DEPARTMENT OF ECONOMICS
JOHANNES KEPLER UNIVERSITY OF LINZ

Returns to Education in Professional Football

by

René BÖHEIM

Mario LACKNER

Working Paper No. 1102
April 2011

Johannes Kepler University of Linz
Department of Economics
Altenberger Strasse 69
A-4040 Linz - Auhof, Austria
www.econ.jku.at

rene.boeheim@jku.at
phone +43 (0)70 2468 -8214, -8217 (fax)

Returns to Education in Professional Football *

René Böheim — University of Linz

Mario Lackner — University of Linz

April 20, 2011

Abstract

After three years in the National Collegiate Athletic Association (NCAA), collegiate football players face a trade-off between spending more time in the NCAA and pursuing a career in the National Football League (NFL) by declaring for the draft. We analyze the starting salaries and signing bonuses for 1,673 rookies in the NFL, who entered the league between 2001 and 2009 through the NFL draft. We instrument the endogenous decision to enter the professional market with a player's month of birth. A player's true talent is only imperfectly observed and the instrument provides a causal link between time at college and subsequent salaries in the NFL through the relative age effect.

Our estimates suggest that a player enjoys a 6% higher starting salary in the NFL, and a 15% higher first-year signing bonus, for each year with the college team. On average, a rookie is estimated to earn $131,000 more in his rookie season, if he enters the NFL one year later. Our analysis of a typical labor market in professional sports shows that the returns to education in sports are sizeable and surprisingly similar to returns to formal education. The results of our analysis provide information for the players who are deciding about declaring for the draft, however, also colleges and the teams in the NFL may find the results of interest.

Keywords: NFL, returns to education, ability bias, labor markets in sports
JEL classification: J31

*Department of Economics, Johannes Kepler University Linz, Austria. Corresponding author: Mario Lackner, Johannes Kepler University of Linz, Department of Economics, Altenbergerstr. 69, 4040 Linz, ph.: +43 732 2468 5145, Mario.Lackner@jku.at. René Böheim, Rene.Boeheim@jku.at, is also affiliated with the Austrian Institute of Economic Research, Austrian Center for Labor Economics and the Analysis of the Welfare State, and IZA, Bonn.

1 Introduction

The typical path to playing in the NFL starts in school and almost all players who played in the NFL from 2001 onwards started their career in various youth football teams during school and continued to play for their high school team. Colleges devote substantial resources to recruit high school graduates for their college football teams (Dumond, Lynch and Platania, 2008). The National Collegiate Athletic Association (NCAA) organizes 88 championships in 23 sports in US colleges and universities, including football. After three years in the NCAA, a football player may declare for the draft, i.e., declare his ambitions to play professionally in the National Football League (NFL). Under NCAA regulations, players are not allowed to receive any form of financial compensation. More time in the NCAA may be interpreted as an investment in sector-specific human capital. Players realize their returns on the investment primarily through a contract with a NFL team. A football player thus faces a trade-off between joining the NFL and the additional time in college devoted to training and to gaining experience, which may improve the chance of a better contract in the NFL.

The decision to enter the NFL is a function of a player's true level of talent, which is only imperfectly observed, and therefore endogenous. A player will declare for the NFL once he believes that he will be drafted and will receive an acceptable contract. The empirical association of time with the college team and the salary in the NFL might be misleading for the evaluation of returns to the time in the NCAA, because a player's true talent is not observed. Players who are relatively more talented will tend to have shorter college careers and will receive higher offers. Estimates of returns to training and experience will therefore be biased. This ability bias can be avoided by using an instrumental variable approach.

We use the month of birth as an instrument for the endogenous decision to join the NFL. The month of birth of a player is random and should not be correlated with the player's talent.[1] A player's decision to enter the draft will depend on several factors, including his true level of talent and the mental and physical maturity by the time of declaring. Mental and physical maturity will be judged relatively to the other competitors in a season's draft class. A draft class consists of one or more cohorts, defined by compulsory schooling laws. Within each school cohort there exists a relative age effect (RAE), which explains differences in maturity. The RAE causes relatively older players to start their professional career earlier than relatively younger ones in their cohorts (Baker, Schorer and Cobley, 2010). The month of birth provides the exogenous variation that we exploit to identify the causal effect of time in the NCAA to differences in NFL rookie contracts, overcoming the endogeneity of the decision to declare for the draft.

Edgar and O'Donoghue (2005) show that in most sports competitions that involve young athletes the selection of players is influenced by the RAE. The RAE appears relevant also in other circumstances. For example, Dhuey and Lipscomb (2008) estimate that relatively oldest students in school cohorts are 4–11 percent more likely to be high school leaders, which makes them more successful in later life. Du, Gao and Levi (2009) investigate the relation between month of birth and CEO performance and suggest that firms are more profitable, if they are managed

[1]See Card (2001) for a survey, or Angrist and Krueger (1991) who use the time of birth as instruments.

by a relatively older manager. McCrary and Royer (2011), however, find small effects on fertility and infant health for women who are relatively older.

Our research contributes to two strands of the economic literature, the returns on investment in sector-specific skills in the labor market and, secondly, the economics of sport. The economic aspects of the NFL have attracted academic interest and studies have been undertaken to investigate hiring strategies (Berri and Simmons, 2009; Boulier et al., 2010; Hendricks et al., 2003), rent-seeking (Bishop et al., 1990) or union behavior (Gramm and Schnell, 1994). We consider the results of our estimates to be valuable information for the players, the colleges and, indeed, the managers of the teams that compete in the NFL. Our results suggest that there are significant returns to spending more time in colleges for football players. These returns consist of higher starting salaries and, through seniority based rules, lead to more income over the entire professional career. We estimate that a player receives a 6% higher starting salary in the NFL, and a 15% higher first-year signing bonus, for each year with the college team. On average, a player is estimated to earn $130,000 more in his rookie season, if he enters the NFL one year later.

2 The Relative Age Effect

Compulsory schooling in the US typically requires children to start school on the 1st of January in the year in which they turn 6. Therefore, students born earlier in the year enter school at an older age than those born later. See Angrist and Krueger (1991). The month of birth may influence educational attainment during compulsory school due to the fact that, on average, older children are relatively more mature—both physically and mentally—than younger children.

Cobley, Baker, Wattie and McKenna (2009) state that the 1-year difference in age during puberty explains most differences in physical development and performance. These effects should perhaps become less important on reaching full (mental and physical) maturity.

Although football players are on average 23 years old, i.e., they have already reached full physical strength, the RAE might be important for a second reason. The (almost) unique route to playing in the NFL is through school, high-school and college teams. If relatively older students have a higher chance to be selected into the school's football team than their relatively younger peers, they receive more training or more time on the playing field. As a consequence, players who were born early in the year have an advantage over those born later in their birth cohort. They should join the NFL earlier than their relatively younger peers, simply because they have acquired more specific human capital.

Thus especially in sports where physical attributes such as height, weight or physical strength are important, players who are relatively older have an advantage and will be overrepresented. Helsen et al. (2000), Helsen et al. (2005) and Edgar and O'Donoghue (2005) find the RAE in competitive sports that involve young athletes and especially in soccer it is a well documented phenomenon (Barnsley et al., 1992; Mujika et al., 2009; Vaeyens et al., 2005). Musch and Grondin (2001) state that the empirical literature has not yet been able to find evidence for a RAE in American football. Indeed, a simple tabulation of the frequencies of the months of birth of the players may lead to such a conclusion. See Figure 1. This Figure plots the frequencies of the months of birth of 1,673 players who started to play in the National Football League between 2001 and 2009 and who were selected through the draft.

However, a more detailed analysis, as provided in Figure 2, does show empirical evidence for the RAE in American football. We plot the average age by quarter of birth of $11,500$ players, who were drafted between 1960 and 2000, for each draft. Every year, of the players who started to play football professionally, those who were born in the first month of a year were younger than those who were born in later months.[2] This, in our view, is compelling evidence in favor of the RAE in the selection of players in the NFL. In essence, the distribution of birth months in the NFL is more uniformly distributed than in other sports, as players can—and do—choose to enter the draft later to compensate for the disadvantage of the late birth month.

The differences between the birth quarters in Figure 2 are due to players who had been born later in their birth cohort and extended their collegiate career by remaining four rather than three years in the NCAA. The additional year in the NCAA may compensate for less training due to the RAE. In addition, a football player may, in agreement with the team and coach, extend the time with the college team to five years by "redshirting". Redshirting is the intentional suspension of the right to participate in NCAA competitions, while permitting a player the participation in training and other team activities. Redshirting prolongs the normal period of team membership and is typically used to provide the athlete with additional time for training and development.

After the end of the college season in January, football players declare for the draft. The draft is conducted at the end of April. The teams, in reverse order of the previous season, select a player in each round of the draft. Since 1994 a draft consists of seven rounds. A team that has drafted a player has exclusive

[2] The age is calculated as the difference between the year of draft and the year of birth to eliminate variation that is caused by the seasonality of hiring. In the NFL, contracts are typically signed in spring for the next season.

bargaining rights with this player. Contracts are typically signed between the draft and the start of the next season, in September. In the summer months, training camps and team activities are organized and the performance in the training camps reveals more about a player's talent. Contracts are typically finalized during this period.

3 Data and Empirical Methodology

Our data describe 1,673 players who started to play in the National Football League between 2001 and 2009 and were selected through the draft.[3] All data were constructed from various sources, obtained from Pro Football References and USA Today.[4] The data provide detailed information on the characteristics of the players at the time they started their professional career, such as height and weight, in which round of the NFL draft they were drafted, and at which pick in the draft. All salary data include information on base salary, signing bonus and overall salary in a player's first season.[5]

Figure 3 plots the average age of drafted players, by their quarter of birth, for our estimating sample. Similar to Figure 2, we see a marked pattern. Players who were born in the first quarter of their cohort were on average almost a year younger than players who were born in the fourth quarters.

Table 1 presents descriptives statistics of key variables. Players were on average slightly younger than 23 years of age when they joined the NFL, with a standard deviation of less than one year. Unfortunately, we know exact college

[3] These are almost 73% of all players who were drafted in this period.

[4] Data are available at USA Today (Retrieved Feb. 2011).

[5] All salary data was downloaded from the USA TODAY Salary Database available at http://content.usatoday.com/sports/football/nfl/salaries/default.aspx. All salary data were deflated to year 2001 prices using the consumer price index.

tenure only for a subset of players, namely those who declared after three years in college ("underclassmen"), for the drafts 2004 to 2009. These players were on average 22 years old. All other players, i.e., those who stays in college longer, had a mean age of 23 years. Figure 6 plots the age distribution for this subsample, distinguishing between these for whom we know that they declared as underclassmen and for those who declared later, but where we do not know exactly how many years they played for the college team. The difference in mean age of one year indicates that the age in the year of the draft is a good proxy for college tenure.

Salaries, including rookie contracts, are regulated by the Collective Bargaining Agreement (CBA) between the NFL and the National Football League Players Association (NFLPA) (NFL, 2006). The CBA was introduced in 1993 and extended five times until 2009. The agreement stipulates, amongst other rules, that players who are selected earlier in the draft have to obtain higher salaries than players who are selected later. The first-year salary will increase each year, according to a seniority wage scale which is detailed in the agreement.

From 2001 to 2009, base salaries were on average about $285,000 and signing bonuses on average some $686,000. Figure 4 plots the average values for the two salary components over all drafts from 2001 to 2009. We see that base salaries remained fairly flat throughout the early 2000s, and increased towards the end of the period. Signing bonuses, on average about three times the base salary, declined between 2003 and 2006, however, they appear to have increased in recent years.

Figure 5 shows for each quarter of births the average values for the salary components. We see that the quarters do not differ in terms of base salary.

Signing bonuses, however, are on average lower for those who were born in the first quarter than for those of later birth quarters. The average signing bonus for players who were born in the first quarter was $620,000 and about $680,000 for those born in the fourth quarter.[6]

We estimate for each player i the salary and length of career Y, where we instrument entry age with month of birth Q:

$$Y_i = \beta_0 + \beta_1 \overline{\text{Entry Age}}_i + \xi \mathbf{X} + \varepsilon_i, \tag{1}$$

$$\text{Entry Age}_i = \pi_0 + \sum_{m=2}^{12} Q_m + \xi \mathbf{X} + \nu_i, \tag{2}$$

where *Entry Age* is the age in the year of the draft, $\overline{\textit{Entry Age}}$ is the predicted value of player i's entry age, and $\mathbf{X}$ is a vector of controls including height, position, whether a player played for the BCS champion of the season before the draft, the draft round and the pick the player was drafted, and the year of the draft.[7] We control for compulsory school regulations which were in place in the state at the time the player was born to account for differences in compulsory school regulations. Other controls include the team that picked the player and interactions between year of the draft and the team.

Height is a characteristic that has previously been shown to matter for selection. We control for a player's draft status as it will determine the salary volume through the NFL's collective bargaining agreement. Position fixed-effects are included because different positions require different levels of physical strength and could be influenced differently by the RAE. The inclusion of dummy variables for the year of the draft controls for the evolution of NFL rookie salaries over time.

[6] A formal test allows to reject the equality of these values at an error level of 5 percent.

[7] Weight is a characteristic that is of direct control to a player, i.e., endogenous, and should therefore not be included in these estimates.

Team fixed effects control for differences in draft behavior between teams, e.g., a preference for certain positions. An interaction of team and draft year should control for a specific demand a team had in a certain year, e.g., for a defensive rather than an offensive position. Such a demand could influence both the selection process, i.e., the pick, as well as the contract negotiations with rookie players, i.e., the signing bonus.

A player's past performance in the NCAA might provide an indicator of his talent. However, there are few indicators that are comparable across all positions, because statistics are position-specific. For example, performance measures such as the passer-efficiency rating is only meaningful for the evaluation of quarterbacks. We, however, include a variable that indicates whether a player played for the BCS champion in the year before the draft.

4 Results

Table 2 presents the estimation results for the influence of a player's entry age into the NFL on his salary. We present separate equations for the base salary, the signing bonus and the total salary. For comparison, we tabulate the results from instrumenting age with the month of birth and standard OLS regressions. The results of our instrumental variable approach show a consistent and positive influence of entry age on a player's earnings in his first year in the NFL. For the estimated effect of age on the salary, we provide the estimated coefficient, the elasticity and the standardized (beta) coefficient. In each case, OLS underestimates the true relationship due to the endogeneity of the player's entry decision.

A later entry age corresponds to a longer time with the college football team, i. e., more accumulated sector-specific human capital, and we interpret this as returns to education in professional football. A one-year increase in entry age will increase a player's base salary by about 5.9 percent and the signing bonus by about 15 percent. Total salary is estimated to increase by about 12.3 percent. In absolute terms, an athlete can increase his total salary as a rookie by more than $131,000 by staying in college football for an additional year.

We also estimate that later compulsory school age leads to a higher signing bonus, but we find no significant differences for the base salary. We interpret this result as indication that older students profit more from training than younger ones. We find no evidence that the age at which compulsory schooling ends has an effect on NFL rookie contracts. This is, however, not surprising, as players who intend to play professionally have to be recruited by a college, i.e., they will, almost without exception, obtain a high school degree. A player's height at the time of the draft, and by age 23 most men are fully grown, had no statistically significant effect on the salary. (If there is any effect of height on salary, there is a small negative effect on the base salary.)[8]

A perhaps unexpected result is the effect of having been a member of the reigning BCS champion, which is negative and sizeable. A player is estimated to have a $270,000 lower signing bonus, if he won the BCS championship. We interpret this result as a consequence of a group effect. Players who had won the BCS championship appear more talented because a winning team has an above average level of talent. This positive signal leads to a higher chance of being drafted. In our sample, about 2.1 players were on average drafted from

[8]The estimated coefficients on the fixed-effects and interaction terms reflect institutional settings, for example, players who are picked earlier have higher salaries or quarterbacks earn more than kickers. These results are available on request.

a non-champion college team between 2001 and 2009. In contrast, an average of 5 players were drafted from the reigning BCS champion team. However, an individual player's talent is revealed during the summer training camps. A lower signing bonus, which provides hiring teams with wage flexibility, might be the consequence.

The reliability of our first stage can be gauged by the F-test on our excluded instruments. (We use the method proposed by Kleibergen and Paap (2006).) The test statistic has a value of 19.2, which rejects the null hypothesis that the instruments are weak. Figure 7 plots the first stage coefficients of birth months dummies on entry age, where January is the base category. The first stage demonstrates that players born in later months of the year are relatively older when they enter they declare for the draft. These estimates formally confirm the presence of the RAE in the NFL, supporting the suggestive correlations of Figure 2. Table 4 reports the estimated coefficients and their p values. Figure 7 suggests that differences between the months of birth are statistically significant for those born in the second half of the year. We have experimented with different sets of instruments, aggregating months to quarters and halves. The results are tabulated in Table 3. The estimated effects change only slightly and our above results are confirmed.

4.1 Length of career

Each player faces a trade-off between declaring for the NFL early and the starting salary, which increases over time due to seniority rules. We estimated that the starting salary is the higher, the longer the player remained in college. If, however, the player shortens his career by remaining in college longer, this higher starting salary (and the subsequent pay rises) may not compensate for lower earnings due to a shorter career.

We estimate a linear probability of playing in the next season, where we also instrument entry age with the month of birth. The results of the estimation are tabulated in Table 5, alongside with estimates where we use the quarter of birth or the half year of birth as instruments. The results from these estimations consistently show that a later entry age lowers the probability of playing in the next season. This demonstrates that being older when declaring for the draft increases the starting salary, however, at the cost of a shorter career.

5 Conclusion

We analyzed NFL starting wages for $1,673$ players, who started their professional football career between 2001 and 2009. We find, in contrast to earlier research, a sizeable relative age effect. The RAE influences the age at which a player declares for the draft and therefore provides a good instrument. Our estimates show that players who are older when they are drafted receive higher wages, especially signing bonuses, than those who are younger. However, players face a trade-off between being selected in the draft, the wage and the length of their career. We interpret the higher wage for players who are older when they start their professional football career as returns to education as they spend more time with their college team. The size of these returns are comparable to estimates of the returns to formal education.

Players will benefit from playing an additional season with their college team as they will gain additional training and experience. The uniform distribution of the rookies' birth months is an indication that declaration for the draft is endogenous, with players who were born later in the year postponing their declaration for the draft.

Our results contribute to the ongoing discussion about whether football players should be allowed to enter the NFL without a college career or not. Moreover, the NCAA system has drawn some criticism. For example, Kahn (2007) argues that the NCAA is a cartel that extracts rents from the exploitation of young football players, who do not earn wages. Our results show that players actually gain experience from their time in the NCAA that leads to subsequent returns in form of higher wages. If these later wages compensate for the loss in income during the players' time with the NCAA, remains to be researched.

References

Angrist, J.D. and A.B. Krueger (1991), 'Does compulsory school attendance affect schooling and earnings?', *The Quarterly Journal of Economics* **106**, 979–1014.

Baker, J., J. Schorer and S. Cobley (2010), 'Relative age effects', *Sportwissenschaft* **40**(1), 26–30.

Barnsley, R.H., AH Thompson and P. Legault (1992), 'Family planning: Football style. The relative age effect in football', *International Review for the Sociology of Sport* **27**(1), 77.

Berri, David J. and Rob Simmons (2009), 'Race and the evaluation of signal callers in the National Football League', *Journal of Sports Economics* **10**(1), 23.

Bishop, John A., J. Howard Finch and John P. Formby (1990), 'Risk aversion and rent-seeking redistributions: Free agency in the National Football League', *Southern Economic Journal* **57**(1), 114–24.

Boulier, Bryan L., H.O. Stekler, Jason Coburn and Timothy Rankins (2010), 'Evaluating National Football League draft choices: The passing game', *International Journal of Forecasting* **26**(3), 589–605.

Card, D. (2001), 'Estimating the return to schooling: Progress on some persistent econometric problems', *Econometrica* **69**(5), 1127–1160.

Cobley, S., J. Baker, N. Wattie and J. McKenna (2009), 'Annual age-grouping and athlete development: A meta-analytical review of relative age effects in sport', *Sports Medicine* **39**(3), 235–256.

Dhuey, Elizabeth and Stephen Lipscomb (2008), 'What makes a leader? Relative age and high school leadership', *Economics of Education Review* **27**(2), 173–83.
URL: *http://www.sciencedirect.com/science/article/B6VB9-4N0HJHT-3/2/352b59469b307525d88075ac3832cbfe*

Du, Qianqian, Huasheng Gao and Maurice D. Levi (2009), Born Leaders: The Relative-Age Effect and Managerial Success. Available at SSRN, http://ssrn.com/abstract=1365006.

Dumond, J. Michael, Allen K. Lynch and Jennifer Platania (2008), 'An economic model of the college football recruiting process', *Journal of Sports Economics* **9**(1), 67–87.

Edgar, S. and P. O'Donoghue (2005), 'Season of birth distribution of elite tennis players', *Journal of sports sciences* **23**(10), 1013–1020.

Gramm, Cynthia L. and John F. Schnell (1994), 'Difficult Choices: Crossing the Picket Line during the 1987 National Football League Strike', *Journal of Labor Economics* **12**(1), 41–73.
URL: *http://www.jstor.org/stable/2535120*

Helsen, W.F., J. Van Winckel and A.M. Williams (2005), 'The relative age effect in youth soccer across Europe', *Journal of Sports Sciences* **23**(6), 629–636.

Helsen, W.F., J.L. Starkes and J. Van Winckel (2000), 'Effect of a change in selection year on success in male soccer players', *American Journal of Human Biology* **12**(6), 729–735.

Hendricks, W., L. DeBrock and R. Koenker (2003), 'Uncertainty, hiring, and subsequent performance: The NFL draft', *Journal of Labor Economics* **21**(4), 857–886.

Kahn, Lawrence M. (2007), 'Markets: Cartel behavior and amateurism in college sports', *The Journal of Economic Perspectives* **21**(1), 209–26.

Kleibergen, F. and R. Paap (2006), 'Generalized reduced rank tests using the singular value decomposition', *Journal of Econometrics* **133**(1), 97–126.

McCrary, Justin and Heather Royer (2011), 'The Effect of Female Education on Fertility and Infant Health: Evidence from School Entry Policies Using Exact Date of Birth', *American Economic Review* **101**(1), 158–95.
URL: *http://www.aeaweb.org/articles.php?doi=10.1257/aer.101.1.158*

Mujika, Iñigo, Roel Vaeyens, Steijn P.J. Matthys, Juanma Santisteban, Juan Goirienab and Renaat Philippaerts (2009), 'The relative age effect in a professional football club setting', *Journal of Sports Sciences* **27**(11), 1153–58.

Musch, J. and S. Grondin (2001), 'Unequal Competition as an Impediment to Personal Development: A Review of the Relative Age Effect in Sport', *Developmental review* **21**(2), 147–167.

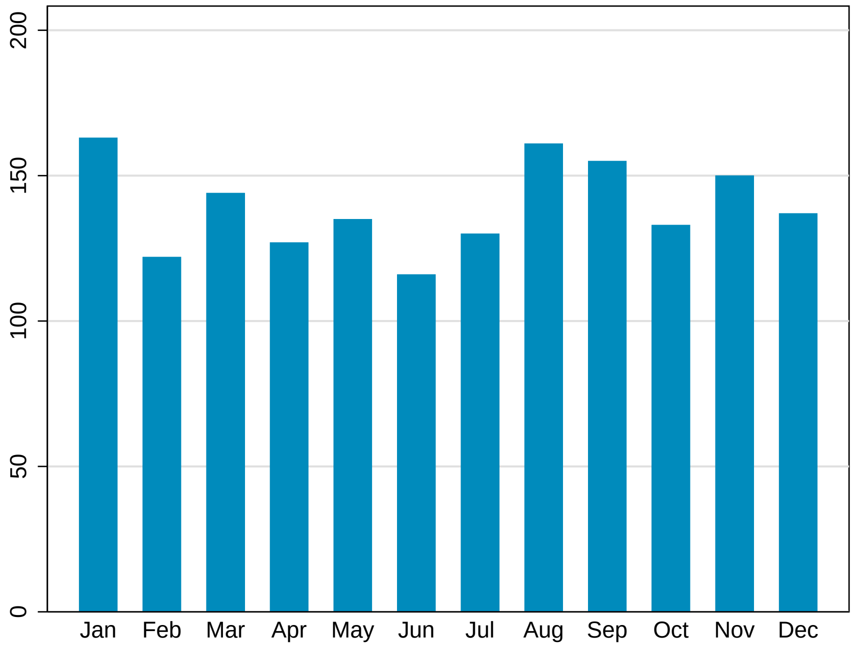
NFL (2006), 'NFL Collective Bargaining Agreement 2006-2012'.

USA Today (Retrieved Feb. 2011), 'USA Today Salary Database'.

Vaeyens, R., R.M. Philippaerts and R.M. Malina (2005), 'The relative age effect in soccer: A match-related perspective', *Journal of Sports Sciences* **23**(7), 747–756.

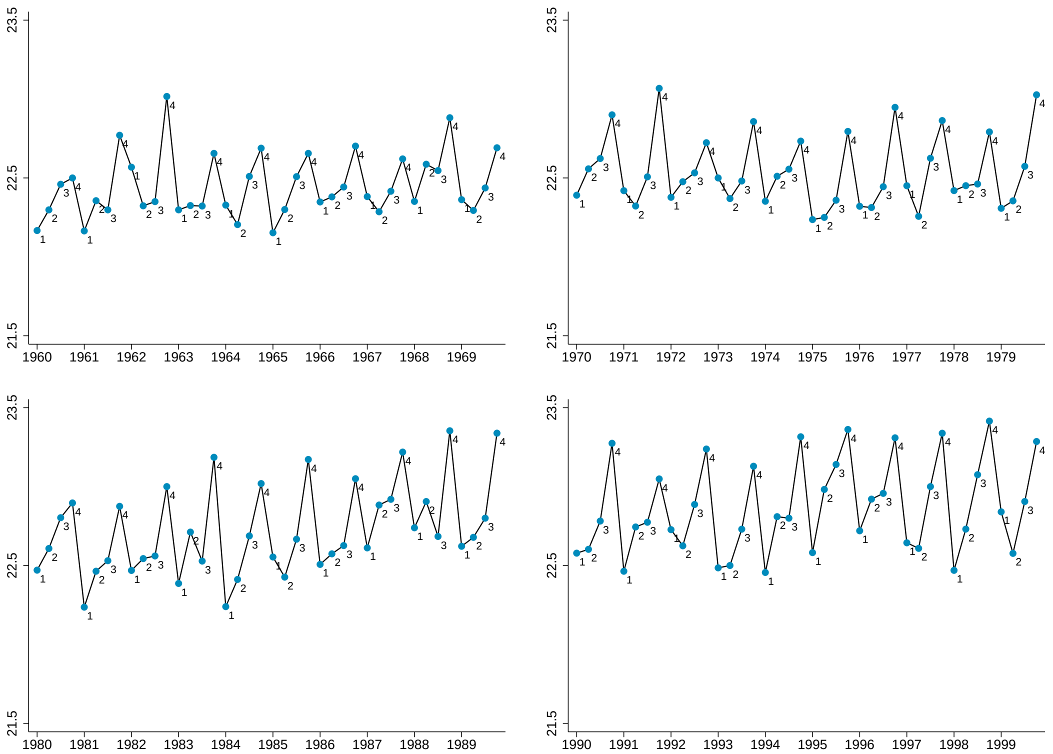
6 Figures and Tables

Figure 1: Distribution of Month of Birth.



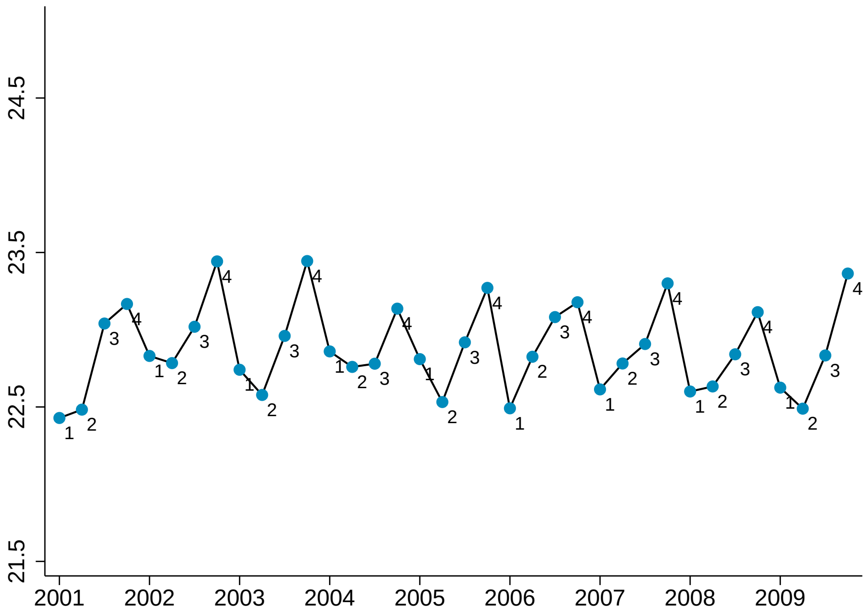
Note: N=1,673 players drafted between 2001 and 2009.

Figure 2: Average Entry Age into NFL over Quarter of Birth.



Note: Each point gives the average age of the players drafted in that year, by their quarter of births. N=11,500, on average 250 to 350 players were drafted each season from 1960 to 2000.

Figure 3: Average age by quarter of birth and year of draft, 2001–2009.



Note: Each point gives the average age of the players drafted in that year, by their quarter of births. N=1,673.

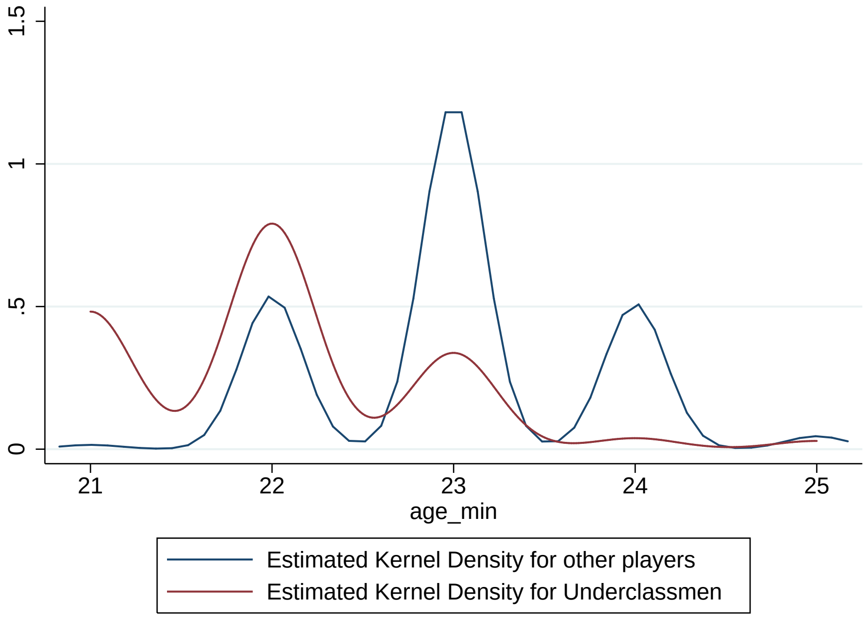
Figure 4: Average Salary in Rookie Season over Draft Years.

Note: N=1,673 players. Each year from 2003 on at least 224 players are drafted. In 2001 and 2002 the Houston Texans were not in operation yet, leading to 217 regular draft picks. Salaries deflated to 2001 prices.

Figure 5: Average Salary in Rookie Season over Quarter of Birth.

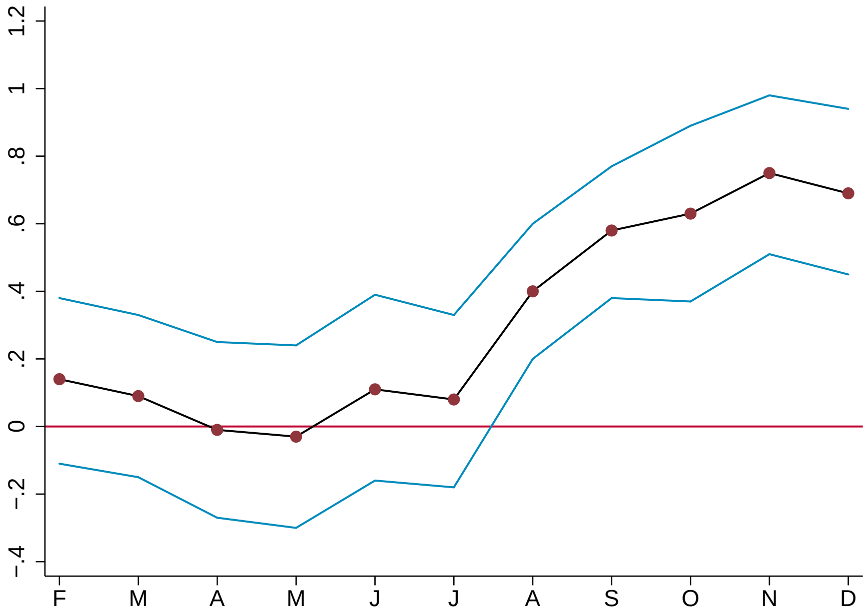
Note: N=1,673 players. Each year from 2003 on at least 224 players are drafted. In 2001 and 2002 the Houston Texans were not in operation yet, leading to 217 regular draft picks. Salaries deflated to 2001 prices.

Figure 6: Estimated Kernel Density



Note: Kernel: Gaussian, bandwidth = 0,1711. All Underclassmen stayed at college for three years. All remaining players stayed either four our five years before they declared eligible for the NFL draft. Mean age of underclassmen is about 22, while all other players enter the NFL at a mean age of about 23.

Figure 7: First Stage Results: Influence of Month of Birth on Entry Age.



Note: N=1,673 players over the period 2001–9. Coefficients, and the 95% confidence interval, are from the first stage regression of NFL starting age on all exogenous regressors and a set of dummy variables for the month of birth.

Table 1: Descriptive Statistics of key variables.

Variable	Mean	Std. Dev.
Entry Age	22.89	0.84
Base Salary	2.85	2.08
Signing Bonus	6.86	11.63
Total Salary	9.72	12.43

N=1,673 players. All data on individual characteristics were obtained from the Pro Football References database available at pro-football-reference.com.
All salary components measured in $ 100,000. Data on salaries were collected from the USA TODAY Salary Database at http://content.usatoday.com/sportsdata/football/nfl/salaries/team.

Table 2: Estimated Effect of Entry Age on Rookie Contracts.

	Base salary		Signing bonus		Total Salary	
	IV[a]	OLS[a]	IV[b]	OLS[b]	IV[c]	OLS[c]
Entry Age in Years						
Coefficient	0.188*	-0.097	1.122*	0.442	1.310**	0.344
Standard error	(0.099)	(0.067)	(0.593)	(0.384)	(0.618)	(0.403)
Elasticity (in %)[d]	[5.926]	[-3.068]	[15.017]	[5.909]	[12.310]	[3.236]
Beta coefficient[e]	{0.065}		{0.076}		{0.083}	
Entry Age Compulsory School[f]	0.025	0.036	0.573**	0.600*	0.598**	0.636*
	(0.060)	(0.073)	(0.265)	(0.333)	(0.282)	(0.356)
Exit Age Compulsory School[g]	-0.079	-0.089	0.008	-0.016	-0.071	-0.104
	(0.053)	(0.066)	(0.224)	(0.287)	(0.205)	(0.264)
Height (in cm)	-0.017*	-0.015	0.029	0.034	0.012	0.019
	(0.009)	(0.011)	(0.051)	(0.061)	(0.053)	(0.064)
BCS Champion[h]	-0.387	-0.352	-2.711**	-2.626*	-3.098**	-2.979*
	(0.332)	(0.394)	(1.227)	(1.515)	(1.406)	(1.718)
Draft Pick Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Position FE	Yes	Yes	Yes	Yes	Yes	Yes
Draft Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Team FE	Yes	Yes	Yes	Yes	Yes	Yes
Team*Draft Interaction FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	1673	1673	1673	1673	1673	1673
Adjusted R^2	0.380	0.389	0.394	0.396	0.443	0.447
F-Statistics[i]	19.733		19.733		19.733	

*, ** and *** indicate statistical significance at the 10, 5, and 1-percent level. Robust standard errors (allowing for heteroskedasticity of unknown form) clustered for state of birth in parentheses. [a] Dependent variable is Base Salary in Rookie Season in 100,000 USD. [b] Dependent Variable is Signing Bonus in Rookie Season in 100,000 USD. [c] Dependent Variable is Total Salary in Rookie Season in 100,000 USD. All Salary Data was obtained from the USA TODAY Salary Database. [d] This elasticity gives the percentage change in the salary category due to an one percentage point increase in entry measured in years. Dependent variable is equal to $\frac{salary}{sample\ mean} * 100$. [e] The standardized (beta) coefficient gives the standard deviation increase in the specific rate (ratio) due to a one standard deviation increases in public social spending. [f] The age of compulsory school entry in the state the player was born. [g] The age compulsory school ends in the state the player was born. [h] Dummy variable taking value 1 if player won the NCAA title in year he was drafted. [i] Kleinbergen-Paap F-statistic (Kleibergen and Paap, 2006); null-hypothesis is that instrument is weak.

Table 3: Robustness: Estimated Effect of Entry Age on Rookie Contracts, different IVs.

	Base salary		Signing bonus		Total Salary	
	IV[a]	OLS[a]	IV[b]	OLS[b]	IV[c]	OLS[c]
Months of birth						
Entry Age in Years						
Coefficient	0.188*	-0.097	1.122*	0.442	1.310**	0.344
Standard error	(0.099)	(0.067)	(0.593)	(0.384)	(0.618)	(0.403)
F-Statistics[d]	19.733		19.733		19.733	
Quarter of birth						
Entry Age in Years						
Coefficient	0.129	-0.097	1.962***	0.442	2.092***	0.344
Standard error	(0.143)	(0.067)	(0.722)	(0.384)	(0.729)	(0.403)
F-Statistics[d]	24.778		24.778		24.778	
Half year of birth						
Entry Age in Years						
Coefficient	0.196	-0.097	2.701***	0.442	2.897***	0.344
Standard error	(0.192)	(0.067)	(1.009)	(0.384)	(0.986)	(0.403)
F-Statistics[d]	67.838		67.838		67.838	

1,673 observations. Specification as in Table 2. *, ** and *** indicate statistical significance at the 10, 5, and 1-percent level. Robust standard errors (allowing for heteroskedasticity of unknown form) clustered for state of birth in parentheses. [a] Dependent variable is Base Salary in Rookie Season in 100,000 USD. [b] Dependent Variable is Signing Bonus in Rookie Season in 100,000 USD. [c] Dependent Variable is Total Salary in Rookie Season in 100,000 USD. All Salary Data was obtained from the USA TODAY Salary Database. [d] Kleinbergen-Paap F-statistic (Kleibergen and Paap, 2006); null-hypothesis is that instrument is weak.

Table 4: The Effect of Month of Birth on Entry Age into the NFL.

Month-of-Birth Effect [p value]										
FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
.145	.083	-.012	-.033	.112	.060	.402	.589	.630	.753	.697
[0.261]	[0.493]	[0.928]	[0.800]	[0.413]	[0.634]	[0.00]	[0.00]	[0.00)	[0.00]	[0.00]

Note: Estimated coefficients from a regression of rookie salary on month of birth. Omitted category is January. Other covariates that were used in the regression are height, BCS champion dummy variable, draft-year FE, position FE, team FE and team*draft year FE. N=1,673. Robust standard errors clustered for the state a player was born in.

Table 5: Estimated probability of playing in the next season.

	Instrument		
	quarter	month	half year
Entry Age	-0.075***	-0.082***	-0.086***
	(0.026)	(0.027)	(0.028)
Season	-0.144***	-0.144***	-0.144***
	(0.003)	(0.003)	(0.003)
Entry Age Compulsory School	-0.014	-0.014	-0.015
	(0.013)	(0.012)	(0.013)
Exit Age Compulsory School	0.013	0.013	0.013
	(0.009)	(0.009)	(0.009)
Size in cm	-0.004	-0.004	-0.004
	(0.003)	(0.003)	(0.003)
NCAA Champion	0.108*	0.110*	0.111*
	(0.065)	(0.064)	(0.064)
Draft Pick Dummies	Yes	Yes	Yes
Team*Draft FE	Yes	Yes	Yes
Position FE	Yes	Yes	Yes
Draft Year FE	Yes	Yes	Yes
Team FE	Yes	Yes	Yes
Observations	4072	4072	4072
Adjusted R^2	0.0957	0.0960	0.0955
F-statistic[a]	64.139	22.817	149.288

Note: Robust standard errors (allowing for heteroskedasticity of unknown form) clustered for state of birth in parentheses. Estimated coefficients from a linear probability model, where the dependent variable is equal to 1 if the player plays in the next season, and 0 if he does not. The estimation is by 2SLS where we instrument entry age by the quarter of birth, the month of birth or the half year of the birth, as indicated by the column heading.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. [a] Kleinbergen-Paap F-statistic (Kleibergen and Paap, 2006); null-hypothesis is that instrument is weak.