Renegotiation Design: Evidence from NFL roster bonuses

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Abstract

Do contracts shape renegotiation? If they do, does changing renegotiation have economically important consequences for transfers and efficiency? We exploit institutional features of the National Football League (NFL) and a unique and novel dataset on contracts of NFL players to address these questions. We show how contractual arrangements in the NFL can lead to contractual hold-up. Unmitigated, this hold-up leads to ex post inefficient matching and transfers between teams and players. We show that a seemingly innocuous change in the timing of payments through the use of "roster bonuses" is used to ameliorate this hold-up problem and to improve matching efficiency. We test the predictions of our model and show that they are consistent with NFL contracting data. We find that shaping future renegotiation is an important part of NFL contracts: players are, on average, willing to forgo approximately $260 thousand for a contract in which the renegotiation incentives are modified. We also observe increased contract termination that arises from shaping renegotiation, which increases matching efficiency between players and teams.
“I have come to the conclusion that the main obstacle faced by researchers in industrial organization is the lack of available data on contracts and the activities of firms” (Ronald Coase, Lecture to the memory of Alfred Nobel, December 9, 1991: The Institutional Structure of Production).

Contractual renegotiation design is the “design of rules that govern the process of renegotiation.” (Aghion, Dewatripont, Rey, 1994, p. 257). Theory suggests that renegotiation design is an important consideration that shapes contracts, and therefore contracting outcomes. Renegotiation design is fundamental in much of the literature in economics. It is essential in the theory-of-the-firm literature and, more broadly for institutional design; in corporate finance for theories on debt and financial structure, and in law and economics. While there has been a lot of attention on the way that contracts are written to shape renegotiation, there has been little empirical work on this phenomenon. Several questions remain open: Do contracts shape renegotiation? If they do, does changing renegotiation have economically important consequences for transfers and efficiency? We exploit institutional features of the National Football League (NFL) and a unique and novel dataset on contracts of NFL players to address these questions.

Empirically researching renegotiation design has proven to be a difficult task. Two sets of issues have hampered empirical research: the lack of appropriate data and the fact that the theoretical predictions depend heavily on features of the institutional environment, which are hard to observe. The latter is a problem because renegotiation design often takes form in simple contracts which rely on equilibrium renegotiation (Bolton and Dewatripont 2008), making it hard to empirically separate renegotiation design from other roles of contracts.

NFL contracts offer a unique institutional setting for exploring the role of contracts in shaping future renegotiation. The NFL contracting process is governed by a Collective Bargaining Agreement, which allows us to identify the contracting environment, which is otherwise hard to observe. The Collective Bargaining Agreement prescribes which contracts are allowed and enforceable, which party has rights to alter the contract, and at what point in time. We even know with which other parties in the market the contract participants are allowed to communicate.

One major problem with studying contracts is that the parties generally can take actions outside of the contract. For example, a worker can be awarded a bonus which was not specified in the contract. Further, informal renegotiations can take place which are not

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1For early work on renegotiation design, see (O. Hart & J. Moore 1988), (P. Aghion, M. Dewatripont & P. Rey 1994), and (G. Nöldeke & K.M. Schmidt 1995).
2For summaries, see (O. Hart 1995) and (P. Bolton & M. Dewatripont 2005), Chapters 11 and 12.
5For bankruptcy law see (M. White 2007); for corporate law and governance see (M. Becht, P. Bolton & A. Röell 2007); for contractual hold-up and damages, see (S. Shavell 2007).
6For example, players under contract are not allowed to talk to other teams about possible contracting arrangements, should their current contract be terminated.
observed in the data. Because the NFL regulates all dealings between the team and the player, all renegotiations are formal, ruling out informal renegotiation and side payments, which otherwise can loom large in the study of contracts.

The second benefit of using NFL contracts is the availability of data uniquely suited to studying renegotiation. Data availability is still one of the major constraints in the contracting literature, particularly if one wants to study renegotiation. The data in this paper include all contracts signed in the 2001 and 2002 seasons in the NFL and are backfilled with a complete contracting history for all players who were in the league at that time. In addition to contract terms, the data contain exact dates on which the contracts were signed and terminated, which is critical for our purposes. Renegotiation is common, and we observe which contracts were renegotiated, on what date, and the terms of the contracts.

For this study, we exploit a seemingly innocuous difference in timing of compensation during the offseason. The contract can specify a roster bonus amount which is paid early in the offseason if the contract is still in place at that point. Alternatively, the contract also can specify a salary payment, due at the end of the offseason instead of the beginning of the offseason. Prima facie, whether compensation is paid as roster bonus or salary is of no importance; only their combined amount should matter. Because the salary and the roster bonus are both due before the beginning of the season, they cannot provide different incentives for performance. Furthermore, little asymmetric information about player quality is revealed during the offseason, so the payments are not there to screen players of different ability unobservable to the team. However, we show that the choice of whether to specify compensation in roster bonuses or salaries is not as innocuous as it seems at first. We model contracting in the NFL and show that the choice of contracting some compensation in roster bonuses rather than salary shapes future renegotiation of the contract.

The main driving force of our model is that as the offseason progresses, there are fewer slots available on other teams for a particular player. In other words, the liquidity or market thickness for player characteristics declines as the offseason progresses. Therefore, if a player’s current contract with the team were terminated, the team which could have used him would have already filled its slots. Consequently, the player would have to sign an inferior contract. We show that teams can exploit this fact and strategically delay renegotiation to extract more surplus from the player. This opportunistic behavior increases the teams’ surplus at the player’s expense, ex post.

The second key ingredient in the model is a friction that prevents ex-post efficient Coasian bargaining between teams. These frictions arise in the NFL from explicit restrictions on transfers of players, compensation in these trades, and side payments stipulated in the Collective Bargaining Agreement. Because of these restrictions, we can use contracting in the NFL as a good laboratory for exploring contracting in a

\(^7\) (T. Piskorski, A. Seru & V. Vig 2009) describe implicit mortgage modification, which is not recorded and in which the borrower is allowed to alter the payment amounts or timing without changing any terms of the mortgage contract.

\(^8\) Any side payments would be fraudulent, and subject to fines.
world with ex-post bargaining frictions. We show that strategic delay of renegotiation in the presence of bargaining frictions leads to inefficient matching between players and teams in the NFL.

Modeling contracting in the NFL serves three purposes. First, it clarifies the contracting forces that shape players’ compensation and allocation in the NFL and how these interact with a clearly defined market friction. In particular, it shows how replacing a part of salary payments with roster bonuses shapes renegotiation. Second, it provides empirical predictions that we take to the data. We test the predictions on: timing of termination and renegotiation; the trade-off between contract characteristics predicted in the model; the value of contracts signed by terminated players; and termination frequency. The predictions from our model are consistent with the data. We also use these tests to show that shaping future renegotiation is an economically important role for contracts in the NFL. Players are on average willing to forgo approximately $260 thousand for a contract in which the renegotiation incentives are modified. Last, the model provides a link between observable outcomes, contract terminations, and the matching efficiency between teams and players. Generally it is hard to empirically draw inferences about the impact of renegotiation design on efficiency. Our model allows us to draw inferences about ex post matching efficiency of different contracts from observed player terminations.

Overall, this paper makes three main contributions. We first show how contractual arrangements in a large market with high stakes, the NFL, lead to contractual hold-up and how this hold-up is resolved through renegotiation design. This renegotiation design is implemented through seemingly innocuous timing of payments in contracts and affects the transfers and allocation of players in the market through altering renegotiation incentives of the contracting parties. The second contribution of the paper is that it sheds light on the economic magnitudes in renegotiation design and hold-up. We estimate the dollar amount of contractual hold-up that is reduced through renegotiation design, which at the same time estimates the lower bound on hold-up in this market. The last contribution of our paper is that we can empirically examine the efficiency of different contracting arrangements in this market.

A competing explanation of our empirical results is that there could be a dimension of player quality that we do not observe, which is potentially correlated with roster bonuses, termination, and renegotiation decisions. While we can control for a wide array of information on player ability, we cannot a priori rule out that possibility. However, we think this alternative explanation is unlikely for two reasons. First, in addition to controlling for observable dimensions of a player’s ability, we can condition on future performance, which should allow us to control somewhat for the unobserved dimension of ability. If this ability does not affect future performance, then it is hard to see how it would be of first-order importance in contracting. Controlling for a future player’s performance has no qualititative or quantitative effect on our results. Moreover, we show that while individual results in our paper are subject to this critique, the combined results are hard to reconcile with a particular dimension of unobserved quality driving them. To drive all of our results, the unobserved

9These frictions are frequently derived from information problems; see, for example, (R. Myerson & M.A. Satterthwaite 1983) – or bargaining cost, for example in (L. Anderlini & L. Felli 2001).
quality would have to be both positively related and negatively correlated with roster bonuses.

This paper proceeds as follows. Section 1 discusses the related literature. Section 2 provides the institutional background on contracting in the NFL. Section 3 describes the data and presents descriptive statistics. Section 4 presents a simple numerical example that provides the intuition on the contracting dynamics in the NFL, and on how they are shaped by contracts. We then formalize this intuition and develop a model that we use to formulate testable predictions. Section 5 presents the results. Section 6 discusses the potential alternative explanations of our results. Section 7 concludes.

1 Related Literature

Our study relates to several strands of the literature. Within the literature on the role of renegotiation design, our paper is most closely related to the study of renegotiation design and default options. As in (Aghion, Dewatripont & Rey 1994), roster bonuses affect default options, but they do so through the timing of the payments. (S. Guriev & D. Kvasov 2005) construct a model in which time is a critical component of the contract. The problem in these papers is inducing the appropriate level of non-contractible ex-ante investment. In our model the friction arises from the restrictions on ex-post bargaining, where a team cannot appropriate the surplus the player would create if he were to sign with another team.

Our paper is related to the legal literature on remedy and contractual hold-up. Shavell (2007, pp. 325-326) defines contractual hold-up as “situations in which a party to a new or existing contract accedes to a very disadvantageous demand, owing to the party’s being in a circumstance of substantial need.” Our contribution is to empirically and quantitatively explore an example of such contractual hold-up and its contractual remedy in the NFL. In fact, (Shavell 2007) points to the lack of empirical data on renegotiation design as support for legal intervention in modifying contracts.

Our paper is also related to the empirical literature on financial contracting. (S.N. Kaplan & P. Strömberg 2003) show that venture capital contracts are consistent with theories of financial contracting. (E. Benmelech & N.K. Bergman 2008) explore how strategic renegotiation of airline leases is related to the liquidation values of the firm’s assets. Liquidation values in that setting play a similar role to market thickness in our setting. (M.R. Roberts & A. Sufi 2009) study the renegotiation of private credit agreements and how it relates to the terms of the initial contract, firm, and macroeconomic variables. (R. Iyer & A. Shoar 2008) experimentally examine hold-up and find that up-front payment is a means of reducing surplus from hold-up by the buyer. (J. Lerner & U. Malmendier 2010) research how contractibility affects contract design between researchers and financing firms in biotechnology.

There is also a large literature on contracting between firms. Our paper comes closest to the literature on the allocation of control rights. Control rights in these papers have generally been interpreted as a device that allocates ex-post bargain-

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10See (F. Lafontaine & M. Slade 2009) for a survey.
ing power to the party who will be held-up in the relationship. (J. Lerner & R.P. Merges 1998) examine which factors drive control rights’ allocation in biotechnology alliance contracts. (B. Arruñada, L. Garicano & L. Vázquez 2001) analyze the determinants of the allocation of decision rights between dealers and car manufacturers. (R. Gil 2009) examines the choice of whether to write formal contracts within the Spanish movie industry and how the choice is shaped by repeated interactions between the parties.

A growing literature on market design has emphasized the role of market thickness and congestion and how it affects the strategic behavior of market participants.11 (A.E. Roth & X. Xing 1997), for example, study congestion in the market for clinical psychologists. The literature has also examined various entry labor markets from doctors in (M. Niederle & A.E. Roth 2003) to new economists in (Roth 2008), and the allocation of post-season football bowls in (G.R. Fréchette, A.E. Roth & M.U. Ünver 2007). (T.N. Hubbard 2001) examines the interaction between market thickness and contract choice in the market for trucking. With the exception of (Hubbard 2001), the focus of this research has mainly been on overall market thickness and considering how markets can be designed to improve allocation. In this paper, we focus on the predictable changes in market thickness for players and how the decline in market thickness over the offseason is strategically exploited by the teams. Furthermore, instead of focusing on a way to redesign this market, we highlight a contractual mechanism, the timing of roster bonuses, which has been developed to mitigate some inefficiencies that arise in the market.

2 Institutional Background

The NFL represents a major entertainment industry: according to the Nielsen Ratings, the Super Bowl is the “premier television event of the year” and Super Bowl XLIV (2010) is the most watched television program of all time among US households (Nielsen 2010)). Therefore, it is not surprising that the NFL’s annual revenues of approximately $7 billion are on the same order as U.S. movie box office revenues of $9.6 billion. The National Football League comprises 32 professional football teams. Each team is allowed a roster of 53 players during the regular season. All NFL player are members of a union, the National Football League Players Association. The relationship between the players and the league is governed by the Collective Bargaining Agreement between The NFL Management Council and The NFL Players Association. In our dataset, the contracts are covered by the Collective Bargaining Agreement, signed in 1993, which was extended four times until a new agreement was reached in 2006. The main feature distinguishing contracts in the NFL from other sports contracts is that they are not guaranteed. While the team generally can terminate the contract at any point, the player is bound by the contract and cannot terminate it. Each contract specifies the length of the contractual relationship, the signing bonus, and—for each year of the contract—the Paragraph 5 salary (salary) plus a roster bonus and potentially some additional contract terms, which we address in Section 6.

11 See (A.E. Roth 2002) and (A.E. Roth 2008) for surveys of the literature.
The roster bonus is paid to the player at a pre-specified date during the offseason—i.e. before the season starts—if the contract is still in place. For example, if a player’s contract calls for a roster bonus of one million dollars due on March 1, 2004, then the team has to pay him that bonus if it did not terminate the contract beforehand. Salary is paid during the regular season. For players who have been in the league for more than four years, the salary is de-facto due at the end of the offseason: it is guaranteed for the year as soon as they are on the roster of the first game of the season. The signing bonus is paid to the player upon signing the contract. For example, a 3-year contract for a player who signed in 2000 would specify the following payments:12

<table>
<thead>
<tr>
<th>Year</th>
<th>Contract term</th>
<th>Earned</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>Signing Bonus</td>
<td>Upon contract signing</td>
<td>$0.5 million</td>
</tr>
<tr>
<td></td>
<td>Roster Bonus</td>
<td>March 1, 2002</td>
<td>$0.3 million</td>
</tr>
<tr>
<td></td>
<td>Salary</td>
<td>First game of regular season in 2002</td>
<td>$0.7 million</td>
</tr>
<tr>
<td>2003</td>
<td>Roster Bonus</td>
<td>March 1, 2003</td>
<td>$0.2 million</td>
</tr>
<tr>
<td></td>
<td>Salary</td>
<td>First game of regular season in 2003</td>
<td>$0.9 million</td>
</tr>
<tr>
<td>2004</td>
<td>Roster Bonus</td>
<td>March 1, 2004</td>
<td>$0.2 million</td>
</tr>
<tr>
<td></td>
<td>Salary</td>
<td>First game of regular season in 2004</td>
<td>$1.0 million</td>
</tr>
</tbody>
</table>

The NFL “League Year” starts on February 20 and ends on February 19 of the following year. The regular season starts on the first Thursday of the first full week in September. Between February and September a terminated player has the right to negotiate and to sign a contract with any other team. At the same time, the teams are allowed to exceed their roster size of 53, but must return to 53 players by the beginning of the regular season.

3 Data

3.1 Data description

The initial data consists of 4,220 contracts signed in the NFL between the 1994 and 2002 seasons, encompassing calendar years 1994 to 2003. The signed contracts began to be coded in 1999 and then were backfilled for all players still active in the league in 2000. We restrict the sample to contracts of players who have a reported playing position upon signing the contract, the date upon which they entered the NFL is available, had observable performance characteristics13 in the previous year, and contracts for which all characteristics are coded. This leaves us with a sample of 4,220 contracts. Since meaningful renegotiation concerns are only present in contracts longer than one year, we restrict our analysis to 1,428 contracts that are 2-year and longer contracts.14

Each contract specifies a signing bonus and, for each year, a roster bonus, a reporting bonus, and a salary. This makes contracts of different lengths difficult to compare and describing them requires many parameters. For example, a 12-year

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12 The data agreement prevents me from including data on individual contracts.
13 This excludes rookie contracts.
14 Our results are robust to including 1-year contracts in the analysis.
contract requires 37 variables. To make contracts of different lengths comparable and to reduce the number of variables needed to describe a contract, we reduce each contract to the following five variables: signing bonus; length; average annual total pay; average bonus share of pay; and back load. The average annual total pay is the sum of all payments that the player obtains were he employed for the complete life of the contract, excluding the signing bonus, divided by the length of the contract. For example, for a two-year contract, the payments for year 1 are roster bonus for year 1, reporting bonus for year 1 and the salary for year 1; the payments from year 2 are roster bonus for year 2, reporting bonus for year 2, and the salary for year 2. We then take the average of the payment for year 1 and the payment for year 2. The roster bonus share is our main variable of interest, and is the sum of roster bonuses divided by the sum of all payments excluding the signing bonus that the player receives if he is employed for the complete term of the contract.

NFL contracts generally are back loaded: the annual payments specified in the contract are higher in the later years of the contracts. We measure contract backload as the gini coefficient of annual payments, excluding the signing bonus. A backload measure should be comparable across contracts of different length. Furthermore, contracts with different average levels of pay also should be comparable. The Gini coefficient is a measure of statistical dispersion, which is both scale and population independent. In the case of the contracts, this translates to independence of contract length and level of pay.

A contract is coded “terminated” if we observe the player signing a contract with a different team during the term of his contract and if such contract has been filed as terminated with the NFL. We use the date that the termination was filed with the NFL as a termination date. A contract is coded “renegotiated” if the player signs a new contract with the same team during the duration of his contract.

There are many statistical measures of player quality in the NFL (38 available statistics for every player in our data, not including the rank of each statistic and the 16 awards that players can receive). While we include many of these statistics in robustness check, we mainly focus on one measure of player quality—percent of team’s plays. Using percent of team’s plays, we infer player quality by how much the player is actually used by his team. The only way a team can take advantage of a player’s ability and transform it into output is to play the player. The NFL keeps track of every play in a game, and the players who participated. Those plays are divided into offensive, defensive, and special team plays. We calculate the percentage of offensive, defensive, and special team plays that the player participated in during the season and assign the player the highest of the three percentages. For example, if a player participated in 48 percent of offensive team plays during the season and 5 percent of defensive team plays, we characterize him as an offensive player and assign him 48 percent. This measure has the advantage that it is comparable across positions. For example, field goal percentage from 19 yards may be a very important statistic for a kicker, but it is completely uninformative about the performance of a quarterback. This measure also partially captures the contributions of players measured by statistics, but that contribute to the team’s output. Second, we use the percentage of games in which a player starts in a season. The better players on a
team typically start the game. Finally, to measure player quality we consider the
awards won in the previous year, ranging from whether the player was on the Pro
Bowl ballot to whether he was on the USA Today All-Pro team.

3.2 Descriptive statistics
Table 1 presents descriptive statistics for our sample of 1428 contracts to help us
obtain a general picture of the NFL contracting data. On average the players obtain
a signing bonus of $1,373,674. The distribution of signing bonuses is skewed, and
the median signing bonus is much smaller – approximately $350,000. In addition
to the signing bonuses, as long as the contract is in place, the player is entitled to
the contract payments specified in the contract. The mean annual pay is $1,772,305.
The player’s realized compensation from this contract, however is likely to be less
than the amount specified, because most contracts are back loaded. That is, they
specify higher pay for later years of the contract. In our sample, over 90 percent of
contracts have some backload. The average Gini coefficient of annual payments in
our sample is 0.11. For a two-year contract, that means that the compensation on
average increases by approximately 22 percent from year 1 to year 2.

Not all contracted payments are due at the same time of the year. Roster bonuses
have to be paid early in the offseason, rather than at the beginning of the regular
season when the salary is paid. The average roster bonus share of annual payments
is 0.08. That is, contracts specify that on average 8 percent of annual compensation is
to be paid early in the offseason rather than at the end. Forty-five percent of contracts
have a positive roster bonus share. For these contracts, the roster bonus represents
18 percent of average annual compensation.

Given that we are specifically interested in the roster bonus share, it is espe-
cially important to understand which types of players are more likely to obtain roster
bonuses, and how their contracts differ on other contract characteristics. Panel B
presents player characteristics and contract characteristics for a subsample of con-
tracts that had a positive roster bonus. Panel C compares them to the characteristics
of contracts which had no roster bonus. Better players sign contracts with roster
bonuses: the average player who signed a contract with a roster bonus participated
in 57 percent of his team’s plays in contrast to players who signed contracts without
roster bonuses and participated in 49 percent of their team’s plays. Contracts with
roster bonuses also are longer on average: 4.29 years versus 3.36 years for contracts
with no roster bonuses. The average annual compensation is, on average, $1.2 mil-
lion higher for contracts with roster bonuses. This difference is ameliorated slightly
by the fact that contracts with roster bonuses have proportionally larger payments in
the later years of the contract; they are more back loaded. Their average back load is
0.03 higher than the back load on contracts without roster bonuses. For a two-year
contract, that means that the second-year payment increases by 6 percentage points
over and above the first-year contracted pay.

4 Theory and Hypotheses
The purpose of this section is to develop a model of contracting in the NFL which
serves three purposes. First, it clarifies the contracting forces that shape players’
compensation and allocation in the NFL and how these interact with a clearly defined market friction. Second, it provides empirical predictions that we take to the data. Last, it provides a link between player termination and the matching efficiency between teams and players. This allows us to draw inferences about ex post matching efficiency of different contracts from observed player terminations.

4.1 Numerical Example

We first present a simple numerical example to build intuition. Suppose that Quarterback has a contract with team A. The contract has one year left, and promises Quarterback the payment of $1 million. Because NFL contracts are non-guaranteed, Team A can terminate Quarterback’s contract at any point without a penalty. Alternatively, the team can keep its contract: Quarterback then has to play, and receives the $1 million specified by the contract. The other option for the team is to try and renegotiate the contract to a lower amount. To do so, it needs Quarterback to agree to that lower amount.

The interaction between Team A and Quarterback depends critically on which other teams are willing to sign Quarterback if he were terminated from his current contract. Team A values his services at $0.95 million. Two other teams also are interested in his services. Team High values his services at $1.2 million and Team Low at only $0.8 million. However, if Quarterback is not terminated early, then Team High picks up a quarterback in the middle of the offseason—perhaps one who is less appropriate—just to make sure that it has an adequate quarterback to direct the offense. In this environment, Team A has to think about the timing of its decisions: it can terminate Quarterback’s contract either early or late in the offseason and get no payoff; can propose to renegotiate Quarterback’s contract to a lower amount either early or late in the offseason, keeping Quarterback employed but at a lower compensation; or, it can keep the old contract in place. Keeping the old contract in place is unattractive, because the team values Quarterback at less than what it would owe him. Suppose Team A tries to renegotiate with Quarterback while Team High still has an open quarterback slot. Quarterback will not want to renegotiate his contract: the only threat the team has is to terminate him, and then he can sign with Team High, which values him at $1.2 million. Alternatively, Team A can wait until late into the offseason. Once Team High fills its quarterback slot, Team A can propose renegotiation to Quarterback. If he is terminated now, the best the Quarterback can do is to sign with Team Low, which values him at $0.8 million. He is better off renegotiating with Team A to an amount lower than the $1 million in his contract, potentially down to an amount of $0.8 million.

This simple example demonstrates several important features of the NFL contracting environment. First, the timing of renegotiation during the offseason can affect both compensation of the parties and the efficiency of the match between players and teams. If Team A can only renegotiate early, it cannot bargain the player down. Furthermore, it has to release him from his contract and allow him to make his best match with Team High. If Team A renegotiates late in the offseason, it can use the timing of renegotiation strategically to hold-up the player and then renegotiate the contract to a lower compensation level and keep the player, thus preventing him from
matching with Team High, leading to inefficient matching.

We conjecture that NFL contracts contain the roster bonus so as to prevent this kind of hold-up by the team under contract, providing the team with incentives on the timing of renegotiation. Suppose that Quarterback’s contract with Team A still owes him $1 million but that $0.3 million is a roster bonus due “early” in the offseason, and the remainder comes due at the beginning of the season. Suppose, further, that Team A still wants to hold-up Quarterback, and wait until the team that values him highly fills the slot with someone else, and to renegotiate with him late in the offseason. Now suppose that it can renegotiate with Quarterback down to the valuation of Team Low, which is $0.8 million; at this point, that would be profitable, because Team A still values him at $0.95 million. However, in order to delay the renegotiation up to this point, Team A would already have had to pay the roster bonus of $0.3 million. Thus, the total compensation paid to Quarterback if Team A wants to renegotiate late is $1.1 million, which is more than his value to Team A, and more than the original contract stipulates. Therefore, Team A will not renegotiate with Quarterback late into the offseason, and it will not terminate Quarterback late in the offseason, because it has to pay a roster bonus to do so. Team A also will not want to preserve the contract because it promises Quarterback $1 million, which is more than his value to Team A. Therefore, it can either renegotiate with Quarterback early in the offseason, or terminate him early. Quarterback will not want to renegotiate the contract down from $1 million, knowing that Team High is valuing him at $1.2 million. Therefore, the only action Team A can take is to terminate Quarterback early in the offseason, at which point he will sign with Team High.

In this example, we demonstrate how the seemingly innocuous shift of compensation to the roster bonus can shape renegotiation. The only change from the earlier example was that we shifted $0.3 million of compensation from the end to the beginning of the offseason. This shift in compensation had no effect on the player’s incentives to play, nor did it reveal information about the player’s ability. Nevertheless, it affected the payoff to the player and the team, and reestablished efficient matching. In the next section we formalize this reasoning in our model.

4.2 Model

To keep the analysis transparent we focus on the simplest possible contracting problem: the player signs a contract in which production takes place only once, and before production there is only one offseason during which this initial contract can be renegotiated. In practice, at least one season has to pass before renegotiation concerns become important. We model this by incorporating shocks to player’s value between the time the contract was signed and when renegotiation concerns materialize. This model abstracts from other features of the NFL contract, such as contract length and backload. Because the NFL contract is an option contract on the player, it is easy to understand the first-order effects of those characteristics on contract value. We also abstract from the sorting in the market and use the presence of other teams as a reduced-form representation of the market sorting mechanism.
4.2.1 Setup

We model the contracting problem of one risk neutral player. The timeline of the model is divided into two stages: initial contracting stage and offseason. The initial contracting stage corresponds to a period during which the player is a free agent and can sign an initial contract with any team in the market. We model initial contracting mainly to obtain a closer link between the model and the data, which allows us to formulate empirical tests of the model and do not solve for the ex ante optimal contract. The offseason is when renegotiation concerns come into play: time has passed from the initial contract signing, teams have reevaluated their demand for the player, and the player’s ability has potentially changed. The player is bound by the contract he signed during the initial contracting season. Demand for player services drops in expectation during the offseason, giving rise to the strategic timing of renegotiation.

The contract the agent signs specifies a signing bonus \( b_s \), salary \( s \), and the roster bonus \( b_r \). A convenient way to express the contract is to define total annual payments as a sum of salary and roster bonus \( w = s + b_s \) and the roster bonuses share as \( y = \frac{b_r}{w} \). Therefore, the contract is a three-touple of \((b_s, w, y)\). When we take the predictions of the model to data, it is useful to impose restrictions in line with the institutional environment: the signing bonus must be positive, \( b_s \geq 0 \), the total compensation is bounded above and below, \( w \leq w_\bar{0} \), and the roster bonus must not be negative, implying \( y \in [0, 1] \).

There are two stages in the model: the initial contracting stage and the offseason. During the initial contracting stage there are \( m + 1 \) risk neutral teams in the market. Let \( z_k \) be the player’s output if he plays for team \( k \). Teams observe public signals of \( z_k \), \( \zeta_k = z_k + \epsilon_k \), where \( \epsilon_k \) are idiosyncratic shocks drawn from the same distribution. Let \( \zeta = (\zeta_0, \ldots, \zeta_m) \) be the vector of signals that all teams observe. Teams make take-it-or-leave-it contract offers to the player who can accept at most one contract. If the offers are ties, then we assume that the player chooses among the teams randomly with equal probability. As soon as he accepts the contract, the signing bonus \( b_s \) is paid.

During the offseason, there are two periods: the early period and the late period. At the beginning of the offseason teams learn the player’s productivity, \( z_k \), for all \( k \). Abusing notation, let \( z_0 \) be the value to the team which has the player under contract. Let subscripts 1 to \( m \) be the order of values of other teams with \( z_m \) representing highest alternative valuation and \( z_1 \) the lowest. Let \( z = (z_0, \ldots, z_m) \).

We model the evolution of demand during the offseason by changing the number of teams interested in filling their slot with the player. Early in the offseason all \( m \) teams, in addition to the team which has the player under contract, are interested in his services. Between the early and late period, \( m - n \) randomly drawn teams fill their slots because they want to make sure they have a player in that position.\(^{15}\)

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15The upper bounds are implied by the club salary cap, which sets a bound on the total compensation of players.
16One potential reason that teams are willing to sign a sub-optimal player before the end of the offseason may be congestion in the market for players. Roth and Xing (1997) show that if processing offers takes even a small amount of time, firms may make offers to sub-optimal players strategically.
Only \( n \) other teams are still interested in the player’s services. Let \( z'_1 \) be the team with the lowest valuation still interested in the player, and \( z'_n \) the highest valuation. \( z' = (z'_1, \ldots, z'_n) \)

At the beginning of each period, the team with the contract can make a take-it-or-leave-it offer of a new contract to the player. He can accept or reject the offer. If he accepts the new contract, the contract cannot be renegotiated or terminated again during this offseason; production takes place. If the player rejects the renegotiation, then team with the contract can decide whether to keep the old contract in place or terminate it. If the contract is kept in place after the early period, the team pays the player the roster bonus of the amount \( w \). If the contract is in place after the late even if all available players participate in the market. In the NFL, the processing time can be relatively long and entail medical clearance.
period, then the team also pays the salary $(1 - \gamma)w$. If the player’s contract with the team is terminated, then all other teams in the market make him simultaneous take-it-or-leave-it offers, and he can accept at most one offer. If the offers are ties, then we assume that the player chooses among the teams randomly with equal probability. After he accepts an offer, production takes place, and the value to the team is realized.

For simplicity, we assume that the player has no moral hazard, nor is there any specific investment taking place on the part of the player or the team. Instead, we assume that ex post teams are not allowed to collude in bargaining for players or to trade players for direct monetary transfers. While stark, these assumptions are approximations of the contracting restrictions arising from the Collective Bargaining Agreement and other frictions, all of which prevent efficient trades from taking place.

4.2.2 Equilibrium of the offseason subgame:

We approach the model through backwards induction. The following lemma characterizes the equilibrium of the late period subgame if the original contract is still in place by that point. At this point: $m - n$ teams have filled up slots that they could have used for the player.

Lemma 1 The equilibrium of the late period subgame is characterized by the following three cases:

1. If $\gamma > 1 - z_0/w$, the team keeps the contract in place.

2. If $\gamma \leq 1 - z_0/w$,

   (a) and $z_0 \leq z'_{n-1}$ team and player renegotiate the contract. The player receives $z'_{n-1}$.

   (b) and $z_0 \leq z'_{n-1}$ team terminates the contract. The player signs up with the team with the highest valuation and obtains $z'_{n-1}$.

The intuition for the lemma is the following. Late in the offseason the roster bonus is already sunk, so the team owes the player $(1 - \gamma)w$ if the contract stays in place. The team makes a profit from the old contract in the late period if $z_0 - (1 - \gamma)w > 0$, which we can rewrite as $\gamma > 1 - \frac{z_0}{w}$. If the contract is profitable, the team does not want to terminate it. The team cannot credibly renegotiate the contract with the player either. It would only propose renegotiation to decrease the player’s compensation. The player can always reject such renegotiation knowing that the team’s threat of terminating the contract is not credible: the team realizes a positive payoff from keeping the contract in place, but nothing if the contract is terminated. The larger the share of compensation that is paid in roster bonuses, the “cheaper” the player is in the late period, and the more likely the contract is to stay in place.

If the current contract is terminated in the late period, the player is paid his second highest valuation in the market $z'_{n-1}$. The team cannot renegotiate the contract with the player if the player can obtain more in termination, which is the case if the second highest valuation in the market is higher than the valuation of the incumbent team, $z_0 \leq z'_{n-1}$.
This lemma also partially demonstrates the role of the roster bonus. If the roster bonus is high enough, it commits the team not to renegotiate or terminate the contract in the late period, since at that point the roster bonus is sunk and the surplus from keeping the contract is too large.

We can now turn to the early period when the team valuations for the player are realized, all the teams still have slots for the player, and the roster bonus has not been paid yet. The following lemma characterizes the equilibrium of the early period subgame.

**Lemma 2** The equilibrium of the early period subgame is characterized by the following cases:

1. If \( \gamma > 1 - \frac{z_0}{w} \)
   
   (a) Contract stays in place if \( w \leq z_0 \).
   
   (b) Contract is renegotiated if \( w > z_0 \) and \( z_0 > z_{m-1} \). Player obtains \( z_{m-1} \).
   
   (c) Contract is terminated if \( w > z_0 \) and \( z_0 \leq z_{m-1} \). The player signs up with the team with the highest valuation and obtains \( z_{m-1} \).

2. If \( \gamma \leq 1 - \frac{z_0}{w} \)
   
   (a) Contract stays in place if \( \gamma \leq \frac{E\left(1_{z_0 > \gamma_{n-1} (z_0 - \gamma_{n-1})} \right)}{w} \).
   
   (b) Contract is renegotiated if \( \gamma > \frac{E\left(1_{z_0 > \gamma_{n-1} (z_0 - \gamma_{n-1})} \right)}{w} \) and \( z_0 > z_{m-1} \).
   
   (c) Contract is terminated if \( \gamma > \frac{E\left(1_{z_0 > \gamma_{n-1} (z_0 - \gamma_{n-1})} \right)}{w} \) and \( z_0 \leq z_{m-1} \).

The intuition for this lemma comes from the team’s trade-off between the roster bonus, \( \gamma w \) and the expected profits of keeping the contract in place until late into the offseason. This structure of the late period payoffs from Lemma 1 simplifies the computation of the expected profits from keeping the contact in place.

We can focus on two major cases, corresponding to conditions 1 and 2 in Lemma 1. In condition 1, when \( \gamma > 1 - \frac{z_0}{w} \), the contract is kept in place in the late period, should it survives into the late period. If the contract is kept in place in the early period its total cost to the team is then the roster bonus \( \gamma w \) and the salary \( (1 - \gamma) w \). The team keeps the contract only if it is profitable—that is if \( z_0 - \gamma w - (1 - \gamma) w \geq 0 \), i.e., if \( w \leq z_0 \). Otherwise, the contract is terminated or renegotiated in the early period. If the contract is terminated in the early period, the player is paid his second highest valuation in the market \( z_{m-1} \). The team cannot renegotiate the contract with the player if the player can obtain more in termination, which is the case if the second highest valuation in the market is higher than the valuation of the incumbent team, \( z_0 \leq z_{m-1} \).
In condition 2, when $\gamma \leq 1 \frac{z_0}{w}$, Lemma 1 implies that in this case contract will be renegotiated or otherwise terminated in the late period if it is still in place at that point. It is first useful to characterize the expected profits from keeping the contract in place. The realized payoff from waiting depends on which teams still have slots in the late period, on the realization of $z'$. Given $z'$, the team’s realized payoff from waiting is the surplus it can extract in renegotiation, $(z_0 - z_{n-1}')$, conditional on renegotiation being profitable, $1_{z_0 > z_{n-1}'}$. The realized profit of waiting, given $z'$ is $1_{z_0 > z_{n-1}'} (z_0 - z_{n-1}')$. The expected profit is the expectation of realized profits over all possible configuration of teams in the late period, given the valuations of teams in the early period, $z$, which we write as $E \left( 1_{z_0 > z_{n-1}'} (z_0 - z_{n-1}') \right)$. If the roster bonus is higher than the expected profits, $\gamma w > E \left( 1_{z_0 > z_{n-1}'} (z_0 - z_{n-1}') \right)$, the contract will be terminated or renegotiated in the early period. As before, the second highest valuation in the market provides the threshold between renegotiation and termination.

4.2.3 Termination and Matching Efficiency

Once we have characterized the equilibrium of the offseason subgame, we can examine how changing the share of compensation paid in roster bonuses affects the matching efficiency between the player and teams. Termination results in the player matching with another team. In the absence of the ex post bargaining friction specified above, the first best player allocation is to the team that values him highest early in the offseason. The team terminates the player’s contract if there is another team that values the player’s services in the early period, if $z_0 < z_m$.

We can summarize the termination decisions and their welfare consequences in our model in the following proposition:

**Proposition 3** Teams terminate players under contract too infrequently relative to the first best. Increasing the share of compensation paid in roster bonuses, $\gamma$, weakly increases contract termination holding the level of annual compensation $w$ and player valuation $z$ fixed. Contracts with a higher roster bonus share, $\gamma$, are more likely terminated in the early period rather than the late period. This increase in termination increases the efficiency of ex post matching between the player and teams.

From Lemma 2 note that the necessary condition for the team to terminate a player’s contract in the offseason subgame is $w > z_0$. In addition we can summarize the termination from Lemma 1 and Lemma 2 by the cutoff for the roster bonus share:

- Terminate in the early period if $\gamma > \min \left( 1 - \frac{z_n}{w}, \frac{E \left( 1_{z_0 > z_{n-1}'} (z_0 - z_{n-1}') \right)}{w} \right)$ and $z_0 \leq z_{m-1}$

\[17\] There is also the degenerate condition when the contract is terminated in the early period if $z_0 \leq z_{m-n-1}$. 

16
- Terminate in the late period if \( \gamma \leq \min \left( 1 - \frac{z_0}{w}, \frac{E \left( 1_{z_0 > z_{m+1}} \frac{(z_0 - z_{m+1})}{w} \right)}{w} \right) \) and 
\[ z_0 \leq z_{n-1} \]

When the roster bonus share is low, \( \gamma \leq \min \left( 1 - \frac{z_0}{w}, \frac{E \left( 1_{z_0 > z_{m+1}} \frac{(z_0 - z_{m+1})}{w} \right)}{w} \right) \) the team has an incentive to pay the roster bonus \( \gamma w \) and wait late into the offseason, hoping that the teams that value the player highly fill up their slots in the meantime. The team then can renegotiate the player to the second highest valuation of the n teams remaining, to \( z'_{n-1} \). This is where the ex post bargaining friction comes into play: if the high value teams could pay the incumbent team to terminate the player early, the allocation of players to teams would be closer to first best.

A higher roster bonus partially alleviates the bargaining friction by making it unprofitable for the team to wait late into the offseason. It decreases the surplus from potential renegotiation, since the player is only owed the remainder of his annual payment \((1 - \gamma) w\). In addition, the team has to pay the player the roster bonus simply to obtain this less valuable renegotiation opportunity. This forces the team to renegotiate or terminate the contract early in the offseason, when all \( m \) teams still have slots and terminate the player when \( z_0 \leq z_{m-1} \). Since \( z'_{m-1} \leq z_{m-1} \leq z_m \), contracts with higher roster bonuses are terminated more frequently and match players to teams more efficiently.

**Corollary 4** Players who are terminated late in the offseason sign contracts following termination that are less valuable, in expectations, than contracts signed by players who are terminated early in the offseason.

The corollary follows directly from Proposition 3. Players who are terminated early in the offseason earn \( z_{m-1} \), and the players who are terminated late in the offseason earn \( z'_{n-1} \leq z_{m-1} \).

### 4.2.4 Player Compensation:

**Proposition 5** Conditional on total annual payments, \( w \), and for any realization of productivity, \( z \), the expected value of the contract to the player at the beginning of the offseason is weakly increasing in the roster bonus share, \( \gamma \).

From Lemma 1 and 2 we know that if \( w < z_0 \), then the contract stays in place and player earns \( w \). The only situation in which roster bonus can affect compensation then is when \( w \leq z_0 \).

We need to analyze the cases:

1. \( \gamma \) increases in the region where \( \gamma > \min \left( 1 - \frac{z_0}{w}, \frac{E \left( 1_{z_0 > z_{m+1}} \frac{(z_0 - z_{m+1})}{w} \right)}{w} \right) \).

The team terminates or renegotiates the player’s contract early, and the player obtains \( z_{m-1} \). In that region, the player’s compensation is independent of \( \gamma \).
2. $\gamma$ increases in the region where $\gamma \leq \min \left(1 - \frac{z_0}{w}, \frac{E\left(I_{z_0 > z_{n-1}}(z_0 - z_{n-1})|z\right)}{w}\right)$.

The team keeps the contract in the early period, and renegotiates or terminates the contract in the late period. The player’s compensation is $\gamma w + E\left(z_{n-1}^r|z\right)$. In this region, the expected compensation is strictly increasing in $\gamma$.

3. $\gamma$ increases across the threshold of $\min \left(1 - \frac{z_0}{w}, \frac{E\left(I_{z_0 > z_{n-1}}(z_0 - z_{n-1})|z\right)}{w}\right)$. Above the threshold the player’s compensation is $z_{m-1}$, and below it is $\gamma w + E\left(z_{n-1}^r|z\right)$. For the team to be willing to keep the contract, the expected benefit of waiting to the late period must exceed the roster bonus, $\gamma w \leq E\left(I_{z_0 > z_{n-1}}(z_0 - z_{n-1})|z\right)$. But the benefit of waiting for the team is bounded by the largest possible surplus it can extract from the player by waiting $z_{m-1} - E\left(z_{n-1}^r|z\right)$. Therefore, $\gamma w \leq z_{m-1} - E\left(z_{n-1}^r|z\right)$, or alternatively $z_{m-1} \geq \gamma w + E\left(z_{n-1}^r|z\right)$. The player’s expected compensation is weakly increasing as the roster bonus share crosses the threshold.

4.2.5 Initial Contracting Stage, the Signing Bonus:

The purpose of this subsection is to obtain a closer link between the model and the data and derive the equations that will serve as a basis of our empirical tests. To do that we only need to describe the trade-off between the roster bonus share $\gamma$ and the signing bonus $b_s$ that the team which will sign the player faces, and do not solve for the optimal contract.

Since all $m$ teams make simultaneous take it or leave it offers, the winning bid must offer the player weakly higher expected compensation than the second most profitable contract. The player values the contract he accepts as the signing bonus plus the expected payments he receives from this contract in the future, given the signal of his quality, $\zeta$, $b_s + E_\zeta U(w, \gamma, z)$. Let $\bar{U}$ be the expected payoff the player receives from accepting the second most valuable contract; then

$$b_s + E_\zeta U(w, \gamma, z) \geq \bar{U}$$  \hspace{1cm} (1)

In fact, if $b_s$, $w$ and $\gamma$ were unrestricted, the equality would bind. Because the choice of signing bonus is non-negative and $w$ and $\gamma$ are constrained, we can rewrite the condition as

$$b_s = \max \left(0, \bar{U} - E_\zeta U(w, \gamma, z)\right)$$  \hspace{1cm} (2)

This equation serves as a basis of empirical tests in the next section. It shows us that there is a trade-off between the signing bonus and the other contracting terms. If, for example, the roster bonus share increases the ex post value of the contract, this will be reflected in a smaller signing bonus in the contract. More formally, suppose we have two contracts, $(b_{s1}, w, \gamma_1)$ and $(b_{s2}, w, \gamma_2)$, which have the same annual payments $w$, for the same player with team valuations of $z$, but the roster bonus represents a different share of these contracts: $\gamma_1 < \gamma_2$. The differences in signing
bonuses between these two contracts represent the lower bound on the magnitude of the difference in the value these contracts have ex post:

$$0 \leq -(b_{1} - b_{2}) \leq E_{Z}U(w, \gamma_{1}, z) - E_{Z}U(w, \gamma_{2}, z)$$ (3)

Proposition 5 suggests that increasing the roster bonus share increases the players contract valuation, holding the total annual payments $w$ and team valuations $z$ fixed, so this difference will be non-negative. An alternative way this comparative static will be reflected in the data is through a negative correlation between the signing bonus and roster bonus share, holding $w$ and $z$ fixed:

$$\frac{\partial b_{r}}{\partial \gamma} \leq - \frac{\partial E_{Z}U(w, \gamma, z)}{\partial \gamma} \leq 0$$ (4)

Equations 2 and 4 form the basis for one of our main empirical tests.

### 4.3 Empirical Predictions:

In this subsection we summarize the empirical predictions that are supplied by our model and that we will take to the data:

- **Prediction 1 (Proposition 3):** Timing of termination and renegotiation
  
  A contract is more likely to be terminated or renegotiated before roster bonuses are due if it contains a roster bonus for that offseason, holding player ability, $z$, and total annual payments, $w$, equal.

- **Prediction 2 (Equation 4):** Value of roster bonus share
  
  Contracts with a higher roster bonus share $\gamma$ have weakly lower signing bonuses, holding holding player ability, $z$, and total annual payments, $w$, equal.

- **Prediction 3 (Corollary 4):** Timing of termination and value of subsequent contract
  
  Players who are terminated earlier in the offseason obtain a more valuable contract than players who were terminated late in the offseason, holding player ability, $z$, fixed.

- **Prediction 4 (Proposition 3):** Termination and matching efficiency
  
  A contract with a higher roster bonus share is more likely to be terminated holding player ability, $z$, and total annual payments, $w$, equal.

### 5 Results

#### 5.1 Prediction 1: Timing of termination and renegotiation during the offseason

Our model suggests that when a player’s contract specifies compensation in roster bonuses instead of salary, the team has an incentive to renegotiate or terminate the contract before the roster bonus is due. To test this prediction, we first estimate the hazard rate of termination during the offseason for contracts that had a roster bonus that season. We show that the hazard rate is related to the timing of roster bonuses. We then repeat this test for timing of renegotiation. Because meaningful renegotiation and termination can only happen after the first season, we focus on off-season after the first year of the contract.
Figure 2.a plots the daily hazard rate of termination during the offseason for players with roster bonuses. The first indication that roster bonuses are related to the timing of termination is that the hazard of termination peaks before March 1st and around June 1st, which is when most roster bonuses are due. Of course, these two peaks in the hazard distribution could simply be generated by the heterogeneity in players or by contract characteristics other than roster bonuses. Therefore, we want to determine the termination hazard of a contract with a roster bonus during the offseason, controlling for player and contract characteristics. We estimate a competing hazards Cox model in which the contract can be terminated, renegotiated, or stay in place. We control for all contract characteristics—average annual pay, contract length,\(^{18}\) contract backload and roster bonus share in future seasons—as well as for several player characteristics, including players’ tenure and a battery of player performance characteristics.\(^{19}\) Figure 2.b presents the estimated baseline hazard of players’ termination. The results mirror the results without controls: the two peaks of the termination hazard do not change. The shape of the hazard function is preserved under alternative permutations of included controls, which we do not report in the paper. These results suggest that if teams terminate players with roster bonuses, they do so before the roster bonuses come due.

The model also suggests that roster bonuses, in addition to affecting the timing of termination, should affect the timing of renegotiation. Roster bonuses commit the team to paying the player for the right to renegotiate late. This gives the team an incentive to renegotiate earlier. Figure 2.c presents the hazard rate of renegotiation during the offseason for contracts with roster bonuses. It, too, has two peaks: the first is before March 1st and the second is after June 1st. The hazard of renegotiation seems to peak slightly later than the hazard of termination, which may be because we code renegotiations only when the new, renegotiated contract is filed with the league. As with the hazard of termination, there is a concern that the high renegotiation hazard rate around March 1st and June 1st could be a result of players with different characteristics matching in the market with teams over time. We again estimate a competing hazards Cox model and obtain the baseline hazard of renegotiation, which we present in Figure 2.d. The peaks around March 1st and June 1st persist, even after controlling for contract and player characteristics. This suggests that if contracts with roster bonuses are renegotiated, they are generally renegotiated before those bonuses are due.

The hazard data on contract termination and renegotiation is consistent with Prediction 1: teams respond to the timing incentives provided by the roster bonuses. If the team is going to terminate a contract with a roster bonus, then it has strong incentives to do so before the roster bonus is due. Furthermore, if it wants to renegotiate with a player later in the offseason, it has to pay the roster bonus, thus providing

\(^{18}\)Of course, we control for contract characteristics that have not already been sunk and will govern the future relationship between the player and the team. For example, if there are two years left on a four-year contract, then we control for the contract characteristics of the two relevant years, not the first two years which have already passed and therefore are sunk from the perspective of the team and player.

\(^{19}\)We control for the percentage of team plays that the player participated in last season, the percentage of games he started, and any awards he could have won.
incentives to renegotiate earlier in the offseason.

5.2 Prediction 2: Signing bonus and roster bonus share

The results from the previous section support our prediction that roster bonuses are placed in contracts to shape the timing of contract renegotiation. However, these results do not tell us whether shaping future renegotiation is economically an important part of NFL contracts. Proposition 5 states that if we compare two contracts with the same combined level of salaries \( s \), and roster bonuses, \( b_r \), then the contract with the larger share of compensation paid in roster bonuses, \( \gamma = \frac{b_r}{b_r + s} \), is less profitable for the team and more beneficial to the player. From Equation 3 we can estimate the lower bound of this difference in contract values from the difference in signing bonuses of these contracts. The difference in values is a consequence of the larger roster bonus share mitigating the hold-up of players by teams through shaping future renegotiation. An economically large difference in signing bonuses implies that shaping future renegotiation is an important part of NFL contracts. We now examine this prediction, first through descriptive statistics and then estimate it by using a tobit.

5.2.1 Descriptive Statistics

From descriptive statistics in Table 1 we know that the roster bonus share and the signing bonus are positively correlated, which is inconsistent with our prediction. This positive correlation should not be surprising, because better players obtain contracts with larger shares of roster bonuses and also obtain larger signing bonuses. In our comparative statics in Equation 3, we shift compensation between roster bonuses and salaries and keep their total amount constant. To approximate that test in descriptive statistics, we form subsets based on the quartiles of average annual compensation (average annual salary and roster bonus combined). Figure 3.a shows the comparison of average signing bonuses for contracts with and without a roster bonus in different compensation-based subsamples. Even such crude conditioning on compensation begins to present a picture that is more consistent with Equation 3. In each of the top three quartiles of compensation, the average signing bonus is lower in contracts with a roster bonus on average than in the contracts without roster bonuses.

We cut the data finer by dividing each of our subsamples based on average annual compensation into subsets based on other contract characteristics and player ability. In Figure 3.b, we sort players further into 25-percentage-point subsets by the percentage of the team plays they participated in last year. Even in these smaller subsamples, the contracts with a roster bonus on average have a lower signing bonus than the contracts without a roster bonus. Again, the one notable exception is in the lowest quartile of compensation, although the positive correlation there is restricted to players who participated in 75 to 100 percent of their team’s plays in a season.

Rather than cutting the compensation subsamples by ability, we can cut them on other contract characteristics. In Figure 3.c we cut the compensation subsamples by contract length. We include only contracts shorter than six years; for longer contracts, the subsamples are very small. Two facts are worth noting. First, this cut of the data supports Equation 3: the average signing bonus is lower in contracts
without roster bonuses in three out of twenty subsamples, and in those subsamples the difference is small. Second, unlike in the previous figures, all subsamples in the lowest average compensation quartile show results consistent with Equation 3. This suggests that the anomaly in the previous two figures is driven by heterogeneity of contract length.

A similar picture emerges if we cut the compensation subsamples by contract backload. Again, only two out of sixteen subsamples are inconsistent with Prediction 2, and they are in the quartile with the lowest average compensation. These descriptive statistics suggest that, consistent with Prediction 2, contracts where some compensation is paid in roster bonuses instead of salaries are less valuable for the team and more valuable for the player, so these players obtain lower ex ante signing bonuses for their contracts, all else equal.

5.2.2 Tobit estimation

The descriptive statistics provide suggestive evidence supporting Prediction 2: contracts in which a share of compensation is paid in roster bonuses instead of salary have lower signing bonuses. We test Prediction 2 more rigorously by estimating the amount of signing bonus the player has to forgo in order to shift a certain percentage of his compensation from salary to roster bonuses, keeping the total amount of roster bonuses and salaries constant. We use tobit specifications as our empirical analog to Equation (2), which adjust for the fact that signing bonuses cannot be negative. While we only present linear specifications of the tobit, the results are robust to non-linear specifications as well.20

The specification of the tobit takes the following general form, where we vary player ability measures across specifications:

\[
Signing\ bonus_i = \max \left(0, \frac{\alpha + \beta_1 \text{bonus share}_i + \beta_2 \text{average annual compensation}_i + \Gamma_1 \text{contract characteristics}_i + \Gamma_2 \text{player ability}_i + \epsilon_i}{+} \right)
\]

In the specification, the dependent variable is the signing bonus the player receives upon signing the contract. The independent variable of interest is the roster bonus share, the share of contracted annual compensation (salary and roster bonuses) that is paid out as roster bonuses. We also control for the level of average annual compensation, so that an increase in the roster bonus share corresponds to replacing contracted payments in salary with roster bonuses.

The tobit specifications support Prediction 2: the share of compensation that is paid in roster bonuses rather than salary is correlated with a lower signing bonus. In the basic specification we only control for contract characteristics, not for any player ability proxies. In addition to average annual pay, we control for contract length and the degree to which contract payments are back loaded. The results, presented in Table 2, are consistent with Prediction 2: roster bonus share has a negative and statistically significant coefficient of $-1.92$ million. A single standard deviation change in the roster bonus share means that 13.6 percentage points more of the annual compensation is to be paid in roster bonuses instead of salary. This change in the share of compensation specified as roster bonuses is correlated with a $260$ thousand average decrease in signing bonuses. This amount suggests that the timing

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20The results can be obtained from the author upon request.
of payments during the offseason is a quantitatively import aspect of NFL contracts through its effect on future renegotiation.

The negative trade-off between roster bonus share and signing bonus in Prediction 2 is conditional on holding player ability fixed. From Table 1 we know that higher ability players obtain contracts with higher roster bonus shares and higher signing bonuses. To condition on players’ ability in our specification we include our main measure of ability, the percentage of their team’s plays in which they participated in the last season. Our second ability measure is the percentage of games the player started during the last year. We further condition on a set of 16 awards, ranging from making the All Pro team to being named Player of the Week. We experimented with numerous other observable ability measures in unreported results, and they had no qualitative or quantitative effect on our results. Similarly, different positions in the NFL are compensated differently, potentially driving our results. We therefore include in our specification dummies for the player position and condition for player experience based on the number of years since the player entered the NFL. The coefficient on bonus share is negative and statistically significant. Moreover, the coefficient has a larger economic magnitude, $-2.24 million, once we control for measures of player ability.

Teams’ demands for player and contract characteristics may also differ, potentially affecting our results. A potential source of these differences is the NFL salary cap, which constrains the annual accounting costs of players’ contracts for a team. Moreover, the returns from winning may differ across teams. Teams may prefer winning the Super Bowl once to being a mediocre team for a decade. It is difficult to pin down how these concerns might affect the trade-off between the roster bonus share and the signing bonus that we test in Prediction 2. Nevertheless, it is conceivable that this heterogeneity may be correlated both with a team’s willingness to pay for a player’s services and with the use of roster bonuses. We control for these concerns by including team-contract year dummies in our specifications and present the results in Table 2. We restrict our attention to the subsample of contracts signed between 1999 and 2002 in order to have enough observations for each team and year pair for maximum likelihood to converge. The coefficient on roster bonus share is somewhat smaller than in previous specifications, but still economically large and statistically significant at $1.94 million. We present additional robustness checks in Appendix A.

While we control for a battery of proxies for player ability, we cannot rule out the possibility that there is a dimension of player ability that teams and players observe that is not captured by our data and is negatively correlated with roster bonus share. One potential test of whether an unobserved dimension of player ability drives our results is to look at future player performance. Teams and players would care about unobservable ability because it is informative about players’ future performance. If unobserved ability does translate into future player performance, which we can observe, then we can use a player’s future performance as a signal of the team’s information that is not contained in the player’s ability we control for in our specifications.

We re-estimate the trade-off between the signing bonus and the roster bonus
share, using the tobit specification described above but also controlling for future player performance. In column 4 we condition on measures of player’s performance in the year after signing his contract. The coefficient on the share of plays in the future is positive and significant, suggesting that teams indeed have information about player ability that is not captured by a player’s past ability and contract characteristics. This ability dimension, however, does not appear to be correlated in any way with roster bonus share that is not already captured by our ability measures. The coefficient on roster bonus is virtually unchanged in magnitude and statistical significance from the coefficient in column 2, which has the same specification without the future values: the coefficient drops from $2,241 to $2,226.

In column 5 we include the player’s performance during the two seasons after the contract was signed. Again, these do not affect the magnitude or the statistical significance of the results. Furthermore, the measures of performance in the second year after contract signing does not contain much information on player ability: F-tests reject their joint significance in the specifications. We further address the issue of unobservable player quality in Section 6.

5.3 Prediction 3: Contracts of previously terminated players

In the last subsection, we tried to infer whether shaping future renegotiation is an economically important concern in NFL contracts. In this subsection, we test our conjecture that players who are terminated later in the offseason sign less valuable contracts as predicted by Corollary 4. Intuitively, these players are terminated later in the offseason and therefore sign with teams, which are in expectation a worse match. In addition, their outside option in negotiations is declining as well. If we compare two contracts with equal average payments, roster bonus share, length and backload for a player of the same ability, then the decrease in value from late termination has to be captured by the signing bonus.

To implement this test, we again estimate a tobit specification, but we restrict it to the subsample of players whose previous contract was terminated.

\[ \text{Signing bonus}_i = \max \left( 0, \beta_1 \text{bonus share}_i + \beta_2 \text{average annual compensation}_i + \right) \\
\alpha + \beta_0 \text{day of termination} + \Gamma_1 \text{contract characteristics}_i + \Gamma_2 \text{player ability}_i + \epsilon_i \]

The dependent variable is again the signing bonus, and the independent variable of interest is the number of days that have passed between the beginning of the offseason and the time the player’s previous contract was terminated. The results are presented in Table 3. The coefficient on day of termination ranges from $-1,812 to $-2,487 for different specifications of controls. Under the most conservative estimate, for each day later in the offseason that the player is terminated, his signing bonus in the new contract will be $1,812 lower, holding his ability and the characteristics of contracts fixed. A player who is terminated at the end of the offseason rather than the beginning is terminated approximately 180 days later, amounting to a loss of $325 thousand dollars. That is the upper bound of the possible loss for the player under this specification. If the player is terminated at the end of the offseason, rather than before the second round of roster bonuses that are due on June 1, then the loss shrinks
by approximately half, or $160 thousand. These results are consistent with players’ matching opportunities with other teams declining over the offseason, giving teams in the NFL substantial potential to hold-up the player.

A possible concern is that even though we are controlling for numerous observable player characteristics, the players who are terminated may be worse on some unobservable ability dimension. If such unobservable ability matters, it is because it is informative about a player’s future performance. As in the previous subsection, we re-estimate the tobit model conditioning on future player performance. We include as a control the share of plays the player participated in, the share of games he started, and the awards he won in the season after the contract was signed. Again, the magnitudes of the coefficients are very close to those estimated in columns 1 and 2, which estimates similar specifications without the future performance measures. We further address the issue of unobservable player quality in Section 6.

5.4 Prediction 4: Termination and Matching efficiency

In this subsection we test Prediction 4: contracts in which a higher share of annual compensation is paid in roster bonuses have a higher probability of termination. This is especially interesting given that roster bonuses are unconditionally given to better players. Furthermore, players have to forgo some signing bonus in order to shift compensation from salaries to roster bonuses. In other words, our model predicts that players are willing to forgo some signing bonus to obtain contracts that are more likely to be terminated. Proposition 3 also shows that this increased termination translates to increased ex post matching efficiency of teams and players.

Table 4 presents the logit model of the probability that a contract will be terminated at some point during its lifetime, given contract and player characteristics. The coefficient of the marginal effects of the roster bonus share range from 15.5 to 16.9 percentage points. This means that a single standard deviation increase in the share of compensation paid early in the offseason rather than late is correlated with a 2 percentage point increase in the probability that a contract will be terminated during its lifetime. Given that 13 percent of contracts are terminated in our sample, this represents a substantial increase in contract termination.

One potential problem is that even though contracts with roster bonuses are terminated more frequently, they may be terminated later in their lifetime. For example, a five-year contract with a roster bonus may have a higher probability of termination overall, but it generally gets terminated in year four. On the other hand, a five-year contract without roster bonuses has a lower probability of termination, but conditional on termination it is likely to be terminated in year two. This suggests that contracts without roster bonuses lead to more re-matching between players and teams even though they are terminated less frequently. Furthermore, our sample ends in the 2002 - 3 season, which means that we do not observe the potential termination of contracts whose duration exceeded that year which were not terminated earlier. This censoring problem also could affect our estimation of termination probabilities.

To address these concerns we estimate the probability of contract termination during a given offseason. Columns 3 and 4 presents a logit model of the probability that a contract will be terminated at some point during a given offseason as a function
of the share of compensation represented by the roster bonus in that offseason. In the specifications we also control for contract and player characteristics. Because one contract now potentially generates several observations in our data we cluster the standard errors on contract. The coefficients are statistically significant and economically sizeable: a single standard deviation increase in the roster bonus share is correlated with a 1 percentage point increase in the probability that a contract will be terminated during a given offseason. The results are consistent with the predictions from our model that higher roster bonus share leads to higher contract termination. Furthermore, our model implies that this increase in termination leads to more efficient ex post matching between players and teams.

In our estimates we are controlling for several player characteristics. Nevertheless, an alternative explanation is that players with roster bonuses are worse on an unobservable dimension, which increases their probability of termination. We address these concerns in the next section.

6 Unobservable player quality

6.1 Unobservable player quality

In this subsection we discuss the alternative: that our results are driven by an unobserved dimension of player quality, which generates the correlations in our data. There are two reasons why this alternative explanation is implausible. First are our tests which use future player performance to proxy for unobserved ability. For unobserved quality to explain our results, it must make the player more valuable. In Table 2 and Table 3, we show that the coefficient on roster bonus share does not change when we control for future player quality. Therefore, the unobservable quality must be correlated with future performance of the player, that our data on future performance does not measure. While we think that such a dimension of quality is not very plausible, we cannot reject it outright.

Second, while unobservable quality might explain each of our results separately, the same type of unobservable quality cannot reconcile all of our results simultaneously. To explain the negative correlation between the signing bonus and the roster bonus share from Prediction 2, this dimension of quality must be negatively correlated with roster bonus share. Since players with roster bonuses are terminated early in the offseason, that implies that players who are terminated early in the offseason have low unobservable ability. Therefore, they should be compensated less in their new contract. This is inconsistent with our results on Prediction 3, which instead show that players terminated early in the offseason obtain higher compensation for the same observed contract and ability bundle. Therefore, to explain the results from Prediction 2 and Prediction 3 simultaneously, we require two dimensions of unobservable quality: one, which is negatively correlated with roster bonuses to explain Prediction 2 and one, which is positively correlated with roster bonuses to explain Prediction 3.
7 Conclusion

We use labor contracts in a large industry, the NFL, as a unique laboratory for exploring contracting in a world with ex post bargaining frictions. We use a model based on the institutional details of contracting in the NFL to show how teams can hold-up players through the timing of renegotiation, which leads to inefficient ex post matching. We then demonstrate that a seemingly innocuous contracting detail can mitigate the hold-up problem. We test the empirical predictions of the model and show that they are supported in the data. We find that hold-up and renegotiation concerns play a quantitatively large role in NFL contracts. We also show that altering the incentives for renegotiation thorough the timing of payments increases the efficiency of player allocation to teams though increased contract termination, which we observe in the data.

To conclude, we want to highlight some issues that are beyond the scope of this paper. We have treated market thickness for player’s skills as exogenous in this paper, which is a reasonable assumption if we focus only on the problem of a single player. If a player’s contract has a larger share of compensation in roster bonus, this will increase liquidity in the market for players in the early part of the offseason and decrease it in the later part of the offseason. Thus, from the perspective of a social planner or market designer, market thickness or liquidity in the market for players is endogenous to the contracting structure. Is it possible that restricting the design of future renegotiation, such as banning roster bonuses, or mandating that a share of compensation always be paid in roster bonuses, would be welfare improving.

We also did not address the question of whether roster bonuses are a second best solution to the contracting problem. One could imagine that there is a schedule of payments a team can promise to a player whereby incremental payments are due each day. Therefore, it is a puzzle why most roster bonuses are due on a single day, and that day is similar across teams, generally March 1 and June 1. While this could simply be an inefficient institutional norm, we speculate that the coordination is an equilibrium result that arises because of endogenous market thickness and liquidity.

References

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Nielsen. 2010. “Super Bowl XLIV most watched Super Bowl of all time.” Web page, [accessed 5 March, 20010]. Available at
http://blog.nielsen.com/nielsenwire/entertainment/super bowl xli v most watched super bowl of all time/.


7.1 Appendix A: Robustness (Not for publication)

7.1.1 Omitted Contract Characteristics

In our specifications we include the most common characteristics of the NFL contract, and we omit incentives and other clauses from our estimation. To partially alleviate concerns about this, we can use the “total contract amount” which the NFL records for salary cap accounting purposes. The total contract amount adds all payments specified in the contract, such as salaries, bonuses and incentive schemes. If the payments are contingent on performance, the NFL evaluates if the players are likely to earn these incentive payments and adds these to the total contract amount. We construct our proxy for omitted contract characteristics by subtracting from the total contract amount the value of the payments that we use in our specifications. This approximates the level of payments in the contract that is not captured by our specifications. In addition to the level of payments we create an additional proxy, which computes the share these uncoded payments in the total contract amount. Table A1 re-estimates the tobit specification of Table 2: the trade-off between the signing bonus and the roster bonus but includes our proxies for uncoded payments. We can see that the proxies for omitted contract characteristics are not statistically significant, suggesting that our data captures the first-order contract characteristics. In addition, the coefficient on the bonus share is practically unchanged from the specifications in Table 2.

7.1.2 Contracts of veteran players

The Collective Bargaining Agreement specifies that contracts of veteran players completely guarantee compensation after the first game of the season. This is not the case for players who have been in the league less than five seasons. If those newer players were terminated during the offseason, the team would not have to pay them the full compensation for the year. In unreported results, we re-estimate all specifications in the paper on the subsample of 793 players who had been in the NFL for at least five years. If anything, our results are more statistically significant and have similar quantitative magnitudes.

7.1.3 How much variance in signing bonus is explained by observables?

Because all of our results come from non-linear estimators, it is difficult to see how much variation in the signing bonus is explained by the variation in observable contract and player characteristics. In unreported results, we therefore estimate the OLS version of our tobit specification from subsection 5.2.2.

\[ \text{Signing bonus}_i = \alpha + \beta_1 \text{bonus share}_i + \beta_2 \text{average annual compensation}_i + \gamma_1 \text{contract characteristics}_i + \gamma_2 \text{player ability} + \epsilon_i \]

In all of our OLS specifications, the coefficient on bonus share is negative and highly statistically significant. The OLS counterpart of the specification in Table 2, column 2 has an R-squared of 50 percent, despite not accounting for the censoring of signing bonuses at 0 and all terms entering linearly. The OLS counterpart of

\[^{22}\text{The results can be obtained from the author upon request.}\]
the specification in Table 2, column 3, which includes team-year fixed effects, increases the R-squared to 57 percent. If we include second-order polynomial terms for contract characteristics and the number of plays the player participated in, we can increase the R-squared to over 65 percent without affecting the coefficient on roster bonus very much.
Figure 2

Figure 2.a
Hazard of termination for players with roster bonuses during offseason

Figure 2.b
Hazard of termination for players with roster bonuses during offseason controlling for contract and player characteristics

Figure 2.c
Hazard of renegotiation for players with roster bonuses during offseason

Figure 2.d
Hazard of renegotiation for players with roster bonuses during offseason controlling for contract and player characteristics
The subsamples are formed on quartile of average annual compensation.

The subsamples are first formed on quartile of average annual compensation and then on share of plays the player participated in.

The subsamples are first formed on quartile of average annual compensation and then on contract length.

The subsamples are first formed on quartile of average annual compensation and then on quartile of contract back load.
Table 1

The sample contains 1,428 NFL contracts. Panel B contains the subsample of 638 NFL contracts, which have a positive roster bonus. Panel C contains the subsample of 790 NFL contracts, which do not have a roster. Average Annual Pay is the average of annual contracted payments except the signing bonus: the P5 salary, the roster bonus and reporting bonus (exempting the signing bonus). Years in contract is the number of years the contract is signed for. Contract backload is the gini coefficient of the annual contracted payments: the P5 salary, the roster bonus and reporting bonus (exempting the signing bonus). Player tenure is the year of the contract minus the year the player entered the league. Plays last year is calculated as the maximum of the share of defensive, offensive or special team plays of the team the player participated in the previous year.

Panel A: Full Sample

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Panel B: Contracts with a positive roster bonus

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Panel C: Contracts with no roster bonus

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Table 2

The specification is a tobit with censoring at 0. The sample contains 1428 NFL contracts. The dependent variable is the signing bonus of a contract. Player position dummies includes 23 dummies for the player's positions at signing of contract. Awards dummies specify 16 dummies for awards player can receive. Last year is is the season before the contract was signed; contract year is the season after contract was signed; second season is the second season following the signing of the contract.

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*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors clustered by player
The specification is a tobit with censoring at 0. The sample contains 266 NFL contracts of players whose previous contract was terminated. The dependent variable is the signing bonus of a contract. Day of termination is the day into the offseason that the player's previous contract was terminated at.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Signing bonus</td>
<td>Signing bonus</td>
<td>Signing bonus</td>
<td>Signing bonus</td>
</tr>
<tr>
<td>Day of termination</td>
<td>-2263***</td>
<td>-1812***</td>
<td>-1768**</td>
<td>-2487***</td>
</tr>
<tr>
<td></td>
<td>(593.4)</td>
<td>(598.8)</td>
<td>(720.7)</td>
<td>(534.4)</td>
</tr>
<tr>
<td>Average annual pay</td>
<td>-0.0462</td>
<td>-0.108</td>
<td>-0.0771</td>
<td>-0.106</td>
</tr>
<tr>
<td></td>
<td>(0.0844)</td>
<td>(0.0982)</td>
<td>(0.0744)</td>
<td>(0.0923)</td>
</tr>
<tr>
<td>Years in contract</td>
<td>254052***</td>
<td>249644***</td>
<td>288816***</td>
<td>154368**</td>
</tr>
<tr>
<td></td>
<td>(80544)</td>
<td>(75505)</td>
<td>(80273)</td>
<td>(68483)</td>
</tr>
<tr>
<td>Contract backload</td>
<td>4.11e+06***</td>
<td>4.28e+06***</td>
<td>4.69e+06***</td>
<td>4.45e+06***</td>
</tr>
<tr>
<td></td>
<td>(975342)</td>
<td>(862497)</td>
<td>(1.06e+06)</td>
<td>(893866)</td>
</tr>
<tr>
<td>Roster bonus share</td>
<td>-765350</td>
<td>-614240</td>
<td>-588528</td>
<td>-608403</td>
</tr>
<tr>
<td></td>
<td>(602406)</td>
<td>(554654)</td>
<td>(586638)</td>
<td>(551729)</td>
</tr>
<tr>
<td>Player tenure</td>
<td>-63658**</td>
<td>-60429**</td>
<td>-83936***</td>
<td>-83936***</td>
</tr>
<tr>
<td></td>
<td>(25182)</td>
<td>(27577)</td>
<td>(25110)</td>
<td>(25110)</td>
</tr>
<tr>
<td>Plays last year (%)</td>
<td>470817</td>
<td>575806*</td>
<td>-148670</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(366927)</td>
<td>(296467)</td>
<td>(426955)</td>
<td></td>
</tr>
<tr>
<td>Games started last year (%)</td>
<td>17645</td>
<td>32777*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(16959)</td>
<td>(18047)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plays contract year (%)</td>
<td>381629</td>
<td>638322</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(297192)</td>
<td>(416961)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Games started contract year (%)</td>
<td></td>
<td>-14326</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(23970)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Award dummies</td>
<td></td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Award dummies contract year</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Player position dummies</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-868703***</td>
<td>-306100</td>
<td>-818149**</td>
<td>-54139</td>
</tr>
<tr>
<td>Constant</td>
<td>(235783)</td>
<td>(294372)</td>
<td>(357190)</td>
<td>(71329)</td>
</tr>
<tr>
<td>Observations</td>
<td>266</td>
<td>266</td>
<td>212</td>
<td>212</td>
</tr>
</tbody>
</table>

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors clustered by player
Table 4
The specification is a logit. The sample in columns 1 and 2 contains 1428 NFL contracts. The dependent variable is a dummy variable taking the value of 1 if the contract was terminated at some point and 0 if it was not terminated. The sample in columns 3 and 4 contains 2478 NFL contract seasons. The dependent variable is a dummy variable taking the value of 1 if the contract was terminated during that season and 0 if it was not terminated. The reported coefficients are marginal effects.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Terminated</th>
<th>(2) Terminated</th>
<th>(3) Terminated</th>
<th>(4) Terminated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual pay</td>
<td>1.42e-08**</td>
<td>1.18e-08*</td>
<td>0.00139***</td>
<td>0.00116***</td>
</tr>
<tr>
<td></td>
<td>(6.48e-09)</td>
<td>(6.83e-09)</td>
<td>(0.000267)</td>
<td>(0.000301)</td>
</tr>
<tr>
<td>Years in contract</td>
<td>-0.0353***</td>
<td>-0.0324***</td>
<td>-0.0273***</td>
<td>-0.0241***</td>
</tr>
<tr>
<td></td>
<td>(0.00746)</td>
<td>(0.00738)</td>
<td>(0.00434)</td>
<td>(0.00443)</td>
</tr>
<tr>
<td>Contract backload</td>
<td>0.192*</td>
<td>0.199**</td>
<td>-0.0576</td>
<td>-0.0467</td>
</tr>
<tr>
<td></td>
<td>(0.107)</td>
<td>(0.0982)</td>
<td>(0.0638)</td>
<td>(0.0605)</td>
</tr>
<tr>
<td>Roster bonus share</td>
<td>0.169***</td>
<td>0.166***</td>
<td>0.0987***</td>
<td>0.0857***</td>
</tr>
<tr>
<td></td>
<td>(0.0637)</td>
<td>(0.0609)</td>
<td>(0.0219)</td>
<td>(0.0216)</td>
</tr>
<tr>
<td>Player tenure</td>
<td>0.00373</td>
<td></td>
<td>0.00519***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.00295)</td>
<td>(0.00149)</td>
<td></td>
</tr>
<tr>
<td>Plays last year (%)</td>
<td>0.00220</td>
<td></td>
<td>-0.0468</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0582)</td>
<td>(0.0337)</td>
<td></td>
</tr>
<tr>
<td>Games started last year (%)</td>
<td>-4.67e-05</td>
<td></td>
<td>0.000500</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.00274)</td>
<td>(0.00159)</td>
<td></td>
</tr>
<tr>
<td>Player position dummies</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Award dummies</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>1428</td>
<td>1414</td>
<td>2478</td>
<td>2419</td>
</tr>
</tbody>
</table>

*** p<0.01, ** p<0.05, * p<0.1
Robust standard errors clustered by player
Table A1

The specification is a tobit with censoring at 0. The sample contains 1428 NFL contracts, which are longer than one year. The dependent variable is the signing bonus of a contract. Uncoded contract amount is the salary cap value of the contract at signing minus the payments coded in the data. Uncoded contract amount share is the uncoded contract amount divided by the salary cap value of the contract. Player tenure is the year of the contract minus the year the player entered the league.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Signing bonus</th>
<th>(2) Signing bonus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual pay</td>
<td>0.0363</td>
<td>-0.153**</td>
</tr>
<tr>
<td></td>
<td>(0.0742)</td>
<td>(0.0768)</td>
</tr>
<tr>
<td>Years in contract</td>
<td>897089***</td>
<td>828575***</td>
</tr>
<tr>
<td></td>
<td>(71526)</td>
<td>(63083)</td>
</tr>
<tr>
<td>Contract backload</td>
<td>8.36e+06***</td>
<td>8.08e+06***</td>
</tr>
<tr>
<td></td>
<td>(1.03e+06)</td>
<td>(938012)</td>
</tr>
<tr>
<td>Roster bonus share</td>
<td>-2118437***</td>
<td>-2259826***</td>
</tr>
<tr>
<td></td>
<td>(738044)</td>
<td>(675951)</td>
</tr>
<tr>
<td>Uncoded contract amount</td>
<td>0.0157</td>
<td>-0.00530</td>
</tr>
<tr>
<td></td>
<td>(0.0423)</td>
<td>(0.0411)</td>
</tr>
<tr>
<td>Uncoded contract amount share</td>
<td>79774</td>
<td>42460</td>
</tr>
<tr>
<td></td>
<td>(86173)</td>
<td>(79875)</td>
</tr>
<tr>
<td>Player tenure</td>
<td>-81283***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(23531)</td>
<td></td>
</tr>
<tr>
<td>Plays last year (%)</td>
<td>1.53e+06***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(324339)</td>
<td></td>
</tr>
<tr>
<td>Games started last year (%)</td>
<td>23703</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(14724)</td>
<td></td>
</tr>
<tr>
<td>Player position dummies</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Award dummies</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>2.21e+06***</td>
<td>2.02e+06***</td>
</tr>
<tr>
<td></td>
<td>(92133)</td>
<td>(82036)</td>
</tr>
</tbody>
</table>

| Observations                      | 1428              | 1428              |

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors clustered by player.