Concussions in Athletics: Risk-Taking Behavior, Compensation, and Legal Remedies

by

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To my loving and supportive parents

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INTRODUCTION

The issue of traumatic brain injuries in athletics has garnered increased attention over the past decade. Mass concussion litigation has led to judgments and settlements totaling more than a billion dollars. Meanwhile, numerous policies at all levels of athletics have been adopted over this short period of time in an effort to reduce the risks of these types of injuries. The attention this issue has gained is well deserved. Traumatic brain injuries, including concussions, pose a great danger to athletes at all levels and can lead to very serious, long-term health consequences. This dissertation seeks to shed further light on the issue of concussions in athletics.

Chapter 1 focuses on state youth concussion laws. This chapter presents the first empirical study on how these laws influence high school participation in athletics. This chapter also adds to the growing literature that examines how these laws affect the reporting of concussions, while exploring how these laws impact the reporting of concussions differently across sports. I find that youth concussion laws lead to decreased participation in certain sports often linked to concussions. However, there is no evidence of substitution from these sports into others. I also find that these laws increase the reporting of concussions, but only for some sports, despite the universal applicability of the laws.

Chapter 2 explores the steps taken to reduce risk and provide compensation for traumatic brain injuries in football. This chapter examines four risk-management systems—market forces, tort liability, regulation, and insurance—that can be used to address the concussion issue. With the goals of creating proper incentives for an optimal level of risk and compensation, I present an argument for which of these systems are best used for each level of football—professional, college, and youth. In doing so, I explain how such systems could operate in practice at each of these levels.

Chapter 3 studies how commitment and payment schemes impact risk aversion. This chapter uses an incentivized experiment in which participants play a multi-stage game in which they must decide how many rounds they wish to play before walking away. Good outcomes lead to additional compensation, while bad outcomes result in a loss of prior gains. In this way, I analogize the experiment to the issues of concussions in athletics, which can lead to major, irreversible effects. I find that individuals are more risk seeking when faced with an upfront commitment and increasing payment structure.

CHAPTER 1: THE IMPACT OF STATE YOUTH CONCUSSION LAWS ON ATHLETIC PARTICIPATION AND REPORTED CONCUSSIONS

I. Introduction

Imagine a fall day in October as you watch your thirteen-year-old son play in his junior high football game. Towards the end of the first half, your son makes a tough tackle and his head slams hard into the ground. He grabs his head and looks to be in some pain. The official takes notice and calls timeout. Your son sits out the remaining three plays of the half. Always wanting to be part of the action, your son feels good enough to return at the start of the second half. The remainder of the game goes on as usual. Suddenly, your son collapses on the field and must be airlifted to a nearby medical center where he must undergo emergency life-saving surgery. Doctors are required to remove the skull from each side of his brain in order to reduce the building pressure.

This story sounds like a nightmare, but unfortunately, it was reality for Victor and Mercedes Lystedt and their son, Zackery. Zack spent the next seven days on a ventilator and was in a coma for a total of three months. It would be nine months until Zack could speak, thirteen months until he was able to move his limbs, and nearly two years until his feeding tube could be removed. The effects of this horrific injury are still present in its aftermath. Physically, the right side of Zack's body drags and his speech is slow and slightly slurred. Mentally, his short-term memory has been severely affected, making it difficult to learn. It is likely that Zack will need a lifetime of assistance. While Zack will never be able to live a normal life, he took it upon himself to fight so that other young athletes do not suffer a similar fate (Booth 2011; Clarridge 2009; Haas 2016; Mickool 2013).

The Lystedts, along with their attorney, began leading the charge to enact legislation focused on "return to play" (Clarridge 2009). "Return to play" refers to the specific protocol that must be followed before an athlete can return to a game or practice after having suffered a concussion. The Lystedts' effort was rewarded in May 2009, when the state of Washington passed the Zackery Lystedt Law, becoming the first comprehensive state law aimed at addressing the issue of youth concussions. Zack and his family continue to educate others about severe brain injuries and ensure that coaches, trainers, parents, and athletes know how to identify concussions and treat them properly.

Youth concussions in athletics are still very much an issue of great concern and while laws like the Zackery Lystedt Law now exist in every state, the effect of these laws deserve further study. This paper is the first to study the impact of state youth concussion laws on high school participation in various athletics. This chapter also adds to the literature examining the impact of youth concussion laws on the reporting of concussions, while using a dataset not previously used to study this topic.

The results reveal that the adoption of a state youth concussion law decreases participation in football and hockey—two sports perceived to be closely linked to concussions. This suggests that these laws reinforce such perceptions. Interestingly, there does not seem to be a substitution effect. Participation in other sports does not increase as a result of these laws; it does not appear that the individuals who stop participating in football and hockey are joining other sports instead. This is potentially concerning, given the many benefits of participating in youth athletics. Given this result, policymakers should consider providing other means by which individuals can still obtain these types of benefits.

I find that these laws improve the reporting of concussions. This result seems to be driven primarily by football and girls soccer. This may make sense from a benefit-cost perspective, since both football and girls soccer have relatively high rates of concussions as compared to other sports. Therefore, it would be efficient for schools to spend their limited resources focusing on these sports; however, whether schools are actually allocating resources in this manner is unknown. Furthermore, the fact that the reporting of concussions in other sports is unchanged by these laws may be concerning due to the fact that these laws are supposed to apply to all sports. State legislators may wish to consider amending their respective laws to better address the sports that do not see increased reporting.

Section II of this chapter provides a brief background of concussions, highlighting the prevalence of these injuries among the youth. Section II also discusses the different attempts that have been made to reduce concussions and provides a literature review of both qualitative and empirical studies related to youth concussion laws. Sections III and IV discuss the data and empirical strategy used to study the impact of these laws on participation and reported concussions. Section V provides a brief summary of the results, while Section VI offers further discussion of the results and their implications. Section VII concludes and provides suggestions for future research.

II. Background

A. Concussions in Youth Athletics

Roughly 500,000 children each year visit emergency rooms for traumatic brain injuries (TBIs), 80-90% of which are classified as concussions (Weill Cornell 2017).[1] These injuries are,

[1] Concussions are often classified as a subset of traumatic brain injuries and considered to be one type of mild traumatic brain injury (mTBI). However, it is worth noting that researchers often use different definitions when discussing concussions, and only now is a consensus building in the biomedical

in fact, the leading cause of emergency room visits among adolescents. The intensity, length of symptoms, and length of recovery differ on an individual level. For some people, the symptoms of concussions may last just days; while for others, they may last weeks or even months. Length of recovery depends on a variety of factors, including age. For the most part, recovery is slower among older adults, young children, and teenagers, than that of other age groups. Those with a history of prior concussions may also take longer to recover if they have additional concussions (Weill Cornell).

Concussions are caused when the brain is shaken inside the skull due to a blow to the head or body, a fall, or other incident (Mayo Clinic; Medline Plus; WebMD). It is no surprise then that contact sports, such as football, are a large source of youth concussions in the United States. In fact, sports are the second-leading cause of traumatic injuries among youth, trailing only motor vehicle accidents (Lowrey 2015). While people may think this issue is almost exclusively driven by tackle football, this is incorrect. Sports like lacrosse and girls soccer also have high incident rates for concussions.[2] Even girls basketball, a sport not commonly associated with concussions, has incident rates close to these other sports.[3] This could partially be due to the fact that females are more prone to concussions and require longer recovery time than their male counterparts (Kwon 2017; Snyder 2015).

More concerning than the commonplace of these injuries among our youth is the frequency at which these athletes are putting themselves at risk to sustain multiple concussions. One study found that 30.8 percent of concussed athletes return to play after a concussion

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community as to how concussions should be defined. Seymour (2013) and Sharp and Jenkins (2015), among others, note that the use of the terms traumatic brain injury and concussion have been applied inconsistently in the past.

[2] Tackle football players sustain 11.2 concussions per 10,000 athletic exposures. Lacrosse players and girls soccer players suffer 6.9 and 6.7 concussions per 10,000 athletic exposures, respectively (Brody 2015).

[3] Girls basketball players suffer 5.6 concussions per 10,000 athletic exposures (Brody 2015).

(Lowrey and Morain 2014). There are several reasons why an athlete might return to play in this situation—he or she might not want to risk losing playing time, the athlete might not think the injury is serious enough to require medical attention, or he or she might feel pressure to play so as to not let his or her team down by sitting out. The risks of sustaining another concussion become much higher after an individual has already been concussed. An individual can sustain a second concussion from a lesser impact than would generally be required to produce the first concussion. Once a high school athlete has suffered one concussion, the risk of him or her sustaining another concussion in that same season increases by a factor of three (Straus 2013).

These repeat concussions pose more potential harm than a single, isolated concussion. Repeat concussions over time can result in serious permanent brain damage or even death. The opportunity for repeat concussions in a sport such as football is a very real one, where collisions are at the very soul of the game. One example of the hazards surrounding repeat concussions is second impact syndrome (SIS), a severe condition brought on by a repeat concussion in which the brain swells rapidly causing intracranial pressure and severe brain damage, all of which can happen in a number of minutes. In many cases, such rapid brain swelling is fatal. Repeat concussions occurring over an extended period of time can have cumulative effects on the brain, resulting in neurological and cognitive defects. These types of concussions have recently received widespread publicity due to some of the new evidence demonstrating the widespread occurrence of these injuries among former players of the National Football League (NFL). In particular, these repetitive concussions have been linked to Chronic Traumatic Encephalopathy (CTE), a degenerative condition associated with dementia, difficulty controlling impulsive behavior, impaired judgment, depression, and other physical difficulties. However, CTE is just one condition on a long list linked to repetitive head trauma,[4] and NFL players are not the only ones susceptible to the long-term consequences of concussions. Several studies have demonstrated other prolonged effects of concussions. These include deficits in attention, concentration, memory, and judgment. As a result, much of policy addressing the youth concussion problem has focused on preventing repetitive concussions.

B. Attempts to Reduce Youth Concussions

A variety of measures have been taken in efforts to reduce the incidence of concussions. One focus has been on improving equipment worn by athletes in sports frequently plagued by concussions. The producers of football helmets are constantly searching for ways to improve their product and make athletes safer. One startup company, Vicis, has even borrowed the crumple-zone concept from the auto industry while developing its helmet prototype.[5] Special headbands for soccer are now being sold, with companies suggesting that they reduce the likelihood of concussions caused by the heading of a soccer ball. Numerous governing bodies have implemented programs in hopes of reducing concussions in youth sports. One such program, the Center for Disease Control and Prevention's *Heads Up* Concussion in Youth Sports initiative, provides information to coaches, parents, and athletes regarding concussions. USA Football, a youth and high school football organization, later developed their own program, financed by the NFL, with the goal of making the game of football safer through proper fitting of equipment, concussion awareness, and the teaching of proper tackling techniques. Governing bodies of high school state football throughout the country have even introduced policies that limit the amount of full-contact drills that athletes may be subjected to throughout a week of

[4] Concussions have also been linked to other degenerative diseases such as Alzheimer's disease, Parkinson's disease, and amyotrophic lateral sclerosis (ALS).
[5] One of these helmets costs $1,500, which is much more expensive than the typical helmet on the market (Gruley and Robison 2016). Notre Dame will become the first team to use these helmets for the majority of its football roster beginning in the 2018 season (Lemire 2017).

practice.[6] Finally, state legislatures have sought to address the concussion problem by enacting comprehensive sports-related concussion laws.

In 2009, Washington became the first state to enact a law focused on decreasing the prevalence of sports-related traumatic brain injuries among youths. This law, named the Zackery Lystedt Law after the middle school football player described previously who suffered a severe brain injury after returning to play after an earlier concussion, became a model for other states wishing to enact their own version of this initiative. The Washington law has three main features: (i) education of athletes, parents, and coaches; (ii) immediate removal from play of a concussed athlete; and (iii) medical clearance before allowing the athlete to return to play (WASH. REV. CODE ANN. § 28A.600.190). Soon after Washington enacted its law, several other states followed suit. Over the years, more states continued to adopt such laws, and now all 50 states and the District of Columbia have some sort of comprehensive youth sports concussion safety law. Figure 1 demonstrates the adoption of these laws over time.

Most state laws are similar and are typically structured around the same three features as in the Washington law. However, there does exist quite a few subtle differences between some of the laws. For example, many state laws require that coaches are not only provided with information regarding concussions, but also require that they undergo formal training in the recognition and management of concussions in order to remain certified. States requiring that parents and athletes be informed of the risks of concussions also differ substantially as to how they ensure such education occurs. Washington and other states require that both the athlete and a parent or guardian sign and return an information sheet before the student is allowed to participate in athletics, while other states, such as Wyoming, simply require that the information

[6] The South Carolina High School League limits full-contract drills to 90 minutes per week (Robinson 2016). The state of Ohio has instructed schools to limit full contact in practice to 30 minutes per day and 60 minutes total per week (McCrabb 2015).

be made available to parents. In addition, some states with existing laws have modified their statutes over the years in hopes of making these laws more effective. Common modifications include expanding coverage, clarifying existing requirements, tightening existing requirements, and adding provisions aimed at primary prevention.

C. Commentary Regarding Youth Concussion Laws

Comprehensive policies directed at sports-related youth concussions have been in effect for less than a decade. As a result, large portions of the literature are non-empirical and instead seek to explore potential weaknesses of these laws and suggest remedies to strengthen their effectiveness. Amberg (2012) considers different provisions of state laws. The specific provisions of these laws vary state by state and many state laws go further than the original Washington statute. Similar to other scholars who have examined these laws, Amberg warns that these laws may be ineffective due to the lack of enforcement mechanisms or penalties for noncompliance. While recognizing that cost is a concern, Amberg stresses the need for both baseline testing and the presence of medical professionals on the sidelines of athletic events.

Brandwein (2013) details the science of concussions, the history of concussions in athletics, and examines the role of this legislation in limiting the effects of concussions on youth athletes. Brandwein argues that the primary goal of sports-related concussion legislation should be to eliminate deaths and injuries caused by secondary impact syndrome. This is because, Brandwein reasons, such secondary concussions are preventable. Subordinate to this goal is the reduction in the total number of concussions and the spreading of awareness and education to those involved in youth sports. He argues that the existence of strict protocols that must be followed once an athlete has suffered a concussion before allowing that athlete to return to competition or practice, more commonly known as "return to play" rules, would act as a restraint on players, coaches, and parents who might otherwise be driven by competitive urges to have the athlete return to play before it is appropriate.

Brandwein contends that the current state laws suffer from four main weaknesses: (i) language that is too general; (ii) informed consent and education requirements that are too vague; (iii) limits in the scope of the statute; and (iv) a lack of funding to monitor and enforce these laws. General language, it is argued, could allow the law to be followed without achieving its purposes; many of the education requirements do not ensure that the appropriate information is provided in a way that leads parents to seriously consider it. In terms of scope, many of the state laws only apply to public school systems. Finally, Brandwein argues that funding is a major shortcoming of these laws because these laws add fiscal burdens to schools and do little to ensure that they are enforced. Enforcement is especially doubtful considering that most of these laws contain immunity provisions.

Harvey (2013) provides a useful description of state laws enacted through the end of 2012. Harvey creates a comprehensive data set of the different state law features, including return to play clearance provisions, concussion awareness requirements, and potential liability. Harvey finds that most states establish a minimum 24-hour period of removal from play, despite the lack of scientific agreement as to what is the optimal removal time frame. This is just one example of where there may be a disjoint between the state law requirements and current scientific knowledge and practice. In addition, this highlights the potential drawbacks of a one-size-fits-all approach taken by these laws. Harvey also finds that a large number of state laws do not require that clearance be provided by an individual trained in concussion awareness, which he finds to be troubling. Harvey also expresses concern regarding the educational requirements in these laws, which he finds to vary widely between states but lack any evidence of efficacy.

Finally, Harvey notes that states differ greatly in their approach to liability waivers and concedes that he has no basis for judging whether waivers would lead to more or less concussions.

D. Empirical Studies Regarding Youth Concussion Laws

Lowrey and Morain (2014) are the first to provide a national, empirical examination regarding the implementation of sports-based concussion laws. They do so through interviews with the individuals actually in charge of administering these laws—representatives from state departments of health and education, as well as state athletic associations. The authors conducted a total of 36 interviews in 35 of the 42 states that had laws in place as of December 31, 2012. The interviews focused on implementation, evaluation, and enforcement of the concussion laws. State respondents expressed several challenges concerning these laws. Some expressed uncertainty as to the scope and coverage of these laws. Several respondents reported difficulties in determining who was qualified to make return to play assessments. Some felt that only those with neurological training should be allowed to make these evaluations, while others believed that team physicians and athletic trainers should also be allowed to make such evaluations. Another common complaint was the lack of formal enforcement or penalties to ensure compliance. While some respondents did reference some sports-related penalties for non-compliance, several noted the lack of liability provisions in these statutes, and added that liability could serve as an additional deterrent. Respondents also suggested stricter education requirements beyond simply providing coaches, parents, and athletes with informational handouts.

Chrisman et al. (2014) focus on the impact of education requirements in Washington's Zackery Lystedt Law. The law requires the state athletic association to "inform and educate coaches, youth athletes, and their parents and/or guardians of the nature and risk of concussion."

In addition, this information sheet must be signed and returned by the athlete and his or her parent prior to participating in athletics. The authors surveyed high school coaches, athletes, and parents three years after the passage of the act. Their study showed that coaches received more education than athletes and parents. One explanation given was that the law was written so as to give immunity to schools that follow the coach education guidelines, thus giving them incentive to ensure their coaches received the required education and training. On the other hand, many of the athletes and a majority of the parents admitted to only signing the required form and did not utilize any further education.

Gibson et al. (2015) sought to measure the effect of concussion laws on health care utilization rates. The authors used emergency department data on commercially insured children aged 12 to 18 from January 1, 2006 through June 30, 2009. They found that this legislation has led to an increase in health care utilization, but acknowledged that the overall increase can also be credited to increased awareness and attention due to heightened media attention. Overall, the authors attributed a 10% increase in health care utilization for concussions to the implementation of concussion legislation.

Yang et al. (2017) examined the trends of new and recurrent concussions suffered by high school athletes using data from High School Reporting Injury Online (RIO). The authors found that the reporting of new concussions increased for a period of 3.8 years after the enactment of youth concussion laws. They also found that the reporting of recurrent concussions appeared to increase for a brief period after the enactment of concussion legislation and then declined significantly 2.6 years after enactment of the laws. One limitation of this study recognized by the authors is that the data may have suffered from sample selection issues. To participate in the surveillance study, schools must have had a certified athletic trainer. The schools willing to participate in the study were likely to be most compliant with state concussion laws and, therefore, may not have provided an accurate representation of how these laws impacted schools across the nation.

Previous literature has examined the impact of youth concussion laws on things such as concussion knowledge and the reporting of concussions. The impact of these laws on athletic participation across different sports, however, has yet to be studied. In the following sections, I describe the data and methods used to perform the first known national, empirical study measuring the impact of sports-related concussion legislation on high school athletic participation. I also add to the increasing literature that seeks to measure the impact of these laws on reported concussions. While the primary goal of these laws may be to prevent repeat concussions, the detection and reporting of concussions is instrumental in achieving this goal. Reporting a concussion allows for proper medical treatment and reduces the risk of an athlete returning to competition before it is safe to do so. As explained in the subsequent section, the dataset I use to examine reported concussions does not suffer from some of the same limitations as previous research. Namely, it is not limited to injuries involving insurance claims, as in Gibson et al. (2015), nor does it rely on a specific sub-sample of schools that are willing to participate in surveillance, as in Yang et al. (2017). The data in my study also span a larger time period (2002–2016).[7]

III. Data

A. State Laws: LawAtlas

The data on state youth concussion laws were collected from LawAtlas, which is a publicly available website that presents law data, showing how laws differ over time and across

[7] Gibson et al. (2015) used data from 2006–2012. Yang et al. (2017) used data from 2005–2015.

jurisdictions. The website gives detailed information regarding the various provisions of youth concussion laws, indicates when each of the laws went into effect, and provides links to and citations of the state laws. The types of provisions documented by LawAtlas include whether the law specifically addresses youth sport concussions, whether an athlete suspected with a concussion must be removed from play, whether the law specifies requirements for a return-to-play policy, whether coaches must undergo training, whether an information sheet regarding TBIs must be distributed and/or signed by parents and/or student athletes, and whether the law explicitly addresses liability. As states have updated their laws over time, certain provisions included in their laws have also changed. These changes are reflected in this dataset, as most states have several effective dates to reflect the various versions of their law. These data were consistent with data published by The Network for Public Health Law. I also corroborated the information from these sources with my own search of state laws using Westlaw.

B. Participation: National Federation of State High School Associations (NFHS)

The National Federation of State High School Associations (NFHS) is an organization for high school athletic and performing arts activities. The association is comprised of 50 member state associations and the District of Columbia. Among other things, the NFHS publishes data on high school participation in athletics and other activities. These data are collected from the state high school athletic associations that comprise the NFHS. The participation data are published annually by the NFHS and are the best source of information available on high school sports participation. I was able to obtain state-level participation data for 13 different sports, seven boys sports and six girls sports. The sports include baseball, boys and girls basketball, boys and girls cross country, football, boys and girls hockey, boys and girls soccer, softball, and boys and girls track. The data span from the 2002-2003 school year through the 2016-2017 school year, amounting to 15 years worth of data.

To link the participation with the law data, it is important to know the start date of each sport season in each state. I was able to collect this data from calendars found on the websites of the high school athletic associations for each state. I then linked these dates with the state law data in order to determine which version of the state's law was in effect at the start date of each sport for each state. This ensured that the appropriate version of the law would be applied.[8]

C. Concussion: National Electronic Injury Surveillance Survey (NEISS)

The National Electronic Injury Surveillance System (NEISS) is a database that collects patient information from a national probability sample of hospitals in the United States. A hospital sample weight is included in the data so that national estimates can be accurately developed. For each of the representative hospitals, every emergency visit involving an injury associated with consumer products is collected. The Consumer Product Safety Commission maintains this database. Some of the variables contained in this database are date, product, gender, age, diagnosis, disposition, and locale.

As one of the diagnoses in this data set is concussion, I am able to code up the injuries as either being a concussion or a non-concussion injury. The product code includes several sports that are of interest—baseball, basketball, football, hockey, soccer, softball, and track. The disposition variable allows me to observe whether the individual was treated and released or if the injury was more serious and he or she was instead hospitalized. The location variable allows me to distinguish whether the injury took place at school, on the sports field, or at some other location. I use data between 2002-2016 so that I am able to match the participation data with this

[8] This would otherwise have been problematic if the state law happened to become effective during the middle of the school year.

injury data. I also limit my research to individuals between the ages of 12 and 18. This is the age group used by those studying youth sports concussion laws, as these laws apply to middle school and high school athletes. Table 1 shows the number of concussions and the percent of concussions relative to the total number of injuries for each of the sports analyzed.

Figure 2 shows the number of reported concussions per 10,000 participants for all sports. Figure 3 depicts the same information, but only for football. The raw data show a rise in the number of reported concussions after the first youth concussion law became effective in 2009. One may also notice that the rise in reported concussions actually first starts to appear a few years earlier, in 2007. This could be due to the fact that this is about the time that these laws entered the public debate and the concussion issue started garnering more attention. In fact, the injury that spurred the proposal of the first of these laws—the one suffered by Zackery Lystedt—occurred in October 2016. It was not until after this that youth concussion laws received any consideration.

IV. Empirical Strategy

A. Participation

I first test the impact of state youth concussion laws on participation in high school athletics. The equation below shows the basic regression used for this analysis.

$$\text{Ln}(Participation_{x,y}) = \alpha_0 + \beta_1 Law_{x,y} + \beta_2 State_x + \beta_3 Time_y + \varepsilon_{x,y} \quad (1)$$

$\text{Ln}(Participation_{x,y})$ is the natural logarithm of the number of athletes participating in a particular sport in state x at time y. Under this specification, each sport was analyzed separately. $Law_{x,y}$ is a dummy variable equal to one if there was any law addressing concussions in place at the start of the particular sport season for that state. $State_x$ is a vector of state identifier variables that accounts for state-specific trends. $Time_y$ is a yearly linear time trend variable that accounts for any national trends that may exist, such as the change in media attention that concussions have garnered. While the time and state variables should already control for changes in youth population that may be occurring over this period, I also conduct my analysis using participation *rates* in order to more explicitly control for this possibility. The results for these regressions are contained in Tables A–2 and A–3 in the Appendix.

If the state laws impact how individuals perceive the risks associated with concussions, which is arguably one of the goals of these laws,[9] one would expect an impact on the number of individuals participating in certain sports to be impacted by the introduction of one of these laws. Theoretically, individuals could have been overestimating or underestimating the risks related to concussions prior to the state laws. If individuals were previously overestimating the risks, one would expect the laws to increase participation for sports associated with concussions. On the other hand, if individuals were previously underestimating the risks related to concussions, the laws should decrease participation. It seems much more likely that individuals were underestimating, rather than overestimating, the risks relating to concussions prior to these state laws. Otherwise, it seems unlikely that state legislatures would see a need to introduce such laws. Therefore, I predict that these laws will decrease participation for certain sports or, in other words, I predict $\beta_1 < 0$ for sports like football to which these laws usually draw attention.

I predict to see such an effect for only certain sports—those that are perceived as being most linked to concussions. Therefore, I would expect to see the laws lead to a decrease in participation for sports like football and hockey, but have no impact on other sports not thought to be linked to concussions, such as track. It is also possible that these laws could increase participation for certain sports due to individuals substituting one risky sport in favor of another

[9] Unfortunately, explicit goals are rarely found in the text of these laws. However, education, including information about the risks associated with concussions, is often seen as an important aspect of these laws.

less risky sport. For example, both football and cross country take place during the fall sports season. Due to these laws, individuals may decide to stop playing football, and instead, join cross country. To gain a better understanding of the impact of these laws on specific sports and to explore this substitution story, I use a difference-in-differences strategy shown in Equation (2) below. The difference-in-differences methodology can be used in instances in which outcomes are observable for both a treatment group and a control group at two or more different time periods, where at least one of the time periods is after a "treatment" has occurred. The methodology works by comparing the outcomes of the two groups before and after the treatment has occurred. Such method removes potential biases that could result from permanent differences between the two groups or from certain time trends.

$$\text{Ln}(\textit{Participation}_{x,y}) = \alpha_0 + \beta_1 \textit{Law}_{x,y} + \beta_2 \textit{Football}_{x,y} + \beta_3(\textit{Law} \times \textit{Football})_{x,y} + \beta_4 \textit{State}_x + \beta_5 \textit{Time}_y + \varepsilon_{x,y} \quad (2)$$

Using this differences-in-differences strategy allows me to account for any unobservable trends that may exist among the different sports. The *Participation*, *Law*, *State*, and *Time* variables are the same as in Equation (1). *Football* is a dummy variable equal to one if the observation is for football and equal to zero if the observation is for the other sport being compared. This variable accounts for the fact that football has much more participation than other sports. The variable of interest is the interaction term, *Law* × *Football*. I choose to use football as the comparison sport because these laws are most often associated with football and so it is most interesting to see how these laws affect football as compared to each of the other male sports. I compare football to each of the male sports separately, which amounts to six estimations.[10] As discussed previously, I would expect these laws to impact football

[10] I choose to only compare football to male sports so as to eliminate the possibility of differences attributable to gender that could obscure the results.

participation, but not necessarily have the same effect on participation of the other sports. Therefore, I predict $\beta_3 < 0$.

B. Reported Concussions

I next test the impact of the laws on reported concussions. Equation (3) below shows the specification used to do so.

$$Concussion = \alpha_0 + \beta_1 Portion\ of\ Athletes\ Covered\ by\ Law + \beta_2 Time + \varepsilon \quad (3)$$

Unfortunately, the NEISS does not provide state-level data. Instead, the data is to be used for national estimates. Therefore, it is not possible to use a law variable in the same manner for which it was used for the participation analysis. One possible solution is to simply use a dummy variable to indicate the post-law period as any point in time after the first state law became effective. However, this does not account for the fact that different states gradually adopted these laws over a period of five years.

Instead, I choose to create the variable *Portion of Athletes Covered by Law*.[11] This variable is the percentage of high school participants that are covered under a youth concussion law for that particular sport at the time of the injury. This construction was possible due to the availability of state-level data on participation and data on the dates in which the laws went into effect. This construction controls for the fact that certain states are much larger than others and will have more participants. *Time* is a yearly linear time trend variable (the same as used in the prior regressions).

Concussion is a dummy variable equal to one if the injury suffered was a concussion and equal to zero if the injury was something other than a concussion. The results of this regression, therefore, indicate how the laws affect the relative proportion of reported injuries that are

[11] As a robustness check, I also conduct the analysis using a post-law dummy variable as done in prior studies. The results of this regression are shown in Table A–1.

concussions (as compared to other injuries). One would expect these laws to possibly affect the reporting of concussions in at least a couple of ways. First, these laws are expected to educate individuals about the risks of concussions. Such education may prompt individuals to seek treatment for concussions that they may not have otherwise before the enactment of such laws. Second, certain provisions contained in these laws are aimed at improving the identification of concussion-related symptoms, which would directly impact the percentage of concussions that get reported. Thus, I predict these laws to increase the reporting of concussions. In other words, I expect $\beta_1 > 0$.

Similar to the participation analysis, I also estimate a difference-in-differences model that compares the injuries suffered in football to the injuries suffered in each of the other male sports.[12] The equation for this difference-in-differences estimation is shown below.

$$\begin{aligned}&\textit{Concussion} = \alpha_0 + \beta_1 \textit{Portion of Athletes Covered by Law} + \beta_2 \textit{Football Injury} + \\ &\beta_3(\textit{Portion of Athletes Covered by Law} \times \textit{Football Injury}) + \beta_4 \textit{Time} + \varepsilon \qquad (4)\end{aligned}$$

Football Injury is a dummy variable equal to one if the injury is football-related and equal to zero if the injury was related to the comparison sport. The state youth concussion laws are supposed to apply universally to all sports. However, as previously argued, it is likely that such laws will tend to be emphasized more in football, which garners the most attention, than in other sports. Therefore, it is interesting to learn how these laws have affected reported concussions suffered in football as compared to concussions suffered in other sports.

The availability of data regarding the location of the injury creates an opportunity for further meaningful examination. The youth concussion laws are targeted at middle schools and high schools and the organized athletics that these schools oversee. Therefore, we would expect the laws to impact only those concussions which occur at these locations and not elsewhere.

[12] This leads to a total of five estimations. Unlike the participation data, the NEISS does not report injuries specific to cross country, so the comparison with this sport is not possible.

This type of scenario is ideal for a difference-in-differences approach, which accounts for pre-policy trends by using a comparison group that is experiencing the same trends, but is not exposed to the policy change. Here, the group exposed to the policy change is injuries occurring at school or the sports field and the comparison group is those injuries that occur elsewhere. The regression used for this analysis is shown below.

$$\textit{Concussion} = \alpha_0 + \beta_1 \textit{Portion of Athletes Covered by Law} + \beta_2 \textit{School or Sport Field} + \beta_3(\textit{Portion of Athletes Covered by Law} \times \textit{School or Sports Field}) + \beta_4 \textit{Time} + \varepsilon \quad (5)$$

By using this specification, I am also able to account for any unobservable differences in concussions for these two types of locations. *School or Sports Field* is a dummy variable equal to one if the injury occurred at school or at a sport's field or arena. It is equal to zero if the injury occurred elsewhere, such as at home, on a street or highway, or at some other location. If these laws have an impact on reported concussions, we would expect the interaction term, β_3, to be significant and positive. I predict that these laws have increased the reporting of concussions (i.e., $\beta_3 > 0$).

V. Results

A. Participation

As shown in Table 2, state youth concussion laws decrease participation in football and hockey. For football, these laws decrease participation by 5.0%. This result is in line with my earlier prediction. As football attracts the most attention with regards to concussions and safety, it is often perceived that the enactment of these laws is to address issues with football. Therefore, much of the debate and discussion surrounding the enactment of youth concussion laws often gets linked to football.

Hockey is similar to football in that both sports are often associated with concussions; however, the effect of the laws is even larger for hockey participation than for football participation. These laws decrease participation by 8.8% for boys hockey and 22.5% for girls hockey. The effects for hockey are quite large, but this could be due to the fact that hockey has a relatively small number of total participants. Hockey is also different from many sports in that, depending on the state, a large portion of high school aged hockey players participate in club leagues instead of high school sanctioned leagues. The participation data used in my study does not account for these other participants, so any conclusions to be drawn from this analysis with regards to hockey should be limited with this in mind.

There is no evidence of any substitution effect. One might believe that with participation decreasing in football as a result of these laws, the athletes no longer participating in football may instead decide to join another sport. There is no indication that this is happening, as these laws do not impact participation for cross country, the other fall season sport. In fact, I do not find a statistically significant effect of these laws on participation for any sports other than football and hockey.

The results for the difference-in-differences analysis shown in Table 3 are in line with the results from Table 2. These results are negative and significant for baseball, cross country, soccer, and track—corroborating the assertion that the youth sports concussion laws have reduced participation in football, but have not had an impact on most other sports. The results for hockey are insignificant, indicating that the laws have not impacted football participation significantly differently from how they have impacted hockey participation, as suggested from the results in Table 2. The results are also insignificant for basketball. This could be due to the fact that basketball is a "cut" sport, with only a limited number of spots available for participants. Therefore, one would not expect participation to vary as much for basketball.

B. Reported Concussions

The results from the estimation of Equation (3) suggest that the impact of youth concussion laws on reported concussions differs based on the sport.[13] These laws have improved the reporting of concussions for both football and girls soccer. The results are significant and negative for girls hockey, which would indicate that these laws have decreased the reporting of concussions. This result is surprising, but with so few states offering girls hockey, a small number of reported injuries could greatly impact the results. No statistically significant effect was found for any of the other sports. The positive effect of these laws for reported concussions in football and girls soccer is in line with expectations. One of the purposes of these laws is that concussions will be better detected and athletes suffering concussions may receive the appropriate medical attention. However, these laws apply to all sports, so it is noteworthy that this effect is only found for these two sports.

As shown in Table 5, the interaction term for the estimation of Equation (4) is positive and significant for baseball, basketball, soccer, and track. This implies that the state youth concussion laws impact football significantly more than the other sports. This is consistent with the results from Table 4. The interaction term in the hockey comparison is negative and significant. This actually suggests that the laws improve the reporting of concussions significantly more for hockey than for football. This result is unexpected, as one would

[13] As previously stated, the analysis with respect to reported concussions is constrained by the fact that the NEISS provides national estimates, rather than state-level data. Therefore, I am unable to control for the adoption of laws by each state in the same straightforward manner (i.e., using a dummy variable for when a state had a law in place and state identifier variables) as when examining the impact of the laws on participation. Instead, I construct a variable that controls for the portion of high school participants that are covered by a youth concussion law.

anticipate the laws to have a similar impact on each of the two sports—both sports being commonly associated with concussions and equally likely to receive attention from these laws.

Table 6 presents what is perhaps the most convincing evidence that the state youth concussion laws have increased the reporting of concussions. If the laws contribute to an increase in the reporting of concussions, then one would expect that reported concussions should increase for injuries occurring at school or on the sports field, and not for injuries occurring elsewhere. This is because the laws only apply to schools and their management of concussions. The interaction term from the difference-in-differences regression is significant and positive. This supports the claim that the laws are improving the reporting of concussions, rather than the effect being driven solely by some other factor, such as the national media attention to concussions.

VI. Discussion

While it is not surprising that the laws lead to less participation in football and hockey, the impact of the laws was at least theoretically ambiguous. On the one hand, the laws could signal to parents and athletes that concussions are a serious issue that must be taken more seriously than before. A natural corollary of this is that these laws would increase the perceived risks of sports like football and hockey. On the other hand, the whole motivation behind these laws is to make participation in sports safer when it comes to concussions. The laws add more rigorous requirements that are supposed to increase the medical attention given to athletes and decrease the risk of secondary concussions. With this in mind, parents and athletes could also view the laws as making sports like football and hockey safer, thereby lowering the perceived risks of such sports. It appears the former possibility is dominant, as the laws lead to less participation in football and hockey.

It also appears that less participation in football and hockey did not lead to more participation in other sports. In other words, there is no evidence that the individuals choosing to no longer participate in these sports are deciding to join other sports instead. This is potentially concerning, as participating in youth athletics provides many benefits. Research has found athletic participation to have not only physical benefits, such as decreased obesity, but also psychological and social health benefits for youth (Eime et al. 2013). Participation in youth sports increases individuals' emotional control and exploration. It also leads to positive relationships with coaches and friends. Participation in a team sport, such as football, is also thought to provide a unique bonding experience not found in individual sports due to the social nature of participation.

Losing the various health benefits of athletic participation is therefore a potential perverse effect of youth concussion laws. However, the results from this study alone are not enough to decisively conclude that this issue exists. It could be that individuals who are choosing to no longer compete in football or hockey are joining other extracurricular activities. As the data used in this study only contain information on athletic participation and not other extracurricular participation, one cannot conclude that individuals are not gaining health benefits from other extracurricular activities, which they may be instead joining. Even if students are losing the health benefits of athletic participation entirely, it may be completely rational. For some students, it may be utility maximizing to stop participating in certain sports. From a cost-benefit perspective, the results of this chapter indicate that certain students may find the costs of potential injury outweigh the health benefits associated with athletic participation.

On average, the results indicate that the laws have had their intended effect of increasing the reporting of concussions. However, given the results for the individual sports, it appears that this result is driven mainly by football and girls soccer, despite the fact that the laws universally apply to all sports. This could be due to a couple of different reasons. First, both football and girls soccer are sports with relatively high rates of concussions. It could be that because of this fact, these sports garnered more attention with the enactment of youth concussion laws. However, this does not explain why the laws did not lead to an increase in reported concussions for hockey—a sport that also has a very high relative rate of concussions.

Another possible reason is that schools simply do not have the resources to devote attention to all sports when it comes to concussion detection and management. Some entities have even recognized such limitations. For example, the Massachusetts Interscholastic Athletic Association only requires that medical personnel be in attendance for football and ice hockey games during the regular season. Sports like baseball, basketball, field hockey, lacrosse, soccer, softball, and volleyball are only required to have medical personnel present during tournaments at the end of their seasons (Thompson 2016). States such as Massachusetts may feel the cost of having medical personnel attend some of the lower risk sporting events is not worth the benefit of the potential reduction in concussions suffered by athletes in those sports, as concussions in such sports are infrequent to begin with. Whether states are actually engaging in this cost-benefit analysis, however, is unknown.

Finally, the nature of the game itself in football, as compared to other sports, is another possible explanation for why these laws have improved the reporting of concussions in football and not other sports. In football, hundreds, if not thousands, of collisions occur in every practice and game. The commonplace of collisions makes it less likely that any one collision in particular will stand out and more likely that a concussion symptom go unnoticed. Conversely, in other sports, collisions are far less frequent and are therefore more likely to be noticed and examined. Therefore, it would make sense that youth concussion laws would have a greater impact on football, where concussions are more easily hidden, than on other sports in which concussions are inherently easier to detect.

VII. Conclusion

This chapter examined one attempt to deal with the issue of youth concussions—state-level youth concussion legislation. This chapter is the first to study how these laws have impacted participation in various high school athletics. It also adds to the expanding literature that has attempted to study how these laws have impacted the reporting of concussions, which can be seen as one potential measure of the effectiveness of the laws.

The results indicate that youth concussion laws have led to a decrease in high school participation for football and hockey. Seemingly, this is because these sports are most often associated with concussions, and individuals treat the youth concussion laws as a signal that these sports are much more dangerous than previously thought. However, more research in this area must be conducted to fully understand the reason behind these decisions.

For instance, it would be worthwhile to determine how people's perceptions of the risks associated with sports like football changed after the laws. It would also be interesting to examine whether the risk perceptions of parents and athletes is close to the actual incidence rates of concussions across different sports. Some studies have tested people's knowledge of concussion symptoms,[14] but literature regarding knowledge of incidence rates of concussions across sports is nonexistent. If the youth concussion laws improve the accuracy of the perception of the risks of suffering concussions, this is a cause for celebration. If instead, these laws lead to

[14] Chrisman et al. (2014) study the education of coaches, athletes, and parents before and after these laws in the state of Washington. Wallace et al. (2017) show that high school athletes with access to an athletic trainer have better knowledge of concussion symptoms.

overestimating the likelihood of suffering a concussion, then these laws may lead to over-deterrence. Future research could explore this question.

There is no evidence that individuals are substituting participation in football and hockey for participation in other sports. This could be concerning due to the health benefits of athletic participation. However, as explained previously, it cannot be determined whether individuals are instead joining non-athletic extracurricular activities, which may include their own health benefits. More research is needed to determine what activities, if any, students are choosing to participate in as a replacement.

The results also suggest that youth concussion laws increase the reporting of concussions, which is consistent with existing literature. However, this result is not consistent across sports and seems to be driven mainly by football and girls soccer. One explanation proposed earlier is that schools have limited resources and must choose which sports on which to focus their efforts. Future research could explore this possibility and look to conduct a benefit-cost analysis with respect to the resources contributed to concussion management and how this translates into the detection and prevention of concussions.

Finally, future research could look more specifically at the particular provisions contained in these state laws, as they vary by state. Such examination is probably better suited for regional or state-level analysis, as the wide variety of language used in these laws makes national studies problematic.[15] Research such as this would be of great use to policymakers trying to ensure that their respective law is as effective as possible. Corresponding such examination into the effectiveness of specific provisions should be an evaluation of the potential

[15] A somewhat crude attempt was made to account for the various provisions contained in the laws. This was done by characterizing laws as "strong" or "weak" based on the types of provisions contained in the state's law. Table A–2 shows how strong and weak laws impact participation, while Table A–3 shows how they impact the reporting of concussions.

costs for each of these provisions so that a proper benefit-cost analysis can eventually be conducted.

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Tables

Table 1: Concussions by Sport (NEISS Data 2002-2016)

		Unweighted			Weighted
		Concussions	Total Injuries	Percentage	Percentage
Boys Sports	Football	7,937	113,325	7.00%	6.37%
	Baseball	875	22,655	3.86%	3.06%
	Basketball	2,256	93,861	2.40%	2.04%
	Hockey	947	9,391	10.08%	7.09%
	Soccer	1,617	26,660	6.07%	5.06%
	Track	83	3,712	2.24%	1.93%
Girls Sports	Softball	700	13,785	5.08%	3.80%
	Basketball	1,404	30,113	4.66%	3.78%
	Hockey	109	1,145	9.52%	6.34%
	Soccer	1,696	21,389	7.93%	6.63%
	Track	51	4,139	1.23%	0.83%

Note: While cross country was studied with regards to participation, the NEISS does not have a code specific to cross country and so no concussion data was available.

Table 2: Log of Participation in High School Athletics

	Boys Sports						
	Football	Baseball	Basketball	Cross Country	Hockey	Soccer	Track
Law Addresses TBIs	− 0.050***	0.004	− 0.002	− 0.002	− 0.088***	0.011	− 0.021
	(0.014)	(0.014)	(0.014)	(0.021)	(0.029)	(0.021)	(0.015)
Time	0.008***	0.006***	0.000	0.028***	0.007**	0.021***	0.016***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Constant	7.510***	6.439***	7.704***	6.757***	6.417***	6.689***	6.936***
	(0.028)	(0.029)	(0.029)	(0.042)	(0.034)	(0.042)	(0.030)
Observations	765	720	765	765	225	754	764
R-squared	0.991	0.990	0.989	0.980	0.984	0.981	0.990
F	1563	1403	1180	666.6	818.0	711.5	1355

	Girls Sports					
	Softball	Basketball	Cross Country	Hockey	Soccer	Track
Law Addresses TBIs	− 0.001	0.003	− 0.002	− 0.225**	− 0.006	− 0.003
	(0.017)	(0.015)	(0.021)	(0.086)	(0.022)	(0.019)
Time	0.003	− 0.006***	0.028***	0.054***	0.021***	0.014***
	(0.002)	(0.002)	(0.002)	(0.010)	(0.002)	(0.002)
Constant	6.408***	7.561***	6.463***	4.444***	6.658***	6.701***
	(0.033)	(0.030)	(0.043)	(0.095)	(0.043)	(0.037)
Observations	727	765	765	165	754	764
R-squared	0.988	0.988	0.981	0.945	0.980	0.985
F	1077	1128	692.4	199.7	662.8	900.7

The dependent variable is Ln(Participation). The law variable is a dummy for whether a state has a youth concussion law in effective at the start of the sport's season. Time is a yearly time trend variable. State dummy variables are also included, but not shown. The data include any state offering the respective sport for the 2002-2003 to 2016-2017 school years. Sample weights are included. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3: Log of Participation Difference-in-Differences Regression Comparing Football to Other Male Sports

	Baseball	Basketball	Cross Country	Hockey	Soccer	Track
Law × Football	− 0.059***	− 0.003	− 0.220***	− 0.035	− 0.175***	− 0.102***
	(0.020)	(0.019)	(0.023)	(0.042)	(0.029)	(0.018)
Law Addresses TBIs	0.013	− 0.019	0.084***	− 0.019	0.067**	0.014
	(0.020)	(0.020)	(0.024)	(0.046)	(0.030)	(0.018)
Football	0.792***	0.591***	1.613***	1.844***	1.081***	0.672***
	(0.012)	(0.012)	(0.014)	(0.030)	(0.018)	(0.011)
Time	0.006***	0.003*	0.018***	0.006*	0.014***	0.012***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)
Constant	6.581***	7.314***	6.327***	6.037***	6.562***	6.885***
	(0.035)	(0.035)	(0.043)	(0.056)	(0.054)	(0.032)
Observations	1,485	1,530	1,530	990	1,519	1,529
R-squared	0.976	0.972	0.972	0.962	0.949	0.978
F	1055	955.9	963.5	437.5	506.9	1234

The dependent variable is Ln(Participation). The interaction term is equal to one if a law was in place and the observation relates to football participation. The law variable is a dummy for whether a state has a youth concussion law in effective at the start of the sport's season. Football is a dummy variable whether the observation was for Football (and not the comparison sports). Time is a yearly time trend variable. State dummy variables are also included, but not shown. For each column, only data for football and comparison sport are used. The data span the 2002-2003 to 2016-2017 school years. Sample weights are included. Standard errors in are parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Reported Concussions Relative to Other Injuries

Boys Sports	Football	Baseball	Basketball	Hockey	Soccer	Track
Portion of Participants Covered by Law	0.023***	0.000	0.006*	0.031*	−0.004	−0.011
	(0.005)	(0.007)	(0.003)	(0.017)	(0.009)	(0.015)
Time	0.003***	0.002***	0.002***	0.003**	0.002**	0.002
	(0.000)	(0.001)	(0.000)	(0.002)	(0.001)	(0.002)
Constant	0.014***	0.001	−0.001	0.023	0.022**	−0.005
	(0.004)	(0.006)	(0.003)	(0.015)	(0.009)	(0.017)
Observations	113,325	22,655	93,861	9,391	26,660	3,712
R-squared	0.009	0.003	0.004	0.009	0.001	0.001
F	249.9	25.07	97.52	26.36	11.39	1.110

Girls Sports	Softball	Basketball	Hockey	Soccer	Track
Portion of Participants Covered by Law	0.005	0.005	−0.083**	0.031***	0.002
	(0.010)	(0.007)	(0.042)	(0.010)	(0.009)
Time	0.003***	0.004***	0.009**	0.003***	0.001
	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)
Constant	−0.008	−0.014**	−0.016	0.017*	−0.002
	(0.009)	(0.006)	(0.040)	(0.010)	(0.011)
Observations	13,785	30,113	1,145	21,389	4,139
R-squared	0.007	0.010	0.005	0.010	0.002
F	32.99	91.11	2.064	56.96	2.147

The dependent variable is a dummy variable equal to one if the injury reported is a concussion and equal to zero if a non-concussion. The variable of interest is the portion of participants that are covered by the law (number of participants in state with law in effect / total participants). Time is a yearly time trend variable. The data span from 2002 to 2016. Sample weights are included. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Reported Concussions Differences-in-Differences Regression Comparing Football to Other Male Sports

	Baseball	Basketball	Hockey	Soccer	Track
Football × Portion Covered by Law	0.033***	0.041***	− 0.032***	0.036***	0.061***
	(0.004)	(0.002)	(0.006)	(0.004)	(0.009)
Portion of Participants Covered by Law	0.004	0.001	0.065***	− 0.000	− 0.026***
	(0.005)	(0.003)	(0.007)	(0.005)	(0.010)
Football	0.019***	0.031***	− 0.020***	− 0.000	0.026***
	(0.002)	(0.001)	(0.004)	(0.002)	(0.006)
Time	0.003***	0.003***	0.004***	0.004***	0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	− 0.008*	− 0.013***	0.027***	0.011***	− 0.016***
	(0.004)	(0.003)	(0.005)	(0.004)	(0.007)
Observations	135,980	207,186	122,716	139,985	117,037
R-squared	0.015	0.023	0.015	0.012	0.014
F	507.0	1193	466.8	415.5	418.2

The dependent variable is a dummy variable equal to one if the injury reported is a concussion and equal to zero if a non-concussion. The second variable is the portion of participants in a state with a youth concussion law, and the third variable is a dummy variable equal to one if the injury was related to football and equal to zero if the injury was related to the comparison sport. The first variable is the interaction of the two. Time is a yearly time trend variable. For each column, only data for football and comparison sport are used. The data span the 2002-2003 to 2016-2017 school years. Sample weights are included. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Reported Concussions Differences-in-Differences Regression Comparing Location of Injury

Location (School or Sports Field) × Portion Covered by Law	0.019***
	(0.004)
Portion of Participants Covered by Law	− 0.005
	(0.005)
Injury Occurred at School or at a Sports Field	0.020***
	(0.001)
Time	0.003***
	(0.000)
Constant	− 0.014***
	(0.003)
Observations	279,095
R-squared	0.008
F	369.6

The dependent variable is a dummy variable equal to one if the injury reported is a concussion and equal to zero if a non-concussion. The second variable is the portion of participants in a state with a youth concussion law and the third variable is a dummy variable equal to one if the injury occurred at school or at a sports field. The first variable is the interaction of the two. Time is a yearly time trend variable. The data span from 2002 to 2016. Sample weights are included. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Figures

Figure 1

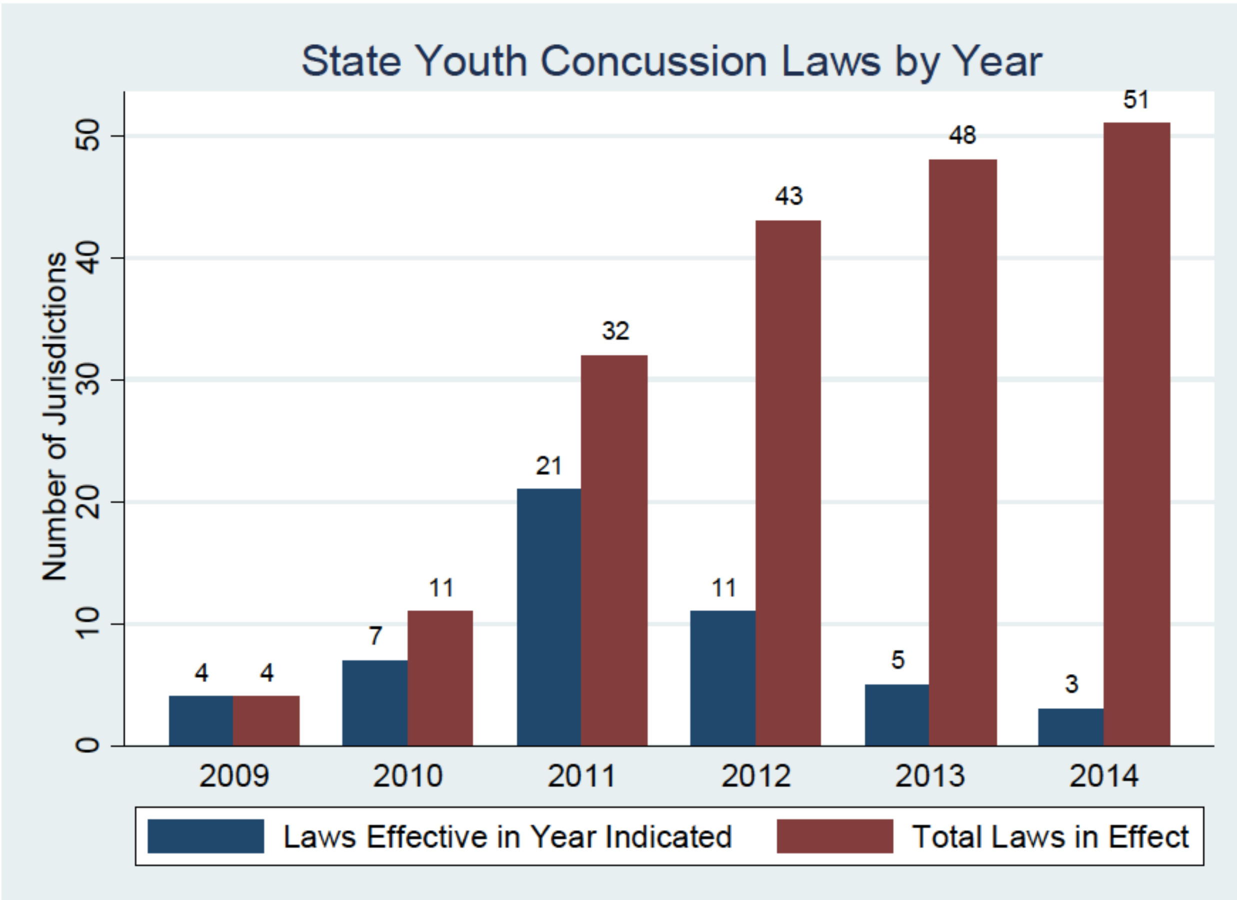
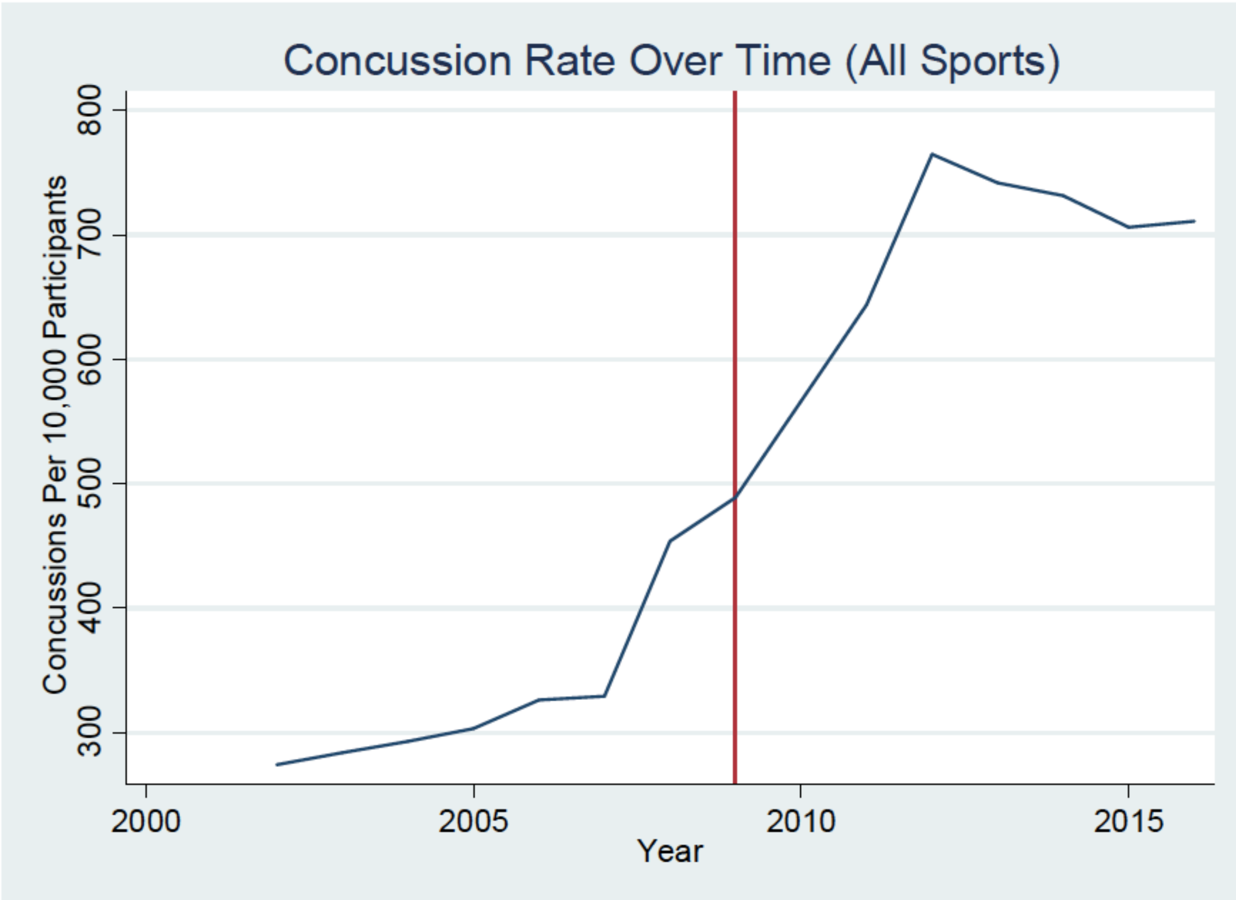
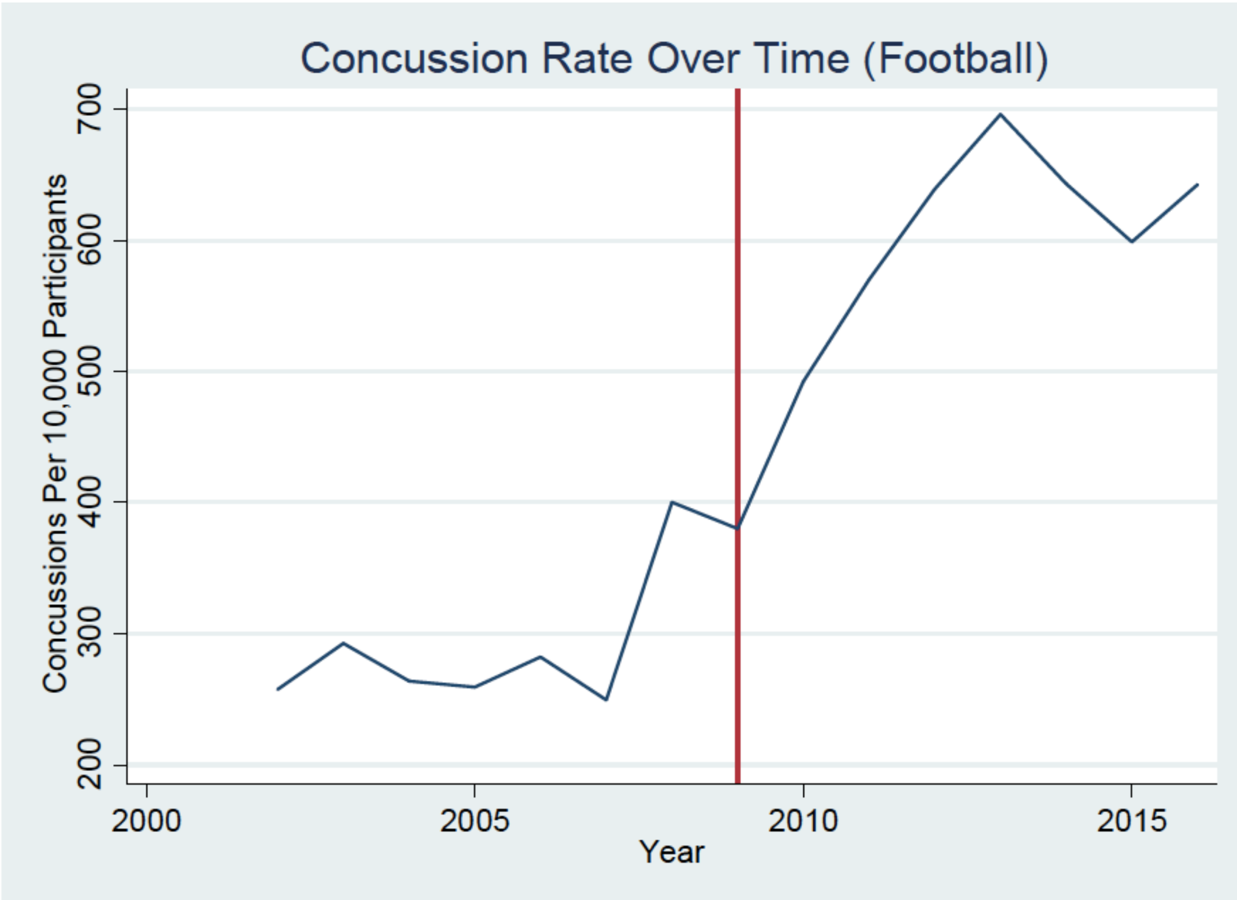


Figure 2



Concussion Rate Over Time (All Sports)
Concussions Per 10,000 Participants
300
400
500
600
700
800
2000
2005
2010
2015
Year

Figure 3


Concussion Rate Over Time (Football)
Concussions Per 10,000 Participants
200
300
400
500
600
700
2000
2005
2010
2015
Year

Appendix

Table A–1: Reported Concussions Relative to Other Injuries (Single Law Dummy)

	Boys Sports					
	Football	Baseball	Basketball	Hockey	Soccer	Track
Post Law	0.012***	− 0.002	0.006**	0.028**	− 0.003	− 0.006
	(0.004)	(0.006)	(0.002)	(0.012)	(0.007)	(0.012)
Time	0.004***	0.002***	0.001***	0.003**	0.002***	0.002
	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.002)
Constant	0.005	− 0.001	− 0.001	0.021	0.023***	− 0.001
	(0.004)	(0.006)	(0.003)	(0.014)	(0.008)	(0.016)
Observations	113,325	22,655	93,861	9,391	26,660	3,712
R-squared	0.008	0.003	0.004	0.010	0.001	0.001
F	261.9	22.86	100.7	28.35	10.98	0.945

	Girls Sports				
	Softball	Basketball	Hockey	Soccer	Track
Post Law	0.000	0.003	− 0.006	0.012	− 0.002
	(0.008)	(0.006)	(0.037)	(0.008)	(0.007)
Time	0.004***	0.004***	0.001	0.004***	0.001
	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)
Constant	− 0.012	− 0.016***	0.049	− 0.000	− 0.006
	(0.009)	(0.006)	(0.037)	(0.010)	(0.010)
Observations	13,785	30,113	1,145	21,389	4,139
R-squared	0.007	0.010	0.000	0.009	0.002
F	31.68	85.89	0.140	58.99	2.024

The dependent variable is a dummy variable equal to one if the injury reported is a concussion and equal to zero if a non-concussion. The post law variable is a dummy equal to one if the injury occurred after July 1, 2009 (the date the first youth concussion law became effective). Time is a yearly time trend variable. The data span from 2002 to 2016. Sample weights are included. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A–2: Participation Rate in High School Athletics (per 10,000 youth)

	Boys Sports						
	Football	Baseball	Basketball	Cross Country	Hockey	Soccer	Track
Law Addresses TBIs	− 16.465**	6.908*	7.546	4.492*	− 3.363	9.629**	− 1.688
	(7.940)	(3.915)	(4.723)	(2.604)	(2.608)	(4.138)	(4.037)
Time	4.965***	1.762***	− 0.239	3.942***	0.922***	4.254***	5.783***
	(0.875)	(0.417)	(0.522)	(0.287)	(0.289)	(0.457)	(0.448)
Constant	414.988***	138.525***	518.944***	222.069***	141.027***	186.935***	228.965***
	(15.876)	(7.817)	(9.345)	(5.206)	(3.032)	(8.123)	(7.943)
Observations	750	705	750	750	210	739	749
R-squared	0.929	0.930	0.963	0.885	0.977	0.919	0.969
F	179.9	181.9	354.6	105.0	541.5	153.8	423.4

	Girls Sports					
	Softball	Basketball	Cross Country	Hockey	Soccer	Track
Law Addresses TBIs	4.883	5.436	3.465	− 4.097*	5.317	2.917
	(3.653)	(4.040)	(2.397)	(2.419)	(3.598)	(3.773)
Time	0.571	− 1.723***	3.266***	1.438***	3.680***	3.923***
	(0.406)	(0.447)	(0.264)	(0.287)	(0.397)	(0.419)
Constant	140.000***	441.462***	161.198***	19.380***	185.250***	180.579***
	(7.076)	(7.995)	(4.793)	(2.676)	(7.066)	(7.424)
Observations	712	750	750	165	739	749
R-squared	0.916	0.962	0.877	0.954	0.926	0.958
F	147.4	349.8	97.27	241.6	169.7	314.8

The dependent variable is the participation rate, which is equal to the number of participants in the sport for that state divided by the number of 14, 15, 16, and 17 year-olds in that state. The law variable is a dummy for whether a state has a youth concussion law in effective at the start of the sport's season. Time is a yearly time trend variable. State dummy variables are also included, but not shown. The data include any state offering the respective sport for the 2002-2003 to 2016-2017 school years. Sample weights are included. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A–3: Participation Rate Difference-in-Differences Regression Comparing Football to Other Male Sports

	Baseball	Basketball	Cross Country	Hockey	Soccer	Track
Law × Football	− 13.760	4.481	− 24.786**	5.634	− 33.240**	− 30.592***
	(10.644)	(9.648)	(11.099)	(13.016)	(13.691)	(8.829)
Law Addresses TBIs	7.586	-4.315	6.406	-16.662	14.970	7.983
	(10.836)	(9.956)	(11.433)	(13.996)	(14.116)	(9.131)
Football	355.061***	278.955***	529.806***	494.439***	435.744***	312.708***
	(6.329)	(5.900)	(6.757)	(9.133)	(8.374)	(5.424)
Time	2.902***	2.151**	4.453***	3.961***	4.311***	5.210***
	(1.002)	(0.963)	(1.101)	(1.063)	(1.366)	(0.886)
Constant	101.087***	328.788***	53.626***	24.399	84.712***	166.026***
	(18.832)	(17.611)	(20.269)	(16.695)	(24.961)	(16.136)
Observations	1,455	1,500	1,500	960	1,495	1,499
R-squared	0.854	0.862	0.887	0.931	0.782	0.886
F	155.0	170.1	213.3	230.9	97.75	211.3

The dependent variable is the participation rate, which is equal to the number of participants in the sport for that state divided by the number of 14, 15, 16, and 17 year-olds in that state. The interaction term is equal to one if a law was in place and the observation relates to football participation. The law variable is a dummy for whether a state has a youth concussion law in effective at the start of the sport's season. Football is a dummy variable whether the observation was for Football (and not the comparison sports). Time is a yearly time trend variable. State dummy variables are also included, but not shown. For each column, only data for football and comparison sport are used. The data span the 2002-2003 to 2016-2017 school years. Sample weights are included. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A–4: Log of Participation in High School Athletics (Strength of Law)

			Boys Sports				
	Football	Baseball	Basketball	Cross Country	Hockey	Soccer	Track
Strong Law	− 0.069***	0.003	0.010	− 0.031	− 0.087***	0.009	− 0.037**
	(0.016)	(0.017)	(0.017)	(0.025)	(0.031)	(0.025)	(0.017)
Weak Law	− 0.035**	0.006	− 0.011	0.019	− 0.090**	0.013	− 0.009
	(0.015)	(0.016)	(0.016)	(0.023)	(0.035)	(0.023)	(0.016)
Time	0.008***	0.006***	− 0.000	0.029***	0.007**	0.021***	0.016***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Constant	7.503***	6.439***	7.709***	6.746***	6.418***	6.688***	6.930***
	(0.028)	(0.029)	(0.029)	(0.043)	(0.035)	(0.043)	(0.030)
Observations	765	720	765	765	225	754	764
R-squared	0.991	0.990	0.989	0.980	0.984	0.981	0.990
F	1543	1373	1159	657.7	766.2	697.1	1334
			Girls Sports				
		Softball	Basketball	Cross Country	Hockey	Soccer	Track
Strong Law		0.033*	0.012	− 0.031	− 0.331***	− 0.034	0.007
		(0.020)	(0.018)	(0.025)	(0.094)	(0.026)	(0.022)
Weak Law		− 0.026	-0.003	0.019	− 0.083	0.013	− 0.011
		(0.019)	(0.017)	(0.023)	(0.101)	(0.024)	(0.020)
Time		0.002	− 0.006***	0.029***	0.056***	0.022***	0.013***
		(0.002)	(0.002)	(0.002)	(0.010)	(0.002)	(0.002)
Constant		6.422***	7.565***	6.746***	4.375***	6.647***	6.705***
		(0.033)	(0.030)	(0.043)	(0.098)	(0.044)	(0.037)
Observations		727	765	765	165	754	764
R-squared		0.988	0.988	0.980	0.947	0.980	0.985
F		1071	1106	657.7	192.7	653.2	883.5

The dependent variable is Ln(Participation). The omitted law variable is if a state had no law at all in effect. Time is a yearly time trend variable. State dummy variables are also included, but not shown. The data include any state offering the respective sport for the 2002-2003 to 2016-2017 school years. Sample weights are included. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A–5: Reported Concussions Relative to Other Injuries (Strength of Law)

	Boys Sports					
	Football	Baseball	Basketball	Hockey	Soccer	Track
Portion of Participants Covered by Strong Law	0.005	0.002	0.001	0.065*	− 0.026*	0.022
	(0.011)	(0.017)	(0.007)	(0.039)	(0.016)	(0.037)
Portion of Participants Covered by Weak Law	0.050***	− 0.002	0.012	− 0.036	0.027	− 0.057
	(0.016)	(0.024)	(0.010)	(0.075)	(0.021)	(0.047)
Time	0.003***	0.002***	0.002***	0.003*	0.002***	0.002
	(0.000)	(0.001)	(0.000)	(0.002)	(0.001)	(0.002)
Constant	0.014***	0.001	− 0.001	0.025*	0.020**	− 0.002
	(0.004)	(0.006)	(0.003)	(0.015)	(0.009)	(0.017)
Observations	113,325	22,655	93,861	9,391	26,660	3,712
R-squared	0.009	0.003	0.004	0.010	0.002	0.002
F	176.1	16.97	69.35	18.00	8.910	0.846
	Girls Sports					
		Softball	Basketball	Hockey	Soccer	Track
Portion of Participants Covered by Strong Law		0.025	0.010	− 0.065	0.003	0.022
		(0.022)	(0.018)	(0.054)	(0.023)	(0.019)
Portion of Participants Covered by Weak Law		− 0.024	− 0.002	− 0.162	0.068**	− 0.026
		(0.029)	(0.026)	(0.182)	(0.032)	(0.026)
Time		0.003***	0.004***	0.009**	0.003***	0.001
		(0.001)	(0.001)	(0.004)	(0.001)	(0.001)
Constant		− 0.007	− 0.014**	− 0.018	0.015	− 0.000
		(0.008)	(0.006)	(0.041)	(0.010)	(0.010)
Observations		13,785	30,113	1,145	21,389	4,139
R-squared		0.007	0.010	0.005	0.010	0.002
F		23.12	64.96	1.390	40.86	1.444

The dependent variable is a dummy variable equal to one if the injury reported is a concussion and equal to zero if a non-concussion. The variables of interest are the portion of participants that are covered by a strong or weak law. Time is a yearly time trend variable. The data span from 2002 to 2016. Sample weights are included. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

CHAPTER 2: TOWARD OPTIMAL RISK AND COMPENSATION FOR CONCUSSIONS IN PROFESSIONAL, COLLEGE, AND YOUTH FOOTBALL

I. Introduction

Over one hundred years ago, an intervention by President Theodore Roosevelt may have saved the sport of football. Between the years of 1900 and 1905, at least 45 individuals died while playing football. Many schools had begun abandoning their football programs. In 1905, President Roosevelt, an avid football fan, invited coaches from Harvard, Yale, and Princeton to the White House for a private meeting. In that year alone, 18 people had died while playing football and another 150 or more had been injured. President Roosevelt sought to encourage a change to the game of football to make the sport safer. The meeting apparently worked, as Harvard's coach, Bill Reid, organized a new rulemaking committee. The committee developed a total of 19 new rules that were implemented in the 1906 season. The forward pass was legalized, the first-down distance changed from five yards to ten, a neutral zone between the offense and defense was created, and dangerous mass formations were banned (Dayen 2014; Klein 2012; Zezima 2014).

The sport of football once again finds itself in the middle of a major safety crisis. The link between football and long-term brain injury now threatens the popularity of the sport, and even the existence of the sport itself, as a decrease in participation at the youth levels has already begun. Some may argue that this threat warrants the type of drastic rule changes made under the Theodore Roosevelt presidency. Others may question whether anything needs to be done at all. After all, athletes have to deal with other sorts of injuries all the time, some of them career-ending. A question one might ask is why should brain injuries be dealt with any differently? One would argue that because traumatic brain injuries impact one's cognitive ability, they deserve special attention. As one doctor has stated, "Our brain is really who we are. In this society, in this time, if your brain has been altered, you have been fundamentally altered."[16]

In this chapter, I explore four risk-management systems with the goal of establishing an optimal system for dealing with concussions at each level of football. The four systems that are often recognized as being available when it comes to managing job-related risks to health and safety are (i) market forces, (ii) tort liability, (iii) government regulation, and (iv) insurance. The costs and benefits of each system are unique and differ depending on the situation. Therefore, it is not necessarily the case that one tool will be best in all situations. This chapter will demonstrate that, by using a combination of these risk-management tools, it is possible to move toward more optimal levels of risk and compensation for each level of football.

I conclude that a market-based approach is most important at the professional level. This approach would rely heavily on the ability of the NFL Players Association (NFLPA) to negotiate certain terms in the next collective bargaining agreement (CBA). Such negotiations could lead to better incentives regarding risk and compensation, including guaranteed contracts, new concussion protocol provisions, and a workers' compensation system self-insured by the NFL. I contend that federal regulation, with oversight from the Department of Education, is the best arrangement for the college level. The NCAA has shown that it and its member institutions are incapable of effective self-regulation and that it is time for government involvement. A market-based approach is not possible at this level because players have virtually no power, and tort liability is futile due to the sovereign immunity of public universities. Finally, I maintain that the current system of state-level legislation is the best system for youth football. Major changes to the current regulations are required if the risks regarding traumatic brain injuries are to be properly managed. For instance, rather than focusing exclusively on detection of concussion

[16] This statement was given during an interview with Dr. Paul Butler. (Brownfield 2012).

symptoms, it is important that state legislatures consider ways in which all concussions can be reduced, and not solely concentrate on repeat concussions.

Section II of this chapter provides a general overview of concussions, their associated harms, and their link to athletics, especially football. The next three sections examine each of the three different levels of football—professional (Section III), college (Section IV), and youth (Section V). For each of these sections, the applicable concussion litigation is discussed and the schemes currently in place to manage concussion risks are analyzed and critiqued. In each of these sections, new schemes are also recommended. I do not claim that the proposed schemes would result in complete optimality; however, implementing the recommended schemes should move each level of football closer to generating efficient levels of risk and compensation. Section VI summarizes and concludes the chapter.

II. The Concussion Crisis: A Brief Background

A concussion is a type of traumatic brain injury that results from rapid acceleration or deceleration of the brain within the skull. This movement causes brain tissue to change shape, damaging brain cells (Concussion Legacy Foundation). The Centers for Disease Control and Prevention (CDC) estimates individuals suffer roughly 3.8 million concussions every year. Organized athletics is a large contributor to this statistic. Sports are, in fact, the second leading cause of concussions among individuals 15 to 24 years old, falling only behind motor vehicle accidents (Gessel et al. 2007; Weisel and Kingdollar 2016). The NCAA's Injury Surveillance System has estimated that nearly 30,000 of its athletes suffered concussions from the years 2004 to 2009. Football had the highest number of concussions, with a reported 16,277 athletes suffering concussions during this time (Axon 2013).

Not only are such injuries common in athletics, they also often go unreported. One survey concluded that 20% to 50% of concussions in college football, hockey, soccer, and rugby go unreported (Weisel and Kingdollar 2016). Underreporting can occur for a variety of reasons. Often individuals, such as parents, coaches, teachers, and trainers, fail to recognize the signs of concussions. Athletes themselves may also go to lengths to hide their own concussions in fear of losing playing time, letting the team down, or simply because they do not realize the seriousness of their injury.

Despite the relatively recent public attention given to the link between concussions and football, evidence of such a relationship has been around for decades. In 1952, the first study considering the link between athletic concussions and football players was published in the *New England Journal of Medicine*.[17] In 1982, *The Wall Street Journal* published an article detailing the cognitive impairments that are a product of concussions, and thus became one of the first examples of the mainstream media taking notice of the issue (Michael 2015). In 1984, neuropsychologist Jeff Barth and others began research on brain injuries and football players at the University of Virginia. He found that players who had suffered a concussion had more difficulty completing the same cognitive test that had been given to them prior to having suffered the concussion. Players also reported headaches, nausea, dizziness, and memory loss after having experienced a concussion (Michael 2015).

The concern over concussions gained momentum in the NFL during the 1994 season. In a shocking move, Chicago Bears running back Merril Hoge retired at the age of 29 due to concussions. That same year three quarterbacks—Troy Aikman, Chris Miller, and Vinny Testaverde—were knocked out of their games on the same week due to concussions. These

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[17] Thorndike, Augustus. 1952. "Serious Recurrent Injuries of Athletes: Contraindications to Further Competitive Participation." *New England Journal of Medicine* 247(15): 554–56.

events led to concussions being discussed more in the mainstream media. Soon after these events, ESPN presented a documentary highlighting the struggles of former players, including Hoge, who had suffered serious brain injuries. At the same time, *The New York Times* published a piece, which called the concussion crisis “a tragedy” (Michael 2015).

Concussions present the risk of both drastic short-term effects and serious long-term harm. Drastic short-term harm can occur when an individual returns to activity before his or her concussion symptoms have subsided. If an individual incurs a repeat concussion over this time period, he or she may suffer serious permanent brain damage, such as second impact syndrome (SIS). SIS is a severe condition brought on by a repeat concussion in which the brain swells rapidly causing intracranial pressure, severe brain damage, and often death. The second type of harm associated with concussions is that associated with repeated, long-term sublethal brain trauma. This type of trauma can lead to chronic traumatic encephalopathy, or CTE. CTE has been defined as a brain-damaging condition resulting in “memory loss, behavioral and personality changes, speech abnormalities, depression, Parkinson’s disease, and Alzheimer’s disease” (Grey, Marchant, and Tyszka 2015). Often times, the symptoms of CTE do not manifest until several years or decades after the injury.

CTE gained notoriety in 2005 when Dr. Bennet Omalu, Allegheny (PA) County medical examiner, published a study regarding the autopsy he had performed on former Pittsburgh Steeler and Hall of Fame center, “Iron” Mike Webster. Omalu concluded that Webster suffered from CTE as a result of repeated head trauma he had sustained from his football career. However, it was not that CTE was an entirely new disease at this time. It was also not the first evidence of a link between CTE and athletics. As early as the 1920s, CTE was described as “punch drunk syndrome” and was found in boxers, jockeys, and wrestlers who had experienced multiple blows to the head. Dr. Omalu's work, however, was the first to ever link the disease to the sport of football. Dr. Omalu's findings would later serve as ammunition for former football professional football players in their lawsuit against the NFL.

III. Professional Football

In the past, a market-based approach failed players at the professional level, in part because the NFL withheld information as to the risks of concussions. This led to a class action lawsuit, which concluded in a settlement valued at roughly $1 billion. While the NFL has enacted several new policies that should improve the way in which risks are managed, more is needed to insure that efficient incentives exist with regards to risk and compensation. In this section, I ultimately conclude that market forces provide a viable tool to manage risks and compensation. This tool relies on the NFLPA demanding certain measures be taken in order to alleviate any concerns regarding asymmetric information that was an issue in the past. I argue that a workers' compensation system that is self-insured by the NFL should also be introduced to deal with certain gaps that may exist if relying solely on market forces. Table 1 denotes the pros and cons of each of the four potential systems that could be used to influence incentives related to risks and compensation and illustrates that a mix of market forces and workers' compensation insurance is ideal for professional football.

A. Concussion Litigation and Settlements

The basis of the concussion litigation at the professional level was built upon years and years of deception and misrepresentations by the NFL. Since the NFL first began formally considering the subject of concussions, when it established the Mild Traumatic Brain Injury (MTBI) committee in 1994, it downplayed concerns, referring to concussions as a "pack journalism issue" (Ezell 2013). Over the years, the league continued to deny any link between long-term brain damage and football. The league repeatedly rejected guidelines recommended by experts in the health field, published papers hoping to discredit other research, and called for the retraction of research that linked football to brain damage (Coates 2013; Ezell 2013). In 2009, Congress got involved, when the House Judiciary Committee held a hearing on the subject of concussions and the NFL. Perhaps the most memorable moment of the hearing was when Rep. Linda Sanchez (D-Calif.) analogized the NFL's response to the concussion issue to big tobacco in the 1990s and that industry's handling of the link between smoking and health issues (Hanna and Kain 2010; Michael 2015). Former players, feeling they had been misled and mistreated by the league, soon moved the debate from the court of public opinion into the actual courtroom.

At one point, the NFL was facing a series of lawsuits that involved over 5,000 of its former players or their families. In 2012, these suits were consolidated and brought before the District Court for the Eastern District of Pennsylvania. The causes of action brought by the players included negligent misrepresentation, fraud, fraudulent concealment, negligent hiring and retention, and wrongful death. At its most basic, the players argument was that the league knew (or reasonably should have known) that repeated head impacts suffered while playing NFL football were likely to expose them to the risk of neurodegenerative disorders and diseases, including CTE. The players claimed that by the NFL voluntarily choosing to study the issue of traumatic brain injuries, it assumed a duty to advise the players of the heightened risk, and by not doing so the, NFL willfully concealed information and misled players as to this risk. Such behavior recklessly endangered the players (Michael 2015).

Following the hearing on the NFL's motion to dismiss, Judge Brody ordered the parties to mediation (Telis 2014). This presented the parties with the opportunity to reach some sort of agreement and avoid years of litigation, which they did in the form of a settlement agreement.

The NFL and the approved settlement class of former players reached a deal in August of 2013 that called for the NFL to pay a total of $765 million for compensation, medical exams, and medical research. A federal judge, however, declined this agreement in January 2014, arguing that the $765 million was inadequate. The settlement was later granted final approval after the cap on awards was removed, meaning that the amount of actual awards to be distributed is open-ended, although the settlement is estimated to cost the NFL approximately $1 billion. The NFL denied any fault in the settlement (Associated Press 2016).

The settlement became final and effective on January 7, 2017, with the claims process being opened on March 23, 2017. The settlement established a compensation fund with a life of 65 years. The settlement is compromised of three benefits to be paid by the NFL: (i) baseline neuropsychological and neurological examinations (up to $75 million), (ii) monetary awards for diagnoses of death with CTE (prior to July 7, 2014), ALS, Parkinson's, Alzheimer's, and certain levels of other neurocognitive impairment (uncapped), and (iii) education programs to promote safety and injury prevention ($10 million). Included in the settlement class were retired professional football players from the NFL, AFL, and NFL Europe League. Representative claimants (i.e., family members) were also included for those retired players who are deceased or legally incompetent. Current NFL players, however, were not included as members of the settlement class ("NFL Concussion Settlement").

In order to qualify for monetary compensation, a retired player need only have a qualifying diagnosis made by an approved qualified specialist. It is not necessary to prove that playing professional football actually caused such disease. Qualifying diagnoses include ALS, Parkinson's, Alzheimer's, Level 2 Neurocognitive Impairment, Level 1.5 Neurocognitive Impairment, or death with CTE. The amount of money that a player is entitled to is dependent on the type of qualifying diagnosis, the age at which the diagnosis occurred, the number of seasons played in professional football, diagnosis of a prior stroke or traumatic brain injury, and participation in the baseline assessment exam funded by the settlement. The maximum awards range in value from $5 million for an individual with ALS to $1.5 million for an individual with Level 1.5 Neurocognitive Impairment. A player with multiple qualifying diagnoses is only entitled to a maximum of $5 million. Award reductions based on age begin at age 45 and decrease the older the individual is when diagnosed. Similarly, award reductions may be made based on the number of seasons played, beginning with less than five seasons. The fewer seasons the individual played, the greater the reduction.[18] No explanation was given in the settlement materials as to how these amounts were derived, so it is difficult to say whether these values are appropriate or not. Actuaries hired by the NFL, though, estimated that 28% of all players would be found to have one of the qualifying diseases (Belson 2014).

In theory, there are several reasons to believe that the compensation fund was a preferable outcome to extensive litigation. For one, it eliminates questions of causation. This would have likely been a highly contentious issue in court, involving costly expert witnesses and studies. The fact that both the class of victims and the party contributing the compensation to the fund is clear makes the fund concept possible. Detailing a clear class of injuries should also make the claims process straightforward and expedient.

However, there have been several criticisms of how the fund has worked in practice. First, a large fraction of potential beneficiaries of the fund have yet to seek or receive funding. While there are 20,395 class members registered under the settlement, only 1,633 claim packages had been received as of February 5, 2018. Furthermore, only 226 monetary awards had been

[18] Tables A–1, A–2, and A–3 in the Appendix demonstrate the different values for each qualifying diagnosis and how reductions from the maximum award value operate based on age and seasons played.

deemed payable by this point ("NFL Concussion Settlement"). Some believe the list of qualifying diagnoses is too narrow. No compensation is provided for other psychological and neurological conditions, including mood and behavioral disorders. With respect to CTE, the only ones compensated for this are those who have died from the disease prior to the settlement date. Those that die from CTE after the settlement date or who may later be diagnosed with the disease while living have no avenue for reimbursement.[19] On a related note, individuals have felt that the offsets for age and seasons of experience are arbitrary and unfair. There have also been complaints that the claims process is unduly burdensome and inefficient. Former players have described the claims process as being filled with roadblocks and trapdoors. Some have said that the league goes "through a series of denials until people give up" and that this is one reason that the number of claims awarded thus far has been so few (Rapp 2017).

Finally, there have been various complaints about the attorneys involved. Such complaints include the aggressive poaching of clients and suspicious deals with lenders and brokers for referral services. Much has also been made of the high legal fees being demanded. This is a concern for players suffering from these serious diseases who need as much money as possible to pay for their medical expenses. One estimate shows that lawyers are getting between 15-40% of eventual awards (Draper 2017). Such percentages may be reasonable under a typical contingency fee case in which a lawyer is investing a great deal of time and money into a case which may or may not result in success. However, in the concussion settlement context, lawyers are providing more of an administrative service in the form of submitting the necessary paperwork to the claims system.

[19] The NFL has argued that many of the symptoms related to CTE are still covered and players could seek compensation this way.

B. Current Risk and Compensation Scheme

For those players who play at least three seasons, the NFL provides health insurance for five years after the player retires and workers' compensation past that. The length of time that workers' compensation benefits exist after retirement varies from state to state. Some states also make special exceptions for professional athletes. For instance, one proposed change to workers' compensation in Illinois has been the source of recent controversy. A bill was proposed to cut off the benefits to injured athletes at either age 35 or five years after the injury date. This is a change from other employees, who receive benefits up to age 67. Changes such as this could seriously hurt former NFL players suffering long-term injuries due to concussions (NFL Players Association 2017).

Even more problematic is that the NFL has encouraged states not to cover CTE as a workers' compensation claim. The league argues that workers' compensation claims rely on a diagnosis, and because CTE cannot be diagnosed in living persons, it cannot be covered. With recent scientific advancements, the time in which the NFL can no longer make such a claim is coming quickly. In the meantime, this action has spurred 38 former players to opt out of the NFL settlement and pursue their own claims for workers' compensation, asking the court to force the NFL to "recognize CTE in living players as an occupational disease and pay the players' benefits" (Simpson 2016). Even if the former players win their argument, one potential issue they may still face is that CTE may be deemed to be a cumulative injury, which some states exclude from workers' compensation.

The NFL has made several changes in an effort to increase safety and reduce the risks of concussions, including rule changes, fines and penalties for certain dangerous plays, and changes in their concussion protocols. In 2011, the league decided to move up the kickoff five yards from the 30-yard line to the 35-yard line in order to increase the number of touchbacks and reduce the number of high impact collisions that are commonplace on kickoffs. The NFL also banned the use of three-man wedges on kickoffs. After implementation of these rules, the number of concussions on kickoffs dropped by 43% (Associated Press 2012). In addition, other dangerous conduct on the field, such as horse-collar tackles, facemasking, late hits, spearing, and hits on defenseless players are penalized and fined to deter such behavior and increase the safety of the game.

Over time, the NFL has adopted and revised its concussion protocol. In December 2009, the league created stricter return-to-play guidelines, which stated that a player with concussion symptoms should not return that same day. Greater changes came in 2013 when the league introduced new concussion guidelines for sideline evaluation, education programs, baseline testing, and the creation of two additional and independent personnel to help with identifying and diagnosing concussions. Under the new revisions, teams can be fined up to $150,000 for the first violation, at least $100,000 for a second violation, and may lose draft picks for failing to take players who have sustained concussions out of games (Belson 2016a; Flynn 2016).

Many argue that the NFL's current system is still inadequate and that the league often times fails to adequately enforce and punish teams that have clearly violated the concussion protocol. One issue is the overly high standard that must be met in order to stop play. For a medical timeout to be called, there must be "clear visual evidence" that a player "displays obvious signs of disorientation or is clearly unstable" (Flynn 2016). Rather than the old mantra "better safe than sorry," this language seems to indicate that the league has the attitude of erring on the side of letting a player continue to play instead of erring on the side of caution.

There have been several examples that highlight the concussion protocol's failures over the past few years. In a 2015 game against the Ravens, then Rams quarterback Case Keenum, suffered a tough hit that resulted in his head slamming against the turf. Keenum immediately grabbed his head in pain and required the help of his teammates to stand up. The game was not stopped, and Keenum was not taken out of the game. After the game, he was diagnosed with a concussion. The Rams were not fined for the incident (Wagner-McGough 2015). Tom Savage, quarterback of the Texans, was hit hard during a 2017 game against the 49ers. After the hit, Savage laid motionless on his back with both of his arms raised stiffly in the air. Although Savage was sent to the sideline to be evaluated, he later returned to the game. After his return, he was seen to be coughing up blood and was removed from the game after throwing two interceptions. Despite allowing Savage to return to the game, the Texans were not fined (Hurley 2017). Finally, in a 2017 playoff game against the Saints, Panthers quarterback Cam Newton took a big hit near the end of the close game. Newton stayed on the ground for a long period of time before getting to his feet and trying to walk off the field; however, he fell before reaching the sideline. The revised concussion policy states that, "Players who stumble or fall when trying to stand will require a concussion evaluation in the locker room." Despite this clear policy, Newton was not taken to the locker room. Instead, he was evaluated in the medical tent on the sidelines and later returned to play during the Panther's next offensive possession. At this time, the NFL and NFLPA are investigating the Panthers to decide whether the team should be fined (Korman 2018; Person and Douglas 2018).

C. Proposed Risk and Compensation Scheme

In professional football, there is a well-defined market. Players are compensated for their talents and the risks of playing the game of football. If assumptions of a perfect market hold, this type of market forces system leads to optimal levels of risk and compensation. However, the more and more deviation there is from the assumption of perfect markets, the less ideal a market forces approach becomes. This was the case previously for the NFL. In the past, professional football players were not adequately compensated, as they were not aware of the full extent of the risks associated with football. The market suffered from a problem of imperfect information. This issue was highlighted during the litigation against the NFL, which revolved around the fact that the league had special knowledge of the risks of football and head injuries and kept this information from the players.

If existing market failures, such as asymmetric information, could be corrected, a market forces approach would be best for professional football. There is reason to believe that players recognize that a tradeoff exists between compensation and risk and would prefer a market-based approach. A large portion of professional football players come from a low socioeconomic background, with over half of all players claiming to have grown up in a below middle class household and nearly 90% of players stating they grew up in households at or below middle class (Klemko 2017). It is no surprise, then, that many players have expressed the notion that the game of football was an escape from poverty for them and an opportunity to provide for their family. This leads credence to the idea that the players themselves would prefer a market-based approach, in which they are given the autonomy to express their risk preferences, as opposed to a heavily regulated system. A recent interview with Tony Dorsett, former Dallas Cowboys running back, illustrates such thinking. After being told that it was likely he had CTE, he stated that he "would still do it all over again" despite knowing the risks and dangers of a career in football (Telis 2014).

Moving forward, steps can be taken to ensure that asymmetric information is not a concern. Under a market-based approach, unions may have a role to play in helping with informational inadequacies. The NFLPA can play a significant role in assuring that players are privy to the same information as the league. The most recent collective bargaining agreement was inked in 2011 and runs through the 2020 season (NFL and NFL Players Association 2011). When it comes time to reach the next agreement, the issue of concussions will no doubt be one of the major items the parties will seek to address. If players have a more equitable knowledge of the risks, players will be able to express their risk preferences through the compensation they seek the same way that other workers do who work in dangerous occupations. Therefore, the NFL and NFLPA should work together to jointly fund medical studies and gather data. In doing so, both parties should agree that any information regarding concussions is shared fully between the league and the NFLPA, which can then distribute such information to the players.

The next CBA should also be sure to address certain issues in order to ensure that the league and players have proper incentives with regards to risk. Among the most important items that the players should demand is guaranteed contracts. According to the NFLPA, guaranteed compensation comprised less than 60% of all payments to players in the 2016 season (Martel and Stapleton 2017). When a team releases a player before the expiration of his contract, the player only receives his remaining guaranteed money, while the balance is lost. This creates undesirable incentives for players wishing to remain on the team and earn the rest of their contract. Players may fear being cut after suffering a concussion. This is especially true if the concussion is not their first, as teams realize that the player is more likely to suffer future concussions and miss playing time. Therefore, in the absence of guaranteed contracts, players have an incentive to hide symptoms. Derek Anderson, current backup quarterback for the

Carolina Panthers, expressed how the current NFL contract system creates these incentives, stating "Guys play with [injuries] they've got no business playing with… [Y]our job security is not there to sit out" (Hanna and Kain 2010). Without a change to the current contract system, players will continue to hide their symptoms to protect their paychecks.

The NFLPA should also urge that certain elements of the concussion protocols be revisited. As previously illustrated, teams often go unpunished for breaching the league's protocols. More resources should be dedicated to ensure the protocols are followed in real time, and that if they are not, teams actually face punishment. The amount of the fines should also be specifically tailored to align with the team's incentives. Rather than fining teams for the same amount of money regardless of the player injured during the protocol breach, the fines should be tied to the individual player's salary. Teams have a greater incentive to sidestep the concussion protocols and return players to the field who are more valuable to their team's success. Because a player's salary usually reflects his value to the team, tying team fines to a player's salary will be more effective than a flat fine.

Even if players were to be given complete and accurate information regarding concussions and harm to make determinations as to their ex ante compensation, there is no guarantee players will use such information optimally. Misperceptions regarding risks are well documented. For example, people tend to overestimate low probability risks and underestimate relatively high probability risks (DellaVigna 2009; Kahneman and Tversky 1984). In regards to concussions in athletics, it may be the case that those involved in sports, such as football, misperceive the risks and harms associated with participation and repetitive head trauma. In fact, such misperception almost certainly exists, as the science regarding the link to repetitive head trauma and long-term health effects is still relatively new and uncertain. The link between football and long-term health effects are probabilistic rather than certain. Not every individual that has played football develops CTE and the exact interaction between exposure and harm is still greatly unknown. This could limit the effectiveness of a market-based approach, which relies on compensating differentials that are based on perceived risks. If these perceived risks are inaccurate, workers will demand an inefficient level of compensation for job-related risks

The way in which risks are framed is known to affect how individuals make decisions (DellaVigna 2009; Kahneman and Tversky 1979; Kahneman and Tversky 1984). The results from the experiment in Chapter 3 of this dissertation support this. In the experiment, individuals were presented with a multi-stage "win or lose it all" game in which they had to determine the number of rounds they wished to play. Such a structure is analogous to the decisions that football players confront when deciding whether to continue their career and risk suffering long-term health consequences. Although most individuals are risk averse, about one-third of the participants engaged in risk-seeking behavior under the experiment's structure. Participants were more risk seeking when asked to make an upfront commitment (rather than a round-by-round commitment) in which the potential risks were framed as happening in the unknown future. This may be akin to how players may think about the risks of CTE. Participants were also more risk seeking when payments were increasing (rather than constant) with larger payments in later rounds. Similarly, player contracts may increase over time with many incentive-based payments occurring on the back-end of their deals. For these reasons, ex ante compensation through market forces may, by itself, be inadequate.

Salary caps may also prevent market force compensation from being fully effective. In 2017, the salary cap was $167 million per team, which was a product of negotiations between the NFL and NFLPA (Pelissero 2017). Even if a player and his team are somehow able to agree upon the optimal ex ante compensation for potential concussion-related injuries, the team may be constrained from doing so because of its salary cap. The salary cap rules in the NFL are much stricter than other professional sports leagues. In other leagues, such as baseball, teams may willingly exceed the salary cap with the understanding that they will have to pay a luxury tax on the amount spent in excess of the cap. This is not the case for NFL teams, which face fines, forfeiture of draft picks, and the possibility of contracts being voided as a result of exceeding the salary cap (Kaylor 2017).

To help circumvent some of the problems that arise due to potential misperceptions with regards to risk and the salary cap, ex ante compensation that occurs through market forces could be supplemented with insurance. Players could insist that an insurance system be put in place that is similar to workers' compensation in which teams obtain insurance to pay for job-related injuries. From the team's perspective, this would involve a shift in costs. In order to pay for the injuries suffered by past players, they would have to offer lower wages to current players. In a competitive market, this would not be feasible because competitors would outbid them. However, the NFL has a virtual monopoly over professional football. While other leagues such as the Canadian Football League (CFL) and the Arena Football League (AFL) exist, they are not true competitors of the NFL. They are much less popular and cannot match the salaries NFL team are able offer. Therefore, some sort of insurance scheme could be viable.

The system should be uniform in that it should provide all players with the same benefits over the same period of time, regardless of where they played. This would address the issue faced by players who formerly played in states that are now seeking to limit the duration of their workers' compensation coverage. The system should also take into consideration that many of the harms associated with football do not manifest until decades later. The workers' compensation should cover injuries like this, such as CTE. With this type of insurance in place, teams would have an incentive to reduce risks in order to keep their premiums lower.

A few issues still exist that limit the effectiveness of insurance in this scenario. This system would not cause teams to fully internalize harm, as these policies generally only compensate for medical costs and lost wages. Such compensation is inadequate for certain injuries that alter the post-injury utility of income, reducing the degree to which money enhances one's well-being (Viscusi 1990; Viscusi and Zeckhauser 2011). Since workers' compensation is unable to account for the full costs of health-related injuries, a market forces approach is necessary so that players are able to take this into consideration when they accept their contracts. Another problem is that insurers may be unwilling to underwrite the types of policies contemplated. This was a problem with respect to hazardous wastes in the 1980s and 1990s. Companies operating treatment, storage, and disposal facilities found it difficult to obtain pollution insurance, as providers either refused to offer policies for these types of risk or offered such policies at prohibitively costly rates (United States General Accounting Office 1994). The great degree of uncertainty that currently exists with regards to the likelihood and degree of harm associated with playing football could present a similar problem.

Further scientific research could make the task of providing insurance easier in the future; however, it is not necessary for the NFL to rely on a third party insurance provider. The NFL could instead self-insure for these workers' compensation claims, as it is certainly within the NFL's ability to do so. The NFL is the highest grossing sports league in the country. It is projected that the league will earn approximately $14 billion for the 2017 season (Kaplan 2017). There is no anticipated slowdown in sight for the league. In fact, Commissioner Roger Goodell has expressed a goal of $25 billion in annual revenue by 2027 (Belzer 2016). A company with revenues of this size is certainly capable of self-insuring its own workers' compensation system.

With the new CBA addressing concussion concerns, tort liability likely becomes an unavailable tool for incentivizing optimal levels of risk and compensation. This is because concussion-related issues, which will clearly be covered by the new CBA, will now have to go through arbitration, and any litigation would be preempted by the CBA. Furthermore, workers waive their right to bring lawsuits under workers' compensation. Players would gladly accept this tradeoff, as lawsuits are expensive and causation is difficult to prove for concussion-related injuries. In addition, regulation is much less useful at the professional level than at other levels of football. At the professional level, the players and the league, rather than a regulatory entity, are in the best position to have information regarding risks, safety costs, and harm. Regulation is typically a great tool for generating information; instead, this issue can be addressed through establishing joint research agreements between the NFL and the NFLPA during the next CBA as previously discussed. There is also the potential of political pushback if the government were to step in and regulate a private industry that does not cause externalities like other types of industries that are typically regulated. Instead, the harm caused by concussions is confined to those within the industry (i.e., the football players) and does not impact third parties.

IV. College Football

Similar to the professional level, a major class action was brought at the college level. The lawsuit resulted in a $75 million settlement agreement. Unlike professional football, several barriers exist that prevent market forces from effectively managing risk and compensation at the college level. Instead, in this section, I argue that regulation is the best course of action. The current system of self-regulation by the NCAA should be replaced by a command and control regulation administered at the federal level by the Department of Education. As part of this regulation, schools should be required to provide insurance to their athletes and guarantee all athletic scholarships for four years. Table 2 shows the pros and cons of each of the four potential systems with respect to football at the college level.

A. Concussion Litigation and Settlements

The first lawsuit filed against the NCAA regarding concussion injuries was filed on September 2011. In December 2013, this lawsuit and others were consolidated in the United States District Court for the Northern District of Illinois. While the suit ultimately became a class action, the original plaintiffs were made up mostly of former collegiate football players (Strauss 2016). In essence, the plaintiffs claimed that the NCAA had failed its duty to protect its student-athletes. The plaintiffs argued that while commonly accepted protocols had been set by organizations such as the National Athletic Trainers' Association and the American College of Sports Medicine on the issues of baseline testing, treatment, or return-to-play, the NCAA failed to adopt them. In fact, it was not until 2010 that the NCAA required schools to have a concussion management in place. Furthermore, the plaintiffs alleged that the NCAA did not bother to enforce this rule (Axon 2013).

Internal NCAA emails provided a major blow to the association. One exchange between the NCAA's director of health and safety, David Klossner, and the NCAA's managing director of government relations, Abe Frank, highlighted just how poor the NCAA was handling the concussion issue. In 2010, when asked by Frank whether concussion recommendations at the youth level exceeded what was required at the college level, Klossner responded, "Well since we don't currently require anything all steps are higher than ours" (Axon 2013).

Other emails demonstrated a casual attitude towards the punishment accompanying the breaching of the NCAA's later developed concussion management plan. The emails revealed that a school that failed to follow the plan would receive only a "secondary" violation. The punishment for this type of violation was equivalent to the punishment faced by "a coach who inadvertently calls a recruit or accepts a Facebook friend request during no-contact periods." In other words, the penalty was next to nothing. In addition, Klosser admitted that he was unaware of any schools that had been punished for failing to enforce the concussion rules (Axon 2013).

In October 2014, the NCAA and the members of the class action suit reached a settlement. It was agreed that the NCAA would pay $75 million, with $70 million going towards a medical monitory fund and $5 million going towards concussion research. As part of the agreement, the NCAA also agreed to revise its concussion policies. While this initial settlement agreement was rejected in December 2014, a new settlement, containing no change in funding from the original settlement, was reached in April 2015. This new settlement agreement was approved in January 2016 (Berkowitz 2016; Keating 2017).

As part of the settlement, former student-athletes waived their right to bring a class-wide claim against the NCAA and its member institutions related to concussion injuries with one exception—current or former student-athletes of a single sport at a single school can still bring class-wide claims. In addition, former athletes maintained the ability to bring *individual* personal or bodily injury claims against the NCAA. This was significant because former student-athletes did not receive any compensation for lost earnings. Furthermore, the $70 million medical monitoring service was designed to identify symptoms. There was no intention that this money be used for treatment or other medical expenses. Thus, more suits seeking these types of damages may develop over time (Berkowitz 2016; Sellers 2017).

Since the initial lawsuit and settlement with the NCAA, several other suits have been brought against the NCAA, its conferences, and its member institutions. Among the conferences named in the lawsuits are the Big Ten, Southeastern, Pacific-12, and Western Athletic. Some of the individual schools also involved in litigation include Penn State[20] and Vanderbilt. While players filing these claims are also from Auburn, Georgia, Oregon, and Utah, these schools were not named as defendants due to issues of sovereign immunity. The damages sought in these cases include compensatory and punitive damages, payments for medical expenses, lost future earnings, lost time, and interest (Berkowitz 2016; Sellers 2017).

B. Current Risk and Compensation Scheme

The management of concussion risks at the college level currently operates through self-regulation. The NCAA promulgates certain minimum standards that it requires its member institutions to meet. Individual schools and conferences are also free to develop their own sets of standards that exceed these baseline standards. In 2015, the power five conferences[21] did just this when they developed the Concussion Safety Protocol Committee to review and approve their schools' concussion protocols.

The biggest complaint with the NCAA's protocols is that there is no structure in place to enforce and punish schools for violating the concussion protocol. In fact, the NCAA has said that, "each school is responsible for the welfare of athletes and that risk can't be completely removed from sports" (Solomon 2014a). The Concussion Safety Protocol Committee suffers from this same issue, as the committee cannot penalize schools that violate the procedures established. In 2014, the Big Ten announced that it would adopt new protocols for its conference that would include penalties for non-compliance. The revisions also called for an independent

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[20] While Penn State is a state-related university, it is not a member of the Pennsylvania System of Higher Education (Present 2011).

[21] The "power five" conferences consist of the ACC, Big Ten, Big 12, Pac-12, and SEC.

athletic trainer to be in the replay booth in order to spot concussion symptoms on the field and contact officials if needed. While this provision was implemented, the Big Ten has yet to establish a system for penalizing schools for noncompliance of the conference's protocols (Solomon 2015b).

The lack of enforcement is a major concern given the prevalence of non-compliance. A 2010 internal study of the NCAA found that 50% of responding schools failed to require a concussed player to see a physician. The study also found that roughly 50% of schools said athletes had been allowed to return to a game in which they had suffered a concussion (Axon 2013). Another survey of college athletic trainers highlighted the pressures that exist to improperly return concussed players to the field. The 2013 study conducted by the *Chronicle of Higher Education* found that almost half of the trainers cited pressure to return players before they were medically ready (Wolverton 2013). This concern has prompted demands that the NCAA adopt the NFL's policy of requiring that an independent medical professional be present alongside the team's own trainers and doctors.

The NCAA requires that athletes have a primary health insurance policy.[22] The schools, themselves, are not required to pay for the policy, although some do. Many argue that the schools should be required to pay for the policy instead of leaving it up to the students, who are forbidden from being compensated. Another problem is that once a student-athlete has completed school or is no longer on scholarship, schools are not required to provide them with medical coverage. For latent harms, like those associated with concussions and CTE, this creates a major problem. Furthermore, scholarships are not guaranteed over an athlete's entire college career. Instead, they can be renewed on a year-to-year basis. This creates the possible issue of

[22] It should be noted that the NCAA has a catastrophic injury insurance program in place for its athletes. This policy has a $90,000 deductible, which must be met within two years of the injury.

an athlete losing his or her scholarship after becoming injured and being left to pay any future medical expenses out of his or her own pocket. Some conferences have attempted to address these concerns. In 2014, the Big Ten announced it would guarantee all athletic scholarships for four years and provide improved, consistent medical insurance for its student-athletes. The Pac-12 quickly followed suit, announcing that it would also guarantee four-year scholarships and that medical expenses for student-athletes injured during their college athletic careers would be covered for up to four years after leaving the institution (Sinha 2014). While these policies were improvements to the current system, they may not go far enough to protect athletes and are far from the norm across the NCAA.

C. Proposed Risk and Compensation Scheme

Regulation is often justified as a policy tool when various types of market failures exist. These failures could include externalities, incomplete information, monopoly power, incomplete markets, or income distribution issues. Regulation is justified because of the several market failures that exist at the college level. Players have very little bargaining power at the college level. Despite their efforts, courts have refused to consider football players to be employees of their respective universities and have prohibited them from unionizing.[23] This issue is exacerbated by the fact that the NCAA has a monopsony over the talent of collegiate athletes. The NFL requires that a player be three years removed from high school before entering the league. Without any minor league football system, players are left with nowhere to turn but the NCAA. Due to this imbalance, college players do not have sufficient leverage to demand information, compensation, or even that certain safety measures be put into place.

Command and control federal regulation should be adopted at the college level to deal with the concussion issue. Federal control over certain aspects in the NCAA and college

[23] *Nw. Univ.*, 362 NLRB No. 167 (Aug. 17, 2015).

athletics is not new. Title IX seeks to prevent sex discrimination in programs that receive federal funding. As the NCAA's member institutions receive an immense amount of federal funding, they must abide by Title IX. This demonstrates the ability of Congress, through its spending power, to regulate the NCAA and implement concussion protocols, if it so chooses. The NCAA's repeated failures at self-regulating its members in the area of concussions indicates that federal regulation is needed to address this issue. Studies have shown an egregious degree of non-compliance when it comes to concussion protocols at the college level, and college athletes do not have the power to effectuate the change that is necessary. On the other hand, federal regulation has proven effective in the past at the college level, as evidenced by Title IX. Federal regulation is also more appropriate than state regulation because college teams compete across state borders and collegiate conferences consist of schools spanning multiple states.

I would recommend that the Department of Education (DoEd) be the agency in charge of this regulation. The DoEd can draw on its experience with Title IX as to how to best regulate colleges and universities. To gain better understanding of the health-related issues of concussions, the agency could consult with experts or seek cross-agency collaboration with an agency such as the Department of Health and Human Services (HHS). This type of collaboration may not be common, but is not unprecedented.[24] I would recommend that the concussion regulation work similarly to Title IX in that the receipt of federal funds should be conditional on compliance with the regulations.

While tying federal funds to the regulations should help a great deal with compliance, monitoring and enforcement are common difficulties associated with command and control regulation. Without any monitoring and enforcement system, regulated entities have no

[24] For example, in 2013, the Department of Justice, DoEd, and HHS sent a joint letter to health-related schools regarding the issue of Hepatitis B discrimination. In this letter, these entities also note that they all jointly enforce Title VI of the Civil Rights Act. (Department of Justice 2013).

incentive to comply with the concussion standards set. In addition, both monitoring and enforcement add costs to the regulatory system. One way to address these issues is to incentivize the NCAA to fulfill the role of monitoring. The DoEd could threaten to take away the NCAA's authority over its member institutions if compliance falls to a rate they find unacceptable. The DoEd recently took a similar approach with regards to the American Bar Association (ABA). In 2016, the DoEd threatened to suspend the ABA's accreditation power for new law schools because of its failure "to implement its student achievement standards and probationary sanctions, while also not meeting its audit process and analysis responsibilities regarding students' debt levels" (Ward 2016). While the ABA was ultimately not suspended, this example helps to illustrate an approach that the DoEd may choose to take with the NCAA.

As part of regulating college athletes, insurance could be used as a supplemental policy tool. Any imposed regulation should include that schools (or the NCAA) be required to provide its athletes with health insurance to cover immediate injuries. Insurance premiums would work as an instrument to provide further incentive for schools (or the NCAA) to reduce risk. While something akin to workers' compensation—which could pay for even latent harms—may be preferable, such a program would face immense political and legal hurdles. Time and time again, the NCAA has remained steadfast in its opinion that college athletes should not be compensated other than the scholarships and minor living stipends they are entitled to receive. Whether one agrees with this opinion, or believes the NCAA's mission to preserve the integrity of "amateurism" is genuine, is beyond the scope of this chapter. It is enough to say that there is no reason to believe that a workers' compensation system would be feasible given the current environment. Instead, providing health insurance is a second-best alternative. Finally, colleges should be required to honor scholarships for a full four years. Players should not have to face the possibility of losing their scholarships due to an injury. Without guaranteed scholarships, players have an incentive to hide concussion symptoms and continue to risk suffering subsequent injuries.

As noted above, market forces provide inadequate incentives at the college level. The lack of bargaining power of college athletes, the NCAA's monopsony over collegiate level athletic talent, and lack of markets for players not meeting the NFL draft age requirements are some of the market failures at the collegiate level. Relying on tort liability to manage concussion risks at the college level is also not ideal. Causation is also a hurdle because plaintiffs would have to show that their injuries did not happen during youth football. Sovereign immunity is another major issue at the college level. The overwhelming majority of universities are public institutions and would be immune from suit. This would leave only the private universities, athletic conferences, and the NCAA as the possible liable parties. This could be an issue if it is the schools themselves that have the most control over managing risk and implementing safety measures, as most schools are public institutions.

V. Youth Football

At the youth level, suits have been brought against a wide range of parties. Many have resulted in confidential settlements that do little to advance risk-management efforts. The current approach to address concussions at the youth levels is through state youth concussion laws, which have been enacted by every state. In this section, I argue that while this type of state-level regulation is the best available tool for youth football, the current schemes leave much to be desired. I argue that states conduct regulation through notice-and-comment rulemaking, allowing them to incorporate information from relevant experts and decisions that are aligned with meaningful benefit-cost analysis. Table 3 provides the pros and cons of the four potential systems with respect to youth football.

A. Concussion Litigation and Settlements

Similar to the college level, a wide range of parties has been subject to suit at the youth levels. Among the defendants in concussion litigation at the youth levels are Pop Warner, USA Football, state athletic associations, and local school districts. While similar claims and defenses have been made across these groups, noteworthy differences exist as well.

Pop Warner is a non-profit organization providing youth football and cheer programs for children aged five to 16 years old. Pop Warner is the largest youth football program in the world and in the past several years has faced a wave of litigation regarding concussion-related injuries. One lawsuit brought in California against Pop Warner involved a child, Donnovan Hill, who became paralyzed after making a goal line tackle during a regional Pop Warner championship game in 2011 (Farrey 2016a). The tackle was made using a headfirst technique allegedly promoted by his coaches. Hill was 13 years old at the time and was rendered a quadriplegic. A settlement was reached in January 2016. The terms of the settlement were confidential, though it was thought to be in excess of $1 million. Hill died later that year (Farrey 2016b). Another action brought against Pop Warner was filed in Wisconsin in February 2015 and involved the death of a former youth football player who began playing football in Pop Warner at the age of 11. During his sophomore year in college, the individual began exhibiting irrational behavior and decreased cognitive ability. In 2012, at the age of 25, he committed suicide. An autopsy of his brain revealed that he had CTE. The case was ultimately settled for less than $2 million (Akinnibi 2016; Belson 2016b; Weisel and Kingdollar 2016).

Two mothers, Kimberly Archie and Jo Cornell, brought the most recent case against Pop Warner.[25] Their sons participated in Pop Warner when they were young and were discovered to have CTE after they died. They argued that Pop Warner failed to monitor games, practices, rules, equipment, and medical care so as to minimize the risks of brain injuries. It was also alleged that Pop Warner did not ensure that its coaches were properly trained in concussion management, as promised (Belson 2016b). This lawsuit also named USA Football as a responsible party. The complaint alleged that USA football made misleading statements regarding the safety brought about by its *Heads Up Football* program. Such statements included that those adopting "Heads Up have 87% lower injury rates" and "82% lower concussion rates." However, an investigation by *The New York Times* discovered that these numbers relied upon flawed research and that the program did not reduce the risk of injury by the numbers reported. The suit is still ongoing at this time.

One lawsuit making its way through the state of Pennsylvania involves claims against the Pennsylvania Interscholastic Athletic Association (PIAA).[26] The plaintiffs in this suit, three high school athletes (two football players and one softball player), have alleged that the PIAA was aware of the health risks associated with sub-concussive blows to the head and concussive results, and that the PIAA failed to timely and adequately impose safety regulations and protocols. The plaintiffs also claimed that the PIAA was in a superior position to know of concussion-injury rates and long-term medical consequences. The plaintiffs also pointed out that unlike professional athletes, who have the capital to pay for medical care, youth athletes range in age from 12 to 18 and do not have similar resources. The PIAA has taken the position that they were

[25] *Archie and Cornell v. Pop Warner Little Scholars, Inc.*, No. 2:16-cv-6603, 2016 WL 4614081 (C.D. Cal. Sept. 1, 2016).

[26] *Hites v. Pennsylvania Interscholastic Athletic Ass'n, Inc.*, No. 8 C.D. 2017, 2017 WL 4507367 (Pa. Commw. Ct. Oct. 10, 2017).

under no duty, and that the claims are non-judiciable due to the effect of a state law covering youth concussions. However, Pennsylvania's youth concussion law expressly states that it is not intended to eliminate civil liability. This same law also imposes obligations upon the Department of Health and Department of Education, and not the PIAA, to promulgate regulations related to concussions. The plaintiffs have countered by pointing to language in the PIAA's bylaws that portrays the association as assuming the role of a guardian of player safety.

A different lawsuit was filed against the Illinois High School Association (IHSA) in November 2014 on behalf of Alex Pierscionek, a former South Elgin football player.[27] The suit called for the IHSA to revise its policies regarding concussions to include further protections. These protections sought that schools be required to have medical professionals with an expertise in concussion management present at all football games and on call for all football practices. The suit also asked for the IHSA to enact new guidelines for screening players for brain injuries and develop a new education program for teachers about identifying concussions. The lawsuit also requested that a medical monitoring program be established to allow ex-high school football players to be tested for cognitive issues related to concussions. The IHSA argued that mandating such policies would be the end of high school football, as not every school could afford to provide these resources. The judge presiding over the case found in favor of the association and held that it was up to the legislature, not the judiciary, to enact such policies. The judge also appeared sympathetic to IHSA's argument with regards to the cost of the demanded policies. In his dismissal, Judge LeRoy Martin stated, "IHSA is simply a governmental entity charged with safeguarding student athletes" and "[imposing] broader liability on this defendant would certainly change the sport of football and potentially harm it or cause it to be abandoned"

[27] *Pierscionek v. Illinois High School Ass'n*, 2015 WL 6550826 (Ill. Cir. Ct.).

(Keilman and Rhodes 2015). This reasoning has received heavy criticism from those who believed that Judge Martin inappropriately inserted his personal beliefs and feelings regarding the preservation of football when making this decision.

Lawsuits have also been brought against specific school districts. One case in Iowa brought by a Bedford High School football player, Kacey Strough, resulted in a nearly $1 million jury verdict. Strough had a preexisting medical condition called cavernous malformation, which involves abnormal blood vessels in the brain. In October 2012, Strough sustained a concussion during practice and complained of headaches and double vision. The jurors found that the district and school nurse were negligent when they failed to notify coaches or his guardian of the possible brain injuries. This resulted in Strough continuing to practice and play football until he was forced to undergo surgery in November 2012 to remove a blood clot near his brain stem. Strough then fell into a coma for a few days and is now permanently disabled, requiring the use of a wheelchair (Naughton 2015; Weisel and Kingdollar 2016).

There have also been numerous other lawsuits against various school districts that have resulted in settlements. While many settlements have remained confidential, there are at least three recent settlements that have been published. One lawsuit against a California high school resulted in a $4.4 million settlement after it was alleged that a coach ignored evidence of a 17-year-old football player's headaches, and instead, allowed the player to return to play. Another claim was settled for $2 million when a 16-year-old football player sustained a head injury during practice. The player was allegedly practicing without a helmet, received a hurried evaluation, and was allowed to drive himself home after being left alone in a training room for 30 minutes. Finally, a $300,000 settlement was reached in a case in which a Montana high school football player was allowed to prematurely return to practice after suffering a concussion (Weisel and Kingdollar 2016).

B. Current Risk and Compensation Scheme

All 50 states and the District of Columbia have enacted legislation regulating youth sports concussions. Most of these state laws are modeled after the Washington state law, which in 2009 became the first state to pass this type of legislation. The Washington law has three main features: (i) education of athletes, parents, and coaches; (ii) immediate removal from play of a concussed athlete; and (iii) medical clearance before allowing the athlete to return to play (WASH. REV. CODE ANN. § 28A.600.190).

In Chapter 1 of this dissertation, I analyzed the impact of these laws on athletic participation and the reporting of concussions. I found that these laws lead to less participation in high school football. I also discovered that having a law in place leads to a statistically significant increase in the reporting of concussions. Policymakers should feel optimistic about this result, as better reporting should, in theory, make the sport safer. Despite the admirable attempts by states to deal with youth concussions through this legislation, these laws have received heavy criticism.

One critique has been that these laws lack the enforcement mechanisms and penalties to effectively deter noncompliance (Amberg 2012; Brandwein 2013). Adding to this problem is the fact that guidelines are typically written in language that is too broad, leaving room to comply with the legal standards without following the spirit of the law. Moreover, the laws often include immunity provisions that protect even those who blatantly fail to meet the required standards that have been set. Some also argue that these laws are too lax and should be made stricter (Brandwein 2013). Critics have called for more extensive educational requirements, mandatory baseline testing, and the requirement that medical professionals be present at all athletic events (Amberg 2012). All of these policies certainly increase costs, but proponents argue these costs are well worth it. Finally, others have complained that these laws have failed to stay current with present medical evidence (Harvey 2013).

Youth football organizations, like Pop Warner, that are not associated with schools often do not fall under the scope of these laws. Instead, these organizations have developed their own set of rules and regulations in order to address the safety concerns of football. For example, Pop Warner has eliminated kickoffs for their youngest divisions, has limited the amount of practice time allowed to be spent on contact to 25%, has required medical clearance for individuals suffering a suspected head injury, and has required *Heads Up Football* training for all coaches ("Pop Warner – Play Safer").

C. Proposed Risk and Compensation Scheme

Regulation is a useful tool when seeking to impact a large and diverse number of individuals. At no level of football is the participant pool larger or more diverse than at the youth levels. Regulation allows for policies to be as tailored as desired, which is important when the target of the risk-management system involves a diverse group of individuals. Therefore, command and control regulation should be used as the primary tool for managing the risks of concussions at the youth levels.

State-level legislation, which is the current system, is the appropriate course of action. The problem is that the current regulation has been executed poorly, and as a consequence, has failed to manage risks in a satisfactory manner. Unlike the college level, state-level regulation is more appropriate than federal-level regulation. One reason for this is that movement across state borders for football competition is far more rare at the youth levels. In addition, states may have different costs and benefits when it comes to football and concussions. For example, state budgets, the ratio of rural to urban areas, and the value that individuals assign to the game of football may differ across states. Such differences, no doubt, impact how concussion management policies should be crafted in order to maximize social welfare.

At the youth levels, the state is in the best position to have obtained a full range of information. Parents and students do not often have access to the full scope of information that is at the state's disposal or simply do not take the effort to learn enough information regarding risks. In addition, schools or local officials may only know information regarding risks and costs insofar as it applies to their specific area. On the other hand, a state regulatory entity would have a better sense of the different needs and concerns across the various entities in that state. Regulation allows for the costs of gathering information to be spread over a large group of individuals and not to be incurred by every party involved. In the youth football context, this means that youth athletes, parents, and schools do not have to directly spend resources to gather information. This is another reason why regulation should not be more localized than the state level. It would be possible to allow for regulation at the county level or at the athletic conference level; however, this would lead to much greater informational costs.

States should conduct its regulation through notice and comment rulemaking so that it can receive comments from experts in the scientific community, schools, parents, and other stakeholders. States should also be committed to revising their regulations often. The biomedical science in the area of concussions continues to evolve, especially with respect to concussions at the youth levels. Although more frequent updates to regulations would be more costly, the benefits likely outweigh the costs because concussion research is evolving rapidly. Furthermore, states should expand the coverage of their regulations to cover all youth football organizations and not just those football programs that take place at schools. This would ensure that organizations like Pop Warner have to meet certain standards rather than relying on self-regulation. States might also consider simultaneously drafting concussion regulation for all sports. A sport like football, however, would be more likely to have different requirements than other sports.

The types of requirements that are ultimately implemented should reflect each state's own careful benefit-cost analysis. Provisions like baseline testing, education and training requirements, and approved clearance providers may differ from state to state or even within a single state. Take, for example, the issue of what type of medical expert is needed and when he or she must be present. A state may require that just a trainer be available at football games for schools in rural areas because of the low supply of doctors in these areas. On the other hand, it may require that schools in urban areas require medical doctors to be available for both football practices and games. It could also be the case that requirements should be completely reversed, as rural schools are located further from hospitals than schools in urban areas. This hypothetical underlines the difficulty of predicting which requirements are optimal without engaging in a full benefit-cost analysis.

The ultimate goal of the state laws should be reducing youth concussions. One problem with current state laws is that this goal is only addressed in an indirect manner. Currently, state laws have focused mainly on detection by seeking to improve the ability of individuals to recognize concussion symptoms. Improved detection allows for concussed athletes to be removed from play and limits the possibility of repeat concussions. Even assuming that the laws accomplish this feat, detection only addresses the issue of repeat concussions. No matter how effective detection becomes, it can do nothing to prevent the first, initial concussion suffered by an athlete.

Therefore, states may consider other policies aimed more directly at initial concussions. It is not beyond the realm of possibility to think that regulators may decide to eliminate football altogether in certain situations. In fact, this is in line with current research. A recent study conducted at Boston University found that "athletes who began playing tackle football before the age of 12 had more behavioral and cognitive problems later in life than those who started playing after they turned 12" (Belson 2017a). States may decide to ban tackle football for children 12 and younger, concluding that the costs outweigh the benefits.[28] If states ultimately decide to ban tackle football in some instances, they need to consider the broader impact of such a decision. As discussed in Chapter 1 of this dissertation, participation in youth sports provides a variety of benefits—physical, cognitive, social, etc. Therefore, a state deciding to ban tackle football must initiate other programs that provide opportunities for youth to gain the same benefits they once derived from participating in tackle football.

Relying on market forces will lead to inadequate protection of youth athletes. One reason is because there is an imperfect information problem. Parents and students typically have less knowledge and access to information than schools or other youth organizations. This is especially true with respect to the cost of risk reduction measures. Another major issue is that young people are typically worse at evaluating risks and are easily influenced by other factors, like peer pressure. Under a market-based system, there would also be little incentive for schools or other organizations to generate risk information or reduce risks, as schools and youth

[28] In fact, Illinois has decided to do just this. On January 25, 2018, the state revealed a bill that would ban organized tackle football for Illinois children younger than 12 years old. The bill is called the Dave Duerson Act to Prevent CTE, named after the former Chicago Bears defensive back, who was diagnosed with CTE after committing suicide at the age of 50 (Golen and Rousseau 2018).

organizations do not compensate participants for undergoing the risk of athletic activity. Finally, some may be concerned with the ethics and morals of allowing market forces to control an issue as sensitive as subjecting our youth to long-term brain injuries.

Although several lawsuits at the youth levels have been successful, tort liability presents serious difficulties when it comes to managing concussion risks. Unlike the college and professional levels, youth players do not have to worry as much about causation because there is no level below them in which the defendant can claim the harm occurred. However, plaintiffs would still meet the tough task of showing that the harm was caused because the defendant fell below the appropriate standard of care and was not caused by the everyday, lawful participation in football. Another big issue at the youth levels when it comes to tort liability is the ability of the wrongdoer to pay. The amount of money at the youth football levels pales in comparison to that of other levels. Unlike the professional and collegiate level, most coaches and schools do not have deep pockets. In addition, the issues of sovereign immunity and damages caps still exist at the youth levels when claims are brought against public schools. Finally, many of the prior lawsuits at the youth level have resulted in confidential settlements. These settlements eliminate the potential for society to gain useful information from the litigation process.

As with other levels of football, insurance related to concussions may be difficult to implement at the youth levels due to insurers unwillingness to provide such insurance policies. The ability of an insurance provider to gain knowledge as to the risks and potential harms at the youth levels is also more difficult than for other levels because of the sheer number of participants, the incredible diversity of participants, and the uncertainty that still surrounds how blows to the head affect young people. In addition, even if insurance was available, many schools would be unable to afford to provide it for all of their athletes. Alternatively, parents could be required to purchase insurance for their children as a prerequisite for participation. This presents a problem for those coming from low-income families who would not be able to afford such a policy. As stated earlier, the majority of NFL players come from low-income families. In addition, these are likely the same kids in which extracurricular activities are most beneficial.

VI. Conclusion

This chapter proposes improvements to risk and compensation schemes related to traumatic brain injuries, suggesting that the optimal system differs for each level of football. While I do not claim that these proposed schemes will completely solve the concussion issue, they should lead to levels of risk and compensation that are closer to the optimal level than currently exist. This chapter is the first to examine how different policies should be implemented at the professional, college, and youth levels. This chapter adds to policy literature that examines the various pros and cons of different policy tools for managing risk, while providing an express application of these tools to an interesting subject. In addition, this chapter adds to the increasing literature in the area of sports-related concussions.

This chapter argues that a mixture of tools is necessary to properly incentivize optimal levels of risk and compensation. In doing so, this chapter illustrates the flaw of relying solely on one method for managing risks. Rather than depending on one method, it is important to consider how the different risk-management systems can overlap and coordinate with each other to ensure that potential weaknesses of one system are addressed by another. In addition, this chapter demonstrates that policymakers cannot rely on a one-size-fits-all approach for managing the risks of even a seemingly similar issue. While the ultimate goal is the same at each level of football—incentivizing optimal levels of risk and compensation—the appropriate means by which to achieve this goal differs immensely at each level.

At the professional football level, I argue that market forces along with insurance in the form of self-insured workers' compensation is the appropriate combination of risk management systems. The market forces approach at the professional level relies heavily upon the NFLPA to ensure that asymmetric information does not once again become a problem. Workers' compensation should supplement the market-based approach to account for issues that may arise because of risk misperceptions and the salary cap. At the college level, a mixture of federal regulation and health insurance is best, as college players have little market power and workers' compensation is not a feasible option because of the issue of amateurism. Finally, I argue that state-based regulation is the most appropriate tool for youth football. However, changes should be made to the current system so that meaningful benefit-cost analysis can occur. Research concerning the risks and harms associated with football continue to develop. As more is learned, each level of football will need to adapt and revise their policies in wake of new scientific information.

This chapter focused on the sport of football. However, the framework provided could prove useful for other sports like hockey and soccer, which have relatively high rates of concussion-related injuries. While each sport will have its own unique set of issues, the four potential systems to manage risk and compensation are the same. Future research could examine which mixture of systems would work best to incentivize optimal levels of risk and compensation in other sports.

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Tables

Table 1: Pros and Cons of Systems for Professional Football

System	Factors In Favor	Factors Against
Market Forces	• Allows players to express their risk preferences • Union has bargaining power to influence policies	• Players may suffer cognitive biases with regards to risk • Salary caps limit ex ante compensation
Tort Liability		• Hard to prove injury is not a result of playing football in college or younger • Suits will become pre-empted by new Collective Bargaining Agreement
Regulation		• Regulating entity is not in a better position to gather information than the league and union
Insurance	• Provides compensation that could be difficult to receive with market forces alone • Incentivizes league to reduce risks	• Does not fully compensate for health-related injuries

Table 2: Pros and Cons of Systems for College Football

System	Factors In Favor	Factors Against
Market Forces		• Players are not allowed to unionize and have little bargaining power
Tort Liability		• Proving causation is difficult • Public schools have sovereign immunity
Regulation	• Several market failures exist at this level • Information costs can be spread across parties	
Insurance	• Would incentivize schools to reduce risks	• Workers' compensation not feasible because of amateurism issue

Table 3: Pros and Cons of Systems for Youth Football

System	Factors In Favor	Factors Against
Market Forces		• Parents and athletes have imperfect information • Youth (and their parents) are poor at evaluating risks and are subject to peer pressure
Tort Liability		• Proving causation is difficult • Public schools have sovereign immunity
Regulation	• Large and diverse number of participants • Information costs can be spread across parties	• Current schemes have been criticized as ineffective
Insurance		• Insurers are unwilling to underwrite • Schools cannot afford to self-insure

Appendix

Table A–1: NFL Settlement – Maximum Awards of Qualifying Diagnoses

QUALIFYING DIAGNOSIS	MAXIMUM AWARD AVAILABLE
Amyotrophic lateral sclerosis (ALS)	$5 million
Death with CTE (diagnosed after death)	$4 million
Parkinson's Disease	$3.5 million
Alzheimer's Disease	$3.5 million
Level 2 Neurocognitive Impairment (*i.e.*, moderate Dementia)	$3 million
Level 1.5 Neurocognitive Impairment (*i.e.*, early Dementia)	$1.5 million

Source: "NFL Concussion Settlement." https://www.nflconcussionsettlement.com/Documents/Long-form_Notice.pdf (last accessed January 2018).

Table A–2: NFL Settlement – Maximum Award Adjustments for Age at Diagnosis

AGE AT DIAGNOSIS	ALS	DEATH w/CTE	PARKINSON'S	ALZHEIMER'S	LEVEL 2	LEVEL 1.5
Under 45	$5,000,000	$4,000,000	$3,500,000	$3,500,000	$3,000,000	$1,500,000
45 - 49	$4,500,000	$3,200,000	$2,470,000	$2,300,000	$1,900,000	$950,000
50 - 54	$4,000,000	$2,300,000	$1,900,000	$1,600,000	$1,200,000	$600,000
55 - 59	$3,500,000	$1,400,000	$1,300,000	$1,150,000	$950,000	$475,000
60 - 64	$3,000,000	$1,200,000	$1,000,000	$950,000	$580,000	$290,000
65 - 69	$2,500,000	$980,000	$760,000	$620,000	$380,000	$190,000
70 - 74	$1,750,000	$600,000	$475,000	$380,000	$210,000	$105,000
75 - 79	$1,000,000	$160,000	$145,000	$130,000	$80,000	$40,000
80+	$300,000	$50,000	$50,000	$50,000	$50,000	$25,000

Source: "NFL Concussion Settlement." https://www.nflconcussionsettlement.com/Documents/Long-form_Notice.pdf (last accessed January 2018).

Table A–3: NFL Settlement – Award Reductions Based on NFL Experience

NUMBER OF ELIGIBLE SEASONS	PERCENTAGE OF REDUCTION
4.5	10%
4	20%
3.5	30%
3	40%
2.5	50%
2	60%
1.5	70%
1	80%
.5	90%
0	97.5%

Source: "NFL Concussion Settlement." https://www.nflconcussionsettlement.com/Documents/Long-form_Notice.pdf (last accessed January 2018).

Chapter 3: When to Walk Away? An Experimental Test of How Commitment and Payment Schemes Influence Risk Aversion

I. Introduction

What would make someone quit their dream job and walk away from nearly $2 million? For former San Francisco 49er's linebacker Chris Borland, the answer is the risk of a blow to the head that could permanently affect his health. Borland was only twenty-four-years-old and coming off a stellar rookie season when he decided to retire in 2015. Borland was set to earn close to $2 million from the remainder of his rookie contract. This is a great deal of money (even without considering the money he might have earned in future contracts), but according to Borland, "From what I've researched and what I've experienced, I don't think it's worth the risk." While past players have retired citing health-related concerns, Borland's retirement is proactive, rather than reactive. Unlike some players who retire after being injured, Borland is in fine health. However, Borland does not think it is worth the risk to wait and take a chance. According to Borland, "I'm concerned if you wait [until] you have symptoms, it's too late. There are a lot of unknowns. I can't claim that 'X' will happen. I just want to live a long healthy life, and I don't want to have any neurological diseases or die younger than I would otherwise." (Florio 2015).

Borland is far from the only National Football League (NFL) player to have retired early citing an uneasiness with the potential risks related to concussions. A.J. Tarpley, a linebacker for the Buffalo Bills, retired after just one year in the NFL because of concussions. The twenty-three-year-old explained, "I suffered the third and fourth concussions of my career this past season, and I am walking away from the game I love to preserve my future health." (Wilson 2016). Former lineman for the Baltimore Ravens John Urschel retired at the age of twenty-six (Belson 2017), just days after the release of a Boston University study, which found chronic traumatic encephalopathy (better known as CTE) to be present in 110 of the 111 brains of former NFL players examined (Mez et al. 2017; Ward et al. 2017). These examples illustrate that NFL players are cognizant of the risks of playing their sport and that the potential of suffering traumatic brain injuries is something they contemplate when deciding whether or not to continue their athletic careers.

The incentivized experiment in this chapter simulates the type of decisions that NFL players and other athletes in contact sports must confront—whether to continue their career at the risk of suffering a concussion, or in extreme cases, irreparable brain damage. Experiment participants are presented with a multi-stage "win or lose it all" risk structure in which they must decide how many rounds of a lottery they wish to play before walking away. With each win, participants earn more money towards their bank. Just one loss, however, results in the participant losing everything. This type of structure is analogous to one of the fears that exist amongst NFL players—one blow to the head could result in major, irreversible effects. As one former player stated, the "next hit to my head could possibly kill me or be life-damaging."[29]

In addition to the unique risk structure, the experiment seeks to investigate how different levels of commitment and different payment structures affect risk preferences. Regarding commitment, a professional athlete may enter into a long-term deal with a team in which he or she agrees to play for multiple years and feels obligated to fulfill such contract. In other cases, an athlete may only have a short-term contract or no contract at all. For example, a high school athlete may feel no sense of obligation to play any longer than his or her sport's current season. In these instances, amateurs are able to re-evaluate their decisions regarding the risk of their sport before each season. Benefits received by athletes may either remain flat or increase over

[29] Adrian Coxson stated this while announcing his retirement from football. This announcement came approximately a month after Coxson had to be taken off the practice field in an ambulance (Block 2016; Demovsky 2015).

time. For example, amateur athletes can be thought of as facing flat payment schemes. In most cases, a college athlete's scholarship remains the same over time. A high school athlete is not compensated in the traditional sense, but does gain value from athletic participation (health benefits, social benefits of belonging and camaraderie, etc.) that one would expect to remain relatively flat over time.[30] On the other hand, in professional sports (and elsewhere) earnings typically increase over time with additional experience and skill.

I find that, in a majority of this experiment's scenarios, nearly one-third of participants play more rounds than is optimal or predicted under the assumption of risk-neutrality. Such results actually understate the degree to which individuals play too long, as most people are risk-averse, not risk-neutral. These findings are concerning when considering the behavior of athletes, especially professional football players, who must decide each year whether they wish to continue their career and risk a life-altering injury. Professional football players may act similarly to the experiment's participants—not taking into account the risk that recurs year-after-year and playing longer than they might otherwise. Experiment participants play more rounds when faced with an upfront commitment and increasing payment structure. Such results provide guidance for policymakers that may be in a position to manipulate such factors in an effort to discourage risk-seeking behavior in which athletes might engage.

For amateur athletes, information may be the most feasible tool for encouraging risk aversion. This is because these athletes are not paid for their participation in the traditional sense, so changing how payment schemes are structured is not applicable. For these athletes, risk

[30] It could be argued that another type of "payment" that might exist for some at the youth level is the increased likelihood of receiving a college athletic scholarship. In this sense, the value of their participation may increase as the athlete nears the end of his or her high school career when scholarship decisions are being made. However, the percentage of high school athletes that go on to earn athletic scholarships is small. A similar argument could be made with respect to a college athlete's hope of being drafted into a professional sports league.

information related to the potential dangers of concussions should be provided at a more frequent basis if more risk-averse behavior is desired. For those high school or younger, youth concussion laws have already been adopted and can be used as a tool for ensuring such information is distributed. At these levels, the information should not only be distributed to the athlete, but also to their parents. In many instances, parents make the ultimate decisions as to whether a youth athlete will be allowed to participate in a sport. At the college level, the National Collegiate Athletic Association (NCAA), athletic conferences, and individual schools can all play a role in supplying the relevant risk information to their athletes.

At the professional level, the league itself and the players' union—for football, this would be the NFL and the NFL Players Association (NFLPA)—would be the parties responsible for offering risk information to players at a more frequent rate. Unlike the situation involving younger athletes, the structure of payments can be manipulated for professional athletes in order to encourage more risk-averse behavior. This would require that the leagues and player unions strike a deal requiring that contracts include more guaranteed upfront compensation and a lesser degree of payment on the back-end, which would otherwise encourage individuals to play longer than they may otherwise desire.

Section II describes the details of the experiment and the subject population. Section III provides an overview of relevant literature and explains how the experiment in this chapter fits into, and contributes to, this literature. Section IV explains the hypotheses that were developed given the prior literature, while Section V discusses the basic results of the experiment and the accuracy of such hypotheses. Section VI discusses the implications of the results, suggesting how certain aspects of payment and commitment duration could be manipulated to affect decisions related to risk. Section VII concludes, summarizing the results and their implications.

II. Experimental Design

Participants took part in the experiment[31] in a lab on the Vanderbilt University campus using Qualtrics, a web-based survey software. Participants consisted of students at Vanderbilt University who were recruited on-campus through the use of flyers. Interested students were able to reserve a time to come into the lab and take the experiment. Walk-ins were also welcome. The only requirement for participation was being 18 years of age or older. Participants completed the experiment using computers that were set up in the lab.

The experiment consists of four games. In each game, participants face a lottery of known probability. Participants are asked to imagine a box consisting of a mixture of winning and losing balls. For each of the games, participants must ultimately choose how many rounds they wish to play the lottery (up to a maximum of 10 rounds per session) before walking away. Choosing to play a round results in a ball being drawn from the box. Drawing a winning ball adds money to the participant's bank. Drawing a losing ball ends the game for that session and results in all of the money in the participant's bank for the current session being forfeited. Choosing to walk away results in the participant earning the amount in their bank for that session, but forfeiting any potential earnings from later rounds.

To illustrate, consider the following example. Assume the participant has played three rounds of the game, having drawn winning balls in each of the first three rounds. The participant now must decide whether or not to play the fourth round or to walk away with the $3.25 in their bank. If the fourth round is played and a winning ball is drawn, the participant's bank will be $4.25, and they will face the same decision of whether to play or walk away in the fifth round. If the fourth round is played and a losing ball is drawn, the participant loses the $3.25 and earns nothing for that session. Figure 1 illustrates what a participant is shown in such a scenario.

[31] This experiment went through Vanderbilt University IRB approval (study #170174).

To help participants gain a better understanding of Game 1, participants play four practice sessions before moving to the real sessions of the game. After completing the practice sessions, participants also have the option of being shown the instructions again before moving on to the real game. Despite the practice sessions, one could be concerned that participants may be suspicious of the authenticity of the drawings. To dispel any belief of the games being fixed, it is explained to participants that a random number generator from an external website (linked to the probabilities in the experiment) is being used to determine whether a winning or losing ball is drawn.

In Game 1, the winnings per round remain flat. Participants start the game with $0.25 in their bank and have the opportunity to win an additional $1 in each round by drawing a winning ball. In all of the games, four different lotteries are used—60%, 70%, 80%, and 90% chance of drawing a winning ball. In the first game, participants play five sessions of each lottery for a total of 20 observations per person. The order in which they play each lottery is determined at random.

Game 2 operates the same as Game 1, except with regards to the payment scheme. Instead of $1 being added to the participant's bank each round ("flat payment scheme"), the amount added to the participant's bank increases in each round ("increasing payment scheme"). In each round, the potential amount to be added to one's bank increases by $0.25. A winning draw in Round 1 adds $1.00 to the participant's bank. A winning draw in Round 2 adds an additional $1.25 to the participant's bank. A winning draw in Round 3 adds an additional $1.50 to the participant's bank, and so on and so forth. As with the first game, participants play four practice sessions before moving to the real game, in which they play five sessions of each of the four lotteries. Table 1 illustrates the two payment schemes that are used in the experiment. Not only is the trajectory of payments different between the schemes, but the amount of money in the participant's bank in each round also differs between the two schemes.

In Game 3 and Game 4, participants face the same lotteries and payment schemes as in Game 1 and Game 2, respectively. Recall that in Games 1 and 2 decisions of whether to play or walk away are made step-by-step at each round ("No Commitment" decision). That is, participants are able to evaluate whether they wish to play or walk away after each round. For Games 3 and 4, participants are forced to decide upfront ("Upfront Commitment" decision) how many rounds they wish to play (0–10) before walking away. To refresh their memory, participants are shown a table of the applicable payment scheme for the game, showing the payoff associated with winning that corresponding round (i.e., the first two columns of each of the tables in Table 1). Participants are also reminded that should they lose any round that is played, their entire bank for that session will be lost. For Games 3 and 4, participants play each lottery only once for a total of four observations per participant for each game. The structure of each of the games is shown in Table 2.

In addition to an $8 show-up fee, participants earn additional money based upon the results of the games. For each of the four games, one result was chosen at random to be added to the participant's total winnings. The stakes at hand were large, both in comparison to the pay for other experiments on campus and to work-study opportunities, a fact that led to confidence that participants took the games seriously. Participants also receive a small payment based on the results of a Holt-Laury lottery choice game taken near the end of the survey.[32] All payments were made in cash after the participant had concluded the experiment. The average payment

[32] The lottery choice game referred to is drawn from Holt and Laury's 2002 paper titled, "Risk Aversion and Incentive Effects." In their experiment, they asked participants to make ten choices between paired lotteries. They were then able to calculate the range of the participant's relative risk aversion based upon the number of "safe" and "risky" choices made.

made to participants was $18.89. On average participants took approximately 18 minutes to complete the experiment.

III. Relevant Literature

My experiment is one of many that explore how individuals make decisions in the face of risk. In the backdrop of all of the four games is risk aversion. Risk aversion describes the behavior by which an individual prefers a lower-risk investment of lower return to a higher-risk investment of higher return. Risk aversion has been well studied and shown to be exhibited in a wide variety of environments. Risk aversion is a matter of degree, with different individuals having different risk premiums—the minimum amount of money by which the expected return on a risky option must exceed the known return on a risk-free option in order to induce the individual to choose the risky option as opposed to the risk-free option. The more risk-averse the person, the greater his or her risk premium. A risk-neutral individual would have a risk premium equal to zero, whereas a risk-seeking individual would actually have a negative risk premium on any lottery.

For purposes of my experiment, choosing to play another round is the risky option and choosing to walk away is the risk-free option. A risk-neutral individual is indifferent between playing another round or walking away when the expected value of playing is equal to his or her current bank, but will walk away once the expected value of playing becomes less than his or her current bank. A risk-averse individual will walk away even when the expected value of playing another round exceeds the payment guaranteed from walking away. The more risk-averse the individual, the fewer rounds he or she will choose to play. The exact opposite holds for an individual that is risk seeking. The more risk-seeking the individual, the more rounds he or she will play.

Like many experiments, mine seeks to examine how individuals deviate from what would be considered "optimal" behavior for an individual under the expected utility theory. Under the expected utility theory, individuals look solely at the expected utility of outcomes and are indifferent to their reference point, not caring how outcomes of gains and losses are framed. Kahneman and Tversky were one of the first to demonstrate that in several instances, individuals' preferences systematically deviate from the expected utility theory. In Kahneman and Tversky (1979), a seminal paper in behavioral economics, the authors established prospect theory. Rather than making decisions based solely on the expected utility of absolute outcomes, prospect theory asserts that individuals think in terms of expected utility relative to a reference point. One central claim of prospect theory is that individuals are risk-averse in gains and risk seeking in losses. The theory also suggests that individuals make risk decisions using certain heuristics and biases. Among these biases are the "certainty effect" and "loss aversion."

In Kahneman and Tversky (1979), the authors presented a series of hypothetical choice problems to students and university faculty. They found that individuals exhibited a significant degree of preference reversal when one of the outcomes was considered certain, rather than probable. One explanation for such behavior is what the authors called the "certainty effect," whereby people underweight outcomes that are merely probable in comparison with outcomes that are obtained with certainty. Such effect, the authors explain, contributes to risk aversion in choices involving sure gains. The authors found this certainty effect present for both monetary and non-monetary outcomes. In my experiment, the walk away option presents an outcome that can be obtained with certainty. Participants choosing to walk away are guaranteed to leave the session with the money currently in their bank. Thus, it might be expected that participants will underweight the play option, as the outcome is merely probable, as compared to the walk away option, in which the outcome can be obtained with certainty.

Loss aversion, first demonstrated by Kahneman and Tversky (1984), refers to an individual's tendency to prefer avoiding a loss to acquiring a gain of equivalent value. In other words, "losses loom larger than gains"—a loss of $X is more undesirable than a gain of $X is desirable. Framing is a fundamental element of loss aversion, as possible outcomes can be framed as gains or losses according to different reference points. In their 1984 paper, the authors asked two groups to choose between a pair of lotteries. Figure 2 shows the structure of the lotteries used in their experiment. The pair of lotteries each of the groups faced was identical in expected value; however, the way in which the lotteries were framed was different. The authors presented the lotteries to the first group of individuals in the form of a two-stage game in which there was a chance of the game ending in the first round. Participants were asked which option they would prefer if they reached the second round. One of the options was a sure gain, while the other involved a risky, but larger gain. The authors presented the second group of individuals a pair of lotteries in the form of a one-stage game. In the one-stage game scenario, there was no sure payout, but the expected values of each option equaled those shown to the first group of individuals. The authors found that when framed as a two-stage game, more people chose the guaranteed gain. When framed as a one-stage game, more people chose the exact opposite—the higher risk, higher gain option. The authors argued that in the two-stage game, individuals ignore the first stage, weighting one option as certain, even though it is not. Similarly, participants in my experiment may act differently when the game is framed as round-by-round decisions (Games 1 and 2) as compared to when the game is framed as one long-term, upfront decision (Games 3 and 4).

Another potential bias related to my experiment is the "endowment effect." Thaler (1980) coined the term "endowment effect" to describe the reluctance of people to part from assets that belong to their endowment. The endowment effect was most famously demonstrated by an experiment conducted by Kahneman, Knetsch, and Thaler (1990) using coffee mugs. The authors found that randomly assigned owners of a coffee mug required significantly more money to sell the mug than randomly assigned buyers were willing to pay for the mug. The endowment effect can arguably be explained by reference-dependence and loss aversion. Individuals first evaluate a potential change by categorizing such change as either a gain or a loss from their current reference point. Once a person feels as if they own an item and establishes this as their reference point, foregoing the item feels like a loss. In my experiment, individuals may view the money in their bank as part of their endowment. Thus, for Games 1 and 2, participants may use their current bank as a reference point. For games 3 and 4, the participants are forced to commit to their decisions upfront, making it impossible for them to use their bank as a reference point. Thus, the endowment effect may influence decisions made during Games 1 and 2, but should not have any influence on decisions for Games 3 and 4.

Thaler et al. (1997) conducted an experiment designed to test the effect of myopia and loss aversion on risk taking, leading to a term they called "myopic loss aversion." The authors defined myopic loss aversion as "the combination of a greater sensitivity to losses than to gains and a tendency to evaluate outcomes frequently." The authors explained that those exhibiting myopic loss aversion are "more willing to accept risks if they evaluate their investments less often." To test for myopic loss aversion, the authors conducted an experiment, which simulated investment decisions over hypothetical funds. One group of subjects was provided with frequent feedback, while the other group was not. The authors concluded that the frequent feedback led to mental accounting and a "narrow framing" that induced subjects to display severe risk aversion.[33] Their experiment parallels mine in that for Games 1 and 2, individuals receive feedback after each round and must constantly decide whether to play or walk away in each round. Whereas, for Games 3 and 4, there is no feedback at all and participants must commit to their decision for all rounds at the start of the game.

Figner et al. (2009) explored how risk decisions differ when "hot" affective processes are prominent as compared to when "cold" deliberative processes govern. The authors conducted an experiment where participants of different age groups played a game called the "Columbia Card Task." In this game, subjects made decisions as to how many cards to turn over, knowing the total number of winning and losing cards, the penalty for a losing card, and the reward for a winning card. In the "hot" version of the game, participants turned cards over sequentially and received immediate feedback. In the "cold" version, participants made a single-time decision and did not receive feedback until all the game rounds had been played. The authors found that more cards were chosen in the "hot" version of the game. An analogy can be drawn between the "hot" and "cold" versions of the Columbia Card Task and the No Commitment and Upfront Commitment versions in my experiment. For Games 1 and 2 in my experiment, participants receive immediate feedback and make decisions as to whether to play or walk away in a sequential matter. For Games 3 and 4 in my experiment, participants must commit to a decision at a single-time (the start of the game) and do not receive feedback for each round. The biggest difference between the card task and my experiment is that participants risk the entirety of their reward in my experiment. If an individual draws a losing ball in my experiment, they forfeit all

[33] An experiment conducted by Brookins et al. (2016) also showed that more frequent feedback tends to lead to less risk-taking.

of their gains, whereas drawing a losing card in the Columbia Card Task resulted only in a partial reduction to that individual's winnings.

The experiment in this chapter adds to the experimental economics literature that examines risk aversion and how framing can impact decisions regarding risks. In this experiment, the framing of two elements—payment schemes and commitment—are the focus of examination. Payments are framed as either constant over time or increasing over time. The decision-making process is also framed differently, with decisions being made on a round-by-round basis in one scenario and with multi-round decisions being committed to upfront in the first round. This experiment also advances the literature in this area by presenting a unique structure. To my knowledge, this is the first experiment that involves a multi-stage game in which participants are placed in a "win or lose it all" scenario. This experiment's multi-stage format consisting of ten potential rounds is also distinctive. Most other multi-stage experiments, like Kahneman and Tversky (1984), only consist of two rounds.

IV. Hypotheses

Through straightforward calculations, participants can evaluate the expected value of choosing to play another round and compare this to their current bank (i.e., the expected value of choosing to walk away). To calculate the expected value of choosing to play a round, one need only multiply their chance of survival from playing (either 60%, 70%, 80%, or 90% depending on the lottery) by the value of what their bank would be in the next round. Tables A–1 and A–2 show the calculations for each round under each probability and payment scheme scenario. Given these calculations and the prior literature, I formed the following hypotheses:

Hypothesis 1: The higher the probability of winning, the more rounds participants will play.

$$\text{Rounds Played}_{60\%} < \text{Rounds Played}_{70\%}$$
$$\text{Rounds Played}_{70\%} < \text{Rounds Played}_{80\%}$$
$$\text{Rounds Played}_{80\%} < \text{Rounds Played}_{90\%}$$

The higher an individual's chance of drawing a winning ball, the more desirable it is to play rather than walk away. Therefore, one would expect that for each game individuals would play more rounds when the chance of winning is higher. This hypothesis can be tested for each game separately—avoiding the possibility of conflating the effect of the win percentage element with other factors, such as loss aversion or endowment, which may impact certain games differently.

Hypothesis 2: Risk-averse participants will play fewer rounds.

$$\text{Rounds Played}_{\text{Holt-Laury Risk-Averse}} < \text{Rounds Played}_{\text{Holt-Laury Risk-Neutral/Seeking}}$$
$$\text{Rounds Played}_{\text{Non-Smokers}} < \text{Rounds Played}_{\text{Smokers}}$$
$$\text{Rounds Played}_{\text{Females}} < \text{Rounds Played}_{\text{Males}}$$

The Holt-Laury lottery game included near the end of the experiment is a trusted and often-used device for measuring one's relative degree of risk aversion. Those displaying risk-averse behavior in the Holt-Laury lottery game would be expected to also exhibit such behavior during the rest of the experiment. This would translate into fewer rounds being played for those evaluated as risk-seeking under the Holt-Laury lottery game. The experiment also asks participants about their smoking behavior. Smokers are thought to have more tolerance for risk than the rest of the population.[34] Therefore, we would expect smokers to play more rounds, and thus take on more risk, than non-smokers. Studies have shown that, on average, females tend to

[34] For example, Hersch and Viscusi (1998) show that smokers are more risk-taking than their non-smoking counterparts in a variety of domains, such as seatbelt use and job choice. Viscusi and Hersch (2001) also show that smokers exhibit more risk-taking behavior when it comes to job safety.

be more risk-averse than males.[35] Therefore, we would expect that females would play fewer rounds than males.

> Hypothesis 3: Participants will play more rounds under the Upfront Commitment method than under the No Commitment method.

$$\text{Rounds Played}_{\text{Game 1}} < \text{Rounds Played}_{\text{Game 3}}$$
$$\text{Rounds Played}_{\text{Game 2}} < \text{Rounds Played}_{\text{Game 4}}$$

From an expected value perspective, no difference exists between the No Commitment and the Upfront Commitment methods.[36] Nonetheless, previous literature has indicated that the risk preferences of individuals may differ due to the timing of these decisions. Several papers have indicated that evaluating outcomes frequently leads to less risk taking. Participants are able to evaluate potential outcomes after each round under the No Commitment method, whereas participants can only evaluate potential outcomes once at the beginning of the game under the Upfront Commitment method. Therefore, it is expected that participants will exhibit higher degrees of risk aversion for Game 1 (Flat Payment, No Commitment) and Game 2 (Increasing Payment, No Commitment) than for Game 3 (Flat Payment, Upfront Commitment) and Game 4 (Increasing Payment, No Commitment), respectively.

> Hypothesis 4: It is unclear whether participants will play a more, less, or an equal number of rounds under the flat payment schemed as compared to under the increasing payment scheme.

$$\text{Rounds Played}_{\text{Game 1}} \; ? \; \text{Rounds Played}_{\text{Game 2}}$$
$$\text{Rounds Played}_{\text{Game 3}} \; ? \; \text{Rounds Played}_{\text{Game 4}}$$

Hypothesis 4 seeks to test how different payment schemes impact individuals' decisions with regards to risk. The effect of the payment schemes is theoretically ambiguous, as there are

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[35] Byrnes et al. (1999) conducted a meta-analysis of 150 studies. The authors discovered that a majority of the studies (about 60%) found males to take more risks than females.

[36] It is worth noting that the expected value computation is more straightforward under the No Commitment method because participants must only do one calculation in each round. The Upfront Commitment method, on the other hand, requires participants to calculate compound probabilities in order to determine the chance of drawing a winning ball for multiple rounds in a row.

several conflating factors at play. On the one hand, the payments are on a higher trajectory under the increasing payment scheme than under the flat payment scheme. This leads to greater rewards under the increasing payment scheme, especially in the later rounds. This should incentivize individuals to play more rounds under the increasing payment scheme. On the other hand, the amount of money in one's bank is also higher in each round under the increasing payment scheme. With more to lose, loss aversion and the endowment effect is stronger under the increasing payment scheme, making the walk away option desirable. It is not clear which of the effects will dominate.

V. Results and Analysis

A. Basic Findings

Table 3 shows the number of rounds that would be played under the expected utility theory in which an individual is risk-neutral and makes decisions strictly based on what maximizes the expected value of the outcomes over the entire game. If the expected value of playing is more than the money currently in the individual's bank, the expected utility theory suggests that an individual should choose to play. If instead their bank is greater, the participant should walk away. For convenience, such risk-neutral strategy is herein referred to as choosing the "optimal" number of rounds to play.

Table 4 shows the average number of rounds played for each of the scenarios in the experiment. Column (1) shows the average number of rounds played by those who "survived," while Column (2) presents the average number of rounds played by those who eventually "died."[37] These observations consist of individuals that drew a losing ball at some point. So, if

[37] "Survived" means that the participant never drew a losing ball. The participant either walked away before drawing a losing ball or happened to play and draw a winning ball in all 10 rounds. If an individual chose to walk away in Round 4, that individual is considered to have played 3 rounds for that

an individual drew a losing ball after choosing to play in Round 4, that individual is considered to have played 4 rounds. Column (3) combines the results of Column (1) and Column (2) and includes observations regardless of whether a person eventually drew a losing ball or not. Unlike the first two columns, Column (3) also includes the number of rounds participants choose to play for Games 3 and 4 under the Upfront Commitment decision method. Table A–3 in the Appendix provides a more detailed look at the number of individuals choosing to play or to walk away in each round for Games 1 and 2. Figures A–1, A–2, A–3, and A–4 in the Appendix show the distribution of rounds chosen to play for each of the games.

Figures 7, 8, 9, and 10 show the number of rounds participants played on average compared to the number of rounds that would be played under the optimal strategy that assumes risk neutrality. For Games 1 and 2 (No Commitment), individuals play fewer rounds than optimal on average. The behavioral economics literature presents several possible explanations for such behavior. Previous literature has shown that individuals do not make decisions based solely on an outcome's expected value. The certainty effect suggests that participants will give relatively too much weight to the walk away option, as it involves a guaranteed gain. In Games 1 and 2 (No Commitment), participants are faced with the walk away option in each round and may accord it too much weight. In addition, individuals will watch their banks grow and consider this to be part of their endowment. The endowment effect and loss aversion suggest that this will incentivize participants to walk away earlier and avoid the possibility of losing all the money in their bank. Thus, the fact that individuals played fewer rounds than the risk-neutral, optimal number is in line with the literature.

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observation. "Died" means the participant drew a losing ball at some point during the session. If an individual drew a losing ball after choosing to play in Round 4, that individual is considered to have played 4 rounds.

For Game 3 (Flat Payment, Upfront Commitment), participants actually play more rounds than optimal for the 60%, 70%, and 80% lotteries and fewer rounds than optimal for the 90% lottery. This is surprising because, other than for the 90% lottery, these outcomes indicate risk-seeking behavior and differ greatly from the results of Game 1 (Flat Payment, No Commitment). One explanation is that participants are not subject to the same biases as in Game 1 because, under the Upfront Commitment method, participants are only faced with the sure option once and cannot assess their endowment because the results of each round are not shown. In Game 4 (Increasing Payment, Upfront Commitment), there is not a statistically significant difference between the rounds played by participants and the optimal number of rounds for the 60% lottery. However, participants play fewer rounds than optimal for the other lotteries.[38]

B. Evaluating the Hypotheses

Hypothesis 1: The higher the probability of winning, the more rounds participants will play.

Result: True.

An increased probability of winning raises the relative attractiveness of playing. As predicted, participants choose to play more rounds when the probability of drawing a winning ball is higher. As demonstrated in Table 4 and most of the figures, participants play more rounds in the 70% probability sessions than in the 60% probability sessions, more rounds in the 80% than in the 70%, and more rounds in the 90% than in the 80%. This holds true across all four games. These differences are statistically significant at the 95% confidence level, as shown in Table A–4.[39] These probabilities were also included as dummy variables in the regressions

[38] For the 70% lottery, the difference is significant at the 90% confidence level. For the 80% and 90% lotteries, the difference is significant at the 95% confidence level.

[39] Paired t-tests were used to test a majority of the hypotheses due to the fact that the results being tested involved responses from the same group of individuals. However, standard t-tests were used in tests, such as Hypothesis 3, in which two independent groups of individuals were being examined.

shown in Tables 5 and 6. Each of the probability variables is significant for all the specifications, indicating that as the probability of drawing a winning ball increases, the number of rounds participants choose to play also increases.

Hypothesis 2: Risk-averse participants will play fewer rounds.

Result: Mixed Results.

Risk aversion makes any lottery less attractive than a sure gain of equal expected value. Here, the play option is the lottery and the walk away option is the sure gain. It appears that, for the most part, those identified as risk-averse according to the Holt-Laury lottery choice game play fewer rounds than other participants. This result is significant at the 90% confidence level for Games 1 and 2 (No Commitment) and at the 95% confidence level for Game 4 (Increasing Payment, Upfront Commitment). Only in Game 3 (Flat Payment, Upfront Commitment), is the difference between the two groups not statistically significant. Smokers appear to play more rounds than non-smokers, which supports the hypothesis.[40] Surprisingly, males seem to play fewer rounds than females. This was unexpected and runs counter to the hypothesis, as females are thought to be more risk-averse than males.

Hypothesis 3: Participants will play more rounds under the Upfront Commitment method than under the No Commitment method.

Result: True.

Thaler et al. (1997) showed that individuals are more risk-averse when given the opportunity to frequently evaluate outcomes, such as under the No Commitment method. As demonstrated in Figures 5 and 6, participants play significantly more rounds under the Upfront Commitment decision scenario than under the No Commitment decision scenario. This result

[40] In the regressions, the results for smokers are statistically significant across most specifications, with the exception being when the standard errors are clustered for Games 1 and 2. In the t-tests, the comparisons were statistically significant at the 90% confidence level for Game 1 and at the 95% confidence level for all the other games.

was consistent across all lottery probabilities. The results were significant at the 95% confidence level for both the flat payment scheme and the increasing payment scheme.

> Hypothesis 4: It is unclear whether participants will play more, less, or an equal number of rounds under the flat payment scheme as compared to under the increasing payment scheme.
>
> Result: Participants played more rounds under the flat payment scheme than under the increasing payment scheme.

As stated previously, it is theoretically ambiguous as to how the different payment schemes should impact individuals' decisions. The increasing payment scheme variables in the regressions under each commitment type (Tables 5 and 6) indicate that individuals play fewer rounds under the increasing payment scheme than under the flat payment scheme. This result is significant at the 99% confidence level for all specifications. The t-tests point to similar conclusions. These results suggest that loss aversion and endowment effects dominate and offset the appeal of higher trajectory winnings.

VI. Discussion

A. Major Takeaways

On average, individuals appear to be risk-averse when faced with the type of lottery structure present in this experiment. The results also indicate that risk preferences are sensitive—both to how payments are structured and to how often individuals are allowed to re-evaluate decisions (i.e., the level of required commitment). On average, individuals tend to be more risk-averse under an increasing payment structure with greater endowment and when forced to sequentially make decisions regarding risk. In fact, the only time in which the average number of rounds played suggests risk-seeking behavior is under Game 3, in which subjects make an upfront commitment and face a flat payment scheme.

These findings suggest that loss aversion is a heavy influence on an individual's decisions regarding risks. Even when the expected values indicate that participants should be playing more rounds under the increasing payment scheme, they choose to walk away earlier. While payments are on a higher trajectory under the increasing payment scheme, the amount of money in one's bank is also higher in each round under the increasing payment scheme than under the flat payments scheme. With more to lose, loss aversion and the endowment effect may influence an individuals' decisions and have them walk away earlier. Under the No Commitment method, individuals are given information about their bank in each round. Therefore, participants are shown what they might lose and may feel a level of dread about losing this money that they would not feel under the Upfront Commitment scenario where they are not informed of their results round-by-round.

Until now, the results have been discussed in terms of *mean* rounds chosen to play. Yet, it is important to know what portion individuals are exhibiting risk-averse or risk-seeking behavior. The results in this experiment can be analyzed by looking at the proportion of individuals who either choose to play "too many" or "too few" rounds. The terms "too many" and "too few" are used not in the normative sense, but instead refer to whether a participant plays more or less rounds, respectively, than the expected value maximizing strategy. For instance, a participant walking away after playing three or more rounds in Game 1 for the 60% probability would be considered to have played too many. If the participant in this scenario had walked away without playing at all or only playing one round, he or she would be considered to have played too few.

Table 7 presents a breakdown of the proportion of participants that play too few, too many, or the optimal number of rounds for each of the games and for each probability. Figures

11–14 show pie charts of the information contained in Table 7. These tables and figures tell a similar story as the results focusing on averages. In almost all cases, the majority of individuals play too few rounds. In no situation does the percentage of participants playing the optimal number of rounds reach more than 36%. However, what is most striking about these results is that a significant portion of individuals play too many rounds—indicating risk-seeking behavior and something that may not have been predicted when looking solely at the averages. Under the flat payment scheme, close to one-third of individuals play too many rounds when the chance to win is 60%, 70%, or 80%. These results are surprising, as we tend to believe that most individuals are risk-averse. In fact, the Holt-Laury task indicated that 77.5% of the individuals in this experiment were risk-averse, 13.5% were risk-neutral, and only 9.0% were risk seeking. Yet, a much larger percentage played too many rounds. This may indicate that individuals are making mistakes when it comes to their decisions, and that the type of risk structure presented in this experiment causes them to take on more risk than they may otherwise desire.

B. Application to Concussions in Athletics

The results from this experiment can be of value to those wishing to influence how individuals make decisions with respect to risk. In some settings, it may be desirable to discourage risk-averse behavior. On the other hand, risk-seeking behavior may be more of a concern. One such area in which this may be the case is in the context of athletics and the risk of traumatic brain injury. Society would likely be more concerned if individuals are exhibiting risk-seeking behavior in the context of traumatic brain injuries than if they are exhibiting risk-averse behavior.

At the youth and college levels, not much can be done regarding the type of payment scheme athletes face. These amateur athletes can be thought of as facing flat payment schemes.

For most at the youth level, the "payment" received is the enjoyment athletes receive from playing their sport and the friendships that accompany being part of a team. Currently, the NCAA forbids athletes from receiving compensation outside of scholarships, of which only a small fraction of athletes receive.[41] To analogize to the experiment, this would be as if participants had very little in their bank for the first few rounds, with larger payments being made in later rounds. Under this context, loss aversion would not have a significant effect, as there is not much at stake to lose. Athletes who may otherwise choose to walk away due to concerns of sustaining a traumatic brain injury may instead decide to continue playing in hopes of obtaining a big payday later as a professional.

The frequency at which youth and college athletes receive information about risk and the extent of commitment required from these athletes are perhaps easier aspects to influence for policymakers. For instance, framing the risk of injury over a more narrow timeframe (like the No Commitment method) will lead to more risk-averse behavior than if framed over a longer period of time (like the Upfront Commitment method). This can be done by framing the risks of injury as the chance of something occurring in one particular season rather than as something that may happen over the entirety of a career.

At the youth level, state youth concussion laws can be used as a tool to deliver this type of information to athletes and parents. Every state and the District of Columbia currently have some sort of legislation dedicated to the youth concussion issue that cover middle school and high school athletes. Therefore, the state-level regulators should insure that information is given to athletes and parents on a frequent basis. For example, states could require that athletes pass some sort of concussion education that explains the associated risks as a prerequisite to

[41] Only six sports (football, men's and women's basketball, women's gymnastics, volleyball, and women's tennis) offer full-ride scholarships. A handful of other sports offer partial scholarships (O'Shaughnessy 2012).

participation. State regulators could also require that athletes and their parents be provided with updated risk information before the beginning of every sports season.[42] At the youth level, it may be more important that parents, rather than the athletes themselves, receive this information. This is because parents have substantial control over whether or not their child participates in a sport. In some cases, parents or guardians must sign permissions slips allowing their children to participate. Participation in athletics at the youth level may also include things such as registrations, purchasing equipment, transportation to practices and games—all of which can be heavily dependent on the actions of parents or guardians. For those youth outside the scope of these state laws (i.e., children below middle school age), the sports organizations in which these children participate—like Pop Warner Football—should provide risk information on a frequent basis. At the college level, the NCAA, athletic conferences, or individual schools could all require that information be provided to college athletes in the same manner as described above for youth athletes.[43]

Future concussion research may create other opportunities for providing a more frequent and salient type of information for athletes. Research is currently underway that could make it possible to diagnosis CTE in living individuals (Barrio et al. 2015; Clark 2017). Previously, it was only possible to diagnose CTE post-mortem through an autopsy. The ability to diagnose CTE while an individual is alive would provide the opportunity for policymakers to provide recurring feedback to athletes as to the existence of CTE. Athletes and their parents would also then be able to re-assess their decision as to whether to continue playing after each test.

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[42] There are still nine jurisdictions that do not require that an information sheet regarding traumatic brain injuries be distributed to student-athletes or their guardians at least annually (Harvey 2017).

[43] Although the NCAA has mandated its member institutions to educate their athletes with regards to the signs and symptoms of concussions since April 2010, this educational requirement does not extend to the risks or long-term consequences of concussions (2014-15 NCAA Sports Medicine Handbook).

Researchers have also made progress in identifying potential biomarkers for CTE (Cherry et al. 2017). This ability could allow individuals to test their susceptibility to the disease and would be another way in which institutions could provide more pertinent risk feedback. This work, however, is still in its infancy and it is yet to be determined if, or when, a reliable method for determining individual susceptibility to CTE will become a reality. One type of biomarker testing has already been put in place at the college level. In 2010, the NCAA implemented a mandatory screening program for sickle cell anemia, requiring that all Division I student-athletes be tested for the sickle cell trait. This policy was developed in response to a legal settlement with the family of a Rice University football player who died after overexertion during a football practice (Tarini, Brooks, and Bundy 2012). The testing is meant to identify those with the sickle cell trait, which may make them more susceptible to complications due to overexertion, so that those players may be properly supervised. One can imagine a similar system being put in place for CTE. This would allow for more frequent and individualized feedback regarding the risks of the disease, which may lead to more risk-averse behavior.

A greater percentage of individuals play too many rounds under the Upfront Commitment method as compared to under the No Commitment method. Such risk-seeking behavior can be dissuaded by avoiding situations in which athletes must commit to play for a certain length of time. College athletes on scholarship may feel an obligation to play all four years regardless of their injury history and risk of future injury. This feeling of obligation and commitment is exacerbated by the fact that, in many cases, schools are not legally required to cover an athlete's medical cost if no longer on scholarship. If a college athlete suffers an injury and is not healthy enough to play, they could lose their scholarship at the end of the academic year and end up having to pay out-of-pocket for medical treatment. Certain major conferences have already addressed this issue by requiring member institutions to pay for medical expenses incurred from athletic injuries for a certain period after a student leaves or graduates.[44] Similarly, the state of California passed a bill[45] in 2012 requiring certain universities to pay for the cost of ongoing medical treatment for at least two years after a student has graduated or left the university (Dodd 2012). Policies like these need to be the norm rather than the exception. Athletes should never have to choose between the benefits of their athletic scholarship and their health. Therefore, the NCAA should require schools to guarantee their athletic scholarships for four years and pay for medical expenses related to athletic injuries during those four years and possibly beyond.

Unlike in the case of amateur athletics, much can be done in terms of how payments are structured for professional athletes. The results of the experiment suggest that long-term contracts would lead to more risk-seeking behavior than year-to-year or other short-term contracts. One possible solution is to simply place a cap on the length of player contracts. While requiring these types of contracts could reduce risk-seeking behavior, forbidding long-term contracts might be quite an unpopular decision for both players and teams, who value continuity and certainty. Another possibility is restructuring the nature of player compensation.

The professional sports league with the biggest potential for improvement is the NFL. Contracts in the NFL are notoriously bad compared to other sports' leagues in terms of providing guaranteed benefits.[46] According to the NFLPA, guaranteed compensation comprised less than 60% of all payments to players in the 2016 season (Martel and Stapleton 2017). If NFL

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[44] In 2014, the Big Ten Conference announced it would guarantee all athletic scholarships and provide improved, consistent medical insurance for its student-athletes (Big Ten Conference 2014). The Pac-12 Conference quickly followed suit, announcing that medical expenses for student-athletes injured during their college athletic careers would be covered for up to four years after leaving the institution (Pac-12 Conference 2014).

[45] SB-1525 Postsecondary education: Student Athlete Bill of Rights (Cal. 2012).

[46] The structure of contracts in the MLB, NBA, and NHL are such that they are either fully guaranteed or may be bought out for a certain percentage (Therber 2016).

contracts were structured such that a larger share of the player's salary came in the form of a signing bonus (or other guaranteed money), players would have less of an incentive to risk their health. When a team releases a player before the expiration of his contract, the player only receives his remaining guaranteed money. Due to this structure, players may feel pressure to hide their concussions out of fear of being cut and losing a large portion of their compensation. Larger signing bonuses also create a sort of endowment effect, which leads to more risk aversion.

These issues would have to be addressed through negotiations between the NFL and NFLPA and would certainly be extremely contentious. The next opportunity for such negotiations will be in 2020 when the next collective bargaining agreement is set to occur. When the time comes, the NFLPA should fight for guaranteed contracts and demand more compensation to occur at the front end of multi-year contracts. Of course, these arguments all assume a goal of having the players exhibit less risk-seeking behavior when it comes to their health.

VII. Conclusion

This chapter presented an experiment with a unique structure. It is the only experiment to my knowledge that involves a multi-stage game in which participants are placed in a "win or lose it all" scenario. This type of scenario mirrors that faced by athletes, who must decide whether to prolong their careers or walk away from their sport. Continuing one's athletic career appeals to one's desire for further financial and social rewards. However, it is also comes with the risk of sustaining a lifelong injury or disease, such as CTE.

In order to make the experiment more straightforward and feasible, losing draws were treated as immediate bad effects. However, this simplifying assumption may not match situations that occur in the real world. In reality, it often takes several decades for the symptoms of diseases like CTE to manifest. This presents one of the limits of this experiment. However, immediate feedback regarding this disease may soon be possible. Research is underway to develop reliable techniques for in vivo diagnosis of CTE (Barrio et al. 2015; Clark 2017). The ability to diagnose CTE in living individuals would provide the opportunity for immediate feedback and would be more representative of the experiment in this chapter.

The findings of this experiment demonstrate that even though, on average, individuals exhibit a strong aversion to risk, a significant portion still demonstrate risk-seeking behavior. This should concern those who find risk-seeking behavior to be undesirable in particular settings, such as when an athlete's life-long health is at stake. Fortunately, the results from this experiment provide useful incites as to how policymakers can promote less risk-seeking behavior.

Individuals tend to exhibit a considerable degree of risk aversion when asked to re-assess their risk choices after being given the opportunity to frequently reflect upon how much they have earned and are putting at risk. This suggests that legislators and others with regulatory power over athletics should encourage risk information be provided more frequently if they wish to encourage risk-averse behavior. On the other hand, risk-averse behavior is less pronounced when participants are asked to make an upfront commitment with regard to risk. This holds true regardless of the type of payment structure. This result suggests individuals will exhibit greater risk aversion over time if faced with a series of short-term contracts than if faced with one, long-term contract. Participants were more risk-averse under the increasing payment structure, which contained a greater endowment. At the professional level, in which athletes are compensated, payment structures could be manipulated to encourage more risk aversion. Players or their unions could bargain to demand a greater percentage of their compensation occur upfront, with less payment happening on the back-end.

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Tables

Table 1: Payment Schemes

Flat Payment Scheme		
Round	Award for Win	Bank
1	$1.00	$0.25
2	$1.00	$1.25
3	$1.00	$2.25
4	$1.00	$3.25
5	$1.00	$4.25
6	$1.00	$5.25
7	$1.00	$6.25
8	$1.00	$7.25
9	$1.00	$8.25
10	$1.00	$9.25

Increasing Payment Scheme		
Round	Award for Win	Bank
1	$1.00	$0.75
2	$1.25	$1.75
3	$1.50	$3.00
4	$1.75	$4.50
5	$2.00	$6.25
6	$2.25	$8.25
7	$2.50	$10.50
8	$2.75	$13.00
9	$3.00	$15.75
10	$3.25	$18.75

Table 2: Game Structures

Game	Payment Scheme	Nature of Decision
1	Flat	No Commitment
2	Increasing	No Commitment
3	Flat	Upfront Commitment
4	Increasing	Upfront Commitment

Table 3: "Optimal" Number of Rounds for Risk-Neutral Individual to Play

		Payment Scheme	
		Flat	Increasing
Chance of Win	60%	2	2
	70%	3	3
	80%	4	6
	90%	9	10

Table 4: Average Number of Rounds Played

Chance of Win	Game	Payment Scheme	Commitment Level	(1) Rounds Played (Survived)	(1) Obs.	(2) Rounds Played (Died)	(2) Obs.	(3) Rounds Played (All)	(3) Obs.
60%	1	Flat	None	1.735	155	1.380	400	1.479	555
60%	2	Increasing	None	1.439	205	1.329	350	1.369	555
60%	3	Flat	Upfront	-	-	-	-	2.297	111
60%	4	Increasing	Upfront	-	-	-	-	2.054	111
70%	1	Flat	None	2.527	186	1.959	369	2.150	555
70%	2	Increasing	None	2.308	224	1.725	331	1.960	555
70%	3	Flat	Upfront	-	-	-	-	3.306	111
70%	4	Increasing	Upfront	-	-	-	-	2.820	111
80%	1	Flat	None	3.673	217	2.379	338	2.885	555
80%	2	Increasing	None	3.117	222	2.066	333	2.486	555
80%	3	Flat	Upfront	-	-	-	-	4.378	111
80%	4	Increasing	Upfront	-	-	-	-	3.783	111
90%	1	Flat	None	5.222	297	3.388	258	4.369	555
90%	2	Increasing	None	4.530	317	2.937	238	3.847	555
90%	3	Flat	Upfront	-	-	-	-	5.892	111
90%	4	Increasing	Upfront	-	-	-	-	5.243	111

Note: For Games 1 and 2 under the "No Commitment" decision method, there are a total of 555 observations. This is because each of the 111 participants played each probability five times. There are only 111 total observations for Games 3 and 4 because each participant only played these games one time for each probability.

Table 5: Rounds Played for Games 1 and 2 (No Commitment)

	If Never Lost		Regardless of Loss	
	OLS	Poisson	OLS	Poisson
Probability = 70	0.829	0.426	0.631	0.367
	(0.105)***	(0.053)***	(0.062)***	(0.033)***
	[0.075]***	[0.039]***	[0.045]***	[0.025]***
Probability = 80	1.798	0.764	1.261	0.634
	(0.104)***	(0.050)***	(0.062)***	(0.031)***
	[0.114]***	[0.046]***	[0.067]***	[0.029]***
Probability = 90	3.267	1.124	2.684	1.059
	(0.097)***	(0.046)***	(0.062)***	(0.029)***
	[0.158]***	[0.048]***	[0.113]***	[0.032]***
Increasing Payment Scheme	− 0.472	− 0.142	− 0.305	− 0.119
	(0.069)***	(0.026)***	(0.044)***	(0.019)***
	[0.083]***	[0.025]***	[0.053]***	[0.021]***
Male	− 0.255	− 0.080	− 0.094	− 0.037
	(0.070)***	(0.027)***	(0.045)**	(0.020)*
	[0.199]	[0.062]	[0.105]	[0.041]
Smoker	0.512	0.151	0.171	0.066
	(0.119)***	(0.043)***	(0.073)**	(0.031)**
	[0.366]	[0.101]	[0.161]	[0.061]
Constant	1.908	0.549	1.602	0.421
	(0.093)***	(0.046)***	(0.053)***	(0.028)***
	[0.123]***	[0.052]***	[0.066]***	[0.031]***
Observations	1,823	1,823	4,440	4,400

Note: The dependent variable is the number of rounds chosen to play. Standard errors are in parentheses. Clustered standard errors are in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Rounds Played for Games 3 and 4 (Upfront Commitment)

	OLS	Poisson
Probability = 70	0.887	0.342
	(0.144)***	(0.060)***
	[0.058]***	[0.025]***
Probability = 80	1.905	0.629
	(0.144)***	(0.056)***
	[0.094]***	[0.033]***
Probability = 90	3.392	0.940
	(0.144)***	(0.054)***
	[0.146]***	[0.041]***
Increasing Payment Scheme	− 0.493	− 0.133
	(0.102)***	(0.035)***
	[0.093]***	[0.024]***
Male	− 0.385	− 0.105
	(0.106)***	(0.037)***
	[0.240]	[0.066]
Smoker	0.906	0.231
	(0.170)***	(0.054)***
	[0.475]*	[0.112]**
Constant	2.502	0.862
	(0.123)***	(0.051)***
	[0.161]***	[0.055]***
Observations	888	888

Note: The dependent variable is the number of rounds chosen to play. Standard errors are in parentheses. Clustered standard errors are in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Rounds Played - Too Few, Optimal, or Too Many

Game 1: No Commitment and Flat Payment Scheme				
Length	60	70	80	90
Too Few	37.50% 69 / 184	44.44% 100 / 225	44.94% 111 / 247	91.64% 274 / 299
Optimal	32.61% 60 / 184	23.56% 53 / 225	19.03% 47 / 247	5.02% 15 / 299
Too Many	29.89% 55 / 184	32.00% 72 / 225	36.03% 89 / 247	3.34% 10 / 299

Game 2: No Commitment and Increasing Payment Scheme				
Length	60	70	80	90
Too Few	53.60% 119 / 222	58.26% 141 / 242	95.98% 215 / 224	97.16% 308 / 317
Optimal	29.28% 65 / 222	26.45% 64 / 242	1.79% 4 / 224	2.84% 9 / 317
Too Many	17.12% 38 / 222	15.29% 37 / 242	2.23% 5 / 224	N/A N/A

Game 3: Upfront Commitment and Flat Payment Scheme				
Length	60	70	80	90
Too Few	27.03% 30 / 111	32.43% 36 / 111	35.14% 39 / 111	88.29% 98 / 111
Optimal	36.04% 40 / 111	33.33% 37 / 111	27.93% 31 / 111	3.60% 4 / 111
Too Many	36.94% 41 / 111	34.23% 38 / 111	36.94% 41 / 111	8.11% 9 / 111

Game 4: Upfront Commitment and Increasing Payment Scheme				
Length	60	70	80	90
Too Few	37.84% 42 / 111	46.85% 52 / 111	89.19% 99 / 111	97.30% 108 / 111
Optimal	28.83% 32 / 111	24.32% 27 / 111	5.41% 6 / 111	2.70% 3 / 111
Too Many	33.33% 37 / 111	28.83% 32 / 111	5.41% 6 / 111	N/A N/A

Figures

Figure 1: Example Screenshot of Experiment

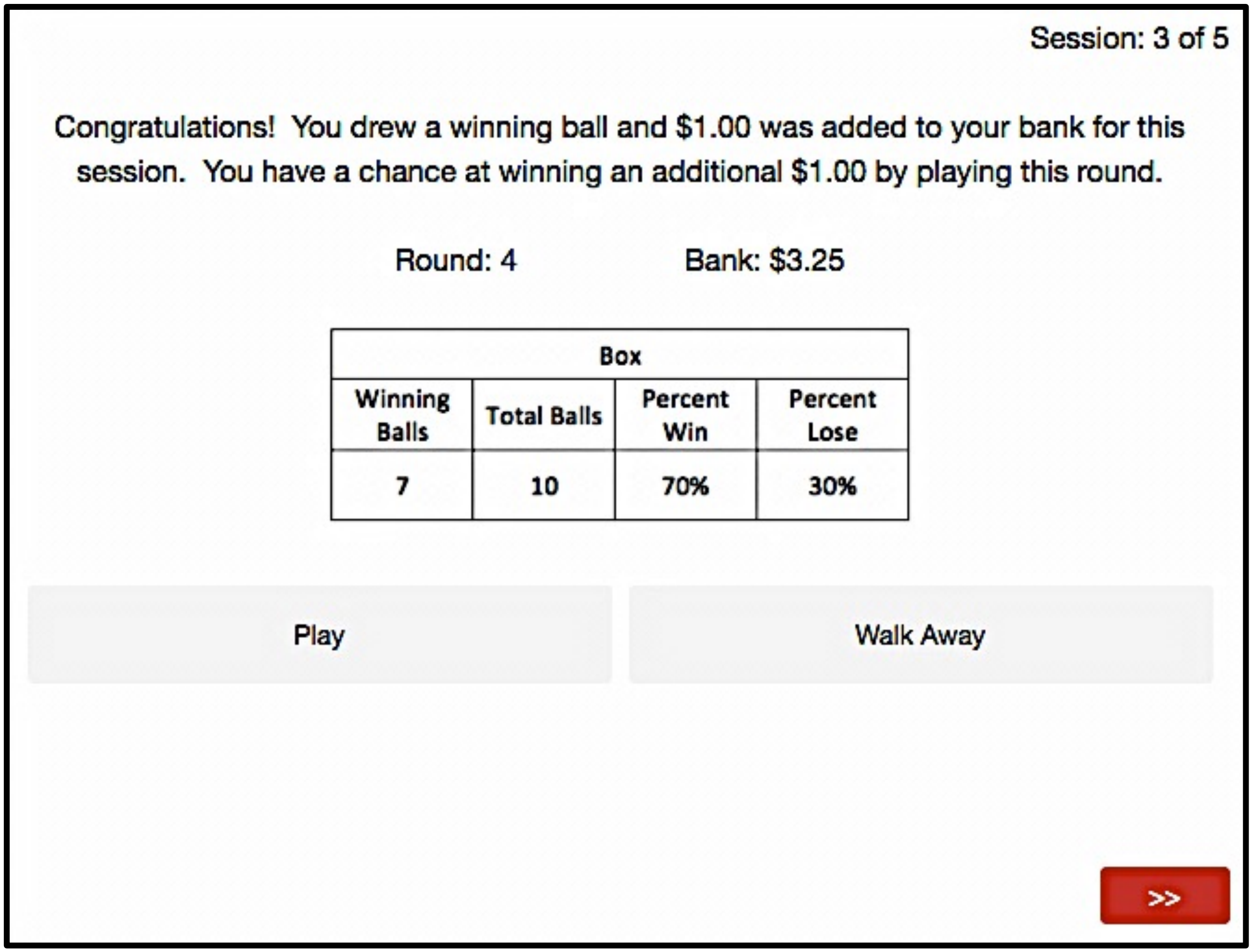


Figure 2: Kahneman and Tversky (1984) Game

Problem 5 ($N = 85$): Consider the following two-stage game. In the first stage, there is a 75% chance to end the game without winning anything and a 25% chance to move into the second stage. If you reach the second stage you have a choice between:

A. a sure win of $30	(74%)
B. 80% chance to win $45	(26%)

Your choice must be made before the game starts, i.e., before the outcome of the first stage is known. Please indicate the option you prefer.

Problem 6 ($N = 81$): Which of the following options do you prefer?

C. 25% chance to win $30	(42%)
D. 20% chance to win $45	(58%)

Figure 3: Game 1 vs. Game 2

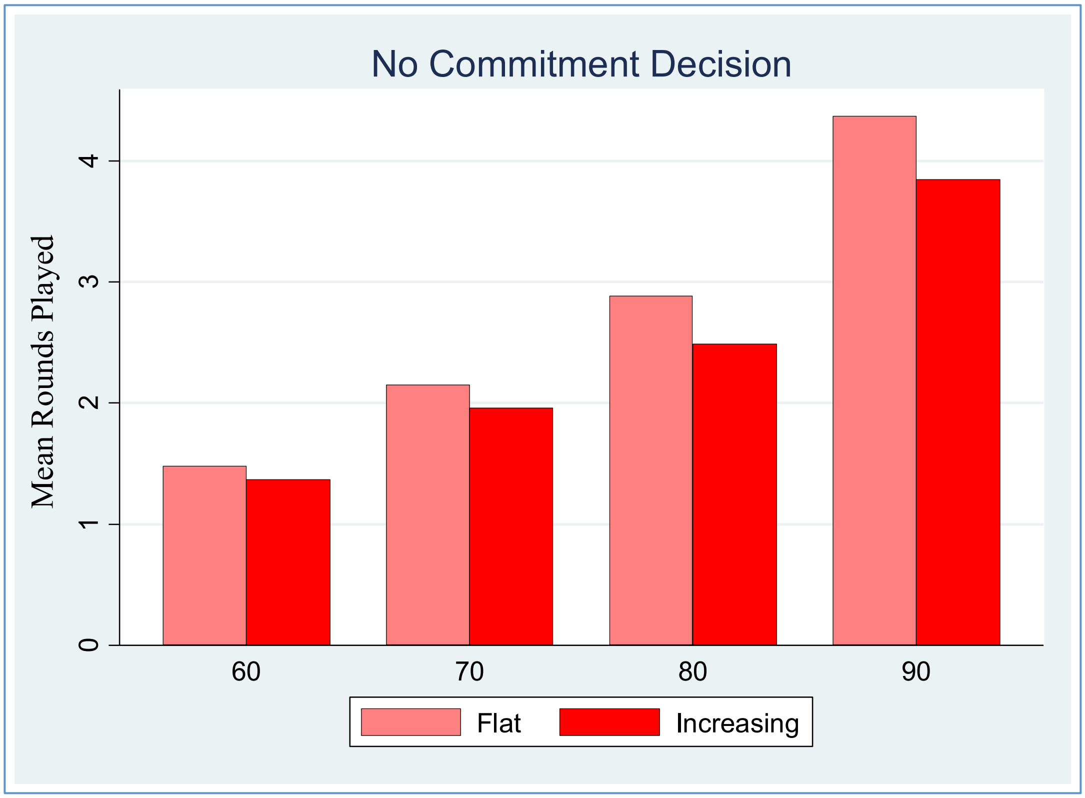


Figure 4: Game 3 vs. Game 4

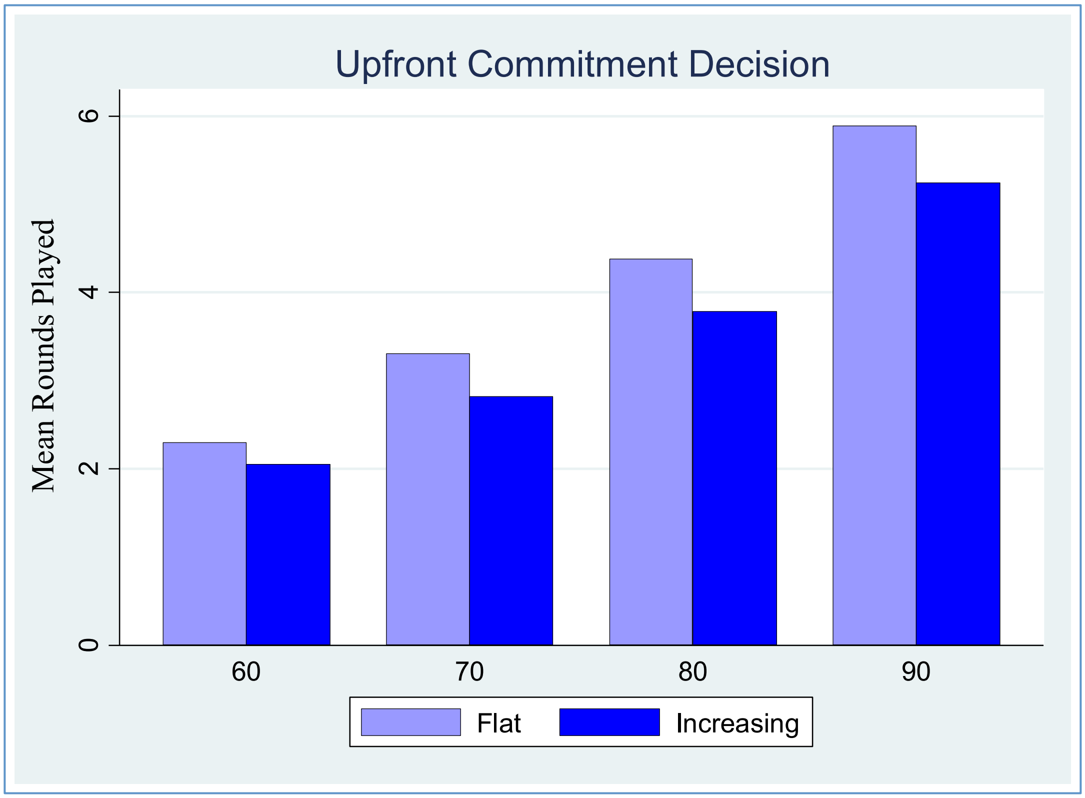


Figure 5: Game 1 vs. Game 3

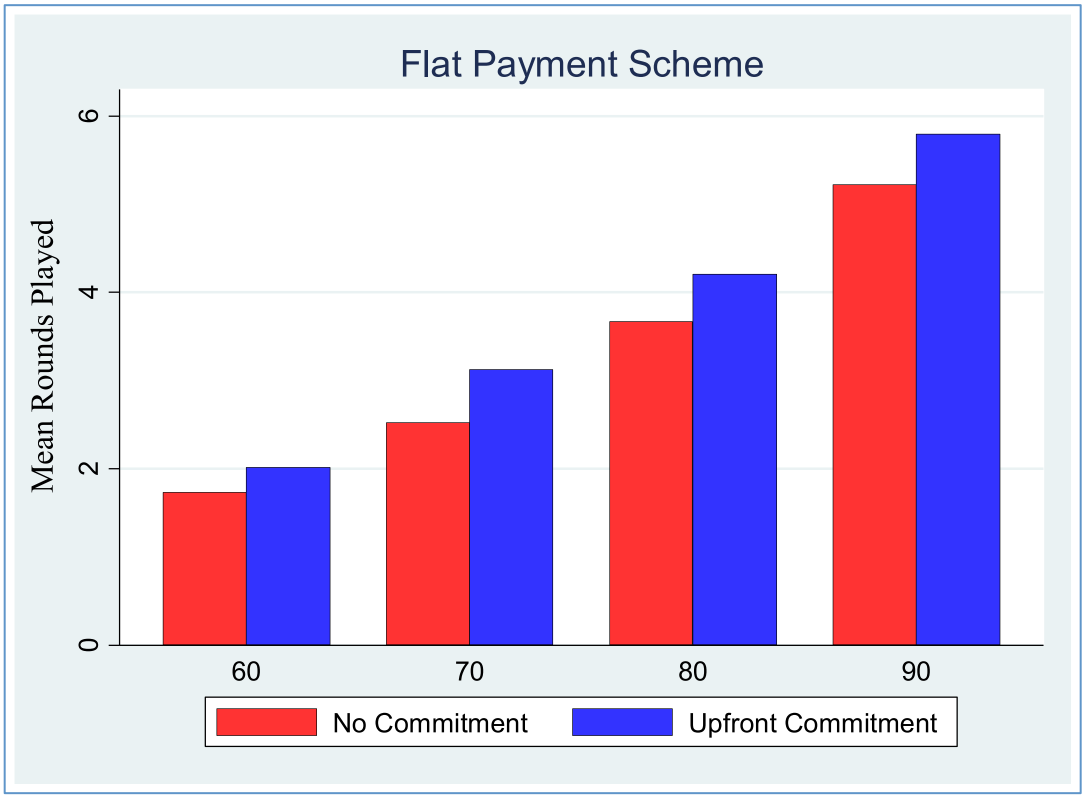


Figure 6: Game 2 vs. Game 4

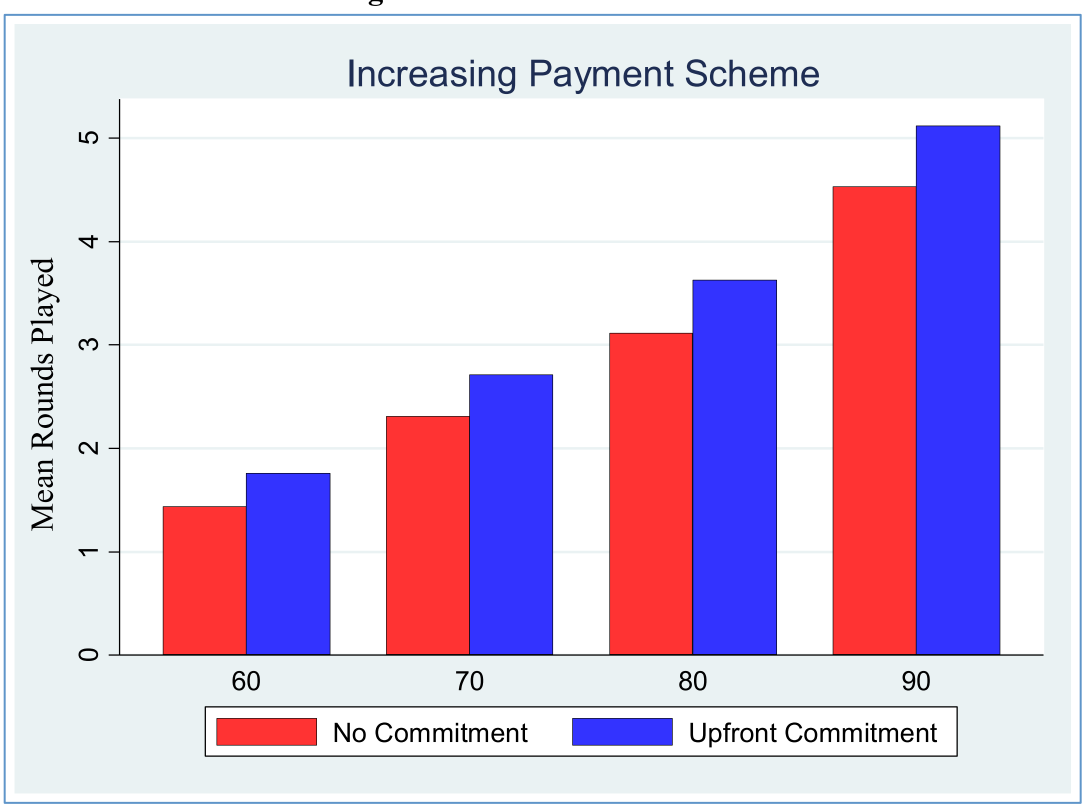


Figure 7

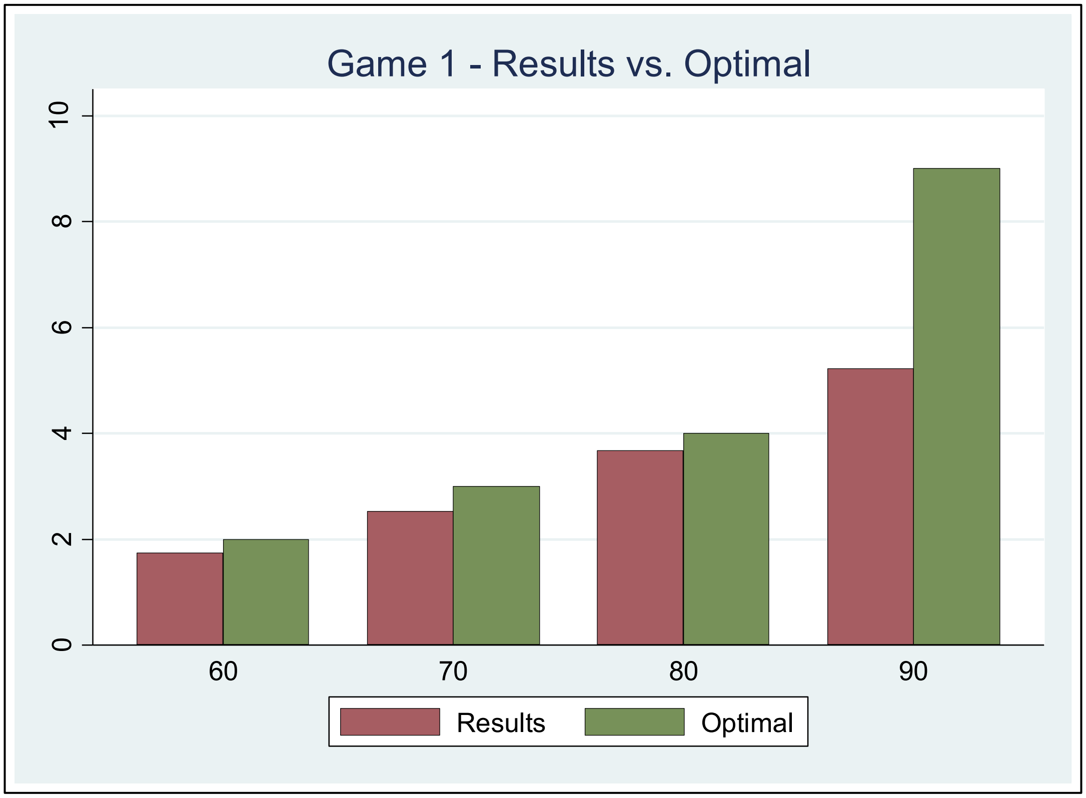


Figure 8

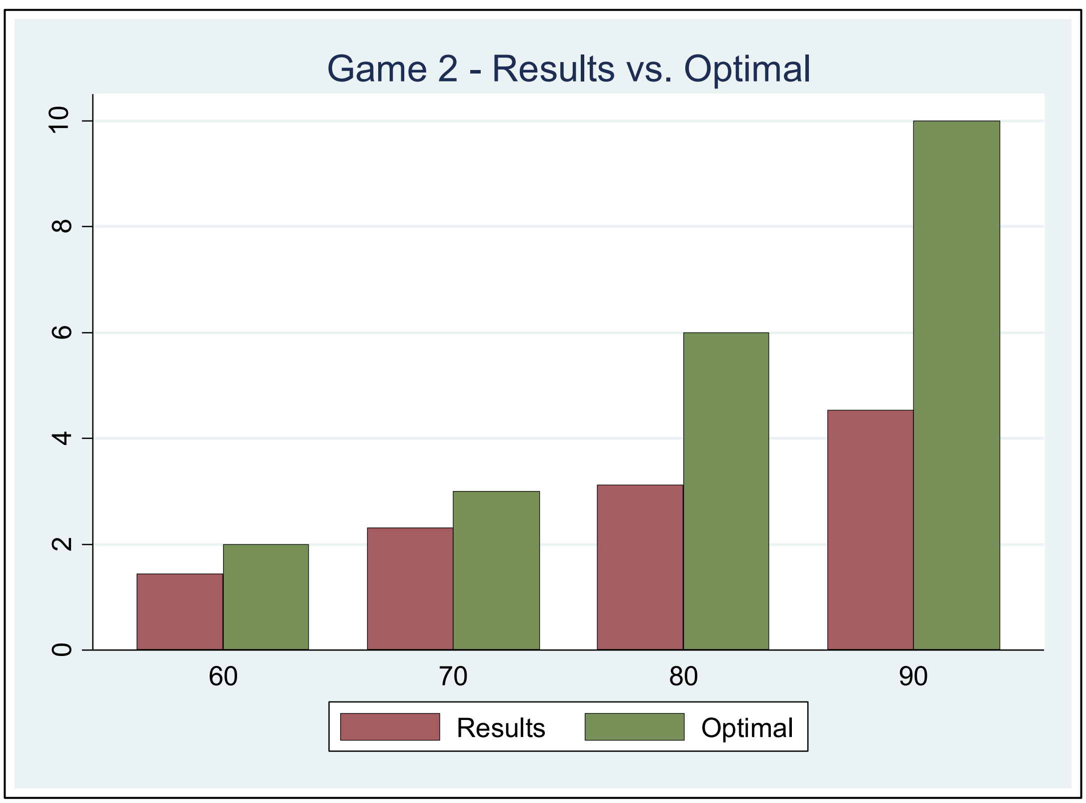


Figure 9

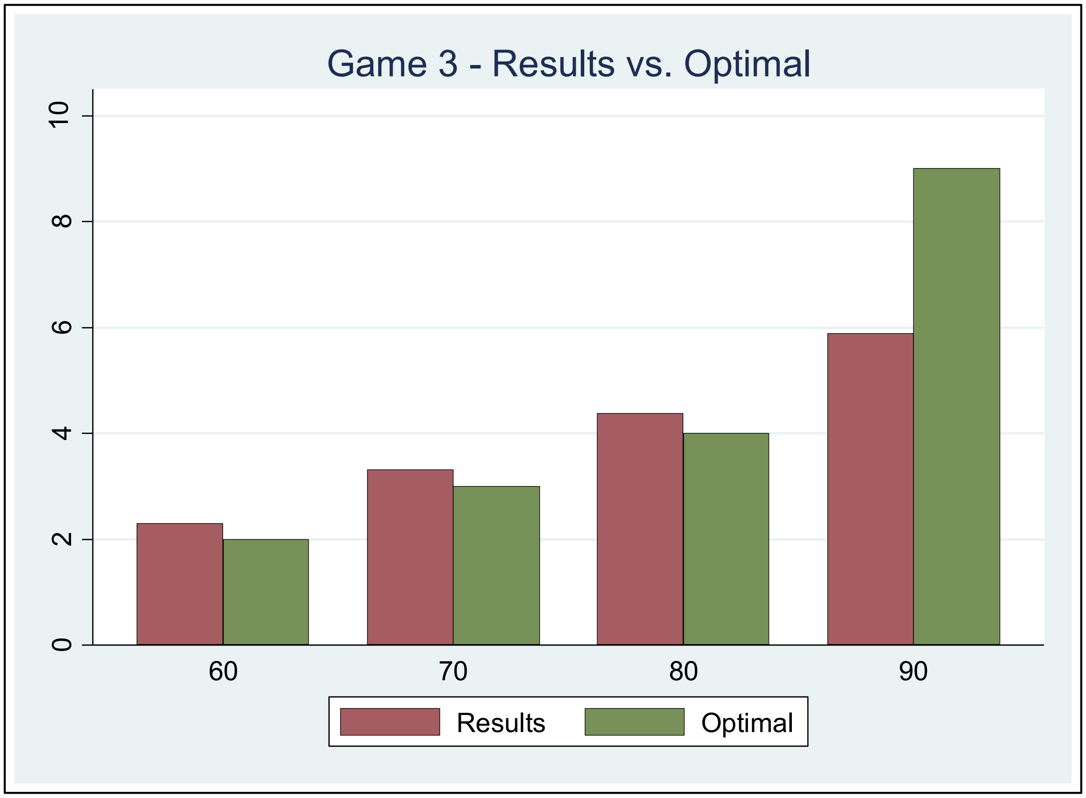


Figure 10

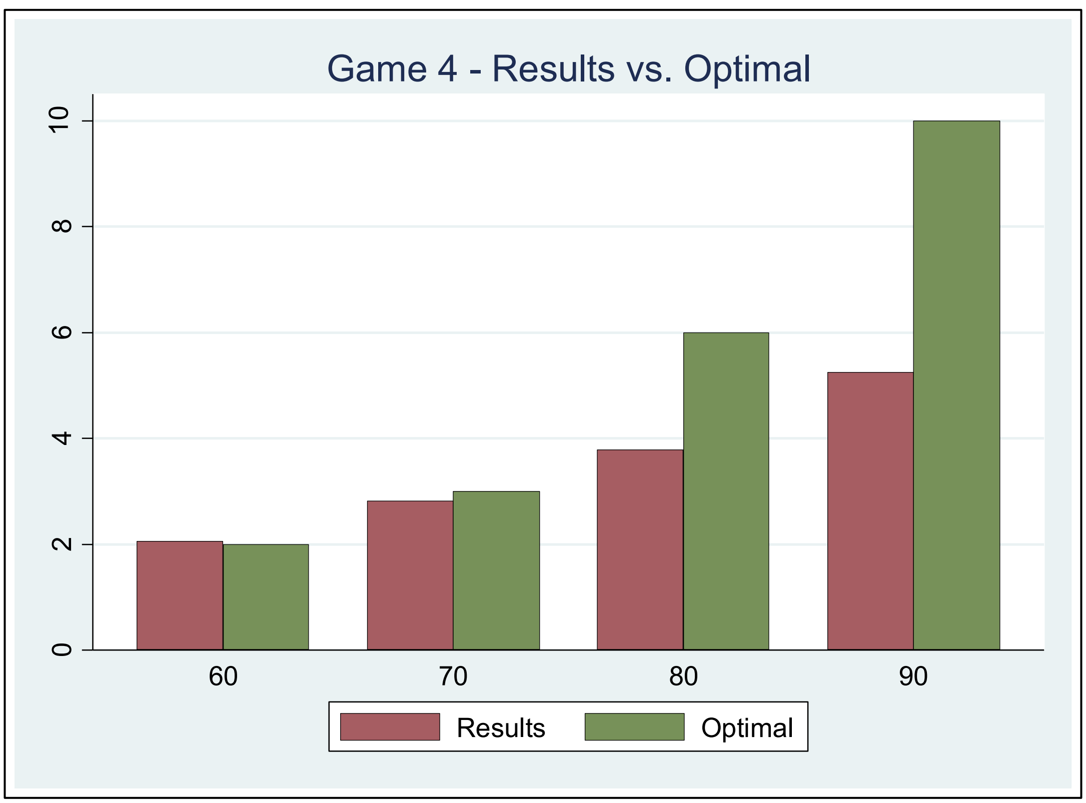


Figure 11

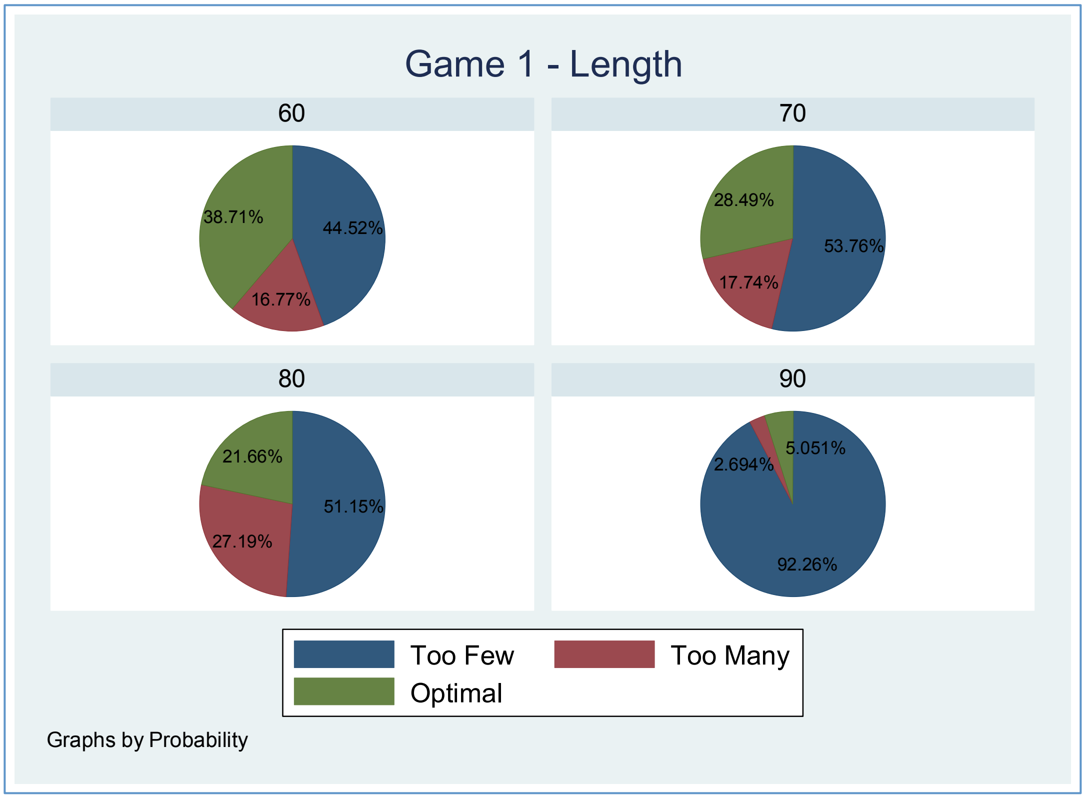


Figure 12

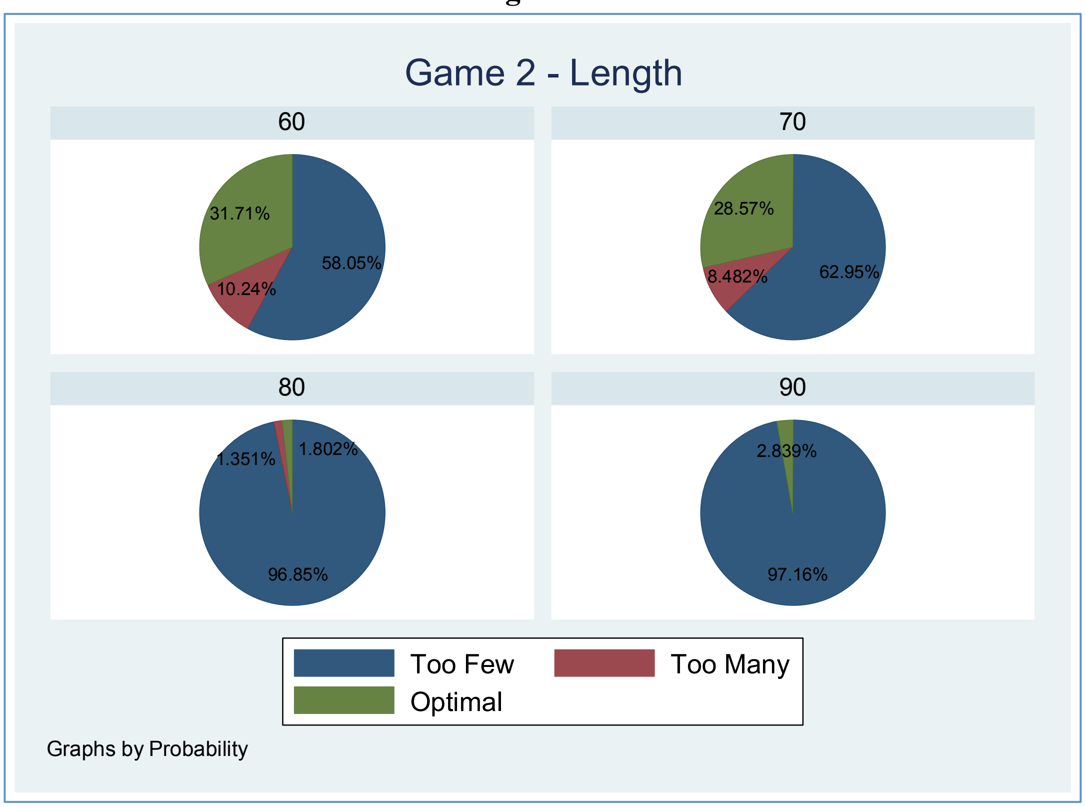


Figure 13

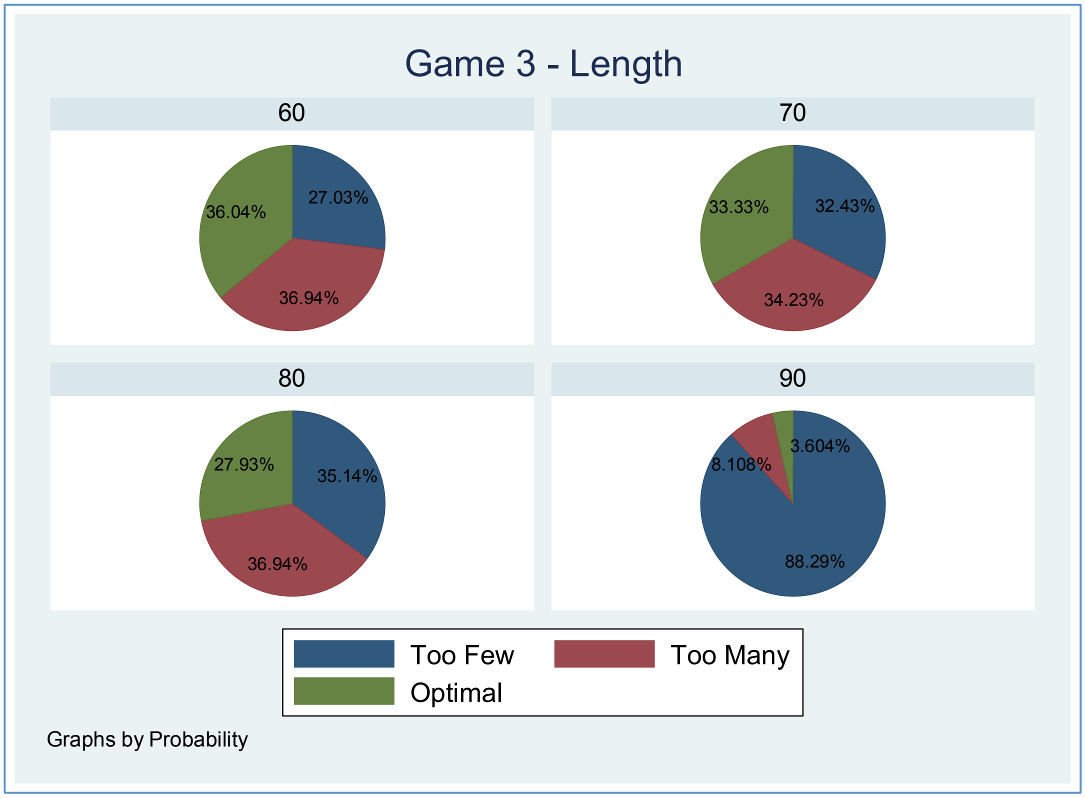
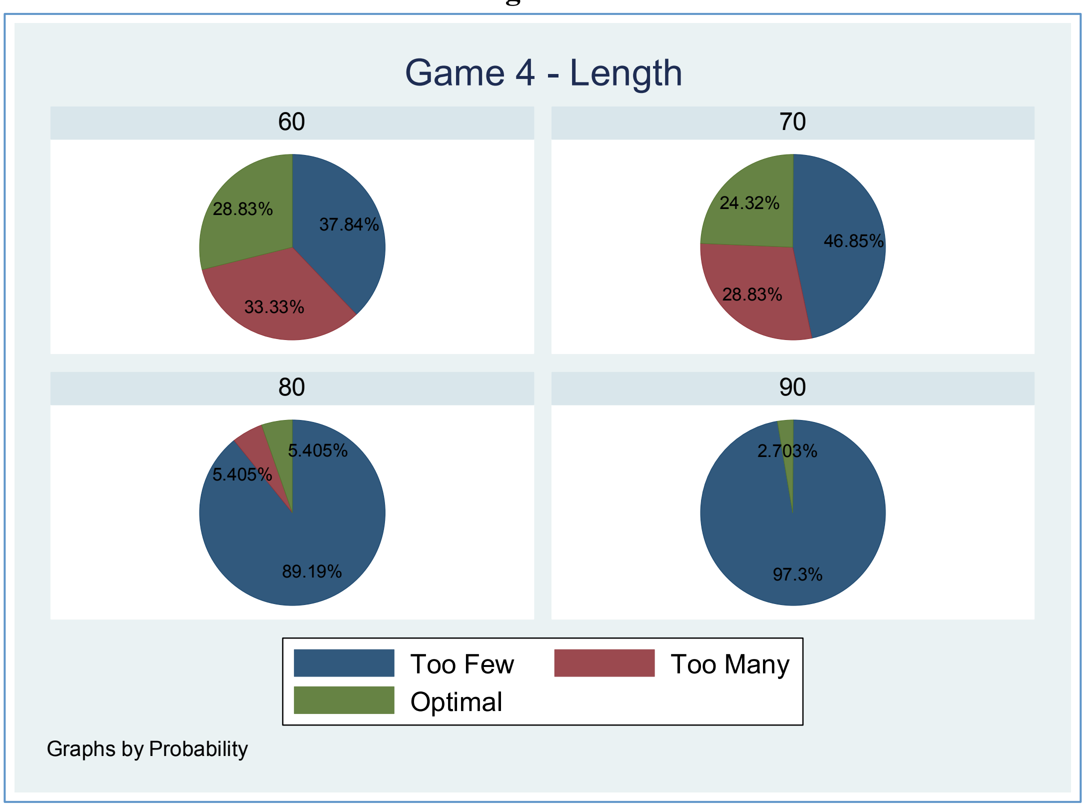


Figure 14



Appendix

Table A–1: "Optimal" Decisions

	Flat Payment Scheme						Increasing Payment Scheme					
	Round	Walk Away Money	Money In Next Round	Chance of Win	Expected Value of Play	Play or Walk Away?	Round	Walk Away Money	Money In Next Round	Chance of Win	Expected Value of Play	Play or Walk Away?
Chance of Win = 60%	1	0.25	1.25	60%	0.75	Play	1	0.75	1.75	60%	1.05	Play
	2	1.25	2.25	60%	1.35	Play	2	1.75	3	60%	1.8	Play
	3	2.25	3.25	60%	1.95	Walk Away	3	3	4.5	60%	2.7	Walk Away
	4	3.25	4.25	60%	2.55	Walk Away	4	4.5	6.25	60%	3.75	Walk Away
	5	4.25	5.25	60%	3.15	Walk Away	5	6.25	8.25	60%	4.95	Walk Away
	6	5.25	6.25	60%	3.75	Walk Away	6	8.25	10.5	60%	6.3	Walk Away
	7	6.25	7.25	60%	4.35	Walk Away	7	10.5	13	60%	7.8	Walk Away
	8	7.25	8.25	60%	4.95	Walk Away	8	13	15.75	60%	9.45	Walk Away
	9	8.25	9.25	60%	5.55	Walk Away	9	15.75	18.75	60%	11.25	Walk Away
	10	9.25	10.25	60%	6.15	Walk Away	10	18.75	22	60%	13.2	Walk Away
	Number of rounds that maximize expected value = 2						Number of rounds that maximize expected value = 2					
Chance of Win = 70%	Round	Walk Away Money	Money In Next Round	Chance of Win	Expected Value of Play	Play or Walk Away?	Round	Walk Away Money	Money In Next Round	Chance of Win	Expected Value of Play	Play or Walk Away?
	1	0.25	1.25	70%	0.875	Play	1	0.75	1.75	70%	1.225	Play
	2	1.25	2.25	70%	1.575	Play	2	1.75	3	70%	2.1	Play
	3	2.25	3.25	70%	2.275	Play	3	3	4.5	70%	3.15	Play
	4	3.25	4.25	70%	2.975	Walk Away	4	4.5	6.25	70%	4.375	Walk Away
	5	4.25	5.25	70%	3.675	Walk Away	5	6.25	8.25	70%	5.775	Walk Away
	6	5.25	6.25	70%	4.375	Walk Away	6	8.25	10.5	70%	7.35	Walk Away
	7	6.25	7.25	70%	5.075	Walk Away	7	10.5	13	70%	9.1	Walk Away
	8	7.25	8.25	70%	5.775	Walk Away	8	13	15.75	70%	11.025	Walk Away
	9	8.25	9.25	70%	6.475	Walk Away	9	15.75	18.75	70%	13.125	Walk Away
	10	9.25	10.25	70%	7.175	Walk Away	10	18.75	22	70%	15.4	Walk Away
	Number of rounds that maximize expected value = 3						Number of rounds that maximize expected value = 3					

	Flat Payment Scheme						Increasing Payment Scheme					
Chance of Win = 80%	Round	Walk Away Money	Money In Next Round	Chance of Win	Expected Value of Play	Play or Walk Away?	Round	Walk Away Money	Money In Next Round	Chance of Win	Expected Value of Play	Play or Walk Away?
	1	0.25	1.25	80%	1	Play	1	0.75	1.75	80%	1.4	Play
	2	1.25	2.25	80%	1.8	Play	2	1.75	3	80%	2.4	Play
	3	2.25	3.25	80%	2.6	Play	3	3	4.5	80%	3.6	Play
	4	3.25	4.25	80%	3.4	Play	4	4.5	6.25	80%	5	Play
	5	4.25	5.25	80%	4.2	Walk Away	5	6.25	8.25	80%	6.6	Play
	6	5.25	6.25	80%	5	Walk Away	6	8.25	10.5	80%	8.4	Play
	7	6.25	7.25	80%	5.8	Walk Away	7	10.5	13	80%	10.4	Walk Away
	8	7.25	8.25	80%	6.6	Walk Away	8	13	15.75	80%	12.6	Walk Away
	9	8.25	9.25	80%	7.4	Walk Away	9	15.75	18.75	80%	15	Walk Away
	10	9.25	10.25	80%	8.2	Walk Away	10	18.75	22	80%	17.6	Walk Away
	Number of rounds that maximize expected value = 4						Number of rounds that maximize expected value = 6					
Chance of Win = 90%	Round	Walk Away Money	Money In Next Round	Chance of Win	Expected Value of Play	Play or Walk Away?	Round	Walk Away Money	Money In Next Round	Chance of Win	Expected Value of Play	Play or Walk Away?
	1	0.25	1.25	90%	1.125	Play	1	0.75	1.75	90%	1.575	Play
	2	1.25	2.25	90%	2.025	Play	2	1.75	3	90%	2.7	Play
	3	2.25	3.25	90%	2.925	Play	3	3	4.5	90%	4.05	Play
	4	3.25	4.25	90%	3.825	Play	4	4.5	6.25	90%	5.625	Play
	5	4.25	5.25	90%	4.725	Play	5	6.25	8.25	90%	7.425	Play
	6	5.25	6.25	90%	5.625	Play	6	8.25	10.5	90%	9.45	Play
	7	6.25	7.25	90%	6.525	Play	7	10.5	13	90%	11.7	Play
	8	7.25	8.25	90%	7.425	Play	8	13	15.75	90%	14.175	Play
	9	8.25	9.25	90%	8.325	Play	9	15.75	18.75	90%	16.875	Play
	10	9.25	10.25	90%	9.225	Walk Away	10	18.75	22	90%	19.8	Play
	Number of rounds that maximize expected value = 9						Number of rounds that maximize expected value = 10					

Table A–2: Expected Values for Each Round Played

Flat Payment Scheme									
Rounds Played	Bank	60		70		80		90	
		Chance of Being Alive	Expected Value	Chance of Being Alive	Expected Value	Chance of Being Alive	Expected Value	Chance of Being Alive	Expected Value
0	0.25	100.00%	0.250	100.00%	0.250	100.00%	0.250	100.00%	0.250
1	1.25	60.00%	0.750	70.00%	0.875	80.00%	1.000	90.00%	1.125
2	2.25	36.00%	0.810	49.00%	1.103	64.00%	1.440	81.00%	1.823
3	3.25	21.60%	0.702	34.30%	1.115	51.20%	1.664	72.90%	2.369
4	4.25	12.96%	0.551	24.01%	1.020	40.96%	1.741	65.61%	2.788
5	5.25	7.78%	0.408	16.81%	0.882	32.77%	1.720	59.05%	3.100
6	6.25	4.67%	0.292	11.76%	0.735	26.21%	1.638	53.14%	3.322
7	7.25	2.80%	0.203	8.24%	0.597	20.97%	1.520	47.83%	3.468
8	8.25	1.68%	0.139	5.76%	0.476	16.78%	1.384	43.05%	3.551
9	9.25	1.01%	0.093	4.04%	0.373	13.42%	1.242	38.74%	3.584
10	10.25	0.60%	0.062	2.82%	0.290	10.74%	1.101	34.87%	3.574

Increasing Payment Scheme									
Rounds Played	Bank	60		70		80		90	
		Chance of Being Alive	Expected Value	Chance of Being Alive	Expected Value	Chance of Being Alive	Expected Value	Chance of Being Alive	Expected Value
0	0.75	100.00%	0.750	100.00%	0.750	100.00%	0.750	100.00%	0.750
1	1.75	60.00%	1.050	70.00%	1.225	80.00%	1.400	90.00%	1.575
2	3	36.00%	1.080	49.00%	1.470	64.00%	1.920	81.00%	2.430
3	4.5	21.60%	0.972	34.30%	1.544	51.20%	2.304	72.90%	3.281
4	6.25	12.96%	0.810	24.01%	1.501	40.96%	2.560	65.61%	4.101
5	8.25	7.78%	0.642	16.81%	1.387	32.77%	2.703	59.05%	4.872
6	10.5	4.67%	0.490	11.76%	1.235	26.21%	2.753	53.14%	5.580
7	13	2.80%	0.364	8.24%	1.071	20.97%	2.726	47.83%	6.218
8	15.75	1.68%	0.265	5.76%	0.908	16.78%	2.642	43.05%	6.780
9	18.75	1.01%	0.189	4.04%	0.757	13.42%	2.517	38.74%	7.264
10	22	0.60%	0.133	2.82%	0.621	10.74%	2.362	34.87%	7.671

Table A–3: Percentage of Individuals Choosing to Play

Game 1: Flat Payment Scheme																
Round	60%				70%				80%				90%			
1	98.74%	548	/	555	99.46%	552	/	555	99.64%	553	/	555	100.00%	555	/	555
2	76.43%	201	/	263	92.73%	357	/	385	97.48%	426	/	437	98.02%	495	/	505
3	47.83%	55	/	115	72.18%	179	/	248	91.99%	310	/	337	97.74%	432	/	442
4	39.39%	13	/	33	57.60%	72	/	125	70.17%	167	/	238	92.65%	353	/	381
5	28.57%	2	/	7	54.35%	25	/	46	65.44%	89	/	136	79.75%	252	/	316
6	100.00%	1	/	1	31.25%	5	/	16	42.03%	29	/	69	67.86%	152	/	224
7	100.00%	1	/	1	75.00%	3	/	4	52.17%	12	/	23	69.57%	96	/	138
8	0.00%	0	/	1	N/A	0	/	0	72.73%	8	/	11	62.96%	51	/	81
9	N/A	0	/	0	N/A	0	/	0	57.14%	4	/	7	61.70%	29	/	47
10	N/A	0	/	0	N/A	0	/	0	100.00%	3	/	3	40.00%	10	/	25
Game 2: Increasing Payment Scheme																
Round	60%				70%				80%				90%			
1	96.58%	536	/	555	99.82%	554	/	555	99.64%	553	/	555	99.64%	553	/	555
2	64.16%	179	/	279	89.01%	340	/	382	97.05%	395	/	407	96.73%	473	/	489
3	36.89%	38	/	103	59.00%	141	/	239	82.52%	255	/	309	96.96%	414	/	427
4	26.92%	7	/	26	36.63%	37	/	101	58.67%	115	/	196	81.16%	293	/	361
5	0.00%	0	/	2	50.00%	12	/	24	48.89%	44	/	90	74.52%	193	/	259
6	N/A	0	/	0	57.14%	4	/	7	37.50%	12	/	32	64.57%	113	/	175
7	N/A	0	/	0	0.00%	0	/	4	55.56%	5	/	9	53.33%	56	/	105
8	N/A	0	/	0	N/A	0	/	0	25.00%	1	/	4	42.22%	19	/	45
9	N/A	0	/	0	N/A	0	/	0	N/A	0	/	0	75.00%	12	/	16
10	N/A	0	/	0	N/A	0	/	0	N/A	0	/	0	81.82%	9	/	11

Table A–4: T-Tests for Differences in Mean Rounds Played

Relevant Hypothesis	Alternative Hypothesis in T-Test	Factor(s) Held Constant	p value	Difference Significant at 95% confidence level?	Supports Hypothesis?
1	60% < 70%	Game 1	0.0000	Yes	Yes
1	70% < 80%	Game 1	0.0000	Yes	Yes
1	80% < 90%	Game 1	0.0000	Yes	Yes
1	60% < 70%	Game 2	0.0000	Yes	Yes
1	70% < 80%	Game 2	0.0000	Yes	Yes
1	80% < 90%	Game 2	0.0000	Yes	Yes
1	60% < 70%	Game 3	0.0000	Yes	Yes
1	70% < 80%	Game 3	0.0000	Yes	Yes
1	80% < 90%	Game 3	0.0000	Yes	Yes
1	60% < 70%	Game 4	0.0000	Yes	Yes
1	70% < 80%	Game 4	0.0000	Yes	Yes
1	80% < 90%	Game 4	0.0000	Yes	Yes
2	H-L Risk-averse < H-L Risk-neutral/Seeking	Game 1	0.0797	No	Mostly
2	H-L Risk-averse < H-L Risk-neutral/Seeking	Game 2	0.0578	No	Mostly
2	H-L Risk-averse < H-L Risk-neutral/Seeking	Game 3	0.1384	No	No
2	H-L Risk-averse < H-L Risk-neutral/Seeking	Game 4	0.0213	Yes	Yes
2	Non-Smokers < Smokers	Game 1	0.0860	No	Mostly
2	Non-Smokers < Smokers	Game 2	0.0090	Yes	Yes
2	Non-Smokers < Smokers	Game 3	0.0007	Yes	Yes
2	Non-Smokers < Smokers	Game 4	0.0501	Yes	Yes
2	Females < Males	Game 1	0.9970	No	No
2	Females < Males	Game 2	0.8328	No	No
2	Females < Males	Game 3	0.8239	No	No
2	Females < Males	Game 4	0.9474	No	No
3	Game 1 < Game 3	60%	0.0069	Yes	Yes
3	Game 1 < Game 3	70%	0.0001	Yes	Yes
3	Game 1 < Game 3	80%	0.0015	Yes	Yes
3	Game 1 < Game 3	90%	0.0009	Yes	Yes
3	Game 2 < Game 4	60%	0.0037	Yes	Yes
3	Game 2 < Game 4	70%	0.0009	Yes	Yes
3	Game 2 < Game 4	80%	0.0034	Yes	Yes
3	Game 2 < Game 4	90%	0.0012	Yes	Yes
4	Game 1 < Game 2	60%	0.9994	No	N/A
4	Game 1 < Game 2	70%	0.9882	No	N/A
4	Game 1 < Game 2	80%	0.9999	No	N/A
4	Game 1 < Game 2	90%	1.0000	No	N/A
4	Game 1 ≠ Game 2	60%	0.0013	Yes	N/A
4	Game 1 ≠ Game 2	70%	0.0237	Yes	N/A
4	Game 1 ≠ Game 2	80%	0.0002	Yes	N/A
4	Game 1 ≠ Game 2	90%	0.0000	Yes	N/A

4	Game 1 > Game 2	60%	0.0006	Yes	N/A
4	Game 1 > Game 2	70%	0.0118	Yes	N/A
4	Game 1 > Game 2	80%	0.0001	Yes	N/A
4	Game 1 > Game 2	90%	0.0000	Yes	N/A
4	Game 3 < Game 4	60%	0.9967	No	N/A
4	Game 3 < Game 4	70%	1.0000	No	N/A
4	Game 3 < Game 4	80%	1.0000	No	N/A
4	Game 3 < Game 4	90%	1.0000	No	N/A
4	Game 3 ≠ Game 4	60%	0.0067	Yes	N/A
4	Game 3 ≠ Game 4	70%	0.0000	Yes	N/A
4	Game 3 ≠ Game 4	80%	0.0000	Yes	N/A
4	Game 3 ≠ Game 4	90%	0.0000	Yes	N/A
4	Game 3 > Game 4	60%	0.0033	Yes	N/A
4	Game 3 > Game 4	70%	0.0000	Yes	N/A
4	Game 3 > Game 4	80%	0.0000	Yes	N/A
4	Game 3 > Game 4	90%	0.0000	Yes	N/A

Figure A–1

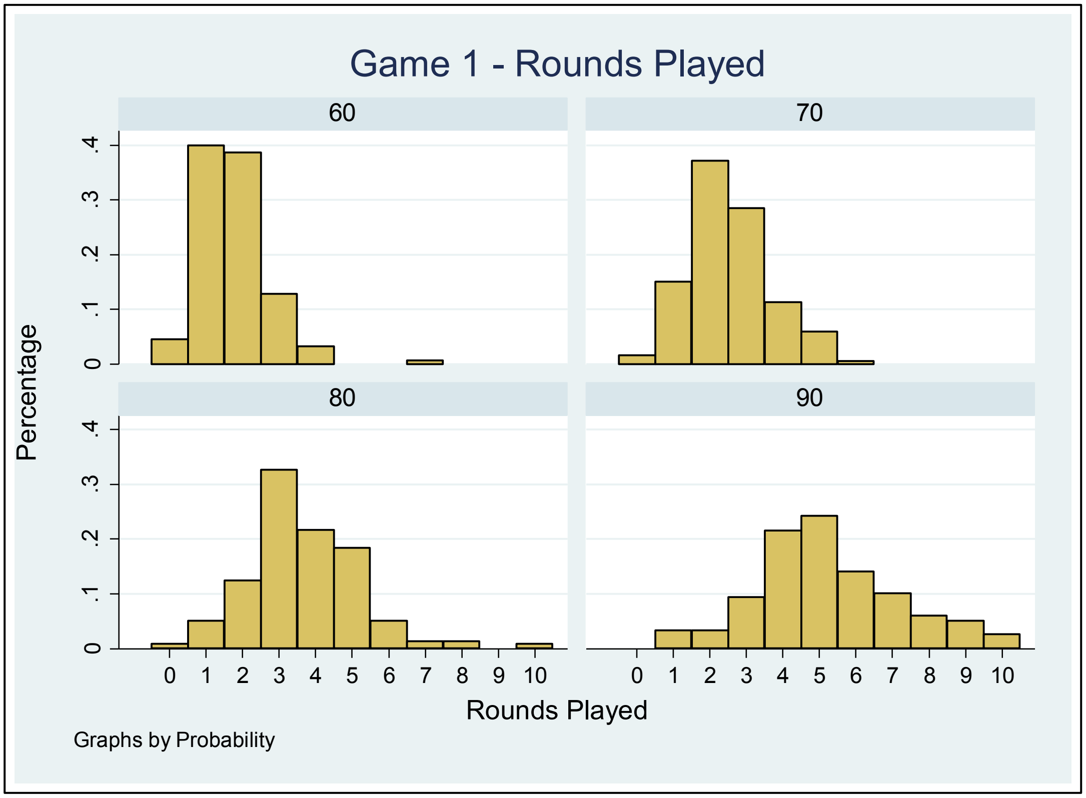


Figure A–2

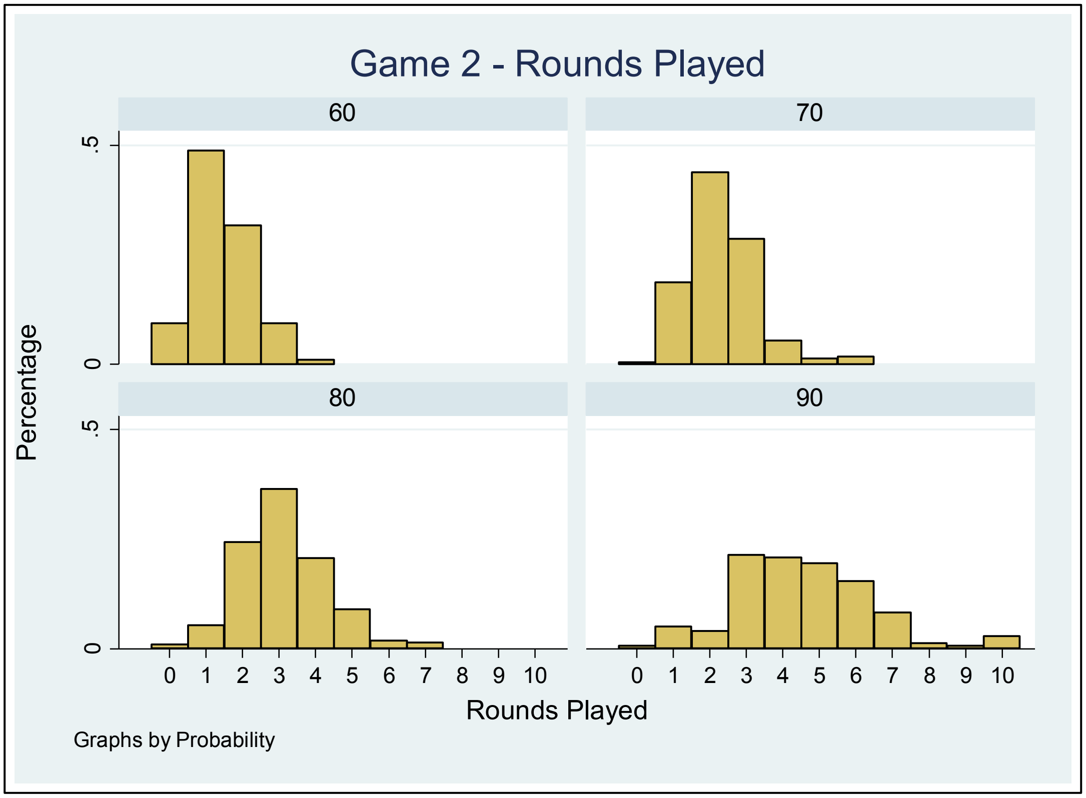


Figure A–3

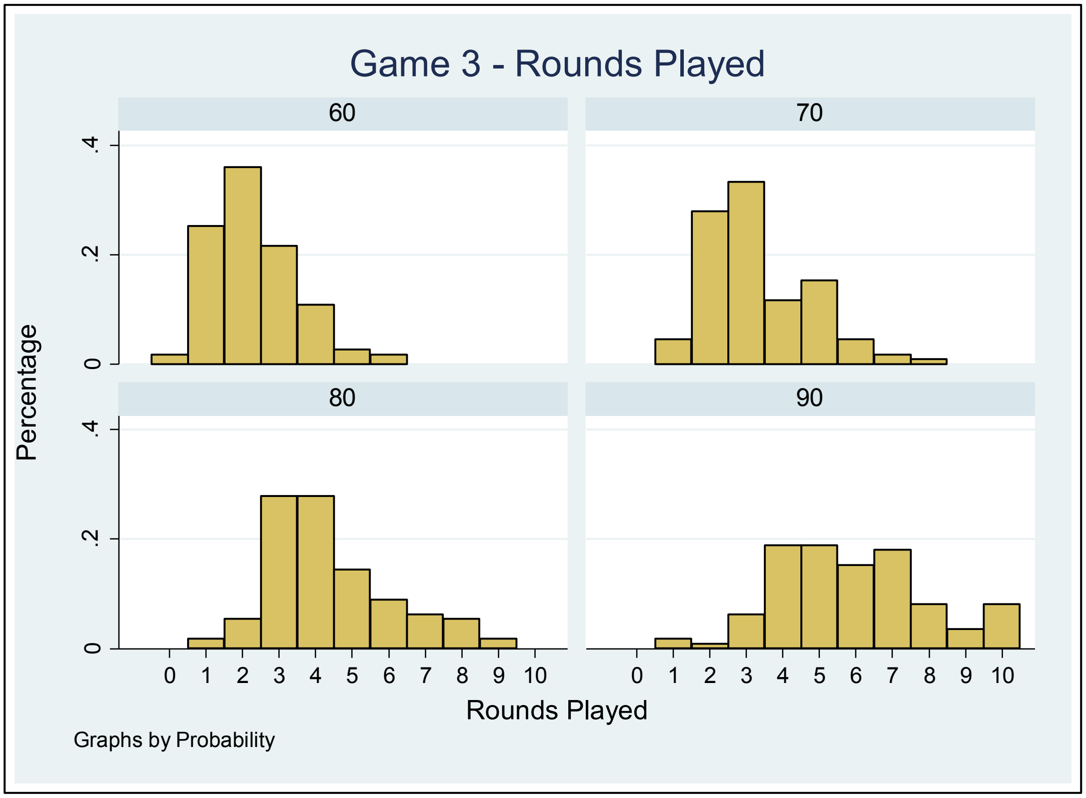


Figure A–4