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Why Do Wages Slope Upwards?
Testing Three Labor Market Theories

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1. Introduction and Research Question

Professional teamsports proposes a unique opportunity to test empirically some predictions that have emerged in labor market theory. Although firm data is very desirable to analyze these conjectures it is – at least in Europe- difficult to obtain relevant data. As a result the economist has to ask where and how to procure "functional equivalent" data that makes an inspection of the theories feasible. Indeed, there is hardly any other field setting where data is more transparent and obtainable than the professional sport. We know the name, face, age, team and career-history for every worker in this industry. In addition, compensation packages and performance indicators for each individual are widely available.[1]

In the current paper we focus on the examination of three established modern labor market theories: The human capital model, the matching hypothesis and Lazear's delayed compensation design. All of them have in common that they identify a climbing concave relationship between a worker's wage rate and his productivity while tenure and/or career-length increase. On the one hand this positive correlation is widely regarded as intuitive, because it is reasonable that workers will earn higher wages as tenure at a particular job increases. On the other hand it is considered enigmatic due to the three theories different implications. Using data from two out of four US Major Team Sports Leagues, the "National Basketball Association" (NBA) and the "National Hockey League" (NHL), we should be able to investigate the three theories empirically and reduce at least some to the unclear implications so far.

However, the latter aspect is thought to be analyzed in a later step, because the paper is not ready developed yet to answer that fundamental question. So far we will first present the mentioned theories and display some descriptive results from the two available databases. We will then proceed with some estimation to provide further analysis of the connection between players' tenure and earnings. Before turning to the theoretical part let us first bridge the gap between the field of sports and economics.

[1] This does not hold for the German Soccer-Bundesliga. Although it is possible to trace performance figures, teams' policy terms on player contracts are not disclosed.

2. Business and the US-Teamsportindustry

More than 40 years ago, Simon Rottenberg (1956) wrote the first economic analysis of labor markets in professional sports, paving the way for most subsequent work. Since then, the sporting world has changed a fair bit and also removed from Baron Pierre Coubertin’s motto “le plus important est de participer”. Today sport has become a big business, with players salaries, franchise values and merchandising gaining in magnitude from season to season.

Sport however, is only one, but increasing part of the entertainment service among others like the music or movie industry.[2] Television is the driving force behind the explosive scope of these activities in recent decades. An event like the NFL Super Bowl or the Baseball World Series match attracts a remarkably large audience all over the world.[3] The “Big Four”- Major League Baseball, the NBA, the NFL and NHL get about half of their revenues from broadcasting. TV revenues collapsed in the early 90s when CBS took a $500 and ESPN a $150 million loss. So there were a major restructuring in 1993 with lower revenue opportunities and fewer guarantees of revenue from TV. Later in the 90s, Fox network upped the bidding in an attempt to use sports as a springboard into the network big time (ABC, NBC, and CBS). Recently the NFL signed an 8-year contract worth $17.6 billion with several networks. This yield $74 million per year per team, by far the best deal on pro sports. The NBA gets about $800 million per year for the next six years, averaging $30 million per year for each team. Baseball TV revenues were hurt by the strike in the 90s but appear to be bouncing back. The deal is worth $14 million on average per team for the 99/00 season. For hockey, television is less profitable than for the other leagues due to the league’s focus in Canada. It only pays the teams on average $5 million per year.

Broader media considerations are not the only rich source of revenue team income. Endorsements and product licensing are very responsible for the enormous prosperity of

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[2] See Franck (1995), pp. 7.

[3] More than 130 million Americans sat around to watch the 1999 Super Bowl, more the 700 million worldwide. Advertisers paid an average of $1.6 million for 30 seconds of commercial time during the broadcast.

the professional teamsport as well. The NBA pioneered the concept of marketing and merchandising units in the mid 90. Last season the NBA made $1.6 billion in licensed products -caps, shirts, cards, toys and computer games, anything with a sports logo on it. But everyone else caught on fast. By the end of the 1990s, pro football led the pack with retail sales of NFL-licensed goods totaling $3.6 billion. Concerning merchandising the NHL did better than in acquiring TV revenues. Past season the NHL sold licensed gear worth $980 million.

Team values did also increase significantly over the past years. Was the average NBA franchise worth $70 million in 1991 it more than doubled in these days ($183). Out of the 29 NBA teams the New York Knicks are valued the most with $334 million. NHL teams did even better. In 1991 the average icehockey franchise accounted for $44 million whereas it was valued $135 million in 1999. The New York Rangers topped the ranking being worth $236 million whereas the Carolina Hurricanes closed the ranking with an estimated worth of $70 million. Franchises are most expensive in the NFL. The average value of the 29 teams is $376 million. The Dallas Cowboys cost $663 million while the cheapest NFL team (the Detroit Lions) is worth $293 million.[4]

According to Forbes Magazine the 118 major league teams are essentially owned by the richest people in the U.S.[5] Microsoft billionaire Paul Allen who has a fortune of $40 billion owns the Seattle Seahawks (NFL) and the Portland Trailblazers (NBA). And then there's i.e. Ted Leonsis, the master marketer at AOL, who paid $85 million for the Washington Capitals (NHL) has a fortune of almost $700 million.[6] [7]

Most people are aware of escalating player salaries. The average baseball salary in 1970 was $29,000. Today it is $2.4 million. In 1990 the NBA paid it's 325 players on average $920,000[8] but it is $2.9 million today. Players like Shaquille O'Neal, Kevin Garnett, Alonzo Mourning earn in excess of $15 million a season. Today there are 80 NBA players

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[4] In early 1999, a Maryland businessman and a New York investment banker offered $800 million for the NFL's Washington Redkins franchise.

[5] Forbes Magazine December 1999, pp. 99.

[6] Internet pioneer Mark Cuban, co-founder of Broadcast.com, purchased the Dallas Mavericks (NBA) in January 2000 from Ross Perot Jr. for approximately $280 million. Cuban is worth $1.2 billion.

[7] Wealth data comes from (http://www.forbes.com).

[8] See Franck, E. (1995), pp. 13.

earning more than $5 million. In fact, O'Neal just re-signed with the Los Angeles Lakers paying him $350 million until 2006. But with so much money to put toward "Superstars", marginal players are often compensated less than $1 million a season. Hockey's financial landscape has also changed dramatically. The average NHL salary this season (1999/2000) is $1.3 million, compared with $271,000 at the beginning of the decade. Pittsburgh Penguins forward Jaromir Jagr signed a long-term contract that will pay him $48 million over six years and there are 25 players earning in excess of $5 million.

3. Competing Labor Market Theories

After having presented the North American teamsport-industry we can now turn to investigate the three rival labor market hypothesis. In this paper we examine age-earnings profiles, that is the growth of wages with work experience and/or tenure. The three theories are the human capital model, the matching hypothesis and seniority pay. They all manifest this relationship but use different approaches in explaining the presence of this positive correlation. However, before starting to analyze the upward sloping age-earnings profile generated by the standard human capital theory, let us briefly illustrate the aspects of an investment in human capital.

3.1. Human Capital Theory

3.1.1. Investment in Human Capital

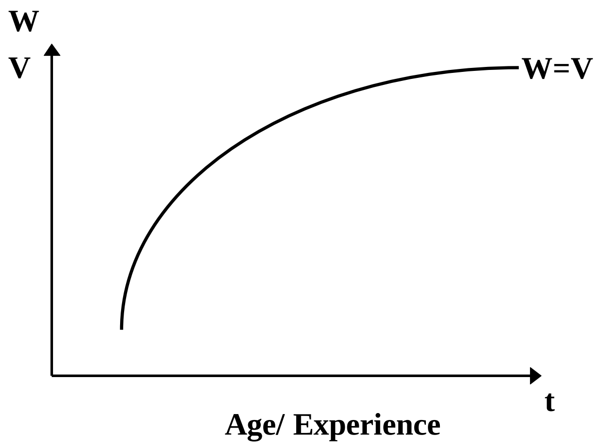
The idea of the human capital model is derived from capital theory and was formulated as early as 1776 by Adam Smith and extended in the work of Milton Friedman and Simon Kuznetz in 1945. Basically, capital theory defines an investment as an initial cost that one hopes to recoup over some period of time. Similarly to that token is the formulation of the human capital model: Individuals make most of their investments in themselves when they are young and to a large extent by foregoing current earnings. Gary Becker (1962, 1964) Jacob Mincer (1958, 1962, 1974) and Theodore Schulz (1960, 1961) significantly developed the theory and analyzed if the expected net present value of an individual's earnings generated by an investment in education exceeds it's initiatory start-up costs. Only in the case of a positive output the investment in human capital is profitable. Determining the exact outcome of an investment in education however, includes a cost-benefit calculation by the investor. On the one hand the investor faces near term expenditures in form of directs costs, which contain tuition, and books. Additionally, there are opportunity costs, because during the investment period it is usually impossible to work. On the other hand the investment in a person's own education (skills) is supposed to enhance the individual's future productivity and consequently alters positively life cycle earnings. Calculating the returns on investment over time requires the progressive discounting of returns lying further into the future. Discounting future benefits is a necessary condition, because rewards that are perceived in the future are valued less than an equal sum of returns received today. The intuition behind that logic is straightforward: Individuals are prone to think myopically and favor to consume their benefits earlier than later. Moreover, if these additional earnings are invested rather than consumed, interest on the investment can be deserved which enlarges the investor's wealth.

Having introduced two inevitable consequences of the investment in human capital we can now explore the-for this paper- more relevant connection between wages and productivity regarding the human capital model.

3.1.2. General Human Capital

The most important type of human capital investment takes place on „on-the-job-training„. According to Becker (1975) it is necessary to distinguish between two types of on-the-job-training, because these two types have different implications for workers income and productivity, but provide a novel explanation for that observation. They are "general" on-the-job-training (GOJT) and "(firm) specific" on-the-job-training (SOJT). The former type of training (GOJT) indicates in it's simplest form that workers are paid wages equal to their marginal revenue product. Marginal revenue product rises because productivity increases. Increasing productivity result from workers' investments in „on-the-job general training„. Figure 1 illustrates the relationship between wage (W), productivity (V) and the time profile (t): Wage and productivity ascent at the same rate but with diminishing returns. The worker's income is depressed at early years, but rises over time as investment declines and as returns on past investment are realized.

Figure 1: Income and Productivity in the General Human Capital Model

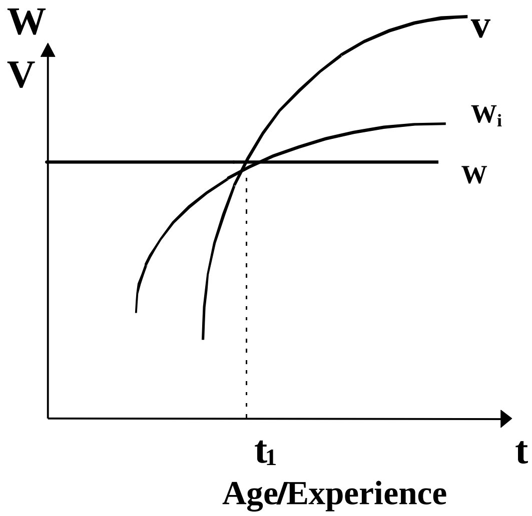


The main characteristic of the general human capital model is it's transferability: Skills acquired in general training are fully portable from firm to firm. Air-Force pilots i.e. suit this type of human capital. Cruising a Jumbo or a C5 is of minor difference except that the C5 is significantly larger. Since the training is general, it is not wise for the firm to pay for this acquisition. Workers who have invested in GOJT will be offered more lucrative compensation packages by firms, which do not have to regain the full return on investment. Facing this threat from competing companies, firms will either not supply any general training at all or they will induce workers to pay for it by accepting lower wages than they would receive otherwise. To keep its' working force the original firm is constantly forced to match the workers wage with his increasing productivity. This is the explanation why the worker's earning profile is coupled with a low starting wage but raises with diminishing returns later in life.

3.1.3. Firm Specific Human Capital

The second explanation for the upward-sloping age-earnings profile in the human capital story is firm specific on-the job training (SOJT). Firm specific on-the-job training differs in many aspects from the general on-the-job training. In contrast to the GOJT, firm specific on-the-job training is not movable from one firm to another. It is only productive in the firm were it is obtained from, but worthless in any other. As a result other firms cannot pirate workers' SOJT. Figure 2 displays the worker's age-earnings profile in the firm specific model. Since the skills are firm specific, the remuneration that the training firm can offer beat that which any other firm can offer (on average over time). This does not imply that the firm is willing to finance all the training, in return for which it would expect to receive the entire difference between productivity and the outside wage that the worker could get.

Figure 2: Age-Earnings-Profile in the Firm Specific Human Capital Model



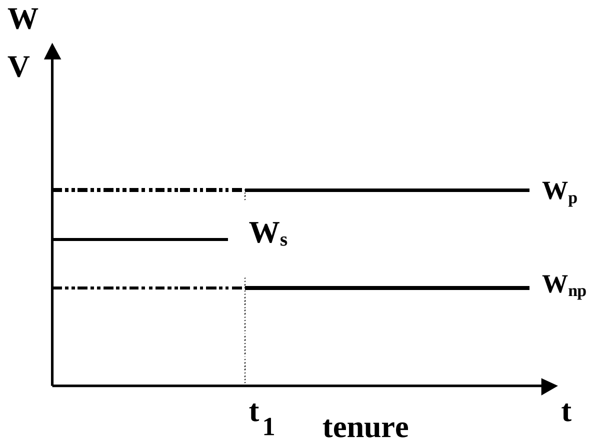
This is an advantage for the worker because he is now in a situation to blackmail the firm by telling to quit. In this case the firm would lose its investment, but the worker is indifferent between working at the current firm or working outside (W_o) because his wage would -on average- be the same.

Turning the argument up side down does not improve the situation: If the worker carries the full cost of training, he wants to reap all benefits, which makes the firm indifferent between hiring the able, but highly paid worker and hiring the unskilled, less well-paid worker. Now the worker is coming short, because the company can threat to dismiss him unless he accepts a depressed salary. This menace is by all means a credible commitment because the firm can simply fire the worker and substitute him. The solution to this dilemma is to split the costs as well as benefits. Since the firm needs to waive some of the profit from investing in the worker, it can ask him to bear some of the costs. Since the worker knows that the firm will be able to force him to accept a wage less than his productivity when he is skilled, he can ask the firm to carry some of the costs. Consequently, as demonstrated in figure 2, firm specific on the job training is *co-financed* by both parties. Productivity (V) is below the worker's wage (W_i), which means that the employer takes some of the investment costs. On the other side the worker earns less than he could earn outside (W_o), until (t_1), which indicates his willingness to pay for the training. The parties do also divide the benefits. The shared benefits implicate that both worker and firm are induced to stay together. The firm profits most from keeping this special employee and both groups would suffer from separation. Once the investment has been finished (t_1) the worker enjoys more gains in his current firm (W_i) than outside (W_o), which does also overcompensate him for his initial investment and makes him reluctant to leave the firm. The firm makes money on its employee because his productivity (marginal revenue product) (V) after (t_1) is higher than the salary paid. Summarizing, in the firm specific human capital investment model are wages below and rise more slowly with diminishing returns than marginal revenue productivity.

3.2. Matching Theory

Human capital theory has offered a clear explanation for rising wage profiles with experience. An alternative point of view for the presence of this correlation is given by Jovanovic (1979). He argues that the match between worker and firm is crucial for the observation of upward-sloping concave wage profiles. More specifically, the matching hypothesis emphasizes that wages and tenure are high because efficient matches between worker and firm will last, while non-productive matches will separate. The major assumption in Jovanovic's theory is the level of imperfect information between employee and employer at the outset of their labor relationship. This means, that the outcome of their relationship is uncertain and cannot be controlled for ex-ante. Although the firm can use certificates and collect some other information (experience, reputation) on it's future worker it cannot completely be sure how he will actually turn out. Both the firm and the worker treat each other as a search good and assess the other party's correct quality. It is further assumed that both the firm and the worker have reservation wages. Figure 3 shows the workers most likely setup wage (W_s). Both parties have to meet "somewhere" that suits their wage ideas at the beginning of the employment: The firm is not willing to compensate an outside worker above a certain level given certain characteristics and the worker will not accept less than a certain pay level given characteristics on the job.

Figure 3: The Adjustment of Earnings in the Job-Match-Process



As tenure however increases (t_1) the firm gains additional information about the worker. After time, both parties learn from each other and it is now easier to estimate the worker's real skills. This does hold for the worker as well, who now has a much better sketch over the job than at the beginning. This accumulation of information decides about the duration of the relationship. Negative information will separate the parties and the worker's income is downward (W_{np}), because he was not productive enough. Conversely, positive information regarding valuable for both sides generate the upward based wage profile (W_p), because the match is productive and creates profits. Summing up, matching theory suggests that good matches are more efficient and end in longer tenure and higher wages.

3.3. Efficiency-Wage Theory

Literature provides a third variant that constructs an explanation for rising concave wage profiles. This theory is Lazear's (1981) delayed compensation model. According to this theory are individuals undercompensated when they are young but are encouraged to work hard in order to stay with the firm and collect their due compensation when they are old.[9] Since Ross (1973), Stiglitz (1974,1975), Mirrlees (1976) and Holmström (1979)[10] we know that workers are agents of the owner and that their interests are not the same. Workers prefer to slow back labor (shirking) while their wage remains constant and owners favor workers who put forth effort in order to enhance productivity. Facing this conflict of interests it is necessary to establish a compensation system that aligns both parties divergent interests.[11] Efficiency wages perform such a job because they reduce the incentive for the worker to shirk. In Lazear's terms the latter aspect is causal for the observation of an upward-based age-earnings profile.

In Lazear's model the worker's wage does *not* correspond to his marginal revenue product even if controlled for tenure. Figure 4 shows that a worker is indifferent between a wage path which offers him his spot wage (V) at each point in time and one which pays him less than his marginal product initially and more than his marginal product at the end of his working career (W).[12] However, this is only then true**,** if the present value of the total upward-sloping wage (W) and the total constant productivity (V) over time (T) is equal. Lazear further assumes that the owner penalizes shirking by the employee in form of lay-offs. As suggested above, if other things are equal, workers are indifferent between the two paths. Other things are *not* equal, however. If shirking results in immediate dismissal the rising wage line creates increasingly higher costs with longer tenure. In other words, the larger the future amount of income for the worker approaching the end of his worklife, the greater the money he forfeits while caught slacking. Figure 4 also exhibit the worker's reservation wage profile (A_w), which indicates his second best job opportunity.

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9 Lazear (1981); pp. 606.

10 These are all economists representing the "Normative Agency-Theory"

11 For an extensive formal derivation of Holmström's principal-agent solution see Prinz (1999).

12 Lazear (1981); pp. 607.

In order to choose the firm with the steep wage profile the alternative pay may not exceed the seniority pay profile and the slope must also be flatter, because otherwise the worker would not have selected the steeper wage shape. Figure 6 displays the worker's opportunity cost if he shirks at point t* and gets fired.

Figure 5: Development of Productivity (V) and Wage Rate (W) with Time/Tenure (T).

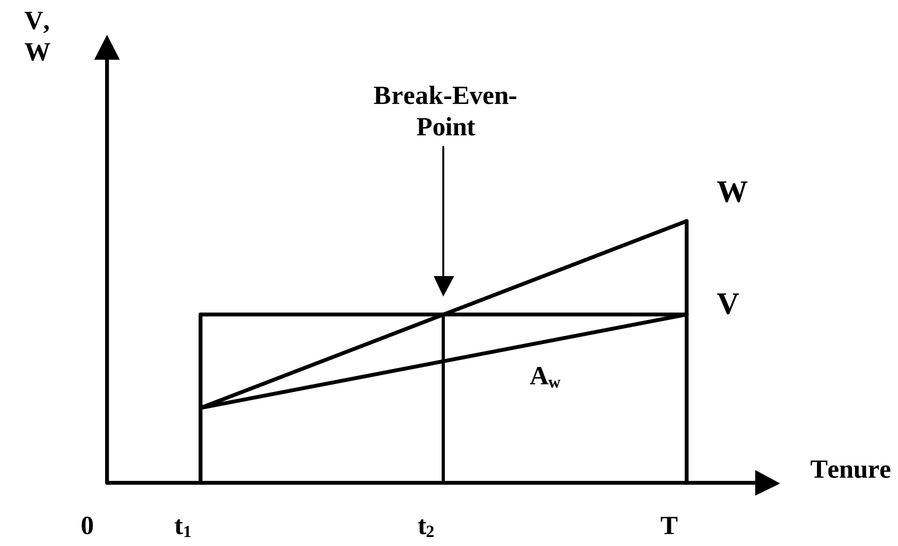
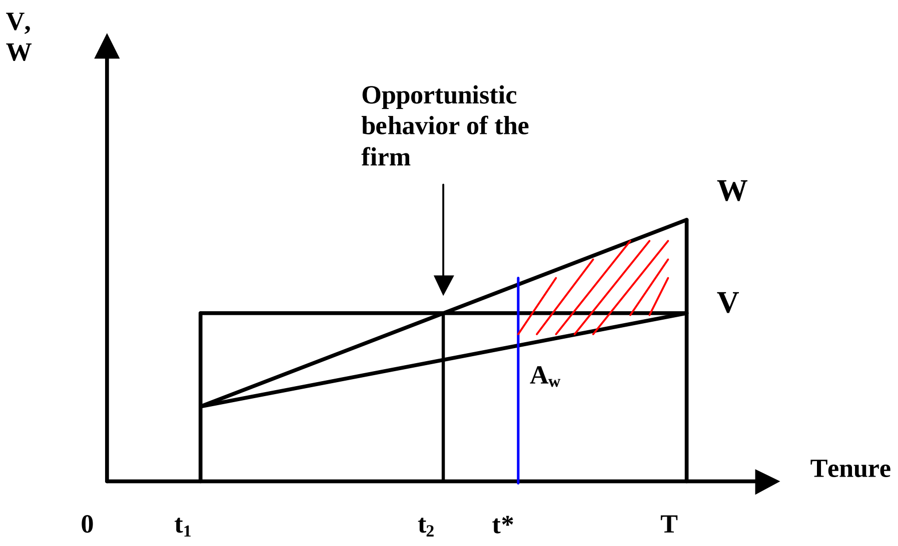


Figure 6: Worker's Opportunity Costs and Moral Hazard on Behalf of the Firm



Shirking costs the worker the shaded area in figure 6, which is the difference between the steep career salary path (W) and the alternative wage (A_w) at shirking time (t*). Due to the mechanism of the rising wage profile, the worker has an incentive not to reduce his effort and remains with the firm, because otherwise he looses his secured high future income if he slacks-off. The worker will not reap the fruits of his labor.

Firms may also deviate from the contract. Moral hazard on behalf of the firm occurs as premature contract termination at the break-even-point (t_2). In an unrealistic case where no information passes from senior to junior workers, it is profitable for the firm to cut their contracts at (t_2), because workers marginal revenue product between time t_1 and t_2 is higher than their wage (costs of the firm). The difference between (V) and (W) at t_1 and t_2 is called the "lay-off gain" for the firm. It saves while not paying the worker his true compensation after the break-even-point. However, older workers tell their younger mates, if the firm violated contract terms in the past. Hence, defaulting is expensive for the firm because it's reputation capital is at stake. Honest firms do not have to worry about that. Firms that disregarded the rules in the past, however, must offer a flatter wage profile with the purpose to acquire employees for the next period. Flattening the wage shape signals a credible commitment from the firm to potential workers not to behave opportunistically and fulfill the contract, because firm incentives to shirk are lessen. Despite that advantage for the firm to recoup its trustworthiness the flatter wage line implements less incentives for workers to intensify effort, which rises the likelihood of shirking. To avoid this disadvantage the firm needs in order to survive in the long haul credibility and behave honestly.

In order to decide which of the determined theories above are relevant, they are now translated to the subsequent set of hypothesis of empirical testing.[13] Testing for the general human capital model we posit the following:

Hypothesis 1: The greater workers' (players') investment in human capital the better their performance.

[13] Hint: Since the paper is not readily developed yet we ignore the matching-hypothesis.

This assumption must be tested against the null hypothesis that while players age their productivity might decrease.

Analyzing for Lazear's seniority incentive mechanism we presume:

Hypothesis 2: The longer the worker (player) remains with his current team the higher his wage, while productivity stays constant.

4. Data, Models and Empirical Findings

We will use longitudinal (panel) data to test empirically the above mentioned hypotheses. The NBA data set is hand-collected and is drawn from two primary sources, the *Sporting News Register* and the *Sporting News Guide*. It consists of all players that appeared in at least one regular season game in any of the NBA-seasons 1993/1994-1999/2000. The total number of observations is about 3200, with some players being active in all 7 seasons and others in only one oft them.[14] While single performance figures (games played, minutes, field goals, free throws, three points, rebounds, assists, blocks, turnovers, steals and individual characteristics -which is essential for this analysis- (career duration, tenure,) are available for athletes[15], this is not the case for player salaries and contract duration. The former information is missing for approximately 2% of the population, the latter for about 36%. Complete player information in the NBA is readily available for 2071 "player years" (64%).

The NHL data is taken from various books of the *Official Guide & Record Hockey Book* covering all players that appeared on ice in any of the NHL seasons 1996/1997-1999/2000 with the exception of the goaltenders.[16] We will explore the performance and salaries of exactly 946 different hockey players out of 2960 valuable cases. Productivity statistics (goals, assists, total points, games played and penalties) are procurable for all the cases,

[14] These are either rookie players (no NBA experience) who just entered the league or veteran players who play their last season.

[15] There are 738 different players for the whole seven years of NBA investigation.

[16] Goalies must be analyzed separately, because they are a different population of players.

but the database lacks information on the “draft” and “salary” variable. The erstwhile is absent for 7% and the last mentioned for one percent. Most important for the hypotheses, we have a transparent survey about every player’s experience in the NHL and their respective years with one and the same team (tenure). Unfortunately, contract duration is not attainable in ice hockey, but other variables that might be of interest like the age and the weight of a hockey player is included. The final NHL data set contains 2763 useful “player years”. All performance data for NBA and NHL are for regular season play.
Table 1 and Table 2 illustrate NBA and NHL players’ summary statistics of the most important variables needed later on.

Table1: Descriptive Statistics of NBA Players for the 1993/1994-1999/2000 seasons.

Player Characteristics	**Mean**	**Std Dev**
Career Length (CL); **Experience**	6,1	3,96
Years with Current Team; **Tenure** (YCT)	2,42	2,20
All Star Games (ASG)	0,46	1,56
Draft Number (DN)	32,84	32,66
Player Statistics (Performance measure)		
Minutes per game(MPG)	20,21	10,87
Scoring Performance per Minute(SP)	0,56	0,25
Non-Scoring Performance per Minute (NSP)	133,12	177,60
Contract Characteristics		
Annual Salary (in US$)	1.785.000	
Contract Duration (CD) in years	3,62	2,40

Table 2: Descriptive Statistics of NHL Players for the 1996/1997-1999/2000 seasons.

Player Characteristics	**Mean**	**Std Dev**
Career Length; **Experience** (CL)	7,1	4,2
Years with Current Team; **Tenure** (YCT)	3	2,56
All Star Games (ASG)	0,55	1,85
Height in cm	186	5
Weight in kg	92	6,54
Age	28	4,3
Draft Number (DN)	66	65,1
Player Statistics (Performance Measure)		
Goals per Game (GPG)	0,14	0,131
Assists per Game (APG)	0,23	0,171
Games Played (GP)	51	26
Penalties in Minutes (PIM)	46	47,3
Contract Characteristics		
Annual Salary (in US$)	1.050.000	

Most of the variables above are used in both data sets. Career length and tenure are already explained above and mean that the NBA athlete plays on average 6 years in the league and stays on average 2.4 years with his current team. The All Star Game variable indicates how many times a player participated in an exhibition game where the best players from the west compete against the best players from the east once a year. The draft mechanism is conducted at the end of the season and is a very important institution in all major-league sports. It is the principal device for the franchises to secure new talent or rebuild after a losing season. The rules of the draft dictate the order in which professional teams get to select amateur college teamsport players. The team with the worst win-loss record of the past season has the highest probability of picking the most talented college player in the "draft-lottery". The rest of the teams in the league then elect players in the inverse order of their prior regular season records, with the best team picking last in each round. Hence, the draft lottery enforces competitive balance in the league and leads to relatively equal playing strength between league members and holds the competition "entertaining".

The primary variable representing offensive NBA ability is the Scoring-Performance variable and measures a player's direct points. We use Harder's (1992) composite measure of defensive performance and team attributes by applying the Non-Scoring-Performance variable.[17]

Some icehockey variables differ from NBA variables. Player characteristics indicate that hockey men stay on average one year longer in their business than basketballers and prefer to remain farther with their present club than the sportsmen from the NBA. Goals and assists are the players' measure for direct productivity whereas penalty in minutes captures a hockey player's intensity of play and defensive skill. As noted in Jones and Walsh (1988), a more intense skater demonstrates a willingness to make the sacrifices required for the team's success. Hockey is a though sport and players need strength to be effective. In order to control for various physical attributes that may affect player performance, and that are not recorded by other performance variables, measures for a player's height and weight are included. *Ceteris paribus*, stronger players may be more effective offensively and defensively as they can use their size to gain strategic position during the game.[18]

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[17] NSP is computed using the following formula: rebounds+assists+blocks+steals - (field goals attempted - field goals made) - (free throws attempted - free throws made)/minutes.

[18] Another variable that represents a player's offensive and defensive skill is the plus/minus statistic. The plus/minus statistic is calculated by assigning a player a plus 1 if he is on the ice when his team scores a full-strength goal, and assigning him a minus 1 if he is on ice and his team gives up a full-strength goal. However, plus/minus statistics are not readily available for players in all seasons, hence we need

As can be seen from a comparison of above tables NBA players earn on average significantly more than their hockey mates, there is however, a little bias in the hockey data because goalies are excluded which on average earn more than skaters.

Perhaps a plain look can already signal us something about NBA and NHL players' salary paths and their corresponding productivity. Figure 7 and 8 display NBA players' effect on income and scoring performance (SP) while experience and tenure rise. This and the following charts do all have US$ values as a common denominator. In other words, productivity is expressed in dollars in order to compare both curves.

Figure 7: Authentic Wage/Productivity Path with Experience for NBA players.

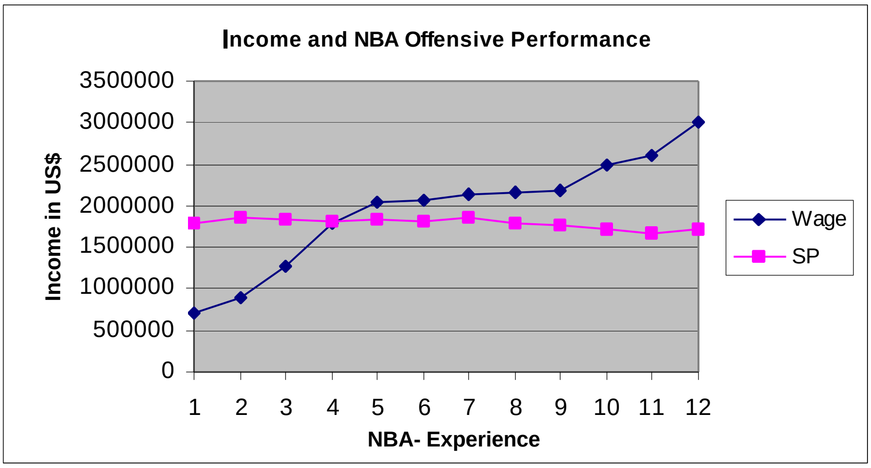
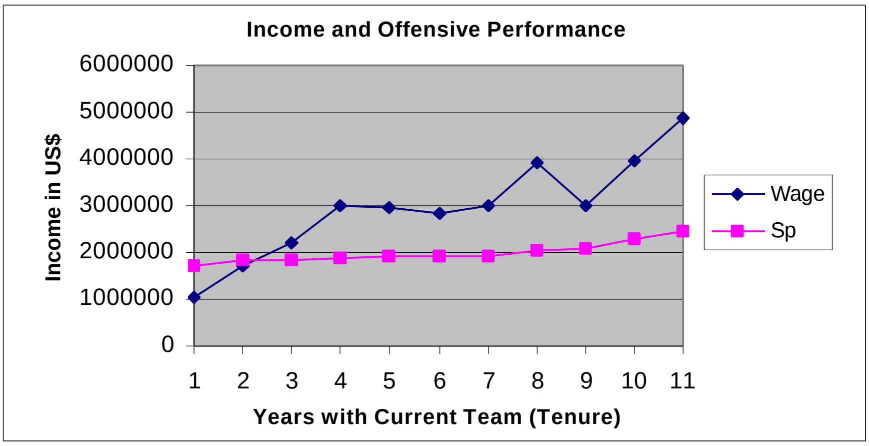


Figure 8: Authentic Wage/Productivity Path with Tenure for NBA players.

to drop that important information.



Both figures demonstrate that wages increase either with experience or tenure. Obviously, staying with one and the same team is more valuable from the outset than rising experience. In the wage-experience figure, players' are four years "undercompensated" before break-even, while in the tenure model players' already "earn" money in their second year.

A closer look at the performance profile indicates that productivity (SP) in figure 7 is downward-sloped. This however, *contradicts* our first hypothesis, because the more players' invest in "on-the job-training" the lower their productivity. This is not the same in the tenure model (figure 8), where performance hikes the longer a basketball player remains with his current team. Due to this it is -so far- more likely that the general human capital model is not applicable for offensive players. The firm-specific human capital model seems to be more relevant in this matter. In order to test if offensive NBA players do really not enhance their productivity while aging, but play better while getting older and stay with their actual club we develop the following model specification:

(1) $SP = \alpha_1 CL + \alpha_2 CL^2 + \alpha_3 YCT + \alpha_4 YCT^2 + \alpha_5 DN + \alpha_6 ASG + \varepsilon$

The human capital model suggests that performance rise with more on-the-job-training. Our model uses direct productivity (SP) as dependent variable whereas career length and in particular tenure are our main regressors in an ordinary least-square estimation. Moreover, we apply on the right hand side a player's physical talent and control further for all-star status. The latter two independent variables are therefore essential, because one could imagine that the pure player talent -expressed by DN and ASG- could themselves be responsible for higher performance. If our descriptive evidence above is correct we should verify the null hypothesis with regard to the experience (CL) coefficient, but should observe a positive correlation between tenure and productivity. The inclusion of the squared terms in above and the following equations captures both, the positive effect of experience –if then any- and the negative impact of aging and controls additionally for non-linearity.

Estimates of equation (1) are reported in Table 3. Most striking, our model rejects the forecasted hypothesis that performance rises with more experience: The coefficient of the experience variable is negatively sloped saying that productivity sinks the longer a player is in the league. Attention however must be paid to the fact, that performance accurately declines, when the player is little past the „experience-peak" (see Table 1 and Figure 7 that on average a player stays 6 years in the league). Hence, the decrease gains in magnitude as the player ages, which is not leveled-off by the gain in experience for offensive-skills. While this indicates to refuse the general human capital model, it invites to adapt the firm-specific human capital pattern. The tenure coefficient is significant at the 1% level telling that players who remains 1.5 years longer with the current team than the average player stays with his former team (average = 2.4 years), produces 8 % more direct points.

Table 3: The Impact of Experience and Tenure with Regard to (SP) Productivity

Variable	B	T
CL	- 0,00000075	**- 0,04+**
CL^2	- 0,000083	- 3,37***
YCT	0,0276	**4,81*** **
YCT^2	0,00231	- 4,32***
DN	- 0,00098	- 7,27***
ASG	0,0516	14,10***
Intercept	0,59	41,56***
R^2	12,2	
F-Value	74,6	
N of Cases	2071	

+ n.s.; *p < .10; **p < .05; *** p < .01

Since this result is somehow surprising we will now investigate the effects of experience and tenure regarding a player's teamwork attributes. Figure 9 demonstrates that it takes a much longer time for a player who invested in team contributing skills (assists, blocks, steals and rebounds) to reap any benefits. In the first four years does the team earn money on the player and then pays him a salary which equals his marginal revenue product. Since the average career length is six years, most of these basketballers are only paid what they are worth. Conversely to their offensive teammates, productivity slopes upward when controlled for experience. This is in line with our first hypothesis and does also indicate that cooperation is a long learning process.

Figure 9: Authentic Wage/ Non-Scoring Productivity Path with Experience for NBA players.

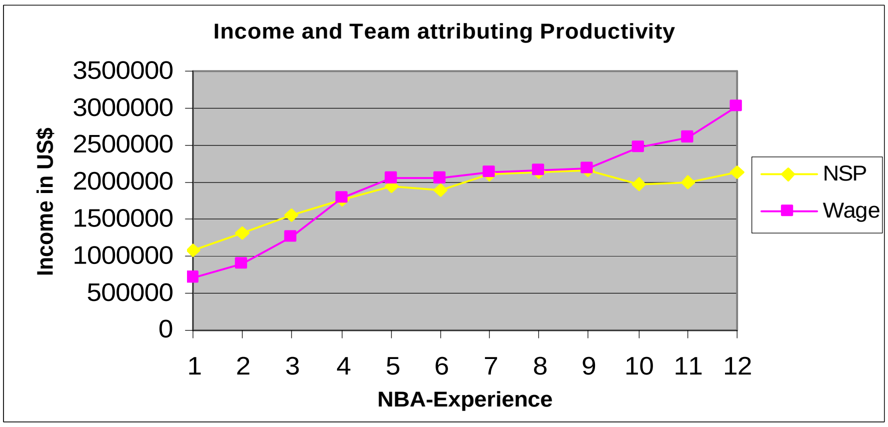
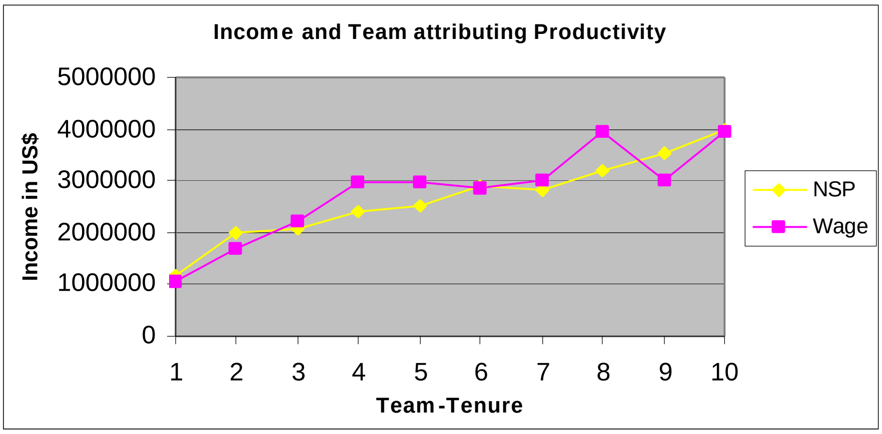


Figure 10: Authentic Wage/ Non-Scoring Productivity Path with Tenure for NBA players.



To test empirically the general human capital model we apply the same equation as above but substitute direct performance with teamwork contributing skills (NSP).

(2) $NSP = \alpha_1 CL + \alpha_2 CL^2 + \alpha_3 YCT + \alpha_4 YCT^2 + \alpha_5 DN + \alpha_6 ASG + \varepsilon$

Table 4 presents results for the relationship between experience and tenure on the one hand and team attributing performance on the other. Diagnostic tests for this estimation report that no statistical assumptions were violated in our analyses. Consistent with hypothesis 1, the results show that teamwork productivity promotes, while players' age and remain longer with their current team. All independent parameters influence productivity in the predicted manner, that is, these coefficients have the sign as anticipated and are statistically significant.

Table 4: The Impact of Experience and Tenure with regard to (NSP) Productivity

Variable	B	T
CL	12,5	**4,87*** **
CL^2	- 0,91	- 5,41***
YCT	35,91	**9,11*** **
YCT^2	- 2,77	- 7,55***

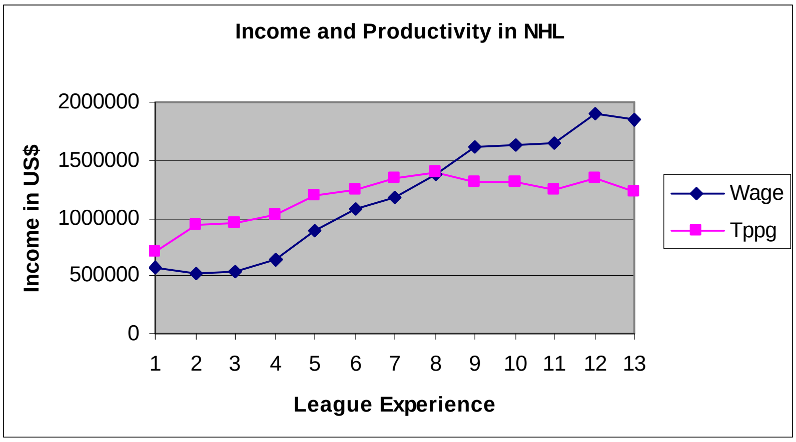
DN	- 058	- 6,29***
ASG	27,44	10,92***
Intercept	48,44	4,95***
R^2	12,0	
F-Value	73,1	
N of Cases	2071	

+ n.s.; *p < .10; **p < .05; *** p < .01

Thus, considering players' teamwork abilities, we are prone to adapt the general human capital model. Since specification (1) failed to explain general human capital, but showed some good evidence for team-specific human capital there is a "tie" with respect to the explanation of Basketball players' age-earnings profile. Fortunately, we are in the position to re-run the estimation with our second database from the National Hockey League.

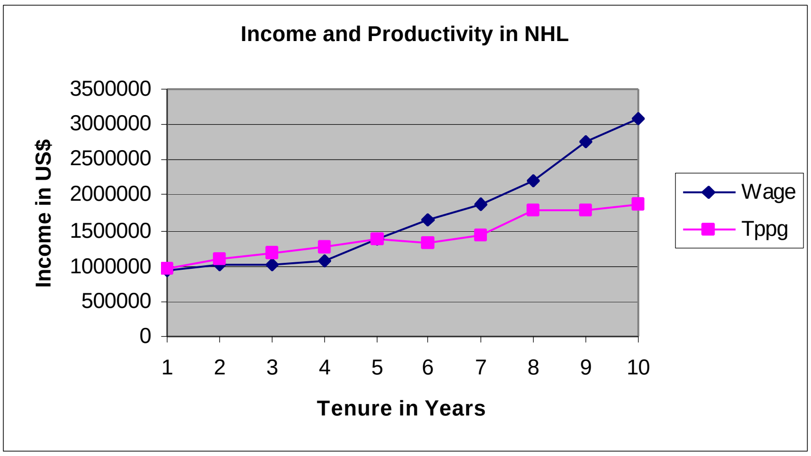
Figure 11 and 12 demonstrate hockey players' earnings and productivity paths. While skaters wages rise -similar than basketball players'- hockey players' quality of play does also improve with experience, which was not the case for offensive players in the NBA. In order to distinguish between the general and firm-specific human capital model we install the hockey data in above model specification: The dependent variable uses total points per game[19] (Tppg) and measures players' productivity. Explanatory parameters remain the same.

Figure 11: Wage and Productivity Slopes with Experience



[19] Total points are the sum of goals plus assists. We do not distinguish between offensive, defensive or teamwork performance.

Figure 12: Wage and Productivity Slopes with Tenure



(3) $Tppg = \alpha_1 CL + \alpha_2 CL^2 + \alpha_3 YCT + \alpha_4 YCT^2 + \alpha_5 DN + \alpha_6\, ASG + \varepsilon$

Table 5 supports conjecture 1 and the descriptive evidence atop. Earnings are strongly upward based after break-even. The coefficient for experience is positively significant as well as the tenure coefficient, even when controlled for talent and stardom: Although one can think of hockey being a fierce and rough sport, players have on average a longer career than basketball players do. The hockey model is more robust than either the offensive or the team attributing performance NBA model. More than 24% of the variation in player productivity is explained by the independent variables, according to the adjusted-R^2 obtained from the regression. This is twice as much than the NBA productivity estimations. Allover, results for hypothesis 1 are mixed but tend to confirm the general human capital model.

Table 5: NHL Players' Productivity Determinants

Variable	B	T
CL	0,043	**10,54*** **
CL^2	- 0,0026	- 11,08***
YCT	0,0352	**7,11*** **
YCT^2	- 0,0024	- 5,97***
DN	- 0,00033	- 4,70***

ASG	0,071	22,30***
Intercept	,841	12,55***
R^2	24,5	
F-Value	122	
N of Cases	2763	

+ n.s.; *p < .10; **p < .05; *** p < .01

Since productivity seems to be correlated with tenure in all empirical tests, we do still lack evidence on efficiency theory. Theoretically, the efficiency wage is a salary that deters cheating, because it exceeds the opportunity wage by an incentive compatible amount. The wage is set higher than market-clearing wages in order to motivate the employee to work more efficiently. By paying an efficiency wage, the company establishes a financial reward for honest behavior from its employees, and so discourage them from shirking.[20] Under hypothesis 2 we should observe workers wages' travelling north while tenure and experience rise even under the control of various productivity and stardom parameters.

To run the test we use the data described above and distinguish between three NBA regression models. Design (1) is the standard Mincer-type wage equation that tries to identify player salary determinants. Special attention is paid to tenure and experience but performance measures are included as well. In model (2) we add a variable that measures the length of the individual player's contract (CD). This variable is important because it incorporates extra information on player salary determinants: The greatest incentive to shirk exists in the period directly following the signing of the new contract, which has the least bearing on future income.[21] Conversely, a player might put forth effort in the final year of his running contract. The logic behind this variable is that a player who will

[20] Milgrom, P.; Roberts, J. (1992).
[21] Maxcy, J. (1997).

become a free agent[22] at the end of a season may play with greater effort and intensity than they might otherwise, with the purpose to impress potential employers. Following this reasoning we expect a positive coefficient for this variable. Pattern (3) extends model (2). Firstly, a dummy variable measuring a team change is added and, second, an interaction term (team change times contract length) is included into the specification. If the new team is less informed about a player's abilities and motivation than his old team, a team change should c.p. lead to an income reduction. It should be straightforward from the remarks just made that individuals salary act as dependent variable whereas regressors feature to explain the variance in players' salaries. Since investments in OJT are recorded in units of time-years and other explanatory variables in units of games, the dependent variable - earnings- is expressed in logarithms. The empirical semi-log models testing hypothesis 2 are formulated as follows:

$$(1)\quad \ln(Y) = \alpha_0 + \alpha_1 DN + \alpha_2 ASG + \alpha_3 CL + \alpha_4 CL^2 + \alpha_5 YCT + \alpha_6 YCT^2 + \alpha_7 MPG + \alpha_8 SP + \alpha_9 NSP + X'TD + X'YD + \varepsilon$$

$$(2)\quad \ln(Y) = \alpha_0 + \alpha_1 DN + \alpha_2 ASG + \alpha_3 CL + \alpha_4 CL^2 + \alpha_5 YCT + \alpha_6 YCT^2 + \alpha_7 MPG + \alpha_8 SP + \alpha_9 NSP + \alpha_{10} CD + X'TD + X'YD + \varepsilon$$

$$(3)\quad \ln(Y) = \alpha_0 + \alpha_1 DN + \alpha_2 ASG + \alpha_3 CL + \alpha_4 CL^2 + \alpha_5 YCT + \alpha_6 YCT^2 + \alpha_7 MPG + \alpha_8 SP + \alpha_9 NSP + \alpha_{10} CD + \alpha_{11} TC + \alpha_{12} CL*TC + X'TD + X'YD + \varepsilon$$

with ln(Y): log of annual salary
DN: draft number

[22] There are two types of free agency. Restricted and unrestricted. An unrestricted free agent is free to sign with any other team, and there's nothing the player's original team can do about it. Restricted free agency gives the player's original team the right to match an offer sheet the player signs with any other team and keep the player.

ASG:	number of all-star games
CL:	years as a professional
YCT:	years with current team
MPG:	minutes per game
SP:	scoring performance
NSP:	non-scoring performance
CD:	contract duration
TC:	new contract signed with new team (0=no; 1=yes)
X' TD:	each model is estimated with team-dummies
X'YD:	each model is estimated with year-dummies
ε:	random error term

where α_n = parameters to be estimated

Since we have a model with an endogenously determined right hand side variable -because contract duration and salary are determined simultaneously- the latter two models are estimated by an instrumental variables approach (2SLS), while model (1) is estimated using ordinary least squares (OLS).

Let us now turn to the results. Estimates of equation 1-3 are reported in Table 6. We find a good deal of evidence that support hypothesis 2: Both predictor parameters are significant at the one- percent level and are sloped upwards. The tenure coefficient i.e. in model 1 indicates that staying 3 years with his current team instead of the average 2.4 years increase a player's salary c.p. more than 15%. Furthermore, playing 8 instead of the average 6 years in the league let c.p. wages grow more than 22%. Since these results are in accordance with our predicted hypothesis 2 it should be emphasized, that these findings are even then highly positive significant, when controlled for performance statistics.

For example a player who scores 1,0 point per minute instead of the average 0,56 direct points (SP) earns c.p.15,4% more than the average performing athlete. Likewise, a player competing 25 minutes per game on the field instead of the average 20 minutes has a 20% higher income. The same is happening with the draft variable. If our expectation is correct, a lower draft pick indicates better talent and players should be compensated more. Hence estimates of α_1 should be negative. The coefficient of the draft variable indicates that being picked at 15th instead of 33rd (average) pays-off in an 18% higher salary. Similarly, all-star players who demonstrate unusual skills that attract fans should earn greater salaries, all else equal. The all-star coefficient displays that a player who has one standard deviation more all star games than the average player c.p. earns 12% more money.

Model (2) displays that the coefficients estimated in model (1) suffer from an "omitted variable bias": Especially our coefficients of the experience and tenure variables are significantly reduced (by about 60% and 50% respectively) once the length of the contract is controlled for. Moreover, contract length has a significantly positive influence on player salaries. Signing a four- instead of a three-year contract (3,6 years is the average) goes hand in hand with a 25%-increase in annual earnings.

Table 6: The Determinants of Player Salaries in the NBA (1993/94-1999/2000).

Variable	**Model (1)**	**Model (2)**	**Model (3)**
DN	-0,011	-0,006	-0,007
	(-16,95)***	(-10,92)***	(8,80)***
ASG	0,073	0,046	0,046
	(4,25)***	(3,17)***	(3,06)***
CL	0,103	0,040	0,054
	(5,90)***	(2,57)*	(3,16)***
CL^2	-0,005	-0,00004	-0,001
	(-4,74)***	(-0,04)+	(-0,86)+
YCT	0,268	0,122	0,096
	(10,17)***	(5,32)***	(2,52)*
YCT^2	-0,017	-0,007	-0,005
	(-7,23)***	(-3,57)***	(-1,80)+
MPG	0,049	0,035	0,030
	(20,10)***	(16,14)***	(12,54)***
SP	0,361	0,367	0,40
	(4,34)***	(5,20)***	(5,84)***
NSP#	0,045	0,032	0,044
	(3,48)***	(2,90)***	(4,35)***

CD	-	0,246 (28,10)***	0,148 (3,03)***
TC	-	-	-0,775 (-11,21)***
TC*CD	-	-	0,174 (4,37)***
CONST	11,73 (89,30)***	11,41 (100,25)***	12,66 (61,59)***
Adj. R^2 * 100	62,6	73,1	74,1
F-Value	76,9	121,1	293,6
N of Cases	2.071	2.071	2.071

*p < .10; ** p < .05; *** p < .01; + n.s. (t-values in brackets).

Coefficient multiplied by 100.

Our last NBA model shows that the influence of contract length on player salaries differs significantly between players who remain with their "old" team and the ones who switch teams. While stayers enjoy a 15%-increase in earnings with every additional year of contract length, movers suffer a 77%-decrease.[23]

Our second database from the NHL also qualifies to test Lazear's seniority approach. If

[23] At first hand this income reduction seems unreasonable large. One aspect is the new club's information deficit with respect to the recent acquired player. Hence, the new club is only willing to pay a wage that is less than he received with his old franchise. In other words this is partly what matching theory suggests. However, there is a second aspect, the so-called "salary-cap". The salary cap is the maximum dollar amount teams can spend on player contracts. A salary cap is also necessary to maintain competitive balance in the league. Without a salary cap, teams with deeper pockets can simply outspend the remaining teams for the better free agents. The basic idea is that a team can only sign a free agent if the total salaries for the team will be below the salary cap. So a team with deep pockets is playing on a level playing field with every other team. To avoid that salary cap restriction teams try to circumvent that obstacle and sign movers by just paying them very little in their first year of new-contracting, but annual income growth heavily in the following years of new-contracting. Thus, that effect might take place in the model and must be tested next for. Nevertheless, the income reduction that follows a team change is likely to be a mixture of asymmetric information and escaping the salary cap.

hypothesis 2 is correct we should observe positive parameters for NHL experience and tenure. In order to investigate for this we apply the subsequent multiple regressions:

$$(1)\ \ln(Y) = \alpha_0 + \alpha_1 DN + \alpha_2 ASG + \alpha_3 CL + \alpha_4 CL^2 + \alpha_5 YCT + \alpha_6 YCT^2 + \alpha_7 Height + \alpha_8 Weight + \alpha_9 GP + \alpha_{10} GPG + \alpha_{11} APG + \alpha_{12} PIM + X'TD + X'YD + \varepsilon$$

$$(2)\ \ln(Y) = \alpha_0 + \alpha_1 DN + \alpha_2 ASG + \alpha_3 CL + \alpha_4 CL^2 + \alpha_5 YCT + \alpha_6 YCT^2 + \alpha_7 Height + \alpha_8 Weight + \alpha_9 GP + \alpha_{10} GPG + \alpha_{11} APG + \alpha_{12} PIM + \alpha_{13} TC\ X'TD + X'YD + \varepsilon$$

The variables Height and Weight are included on the grounds that certain physical attributes, such as reach and strength, allow the player to accomplish more on the ice. Thus, Height and Weight may proxy "all-round" quality of play that is not otherwise captured by the model. We anticipate a positive relationship between physical size and salary up to some optimal height and weight and therefore negative correlations for squared terms.

Estimates of NHL equations 1 and 2 are reported in Table 7. Looking now at the basic specification in column (1) we see that all independent variables have the predicted signs and each is statistically significant, with the exception of player Height and PIM. The career length coefficient says that a player who manages to stay one year longer in the league than the average 7 years earns, all else equal 10% more. Analogously, a player staying two years longer with his original team makes c.p. 10,4% more money than the player who quits his current team after 3 years. Similar to the experience variable (CL) might (GP) be interpreted.[24] It's coefficient is weaker than the experience and tenure coefficient but still highly significant. We anticipate that skill increases with the number of games played and this should be reflected in salary. The (GP) coefficient of 0,00095 says that a player who is 70 instead of the average 51 games on ice earns, all the same $20,000 more. Most strongly positive correlated to wages are players' abilities. Making i.e. one standard deviation more assists than average skaters pays-off in a 23% higher salary. This underlines hockey's importance of cooperation. Also a player's strength (Weight) is an element in the hockey salary determination process:[25] A 100 kilogram "tank" is compensated 8,7% more than his average lighter coworker.[26]

Results for NHL regression 2 is given in column 2 of Table 7. In this model we add a team change variable (TC) in order to test if players' income is reduced after switching teams.

Table 7: The Determinants of Player Salaries in the NHL (1996/97-1999/2000).

Variable	**Model (1)**	**Model (2)**
DN	-0,0011	-0,0009
	(-8,01)***	(-4,94)***
ASG	0,0865	0,085
	(11,88)***	(10,58)***
CL	0,10	0,156
	(11,35)***	(13,00)***
CL^2	-0,0025	-0,0051
	(-4,98)***	(-8,00)***
YCT	0,0521	0,053
	(4,91)***	(3,38)***
YCT^2	-0,0027	-0,0028
	(-3,15)***	(-2,59)***
Weight	0,0092	0,0133
	(4,28)***	(5,13)***
Height	0,0030	0,0010
	(1,02)+	(0,30)+

[24] Recall from page 15 that (GP) is the amount of games a skater played. PIM are the Penalties.

[25] It is obvious that a player's height in the NBA is essential but not incorporated in our NBA regression It is predicted here, that larger NBA players will c.p. earn higher wages, because it is part of a player's natural talent, which should affect his productivity.

[26] We also experimented a combined Height * Weight variable representing a player's "Total-Mass", but we did not find it to be significant.

GPG	0,89	0,85
	(9,28)***	(7,80)***
APG	1,23	1,38
	(15,91)***	(15,48)***
GP	0,00095	0,0009
	(2,00)***	(1,66)*
PIM	-0,0002	-0,00007
	(- 0,84)+	(0,24)+
TC	-	-0,0631
		(-1,73)*
Intercept	11,14	10,87
	(25,80)***	(20,9)***
Adj. R^2 * 100	56,8	58,0
F-Value	288	298
N of Cases	2.763	2.763

*p < .10; ** p < .05; *** p < .01; + n.s. (t-values in brackets).

The hockey data verifies our results from the NBA. The (TC) coefficient has the correct slope and is significant at the 10% level telling that hockey players suffer an income decrease when moving to another team.[27] Unlike professional basketball the institutional environment for salaries in the NHL is open. Hockey has no salary cap but our result is significant negative hinting evidence that asymmetric information plays a big role.

5. Conclusion and Implications for Further Research

This paper has attempted to draw out the positive relationship between tenure/ job-experience and rising wages. The problem is that three different modern labor market approaches can be used to explain this correlation and we tried to find out which one is the most appropriate. Our specific empirical focus has been on professional basketball and hockey because data is readily available to analyze the three theories. We were able to

[27] If we run the regression with GOALS and ASSISTS instead of GPG and APG, the TC coefficient is

investigate the human capital model and found out that more investments in general on-the job training improves a worker's productivity significantly, even when controlled for talent. Furthermore, we were able to test for seniority compensation: Descriptive evidence as well as numerous multiple regressions from both databases implied that players' are paid greater wages when they are old than when they are young even under the inclusion of performance parameters. This efficiency wage model needs some more investigation: The next step to be taken in this aspect is to find players with the same job assignment (position) and the same average productivity (performance) and test if older players tend to be paid more than younger players.[28]

Many aspects of the underlying question however remain. As said in the beginning, the paper is far from being fully developed. Since we could only show the relationship between the amount of investment in human capital to the worker's productivity we weren't successful in showing that this results in upward-sloping earnings. Regarding this aspect the next step to be taken is to distinguish between general and team specific human capital for both sports. We need to investigate if "movers" do really perform poorer with a new team than with their old club and thus are rewarded less. In order to do this, we need to separate the player population and look where single athletes travel. So far, we did not take full advantage of our longitudinal data sets: Both provide an opportunity to use more complex and efficient estimation techniques than applied yet. Two frameworks advance the classical regression model and take advantage of the nature of the data: The fixed-effects model and the random-effects model. The advantage of these models is that each allows for estimation of the heterogeneity across groups and each eliminates the problem of omitted variables.[29] More precisely, the fact that we face data considering *n* units (players) over T *time* (years) periods were we have income and other characteristics of these *n* (players) surveyed each of T (years), this cross-sectional time-series dataset must take account for that. Moreover, attention must be paid to the fact that some players are only paid minimum wages which strongly recommends the use of a random-effects tobit

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not significant but has the negative sign.

28 We just calculated players' actual age for each observation.

29 See Kahn (1993a).

model, since the salary variable is consequently left-censored.

There is another major empirical challenge: The matching hypothesis, which we introduced in the theoretical part of this article, was not empirically tested. Doing this won’t be easy, but Chapman and Southwick (1991), Ohkusa and Othake (1996) and Prisinzano (2000) apply a model that uses a Cobb-Douglas function, which seems to be suggestive.