Renegotiation Design:
Evidence from NFL roster bonuses

Gregor Matvos
University of Chicago, Booth School of Business
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Abstract

Does shaping future renegotiation play a role in contracting? This question arises in policy debates and is centrally important is such fields as contract theory, corporate finance, and law and economics. Yet empirically testing this question has proven to be difficult. We use a unique dataset in an environment particularly suited to studying the issue, the market for National Football League (NFL) players. With a simple model, we show that teams have an incentive to hold-up players under contract by strategically choosing to renegotiate their contracts at a time when players' opportunities with other teams are limited. Unmitigated, this hold-up leads to ex post inefficient matching between teams and players. Using the same model, we then show that a seemingly innocuous NFL contract term, "the roster bonus", 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 $260 thousand for a contract in which the renegotiation incentives are modified.

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"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)

Contracts perform many roles, among them are: risk sharing; providing incentives to elicit effort, non contractible investment, or information acquisition; screening; and allocating decision rights. An additional role of contracts is to shape the renegotiation of the future relationship between the parties. Theory suggests that this "renegotiation design " is an important consideration that shapes contracts, and therefore contracting outcomes.[1] Renegotiation design is fundamental in a much of the literature in economics.[2] It is essential in the theory-of-the-firm literature and for institutional design more broadly;[3] in corporate finance for theories on debt[4] and financial structure, [5] and in law and economics, [6] to name a few. 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. Shavell (2007) claims that the absence of empirical data on contracts being written to shape future renegotiation can be used to justify modification of contracts by means of the legal system, which has been featured prominently in the recent debate on remedies for the foreclosure crisis.[7]

Determining whether contract terms are written so as to shape future renegotiation 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 2005), making it hard to empirically separate renegotiation design from other roles of contracts. We exploit institutional features of the National Football League (NFL) and a unique and novel dataset on contracts of NFL players to demonstrate that shaping future renegotiation is an important part of contracts in this market.

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 (CBA), which allows us to identify the contracting environment, otherwise hard to observe. The CBA prescribes which contracts are allowed and enforced, which party has rights to alter the contract, and at what point in time. We even know which other parties in the market the contract participants are allowed to communicate with.[8] One major problem with studying contracts is that the parties can take

1 (Aghion, Dewatripont, Rey, 1994, p. 257)
2 For early work on renegotiation design, see Hart and Moore (1988), Aghion, Dewatripont, Rey (1994), and Noldeke and Schmidt (1995)
3 For summaries, see Hart (1995) and Bolton and Dewatripont (2005), Chapters 11 and 12
4 Aghion and Bolton (1992) and Bolton and Scharfstein (1996)
5 Dewatripont and Tirole (1994), Berglof and Von Thadden (1994), Bolton and Scharfstein (1996)
6 For bankruptcy law see White (2007); for corporate law and governance see Becht, Bolton and Röell (2007) ; for contractual hold-up and damages, see Shavell (2007)
7 See, for example, the failed bill S.2136: Helping Families Save Their Homes in Bankruptcy Act of 2008.
8 For example, players under contract are not allowed to talk to other teams about possible contracting arrangements, were their current contract terminated

actions outside of the contract. For example, a worker can be awarded a bonus, which was not specified in the contract. This is not the case in the NFL, though. No transfers between the team and the player are allowed unless specified in a contract. Further, informal renegotiations can take place, which are not observed in the data.[9] Contracts completely regulate the relationship between the team and the player. 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.[10]

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, especially severe 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 what the subsequent contracts involved. The NFL also provides measures of player output and ability that exceed the degree to which we observe output in most other industries.

For this study, we exploit the difference between the contract payments specified in roster bonuses instead of salary. The roster bonus is a simple provision in NFL contracts. If the contract specifies a roster bonus amount, then the team has to pay the player that amount 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. 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. Prima facie, whether compensation is paid as roster bonus or salary is of no importance; only their combined amount should matter. 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. Using a simple model, we show that the choice of contracting some compensation in roster bonuses rather than salary shapes future renegotiation of the contract.

We also demonstrate that the team's threat point in potential renegotiation with the player changes during the offseason. 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, and the team who could have used his skill had already filled their slots. Then 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'

9 Piskorski et al (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.
10 Any side payments would be fraudulent, and subject to fines.

surplus at the players expense, ex post. Furthermore, we show that it can lead to inefficient matching between players and teams, destroying surplus.

For inefficient matching to persist, we need a friction that prevents ex-post efficient Coasian bargaining. Our model allows for frictionless bargaining between the contracting parties, but not for Coasian barraging (collusion) between teams. We are confident that all Coasian trades do not take place in the NFL because, in addition to standard frictions, explicit restrictions on transfers of players, and compensation in these trades, are stipulated in the Collective Bargaining Agreement. Furthermore, there are restrictions on side payments from the player to the team. Because of these frictions, we can use contracting in the NFL as a good laboratory for exploring contracting in a world with some ex-post bargaining frictions. These frictions frequently are derived from information problems-- see, for example, Myerson and Sathertwaite (1983) -- or barraging cost, for example in Anderlini and Felli (2001). In the absence of Coasian bargaining, teams have an incentive to hold on to a player's contract late into the offseason. This way they can hold-up the player and renegotiate the contact at a lower amount than they would have been able to otherwise. In the process, they do not internalize the inefficient matching that is caused by their opportunism.

With our simple model, we show that shifting some compensation from salaries to roster bonuses ameliorates this opportunism and improves matching between teams and players. Because the roster bonus is due at the beginning of the offseason, it forces the team to pay the player in order to hold him up late in the offseason. Thus, it provides incentives for renegotiation and contract termination early in the offseason, which reduces opportunistic behavior by the teams and improves matching between teams and players. From our model, we develop several hypotheses. We test the predictions on: timing of termination and renegotiation; the tradeoff 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.

A competing explanation to our theory 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 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 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. There seems to be a dimension of ability that teams and player contract on, but we do not observe, which is not correlated with roster bonuses. In other words, controlling for a future player's performance has no qualitative or quantitative affect on our results. Moreover, we show that while certain 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 quality would have to be both positively related and negatively correlated with roster bonuses.

While NFL contracts operate in a specific setting, the structure of contracts more generally is driven by forces central to other settings and markets. Our study relates to several strands of the literature. Within the literature in 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. Guriev and Kvasov (2005) construct a model in which the critical time component is the duration of the contract; in our framework, timing is important because it related to the thickness of the market for a player of given characteristics. Furthermore, unlike in these papers, our model's problem is not inducing the appropriate level of ex-ante investment, which cannot be contracted. Rather 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 also related to the empirical literature on financial contracting. Kaplan and Stromberg (2003)) show that venture capital contracts are consistent with theories of financial contracting. We can interpret the non-compete provisions, combined with vesting of compensation in venture contracts that they study, in a context similar to NFL contracts. The venture provisions prevent the entrepreneur from holding up the company early in its life, when it is important for the entrepreneur to stay with the company. But they decrease over time as the entrepreneur becomes less important and professional managing takes over. Benmelech and Bergman (2008) explore how strategic renegotiation of airline leases is related to the liquidation values of the firm's assets. In their setting, liquidation values play a similar role to market thickness in our setting. Roberts and Sufi (2009)) study the renegotiation of private credit agreements and how it relates to the terms of the initial contract, firm, and macroeconomic variables. Iyer and Shoar (2008) find that orders of pens customized to the buyer require a higher upfront payment. They interpret this upfront payment as a means of reducing surplus from hold-up by the buyer in a later stage, thus performing a role similar to the NFL roster bonus.

There is also a large literature on contracting between firms.[11] 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 bargaining power to the party who will be held-up in the relationship. Lerner and Merges (1998) examine which factors drive control rights' allocation in biotechnology alliance contracts. Arruñada et al (2001) analyze the determinants of the allocation of decision rights between dealers and car manufacturers. Gil (2009) examines the choice of whether to write a 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.[12] Roth and Xing (1997), for example, study congestion in the market for clinical psychologists. As in the NFL, the between workers and firms matching in that market has to be accomplished by a set deadline. They show that if

11 See Lafontaine and Slade (2009) for a survey.
12 see Roth (2002) and Roth (2008) for surveys of the literature.

processing offers takes time, then market participants' strategic behavior will lead to inefficient matching. This same friction is certainly at work in the NFL and is responsible for teams signing up players who may not be efficient matches early in the offseason, rather than waiting for better matches later in the offseason. The NFL market and the market for clinical psychologists are no exceptions, as the literature has examined various entry labor markets from doctors (Niederle and Roth 2003) to new economists (Roth 2008), and the allocation of post-season football bowls (Fréchette et al 2007). 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 thickens 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 roster bonus, which has been developed to mitigate some inefficiencies that arise in the market.

Our paper is also 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." The strategic use of timing of renegotiation in the NFL is an example of such contractual hold-up and the roster bonus is a contractual remedy introduced by the parties to address the problem. The focus of this literature is how government intervention can remedy such problems, either through contractual law, price controls, admiralty law, or other means (Shavell 2007). A key component of this literature is whether parties can, and do, write contracts that provide mechanisms that will shape renegotiation in the future. In fact, Shavell (2007)points to the lack of empirical data on renegotiation design as support for legal intervention in modifying contracts.

This paper proceeds as follows. Section 2 provides the institutional background on contracting in the NFL. Section 3 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 simple model that we use to formulate testable predictions. Section 4 describes the data and presents descriptive statistics. Section 5 presents the results. Section 6 discusses the potential alternative explanations of our results and presents some additional robustness checks, including a back-of-the-envelope quantitative evaluation of our estimates. Section 7 concludes.

2. Institutional Background:

The NFL represents a major entertainment industry: according to Nielsen Ratings, the top four most watched sports broadcasts in U.S. history were all NFL games. Super Bowl XLII (2008) was watched by over 90 million people in the United States. Therefore, it is not surprising that the NFL 's annual revenues of around $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 (NFLPA). The relationship between the players and the league is governed

by the Collective Bargaining Agreement (CBA) between The NFL Management Council And The NFL Players Association. In our dataset the contracts are covered by the CBA, signed in 1993, and 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. This means that, while the team generally can terminate the contract at any point, the player is bound by the contract and cannot terminate it. In other words, the team holds an option contract on the player, which it can exercise each year by paying the player the amount specified in the contract. If at any point in time it chooses not to make a payment, the option is forfeited, i.e. the contract is terminated. Each contract specifies the length of the contractual relationship, the signing bonus, and--for each year of the contract--the Paragraph 5 salary (P5 salary) plus a roster bonus and potentially some other contract terms, which we address in Section 6.

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. Paragraph 5 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:

Year		Earned	Amount
2002	Signing bonus	Upon contract signing	$0.5 million
	Roster bonus	March 1, 2002	$0.3 million
	P5 Salary	First game of regular season in 2002	$0.7 million
2003	Roster bonus	March 1, 2003	$0.2 million
	P5 Salary	First game of regular season in 2003	$0.9 million
2004	Roster bonus	March 1, 2004	$0.2 million
	P5 Salary	First game of regular season in 2004	$1.0 million

According to the CBA, the NFL "League Year" (CBA 2002, p. 4) 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 a 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. Theory and Hypotheses

First we present a simple numerical example that shows the dynamics of contracts during the NFL's offseason. Our goal is to outline how the option feature of NFL contracts, coupled with renegotiation, leads to a hold-up problem. Then we introduce the main friction in NFL contracting through which hold-up leads to inefficient outcomes. Next, we illustrate how the roster bonus shapes renegotiation, reducing the hold-up and increasing efficiency. After formalizing this example and developing a simple model of contracting dynamics during the NFL offseason, we use the framework to develop testable hypotheses about player compensation, the team value of contracts, and the timing and amount of contract renegotiation and termination.

3.1) Numerical Example

To understand the dynamics of contract termination and renegotiation in the NFL consider a simple example. 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. Or, the team can is keep its contract: Quarterback then has to play, and receives the $1 million specified by the contract. In other words, the NFL contract is an option contract that Team A has on Quarterback with the exercise price of $1 million. 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 offer. Because the contract binds Quarterback, the team would never renegotiate the contract upwards.

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. Suppose that 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 a decent 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, keeping Quarterback employed but at a lower compensation, either early or late in the offseason; or, it can exercise its option on Quarterback and keep the old contract in place. Keeping the old contract in place is unattractive, because the team values Quarterback 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 High can wait until late into the offseason. Once Team High fills its quarterback slot, Team A can propose renegotiation to Quarterback. Quarterback knows that if he is terminated now, the best he can do is to sign up 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 for, potentially all the way down to $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 then bargain the player down to a lower compensation level, and keep him, thus preventing him from matching with Team High. Further, Team A can use the timing of renegotiation strategically: it can wait until the end of the offseason to hold-up the player and renegotiate the contract down. Third, Team A's private incentives for renegotiating late in the offseason can prevent the player from signing 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 rest comes due at the beginning of the season. Suppose, further, that the team still wants to hold-up Quarterback, to 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 the remaining team, which is $0.8 million; at this point, that would be profitable, because his current team still values him at $0.95 million. However, in order to delay the renegotiation up to this point, the team would already have had to pay the roster bonus of $0.3 million. Thus, the total compensation paid to Quarterback if the team 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. It will not terminate Quarterback late in the offseason, because it has to pay a roster bonus to do so. It also will not want to hold on to 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 A is out there valuing him at $1.2 million. Therefore, the only thing Team A can do 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 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.

3.2) Model

To keep the analysis transparent and for clarity of exposition, we focus on one offseason contracting problem between one player and one team, and we focus on the simplest possible

contracting problem in the offseason with the player under contract for only one more season. This abstracts from other features of the 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.

The contract

Team A has and a player Quarterback under contract with for one more year. His contract specifies total compensation w. To simplify the analysis and make the tradeoffs as stark as possible, Quarterback's compensation is paid either as a roster bonus or as salary. The team values Quarterback's services at W_o.

Other teams

During the offseason, there are two periods: the early period and the late period. We model the evolution of demand for Quarterback during the offseason by assuming that two teams in addition to Team A, are interested in his services in the early period: Team High, which values Quarterback's services at W_h, and Team Low, which values Quarterback's services at W_l. Quarterback is strictly more productive with team High than team Low, $W_h > W_l$. Either Team High or Team Low will its slot between the early and the late period, because it wants to make sure it has a player in that position.[13] Therefore, in the late period, only the remaining team is interested in Quarterback's services. The probability of High team filling its slot between the early and late period is 1-p, and the probability for the Low team is p.

Timeline and bargaining during the offseason

Timeline: see Appendix A.

At the beginning of each period, Team A can make a take-it-or-leave-it offer (TIOLI) of a new contract to Quarterback. 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, and W_o is realized. If Quarterback rejects the renegotiation, then Team A can decide whether to keep the old contract in place or terminate it. If the contract is kept in place after the early period, and the contract has specified payment in roster bonuses, then the team has to pay the player the roster bonus of the amount w. If the contract is in place after the late period, and the contract has specified the compensation in bonuses, then the team pays the salary 0. If the contract has specified no roster bonus,

13 One 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 even if all available players participate in the market. In the NFL the processing time can be relatively long and entail medical clearance.

then the team has to pay the player his salary of the amount w. Production takes place immediately upon payment of the player's salary. If the Quarterback's contract with Team A is terminated, then all teams in the market, including Team A, make him simultaneous TIOLI 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.

The market friction

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 CBA and other frictions, all of which prevent efficient trades from taking place.

Proposition 1: Holding fixed the total compensation amount specified in the contract, w, a contract in which the compensation is paid in roster bonus rather than salary has

- weakly higher expected profitability to the player
- weakly lower expected profitability to the team holding the contract
- is terminated and renegotiated in the early rather than the late period
- higher probability of termination

Proof: See Appendix B

The earlier example illustrates the intuition from the proof. The roster bonus makes the teams pay to try to renegotiate with the player or to terminate him late in the offseason. This decreases the team's surplus from holding up the player. Because it decreases the profits from holding up the player, it increases the payoff to the player and decreases the payoff to the team holding the contract. The roster bonus thus improves the ex post matching between the players and the team. It effectively gives the team an incentive to take action, either to renegotiate or terminate, early in the offseason while there are still good matches available for the player. The presence of these matches provides the team with incentives that are more aligned with maximizing the total surplus.

3.2) Hypotheses:

This simple model allows us to formulate several testable hypotheses, which we can take to the data. The first hypothesis follows directly from Proposition 1:

Hypothesis 1: 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 all else equal.

From Proposition 1 we know that shifting the compensation from salary to roster bonuses weakly decreases the value of the contract to the team and increases the value of the contract to the player. Players are paid a signing bonus for a contract. Therefore, if a contract is less valuable for a team and more valuable for a player, the signing bonus should reflect that difference. In other words, a team should be willing to pay less for a contract with a signing bonus.

Hypothesis 2: Contracts in which a higher share of compensation (roster bonus plus salary) is paid in roster bonuses have lower signing bonuses, holding all else equal.

In our model, we assume that the matching opportunities for the player decline during the offseason. Upon termination, the player always is paid his second highest match. Because the player is better matched early in the offseason, he should get paid more for the same contract. Holding fixed contract characteristics and player quality, he will obtain a higher signing bonus for the contract.

Hypothesis 3: Players who are terminated earlier in the offseason obtain a higher signing bonus than players who were terminated late in the offseason, holding player quality and contract characteristics fixed.

When the team holding the contract is not the best match for the player, the player's contract sometimes is terminated. Proposition 1 states that roster bonuses increase the probability of contract termination and thereby increase efficiency of the ex post matching between the players and teams.

Hypothesis 4: Contracts in which a higher share of compensation, defined as roster bonuses and salary, is paid in roster bonuses have a higher likelihood of termination than contracts without roster bonuses.

Now we turn to the data used to test these hypotheses

4. Data

4.1) Data description

Contract information

The sample 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, have a date when they entered the NFL, had observable performance characteristics[14] in the previous year, and to contracts for which

14 This excludes rookie contracts.

all characteristics are coded. This leaves us with a sample of 4, 220 contracts. Table 1 presents the distribution of signing dates.

Each contract specifies a signing bonus and, for each year a roster bonus, a reporting bonus, and a P5 salary. This makes contracts of different lengths difficult to compare and describing them requires many parameters. For example, a 12-year contract requires 37 variables. Furthermore, contracts have to be indexed by length: increasing the P5 salary in year 5 may be of different importance in a 5-year contract than in a 12-year contract, and it is completely meaningless for a 4-year contract.

To make comparable contracts of different lengths 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 from year 1, are roster bonus for year 1, reporting bonus for year 1 and the P5 salary for year 1; the payments from year 2 are roster bonus for year 2, reporting bonus for year 2, and the P5 salary for year 2. We then take the average of the payment for year 1 and the payment for year 2. The bonus share 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. A backload measure should be comparable across contracts of different length. Furthermore, contracts with different average levels of pay also should be comparable. We measure contract backload as the gini coefficient of annual payments, excluding the signing bonus. 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.

Termination and Renegotiation

A contract is coded "terminated" if we observe the player signing a contract with a different team during the duration of his contract and if the 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. For example, if a contract covers seasons 1999 to 2004, but there is a new contract signed with the same team in 2001, then we code the original contract as being renegotiated. The date of renegotiation is the date that the new contract was signed.

Performance Information

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 a many of these statistics our robustness check, we mainly focus throughout the paper on two measures of player quality. First, 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 specialty 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.

4.2) Descriptive statistics

This subsection presents some descriptive statistics to help us obtain a general picture of the NFL contracting data. To better understand what drives the results in the rest of the paper, we explore differences among players and how they are correlated with the contracts these players sign. NFL contracts differ in their lengths, the payments that are promised to the player, how back loaded these payments are in the contract and, critically, in the amount of these payments that is promised as roster bonuses early in the offseason. The distribution of contract length is presented in Table 2. In this sample, most contracts are one-year contracts (2,792), but a significant share of contracts are longer. Twenty-four percent of the sample is 2-year and longer contracts. Meaningful renegotiation concerns are only present in contracts longer than one year, so this subsample of 1,428 contracts is the focus of the descriptive statistics. The contract length represents the length of the option. The upfront payment the player obtains to sign the contract--the signing bonus--is the price of this option. On average, for signing a contract longer than one year, 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 contract payments specified in the contract. The mean annual pay specified in NFL contracts of more than one year 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 fact, in our sample, over 90 percent of contracts have some backload. We use the Gini coefficient of contract payments to capture a contract's

backload with a single parameter: 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. [15]

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 P5 salary is paid. The average roster bonus share in contracts longer than one year 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 its end. Forty-five percent of contracts longer than one year have a positive roster bonus at some point during the contract. For these contracts, the roster bonus represents a larger share of compensation. Table 3, Panel B presents the characteristics of contracts, with a positive roster bonus. In these, the share of compensation that is paid in roster bonuses is more than 18 percent.

We expect players with different abilities to sign different contracts. In Table 4 we examine how the characteristics of players' contracts are correlated with their ability. Again we focus on the subsample of contracts longer than one year. We group players in 10-percentage-point subsamples by the percentage of their club's plays they participated in last season. For each group of players we compute the mean of the contract characteristics. For example, players who participated in 40 to 50 percent of their team plays signed contracts with an average length of 3.35 years. We can see that better players sign longer contracts, which have higher annual contracted compensation, a higher signing bonus, higher roster bonuses, and which are more back loaded. Players who participate in over 90 percent of their teams plays sign a 4.61-year contract on average, versus players who participate in less than 10 percent of their teams plays who sign 2.51-year contracts on average. The difference in contracted annual compensation averages $2,073,191. The difference in average backload is also substantial, increasing from 0.067 in the lowest ability subsample to 0.147 in the highest ability subsample. For two-year contracts, that difference in backload would imply that the contracted compensation in the second year of the contract would be almost 30 percent higher for high ability players, and would increase by 13 percent for players in the lowest ability subsample. Players in the highest ability subsample on average also obtain a larger part of their compensation in roster bonuses: 11.2 percent, relative to 2.4 percent for players in the lowest ability subsample. On the margin, holding player ability and other contract characteristics fixed, the contract value to the team increases in contract length and backload, and decreases in mean annual compensation and roster bonus share. The signing bonus is the lump sum payment that compensates the players if they sign a contract that yields more expected profits to the team. Therefore, it is not obvious that it should be monotonically correlated with ability. In the data, the signing bonus is increasing across most ability subsamples. On average, players in the highest ability bin obtain a $2,306,593 higher signing bonus for the contracts than the players in the lowest ability subsample.

Given that we are specifically interested in roster bonuses, it is especially important to understand which types of players are more likely to obtain roster bonuses, and how their contracts

15 For a two-year contract, the Gini coefficient can be expressed as (d/2)/u, where u is the average compensation and d is the difference between the payment in the second year and the payment in the first year.

differ on other contract characteristics. Table 3, Panel B presents player characteristics and contract characteristics for a subsample of contracts that had a positive roster bonus. Panel C compares them to the characteristics of contracts which had no roster bonus. Consistent with our results described above, the better players sign contracts with roster bonuses: the average player who signed a contract without a roster bonus participated in 57 percent of his team's plays in contrast to players who signed contracts with 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 on average is $1.2 million 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. In light of the results on correlation of ability and contract characteristics, these results are not surprising: the correlation between roster bonuses and contract characteristics could be driven by their correlation with ability.

4.3) Which players obtain roster bonuses

The predictions of our model are conditional on holding player characteristics fixed, so in testing our hypotheses we mainly condition on player characteristics. Nevertheless, before we proceed to testing our hypotheses, we examine which types of players are likely to sign contracts containing roster bonuses and provide a possible explanation for the results based on our model. While our model was not designed to capture the entire complexity of the contracting interaction between teams and players in the NFL, it does suggests that the benefit of introducing the roster bonus into the contract is proportional to the loss in matching quality over the offseason. Therefore, roster bonuses generate the most surplus when they exist in contracts of players whose matching opportunities would decline most during the offseason. In Table 5 we present results from a logit model in which we estimate the probability of a player's contract containing a roster bonus, given the team the player signed with and the observable characteristics of the player. Our results confirm that some of the variation in roster bonuses is correlated with player position. The Wald test confirms that the player position dummies are jointly significant across all specifications. This is hardly surprising: for example, relative scarcity of players across positions will make matching more important for some positions than others. Furthermore, if player ability in certain positions is complementary to other players' ability (for example, quarterback and running back), then matching of teams and players will be more important for these characteristics.

Individual player characteristics, conditional on player position and team, also are correlated with players' contracts containing roster bonuses. In particular, players who start a higher fraction of games, conditional on the number of plays they participated in are more likely to have a roster bonus in their contract. Players who are starters are more skilled, but their skills are also probably more specific. Players who start less are thus more easily replaceable from the perspective of the team. That means

that matching with a particular team is less important for productivity of non-starters: just as they are replaceable from the teams' perspective, so are teams replaceable from their perspective. Roster bonuses therefore generate more surplus for starters, which might explain why starters are more likely to have roster bonuses. In addition to starters, players with higher tenure in the league are more likely to have contracts that contain a roster bonus. One possible explanation for this is that younger players' athletic ability makes them more versatile, while older players rely more on specific skills. However, these skills are by definition more specific than athletic ability, and require a more specific match. Optimal matching of teams and veterans is thus more important than matching of younger players.

One observation that our model does not address is that some of the variation in roster bonuses is explained by the identity of the team signing the contract. The dummies for signing team are jointly significant in our logit specification. Some teams are more likely to sign contracts with roster bonuses than others. This variation could simply occur because teams have different objective functions: some teams value winning more than other teams, so they may be willing to pay to not have to decide on players early in the offseason, offering fewer roster bonuses. Alternatively, if a team already has included roster bonuses for several of its players, then it will have to decide on a lot of its players early in the offseason, decreasing the cost of issuing roster bonuses to other players.

5. Results

5.1) Hypothesis 1: Timing of termination and renegotiation during the offseason

As our simple model suggests, 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. This is how the contract shapes renegotiation in the offseason. To test Hypothesis 1, we ask whether the timing of renegotiation and termination is related to the timing of roster bonuses. In other words, if contracts with roster bonuses are terminated or renegotiated, does that happen before roster bonuses are due, as predicted by our model? To do this, we first examine whether the hazard rate of termination during the offseason for contracts that had a roster bonus that season is related to when roster bonuses are due. We then repeat this test for timing of renegotiation. Because we are interested in renegotiation and termination, we focus on the offseasons after the first year of the contract.

Figure 1 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 bonus. 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, and which uses contract and player characteristics as covariates. From this model, the baseline hazard rate of termination represents the hazard during the

offseason, controlling for player and contract characteristics. 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.

Figure 2 presents the baseline hazard of players' termination during the offseason after controlling for contract and player characteristics. We control for all contract characteristics--average annual pay, contract length, contract backload, roster bonus share in future seasons--and for several player characteristics including players' tenure and a battery of player performance characteristics.[16] 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 3 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. Thus we can obtain the hazard of renegotiation during the offseason while controlling for contract and player heterogeneity. In Figure 4 we present the hazard of renegotiation during the offseason after controlling for the same contract and player characteristics as before. 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 Hypothesis 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 incentives to renegotiate earlier in the offseason.

16 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.

5.2) Hypothesis 2: Price of Roster Bonuses at Contract Signing

The results from the previous section support our conjecture 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 an important part of NFL contracts, or whether it is unimportant economically. Our model suggests that if we compare two contracts with the same combined level of salaries and roster bonuses, then the contract, with the larger share of compensation paid in roster bonuses is less profitable for the team and more beneficial to the player. The contract with the higher share of roster bonuses will mitigate the hold-up of players by teams. The larger the hold-up, and the more it is mitigated by roster bonuses, the bigger the wedge in the surplus that the team can extract from the player between the two contracts. If shaping future renegotiation through roster bonuses is an important part of NFL contracts, then the contract with a smaller share of compensation paid in roster bonuses should be significantly less profitable for the player.

We can approximate the profitability of the contract for the player by looking at the signing bonus. To make the player willing to sign a contract in which the roster bonus share of compensation is smaller, all else equal, the team must pay the player a signing bonuses at contract signing. This signing bonus has to make up for the expected loss of compensation that the player suffers because the future renegotiation is designed differently. To test Hypothesis 2, we estimate the additional amount of signing bonus the team pays the player as a function of the share of compensation the player's contract specifies in roster bonuses rather than salary, holding the total amount that the player is paid in salary and bonus fixed, and fixing other contract characteristics as well. If this tradeoff is large, then shaping future renegotiation is an important part of NFL contracts. We now examine this tradeoff, first through descriptive statistics and then estimate it by using a tobit.

Descriptive Statistics

Hypothesis 2 predicts that the share of roster bonuses (roster bonuses /(salaries + roster bonuses) and the signing bonus are negatively correlated. From previous descriptive statistics we know that the data does not unconditionally support our hypothesis: the roster bonus ratio and the signing bonus are positively correlated: contracts that pay roster bonuses on average have signing bonuses that are $700 thousand higher, and the median difference is $380 thousand. 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 model we shift compensation between roster bonuses and salaries and keep their total amount constant. To roughly 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 5 shows the comparison of average signing bonus 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 Hypothesis 2. In each of the top three quartiles of

compensation, the average signing bonus is lower in contracts with roster bonuses 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 6, we sort players further into 25-percentage-point subsets by the percentage of their club 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. The one notable exception again 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 of cutting the compensation subsamples on compensation, we can cut them on other contract characteristics. In Figure 7 we cut the compensation subsamples by contract length. We present only contracts shorter than six years; for longer contracts the subsamples get very small. Two facts are worth noting. First, this cut of the data supports Hypothesis 2: in only three out of twenty subsamples, the average signing bonus is lower in contracts without roster bonuses, and in those subsamples the difference is quantitatively small. Second, unlike in the previous figures, all subsamples in the lowest average compensation quartile show results consistent with Hypothesis 2. 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 not consistent with Hypothesis 2, and they are in the quartile with the lowest average compensation. These descriptive statistics suggest that, consistent with Hypothesis 2, contracts that contain roster bonuses 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. In the next section, we approach this tradeoff more rigorously, conditioning on all observable contract and player characteristics. This allows us to evaluate the magnitude of the tradeoff and to better understand whether shaping future renegotiation is an important part of NFL contracts.

Tobit estimation

The descriptive statistics provided some suggestive evidence supporting Hypothesis 2: once we cut the data into subsets on player ability and contract characteristics, the contracts with roster bonuses have lower signing bonuses than those without roster bonuses. Now we make this argument more rigorous. We use tobit specifications, which adjust for the fact that teams are not allowed to pay a negative signing bonus in a contract. The CBA imposes certain constraints on contract characteristics. For example, it mandates the minimal annual compensation of players of a certain tenure. If the contracting were otherwise unconstrained, then the team would extract the surplus the player receives from these constraints by negotiating a payment from the player at contract signing, that is, a negative signing bonus. Negative signing bonuses are precluded by the CBA, and the tobit adjusts for that constraint. The specification of the tobit takes the following general form, where we vary player ability measures across specifications:

$$Signing\ bonus_i = \max(0, \alpha + \beta * bonus\ ratio_i + \Gamma_1 * contract\ characteristcs_i + \Gamma_2 * player\ ability_i + \varepsilon_i)$$

In the specification the dependent variable is the signing bonus the player receives upon signing the contract. The independent variable of interest is the share of contracted annual compensation (salary and roster bonuses) that is paid out as roster bonuses. The tobit specifications support Hypothesis 2: the share of compensation that is paid in roster bonuses rather than salary is correlated with a lower transfer at the signing of the contract, that is, a lower signing bonus. In the basic specification we only control for contract characteristics, not for any player ability proxies. We control for the average annual pay specified in the contract; in other words, we condition on the average amount that is paid in salaries and roster bonuses in the contract per year. We also control for contract length and how back loaded the contract payments are. The results, presented in Table 6, are consistent with Hypothesis 2: roster bonuses have a negative and statistically significant coefficient of $-1.92 million. A single standard deviation change in the bonus ratio means that 13.6 percentage points more of the annual compensation is paid in roster bonuses versus salary, which is paid at the beginning of the season. This change in the share of compensation specified as roster bonuses is correlated with a $260 thousand average decrease in signing bonuses players obtain for the contract. This amount suggests that roster bonuses, and in particular their effect on future renegotiation, are an important aspect of NFL contracts.

Different positions in the NFL are compensated differently involve contracts with different roster bonuses shares, potentially driving our results. To address this concern, we include in our specification dummies for the position that the player was signed to. We also include a specification to condition for player experience: the number of years since the player entered the NFL. Controlling for player position and tenure drops the coefficient slightly to $-1.82 million.

From the descriptive statistics, we know that players of different ability sign contracts that differ on several dimensions, including roster bonuses and signing bonuses. While the higher ability players obtain higher roster bonuses and higher signing bonuses, it is possible that this is true only in a univariate sense, and that the better players obtain contracts with lower roster bonuses, all else equal. We condition first on our main measure of ability, the percentage of team plays a player participated in, also then on additional ability measures: because better players generally start games, and are more likely to obtain roster bonuses, we condition on the percentage of games the player started during the year. We further condition on a set of 16 awards, ranging from making the All Pro team to being named Player of the Week. The coefficient on bonus ratio is negative and statistically significant in all of our specifications. Also, we obtain coefficients with the largest economic magnitudes, $-2.24 million, once we control for measures of player ability. These results suggest that the potential for hold-up in future off-seasons in the NFL is large and that roster bonuses can shape the timing of renegotiation to significantly alleviate these concerns.

Teams' demands for player and contract characteristics also differ, potentially affecting our results. One 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. Also, teams may be willing to trade winning in a certain year for winning several years down the road: for example, a chance at winning the Super Bowl once in a decade may be worth more than being a mediocre team for a decade. It is hard to pin down in how these concerns might affect the tradeoff

between the roster bonus share and the signing bonus that we test in Hypothesis 2. Nevertheless, it is conceivable that this heterogeneity may be correlated both with team's willingness to pay for 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 7. We restrict our attention to the subsample of contracts signed between 1999 and 2002 in order to have enough observations for each team/year for maximum likelihood to converge. The coefficient on roster bonuses is somewhat smaller than in previous specifications, but still economically large and statistically significant, ranging from $1.41 million to $1.94 million. Heterogeneity in teams has a statistically significant impact on contracting: the Wald test for the team dummies being jointly different than zero is statistically significant.

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 but that is not captured by our data. One potential test of whether an unobserved dimension of player ability drives our results is to look at future player performance. Teams and players both would care about unobservable ability because it is informative about players' future performance. If the unobserved ability does translate into future player performance, which we can observe, then we can use player's future performance as a signal of the team's information that is not contained in the ability we control for in our specification.

We re-estimate the tradeoff between the signing bonus and the roster bonus ratio, using the tobit specification described above but also controlling for future player performance. Table 8 presents these results. In column 1 and column 3, we condition on the share of his team's plays that the player participated in the year after signing his contract, and the following year. 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 player's past ability and contract characteristics. However, this ability dimension does not appear to be correlated in any way with the use of roster bonuses that is not already captured by our ability measures. The coefficient on roster bonus is virtually unchanged in magnitude and statistical significance from the one in Table 6, column 3, which has the same specification without the future values: the coefficient drops from $2,048 to $1,985. Including other dimensions of future performance does not change the magnitudes or statistical significance of these results. In column 2 we include the percentage of games the player started during the two seasons after the contract was signed and the awards he won. Again, these do not affect the magnitude or the statistical significance of the results. Nor does it not seem that they contain much information on player ability, because an F-tests reject their joint significance in the specifications. We further address the issue of unobservable player quality and additional robustness checks of results from this subsection in Section 6.

5.3) Hypothesis 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 want to test our conjecture that players who

are terminated later in the offseason will sign contracts which, all else equal, are less valuable. One way to test whether a contract is more valuable is to see whether a player who signed a contract with a given length, mean annual pay, roster bonus share, and contract backload was paid a higher signing bonus than a player of the same quality who signed a contract with the same characteristics but was terminated later in the offseason. To implement this test, we again estimate a tobit specification, but we restrict it to the subsample of players whose previous contract was terminated. The dependent variable again is the signing bonus and the independent variable of interest is the day in the offseason when the player's previous contract was terminated. This specification includes controls for player ability and contract characteristics. As we did earlier we also control for the player's position, the time since he entered the league, the percentage of his team's plays he participated in, the percentage of games he started, and the awards he received in the previous year.

The results are presented in Table 9. The coefficient on day of termination ranges from $-1,812 to $-2,570 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 the contracts signed fixed. A player who is terminated at the end of the offseason rather than the beginning is terminated about 180 days later, amounting to a loss of approximately $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 approximately half, or $160 thousand.

These results suggest that players who are terminated later in the offseason obtain a lower signing bonus for the new contract, holding fixed contract characteristics, players' tenure, position, share of plays the player participated, share of games in which the player started, and the awards the player received last year. 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 with this specification 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. The results are presented in Table 10. Again, the magnitudes of the coefficients are very close those estimated in Table 9, which estimates similar specifications without the future performance measures.

5.4) Hypothesis 4: Matching efficiency

In this subsection we argue that the data on contract termination is consistent with Hypothesis 4, suggesting that roster bonuses increase the ex post matching efficiency of teams and players. Our model suggests that if there are restrictions on ex post efficient bargaining between teams, then hold-

up by the teams potentially leads to inefficient matching ex post. This inefficient matching occurs when players' contracts are not terminated so they can sign up with other teams. The model also shows that this hold-up is mitigated by roster bonuses, and is expressed in an increase in contract terminations, as suggested by Hypothesis 4. This is especially interesting in light of the fact that roster bonuses are unconditionally given to better players. Furthermore, players have to forgo some signing bonus in order for their contracts 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.

Table 11 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 ratio range from 15.5 percent to 16.9 percent. This means that a single standard deviation increase in the share of compensation paid early rather in the offseason than late is correlated with a 2 percent increase in the probability that a contract will be terminated during its lifetime.

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 account for these possibilities, we focus on the probability of a contract being terminated during a given offseason. For this test the relevant length is not the contract length at the signing of the contract but rather the length of the remaining contract. When there are two years left on the contract, it does not matter whether the original contract was a five-year or three-year for the termination decision at that point in time. We estimate the probability of termination using a matching estimator. We match the contracts on contract characteristics (average annual mean compensation, contract backload) and on a range of specifications including perturbations of the following player characteristics: the percentage of his team's plays the player participated in the previous year, player position, and his tenure. The coefficients range from 3.6 to 7.3 percentage points across the specifications. Again, the coefficients are more stable across specifications when we include a larger number of matches. Furthermore, the coefficients are not statistically significant in the simplest specification. Once we match the players on position and tenure, though, the precision of the estimates increases and the coefficients become statistically significant. The interpretation of these coefficients is that a contract, matched on the average amount of compensation, length, and player characteristics, is over 4 percentage points more likely to be terminated during the offseason if the team has to play the player any part of the compensation early rather than late in the offseason. Of course, although our results are consistent with the theory and we are matching on important player characteristics, and are doing so in

a flexible manner, an alternative explanation is that players with roster bonuses are worse on some unobservable dimension, which increases their probability of termination. We partially address these concerns in Section 6.

Together, these results on termination suggest that the data is consistent with Hypothesis 4: after contracts are signed, contracts that contain roster bonuses are more likely to be terminated. By definition, termination is a new matching between a player and a team. Because renegotiation of the contract is also a possibility, it is very likely that the players who were terminated have signed up with a team that was a better match for their skills than their old team. If this were not the case, then the old contract could have been renegotiated. These results thus suggest that roster bonuses are put into contracts to alter incentives of teams to renegotiate, thereby increasing the ex post matching efficiency between players and teams.

6. Unobservable player quality, back of the envelope calculation, and robustness

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. For unobserved quality to explain our results, it must make the player more valuable. In Table 8 and Table 10, we show that the coefficient on roster bonus does not change when we control for future player quality. Therefore, the unobservable quality must be specifically correlated with future performance of the player, something 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. Furthermore, while such a dimension of quality might explain each of our results separately, we argue that it cannot reconcile all of our results simultaneously. To explain the negative correlation between the signing bonus and the roster bonus share that is predicted in Hypothesis 2, this dimension of quality must command a high signing bonus ex ante, holding other contract characteristics equal, and be negatively correlated with roster bonuses. However, it predicts that given that players with roster bonuses are terminated earlier in the offseason, the players who are terminated earlier are worse on this dimension of ability. Therefore, they should be compensated less in their new contract, reflecting this low unobserved ability, generating results inconsistent with Hypothesis 3. Our results instead show that players terminated early in the offseason obtain higher compensation for the same observed contract and ability bundle.

6.2) Back-of-the-envelope calculation

We can use a back-of-the-envelope calculation to provide a crude check of whether our estimates are quantitatively plausible. Paying compensation in roster bonuses versus salaries is supposed to provide teams incentives to either terminate the player early or to renegotiate while the player's matching opportunities with other teams are still high. The roster bonus therefore has to exceed the expected rents the team can extract from a player by waiting until past the roster bonus

date. Suppose we approximate the rents that the team can extract from the player as the drop in the compensation the player would face if terminated. Under different specifications the estimates of the cost of being terminated late range from $160 to $325 thousand (Table 9). The average bonus ratio in contracts, with roster bonuses is 18 percent and the mean compensation for these contracts is $2, 460 million (Table 3). The average roster bonus in these contracts is thus about $500 a year. The average roster bonus is higher than the change in the matching opportunities of the player, suggesting that the results of our estimation are in the correct ballpark.

6.3) Robustness

In this subsection, we first address some potential concerns about our data selection. Then we show that our specifications are sensible, first by showing how much variation is explained by our observables. Next we re-examine our results from Table 6: we focus on coefficients, which we did not discuss in Section 5.2. We show that these coefficients are consistent with the option nature of non-guaranteed NFL contracts, suggesting that our tobit specification is sensible. Finally, we show that our results are not sensitive to the tobit specification by re-estimating our tests using matching estimators, which can capture potential non-linearities that the tobit specification assumes away.

Omitted Contract Characteristics

We included the most common characteristics of the NFL contract, we omitted incentive and other clauses from our estimation. To partially alleviate concerns about this, we can use the total contract amount as recorded by the NFL, which is supposed to capture the value of the contract for salary cap purposes, and which does not discount the future cash flows to the player. Then we can take the value of the contract, and subtract from it the value of the payments that are coded in our data. The difference represents a proxy for the value that the NFL assigned to these other terms. Table 13 re-estimates the tobit specification of the tradeoff between the signing bonus and roster bonus which we present in Table 6. 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 ratio is practically unchanged from the specifications in Table 6.

Contracts of veteran players

The CBA specifies that contracts of veteran players completely guarantee the 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. So, 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,[17] we re-estimate all specifications

17 The results can be obtained from the author upon request.

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.

How much variance in signing bonus is explained by observables?

Because all of our results come from non-linear estimators, it is hard 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.

$$Signing\ bonus_i = \alpha + \beta * bonus\ ratio_i + \Gamma_1 * contract\ characteristcs_i + \Gamma_2 * player\ ability_i + \varepsilon_i$$

In all of our OLS specifications, the coefficient on bonus ratio is negative and highly statistically significant. The OLS counterpart of the specification in Table 6, column 5 has an R-squared of 50 percent, despite not accounting for the censoring of signing bonuses at 0 and all terms entering linearily. The OLS counterpart of the specification in Table 7, column 4, 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 much.

Hypothesis 2: Pricing other contract terms

In Section 5 we run the following tobit specification to test Hypothesis 2:

$$Signing\ bonus_i = \max(0, \alpha + \beta * bonus\ ratio_i + \Gamma_1 * contract\ characteristcs_i + \Gamma_2 * player\ ability_i + \varepsilon_i)$$

Our main focus in Section 5.2 was the coefficient on the roster bonus ratio. However, interpreting the coefficients on other contract characteristics can serve as a robustness check on whether the tobit specification is appropriate for this setting.

The non-guaranteed NFL contract gives the team an option on the player. As long as the team is paying the player the specified compensation, it keeps the option. Therefore, the compensation each year acts as a strike price of an option. The higher the player's compensation, the less the value the contract has to the team, all else equal. In other words, if a team can sign a player of a given quality for lower annual average pay, all other contract terms equal, then it must have had to compensate the player for this with a signing bonus when he signed the contract. The univariate results show that players' higher average annual compensation is positively correlated with the signing bonus, and that both are correlated with our proxies for player ability.

From Table 6 we can see that controlling for other contract characteristics is not sufficient to yield a negative correlation between average annual compensation and the signing bonus. If we include controls for experience and position, then the correlation becomes statistically indistinguishable from zero. Once we include the control for player ability, though, we find that players with higher average

annual compensation have lower signing bonuses. A team will want to pay less upfront for a player's contract if the contract has higher promised mean compensation for the player. On average, for every additional dollar in compensation that the team promises the player in future years, the signing bonus will decrease by seventeen cents.

Given player characteristics and contract specifications, the team will benefit from a longer contract. If the player's ability is worth more than the contracted compensation, then the team does not terminate the player and captures the rent. If the player's ability is below the promised payment, then the team can simply terminate him or renegotiate the contract. As predicted by the theory, holding fixed other contract and player characteristics, players with longer contracts, receive a larger upfront payment in order to be willing to extend the team's option for another year. On average, a one-year longer contract is worth an additional $843 thousand dollars.

For a given level of mean annual compensation, a contract in which payments are back loaded has higher value for the team, and therefore should command higher upfront compensation for the player. Decreasing the compensation in the early years of the contract and increasing it in later years means that compensation will be paid out only if the player turns out to be good. This increases the option value of the contract. To evaluate the magnitude of this coefficient, assume a two-year contract where the payments are equal in both years, for example $9 million per year. Then, take 10 percent of the mean payment, subtract it from the first year of the contract, and add it to the second year of the contract--so, the promised payment is $9 million for the first year and $11 million for the second year. This increases the Gini coefficient of the contract from 0 to 0.1. This would change the value of the contract by $780 thousand. The simple tobit specification we estimated to test Hypothesis 2 seems to be able to capture the same qualitative sign as predicted by the theory.

Non-linearity

Hypothesis 2:

Because NFL contracts are de facto option contracts, their contract value could be non-linear in contract characteristics, and therefore our results may be identified from the functional-form assumptions we impose on our tobit specification. To control for that potential non-linearity, we implement the nearest-neighbor matching estimator of Abadie and Imbens (2002). The benefit of this approach is that we rely less on the parametric linear structure of the tobit and can better capture the non-linearity in the option price of the contract. The cost is that we only can estimate the average effect of the contract containing a roster bonus, but we do not obtain any information from the variation in the size of the bonus ratio. In this approach, for every contract with a roster bonus we are trying to find one or more contracts which are closest on observable contract and player characteristics, but without a roster bonus and compare their signing bonuses. For example, in the baseline specification we try to match contracts by length, average annual pay, and backload. Once we've found the nearest match, the estimator also corrects for bias arising from imperfect matches. Instead of using one match, we can match each contract on a larger number of contracts, where the number of matches performs a

smoothing role similar to that of bandwidth in a kernel estimation. Intuitively, this approach comes very close to the results presented in the descriptive statistics section, where we compared the average signing bonus of contracts with and without roster bonuses in subsamples based on player ability and contract characteristics.

Table 14 presents the estimates of the average difference in signing bonuses for contracts with roster bonuses and the matched contracts without roster bonuses. The estimate is lowest if we only control for contract characteristics, and use one contract as a match. The coefficient of $-286 thousand means that holding other contract characteristics constant, contracts with roster bonuses on average have $286 thousand lower signing bonuses. The magnitudes of the estimates increase as we include matching on player position and ability metrics, reaching up to $-425 thousand. The coefficient estimates are more stable across different controls if we match on four contracts, instead of one, ranging from $-304 thousand to $-353 thousand.

We then can compare these magnitudes to those obtained from the tobit estimation. For contracts with positive roster bonuses the average roster bonus is 18 percent. Multiplying that by the coefficient of specification 4 in Table 6 ($-2.048 million), we obtain a $369 thousand decrease in the signing bonus if we increase the roster bonus from zero to the mean level. This puts us within the range of estimates we obtain with our matching estimator.

Hypothesis 3:

We match the contracts of players whose old contracts were terminated before the second round of roster bonuses was due on June 1 with the contracts of players whose contracts were terminated later in the offseason. We match on contract characteristics (average annual mean compensation, share of compensation paid as roster bonuses, contract backload) and on a range of specifications, including perturbations of the following player characteristics: the percentage of team plays player participated during the previous year, player position, and tenure. The estimator also adjusts for the bias resulting from imperfect matches. Table 15 presents the results for different specifications of controls and numbers of neighbors. The lowest estimate of the cost of being terminated after roster bonuses are due is $152 thousand. This suggests that players who are terminated after June 1 in the offseason receive on average a $152 thousand lower signing bonus for the same bundle of contract characteristics and ability as players who were terminated before roster bonuses were due. This is very close to the estimate obtained in the tobit specification for a similar experiment. The highest estimate using the matching estimator is $268, below the upper bound obtained in the tobit specification.

Hypothesis 4:

As an alternative to the parametric logit specification, we can use the matching estimator and compare the probability of termination for contracts with and without roster bonuses. To match contracts we use the same matching characteristics as before. The results are presented in Table 16. The magnitudes from these specifications are larger than from the logit specifications. Our lowest estimate suggests that contracts with roster bonuses are 4.7 percent more likely to be terminated at

some point then contracts of a player with similar characteristics, contract length, average annual payment, and backload of contract payments.

7. Conclusion

In addition to its importance in the economics literature, understanding whether contracts are written to more efficiently shape future renegotiation has direct policy consequences. Modification of mortgage contracts, and debt contracts in general, has been one of the focal points of the policy discussion in the current financial crisis (cite). Shavell (2007) claims that legal intervention in contract modification is justified if parties do not consider renegotiation design in writing contracts; whether the parties do so is, in the end, an empirical question. The answer to these questions have evaded us because of several problems, a central one being data limitations. For example , consider the current debate on mortgage renegotiation. Psikorski et al (2009) and Foote et al (2009) come to different conclusions on the frictions surrounding mortgage renegotiation. One of the differences between those papers can be traced to how renegotiation is measured, because a large share of renegotiation may be implicit, and therefore not recorded in the data.

We use labor contracts in a large industry, the NFL, as a unique laboratory for exploring contracting in a world with some ex post bargaining frictions. In the NFL, the hold-up operates through the timing of renegotiation, and it leads to inefficient ex post matching. We focus on a seemingly innocuous difference between paying a player in salary versus roster bonuses. We use a simple model based on the institutional details of contracting in the NFL to show how this seemingly innocuous contracting detail can mitigate the hold-up problem. We then test the empirical predictions of the model and show that they are supported in the data. We find that renegotiation concerns play an economically large role in NFL contracts.

To conclude, we want to highlight some that are beyond the scope of this paper. We have treated market thickness for player skills as exogenous in this paper, which is a reasonable assumption if we focus only on the problem of a single player and team. If a player's contract has a 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?

Also, we 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.

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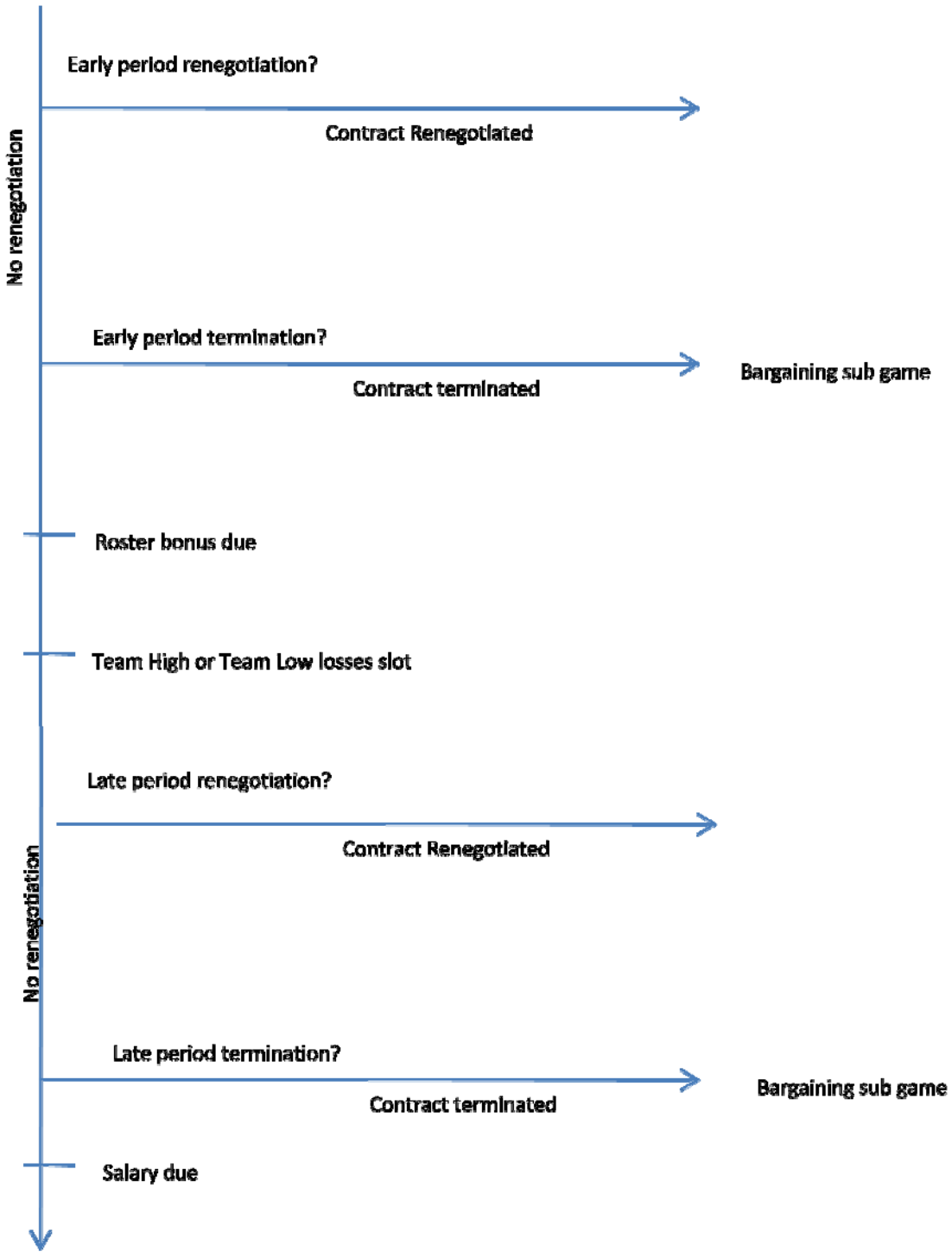
Appendix A


Early period renegotiation?
Contract Renegotiated
No renegotiation
Early period termination?
Contract terminated
Bargaining sub game
Roster bonus due
Team High or Team Low losses slot
Late period renegotiation?
Contract Renegotiated
No renegotiation
Late period termination?
Contract terminated
Bargaining sub game
Salary due

Appendix B

Proof of Proposition 1:

We first prove two lemmas.

Lemma 1:

The expected compensation of a player with a roster bonus is $\min(w, W_o, W_h)$. Contracts of players with roster bonus are never renegotiated or terminated in the late period. The player is terminated in the early offseason when $\min(w, W_o, W_h) = W_o$; the contract is renegotiated early in the offseason if $\min(w, W_o, W_h) = W_h$, and is kept in place if $\min(w, W_o, W_h) = w$.

Proof:

Consider the subgame in which the original contract was maintained into the late period. The compensation the current team owes to the player is 0. Since $W_o > 0$, the team always retains the player; it cannot renegotiate the contract lower than 0, and cannot do better by terminating the player.

In the early period if the player rejects the team's renegotiation offer, the team can terminate the contract. It is straightforward to show that in the bargaining subgame the player's payoff is ε (formally $\lim \varepsilon \to 0, \varepsilon > 0$) in excess of the second highest valuation of teams present in the market. Therefore, if terminated in the early period the player realizes a payoff of $\min(W_o + \varepsilon, W_h + \varepsilon)$ in the bargaining subgame between Team A , Team High, Team Low and the Quarterback. If the player rejects renegotiation, the team has to pay the player the roster bonus w before entering the late period, so the total expected compensation from keeping the contract is w. In the subgame, in which the player rejects the renegotiation offer he will either be terminated and obtain $\min(W_o + \varepsilon, W_h + \varepsilon)$ or the contract stays in place, the team pays the roster bonus, and he obtains w. The team will keep the contract in place if if $\min(w, W_o + \varepsilon, W_h + \varepsilon) = w$. Therefore the players compensation from the subgame after rejecting renegotiation is $\min(w, W_o + \varepsilon, W_h + \varepsilon)$.

The team can also propose renegotiation. The players' strategy is to accept any offer higher or equal than the lowest amount he could obtain in the subgame of rejecting the offer, which is $\min(w, W_o + \varepsilon, W_h + \varepsilon)$. It is straightforward to check that the equilibrium strategies is the following: Team A's strategy is to propose $\min(w, W_o, W_h + \varepsilon)$. We will assume that if the team and player are indifferent between keeping the contract in place or renegotiation it, they will keep it in place.

Therefore If $\min(w, W_o, W_h) = W_h$ Quarterback accepts Team A's offer $W_h + \varepsilon$. Otherwise renegotiation is rejected.

If $\min(w, W_o, W_h) = W_o$, Team A proposes renegotiation for W_o, Quarterback rejects the offer. The contract is terminated by Team A, and the player signs with Team High in the bargaining subgame for $W_o + \varepsilon$.

If $\min(w, W_o, W_h) = w$ the contract stays in place.

Lemma 2:

The expected compensation of a player without a roster bonus is $p * \min(w, W_o + \varepsilon, W_h + \varepsilon) + (1-p) * \min(w, W_l + \varepsilon)$. The player rejects contract renegotiation in the early period, the contract is kept in place into the late period. If the team remaining in the late period is team High, the contract is kept in place if $w \leq \min(W_o, W_h)$ and is renegotiated if $\min(W_o, W_h) = W_h$ and is terminated if $\min(W_o, W_h) = W_o$. If the team remaining in the late period is team Low, the contract is kept in place if $w \leq W_l$ and renegotiated otherwise.

is renegotiated $\min(w, W_o, W_h) = W_h$, terminated if $\min(w, W_o, W_h) = W_o$ and kept in place if $\min(w, W_o, W_h) = w$. If the team remaining in the late period is Low, the contract is renegotiated if $\min(w, W_l) = W_l$ and kept in place if $\min(w, W_l) = W_l$.

Proof:

Consider the subgame in the late period after the player rejects the renegotiation offer from Team A. If team High is present, then if:

- $w \leq \min(W_o, W_h)$: contract is kept in place
- $w > \min(W_o, W_h)$ and
    - o $\min(W_o, W_h) = W_o$: contract terminated and Quarterback signs with Team High for $W_o + \varepsilon$ in the ensuing bargaining game
    - o $\min(W_o, W_h) = W_h$: contract terminated and Quarterback signs with Team A for $W_h + \varepsilon$ in the ensuing bargaining game

If team Low is present, then:

- if $w > W_l$: contract terminated and Quarterback signs with Team A for $W_l + \varepsilon$ in the ensuing bargaining game
- $w \leq W_l$: contract is kept in place if

In the renegotiation stage in the late period the players' strategy is to accept any offer higher or equal than expected amount he could obtain in the subgame of rejecting the offer. Therefore, If Team High is present, then the Quarterback's strategy is to reject any offer below $\min(w, W_o + \varepsilon, W_h + \varepsilon)$ and if Team Low is present, reject any offers below $\min(w, W_l + \varepsilon)$

Therefore Team A's strategy is to propose $\min(w, W_o, W_h + \varepsilon)$. Note that Team A is indifferent between the proposed strategy and any strategy that specifies a lower offer.

Consider the subgame in the early period, in which the player rejects the team offer of renegotiation. If the player is terminated in the early period, his payoff is $\min(W_o + \varepsilon, W_h + \varepsilon)$. If the contract is kept in place, his payoff is the expected payoff from the subgame in which the contract is in place: $p *$

$\min(w, W_o + \varepsilon, W_h + \varepsilon) + (1-p) * \min(w, W_l + \varepsilon)$. Therefore, if the Quarterback rejects renegotiation in the early period, the contract stays in place. The Quarterback's contract is never terminated in the early period.

The team can also propose renegotiation. The player's equilibrium strategy is to accept any offer higher than his expected payoff from rejecting the offer, $p * \min(w, W_o + \varepsilon, W_h + \varepsilon) + (1-p) * \min(w, W_l + \varepsilon)$. The team's expected profits from holding on to the contract are $p * (W_o - \min(w, W_o, W_h + \varepsilon)) + (1-p) * (W_o - \min(w, W_l + \varepsilon)) = W_o - (p * \min(w, W_o, W_h + \varepsilon) + (1-p) * \min(w, W_l + \varepsilon))$. Therefore it is willing to offer at most $(p * \min(w, W_o, W_h + \varepsilon) + (1-p) * \min(w, W_l + \varepsilon)$, which is weakly less than what the Quarterback is willing to accept. Therefore the contract stays in place in the early period.

a) Contract with roster bonus is weakly more profitable for the Quarterback

From Lemma 2 the expected compensation of the Quarterback from the contract without a roster bonus is $p * \min(w, W_o + \varepsilon, W_h + \varepsilon) + (1-p) * \min(w, W_l + \varepsilon)$

Since $W_h > W_o > W_l$ we know that $\min(w, W_o + \varepsilon, W_h + \varepsilon) \geq \min(w, W_l + \varepsilon)$

then $p * \min(w, W_o + \varepsilon, W_h + \varepsilon) + (1-p) * \min(w, W_l + \varepsilon) \leq p * \min(w, W_o + \varepsilon, W_h + \varepsilon) + (1-p) * \min(w, W_o + \varepsilon, W_h + \varepsilon) = \min(w, W_o + \varepsilon, W_h + \varepsilon)$, which is the expected compensation from the contract with a roster bonus from Lemma 1.

Contract with roster bonus is weakly less profitable for Team A

b) Observe that the expected profits of Team A from a contract W_o minus the expected compensation of the player, regardless of which team the player eventually plays for. Therefore, the result follows straight from point a).

c) Contract with roster bonus is terminated and renegotiated in the early rather than late period

Follows straight from Lemma 1 and Lemma 2

d) Contract with roster bonus has a weakly higher probability of termination

From Lemma 1 we know that the contract with a roster bonus is terminated whenever $\min(w, W_o, W_h) = W_o$. If the contract does not have a roster bonus, it is terminated if $\min(w, W_o, W_h) = W_o$ with probability p, which is the probability that the team that had an open slot in the late period was Team High.

Table 1

The sample contains 4,220 NFL contracts. Year contract signed is the year in which the contract was signed.

Years in contract	Frequency	Percent (%)	Cumulative Distribution (%)
1994	10	0.24	0.24
1995	25	0.59	0.83
1996	16	0.38	1.21
1997	14	0.33	1.54
1998	25	0.59	2.13
1999	273	6.47	8.6
2000	712	16.87	25.47
2001	1,478	35.02	60.5
2002	1,654	39.19	99.69
2003	13	0.31	100
Total	4,220	100	

Table 2

The sample contains 4,220 NFL contracts. Panel B contains the subsample of 1428 NFL contracts, which are longer than one year. Years in contract is the number of years the contract is signed for.

Panel A: Full Sample

Years in contract	Frequency	Percent (%)	Cumulative Distribution (%)
1	2,792	66.16	66.16
2	395	9.36	75.52
3	348	8.25	83.77
4	219	5.19	88.96
5	237	5.62	94.57
6	142	3.36	97.94
7	65	1.54	99.48
8	15	0.36	99.83
9	4	0.09	99.93
10	2	0.05	99.98
12	1	0.02	100
Total	4,220	100	

Panel B: Contracts longer than 1 year

Years in contract	Frequency	Percent (%)	Cumulative Distribution (%)
2	395	27.66	27.66
3	348	24.37	52.03
4	219	15.34	67.37
5	237	16.6	83.96
6	142	9.94	93.91
7	65	4.55	98.46
8	15	1.05	99.51
9	4	0.28	99.79
10	2	0.14	99.93
12	1	0.07	100
Total	1,428	100	

Table 3

The sample contains 1,428 NFL contracts longer than 1 year. 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

	No. observations	Mean	St. Dev	Median
Signing bonus	1428	1373674	2287912	350000
Average annual pay	1428	1772305	1591772	1164583
Years in contract	1428	3.77451	1.614882	3
Contract backload	1428	0.1144489	0.098844	0.108205
Roster bonus ratio	1428	0.0804845	0.1358803	0
Plays last year	1428	0.5730077	0.3233307	0.6247056
Player tenure	1428	5.62535	3.165662	5

Panel B: Contracts with a positive roster bonus

	No. observations	Mean	St. Dev	Median
Signing bonus	638	1760925	2597648	632505
Average annual pay	638	2459650	1704359	2078036
Years in contract	638	4.286834	1.64918	4
Contract backload	638	0.1439515	0.097953	0.1524301
Roster bonus ratio	638	0.1801441	0.1529065	0.1354824
Plays last year	638	0.6737312	0.2887275	0.7359975
Player tenure	638	6.294671	3.036306	6

Panel C: Contracts with no roster bonus

	No. observations	Mean	St. Dev	Median
Signing bonus	790	1060931	1949428	250000
Average annual pay	790	1217208	1243700	715833.3
Years in contract	790	3.360759	1.461887	3
Contract backload	790	0.0906227	0.0930154	0.0681278
Plays last year	790	0.4916639	0.3270251	0.5069767
Player tenure	790	5.08481	3.166547	4

Table 4

The sample contains 1,428 NFL contracts longer than 1 year cut into subsamples. The subsamples are formed on 10 percentage point bins of plays last year. 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. 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).

Subsample	Statistic	Years in contract	Average annual pay	Contract backload	Roster bonus ratio	Signing bonus
0 - 0.1	Mean	2.51462	676362.3	0.0666026	0.0235829	170105.3
	St. error	0.0720035	64359.16	0.0064083	0.0056731	63720.08
	No. ob.	171	171	171	171	171
0.1 - 0.2	Mean	2.988889	1072845	0.0856065	0.0534897	286512.3
	St. error	0.1382018	145566.8	0.0078309	0.0113864	66736.87
	No. ob.	90	90	90	90	90
0.2 - 0.3	Mean	2.985915	853878.4	0.0816961	0.0310219	536732.4
	St. error	0.1480836	74381.7	0.008453	0.0081181	112614.9
	No. ob.	71	71	71	71	71
0.3 - 0.4	Mean	3.725806	1143774	0.0999756	0.0677256	766472
	St. error	0.1346863	101636.9	0.0072635	0.0110519	135962.3
	No. ob.	124	124	124	124	124
0.4 - 0.5	Mean	3.349057	1244731	0.0906088	0.0882354	624981.2
	St. error	0.1406201	127696.3	0.0112287	0.0136271	114591.6
	No. ob.	106	106	106	106	106
0.5 - 0.6	Mean	3.788136	1631251	0.1279838	0.0757287	1364972
	St. error	0.142844	129783.2	0.0090753	0.0127151	212574.5
	No. ob.	118	118	118	118	118
0.6 - 0.7	Mean	3.685897	1647297	0.1100538	0.0766511	1080586
	St. error	0.1195541	123765.9	0.0070305	0.0094792	144200.1
	No. ob.	156	156	156	156	156
0.7 - 0.8	Mean	4.219697	2215732	0.1257907	0.1065332	1896561
	St. error	0.1361691	145723.1	0.0094947	0.0147012	221991.2
	No. ob.	132	132	132	132	132
0.8 - 0.9	Mean	4.368421	2605177	0.1491179	0.1104345	2406599
	St. error	0.1153458	128098.8	0.0072715	0.0126536	226519.7
	No. ob.	152	152	152	152	152
0.9 - 1	Mean	4.609121	2749553	0.1465986	0.1117224	2476698
	St. error	0.0964053	91984.3	0.0060192	0.0086006	165535.2
	No. ob.	307	307	307	307	307

Table 5

The specification is a logit. The sample contains 1428 NFL contracts, which are longer than one year. The dependent variable is whether the contract contains a roster 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. Games starter last year is the number of games the player started last year divided by the number of games of the team. Player position dummies includes 23 dummies for the player's positions at signing of contract. Team dummies incudes the dummies for teams in the NFL. Awards dummies specify 16 dummies for awards player can receive. The statistical significance levels for the joint significnace of dummies are computed using the Wald test. The reported coefficients are marginal effects.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Signing bonus	Signing bonus	Signing bonus	Signing bonus	Signing bonus
Player tenure				0.0193***	0.0185***
				(0.00518)	(0.00574)
Plays last year (%)				0.166*	0.122
				(0.0901)	(0.0992)
Games started last year (%)				0.0122***	0.0166***
				(0.00420)	(0.00474)
Player position dummies	Y*	N	Y**	N	Y*
Team dummies	N	Y***	Y***	N	Y***
Award dummies	N	N	N	Y	Y
Observations	1416	1414	1402	1428	1402

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

Robust standard errors clustered by player

Table 6

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. 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. Games starter last year is the number of games the player started last year divided by the number of games of the team. 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.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Signing bonus	Signing bonus	Signing bonus	Signing bonus	Signing bonus
Average annual pay	0.000859	-0.0682	-0.0362	-0.136*	-0.167**
	(0.0730)	(0.0719)	(0.0752)	(0.0725)	(0.0718)
Years in contract	977586***	996993***	988316***	885324***	843101***
	(76435)	(74020)	(73962)	(70539)	(66362)
Contract backload	7.62e+06***	8.08e+06***	8.03e+06***	7.75e+06***	7.87e+06***
	(1.25e+06)	(1.23e+06)	(1.22e+06)	(1.16e+06)	(1.01e+06)
Roster bonus ratio	-1920600***	-1865854***	-1820327***	-2048420***	-2241238***
	(699479)	(694464)	(691470)	(670348)	(649026)
Player tenure			-42820*	-81110***	-81769***
			(24026)	(24166)	(23615)
Plays last year (%)				2.14e+06***	1.52e+06***
				(251267)	(323813)
Games started last year (%)					25172*
					(14454)
Player position dummies	N	Y	Y	Y	Y
Award dummies	N	N	N	N	Y
Constant	-3707358***	-3589186***	-3357604***	-3905906***	-3649066***
	(226829)	(378866)	(391134)	(424603)	(402629)
Observations	1428	1428	1428	1428	1428

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

Robust standard errors clustered by player

Table 7

The specification is a tobit with censoring at 0. The sample contains 1335 NFL contracts, which are longer than one year and were signed between 1999 and 2002. The dependent variable is the signing bonus of a contract. 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. Games starter last year is the number of games the player started last year divided by the number of games of the team. 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. Club dummies specify dummies for the club signing the contract.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Signing bonus	Signing bonus	Signing bonus	Signing bonus	Signing bonus
Average annual pay	-0.00886	-0.0805	-0.0720	-0.169**	-0.191***
	(0.0690)	(0.0682)	(0.0713)	(0.0688)	(0.0669)
Years in contract	980241***	1.01e+06***	1.01e+06***	907355***	864402***
	(78350)	(76375)	(76213)	(71279)	(65309)
Contract backload	8.34e+06***	8.50e+06***	8.47e+06***	8.08e+06***	8.21e+06***
	(1.34e+06)	(1.30e+06)	(1.31e+06)	(1.23e+06)	(1.03e+06)
Roster bonus ratio	-1411367**	-1428348**	-1414147**	-1752430**	-1944532***
	(712953)	(718072)	(716556)	(711362)	(696612)
Player tenure			-13530	-55054**	-56037**
			(23489)	(23169)	(22260)
Plays last year (%)				2.14e+06***	1.38e+06***
				(245396)	(353197)
Games started last year (%)					29101*
					(16131)
Club dummies	Y	Y	Y	Y	Y
Player position dummies	N	Y	Y	Y	Y
Award dummies	N	N	N	N	Y
Constant	-4600221***	-4688071***	-4569277***	-5105127***	-5536652***
	(1.14e+06)	(1.12e+06)	(1.13e+06)	(1.16e+06)	(963896)
Observations	1335	1335	1335	1335	1335

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

Robust standard errors clustered by player

Table 8

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. 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 in a year is calculated as the maximum of the share of defensive, offensive or special team plays of the team the player participated in a year. Plays last year is calculated for the season before the contract was signed. Plays contact year is calculated for the first season of the contract. Plays second season is calculated for the second season of the contract. Games starter in a year is the number of games the player started last year divided by the number of games of the team. 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 for the year.

	(1)	(2)	(3)	(4)
VARIABLES	Signing bonus	Signing bonus	Signing bonus	Signing bonus
Average annual pay	-0.162**	-0.185***	-0.173**	-0.190**
	(0.0721)	(0.0716)	(0.0759)	(0.0753)
Years in contract	826190***	767097***	853593***	802833***
	(70616)	(64493)	(74609)	(69816)
Contract backload	7.69e+06***	7.69e+06***	8.02e+06***	8.06e+06***
	(1.14e+06)	(993126)	(1.26e+06)	(1.08e+06)
Roster bonus ratio	-1997129***	-2225526***	-1984976***	-2202995***
	(660470)	(599360)	(694401)	(617856)
Player tenure	-63444**	-68980***	-49021*	-59289**
	(24826)	(24109)	(29007)	(28612)
Plays last year (%)	1.42e+06***	673325*	1.33e+06***	555497
	(282356)	(374012)	(317872)	(435596)
Games started last year (%)		32239*		35329*
		(16632)		(18820)
Plays contract year (%)	1.60e+06***	1.60e+06***	993750***	1.44e+06***
	(291596)	(423396)	(352112)	(526052)
Games started contract year (%)		-3008		-23386
		(18470)		(23137)
Plays second season (%)			706495***	330228
			(266646)	(437343)
Games started second season (%)				15280
				(21315)
Player position dummies	Y	Y	Y	Y
Award dummies		Y		Y
Award dummies contract year		Y		Y
Award dummies second season				Y
Constant	-4424554***	-4002909***	-4561070***	-4155703***
	(428353)	(407283)	(483392)	(471088)
Observations	1356	1356	1133	1133

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

Robust standard errors clustered by player

Table 9

The specification is a tobit with censoring at 0. The sample contains 266 NFL contracts, which are longer than one year for 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. 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. Games starter last year is the number of games the player started last year divided by the number of games of the team. 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.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Signing bonus	Signing bonus	Signing bonus	Signing bonus	Signing bonus
Day of termination	-2263***	-2169***	-2570***	-2168***	-1812***
	(593.4)	(586.4)	(624.0)	(615.3)	(598.8)
Average annual pay	-0.0462	-0.0791	-0.0334	-0.0597	-0.108
	(0.0844)	(0.0715)	(0.0727)	(0.0732)	(0.0982)
Years in contract	254052***	296061***	316659***	288904***	249644***
	(80544)	(68877)	(71035)	(75005)	(75505)
Contract backload	4.11e+06***	3.99e+06***	3.86e+06***	3.82e+06***	4.28e+06***
	(975342)	(921002)	(908416)	(923219)	(862497)
Roster bonus ratio	-765350	-571576	-437435	-690838	-614240
	(602406)	(544409)	(545532)	(552611)	(554654)
Player tenure			-58157**	-69115***	-63658**
			(24568)	(24833)	(25182)
Plays last year (%)				716767***	470817
				(249841)	(366927)
Games started last year (%)					17645
Award dummies					(16959)
Player position dummies	N	Y	Y	Y	Y
	N	N	N	N	Y
Constant	-868703***	-672542**	-303588	-348563	-306100
	(235783)	(290760)	(294149)	(312024)	(294372)
Observations	266	266	266	266	266

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

Robust standard errors clustered by player

Table 10

The specification is a tobit with censoring at 0. The sample contains 212 NFL contracts, which are longer than one year for 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. 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 in a year is calculated as the maximum of the share of defensive, offensive or special team plays of the team the player participated in a year. Plays last year is calculated for the season before the contract was signed. Plays contact year is calculated for the first season of the contract. Plays second season is calculated for the second season of the contract. Games starter in a year is the number of games the player started last year divided by the number of games of the team. 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 for the year.

	(1)	(2)
VARIABLES	Signing bonus	Signing bonus
Day of termination	-1768**	-2487***
	(720.7)	(534.4)
Average annual pay	-0.0771	-0.106
	(0.0744)	(0.0923)
Years in contract	288816***	154368**
	(80273)	(68483)
Contract backload	4.69e+06***	4.45e+06***
	(1.06e+06)	(893866)
Roster bonus ratio	-588528	-608403
	(586638)	(551729)
Player tenure	-60429**	-83936***
	(27577)	(25110)
Plays last year (%)	575806*	-148670
	(296467)	(426955)
Games started last year (%)		32777*
		(18047)
Plays contract year (%)	381629	638322
	(297192)	(416961)
Games started contract year (%)		-14326
		(23970)
Player position dummies	Y	Y
Award dummies		Y
Award dummies contract year		Y
Constant	-818149**	-54139
	(357190)	(71329)
Observations	212	212

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

Robust standard errors clustered by player

Table 11

The specification is a logit. The sample contains 1428 NFL contracts, which are longer than one year. 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. 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. Games starter last year is the number of games the player started last year divided by the number of games of the team. 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. The reported coefficients are marginal effects.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Terminated	Terminated	Terminated	Terminated	Terminated
Average annual pay	1.42e-08**	1.24e-08*	9.11e-09	9.63e-09	1.18e-08*
	(6.48e-09)	(6.39e-09)	(6.58e-09)	(6.79e-09)	(6.83e-09)
Years in contract	-0.0353***	-0.0349***	-0.0343***	-0.0339***	-0.0324***
	(0.00746)	(0.00714)	(0.00715)	(0.00748)	(0.00738)
Contract backload	0.192*	0.200**	0.202**	0.204**	0.199**
	(0.107)	(0.100)	(0.0999)	(0.100)	(0.0982)
Roster bonus ratio	0.169***	0.162***	0.155**	0.156***	0.166***
	(0.0637)	(0.0604)	(0.0608)	(0.0605)	(0.0609)
Player tenure			0.00391	0.00408	0.00373
			(0.00279)	(0.00291)	(0.00295)
Plays last year (%)				-0.00939	0.00220
				(0.0361)	(0.0582)
Games started last year (%)					-4.67e-05
					(0.00274)
Player position dummies	N	Y	Y	Y	Y
Award dummies	N	N	N	N	Y
Observations	1428	1414	1414	1414	1414

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

Robust standard errors clustered by player

Table 12

The specification is a logit. 2478 NFL contract offseason pairs, for contracts that are longer than one year. 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. 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. Games starter last year is the number of games the player started last year divided by the number of games of the team. 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. The reported coefficients are marginal effects.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Terminated	Terminated	Terminated	Terminated	Terminated
Average annual pay	0.00139***	0.00128***	0.000908***	0.00113***	0.00116***
	(0.000267)	(0.000277)	(0.000283)	(0.000292)	(0.000301)
Years in contract	-0.0273***	-0.0268***	-0.0264***	-0.0242***	-0.0241***
	(0.00434)	(0.00429)	(0.00424)	(0.00434)	(0.00443)
Contract backload	-0.0576	-0.0525	-0.0506	-0.0554	-0.0467
	(0.0638)	(0.0609)	(0.0579)	(0.0569)	(0.0605)
Roster bonus ratio	0.0987***	0.0955***	0.0823***	0.0854***	0.0857***
	(0.0219)	(0.0212)	(0.0215)	(0.0216)	(0.0216)
Player tenure			0.00488***	0.00548***	0.00519***
			(0.00150)	(0.00149)	(0.00149)
Plays last year (%)				-0.0435**	-0.0468
				(0.0182)	(0.0337)
Games started last year (%)					0.000500
					(0.00159)
Player position dummies	N	Y	Y	Y	Y
Award dummies	N	N	N	N	Y
Observations	2478	2453	2453	2453	2419

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

Robust standard errors clustered by player

Table 13

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. 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). Uncoded contract amount is the salary cap value of the contract at signing minus the payments coded in the data. Uncoded contract amount ratio 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. 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. Games starter last year is the number of games the player started last year divided by the number of games of the team. 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.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Signing bonus	Signing bonus	Signing bonus	Signing bonus	Signing bonus
Average annual pay	0.0363	-0.0331	-0.000780	-0.107	-0.153**
	(0.0742)	(0.0751)	(0.0776)	(0.0755)	(0.0768)
Years in contract	897089***	937164***	927965***	842491***	828575***
	(71526)	(70587)	(70007)	(66564)	(63083)
Contract backload	8.36e+06***	8.67e+06***	8.61e+06***	8.23e+06***	8.08e+06***
	(1.03e+06)	(1.02e+06)	(1.01e+06)	(971499)	(938012)
Roster bonus ratio	-2118437***	-1997809***	-1953882***	-2134825***	-2259826***
	(738044)	(733384)	(730801)	(708420)	(675951)
Uncoded contract amount	0.0157	0.00326	0.00387	-0.000462	-0.00530
	(0.0423)	(0.0418)	(0.0417)	(0.0414)	(0.0411)
Uncoded contract amount ratio	79774	83272	82023	71605	42460
	(86173)	(85497)	(85036)	(84453)	(79875)
Player tenure			-43076*	-80398***	-81283***
			(23650)	(23882)	(23531)
Plays last year (%)				2.09e+06***	1.53e+06***
				(251985)	(324339)
Games started last year (%)					23703
					(14724)
Player position dummies	N	Y	Y	Y	Y
Award dummies	N	N	N	N	Y
Constant	2.21e+06***	2.16e+06***	2.15e+06***	2.10e+06***	2.02e+06***
	(92133)	(89493)	(88964)	(88105)	(82036)
Observations	1428	1428	1428	1428	1428

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

Robust standard errors clustered by player

Table 14

The sample contains 1428 NFL contracts, which are longer than one year. The results are estimates of the average treatment effect of the presence of a positive roster bonus in the contract on the signing bonus. The estimator is the Abadie and Imbens (2002) nearest neighbor estimator. Panel A presents results using 1 matching neighbor. Panel B presents results using 4 matching neighbors. In specifications where matching categories include player tenure and player position, exact matching on those characteristics is applied. The bias correction is applied for variables not exactly matched.

Panel A: One neighbor				
	(1)	(2)	(3)	(4)
VARIABLES	Signing bonus	Signing bonus	Signing bonus	Signing bonus
Positive roster bonus	-285586**	-361026***	-276489**	-424819***
	(131363)	(116736)	(120514)	(119052)
Observations	1428	1428	1428	1428
Matched on:				
Average annual pay	Y	Y	Y	Y
Years in contract	Y	Y	Y	Y
Contract backload	Y	Y	Y	Y
Player tenure	N	Y	N	Y
Player position dummies	N	Y	N	Y
Plays last year (%)	N	N	Y	Y

Panel B: Four neighbors				
	(1)	(2)	(3)	(4)
VARIABLES	Signing bonus	Signing bonus	Signing bonus	Signing bonus
Positive roster bonus	-304005***	-324160***	-309696***	-352988***
	(91871)	(118990)	(92085)	(120520)
Observations	1428	1428	1428	1428
Matched on:				
Average annual pay	Y	Y	Y	Y
Years in contract	Y	Y	Y	Y
Contract backload	Y	Y	Y	Y
Player tenure	N	Y	N	Y
Player position dummies	N	Y	N	Y
Plays last year (%)	N	N	Y	Y

Table 15

The sample contains 266 NFL contracts, which are longer than one year for players whose previous contract was terminated. The results are estimates of the average treatment effect of the previous contract being terminated before June 1 the contract on the signing bonus. The estimator is the Abadie and Imbens (2002) nearest neighbor estimator. Panel A presents results using 1 matching neighbor. Panel B presents results using 4 matching neighbors. In specifications where matching categories include player tenure and player position, exact matching on those characteristics is applied. The bias correction is applied for variables not exactly matched.

Panel A: One neighbor

	(1)	(2)	(3)	(4)
VARIABLES	Signing bonus	Signing bonus	Signing bonus	Signing bonus
Previous contract terminated before June 1	255478**	282095***	240247*	267720***
	(112514)	(85982)	(136562)	(87263)
Observations	266	266	266	266
Matched on:				
Average annual pay	Y	Y	Y	Y
Years in contract	Y	Y	Y	Y
Contract backload	Y	Y	Y	Y
Roster bonus ratio	Y	Y	Y	Y
Player tenure	N	Y	N	Y
Player position dummies	N	Y	N	Y
Plays last year (%)	N	N	Y	Y

Panel B: Four neighbors

	(1)	(2)	(3)	(4)
VARIABLES	Signing bonus	Signing bonus	Signing bonus	Signing bonus
Previous contract terminated before June 1	245538***	193210**	205360***	151622**
	(55794)	(77199)	(57990)	(77344)
Observations	266	266	266	266
Matched on:				
Average annual pay	Y	Y	Y	Y
Years in contract	Y	Y	Y	Y
Contract backload	Y	Y	Y	Y
Roster bonus ratio	Y	Y	Y	Y
Player tenure	N	Y	N	Y
Player position dummies	N	Y	N	Y
Plays last year (%)	N	N	Y	Y

Table 16

The sample contains 1428 NFL contracts, which are longer than one year. The results are estimates of the average treatment effect of the presence of a positive roster bonus in the contract on the probability of the contract being terminated a some point. The estimator is the Abadie and Imbens (2002) nearest neighbor estimator. Panel A presents results using 1 matching neighbor. Panel B presents results using 4 matching neighbors. In specifications where matching categories include player tenure and player position, exact matching on those characteristics is applied. The bias correction is applied for variables not exactly matched.

Panel A: One neighbor

	(1)	(2)	(3)	(4)
VARIABLES	Terminated	Terminated	Terminated	Terminated
Positive roster bonus	0.0739***	0.0650***	0.0754***	0.0680***
	(0.0282)	(0.0231)	(0.0256)	(0.0233)
Observations	1428	1428	1428	1428
Matched on:				
Average annual pay	Y	Y	Y	Y
Years in contract	Y	Y	Y	Y
Contract backload	Y	Y	Y	Y
Player tenure	N	Y	N	Y
Player position dummies	N	Y	N	Y
Plays last year (%)	N	N	Y	Y

Panel B: Four neighbors

	(1)	(2)	(3)	(4)
VARIABLES	Terminated	Terminated	Terminated	Terminated
Positive roster bonus	0.0564**	0.0719***	0.0466*	0.0728***
	(0.0254)	(0.0201)	(0.0250)	(0.0198)
Observations	1428	1428	1428	1428
Matched on:				
Average annual pay	Y	Y	Y	Y
Years in contract	Y	Y	Y	Y
Contract backload	Y	Y	Y	Y
Player tenure	N	Y	N	Y
Player position dummies	N	Y	N	Y
Plays last year (%)	N	N	Y	Y

Figure 1

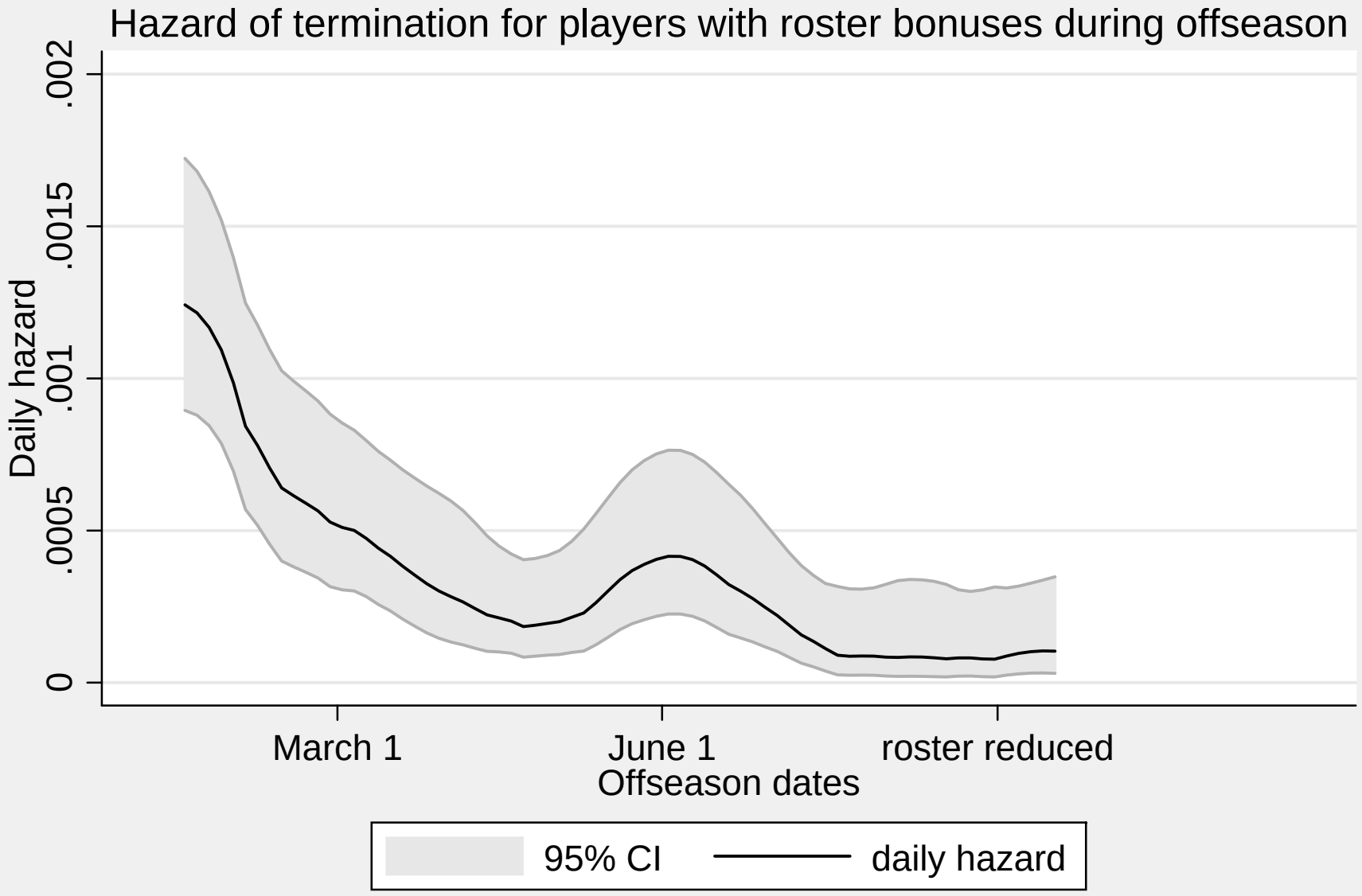
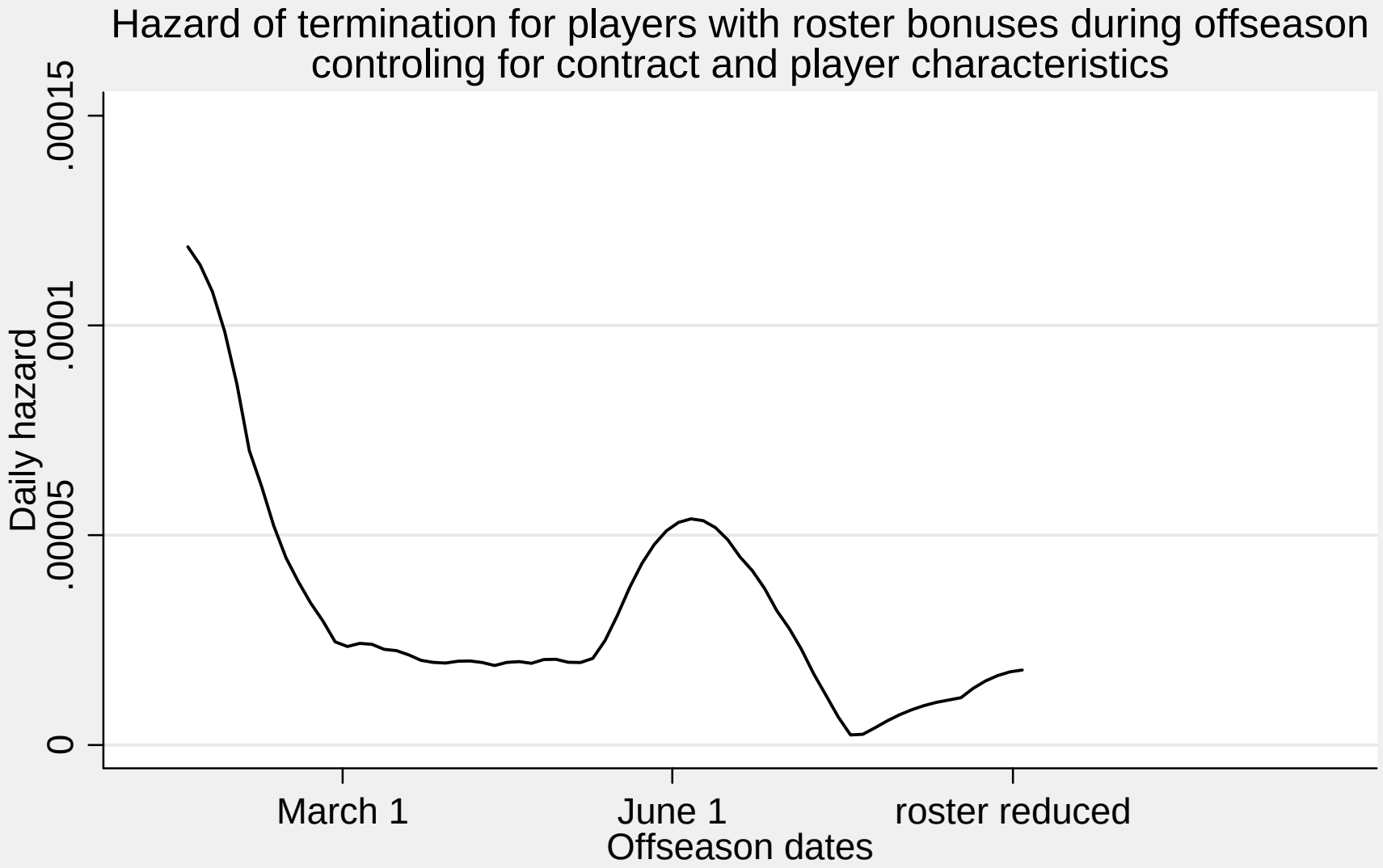

Hazard of termination for players with roster bonuses during offseason
Daily hazard
0
.0005
.001
.0015
.002
March 1
June 1
roster reduced
Offseason dates
95% CI
daily hazard

Figure 2



Baseline hazard from a Cox model controlling for contract and player characteristics

Figure 3

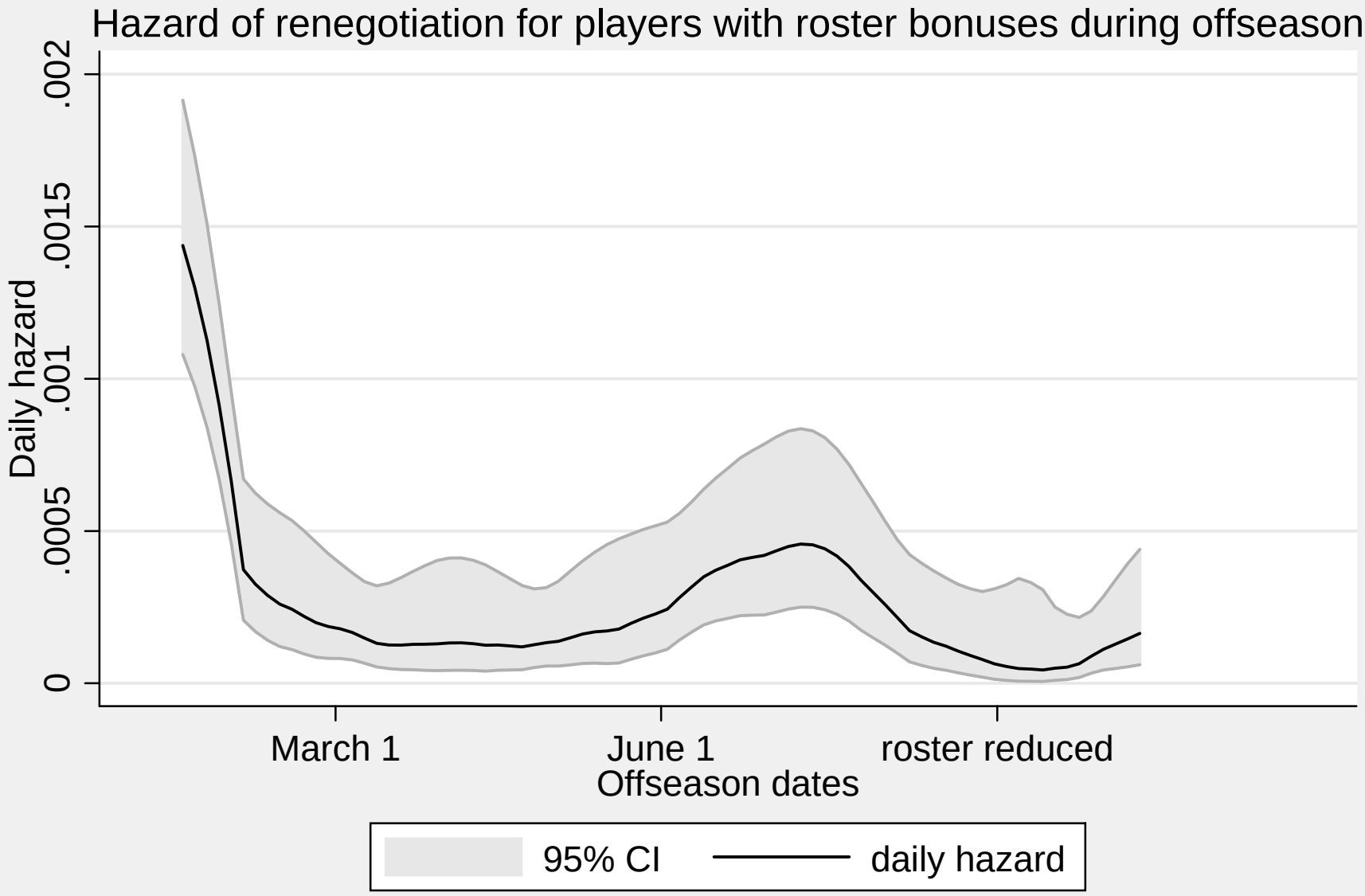
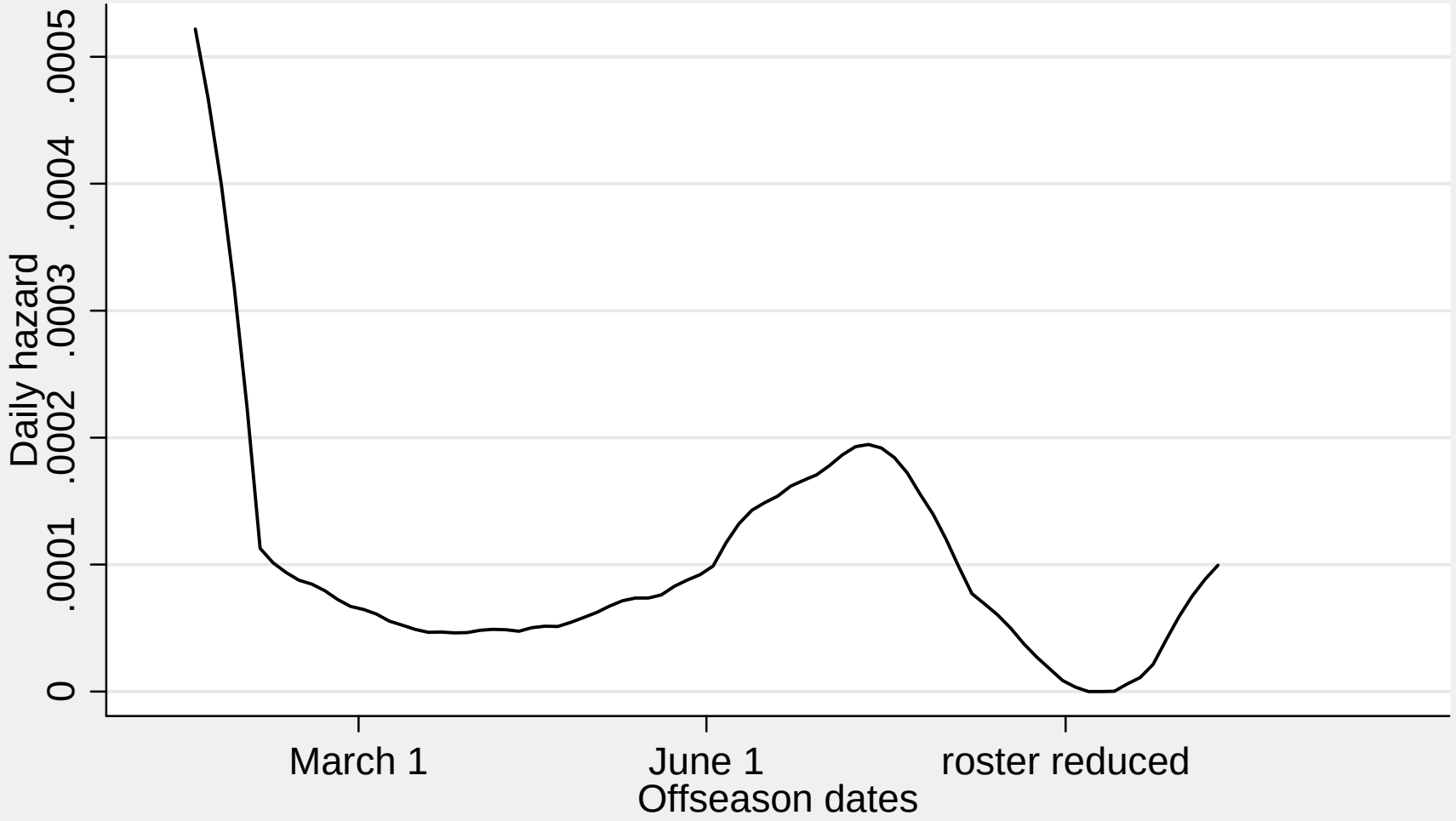

Hazard of renegotiation for players with roster bonuses during offseason
Daily hazard
0
.0005
.001
.0015
.002
March 1
June 1
roster reduced
Offseason dates
95% CI
daily hazard

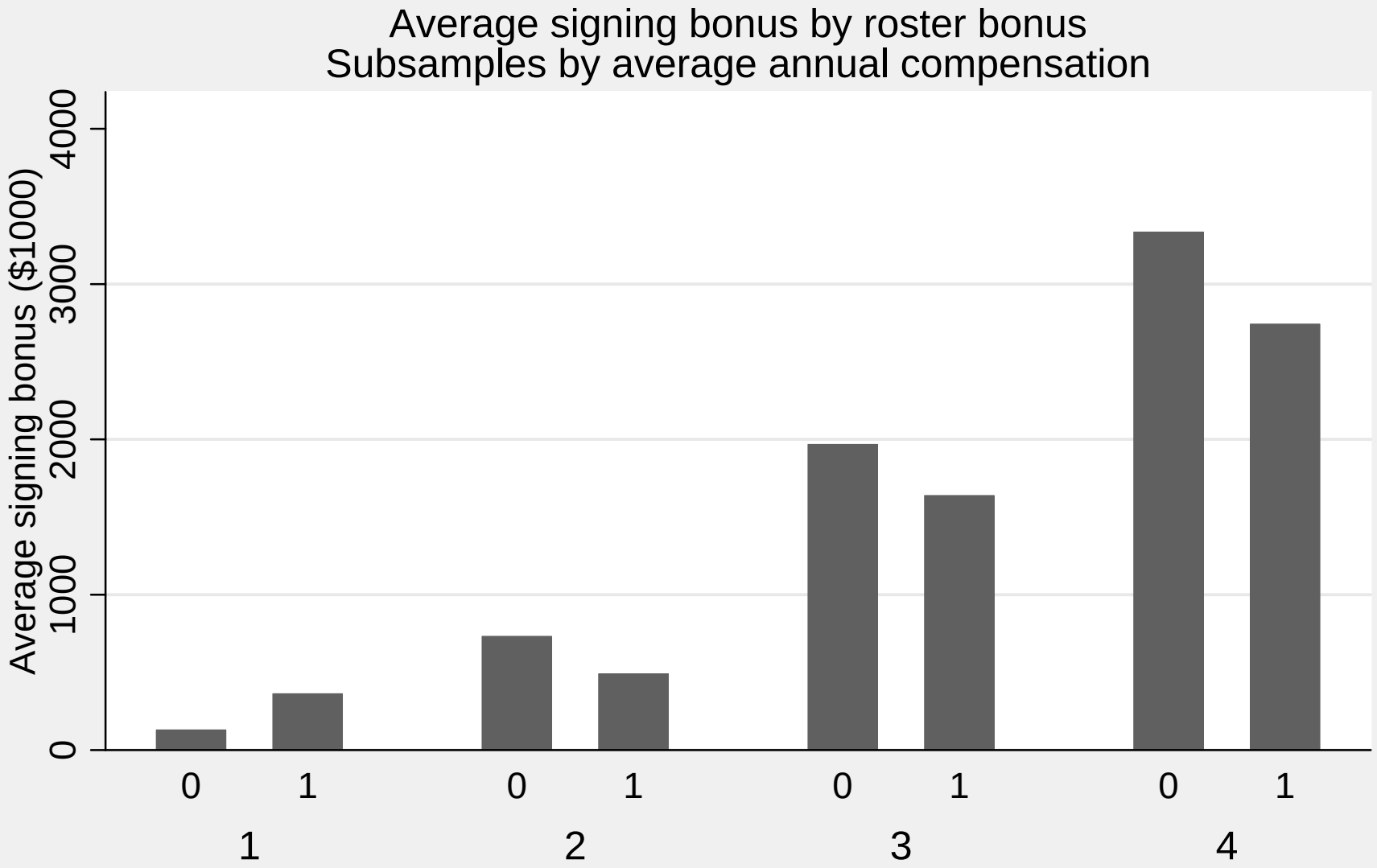
Figure 4

Hazard of renegotiation for players with roster bonuses during offseason controling for contract and player characteristics



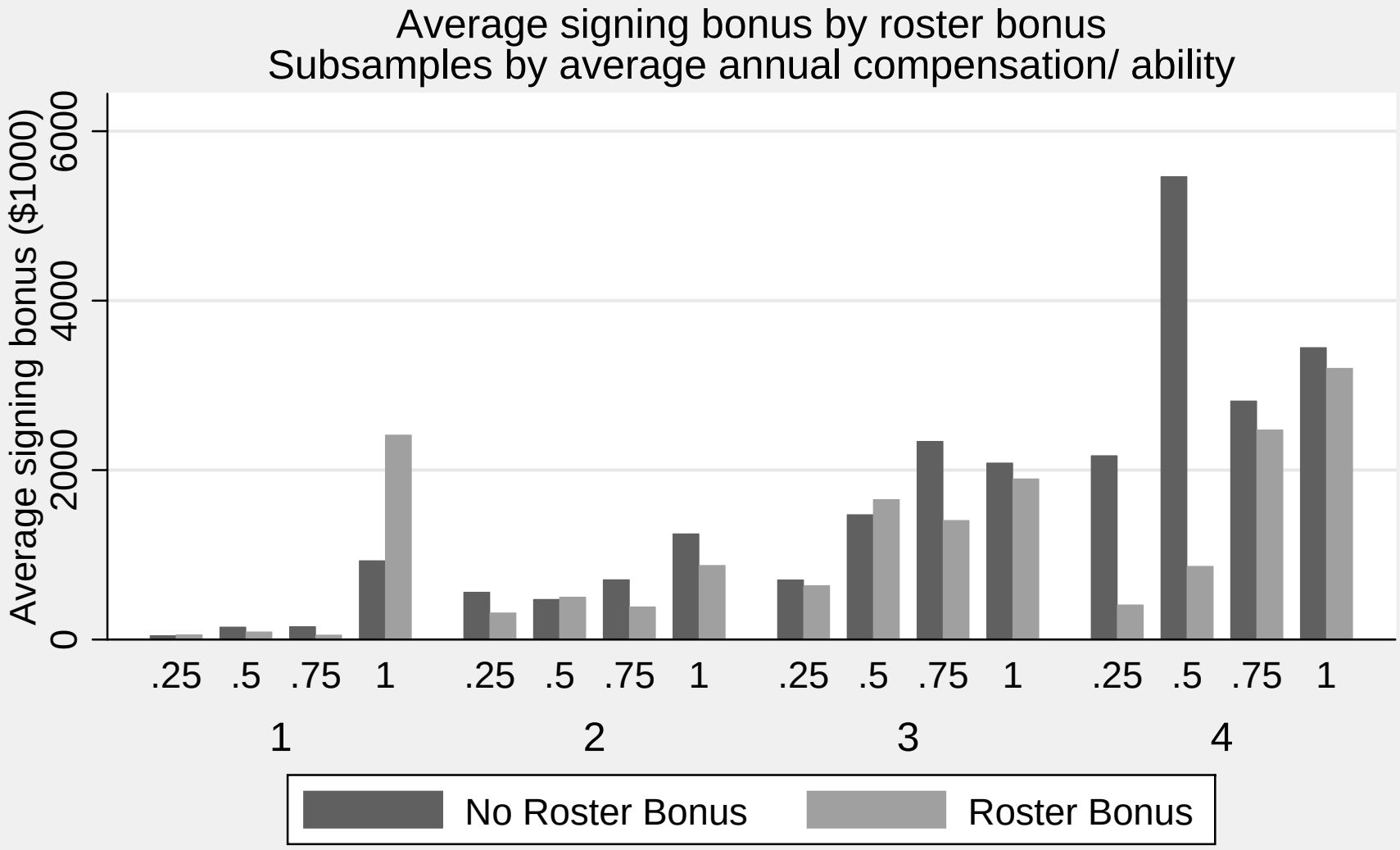
Baseline hazard from a Cox model controlling for contract and player characteristics

Figure 5



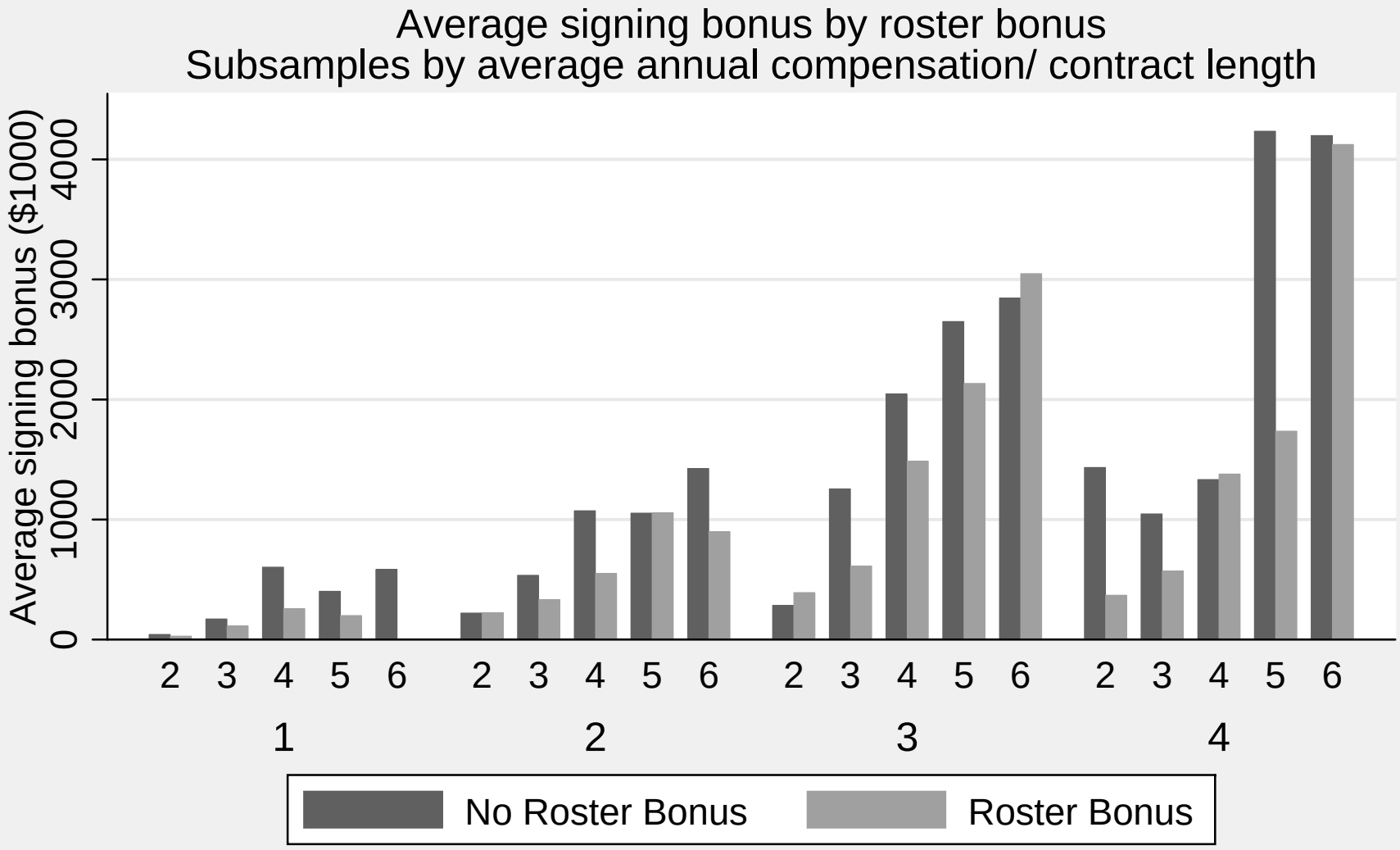
The subsamples are formed on quartile of average annual compensation.

Figure 6



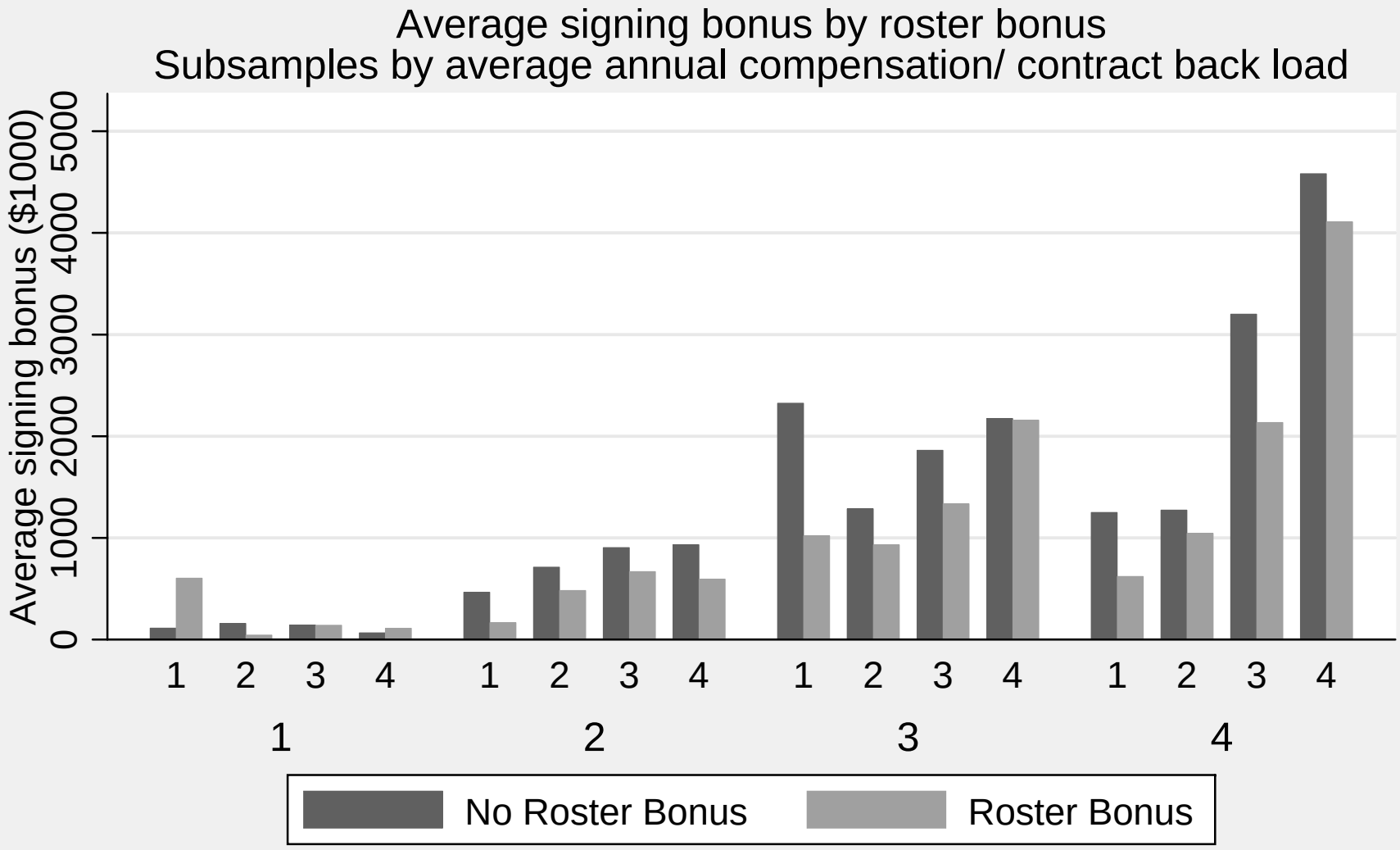
The subsamples are first formed on quartile of average annual compensation and then on share of plays the player participater in.

Figure 7



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

Figure 8



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