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# Early Entry in the NBA Draft: The Influence of Unraveling, Human Capital, and Option Value

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## ABSTRACT

In an influential article, “Unraveling in Matching Markets,” Li and Rosen (1998) note that the first 7 picks, and 17 among 29 first-round selections, of the 1997 National Basketball Association (NBA) draft were not college seniors. By 2004, the first pick was a high school senior, and 25 of the first 29 picks were not college seniors.We suggest that recent NBA contract provisions implemented to slow the early entry of talented players have instead provided additional incentives to both players and firms for early entry into the NBA.We explore two competing models that predict why teams choose a talented player sooner in the new rookie contract system: the human capital model and Lazear’s option value model. To test why unraveling occurs, we use a panel study of all NBA players for 12 years, from 1989 through 2002.

In the pursuit of the best qualified worker, unraveling may occur in the labor market (Li&Rosen, 1998; Roth, 1991; Roth&Xing, 1994). In the literature, two types of unraveling are identified. The first type is identified as jumping-the-gun unraveling, which occurs when offers are made earlier and earlier around a central clearing time. Examples of this type include early admissions at colleges and hiring of MBA candidates. The second type occurs when offers are extended early and workers do not join the firm until a later period. Examples of this type generally come from educational markets, where firms hire workers a year or 2 years before their education is complete.

On the surface, the National Basketball Association (NBA) labor market seems like a good example of the second type of unraveling. In this instance, the NBA has a centralized matching system to hire new talent: the NBA draft. Teams in the pursuit of talent have drafted players earlier and earlier in their college careers or from high school, but here is where the similarity ends. In the unraveling model, once a match has been made, workers complete their education and then report towork. In the NBA draft, players once drafted start playing without finishing their education. Why does early entry occur? We suggest two models predict early entry into the draft: human capital and option value. The human capital model suggests that players enter the NBA once a certain skill level is obtained. Thus, highly talented players reach the NBA earlier because they do not need as much experience as do less talented players. The option value model suggests that college basketball provides signals for players. Therefore, the longer a player stays in college, the better the signal. Teams will then choose players who have a more varied signal (less college experience) if they can minimize the downside risk and capitalize on the upside potential.

In the first section, we outline the history of the NBA collective bargaining agreement (CBA) to establish how monopsonistic exploitation has increased with the rookie contract. In this section, we explore how institutional and contract structures have increased unraveling in the NBA draft. In the second section, we model the early entry decision for both players and firms and then focus on testable implications of both human capital and option value models of early entry. In the third section, we conclude with policy implications.

## INSTITUTIONAL ASPECTS OF NBA CBAS AFFECTING EARLY ENTRY

A Supreme Court ruling in the *Haywood v. NBA* case in 1971 voided the requirement that entrants into the NBA draft wait until their college class graduated. For a brief period, the NBA allowed only early entrants who requested and were approved entry based on financial hardship; in 1975, the NBA dropped the hardship criteria. The figures in Table 1 indicate that from 1976 through the 1994 draft, only 18.1% of the first-round draft picks were early or foreign entrants; of these early entrants, 79.5% of the first-round draft picks into the NBA were college juniors. The only foreign first-round picks were Arvydas Sabonis, the star center on the Soviet Union gold medal Olympic team of 1988, who was drafted by Portland in 1986 but did not come to the NBAuntil 1995, and Vlade Divac, a 21-year-oldmember of the 1988 and 1996 silver medal Yugoslavian Olympic teams. Divac was drafted by the Lakers in 1989 and joined the NBA that year. During this time period, a rookie player individually negotiated a contract with the team that drafted him. Salaries and contract length varied greatly.

The introduction of team salary caps in the 1983 CBA was a compromise between owners and the players' union, in return for 53% of NBA gross revenue being allocated to player salaries. The early cap level was below the payroll of five teams whose cap levels were frozen at their existing payroll (Staudohar, 1996). The introduction of the salary caps led to some inequities in rookie salaries. Teams could pay a rookie only either the league minimum, if they were at the cap, or the amount of room under the cap, in other cases. In 1987, for example, the third pick in the draft, Dennis Hopson, was paid a reported $400,850 for his rookie season, whereas the fifth pick in the draft, Scottie Pippen, earned $725,000 his first season. The first pick in the draft in 1987, David Robinson, earned a reported salary of $1,046,000 from San Antonio, the highest salary on his team by more than $250,000.

Discontent among veterans at the prospect of unproven rookies earning more than they did and dissatisfaction with the inequities the salary cap was exacting on the distribution of draft pick pay led to the introduction of a rookie pay scale in the 1995 NBA CBA. Under the terms of the 1995 CBA, first-round draft picks were given guaranteed 3-year contracts, with salaries set according to a published table. Teams were allowed to exceed the published salaries by 20%, and most did so. Second-round draft picks were paid the league minimum, and contracts were not guaranteed.

Immediately following the introduction of this 3-year rookie pay scale, the level and composition of early entrants into the NBA changed. During the period encompassing the 1995 to 1997 drafts, 44% of the first-round draft picks were early or foreign entrants; only 20% of the first-round draft picks were juniors. In addition, four high school graduates were drafted with no college experience. Players sought earlier entry into the draft, knowing that the 3-year rookie scale would delay the attainment of hefty free-agent salaries.

From 1995 to 1997, six young, foreign players were drafted. Rule changes in 1989 allowed professional players to play in the Olympics. This change induced foreign players, who previously could not play in the NBA and also play for their home country in the Olympics, to seek entry into the NBA; the change also allowed NBA scouts to evaluate foreign players as they competed against a team of select NBA players. A surge in world popularity for basketball followed the U.S. Olympic "Dream Team" winning of the gold medal in Barcelona, Spain, in 1992. Although the first Dream Team dominated world competition, the U.S. team of NBA stars won only a bronze medal in the 2004 Olympics in Athens. The NBA is now searching globally for the best basketball talent.

TABLE 1: Declared and Drafted Foreign and Early Entrants in the NBA (1976 to 2004)

| | | *Declared But Not Drafted* | | | | | *First Round Picks* | | | | | *Second Round Picks* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Year* | *Picks per Round* | *HS* | *FR* | *SO* | *JR* | *FL* | *HS* | *FR* | *SO* | *JR* | *FL* | *HS* | *FR* | *SO* | *JR* | *FL* |
| 1976 | 17 | | | 2 | 4 | | | | | 4 | | | | 1 | 2 | |
| 1977 | 22 | | | | 2 | | | | | 3 | | | | | | |
| 1978 | 22 | | | 1 | | | | | | 4 | | | | | | |
| 1979 | 22 | | | | | | | | 2 | 1 | | | | | | |
| 1980 | 23 | | | | 3 | | | | | 1 | | | | | 2 | |
| 1981 | 23 | | | | | | | | 1 | 2 | | | | | | |
| 1982 | 23 | | 1 | | 3 | | | | | 9 | | | | | | |
| 1983 | 24 | | | | | | | | 1 | 4 | | | | | 1 | |
| 1984 | 24 | | | | 1 | | | | | 4 | | | | | 3 | |
| 1985 | 24 | | | | 1 | | | | | 5 | | | 1 | | | |
| 1986 | 24 | | | | 2 | | | | | 2 | 3 | 1 | | | | 1 |
| 1987 | 23 | | | | 3 | | | | | | 2 | | | | 1 | 1 |
| 1988 | 25 | | 2 | | | | | | 1 | 2 | | | | 2 | 1 | |
| 1989 | 27 | | 2 | 2 | 4 | | | 1 | | 2 | 1 | | | 1 | 1 | |
| 1990 | 27 | | | | 7 | | | | 2 | 1 | | | | 1 | 3 | |
| 1991 | 27 | | | 1 | 3 | | | | 1 | 3 | | | | | 2 | 1 |
| 1992 | 27 | | | 2 | 10 | | | | | 4 | | | | | | |
| 1993 | 27 | | 5 | | 7 | | | 1 | 1 | 5 | | | | | | |
| 1994 | 27 | | 1 | | 6 | | | | 2 | 7 | | | 1 | | 2 | |
| 1995[a] | 29 | | | | 5 | 1 | 1 | | 4 | 5 | | | | 2 | 1 | |
| 1996 | 29 | 1 | 2 | 3 | 15 | | 2 | 2 | 2 | 7 | 5 | | | 1 | 3 | |
| 1997 | 28 | 1 | | 4 | 20 | 3 | 1 | 1 | 2 | 5 | 1 | | 1 | 3 | 1 | 5 |
| 1998 | 29 | 2 | 2 | 5 | 8 | 2 | 1 | 2 | 2 | 7 | 4 | 2 | | | 3 | 1 |
| 1999 | 29 | 1 | 3 | 3 | 8 | 9 | 2 | 2 | 7 | 3 | 2 | | | | | 3 |
| 2000 | 29 | | 2 | 6 | 10 | 13 | 2 | 2 | 7 | 3 | 4 | | | 2 | 3 | 5 |
| 2001 | 28 | 1 | 6 | 8 | 13 | 11 | 4 | 4 | 5 | 6 | 4 | 1 | 2 | 2 | 3 | 3 |
| 2002 | 28 | 3 | 6 | 9 | 16 | 10 | 1 | 1 | 3 | 10 | 6 | | 2 | 1 | 3 | 8 |
| 2003 | 29 | 1 | 4 | 5 | 16 | 11 | 4 | 2 | 1 | 5 | 8 | 1 | | 2 | 1 | 12 |
| 2004 | 30 | 4 | 3 | 5 | 22 | 24 | 8 | 2 | 1 | 8 | 6 | | 2 | 1 | | 8 |

SOURCE: These data were compiled from *The Official NBA Basketball Encyclopedia* (3rd ed.), Patricia Bender's Web site (www.dfw.net/~patricia/), the official NBA Web site (www.nba.com), www.sportsstats.com, and various editions of the *Official NBA Register*.

NOTE: In select cases, the number of first-round picks is different from the number of second-round picks because teams were made to forfeit a draft pick for violation of league rules. HS = high school; FR = freshman; SO = sophomore; JR = junior; FL = foreign league.

a. In 1995, players were allowed to withdraw from the draft and return to school if no agent was signed.

The distribution of salaries in the NBA became more and more skewed to the right (Hill & Groothuis, 2001) as pay for top free agents skyrocketed in the new agreement. The league pressed for individual caps on salaries during negotiations for a new CBA, following the 1997-1998 season. The main impetus for the hard-line stance of management during the negotiations was the $121 million, 6-year contract signed by Kevin Garnett following his 2nd year in the league, while he was still under the rookie scale contract he signed as an early entrant out of high school. Fearing that this might be a portent of the future, the league locked out the players during negotiations. The new CBA signed in 1999, but effective for 1998 draftees, was an interesting compromise agreement that established caps on individual player salaries, lowered the 3-year pay scale for rookies somewhat, added a 4th-year option for teams at set percentage salary increases, set minimum salaries for players on an increasing sliding scale based on years of experience, and added a median player salary exception to the list of other salary cap exceptions.

TABLE 2: Average Age of First-Round Draft Picks in the NBA (1989 to 2004)

| *Year* | *Age* | *Number of Picks* |
|---|---|---|
| 2004 | 20.5 | 29 |
| 2003 | 20.9 | 29 |
| 2002 | 21.6 | 28 |
| 2001 | 20.6 | 28 |
| 2000 | 21.6 | 29 |
| 1999 | 21.3 | 29 |
| 1998 | 21.6 | 29 |
| 1997 | 22.0 | 28 |
| 1996 | 21.3 | 29 |
| 1995 | 22.0 | 29 |
| 1994 | 22.3 | 27 |
| 1993 | 22.5 | 27 |
| 1992 | 22.0 | 26 |
| 1991 | 22.4 | 26 |
| 1990 | 22.3 | 27 |
| 1989 | 22.4 | 27 |

The addition of another year to a rookie’s tenure before free agency caused more players to seek early entry to the draft. For instance, in Table 1, we show that in 1976, only six players declared entry into the draft and were not drafted, but by 2004, 58 players declared for the draft and were not drafted. In addition, teams were more willing to accept early entrants. From 1998 to 2004, 74% of the first-round draft picks were early or foreign entrants; only 23% of the first-round picks were college juniors. The figures in Table 2 dramatically illustrate the effect of the rookie pay scale on the age of first-round draft picks: First-round picks in 2004 are almost 2 years younger, on average, than their 1994 counterparts. Given these shifts, owners now find free agents and rookies are no longer close substitutes. In particular, a very talented new entrant becomes highly preferred, because he costs much less than a veteran player and is more productive.

Roth and Xing (1994) predicted that unraveling accelerates when senior candidates are not close substitutes for new entrants. In their article, they further state, “It may be possible to develop quantitative tests of the effect of the availability of senior candidates on unraveling in the market for junior candidates by considering the markets for professional athletes such as baseball” (p. 1037). We suggest that changes in the NBA CBA provide just such a natural experiment to test the theories of unraveling, human capital, and option value.

## THEORIES OF UNRAVELING: HUMAN CAPITAL AND OPTION VALUE

College basketball has long been the “minor league” for the NBA. As a minor league, it serves a dual purpose. First, it is a training ground where players can hone their skills and become more productive. It is where players move from playing in front of small crowds to playing in front of large crowds and on national television. Second, college basketball serves as a signaling device to provide information and sort players into the NBA. When players leave early, they have less experience and a noisier signal than a player who stays in college. When owners choose an early entrant, they choose a player who is both riskier and with less experience.

### Player’s Decision for Early Entry

Consider an individual who decides whether to wait one more year to enter the NBA. The rookie salary contract lasts for $T$ years. An individual has an expected career of $N$ years, $N > T$.1 Let $A$ equal a player’s ability when he decides whether to enter the league or wait 1 year. Staying in school one more year would add to one’s ability.2 One could argue that those with lower ability have more to gain from staying in school. Alternatively, if staying in school tends to increase ability by a given percentage, then the more able have more to gain from staying in school. We assume that the increase in ability from staying in school, $\alpha$, is independent of initial ability, $A$.

Ignoring discounting, a player is paid less than the value of his productivity during the rookie contract.3 Let $k$ equal the fraction of a player’s worth he receives during the rookie contract, $0 < k < 1$. After fulfilling the rookie contract, the player is paid a wage commensurate to his ability. Thus, the career earnings from one who stays one more year, $W_{stay}$, equal

$$W_{stay} = k(A + \alpha)T + (A + \alpha)(N - 1 - T) = (A + \alpha)[(k - 1)T + N - 1]. \tag{1}$$

The career earnings for one who enters the league now, $W_{go}$, equal

$$W_{go} = A(kT + N - T) = A[(k - 1)T + N]. \tag{2}$$

Thus, a player will enter the league now if $W_{go} \geq W_{stay}$ or if

$$A \geq \alpha[(k - 1)T + N - 1] \equiv A^*. \tag{3}$$

Note $A^*$ is positive for $W_{stay} > 0$. Only those with ability of at least $A^*$ will leave school early. With a given distribution of $A$, the larger $A^*$ is, the fewer individuals there are who leave early. We have

$$\frac{\partial A^*}{\partial \alpha}, \frac{\partial A^*}{\partial k}, \text{ and } \frac{\partial A^*}{\partial N} > 0, \text{and} \frac{\partial A^*}{\partial T} < 0. \tag{4}$$

If the increase in ability from staying in school is larger ($d\alpha > 0$), fewer individuals leave early. The less rookies are underpaid ($dk > 0$), the fewer individuals there are who leave early. The longer one's expected career ($dN > 0$) is, the fewer individuals there are who leave early. Finally, an increase in the length of the rookie contract ($dT > 0$) results in more individuals leaving early.

**Firm's Decision for Early Entry—Human Capital**

Becker (1993) argues that employees will pay for general training. Consider the standard two-period human capital investment model. In period 1, employees undertake training that will increase their marginal revenue product (MRP) in all firms in an industry. If the employees' wage during this period (W1) exceeds the employee's MRP during this period (MRP1), then the firm can only recoup this investment cost if the MRP of the employee in period 2 (MRP2), posttraining, exceeds the wage paid during this period (W2), which, with general human capital, usually can not occur. One paid less than one's MRP will quit, unless there is some monopsonistic power by firms.

In professional sports, leagues use a variety of methods to ensure that the cost of general training is not borne by teams. In football and basketball, professional franchises have typically allowed the bulk of general training to be performed by colleges. Early entry erodes this approach. In baseball and hockey, professional teams have traditionally used minor league affiliates to provide training. These minor league teams are subsidized by the major league parent franchises. To recoup their training costs, leagues do not allow players to become free agents until they have been in the major league for a certain time period. In baseball, players must be in the major league for six seasons before they can opt for free agency. This approach is designed to provide teams a period of time in which overall player MRPs exceed wages so that teams can recoup investment in players in the minors, but it obviously involves some cross-subsidization (Hill, 1985).

In the years following the *Haywood* decision, teams in the NBA were free to draft players who had not completed college. The figures in Table 1 suggest that from 1976 to 1994, teams in the NBA, in general, drafted only college juniors. The human capital model would suggest, lacking a framework in which to recoup investment in general on-the-job (OTJ) training costs, franchises were reluctant to draft a player whose MRP would not at least equal his wage.

This approach dramatically shifted with the addition of the "rookie scale' in the 1995 NBA CBA. With first-round draft picks locked into 3-year contracts with a predetermined salary, teams could now draft earlier entrants who might require some general training, as long as the teams could recoup these costs before the end of the rookie scale contract. The changes in the 1999 CBA gave teams even more incentive to draft earlier entrants. By lowering the rookie scale contract salaries and adding a 4th-year option for teams, at a predetermined percentage pay increase, the league and union added even more opportunities at the bargaining table for teams to recoup general OTJ training costs.

Other aspects of the NBA CBA make the above scenario more likely. In 1999, individual maximum salary caps based on years of experience were added to the CBA. This could allow teams to pay superstar players a wage below their MRP. To increase the likelihood a team that drafts and develops such a player is able to retain him past the 4th year of the rookie scale contract and option, a team is able to offer a 12.5% annual pay increase to players who have been with the club for three or more seasons but can only offer a 10% annual salary increase to others.4 For stars earning $9 million, this 2.5% pay difference is substantial.5 An alternative explanation of early entry is Lazear's (1995) option value.

**Firm's Decision for Early Entry—Option Value**

Lazear (1995) argues that risky workers are preferred to safe ones at a given wage, because the risky workers have an upside option value. Firms are willing to hire risky workers if they can dismiss workers who do not measure up and keep workers with upside potential. For this strategy to work, the employer must have some ex post advantage over other firms, such as costly mobility or private information; if not, the option value vanishes as the worker moves. In basketball, the rookie contract and provisions in the CBA may provide just this advantage.

Previous studies have looked at the role of option value in the sports economic literature. For instance, Hendricks, DeBrock, and Koenker (2003) find in the NFL that "as long as the employer can eliminate poor performers . . . it seems quite possible that employers take chances on risky workers in the hope of finding 'stars'" (p. 883). In baseball, Bollinger and Hotchkiss (2003) find that risky workers receive a pay advantage as long as firms enjoy some degree of market power. In the NBA, we explore the possibility that early entrants are, indeed, risky workers who thus provide option value to the team that drafts them. To examine option value in the presence of monopsonistic rent, consider the following model.

Suppose an individual is under contract for a length of time $T$. After a length of time $bT$, $b < 1$, the firm may terminate the individual. The individual is paid W per unit of time. The individual's marginal value product, $Q$, equals $A + D$. Assume $A$ is a measure of ability that is known to all prior to the contract. $D$is an ability measure (drive, perhaps) that is unknown to the firm but is learned before the firm may terminate the worker. Assume $D$ is distributed continuously on [$D$min, $D$max], with a probability density function and cumulative density function of $f(D)$ and $F(D)$, respectively. Further assume $E(D) = 0$ and the firm has monopsony power so $E(Q) = A > W$. With $\pi$ a firm's expected profit, the probability of firing (respectively keeping) an individual given by prob(fire)[resp. prob(keep)], and the discount rate equal to zero, we have

$$\pi = T\{\text{prob(fire)}[E(D|\text{fire}) + A - W]b + \text{prob(keep)}[E(D|\text{keep}) + A - W]\}. \qquad (5)$$

Now a firm will fire an individual only if $A + D <$ W, or if $D <$ W – $A$. Thus,

$$\text{prob(fire)} = \int_{D_{\min}}^{W-A} f(D)dD = F(W-A) \text{ and}$$

$$\text{prob(keep)} = \int_{W-A}^{D_{\max}} f(D)dD = 1 - F(W-A)\ .$$

It is assumed $W - A > D_{\min}$, so prob(fire) > 0. Consider the first term in brackets in Equation 5. Because $E(D|\text{ fire}) = \frac{1}{F(W-A)}\int_{D_{\min}}^{W-A} D(f(D)dD$ is negative and larger in absolute value than $W - A$, $E(D|\text{fire}) < W - A$, and $E(D|\text{fire}) + A - W < 0$. With prob(fire) + prob(keep) = 1, and prob(fire)$E(D|\text{fire})$ + prob(keep)$E(D|\text{keep})$ = $E(D) = 0$, then $\pi|_{b=1} = A - W$, which is positive by assumption. Using Equation 5 and the fact $E(D|\text{fire}) + A - w < 0$, $\frac{\partial \pi}{\partial b} < 0$. Thus, $\pi > 0\ \forall b$, and $\pi > A - W$ for $b < 1$. Note that $\pi = A - W$ for an individual with zero risk and that $E(D) = 0$, so for $b < 1$, $\pi$ is greater for a risky worker, which is the basic result in Lazear (1995).

One argument against early entry of players in the NBA is that players have lower ability as more players leave college early or enter the NBA directly from high school. If the model herein represents the average individual a firm considers drafting, then (average) ability may be reduced as the contract period, $T$, is increased. This follows the argument that more players enter the NBA early as $T$ increases, because they are not free agents until after their initial contracts have expired. Let $A = A(T, \theta)\,\frac{\partial A}{\partial T} < 0, \frac{\partial A}{\partial \theta} = 1$, and $\frac{\partial^2 A}{\partial A \partial \theta} = 0$, where $d\theta > 0$ represents an exogenous increase in $A$. Note that an exogenous increase in $A$ raises $\pi$:

$$\frac{\partial \pi}{\partial \theta} = T[bf(W-A) + 1 - F(W-A)] > 0. \quad (6)$$

[8]

Assume the firm can choose *T*, but *b* is exogenous. Clearly, for NBA teams, *T* and *b* are both subject to bargaining with the players' union. In recent contracts, the union apparently has shifted wealth from new players to existing ones by allowing for a longer period before free agency and by accepting a salary scale for rookies. Assuming *T* is and *b* is not chosen by the firm (i.e., the league), the firm essentially treats the league-union bargaining as allowing more rent to be taken from rookies as *T* increases, with the union insisting on a given value for *b* to limit such rent extraction. If the firm or team is not constrained by *b*, it will terminate those with $D < W - A$ once it learns *D*.

One can ask how a representative team would set *T* to maximize $\pi$. The first-order condition (FOC) is

$$\frac{\partial \pi}{\partial T} = \frac{\pi}{T} + T\left\langle \begin{array}{l} b\left[\text{prop(fire)}\left(\frac{\partial E(D|\text{fire}}{\partial A}+1\right) - f(W-A)(E(D|\text{fire})+A-W)\right] \\ +\text{prob(keep)}\left(\frac{\partial E(D|\text{keep}}{\partial A}+1\right) + f(W-A)(E(D|\text{keep})+A-W) \end{array}\right\rangle \frac{\partial A}{\partial T} \tag{7}$$

$$= \frac{\pi}{T} + T[bF(W-A)+1-F(W-A)]\frac{\partial A}{\partial T} = 0$$

The second-order condition (SOC) is

$$\frac{\partial^2 \pi}{\partial T^2} = -\frac{\pi}{T^2} + \frac{1}{T}\frac{\partial \pi}{\partial T} + [bf(W-A)+1-F(W-A)]\frac{\partial A}{\partial T} \tag{8}$$
$$+ T(1-b)f(W-A)\left(\frac{\partial A}{\partial T}\right)^2 + T[bf(W-A)+1-F(W-A)]\frac{\partial^2 A}{\partial T^2}.$$

The first and third terms in the SOC are negative, the second term is zero from the FOC, the fourth term is positive, and the sign of the fifth term depends on the sign of $\frac{\partial^2 A}{\partial T^2}$. Assuming the SOC is negative and for simplicity, $\frac{\partial A}{\partial T} \equiv x$, a negative constant, so $\frac{\partial^2 A}{\partial T^2} = 0$, totally differentiate the FOC:

$$\begin{aligned}&(\text{SOC})dT + T[bF(W-A)+1-F(W-A)]dx + [TxF(W-A) \\ &+ F(W-A)(E(D|\text{fire})+A-W)]db + [Tx(1-b)f(W-A) \\ &+ bF(W-A)+1-F(W-A)]d\theta = 0.\end{aligned} \tag{9}$$

Clearly, $\frac{dT}{dx}$ is positive and $\frac{dT}{db}$ is negative. As $x$ increases (becomes a smaller negative number), the reduction in $A$ as $T$ increases is smaller, so the team desires a longer contract. As $b$ increases, it takes longer to fire one with a low realized value of $D$, so the team desires a shorter contract. The effect of θ on $T$ is ambiguous. Even though $\frac{\partial \pi}{\partial \theta}$ is positive (Equation 6), an exogenous increase in θ increases the expected duration of employment—$T[bF(W-A)+1-F(W-A)]$—as captured in the term $Tx(1-b)f(W-A)d\theta$ in Equation 9. As $T$ increases, $A$ is reduced, and the cost to the team of raising $T$ is larger the longer the expected duration of employment. Thus, an increase in θ does not unambiguously increase the optimal (to the team) length of the contract. From Equation 9, $\frac{dT}{d\theta}$ is positive only if

$$bF(W-A)+1-F(W-A) > -Tx(1-b)F(W-A). \tag{10}$$

From Equation 10, as |x| becomes larger (x becomes smaller), the right-hand side of Equation 10 does not necessarily rise, because $\frac{dT}{dx} > 0$ and a larger |x| implies a smaller $x$ and a smaller $T$. However, a smaller $b$ implies a larger value for $T$, so the right-hand side of Equation 10 is negatively related to $b$, whereas the left-hand side of Equation 10 is positively related to $b$. Thus, when $b = 0$, the possibility $\frac{dT}{d\theta} < 0$ is the largest. In this case, a positive value for $\frac{dT}{d\theta}$ requires a sufficiently small $T$:

$$T < \frac{1 - F(W - A)}{-xf(W - A)}. \tag{11}$$

An exogenous increase in θ *could* result in a shorter desired contract length. However, even if this were true, as demonstrated above, team profit increases if it hires individuals with more ability and with more risk, given ability. Many critics have noted the reduced skill level of NBA players because of early entry. This effect is allowed for above with the assumption $\frac{\partial A}{\partial T}$ is negative. As long as the negative effect of $T$ on $A$ is not extremely large, the rent earned during the contract period ensures an interior solution for $T$. If $b \to 1$, and $W \to A$, then $\pi \to 0$, and the FOC for $T$ would be negative: The optimal $T$ would be zero. Otherwise, early entry of players may lower $A$ but still increase $\pi$.

An additional return to hiring risky workers in the NBA is the limit on what teams other than one's current team can pay the individual once he is a free agent (that is, after the contract period considered above). The so-called Larry Bird rule allows teams to exceed the salary cap to re-sign their own players. Salary cap rules may prevent a raiding team from offering a player his marginal value product. Thus, a player who turns out to be highly productive may be retained if his team pays him more than another team can pay him, leaving some rent for his current team. The new maximum individual salary caps for players, added to the 1999 CBA, undoubtedly suppress superstar salaries below competitive market levels. Overall, this model suggests that firms in the pursuit of talent will choose riskier players, ceteris paribus, to capture upside potential. To test both the human capital and option value models, we use a natural experiment approach, focusing on the changes in the collective bargaining agreements in the NBA.

**Empirical Evidence**

The change in the CBA provides an opportunity to test how incentives influence choices by both players and owners. To best focus on the changes, we estimate wage equations for two time periods, 1997 and 2002.We examine the effect of the rookie scale salary using a log-linear regression model. Salary regression models for professional sports are usually estimated using the log of salary to adjust for the large disparity in salaries between average and superstar players. Using the log of salary as the dependent variable helps to make the regression line more linear and reduce problems with heteroskedasticity inherent in such estimations.7 Performance statistics included as independent variables included points per game, rebounds per game, assists per game, steals per game, blocks per game, and turnovers per game. A priori, the coefficients of points, rebounds, assists, and steals are expected to be positive, whereas the coefficient of turnovers is expected to be negative. A dummy variable equal to one if the player is under a rookie scale contract is included in the model. An interaction variable of years of experience times the rookie scale dummy variable is also included. The coefficients of these two variables should give insight into the impact of the rookie scale on player salaries. Draft number is also included in the model, because the rookie scale is a sliding scale based on draft position in the first round. The regressions are estimated using all players in the league; older players who were drafted prior to the adoption of the rookie scale should also exhibit an inverse correlation between their salary and their draft number if the draft is an efficient indicator of potential. The number of years of experience and the number of years of experience squared are included to model the typical age-earnings profile.

The model is estimated using 1997 and 2002 salary data separately. These 2 years of observations were chosen to illustrate the impact of the changes in the rookie scale clause in the CBA. Because the original rookie scale was adopted in the 1995 CBA, using 1997 gives observations with 1, 2, and 3 years under the rookie scale. The scale was changed for the 1998 rookie class; using the 2002 season gives observations with 1, 2, 3, and 4 years under the new scale.

The results are presented in Table 3. The coefficients of years of experience are positive and significant for both years; the coefficients of years of experience squared are negative and significant for both years. The coefficient of draft number is negative and significant for both years. Performance statistics did not perform as well as anticipated. The coefficient of points per game is positive and significant for both years. The coefficient of rebounds per game is positive and significant for 1997 but is improperly signed and insignificant for the 2002 regression. The coefficient of assists per game is positive for both years but significant only for the 1997 regression. The coefficient for steals per game is negative for both years and significant in the 1997 regression. The coefficient of blocks is positive and significant for both years. The coefficient of turnovers is positive in 1997 yet is negative in 2002 and is insignificant in both regressions.

TABLE 3: NBA Salary Regressions: 1997 and 2002

| | *1997* (N = *398*) | | *2002* (N = 389) | |
|---|---|---|---|---|
| *Variable* | *Coefficient* | t | *Coefficient* | t |
| Constant | 13.117 | 88.008 | 13.554 | 81.736 |
| Years of experience | 0.252 | 7.751 | 0.325 | 10.192 |
| Years of experience squared | –0.015 | –6.784 | –0.0170 | –8.313 |
| Rookie scale | 0.319 | 1.992 | 0.274 | 1.696 |
| Rookie Scale × Experience | –0.341 | –3.518 | –0.246 | –3.647 |
| Draft number | –0.016 | –8.344 | –0.013 | –5.568 |
| Points per game | 0.047 | 3.742 | 0.040 | 3.232 |
| Rebounds per game | 0.078 | 3.595 | –0.005 | –0.200 |
| Assists per game | 0.111 | 3.155 | 0.001 | 0.031 |
| Steals per game | –0.210 | –1.894 | –0.058 | –0.487 |
| Blocks per game | 0.209 | 2.472 | 0.232 | 2.410 |
| Turnovers per game | –0.061 | –0.579 | 0.132 | 1.244 |
| Adjusted $R^2$ | .617 | | .599 | |

The results for the coefficients of rookie scale and of Rookie Scale × Experience tell an interesting tale. The coefficient of rookie scale is positive and significant for both years; the coefficient of Rookie Scale × Experience is negative and significant both years. When experience equals zero for rookies, then the overall effect of the rookie scale is positive on player salaries. When first-round draft picks are under the rookie scale and have 1 year of experience, the overall impact on salary from the rookie scale is almost zero in each regression. However, when years of experience is set equal to two and players are still under the rookie scale, the overall impact of the rookie scale is negative for both the 1997 and 2002 regressions. Adding the 4th-year option to the rookie scale in the 1999CBAmeans that, for our 2002 regression, a player with 3 years of experience who is still under the rookie scale would see an even greater negative impact on his salary.

The results of the salary regressions lend support to the human capital model. First-round draft picks are apparently paid more under the rookie scale than their performance would indicate in their 1st year in the league. During their second season, their performance and pay tend to approximate that of others in the league not under a rookie scale contract. However, in the 3rd year in the league under the 1995 CBA and in the 3rd and 4th years in the league under the 1999CBArookie scale, the players are paid less than the value of their performance. Through the CBA, the NBA has set up an institutional arrangement that allows teams to capture the cost of general training that takes place during the first season in the league.

In Table 4, median estimated salaries for the 1997 and 2002 class of rookies are compared assuming the player is under the rookie scale versus not under the rookie scale. The difference between these two salaries is offered as a proxy for the rent the player receives on new first-round picks. We calculate the medians using exp($x$riβ), where $x$ri is the means of the variables of the players under the rookie contract with either 0, 1, 2, or 3 years of experience. In the first column, the rookie dummy is coded as 1, indicating the rookie is covered by the contract. In the second column, the rookie dummy is coded as 0, which estimates what a rookie would have earned if not covered by the rookie contract. For the 1997 group, players earn more than their market value in their first season. Teams earn a surplus during the players' next two seasons. The total rent going to team owners is estimated at $539,141. For the 2002 group, players earn a surplus in their first two seasons. Teams reap a surplus in the next two seasons because there is a 4th-year option for these rookies. Overall, the estimated rent for teams is $1,294,917. This result is consistent with the firm-specific human capital rent-sharing hypothesis.

TABLE 4: Rent Estimates for 1997 and 2002 Rookies

| | *1997 Estimated Salary* | | | *2002 Estimated Salary* | | |
|---|---|---|---|---|---|---|
| *Years of Experience* | *With Rookie Scale* | *With No Rookie Scale* | *Difference as Rent Estimate* | *With Rookie Scale* | *With No Rookie Scale* | *Difference as Rent Estimate* |
| 0 | $1,468,864 | $1,067,895 | $400,969 | $1,357,289 | $1,031,990 | $325,299 |
| 1 | $1,832,149 | $1,873,651 | –$41,503 | $1,588,022 | $1,544,174 | $43,848 |
| 2 | $2,049,281 | $2,947,899 | –$898,607 | $1,599,177 | $1,988,716 | –$389,539 |
| 3 | | | | $2,158,663 | $3,433,189 | $1,274,524 |
| Total | | –$539,141 | | | –$1,294,917 | |

To examine whether the application of the human capital model can explain early entry into the NBA, we shall use a measure of player performance called the efficiency formula. As reported byNBA.com, this index is calculated on a per game basis as (points + rebounds + assists + steals + blocks) – ((field goals attempted – field goals made) + (free throws attempted – free throws made) + turnovers). The figures on player efficiency, presented in Table 5, lend support to the human capital model as an explanation for the increase in early entry into the NBA. Player efficiency rises for players' first four seasons in the league no matter what their level of college experience, with the exception of players with 2 years of college between their third and fourth seasons. If early seasons represent OTJ training for players, the rise in productivity is dramatic between the first and fourth seasons and is even more so for players with little or no college experience.

If teams invest in player human capital in their early seasons, it seems logical to expect that minutes played per game would be lower in early seasons and rise with tenure in the league. The numbers in Table 6 on minutes played per game confirm this. First-round picks average more minutes played per game during each of their first 4 years in the NBA. Although players with two or more years of college play more minutes than those with 1 year of college or with no college experience, the first two seasons in the league, this situation is soon reversed. The figures in Tables 5 and 6 lend support to the human capital model as an explanation for early entry into the NBA.

TABLE 5: Efficiency Index for NBA First-Round Picks in Their First Four Seasons (1987 to 2002)

| | *Season in NBA* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *1* | | | *2* | | | *3* | | | *4* | | |
| *Years in College* | M | SD | n | M | SD | n | M | SD | n | M | SD | n |
| 0 | 7.75 | 5.26 | 31 | 10.86 | 5.96 | 20 | 14.55 | 7.38 | 14 | 17.61 | 7.30 | 12 |
| 1 | 6.87 | 4.96 | 15 | 9.90 | 5.35 | 11 | 13.00 | 6.06 | 7 | 16.55 | 5.33 | 5 |
| 2 | 9.15 | 6.51 | 46 | 12.74 | 6.46 | 39 | 14.10 | 6.36 | 31 | 13.78 | 6.96 | 24 |
| 3 | 9.26 | 5.37 | 54 | 12.12 | 6.28 | 49 | 12.83 | 6.50 | 51 | 14.04 | 7.84 | 50 |
| 4 | 8.16 | 5.44 | 268 | 10.04 | 6.13 | 260 | 10.60 | 6.48 | 262 | 11.94 | 6.49 | 236 |

NOTE: This table includes foreign players. If foreign players who did not attend college in the United States are deleted from the population, then the first row of the table would reflect mean efficiency as follows: 6.84 ($SD$ = 4.02, $n$ = 12) for Season 1, 11.21 ($SD$ = 6.52, $n$ = 8) for Season 2, 15.50 ($SD$ = 8.09, $n$ = 6) for Season 3, and 20.07 ($SD$ = 8.23, $n$ = 5) for Season 4.

TABLE 6: Minutes Played per Game for NBA First-Round Picks in Their First Four Seasons (1987 to 2002)

| | *Season in NBA* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *1* | | | *2* | | | *3* | | | *4* | | |
| *Years in College* | M | SD | n | M | SD | n | M | SD | n | M | SD | n |
| 0 | 16.85 | 8.21 | 31 | 22.36 | 8.97 | 20 | 26.33 | 10.78 | 14 | 29.7 | 9.76 | 12 |
| 1 | 17.1 | 10.41 | 15 | 21.69 | 9.30 | 11 | 27.34 | 10.4 | 7 | 32.17 | 6.88 | 5 |
| 2 | 21.49 | 12.15 | 46 | 27.58 | 11.45 | 39 | 29.53 | 9.62 | 31 | 29.7 | 11.2 | 24 |
| 3 | 20.85 | 9.44 | 54 | 25.19 | 10.11 | 49 | 26.21 | 10.13 | 51 | 27.14 | 10.28 | 50 |
| 4 | 18.86 | 9.82 | 268 | 21.87 | 10.08 | 260 | 22.65 | 10.38 | 262 | 24.66 | 9.91 | 236 |

NOTE: This table includes foreign players. If foreign players who did not attend college in the United States are deleted from the population, then the first row of the table would reflect mean minutes as follows: 15.23 ($SD$ = 7.3, $n$ = 12) for Season 1, 23.11 ($SD$ = 9.52, $n$ = 8) for Season 2, 27.77 ($SD$ = 11.4, $n$ = 6) for Season 3, and 32.32 ($SD$ = 11.5, $n$ = 5) for Season 4.

TABLE 7: First-Round Draft Picks' Survival Through First 4 Years

| Draft Pick | Year 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | * | * | * | * | * | * | * | * | * | * | * |
| 2 | * | * | * | * | * | * | * | * | * | * | * |
| 3 | * | * | * | * | * | * | * | * | * | * | * |
| 4 | * | * | * | * | * | * | * | * | * | * | * |
| 5 | * | * | * | * | * | * | * | * | * | * | * |
| 6 | * | * | * | * | * | * | * | * | * | * | * |
| 7 | * | * | * | * | * | * | * | * | * | * | * |
| 8 | * | * | * | * | * | * | X (4) | * | * | * | * |
| 9 | * | * | * | * | * | * | X (4) | * | * | * | * |
| 10 | * | * | * | * | * | * | * | * | * | * | * |
| 11 | * | * | * | * | * | * | * | * | * | * | X (4) |
| 12 | * | * | * | * | * | * | * | * | * | * | X (2) |
| 13 | X (4) | * | * | * | * | * | * | * | * | * | * |
| 14 | * | X (4) | * | * | X (4) | * | * | * | * | * | * |
| 15 | * | * | * | * | * | * | * | * | * | * | X[a] |
| 16 | * | * | * | * | * | * | * | * | * | * | * |
| 17 | * | * | * | * | * | * | * | * | X (4) | * | X (4) |
| 18 | * | * | X (4) | * | X (2) | * | * | * | X[a] | X[a] | * |
| 19 | X (4) | * | X (4) | * | * | * | * | * | * | * | X (4) |
| 20 | X (4) | X (4) | X (4) | * | * | * | * | * | X (4) | * | * |
| 21 | * | * | X (4) | * | * | * | * | X(3) | X (4) | * | * |
| 22 | X (4) | * | X (4) | * | * | * | X (4) | * | X (4) | * | * |
| 23 | X (4) | * | * | * | * | * | * | X[a] | * | * | * |
| 24 | * | * | * | * | * | * | * | * | X (4) | * | * |
| 25 | X (4) | * | X (4) | * | * | * | * | X (F) | X (4) | * | X (4) |
| 26 | * | X (4) | X (4) | X (4) | X (4) | * | X (4) | * | X (4) | X (4) | X (4) |
| 27 | X (4) | * | * | * | X (4) | X (4) | X (3) | X (4) | * | * | * |
| 28 | | | | | | | | X (1) | X (4) | X (2) | * |
| 29 | | | | | | | | * | | * | X (0) |

NOTE: An asterisk (*) denotes that the player lasted through his first four seasons. *X* denotes that the player did not last through his first four seasons. Numbers in parentheses indicate years of college attended for players who did not last through his first four seasons.

a. Foreign-born player who did not attend college in the United States.

To empirically test Lazear's option value model, consider two groups: early entrants and 4-year college entrants. The signal for the early entrant is expected to be noisier and riskier than for the 4-year college performer. Thus, we predict that when the cost of choosing a lemon falls, more early entrants will be selected. In the NBA, costs fell with the CBA in both 1995 and 1999. To test if option value matters, we focus on both the upper and lower tail of the distribution. In Table 7, we focus on the lower tail and look at players who wash out of the NBA in their first 4 years. We find that only 1 of the 31 early entrants from the 1989 through 1994 drafts failed to stay in the NBA for his first 4 years. For the 1995 through 1999 draftees, when rookie scale measures were in effect, 6 out of 58 early entrants failed to stay in the NBA for 4 years. These results suggest that we can not reject the option value model.

To further test the impact of option value, we estimate an all-star equation to see if early entrants are more likely to be all-stars. All-star status is used because it is one measure of a player being in the upper tail of talent.
Consider the following equation:

$$AS = x\beta + \tau + \varepsilon,$$

where AS is all-star status and equals 1 if the NBA player is on the all-star team. $x\beta$ is a vector of explanatory variables where we specify three separate models. In all three specifications, we include early entry, which is a dummy equal to 1 if the player did not have a complete college career; years in the league; years in the league squared; height; weight; and White, a dummy variable equal to 1 if the player was White and equal to 0 otherwise. The second specification also includes draft number. The third specification adds the efficiency measure. The models are estimated using a random effects probit model for a panel study. In our panel, we have 5,132 observations on 1,092 players. The panel length varies from 1 year to 13 years, depending on how long the player's career is and whether the panel is right or left censored. The average length of the panel is 4.7 years.

We report the results of the random effects probit in Table 8. In all specifications, the coefficient on years in the league is positive, whereas years squared is negative. Both are statistically significant. This result supports the OTJ hypothesis that players gain human capital with increased experience in the league. The negative coefficient on years squared supports the hypothesis that athletic skill declines with age.

TABLE 8: All-Star Status in the NBA (1987 to 2002)

| | *Model 1* | | *Model 2* | | *Model 3* | |
|---|---|---|---|---|---|---|
| *Variable* | *Coefficient* | *Absolute-Value z* | *Coefficient* | *Absolute-Value z* | *Coefficient* | *Absolute-Value z* |
| Constant | –9.500 | 3.19 | .718 | 0.27 | –5.440 | 2.71 |
| Early entrant | 1.110 | 5.20 | .117 | 0.34 | .038 | 0.23 |
| Years | .566 | 9.31 | .531 | 8.98 | .275 | 4.32 |
| Years squared | –.041 | 9.22 | –.040 | 9.40 | –.015 | 3.71 |
| Height | .079 | 1.47 | –.040 | 0.98 | –.003 | 0.10 |
| Weight | –.009 | 1.30 | –.003 | 0.55 | –.007 | 1.79 |
| White | –.748 | 3.26 | –.149 | 0.60 | .165 | 0.71 |
| Draft number | | | –.063 | 8.50 | –.013 | 2.40 |
| Efficiency | | | | | .290 | 15.47 |
| Log likelihood | –710.290 | | –668.690 | | –411.140 | |
| Rho | .766 | | .700 | | .282 | |

NOTE: Random effects probit model. observations = 5,132. groups = 1,092. Observations per group range from 1 to 13, with an average of 4.7.

When focusing on early entry, we find in the first specification that the coefficient is positive and significant, supporting the unraveling conjecture: In the pursuit of talent, teams draft future all-star players earlier. This lends support to the option value model: Teams pursue players with upside potential. Early entry becomes insignificant, however, once we control for draft number. The coefficient on draft number is negative and significant, indicating the draft is efficient in sorting talent.

In the third specification, we also include the efficiency measure. The coefficient on efficiency is positive and significant, showing that skill is indeed important in determining all-star status. In this specification, draft number is negative and significant, whereas early entry is insignificant. Overall, the results tend to lend slight support to the option value model of unraveling in the labor market.

## CONCLUSIONS

Roth and Xing (1994) suggest that professional sports provide a laboratory to observe what causes jumping-the-gun equilibriums in labor markets. We suggest that the changing institutional structures in the NBA CBA provide incentives to both employers and employees to change the timing of entry decisions. Indeed, early entry in the NBA is becoming common. In 2003, the first pick in the NBA draft was a high school senior with no college experience, and 21 of the first 29 picks were not college seniors. We suggest that early entry is a modified form of unraveling in a labor market, as firms attempt to secure the most promising player and players wish to lengthen their careers. We also suggest that the recent NBA contract, particularly the lowering of the fixed wage contract and the lengthening of rookie contracts, has given firms the ability to pay for general human capital.

Our analysis shows that players who enter early improve more quickly and play fewer minutes in their 1st year than do those with 4 years of college experience. Our results suggest teams in the pursuit of talent are willing to take players who are less skilled than in the past. With the addition of the 4th-year option to the rookie scale, both teams and players have incentives for early entry for players to obtain additional skills on the job instead of in the NCAA. Our results also lend slight support to the option value hypothesis that firms select players early to capitalize on upside potential. Last, we suggest that early entry is particularly true for young, superstar athletes. With these players, teams not only capitalize on the rookie scale, but they also use the maximum salary caps that limit superstar salaries. Thus, if a team captures a superstar early, it can exploit the economic rent from him for years.

**NOTES**

1. It would be straightforward to consider a situation in which $N < T$, but $N$ is a random variable which can have values greater than $T$. Also, one could assume that an individual who waits 1 year to enter the NBA reduces his expected work life by some amount δ, $0 \leq \delta \leq 1$. Such an assumption would have little effect on the theoretical results.

2. For a high school graduate, the decision is whether to go to college for 1 year. The possibility of a high school dropout entering the league is ignored.

3. If we allowed for discounting, a higher interest rate would increase the tendency for players to leave early.

4. In some cases teams are allowed to pay a 12.5% increase to players with only 2 or fewer years tenure with the club if certain criteria are met.

5. Nine million dollars was the maximum allowable pay for a player with fewer than 7 years experience in 1999.

6. The term $\frac{\partial \pi}{\partial T}\frac{\partial T}{\partial \theta}$ is omitted from Equation 2 because $\frac{\partial \pi}{\partial T} = 0$ for a maximum of $\pi$ (Equation 3).

7. The Cook-Weisberg test for heteroskedasticity was run for the regression equations in Table 5 and for the same regression model using salary instead of the log of salary. The chi-square statistic for the 1997 model was 582.04 for the linear model and 0.46 for the log-linear model; the chi-square statistic for the 2002 model was 189.62 for the linear model and 4.51 for the log-linear model.

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