probability than clubs ranked in the third and bottom tier. Higher ranked clubs are typically financially superior, and this indicates that their financial strength allows them to rely on external sources (i.e. the transfer market) for new additions to the first-team. This could be an indication that lower-ranked clubs, which can be assumed to be less well-off financially, can-

[20] M2 and M3 results indicate that the model is not misspecified at the 1% level of significance. However, M1's results are indicative only at the 10% level, which further outlines the improvement in specification when controlling for additional covariates.

not compete for talent in the transfer market with larger clubs, even after the Bosman ruling. One would assume that larger clubs had more of an advantage in terms of securing talent from external sources prior to the Bosman ruling when the quota for foreign players restricted the amount of spots for them in the first-team. However, it appears that the removal of the quota did not close the gap among these differently ranked clubs in terms of their ability to scout abroad. In fact, the gap grew even further in favor of larger clubs signalling their ability to adapt to the new environment more efficiently.

The age of the foreign sourced player has a positive and statistically significant (at the 1% level) effect on selection in the first team. This suggests that experience in foreign leagues is valued more than raw potential of youth by Premier League clubs, when hiring foreign players. Interestingly, the position dummies lose significance when we move from M1 to M3. M2 results indicate that foreign players are recruited more at the most technical positions, midfield and forwards, which is consistent with the patters described in the data section of this paper. Players are selected from foreign sources at the forward position with greatest probability. However, as we move to a better specified model (M3), the loss in significance of these position coefficients renders them irrelevant for interpretation purposes. The Bosman ruling has a strong and predictable positive effect on foreign player selection, meaning that their probability of selection by one of the Premier League clubs increased significantly after the ruling. The positive effect does diminish as we improve model specification in M3. In addition, a foreign player's market (transfer) value has a positive and statistically significant effect on his first-team selection; the higher the player's transfer value, the higher the probability he gets an opportunity in the first-team. A player's senior international experience for his country signals his quality and has a predictable positive effect on his selection, statistically significant at the 1% level.

The goodness of fit and misspecification tests are conducted in the same fashion as for selection of youth players, but the resulting tables are not reported. There is a close match between the mean and standard deviation of actual foreign player selection against the corresponding moments implied by the estimated probit model, which indicates a good fit of the model. In addition, the link test for both specifications indicates that the models are not misspecified at the 1% level of statistical significance. The joint significance test for the Team ranking coefficients indicates that they are statistically different from zero.

5.3 Multinomial Logit Results

In this type of model, we have an unordered categorical dependent variable. The basic idea is that the decision by clubs to hire new and unproven Premier League players from internal or external sources encompasses three possible choices: (i) players from their own youth system, (ii) players sourced from lower leagues, and (iii) players sourced from lower-level domestic leagues. The independent probit modelled youth or foreign selection as a binary choice between internal promotion and external hiring, while the multinomial logit breaks down the externally sourced players in two separate groups for a total of three alternatives available to clubs. The results are structured and interpreted against the base alternative, which consists of domestically sourced players from lower-level leagues.

Table 8 outlines the estimation results for youth and foreign sources vs. the base domestic source, and the interpretation here relates to the top panel of the data, which represents the intended segment of the research at hand. The youth program ranking is highly statistically significant for all categories in the index for players sourced internally (Youth), with category 2 being significant at the 5% level and all others at the 1% level. The negative coefficients indicate that the relative log odds of youth selection vs. domestically sourced players decreases by 1.20 if the youth player originates from a category 4 vs. category 1 youth training program. Once again, this result reiterates the independent probit results that the probability of youth selection is higher at higher ranked youth clubs. Panel C of Table 6 provides the predicted probabilities of youth selection for clubs in all four youth ranking categories for M2; youth players originating from category 1 youth programs have a 31% probability of being selected in the first-team, while the next highest category has a 22% probability of youth selection. These results are consistent with the independent probit results for youth selection, and similar reasoning is applicable relevant to the motivating theory. The player position dummies are statistically significant for both specifications, indicating that youth players have the highest probability of being selected in midfield position vs domestically sourced players. Representing a country in the junior ranks has a predictable and statistically significant effect on the probability of youth selection, as it provides a strong signal about a player's ability and potential. Unsurprisingly, the Bosman dummy is negative and statistically significant (at the 1% level) implying the ruling had a negative effect on youth selection.

In terms of log-likelihood, there isn't much difference in the two specifications indicating that the results are robust and interpretation is similar whether Man U is included in category 3 or 1. Both specifications fit the data well in terms of improvement in log-likelihood from a baseline or constant only model. The improvements in the significance are also evident in the AIC and BIC criteria when we move towards the M1 and M2 specifications from the baseline model. Joint significance of the Youthrank coefficients in all equations indicates the overall effect of the youth ranking index is statistically significant at the 1% level. In addition, there is no evidence that the coefficients in the estimated equations are different.[21] The marginal effects of the youth ranking index categories are all statistically significant and consistent with the ranking implied by the index for M2. This is particularly important because much like the estimated probabilities listed in Table 6, these effects do not vary with the choice of the base category for comparisons, unlike the displayed coefficients (log-rank ratios) that differ for each chosen base category.

Considering the goodness of fit, there is a close match between the first and second moments from the actual selections and the ones implied by the estimated multinomial logit model.[22] Upon examining the output from the Hausman test, there is no evidence that the IIA assumption has been violated in any of the scenarios tested.

6 Intensive Margin Analysis: Survival Analysis Results

The results of the semiparametric estimations are presented in Table 9. There isn't much difference in log likelihoods of M1 and M2, but the frailty specification (M3) significantly improves the likelihood of the model. The evidence of unobserved heterogeneity is statistically significant, but only at the 10% level. The estimated parameter θ, a measure of heterogeneity or overdispersion, is 0.06. Typically, a lower measure of heterogeneity is preferred, and the lower it is the more reliable the interpretation of the estimated hazard ratios becomes. Therefore, the rather low value of the overdispersion and its statistical significance allow for a more reasonable interpretation of the results. Nonetheless, the

[21] This is true for all of the estimated coefficients, as well as for the youth ranking index tested independently.

[22] The results are similar to Table 4 results, and are not presented in the paper.

results will be interpreted in terms of M1 and M2, but the general conclusions are consistent among all specifications.

Players originating from a more reputable youth program have an exit probability that is 19% (26%) lower in M1 (M2) than players from the rest of the youth programs considered here, which is statistically significant in all specifications. This result validates the empirical observations and the benchmark results from Radoman and Voia (2015). Youth program participation and training has an impact on a player's career path, and duration at the top-level of European football. The performance measures have a statistically significant and predictable negative effect on the hazard rate in all specification: each additional appearance per season reduces the exit probability for a player by 4%, an additional 10 minutes spent on the pitch per game decreases the exit probability by 6-7%, each international appearance reduces the exit probability by 16-17%, and each goal scored decreases the exit probability by 13%. The disciplinary measure, yellow cards, presents an interesting and statistically significant result, which indicates that an additional yellow card per season increases the exit probability by 7%. This means that more disciplined players will tend to have longer careers as this is a valued player virtue among Premier League clubs, which is that much more important for youth players in the tender and early years of their careers. The Bosman ruling dummy is not significant at any reasonable level. Out of the four positions considered, it is not surprising that goaltenders tend to have the longest careers. The dummies for defenders and midfielders are significant (at the 5% and 10% level, depending on the model) and suggest that defenders have a lower exit probability than midfielders, while the forward dummy is not significant. This suggests that youth players occupying positions that require lower technical skills have longer careers at the top level.

The results indicate that unobserved heterogeneity is not statistically significant at the player level, but it is significant at the youth program (team) level, which is presented in M3. This suggests that there is something unique to each youth program, rather than at a player talent level. At least it can be said that youth sourced players in this sample, who made at least one appearance in the Premier League, appear to be fairly homogenous, while their youth-club training generates heterogeneity among them that could be a deciding factor in their careers.

6.1 Robustness Analysis-Tests

A set of informal and formal tests are used to check the robustness of the results. In particular we plot the estimated hazard measurers against the empirical hazard measure that is computed from the data and see how close are the prediction to the actual data. Figure 2 displays the baseline hazards of all three specifications, which show that duration dependence is modelled adequately by all models in terms of mimicking the slope of the empirical hazard. Figure 3 shows the estimated hazards for M2 and M3, with M1 omitted due to its nearly identical alignment with M2. Both specifications slightly underpredict the empirical hazard and are fairly close to each other, with M2 being marginally higher and closer to the empirical hazard.

In addition to the visual techniques, other tests are considered. In particular Cox-Snell residuals are used to assess the goodness of fit for M1 and M2, which provided evidence of satisfactory fit of the data. In addition to the analysis of Cox-Snell residuals we propose a split sample test, as suggested in the methodology section, to check if unmeasured confoundedness (endogeneity) is still present in our youth model. The results are reported in Table 10. We observe that while there are mostly non significant results for the parameters tested in the second sample, we still have a significant result for the minutes per game variable. This result may suggest some remaining unmeasured confoundedness is still present in the model. Therefore, we employ a DFM model as suggested in the methodology, with the results presented in Table 11. The discrete mixtures hazard results for the youth model indicate that unobserved heterogeneity of players is present in the model in the form of two types (type 1 players representing around 33% of the sample, and type 2 players representing around 67% of the sample). There are many unobservables that could drive this result, including players' natural ability or talent level, effort level and determination, intelligence or human capital that is a necessary complement to talent at the top level of European soccer, etc. The estimated hazard for type 2 players is far more stable than its counterpart for type 1 players, and it appears that these type 1 players drive the exit rate throughout the analysis, as evident in Figure 4. The volatility of the hazard rate for type 1 players signals that their type is most frequently replaced at the top level. Considering the presence of unobservable heterogeneity in the results, type 1 players might be of lower natural ability, human capital, or simply don't possess the drive and determination to succeed at that level for an extended period of time. Young players in soccer have the highest attrition rate among all players. Oshor Williams of the Professional Footballers Association's (PFA) education department, which offers support and training to prepare them for a life outside professional football, stated in an interview for BBC Sport:[23]

"Of those entering the game aged 16, two years down the line, 50% will be outside professional football. If we look at the same cohort at 21, the attrition rate is 75% or above."

Our results might have very well identified those players from this cohort that survived past age 21 as type 2 players, which represent 67% of the sample at hand. The remaining players of type 1 probably fall in the category of players described by Mr. Williams that exit between the ages of 18 and 21, having in mind that our data is comprised of players that were signed professionally at 18 and survived the first axe that resulted in 50% of players exiting the professional game. Granted, this article considers players that drop out of professional soccer altogether, rather than the top European leagues considered in our analysis. Nevertheless, the overlap could be quite significant and it quite possibly sheds light on the identification of two types of players that are evident in our results. Perhaps there exists an unobservable threshold level of player talent, human capital, and effort (among other unobservables) that differentiates the two types of players, in terms of survival at the top level, and leads to their identification in the discrete hazard results.

Finally, the empirical analysis with the DFM results in the significance of the Bosman dummy variable. This significant negative result in the hazard suggests that the youth players that were hired post-Bosman are having longer careers than their pre-Bosman counterparts. Considering that the Bosman ruling has a negative effect on youth/internal hiring, this result indicates that the fewer number of hires in the post-Bosman period are of higher quality, which is necessary to succeed in the more competitive environment after the ruling. The filtering of talent from the internal (youth) channel seems to have improved in response to the more competitive post-Bosman environment. These additional results obtained with the DFM model are providing new insights on the role of the unobservables, when they are properly accounted for, in the analysis. The graphical representation of the DFM model in Figure 4 also suggest that DFM model has better predictive ability of the data than the Cox PH model.

[23] 2014 online article published by BBC Sport: http://www.bbc.com/sport/0/football/28950665.

7 Conclusion

This paper establishes a connection between relevant labor theory and the hiring/promotion decisions of English Premier League clubs, when it comes to offering first-team opportunities to new and unproven players. Two proprietary data sets are combined to address the research questions at hand, using a sequential econometric approach that addresses multiple issues. More reputable clubs in terms of producing higher-quality youth players display a higher degree of "bottom-heaviness", and as such provide more opportunities for their youth players through internal promotion. These results are consistent in the wake of the Bosman case ruling, which certainly had an effect on clubs' decision making process. Unsurprisingly, foreign sourced players increased their presence in the league significantly after the removal of the foreign player quota, and became the dominant stream for acquisition of new players. Better ranked, or financially superior, clubs had a higher probability of selecting foreign players, which speaks to their ability to re-allocate their internal resources more efficiently towards foreign-player scouting than smaller (lower-ranked) clubs when accounting for the Bosman ruling.

In addition to the main results and objectives, the survival analysis in this paper upholds the results established in Radoman and Voia (2015) and demonstrates that the best-ranked youth programs in that paper consistently outperform the others in terms of career duration of their youth products in this narrower sample that controls for the Bosman ruling. Unobserved heterogeneity is statistically significant at the parent youth-club level, rather than at the player level, which lends further support to the notion that each youth academy has differential ability in "schooling" their players at the youth level that plays an important role in the careers of otherwise homogeneous players. When the unobserved heterogeneity is modelled using discrete finite mixtures we get new insights on the role of the unobservables in the analysis. In particular two types of players are identified in the data, one type that represent 33% is the one that drives the exits of the youth players. Also, this model shows that Bosman ruling positively impacts the career duration of youth players, that signals a refined filtering process by parent clubs in response to competitive pressure arising from the institutional change, having in mind that the ruling had a negative effect on youth player selection.

One of the limitations of this data is that it does not account for all of the youth players under contract in the clubs examined. This sort of detail, which could become possible and accessible in future years with improvements in data availability, would aid in providing a more reasonable assessment of "bottom-heaviness" of clubs and better address their probability of promoting from within. Such an analysis can be extended to other sports that are structured in a similar fashion, like European basketball or hockey in North America. The internal vs. external hiring decisions and associated labor economics theories have significant potential to be empirically tested further in the sports economy sector.

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Table 1: Breakdown by Source

Variables	**Pre-Bosman**			**Post-Bosman**		
Ythrank	Domestic	Youth	Foreign	Domestic	Youth	Foreign
1	16	40	17	9	35	63
2	14	15	18	13	22	60
3	28	44	22	28	26	55
4	73	48	22	60	66	63
Position						
G	11	6	4	13	7	19
D	48	45	24	44	56	73
M	34	66	28	32	49	75
F	38	30	23	21	37	74
Clubrank						
Top 7	32	34	24	15	43	89
8-15	42	62	26	47	56	91
Bottom 5	57	51	29	48	50	61

Table 2: Youth Breakdown by International Experience

	Pre-Bosman		**Post-Bosman**	
Ythrank	Yes	No	Yes	No
1	20	20	18	17
2	4	11	9	13
3	10	34	11	15
4	11	37	33	33

Table 3: Probit Results for Youth Selection

	M1	M2	M3
Youthranking - 1 is the benchmark			
2	-.42**	-.37**	-.42***
	(.15)	(.17)	(.17)
3	-.22	-.25	-.41***
	(.13)	(.15)	(.16)
4	-.19*	-.37***	-.42***
	(.12)	(.14)	(.13)
forshare	-.009*	.05***	.05***
	(.005)	(.01)	(.01)
Position - Goalie is the benchmark			
defence	.42**	.45**	.45**
	(.20)	(.22)	(.22)
midfield	.54***	.59***	.60***
	(.20)	(.22)	(.22)
forward	.25	.33	.34
	(.20)	(.23)	(.23)
Bosman		-.94***	-.95***
		(.28)	(.28)
Inter. Exp. - no exp. is the benchmark			
1 (Senior)		-2.26***	-2.27***
		(.27)	(.27)
2 (Junior)		.31***	.30***
		(.11)	(.11)
Const.	-.23	-1.83***	-1.79***
	(.29)	(.52)	(.52)
Observations	857	857	857
Log Likelihood	-540.18	-420.91	-418.74

Note: *, **, and *** indicates statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 4: Goodness of Fit

Variable	Mean (M3)	St. Dev. (M3)	Mean (M2)	St. Dev. (M2)
Youth Selection (actual)	.3442	.4754	.3442	.4754
Fitted prob. of youth selection	.3448	.2346	.3447	.2322

Table 5: Link Test for Misspecification - Youth

Youth Selection	Coefficient (M3)	Coefficient (M2)
Prediction	1.11***	1.11***
	(.16)	(.17)
Prediction squared	.07	.06
	(.08)	(.08)

Note: *** indicates statistical significance at 0.01 level

Table 6: Predicted Probability Analysis

Youth (A)		**Foreign (B)**		**Multinomial (C)**	
Ythrank	Margin (M3)	Team rank	Margin (M2)	Ythrank	Margin (M2)
1	.34***	1	.45***	1	.31***
	(.04)		(.04)		(.05)
2	.20***	2	.34***	2	.18***
	(.04)		(.04)		(.04)
3	.20***	3	.30***	3	.22***
	(.04)		(.03)		(.05)
4	.19***			4	.21***
	(.03)				(.04)

Table 7: Probit Results for Foreign Selection

	M1	M2
Team ranking - 1 is the benchmark		
2	-.36***	-.28**
	(.13)	(.15)
3	-.59***	-.39***
	(.13)	(.15)
Age	.20***	.14***
	(.01)	(.02)
Position - Goalie is the benchmark		
def	.20	-.03
	(.21)	(.22)
mid	.44**	.14
	(.21)	(.22)
for	.60***	.25
	(.21)	(.23)
Bosman	.64***	.35***
	(.10)	(.12)
Transfer Value		2.96e-07***
		(5.53e-08)
Inter. Exp. - no exp. is the benchmark		
1 (Senior)		1.42***
		(.15)
2 (Junior)		.17
		(.14)
Const.	-5.44***	-4.33***
	(.41)	(.48)
Obs.	857	857
Log Likelihood	-409.01	-311.45

Note: *, **, and *** indicates statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 8: Multinomial Logit Results

	M1	M2
Base - Domestic Source		
Youth Source		
Youthranking - 1 is the benchmark		
2	-.79** (.36)	-.87** (.34)
3	-.83*** (.31)	-1.12*** (.31)
4	-1.20*** (.30)	-1.33*** (.29)
Team ranking - 1 is the benchmark		
2	-.18 (.25)	-.05 (.25)
3	-.17 (.27)	-.02 (.27)
Inter. exp. - no exp. is the benchmark		
1 (senior)	-2.86*** (.74)	-2.84*** (.74)
2 (junior)	.55*** (.22)	.52** (.22)
Position - Goalie is the benchmark		
D	.71* (.39)	.73* (.50)
M	1.12*** (.40)	1.14*** (.40)
F	.72* (.41)	.74* (.41)
forshare	.11*** (.03)	.11*** (.03)
Bosman	-1.69*** (.50)	-1.71*** (.50)
constant	-3.40*** (.95)	-3.44*** (.94)
Foreign Source		
Youthranking - 1 is the benchmark		
2	-.26 (.37)	-.23 (.36)
3	-.99*** (.35)	-1.05*** (.35)
4	-1.47*** (.33)	-1.47*** (.33)
Team ranking - 1 is the benchmark		
2	-.42 (.27)	-.30 (.28)
3	-.22 (.30)	-.11 (.31)
Inter. exp. - no exp. is the benchmark		
1 (senior)	2.46*** (.26)	2.47*** (.26)
2 (junior)	.13 (.27)	.12 (.27)
Position - Goalie is the benchmark		
D	.02 (.40)	.03 (.40)
M	.40 (.41)	.41 (.41)
F	.41 (.41)	.42 (.41)
forshare	.08*** (.03)	.08*** (.03)
Bosman	-.22 (.48)	-.25 (.48)
constant	-2.84 (.97)	-2.97 (.97)
Log Likelihood	-680	-677

Note: *, **, and *** indicates statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 9: Cox Semiparametric Survival Results

	M1	M2	M3
Youthrank	$.81^{**}$	$.74^{***}$	$.63^{**}$
	(.07)	(.06)	(.11)
Apps	$.96^{***}$	$.96^{***}$	$.96^{***}$
	(.007)	(.007)	(.01)
Intapps	$.83^{***}$	$.84^{**}$	$.71^{**}$
	(.06)	(.06)	(.12)
Mpg	$.994^{***}$	$.993^{***}$	$.993^{**}$
	(.002)	(.002)	(.003)
Goals	$.87^{***}$	$.87^{***}$	$.88^{**}$
	(.04)	(.03)	(.06)
Yellow	1.07^{**}	1.07^{**}	1.09^{*}
	(.03)	(.03)	(.06)
Bosman	1.04	1.03	1.11
	(.08)	(.08)	(.13)
Player Position - Goalie is the benchmark			
Defence	$.66^{*}$	$.68^{*}$	$.53^{**}$
	(.14)	(.15)	(.16)
Midfield	$.64^{**}$	$.66^{*}$	$.44^{***}$
	(.14)	(.15)	(.14)
Forward	.81	.82	$.56^{*}$
	(.18)	(.19)	(.19)
θ			$.06^{*}$
			(.05)
Obs.	1537	1537	938
Log Likelihood	-1944	-1941	-1349

Note: *, **, and *** indicates statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 10: Split Sample Endogeneity Test

	Coefficients	Standard Error
Youthrank	-0.039	0.058
Apps	0.001	0.004
Mpg	-0.003**	0.002
Intapps	0.019	0.016
Goals	0.004	0.011
Yellow	-0.001	0.014
Defence	0.245	0.183
Midfield	0.146	0.187
Forward	0.185	0.199
Bosman	-0.056	0.056
Constant	0.864***	0.213

Note: *, **, and *** indicates statistical significance based on p-values at the 0.1, 0.05, and 0.01 levels, respectively.

Table 11: Discrete Mixtures Hazard Model

	Coefficients	Standard Error
Youthrank	-0.693***	0.223
Apps	-0.063***	0.015
Mpg	-0.002	0.004
Intapps	-0.308	0.196
Goals	-0.103	0.095
Yellow	0.005	0.078
Defence	-0.244	0.478
Midfield	-0.812	0.510
Forward	-0.425	0.519
Bosman	0.457**	0.216
Constant	0.324	0.572
M2 (cons)	-15.44	455.17
Logitp2 (cons)	-0.691***	0.181
Prob. Type 1 = 0.33***		
Prob. Type 2 = 0.67***		
Log-Likelihood = -416		

Note: *, **, and *** indicates statistical significance based on p-values at the 0.1, 0.05, and 0.01 levels, respectively.

Figure 1: Smoothed Empirical Hazards

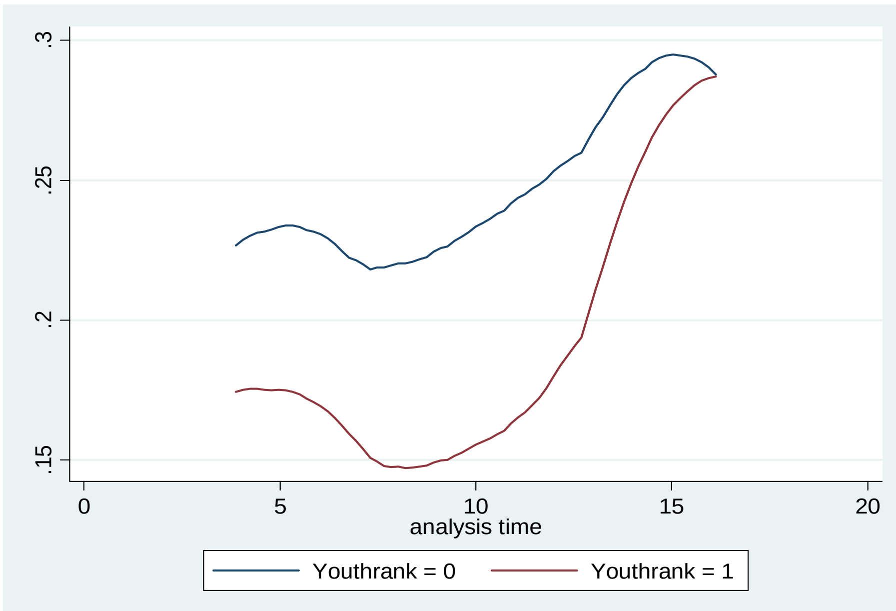

Figure 2: Cox Baseline Hazard Estimates

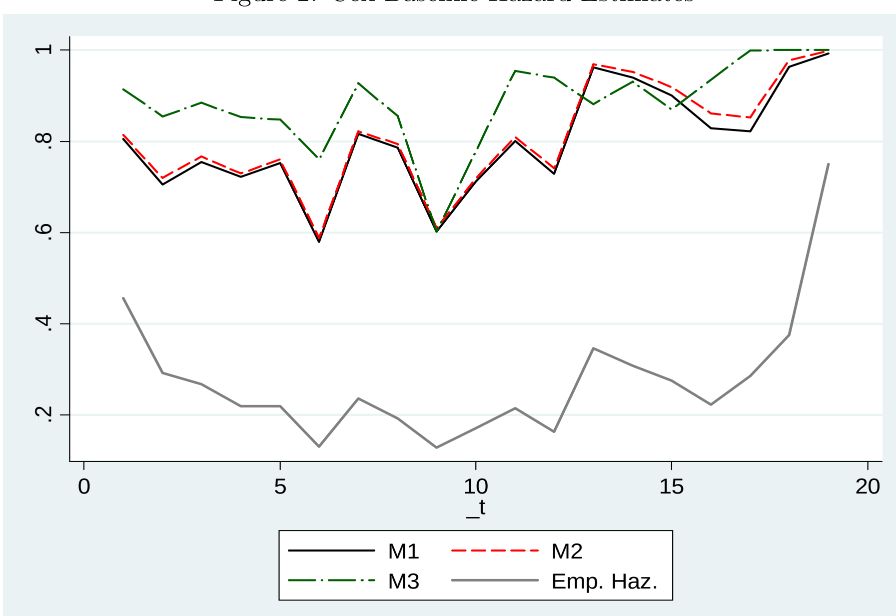

Figure 3: Cox Estimated Hazards

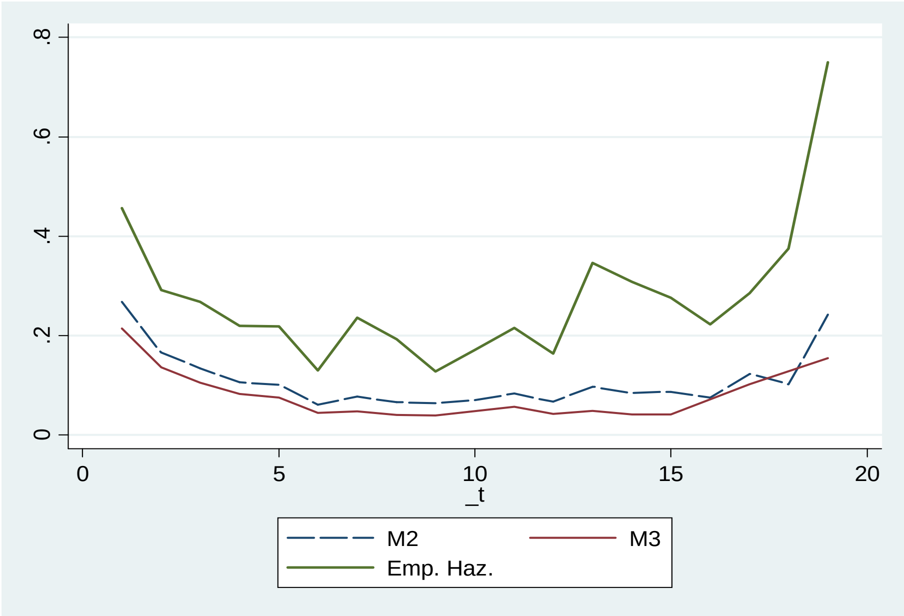

Figure 4: Dicrete Mixtures vs Cox SP Hazards