Renegotiation Design: Evidence from NFL roster bonuses

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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 fields such as contract theory, corporate finance, and law and economics. Empirically testing this question, however, 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 approximately $260 thousand for a contract in which the renegotiation incentives are modified.

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1 Introduction

"I have come to the conclusion that the main obstacle faced by researchers in industrial organization is the lack of available data on contracts and the activities of firms" (Ronald Coase, Lecture to the memory of Alfred Nobel, December 9, 1991: The Institutional Structure of Production).

Contractual renegotiation design is the "design of rules that govern the process of renegotiation." (Aghion, Dewatripont, Rey, 1994, p. 257). Theory suggests that renegotiation design is an important consideration that shapes contracts, and therefore contracting outcomes. Renegotiation design is fundamental in much of the literature in economics.[1] It is essential in the theory-of-the-firm literature and, more broadly for institutional design;[2] in corporate finance for theories on debt[3] and financial structure,[4] and in law and economics.[5] While there has been a lot of attention on the way that contracts are written to shape renegotiation, there has been little empirical work on this phenomenon. Several questions remain open: Do contracts shape renegotiation? If they do, does changing renegotiation have economically important consequences for transfers and efficiency? We exploit institutional features of the National Football League (NFL) and a unique and novel dataset on contracts of NFL players to address these questions.

Empirically researching renegotiation design has proven to be a difficult task. Two sets of issues have hampered empirical research: the lack of appropriate data and the fact that the theoretical predictions depend heavily on features of the institutional environment, which are hard to observe. The latter is a problem because renegotiation design often takes form in simple contracts which rely on equilibrium renegotiation Bolton and Dewatripont (2005), making it hard to empirically separate renegotiation design from other roles of contracts.

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

[1] For early work on renegotiation design, see Hart and Moore (1988), Aghion, Dewatripont, and Rey (1994), and Nöldeke and Schmidt (1995).

[2] For summaries, see Hart (1995) and Bolton and Dewatripont (2005), Chapters 11 and 12.

[3] Aghion and Bolton (1992) and Bolton and Scharfstein (1996).

[4] Dewatripont and Tirole (1994), Berglöf and Von Thadden (1994), Bolton and Scharfstein (1996).

[5] 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).

allowed to communicate.[6] One major problem with studying contracts is that the parties generally can take actions outside of the contract. For example, a worker can be awarded a bonus which was not specified in the contract. Further, informal renegotiations can take place which are not observed in the data.[7] 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.[8]

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

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

The main driving force of our model is that as the offseason progresses, there are fewer slots available on other teams for a particular player. In other words, the liquidity or market thickness for player characteristics declines as the offseason progresses. Therefore, if a player's current contract with the team were terminated, the team which could have used his skill

[6]For example, players under contract are not allowed to talk to other teams about possible contracting arrangements, should their current contract be terminated.

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

[8]Any side payments would be fraudulent, and subject to fines.

would have already filled its slots. Consequently, the player would have to sign an inferior contract. We show that teams can exploit this fact and strategically delay renegotiation to extract more surplus from the player. This opportunistic behavior increases the teams' surplus at the player's expense, ex post.

The second key ingredient in the model is a friction that prevents ex-post efficient Coasian bargaining between teams. These frictions arise in the NFL from explicit restrictions on transfers of players, compensation in these trades, and side payments stipulated in the Collective Bargaining Agreement. Because of these restrictions, we can use contracting in the NFL as a good laboratory for exploring contracting in a world with ex-post bargaining frictions.[9] We show that strategic delay of renegotiation in the presence of bargaining frictions leads to inefficient matching between players and teams in the NFL.

Modeling contracting in the NFL serves three purposes. First, it clarifies the contracting forces that shape players' compensation and allocation in the NFL and how these interact with a clearly defined market friction. In particular, it shows how paying compensation in roster bonuses instead of salaries shapes renegotiation.

Second, it provides empirical predictions that we take to the data. We test the predictions on: timing of termination and renegotiation; the trade-off between contract characteristics predicted in the model; the value of contracts signed by terminated players; and termination frequency. The predictions from our model are consistent with the data. We also use these tests to show that shaping future renegotiation is an economically important role for contracts in the NFL. Players are on average, willing to forgo approximately $260 thousand for a contract in which the renegotiation incentives are modified.

Last, it provides a clear link between observable outcomes, contract terminations, and the matching efficiency between teams and players. Generally it is hard to empirically draw inferences about the impact of renegotiation design on efficiency. Our model allows us to draw inferences about ex post matching efficiency of different contracts from observed player terminations.

A competing explanation of our empirical results is that there could be a dimension of player quality that we do not observe, which is potentially correlated with roster bonuses, termination, and renegotiation decisions. While we can control for a wide array of information on player ability, we cannot *a priory* rule out that possibility. However, we think this alternative explanation is unlikely for two reasons. First, in addition to controlling for observable dimensions of a player's ability, we can condition on future performance, which should allow us to control somewhat for the unobserved dimension of ability. If this ability

[9] These frictions are frequently derived from information problems; see, for example, Myerson and Satterthwaite (1983) – or bargaining cost, for example in Anderlini and Felli (2001).

does not affect future performance, then it is hard to see how it would be of first-order importance in contracting. Controlling for a future player's performance has no qualitative or quantitative effect on our results. Moreover, we show that while individual results in our paper are subject to this critique, the combined results are hard to reconcile with a particular dimension of unobserved quality driving them. To drive all of our results, the unobserved quality would have to be both positively related and negatively correlated with roster bonuses.

This paper proceeds as follows. Section 2 discusses the related literature. Section 3 provides the institutional background on contracting in the NFL. Section 4 describes the data and presents descriptive statistics. Section 5 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 6 presents the results. Section 7 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 8 concludes.

2 Related Literature

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, and 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 Strömberg (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 up-front payment. They interpret this up-front 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.[10] 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, Garicano, and Vázquez (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.[11] 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 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, Roth, and Ünver (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

[10] See Lafontaine and Slade (2009) for a survey.

[11] See Roth (2002) and Roth (2008) for surveys of the literature.

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.

3 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 between The NFL Management Council And The NFL Players Association. In our dataset the contracts are covered by the Collective Bargaining Agreement, signed in 1993, 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 (salary) plus a roster bonus and potentially some other contract terms, which we address in Section 7.

The roster bonus is paid to the player at a pre-specified date during the offseason–i.e. before the season starts–if the contract is still in place. For example, if a player's contract calls for a roster bonus of one million dollars due on March 1, 2004, then the team has to pay him that bonus if it did not terminate the contract beforehand. Salary is paid during the regular season. For players who have been in the league for more than four years, the salary is de-facto due at the end of the offseason: it is guaranteed for the year as soon as they are on the roster of the first game of the season. The signing bonus is paid to the player upon signing the contract.

For example, a 3-year contract for a player who signed in 2000 would specify the following payments:[12]

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

According to the Collective Bargaining Agreement, the NFL "League Year" (Collective Bargaining Agreement 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.

4 Data

4.1 Data description

The initial 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

[12] The data agreement prevents me from including data on individual contracts

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[13] in the previous year, and to contracts for which all characteristics are coded. This leaves us with a sample of 4, 220 contracts. Table 1 presents the distribution of signing dates. 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. Since meaningful renegotiation concerns are only present in contracts longer than one year we restrict our analysis to 1,428 contracts are 2-year and longer contracts.[14]

Each contract specifies a signing bonus and, for each year a roster bonus, a reporting bonus, and a salary. This makes contracts of different lengths difficult to compare and describing them requires many parameters. For example, a 12-year contract requires 37 variables. Furthermore, contracts have to be indexed by length: increasing the 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 salary for year 1; the payments from year 2 are roster bonus for year 2, reporting bonus for year 2, and the salary for year 2. We then take the average of the payment for year 1 and the payment for year 2. The 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.

[13] This excludes rookie contracts.

[14] Our results are robust to including 1-year contracts in the analysis in the specifications in which it is meaningful to include them.

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.

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. 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

[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.

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. 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 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.

5 Theory and Hypotheses

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

5.1 Numerical Example

We first present a simple numerical example to build intuition on the dynamics of contracts during the NFL's offseason. We then formalize this example by developing a model of contracting in the NFL in the next subsection. Suppose that Quarterback has a contract with team A. The contract has one year left, and promises Quarterback the payment of $1 million. Because NFL contracts are non-guaranteed, Team A can terminate Quarterback's contract at any point without a penalty. Alternatively, the team can keep its contract: Quarterback then has to play, and receives the $1 million specified by the contract. 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 amount. 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 an adequate quarterback to direct the offense. In this environment, Team A has to think about the timing of its decisions: it can terminate Quarterback's contract either early or late in the offseason and get no payoff; can propose to renegotiate Quarterback's contract to a lower amount either early or late in the offseason, keeping Quarterback employed but at a lower compensation; or, it can 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 at less than what it would owe him. Suppose Team A tries to renegotiate with Quarterback while Team High still has an open quarterback slot. Quarterback will not want to renegotiate his contract: the only threat the team has is to terminate him, and then he can sign with Team High, which values him at $1.2 million. Alternatively, Team A can wait until late into the offseason. Once Team High fills its quarterback slot, Team A can propose renegotiation to Quarterback. Quarterback knows that if he is terminated now, the best he can do is to sign with Team Low, which values him at $0.8 million. He is better off renegotiating with Team A to an amount lower than the $1 million in his contract, potentially down to an amount of $0.8 million.

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

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

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

5.2 Model

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

5.2.1 Setup

We model the contracting problem of one risk neutral player. The timeline of the model is divided into two stages: initial contracting stage and offseason. The initial contracting stage corresponds to a period during which the player is a free agent and can sign an initial contract with any team in the market. We model initial contracting mainly to obtain a closer link between the model and the data, which allows us to formulate empirical tests of the model. The offseason is when renegotiation concerns come into play: time has passed from the initial contract signing, teams have reevaluated their demand for the player, and the player's ability has potentially changed. The player is bound by the contract he signed during the initial contracting season. Demand for player services drops in expectation during the offseason, giving rise to the strategic timing of renegotiation.

The contract The contract the agent signs specifies a signing bonus b_s, salary s, and the roster bonus b_r. A convenient way to express the contract is to define total annual payments as a sum of salary and roster bonus $w = s + b_r$ and the roster bonuses share as $\gamma = \frac{b_r}{w}$. Therefore, the contract is a three-touple of (b_s, w, γ). When we take the predictions of the model to data, it is useful to impose restrictions in line with the institutional environment: the signing bonus must be positive, $b_s \in \left[0, \bar{b}_s\right]$, the total compensation is bounded above and below, $w \in [\underline{w}, \bar{w}]$, and the roster bonus must not be negative, implying $\gamma \in [0, 1]$.[16]

Timeline See below.

[16] The upper bounds are implied by the club salary cap, which sets a bound on the total compensation of players.

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

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

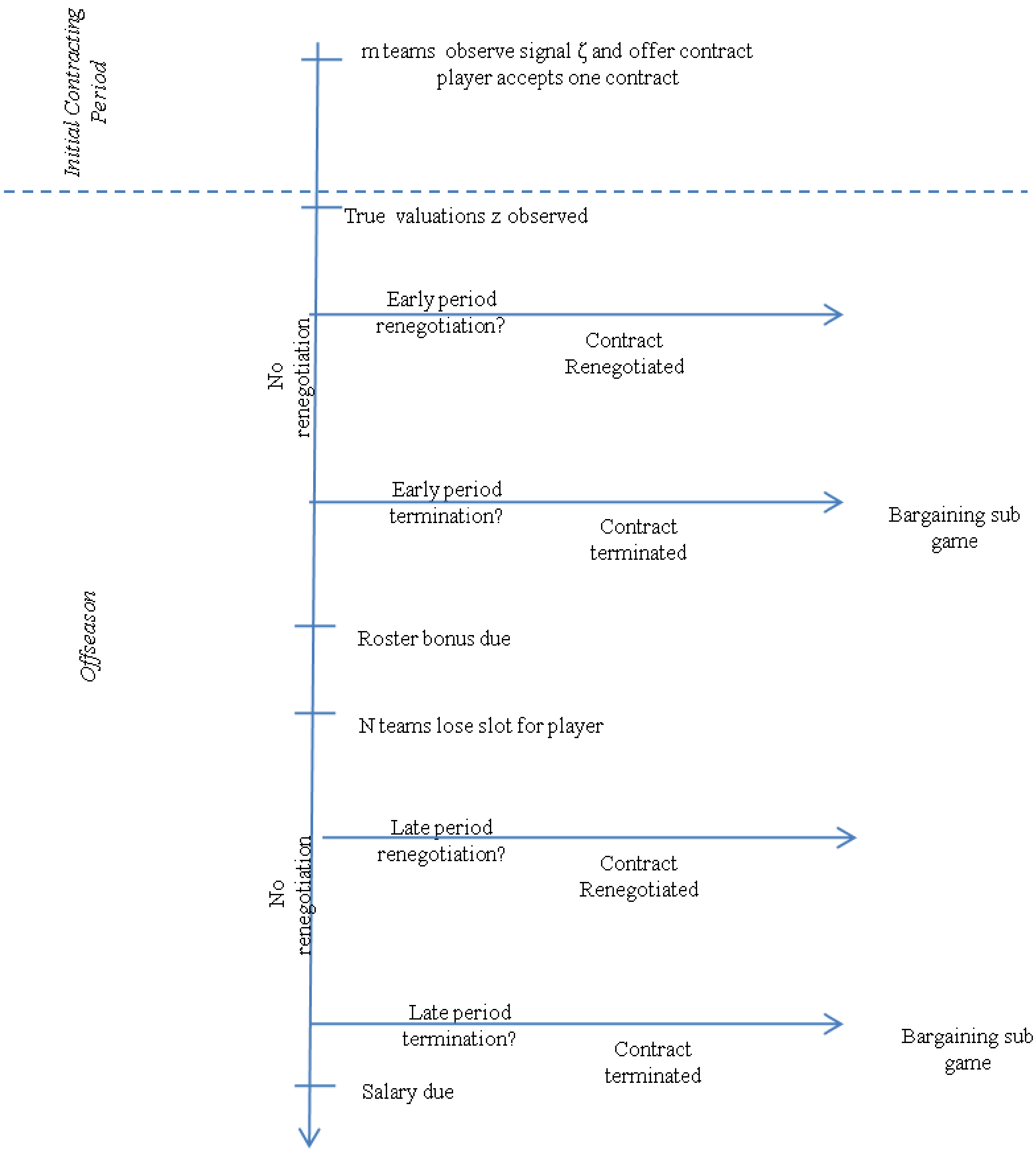
We model the evolution of demand during the offseason by changing the number of teams interested in filling their slot with the player. Early in the offseason all m teams, in addition to the team which has the player under contract, are interested in his services. Between the early and late period, $m-n$ randomly drawn teams fill their slots because they want to make sure they have a player in that position.[17] Only n other teams are still interested in the player's services. Let z_1' be the team with the lowest valuation still interested in the player, and z_n' the highest valuation. $z\prime = (z_1', \ldots, z_n')$

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

[17] 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.

The bargaining 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 Collective Bargaining Agreement and other frictions, all of which prevent efficient trades from taking place.

Timeline



5.2.2 Equilibrium of the offseason subgame:

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

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

1. *If* $(1-\gamma) w \leq z_o$ *the team keeps the contract in place.*
2. *If* $(1-\gamma) w > z_o$
   (a) *and* $z_o \leq z'_{n-1}$ *team and player renegotiate the contract. The player receives* z'_{n-1}.
   (b) *and* $z_o \leq z'_{n-1}$ *team terminates the contract. The player signs up with the team with the highest valuation and obtains* z'_{n-1}.

The intuition for the lemma is the following. Late in the offseason the roster bonus is already sunk, so the team owes the player $(1-\gamma) w$ if the contract stays in place. If the team makes a profit from the old contract, $(1-\gamma) w \leq z_o$ it will not want to terminate it. The team cannot credibly renegotiate the contract with the player wither.It would only propose renegotiation to decrease the player's compensation. The player can always reject such renegotiation knowing that the team's threat of terminating the contract is not credible: it gets a positive payoff from keeping the contract in place, but nothing if the contract is terminated. The larger the share of compensation that is paid in roster bonuses, the "cheaper"the player is in the late period, and the more likely the contract is to stay in place.

If the current contract is terminated in the late period, the player is paid his second highest valuation in the market z'_{n-1}. The team cannot renegotiate the contract with the player if the player can obtain more in termination, which is the case if the second highest valuation in the market is higher than the valuation of the incumbent team, $z_o \leq z'_{n-1}$,

This lemma also partially demonstrates the role of the roster bonus. If the roster bonus is high enough, it commits the team not to renegotiate or terminate the contract in the late period, since at that point the roster bonus is sunk and the surplus from keeping the contract is too large.

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

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

1. *If* $\gamma > 1 - \frac{z_o}{w}$

   (a) *Contract stays in place if* $w \leq z_o$.

   (b) *Contract is renegotiated if* $w > z_o$ *and* $z_o > z_{m-1}$. *Player obtains* z_{m-1}.

   (c) *Contract is terminated if* $w > z_o$ *and* $z_o \leq z_m - 1$. *The player signs up with the team with the highest valuation and obtains* z_{m-1}.

2. *If* $\gamma \leq 1 - \frac{z_o}{w}$

   (a) *Contract stays in place if* $\gamma w \leq E\left(I_{z_o > z'_{n-1}}\left(z_o - z'_{n-1}\right)|z\right)$.

   (b) *Contract is renegotiated if* $\gamma w > E\left(I_{z_o > z'_{n-1}}\left(z_o - z'_{n-1}\right)|z\right)$ *and* $z_o > z_{m-1}$.

   (c) *Contract is terminated if* $\gamma w > E\left(I_{z_o > z'_{n-1}}\left(z_o - z'_{n-1}\right)|z\right)$ *and* $z_o \leq z_{m-1}$.

The intuition for this lemma is that the team keeps the contract in place if the roster bonus, γw, is smaller than the expected profits of keeping the contract in place. If that is the case, then a renegotiation offer of the team will always be rejected by the players knowing that the team will not want to terminate the contract following rejection.

This structure of the late period payoffs simplifies the computation of the expected profits from keeping the contact in place. From Lemma 1 we know that the contract is kept in place in the late period if $(1 - \gamma) w \leq z_o$, or rewriting the expression, if $\gamma > 1 - \frac{z_o}{w}$. Intuitively, this means that the team's decision as to whether the contract will be kept in the late period is independent of which teams have slots remaining in the late period. We can therefore focus on two major cases. In one case, the contract will be kept in place if it survives into the late period if the roster bonus share is high, $\gamma > 1 - \frac{z_o}{w}$; then the player will earn the roster bonus γw and the salary $(1 - \gamma) w$ if the contract is kept in place in the early period. The team will keep the contract only if it is profitable–that is if $w \leq z_o$. Otherwise, the contract will be terminated or renegotiated early, with the second highest valuation in the market providing the threshold.

Alternatively, the contract will be renegotiated or otherwise terminated in the late period if it is still in place at that point. If the roster bonus is small, $\gamma \leq 1 - \frac{z_o}{w}$, then the contract will either be terminated or it will be renegotiated in the late period, if it is in place up to that point. The team's expected payoff from waiting, $E\left(I_{z_o > z'_{n-1}}\left(z_o - z'_{n-1}\right)|z\right)$, is the surplus it can extract in renegotiation $z_o - z'_{n-1}$, conditional on renegotiation being profitable,

$I_{z_o > z'_{n-1}} = 1$, and conditional on the realized value of z. As before, the second highest valuation in the market provides the threshold between renegotiation and termination.

Lemma 2, condition 1, implies a useful remark that we will use later on.

Remark 1 *If $w < z_o$ the contract always stays in place.*

5.2.3 Termination and Matching Efficiency

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

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

Proposition 1 *Teams terminate players under contract too infrequently relative to the first best. Increasing the share of compensation paid in roster bonuses, γ, weakly increases contract termination holding the level of annual compensation w and player valuation z fixed. Contracts with a higher roster bonus share, γ, are more likely terminated in the early period rather than the late period. This increase in termination increases the efficiency of the ex post matching between the player and teams.*

From Lemma 2 note that the necessary condition for the team to terminate a player's contract in the offseason subgame is $w > z_o$.[18] In addition we can summarize the termination from Lemma 1 and Lemma 2 by the cutoff for the roster bonus share:

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

When the roster bonus share is low, $\gamma \leq \min\left(1 - \frac{z_o}{w}, \frac{E\left(I_{z_o > z'_{n-1}}\left(z_o - z'_{n-1}\right)|z\right)}{w}\right)$ the team has an incentive to pay the roster bonus γw and wait late into the offseason, hoping that

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

the teams that value the player highly fill up their slots in the meantime. The team then can renegotiate the player to the second highest valuation of the n teams remaining, to z'_{n-1}. This is where the ex post bargaining friction comes into play: if the high value teams could pay the incumbent team to terminate the player early, the allocation of players to teams would be closer to first best.

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

Corollary 1 *Players who are terminated late in the offseason sign contracts following termination that are less valuable, in expectations, then contracts signed by players who are terminated early in the offseason.*

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

5.2.4 Player Compensation:

Proposition 2 *Conditional on total annual payments, w, and for any realization of productivity, z, the expected value of the contract to the player at the beginning of the offseason is weakly increasing in the roster bonus share, γ.*

From Lemma 1 and 2 we know that if $w < z_o$, then the contract stays in place and player earns w. The only situation in which roster bonus can affect compensation then , is when $w \leq z_o$. If $w \leq z_o$ we have to look at three cases:

If $\gamma > \min\left(1-\frac{z_o}{w}, \frac{E\left(I_{z_o>z'_{n-1}}\left(z_o-z'_{n-1}\right)|z\right)}{w}\right)$, the team terminates or renegotiates the player's contract early, and the player obtains z_m. In that region, the player's compensation is independent of γ.

If $\gamma \leq \min\left(1-\frac{z_o}{w}, \frac{E\left(I_{z_o>z'_{n-1}}\left(z_o-z'_{n-1}\right)|z\right)}{w}\right)$, the team keeps the contract in the early period, and renegotiates or terminates the contract in the late period. The player's compensation is $\gamma w + E\left(z'_{n-1}|z\right)$. In this region, the expected compensation is strictly increasing in γ.

Now we have to show that the player's expected compensation weakly increases as the roster bonus share crosses the threshold. For the team to be willing to keep the contract, the expected benefit of waiting to the late period must exceed the roster bonus, $\gamma w \leq E\left(I_{z_o > z'_{n-1}}\left(z_o - z'_{n-1}\right)|z\right)$. But the benefit of waiting for the team is bounded by the largest possible surplus it can extract from the player by waiting $z_{m-1} - E\left(z'_{n-1}|z\right)$. Therefore, $\gamma w \leq E\left(I_{z_o > z'_{n-1}}\left(z_o - z'_{n-1}\right)|z\right) \leq z_{m-1} - E\left(z'_{n-1}|z\right)$, or alternatively $z_{m-1} \geq \gamma w + E\left(z'_{n-1}|z\right)$. The player's expected compensation is weakly increasing as the roster bonus share crosses the threshold.

5.2.5 Initial Contracting Stage, the Signing Bonus:

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

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

In fact, if b_s, w and γ were unrestricted, the equality would bind.[19] Because the choice of signing bonus is non-negative and w and γ are constrained, we can rewrite the condition as

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

This equation serves as a basis of empirical tests in the next section. It shows us that there is a trade-off between the signing bonus and the other contracting terms. If, for example, the roster bonus share increases the ex post value of the contract, this will be reflected in a smaller signing bonus in the contract. More formally, suppose we have two contracts, (b_{s1}, w, γ_1) and (b_{s2}, w, γ_2), which have the same annual payments w, for the same player with team valuations of z, but the roster bonus represents a different share of these contracts: $\gamma_1 < \gamma_2$. The differences in signing bonuses between these two contracts represent the lower bound on the magnitude of the difference in the value these contracts have ex post:

[19] Formally, $b_s = \lim_{\varepsilon \to 0} \bar{U} - E_\zeta\left(w, \gamma, z\right) + \varepsilon, \varepsilon > 0$

$$0 \leq -\left(b_{s1} - b_{s2}\right) \leq E_{\zeta}U(w, \gamma_1, z) - E_{\zeta}U(w, \gamma_2, z) \tag{3}$$

Proposition 2 suggests that increasing the roster bonus share increases the value of the contract to the player, holding the total annual payments w and team valuations z fixed, so this difference will be non-negative. An alternative way this comparative static will be reflected in the data is through a negative correlation between the signing bonus and roster bonus share, holding w and z fixed:

$$\frac{\partial b_s}{\partial \gamma} \leq -\frac{\partial E_{\zeta}U\left(w, \gamma, z\right)}{\partial \gamma} \leq 0 \tag{4}$$

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

5.3 Empirical Predictions:

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

Prediction 1 (Proposition 1): Timing of termination and renegotiation

A contract is more likely to be terminated or renegotiated before roster bonuses are due if it contains a roster bonus for that offseason, holding all else equal.

Prediction 2 (Equation 4): Value of roster bonus share γ

Contracts with a higher roster bonus share γ have lower signing bonuses, holding all else equal.

Prediction 3 (Corollary 1): Timing of termination and value of subsequent contract

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.

Prediction 4 (Proposition 1): Termination and matching efficiency

A contract with a higher roster bonus share is more likely to be terminated holding all else equal.

6 Results

6.1 Prediction 1: Timing of termination and renegotiation during the offseason

Our model suggests that when a player's contract specifies compensation in roster bonuses instead of salary, the team has an incentive to renegotiate or terminate the contract before the roster bonus is due. To test Prediction 1, we first estimate the hazard rate of termination during the offseason for contracts that had a roster bonus that season. We show that the hazard rate is related to the timing of roster bonuses. We then repeat this test for timing of renegotiation. Because meaningful renegotiation and termination can only happen after the first season, we focus on 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 bonuses. Therefore, we want to determine the termination hazard of a contract with a roster bonus during the offseason, controlling for player and contract characteristics. We estimate a competing hazards Cox model in which the contract can be terminated, renegotiated, or stay in place. We control for all contract characteristics–average annual pay, contract length,[20] contract backload and roster bonus share in future seasons–as well as for several player characteristics, including players' tenure and a battery of player performance characteristics.[21] Figure 2 presents the estimated baseline hazard of players' termination. The results mirror the results without controls: the two peaks of the termination hazard do not change. The shape of the hazard function is preserved under alternative permutations of included controls, which we do not report in the paper. These results suggest that if teams terminate players with roster bonuses, they do so before the roster bonuses come due.

The model also suggests that roster bonuses, in addition to affecting the timing of termination, should affect the timing of renegotiation. Roster bonuses commit the team to paying the player for the right to renegotiate late. This gives the team an incentive to renegotiate earlier. Figure 3 presents the hazard rate of renegotiation during the offseason for contracts

[20] 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.

[21] 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.

with roster bonuses. It, too, has two peaks: the first is before March 1st and the second is after June 1st. The hazard of renegotiation seems to peak slightly later than the hazard of termination, which may be because we code renegotiations only when the new, renegotiated contract is filed with the league. As with the hazard of termination, there is a concern that the high renegotiation hazard rate around March 1st and June 1st could be a result of players with different characteristics matching in the market with teams over time. We again estimate a competing hazards Cox model and obtain the baseline hazard of renegotiation, which we present in Figure 4. The peaks around March 1st and June 1st persist, even after controlling for contract and player characteristics. This suggests that if contracts with roster bonuses are renegotiated, they are generally renegotiated before those bonuses are due.

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

6.2 Prediction 2: Signing bonus and roster bonus share

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 economically an important part of NFL contracts. Proposition 2 states that if we compare two contracts with the same combined level of salaries (s), and roster bonuses, (b_r), then the contract with the larger share of compensation paid in roster bonuses, $\gamma = \frac{b_r}{b_r+s}$, is less profitable for the team and more beneficial to the player. From equation 3 we can estimate the lower bound of this difference in contract values from the difference in signing bonuses of these contracts. The difference in values is a consequence of the larger roster bonus share mitigating the hold-up of players by teams through shaping future renegotiation. An economically large difference in signing bonuses implies that shaping future renegotiation is an important part of NFL contracts. We now examine this prediction, first through descriptive statistics and then estimate it by using a tobit.

6.2.1 Descriptive Statistics

From descriptive statistics in Section 4.2 we know that the roster bonus ratio and the signing bonus are positively correlated, which is inconsistent with our prediction. This positive correlation should not be surprising, because better players obtain contracts with larger shares of roster bonuses and also obtain larger signing bonuses. In our comparative statics in equation 3, we shift compensation between roster bonuses and salaries and keep their total amount constant. To approximate that test in descriptive statistics, we form subsets based on the quartiles of average annual compensation (average annual salary and roster bonus combined). Figure 5 shows the comparison of average signing bonuses for contracts with and without a roster bonus in different compensation-based subsamples. Even such crude conditioning on compensation begins to present a picture that is more consistent with equation 3. In each of the top three quartiles of compensation, the average signing bonus is lower in contracts with 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 the 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. Again, the one notable exception is in the lowest quartile of compensation, although the positive correlation there is restricted to players who participated in 75 to 100 percent of their team's plays in a season.

Rather than cutting the compensation subsamples by ability, we can cut them on other contract characteristics. In Figure 7 we cut the compensation subsamples by contract length. We present only contracts shorter than six years; for longer contracts, the subsamples are very small. Two facts are worth noting. First, this cut of the data supports equation 3: the average signing bonus is lower in contracts without roster bonuses in only three out of twenty subsamples, 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 equation 3. This suggests that the anomaly in the previous two figures is driven by heterogeneity of contract length.

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

6.2.2 Tobit estimation

The descriptive statistics provide suggestive evidence supporting Prediction 2: contracts in which a share of compensation is paid in roster bonuses instead of salary have lower signing bonuses. We test Prediction 2 more rigorously by estimating the amount of signing bonus the player has to forgo in order to shift a certain percentage of his compensation from salary to roster bonuses, keeping the total amount of roster bonuses and salaries constant. We use tobit specifications as our empirical analog to equation (2), which adjust for the fact that teams are not allowed to pay a negative signing bonus in a contract. The specification of the tobit takes the following general form, where we vary player ability measures across specifications:

$$Signing\ bonus_i = \max\left(0, \begin{array}{c} \alpha + \beta_1 bonus\ ratio_i + \beta_2 average\ annual\ compensatoin_i + \\ +\Gamma_i contract\ characteristics_i + \Gamma_2 player\ ability + \varepsilon_i \end{array}\right)$$

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

The tobit specifications support Prediction 2: the share of compensation that is paid in roster bonuses rather than salary is correlated with a lower signing bonus. In the basic specification we only control for contract characteristics, not for any player ability proxies. In addition to average annual pay we control for contract length and how back loaded the contract payments are. The results, presented in Table 6, are consistent with Prediction 2: roster bonus share has a negative and statistically significant coefficient of $-1.92 million. A single standard deviation change in the bonus ratio means that 13.6 percentage points more of the annual compensation is to be paid in roster bonuses instead of salary. This change in the share of compensation specified as roster bonuses is correlated with a $260 thousand average decrease in signing bonuses 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 with differently, potentially driving our results. To address this concern, we include in our specification dummies for the player position. 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. Our second ability measure is the percentage of games the player started during the year; better players generally start games and are more likely to obtain roster bonuses. 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 may 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. 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 trade-off between the roster bonus share and the signing bonus that we test in Prediction 2. Nevertheless, it is conceivable that this heterogeneity may be correlated both with 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 and year pair 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 would care about unobservable ability because it is informative about players' future performance. If unobserved ability does translate into future player performance, which we can observe, then we can use player's future performance as a signal of the team's information that is not contained in the ability we control for in our specifications.

We re-estimate the trade-off between the signing bonus and the roster bonus ratio, using the tobit specification described above but also control 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 7.

6.3 Prediction 3: Contracts of previously terminated players

In the last subsection, we tried to infer whether shaping future renegotiation is an economically important concern in NFL contracts. In this subsection, we test our conjecture that players who are terminated later in the offseason sign less valuable contracts as predicted by Corollary 1. Intuitively, because these players are terminated later in the offseason sign with teams, which are in expectation a worse match. In addition, their outside option in negotiations is declining as well. If we compare two contracts with equal average payments, roster bonus share, length and backload for a player of the same ability, then the decrease in value from late termination has to be captured by the signing bonus.

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

$$Signing\ bonus_i = \max\begin{pmatrix} & \alpha + \beta_0 day\ of\ termination \\ 0, & \beta_1 bonus\ ratio_i + \beta_2 average\ annual\ compensatoin_i + \\ & +\Gamma_i contract\ characteristics_i + \Gamma_2 player\ ability + \varepsilon_i \end{pmatrix}$$

The dependent variable is again the signing bonus and the independent variable of interest is the number of days that have past between the beginning of the offseason and the time the player's previous contract was terminated. 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 proximally 180 days later, amounting to a loss of \$325 thousand dollars. That is the upper bound of the possible loss for the player under this specification. If the player is terminated at the end of the offseason, rather than before the second round of roster bonuses that are due on June 1, then the loss shrinks approximately half, or \$160 thousand. These results are consistent with players' matching opportunities with other teams declining over the offseason, giving teams in the NFL substantial potential to hold-up the player.

A possible concern 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.

6.4 Prediction 4: Termination and Matching efficiency

In this subsection we test Prediction 4: contracts in which a higher *share* of annual compensation is paid in roster bonuses have a higher probability of termination. This is especially interesting in given 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. Proposition 1 shows that this increased termination translates in increased ex post matching efficiency of teams and players.

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.[22] 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. Our results are consistent with the model showing that higher roster bonus share leads to higher contract termination, and consequently, to more efficient ex post matching between players and teams. In our estimates are matching on important player characteristics, and are doing so in a flexible manner. Nevertheless, 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 7.

[22] 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.

7 Unobservable player quality, back of the envelope calculation, and robustness

7.1 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 Prediction 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 Prediction 3. Our results instead show that players terminated early in the offseason obtain higher compensation for the same observed contract and ability bundle.

7.2 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.

7.3 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 6.2.2. 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.

7.3.1 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 trade-off 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.

7.3.2 Contracts of veteran players

The Collective Bargaining Agreement 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,[23] we re-estimate all specifications in the paper on the subsample of 793 players who had been in the NFL for at least five years. If anything, our results are more statistically significant and have similar quantitative magnitudes.

[23] The results can be obtained from the author upon request.

7.3.3 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 6.2.2.

$$Signing\ bonus_i = \begin{array}{c} \alpha + \beta_1 bonus\ ratio_i + \beta_2 average\ annual\ compensatoin_i + \\ +\Gamma_i contract\ characteristics_i + \Gamma_2 player\ ability + \varepsilon_i \end{array}$$

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.

7.3.4 Prediction 2: Pricing other contract terms

Our main focus in Section 6.2.2 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 up-front 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 up-front 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 up-front 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 Prediction 2 seems to be able to capture the same qualitative sign as predicted by the theory.

7.4 Non-linearity

7.4.1 Prediction 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.

7.4.2 Prediction 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.

7.4.3 Prediction 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 than contracts of a player with similar characteristics, contract length, average annual payment, and backload of contract payments.

8 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.

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 has evaded us because of several problems, a central one being data limitations. For example , consider the current debate on mortgage renegotiation. Piskorski, Seru, and Vig (2009) and Foote, Gerardi, Goette, and Willen (2009) come to different conclusions on the frictions surrounding mortgage renegotiation. One of the differences between these 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 issues that are beyond the scope of this paper. We have treated market thickness for player's skills as exogenous in this paper, which is a reasonable assumption if we focus only on the problem of a single player 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?

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

References

Abadie, A., and G. Imbens (2002): "Simple and bias-corrected matching estimators for average treatment effects," *Working Paper*.

Aghion, P., and P. Bolton (1992): "An incomplete contracts approach to financial contracting," *The Review of Economic Studies*, 59(3), 473–494.

Aghion, P., M. Dewatripont, and P. Rey (1994): "Renegotiation design with unverifiable information," *Econometrica*, pp. 257–282.

Anderlini, L., and L. Felli (2001): "Costly bargaining and renegotiation," *Econometrica*, 69(2), 377–411.

Arruñada, B., L. Garicano, and L. Vázquez (2001): "Contractual allocation of decision rights and incentives: The case of automobile distribution," *Journal of Law, Economics, and Organization*, 17(1), 257.

Becht, M., P. Bolton, and A. Röell (2007): "Corporate law and governance," *Handbook of Law and Economics*, 2, 829–943.

Benmelech, E., and N. Bergman (2008): "Liquidation values and the credibility of financial contract renegotiation: Evidence from US airlines," *Quarterly Journal of Economics*, 123(4), 1635–1677.

Berglöf, E., and E. Von Thadden (1994): "Short-term versus long-term interests: capital structure with multiple investors," *Quarterly Journal of Economics*, 109, 1055–1055.

Bolton, P., and M. Dewatripont (2005): *Contract Theory*. The MIT Press.

Bolton, P., and D. Scharfstein (1996): "Optimal debt structure and the number of creditors," *The Journal of Political Economy*, 104(1), 1–25.

Coase, R. (1993): "1991 Nobel lecture: The institutional structure of production," *The Nature of the firm: Origins, evolution, and development*, p. 227.

Dewatripont, M., and J. Tirole (1994): "A theory of debt and equity: Diversity of securities and manager-shareholder congruence," *The Quarterly Journal of Economics*, 109(4), 1027–1054.

Foote, C., K. Gerardi, L. Goette, and P. Willen (2009): "Reducing foreclosures: No easy answers," *NBER working paper*.

Fréchette, G., A. Roth, and M. Ünver (2007): "Unraveling yields inefficient matchings: Evidence from post-season college football bowls," *RAND Journal of Economics*, 38(4), 967–982.

Gil, R. (2009): "The interplay of formal, informal and relational contracts: Evidence from movies," *mimeo*.

Guriev, S., and D. Kvasov (2005): "Contracting on time," *The American Economic Review*, 95(5), 1369–1385.

Hart, O. (1995): *Firms, contracts, and financial structure*. Oxford University Press, USA.

Hart, O., and J. Moore (1988): "Incomplete contracts and renegotiation," *Econometrica*, 56(4), 755–785.

Hubbard, T. (2001): "Contractual form and market thickness in trucking," *The RAND Journal of Economics*, 32(2), 369–386.

Iyer, R., and A. Shoar (2008): "The importance of hold-up in contracting: Evidence from a field experiment," *Working Paper.*

Kaplan, S., and P. Strömberg (2003): "Financial contracting theory meets the real world: An empirical analysis of venture capital contracts," *The Review of Economic Studies*, 70(2), 281–315.

Lafontaine, F., and M. Slade (2009): "Inter-firm contracts: Evidence," *The Handbook of Organizational Economics.*

Lerner, J., and R. Merges (1998): "The control of technology alliances: An empirical analysis of the biotechnology industry," *The Journal of Industrial Economics*, 46(2), 125–156.

Myerson, R., and M. Satterthwaite (1983): "Efficient mechanisms for bilateral trading," *Journal of Economic Theory*, 29, 265–281.

Niederle, M., and A. Roth (2003): "Unraveling reduces mobility in a labor market: Gastroenterology with and without a centralized match," *Journal of Political Economy*, 111(6), 1342–1352.

Nöldeke, G., and K. Schmidt (1995): "Option contracts and renegotiation: A solution to the hold-up problem," *RAND Journal of Economics*, 26(2), 163–179.

Piskorski, T., A. Seru, and V. Vig (2009): "Securitization and distressed loan renegotiation: Evidence from the subprime mortgage crisis," *Working Paper.*

Roberts, M., and A. Sufi (2009): "Renegotiation of financial contracts: Evidence from private credit agreements," *Journal of Financial Economics*, 93(2), 159–184.

Roth, A. (2002): "The economist as engineer: Game theory, experimentation, and computation as tools for design economics," *Econometrica*, 70(4), 1341–1378.

——— (2008): "Deferred acceptance algorithms: history, theory, practice, and open questions," *International Journal of Game Theory*, 36(3), 537–569.

Roth, A., and X. Xing (1997): "Turnaround time and bottlenecks in market clearing: Decentralized matching in the market for clinical psychologists," *Journal of Political Economy*, 105(2), 284–329.

Shavell, S. (2007): "Contractual holdup and legal intervention," *The Journal of Legal Studies*, 36(2), 325–354.

WHITE, M. (2007): "Bankruptcy law," *Handbook of Law and Economics*, 2.

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.

VARIABLES	(1) Signing bonus	(2) Signing bonus	(3) Signing bonus	(4) Signing bonus	(5) 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.

VARIABLES	(1) Terminated	(2) Terminated	(3) Terminated	(4) Terminated	(5) 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	255478**	282095***	240247*	267720***
before June 1	(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	245538***	193210**	205360***	151622**
before June 1	(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

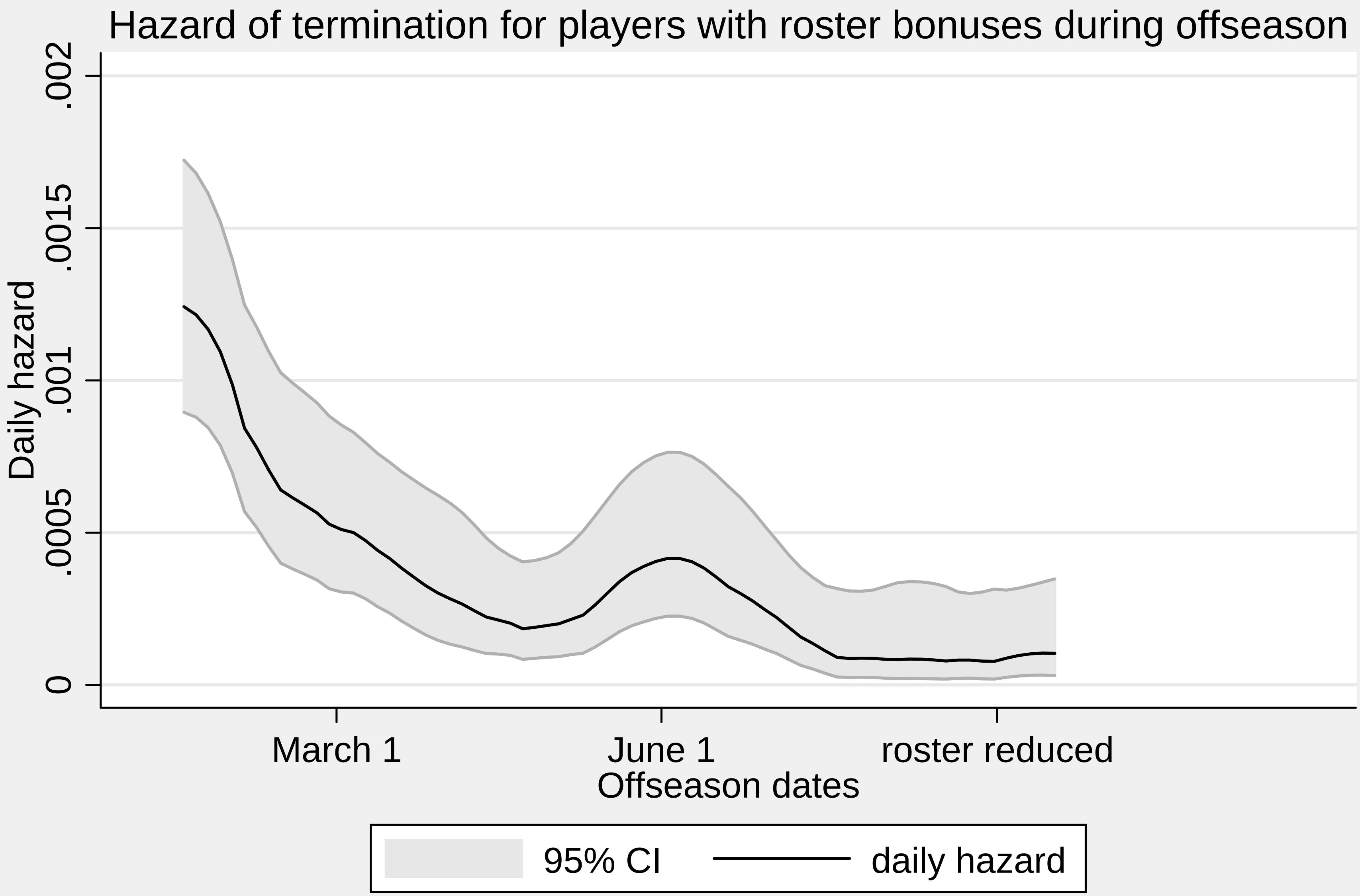
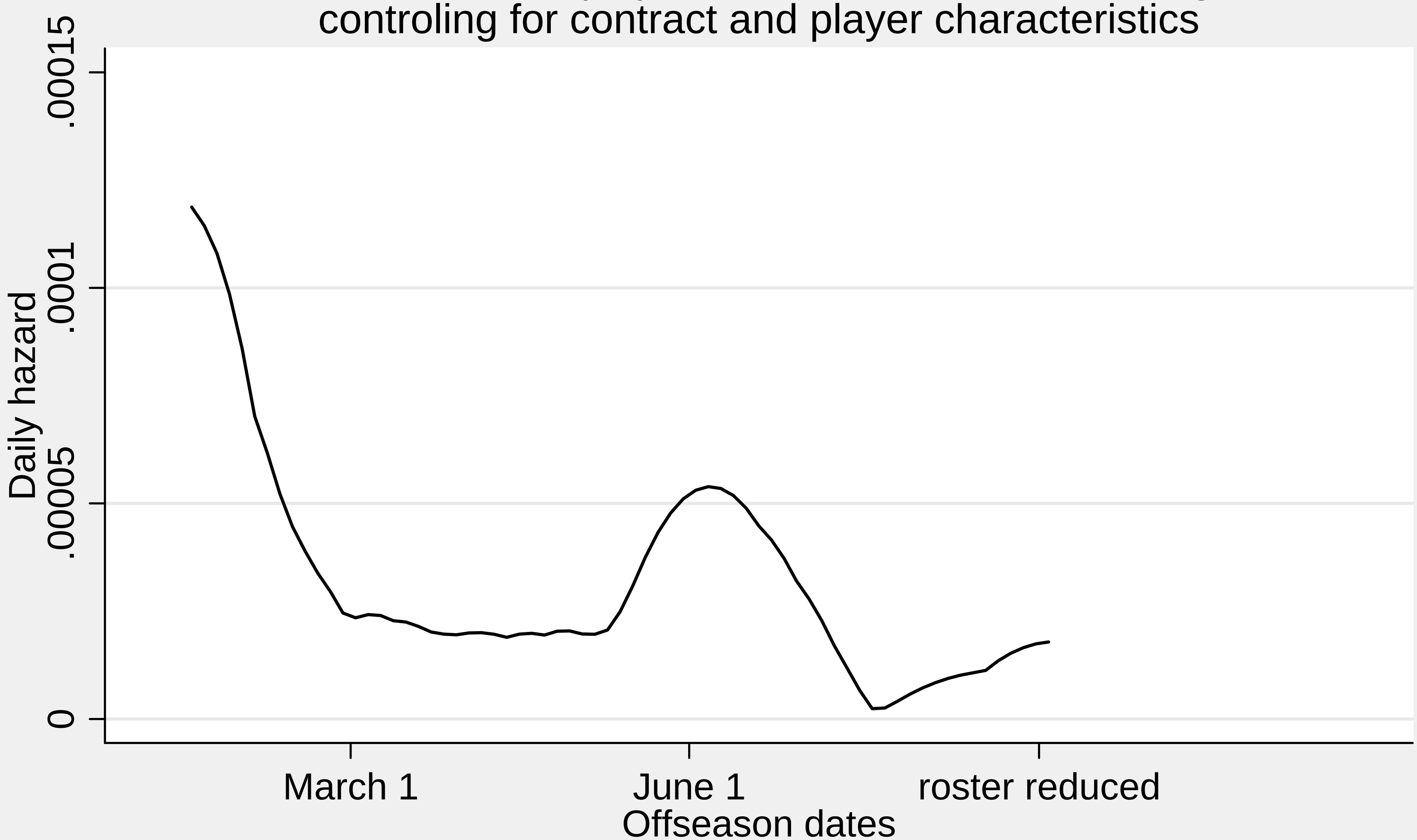

Hazard of termination for players with roster bonuses during offseason
Daily hazard
0
.0005
.001
.0015
.002
March 1
June 1
roster reduced
Offseason dates
95% CI
daily hazard

Figure 2

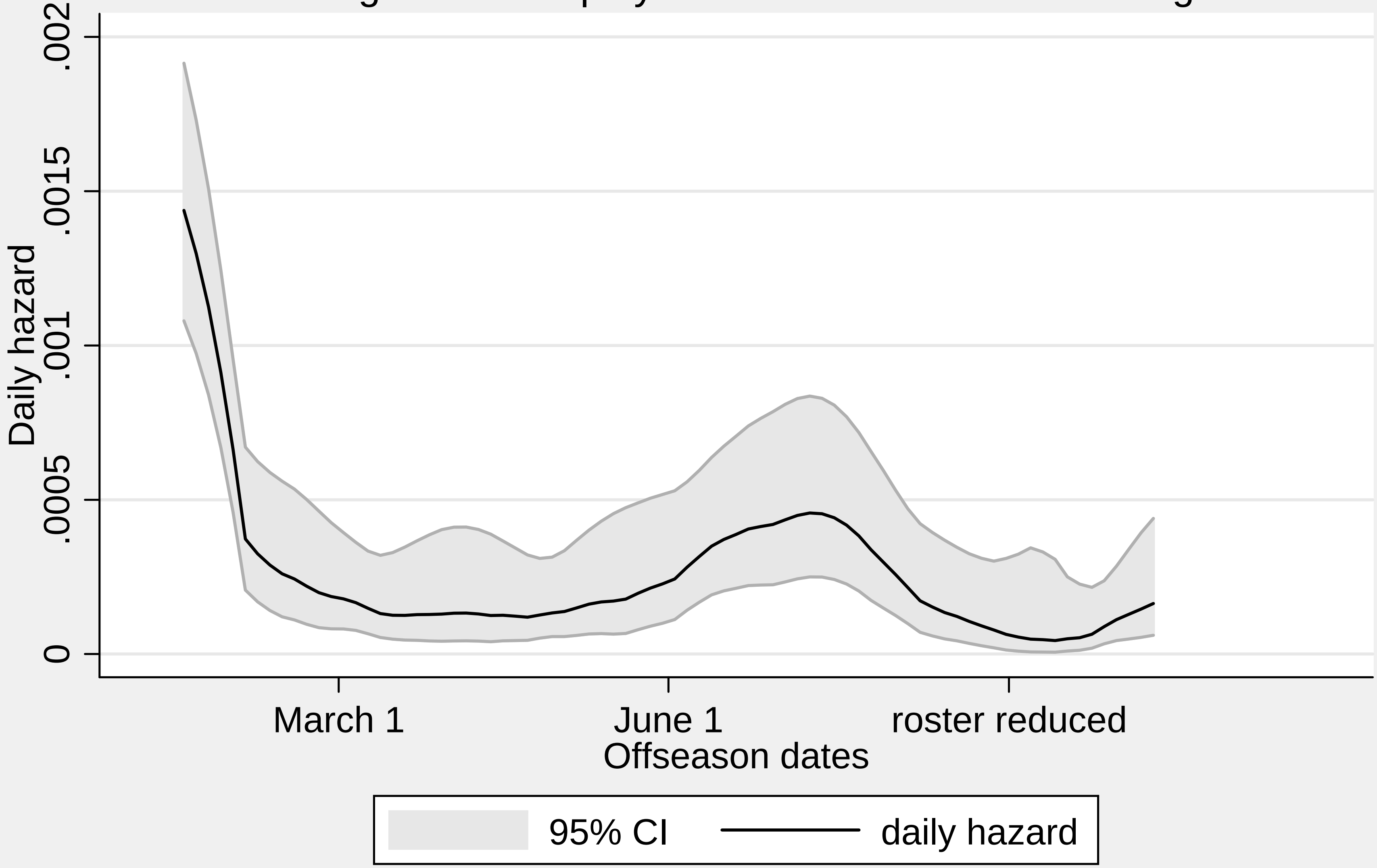
Hazard of termination for players with roster bonuses during offseason
controling for contract and player characteristics



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

Figure 3

Hazard of renegotiation for players with roster bonuses during offseason



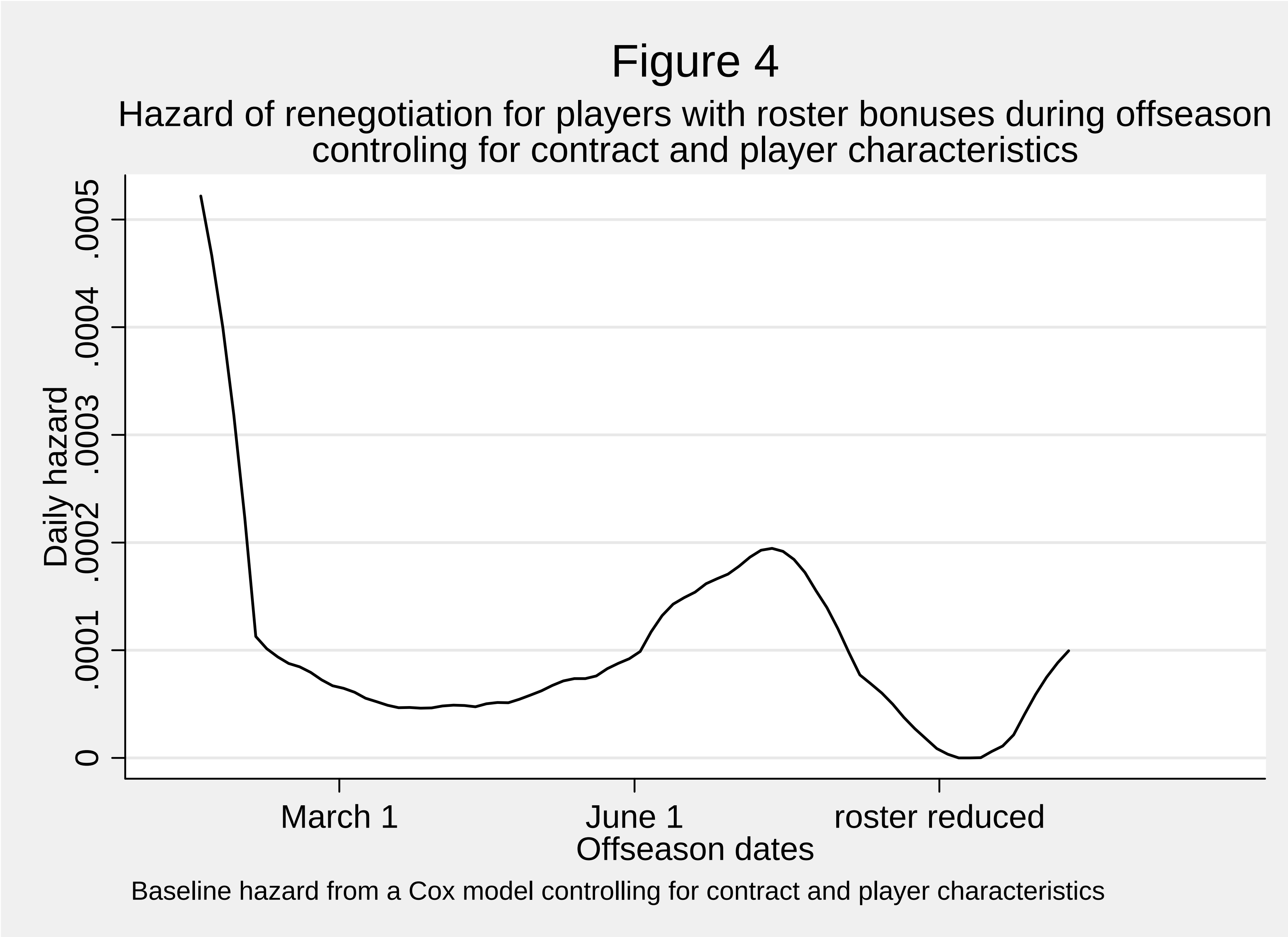
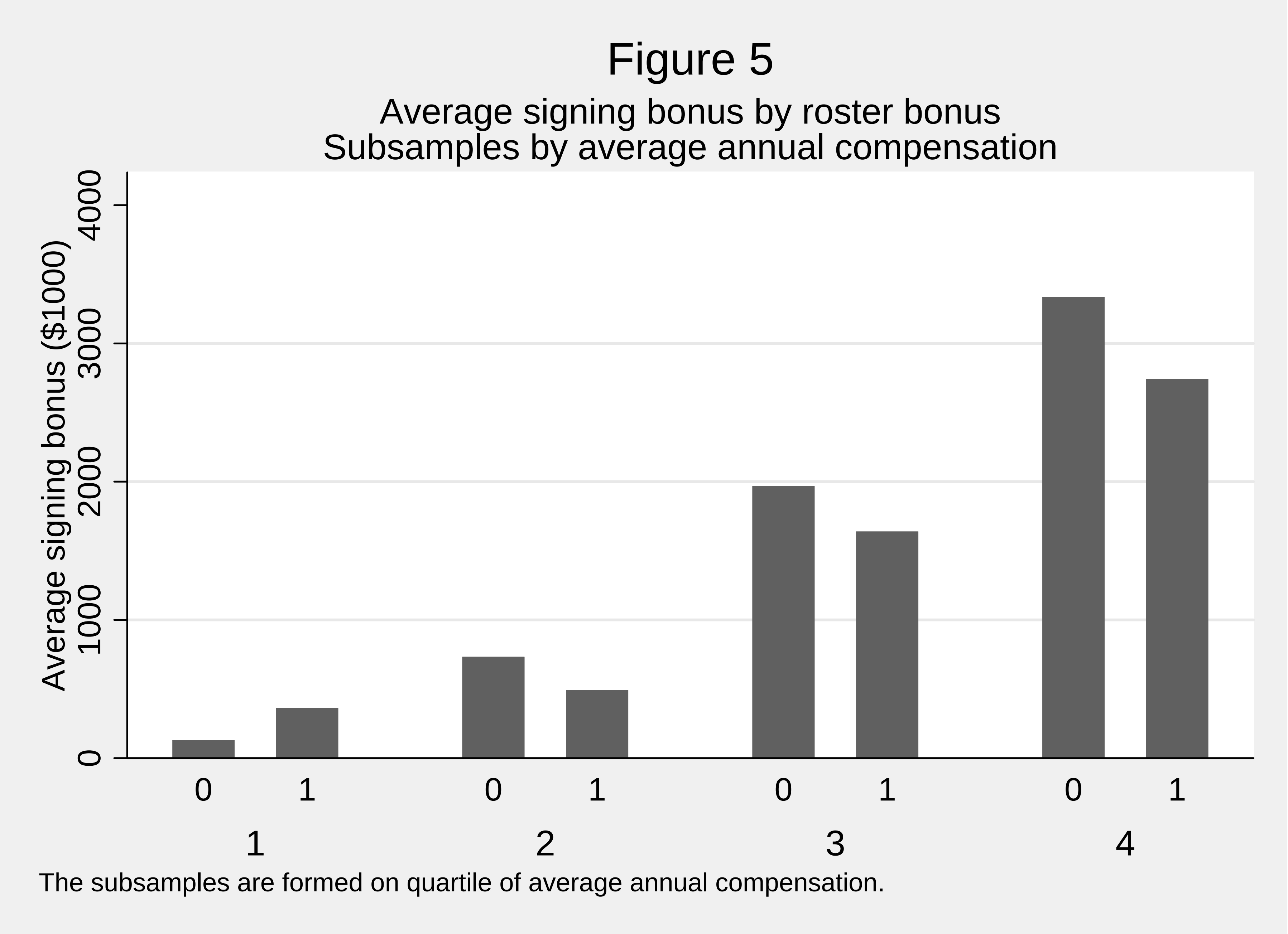


Figure 4
Hazard of renegotiation for players with roster bonuses during offseason
controling for contract and player characteristics
Daily hazard
0
.0001
.0002
.0003
.0004
.0005
March 1
June 1
roster reduced
Offseason dates
Baseline hazard from a Cox model controlling for contract and player characteristics

Figure 5



Average signing bonus by roster bonus
Subsamples by average annual compensation
Average signing bonus ($1000)
0
1000
2000
3000
4000
0
1
0
1
0
1
0
1
1
2
3
4
The subsamples are formed on quartile of average annual compensation.

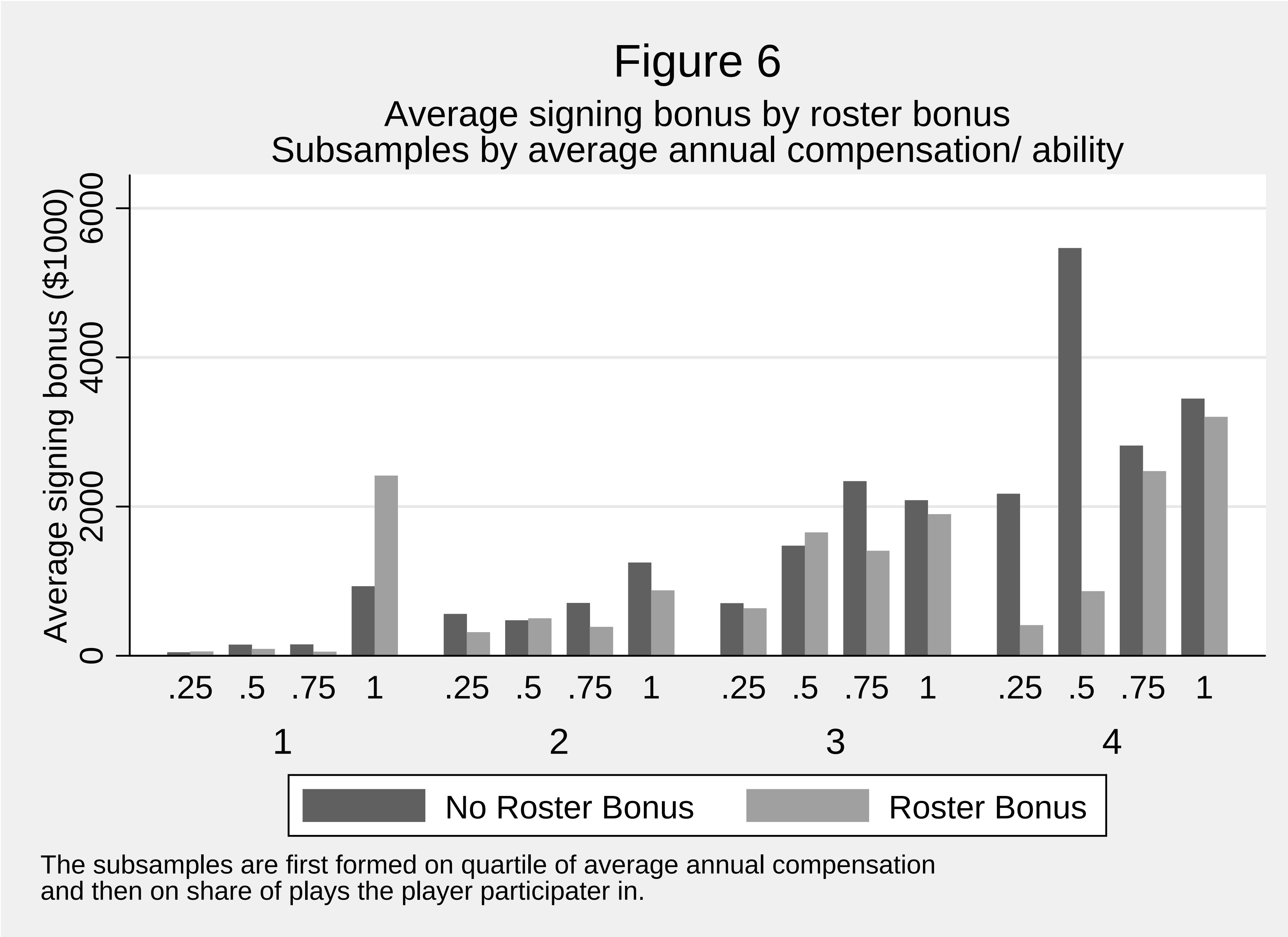
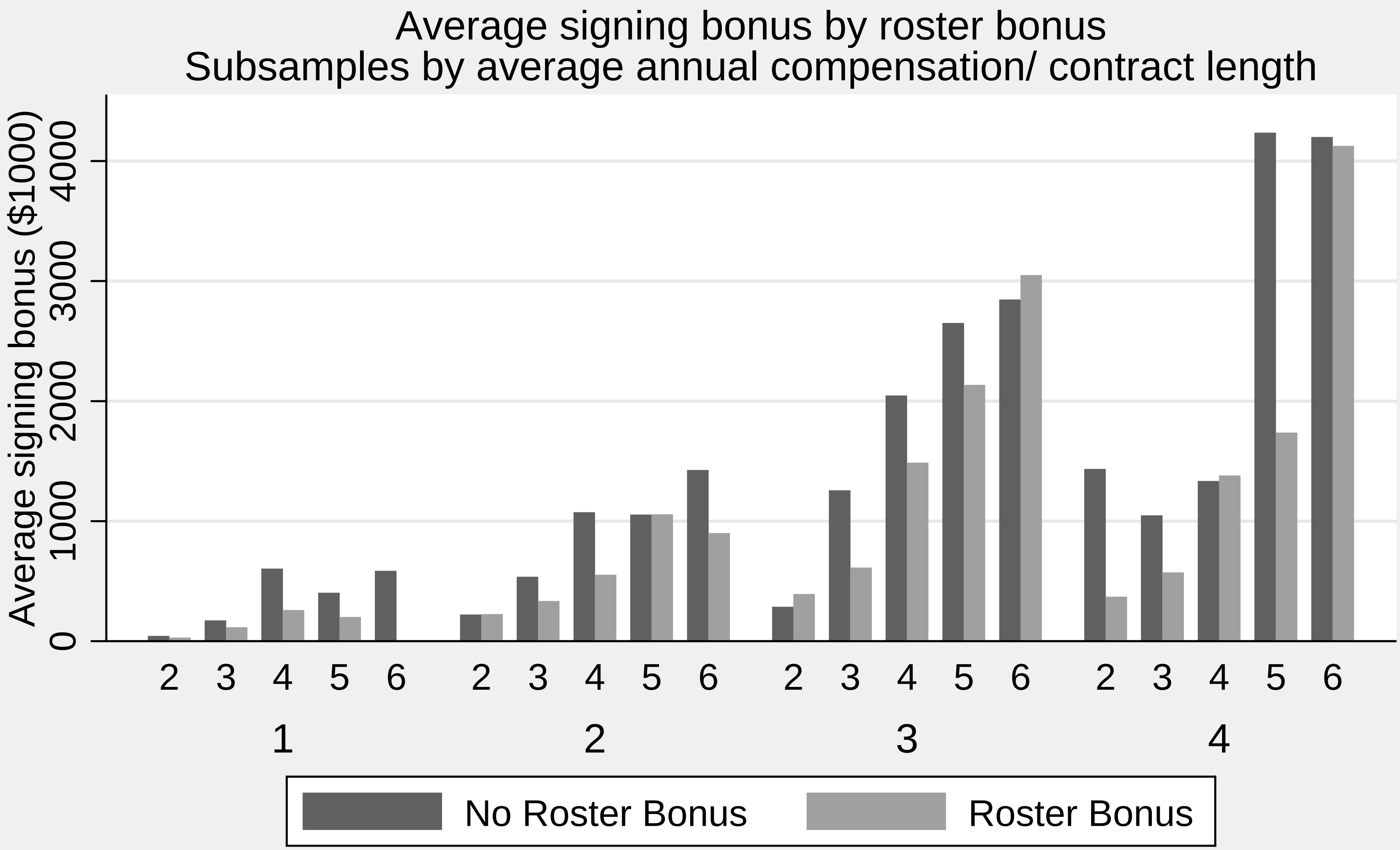


Figure 6
Average signing bonus by roster bonus
Subsamples by average annual compensation/ ability
Average signing bonus ($1000)
0
2000
4000
6000
.25
.5
.75
1
1
2
3
4
No Roster Bonus
Roster Bonus
The subsamples are first formed on quartile of average annual compensation
and then on share of plays the player participater in.

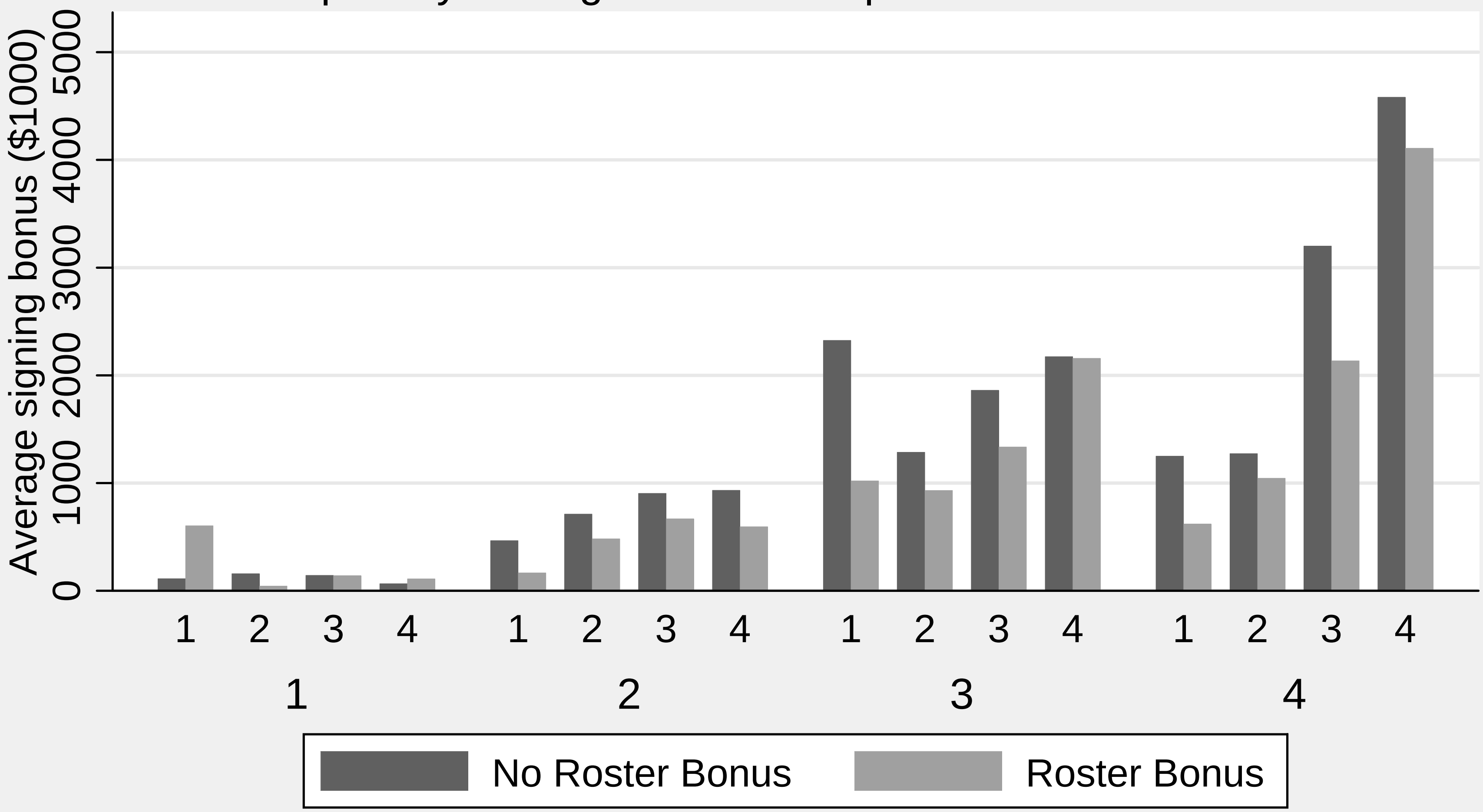
Figure 7



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

Figure 8

Average signing bonus by roster bonus
Subsamples by average annual compensation/ contract back load



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