Career Interruption and Productivity: Evidence from Major League Baseball during the Vietnam War Era

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Can temporary shocks to training and early career experience permanently reduce productivity? Using detailed data on the careers and productivity of Major League Baseball players subject to the Vietnam War draft, we find that birth dates randomly drawn in the draft produce 19 percent fewer major league players. Players born on draft days who do make it to Major League Baseball produce 29 percent fewer wins than those born on nondraft days, a gap that is largest for the most productive players and persists as players age. In addition, the tendency of the draft to push men toward more schooling generates at least some of our results.

I. Introduction

A large literature demonstrates that military conscription lowers average earnings (Angrist 1990; Imbens and van der Klaauw 1995; Angrist, Chen, and Song 2011; Siminski 2013), with particularly negative effects for white men (Angrist 1990), potential chief executive officers (Frank 2012), and others toward the top of the income distribution. However, we have less direct evidence on whether lower earnings result from lower productivity of draftees or other mechanisms. The draft may affect earnings through channels unrelated to productivity including discrimination against veterans of unpopular wars, greater eligibility for public benefit programs (Siminski 2013), or different preferences regarding risky jobs with higher wages. Being drafted may also affect earnings by changing productivity via

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the direct effect of military service on labor market experience, health (Dobkin and Shabani 2009), or schooling through the GI Bill (Angrist and Chen 2011). Finally, conscription may lower productivity by encouraging draft-avoidance behavior leading to suboptimal accumulation of human capital, for example, encouraging overuse of formal higher education to achieve a military service deferment (Card and Lemieux 2001). However, data constraints, including lack of direct productivity measures and detailed school choice data, typically prevent testing the mechanism through which military drafts lower earnings.

In the present paper, we conduct an in-depth study of the effect of the Vietnam War draft on Major League Baseball (MLB) players, exploiting detailed performance data to test how being drafted affects training decisions, productivity, and labor market outcomes. We follow the career paths of professional baseball players using individual-level data from MLB on participation, highest level of schooling, and a common individual-level baseball performance measure, Wins above Replacement. We combine these detailed data with random variation in draft eligibility from the Vietnam War draft lottery as in Angrist (1990) to measure the causal effect of being drafted on school choice, productivity, and labor market success.

We generate several important findings. First, drafted players are missing from MLB. Birth dates randomly selected to be drafted produce fewer major league players. A total of 27 players, just surpassing one full team's roster, are missing from the drafted days. Second, drafted players reaching MLB are less productive. The average drafted birth date generates players producing 45 percent fewer wins than the average undrafted day. While part of this can be accounted for by players who simply do not make the major leagues, players born on drafted days are also 29 percent less productive over the course of their careers conditional on playing in MLB. Third, the drop in productivity appears most important for superstars at the top of the distribution: none of the 10 most productive players and none of the six Hall of Fame players in our sample were born on drafted dates. Fourth, drafted players never fully catch up with undrafted players, continuing in underrepresentation and lower productivity throughout their entire careers. Altogether, we find that being drafted harms career prospects of professional baseball players because it permanently lowers productivity, leading some players to never arrive in MLB and others to be less valuable employees upon arriving.

We find evidence that education incentives created by the draft cause players to interrupt their baseball training, leading to at least part of their reduced success in professional sports. We observe the greatest underrepresentation of drafted birth dates among players who exit education after high school or 2-year college, consistent with the hypothesis that drafted men switch toward more education because veteran education subsidies and military service deferments for students incentivize greater formal education. Also, we do not observe underrepresentation of drafted birth dates in the National Football League, which essentially requires attendance at a 4-year school. Altogether, we find evidence that being drafted permanently hinders labor market success, partially because of the direct effects of military service but also by inducing suboptimal training decisions.

We provide a clear contribution to the literature on military conscription through the draft. First, we provide new results showing that military drafts lower the quality of professional sports by placing worse players on the field. MLB attracted 73 million spectators (Major League Baseball 2014) and spent $3.2 billion on player salaries (Lahman baseball database) in 2014, making the narrowest interpretation of the present results valuable to a large and interesting industry. More broadly, we provide the first evidence that military drafts directly affect the productivity of workers. While earnings could also decrease because of discrimination or changing risk attitudes, the present in-depth study provides evidence in one profession that changes in earnings and occupational choice are linked to lower productivity.

Our results also provide a useful contribution to the literature on career interruptions for high-skilled workers. A large literature argues that interruptions to continuous career experience diminish labor market outcomes for high-skilled individuals, for example, for women temporarily exiting the labor market for childbirth (Bertrand, Goldin, and Katz 2010). If career interruptions lead to earnings losses because they lower productivity, then alleviating gender gaps in earnings will prove costly. However, a lack of productivity data generally prevents directly testing this question. Hockenberry, Lien, and Chou (2008) and Hockenberry and Helmchen (2014) provide the most direct evidence, demonstrating that surgeons with an additional day between surgeries perform with less skill, generating more complications. However, these existing studies cover much shorter breaks in experience than a typical career interruption. To our knowledge no existing studies measure the effect of a large and completely random shock to early career training on productivity measures throughout the career. Some caution should be taken in applying results of conscription of male professional athletes to, for example, the labor market implications of female fertility. However, the unique data of professional sports allow us to demonstrate that career interruptions at an early date can persistently lower performance.

The remainder of our paper provides the study in greater detail. Section II discusses the relevant background information for the Vietnam draft lottery, the literature on career interruptions, and the labor market for professional baseball players. Section III describes potential theoretical mechanisms to frame the empirical results. Section IV describes the data and our identification strategy. Section V provides the results, and we present conclusions in Section VI.

II. Background and Existing Literature

A. *The Vietnam Draft Lottery and Labor Market Outcomes*

The effect of veteran service on postservice outcomes has been studied in many contexts. Different birth dates were selected at random to be eligible for the draft, allowing the researcher to measure the effect of being drafted with a simple comparison of men born on drafted and undrafted dates. Angrist (1990) uses income data for men with drafted and undrafted birth dates to estimate the effect of military service on future earnings. He finds that in the early 1980s, white veterans earned 15 percent less, on average, than nonveterans. In follow-ups to this study, Angrist and Chen (2011) and Angrist et al. (2011) use expanded data to document that by the early 1990s the income gap for white veterans had closed. Increases in educational attainment appear to offset the negative labor market effects of participating in war. Drafted men eventually attained greater levels of schooling, likely because education subsidies from the GI Bill encouraged greater schooling, and education can account for closing the income gap later in life (Angrist and Chen 2011). Drafted men may have also increased their educational attainment to avoid military service. Early in the war, the US military allowed men to defer service if enrolled in higher education, and Card and Lemieux (2001) find evidence of increased schooling of men relative to women during the first part of the war.

Several studies have produced comparable results in other countries with compulsory military service. Imbens and van der Klaauw (1995) examine the effects of compulsory military service in the Netherlands. Ten years after military service, they find that drafted individuals earned 5 percent less, on average, than nondrafted members of their same cohort. Siminski (2013) undertakes a similar analysis among Vietnam draftees in Australia. He finds a negative impact of military service on employment, which actually widens over time because of veteran disability payments. Similar analysis on the German draft in the 1950s finds no long-term earnings differences between veterans and nonveterans (Bauer et al. 2009). Galiani, Rossi, and Schargrodsky (2011) exploit the random draft in Argentina and find that being drafted increases the likelihood of having a criminal record. They also find that being drafted worsens labor market outcomes and suggest that this may drive crime by decreasing the opportunity cost of committing a property crime.

We contribute to this existing literature by testing how being drafted into the military affects career paths and productivity for a profession at the top of the income distribution. To our knowledge, there is no literature on career interruption through military draft that measures productivity directly. This is a significant advantage to our context. The statistics kept in professional sports allow for better observation of productivity than in most professions, which allows us to test if observed effects of the draft on earnings and occupational choice occur because being drafted lowers productivity. Furthermore, we pair productivity and occupational choice data with schooling data that allow us to test whether productivity effects relate to previously measured effects of the draft on schooling choice.

Our study also fits within a branch of the literature that examines whether conscription has different effects across the income distribution. The original Angrist (1990) study finds no effect of draft eligibility for nonwhites, suggesting that the negative effects of military service are concentrated among those with the best ex ante labor market prospects. Card and Cardoso (2012) examine the Portuguese draft during a time of peace and find a positive effect on wages for drafted individuals with little education and almost no effect for the more educated. Frank (2012) uses the standard draft eligibility instrument but examines its effect on a sample of corporate executives. This analysis bears the greatest similarity to the present paper in that it selects a specific, highly skilled labor market for analysis. Frank finds that drafted individuals are underrepresented in his sample of top corporate executives. Additionally, he finds evidence that draft status explains variation in earnings and age of entry into top executive positions. We provide similar evidence in the context of professional baseball with the additional richness that data on productivity and schooling choice allow. Examining the case of MLB players allows us to confirm these results in a new context and test whether large negative effects of the draft on highly skilled individuals relate to effects on productivity and schooling.

B. *The Vietnam Draft Lottery as Career Interruption*

More generally, being selected in the Vietnam draft lottery represents a career interruption rather than simply an induction into military service. During the time frame on which we focus, being selected for the draft increased the probability of serving in the military by only 16 percent (Angrist et al. 2011) because some undrafted men volunteered while many drafted men did not serve because of health, education, and family-related exemptions from military service. Kutinova (2009) argues that draft deferments for married fathers may have affected fertility. Card and Lemieux (2001) argue that the Vietnam draft increased college enrollment by 4–6 percentage points during the early part of the war. During the latter part of the war, which is our sample period, such deferments became less common. Even so, Angrist and Chen (2011) find that men drafted in the late-war lottery do attain higher levels of schooling and argue that education subsidies for veterans via the GI Bill help explain this phenomenon. Overall, the draft sometimes interrupted careers via military service but also sometimes by altering education and fertility decisions with important career implications. Given results we observe below, we will interpret our results as being driven by a general career interruption rather than only military service.

Thus, we relate the present study to the broader literature on career interruptions. A large literature focuses on whether bearing children has a negative effect on women's labor market outcomes (e.g., Albrecht et al. 1999; Gupta and Smith 2002; Kunze 2002; Miller 2011) and whether contraception availability affects female labor market participation (Bailey 2006). Other studies debate whether career interruptions pose a particular challenge for highly skilled women (Amuedo-Dorantes and Kimmel 2005; Wilde, Batchelder, and Ellwood 2010). Bertrand et al. (2010) follow a sample of graduates from a top US master of business administration program, finding that a wide earnings gap opens between men and women mainly because women work fewer hours and have less continuous experience. Interestingly, they find that pay responds to career interruptions nonlinearly, with the existence of any career interruption more important than the number of such interruptions.

Career interruptions may have such negative effects because lost experience and training lower a worker's productivity; however, few studies directly test for the effect of career interruptions on productivity. To our knowledge, the studies coming closest to this goal are Hockenberry et al. (2008) and Hockenberry and Helmchen (2014). Hockenberry et al. (2008) show that surgeries in Taiwan result in negative health outcomes more frequently when surgeons take more off days between surgeries. Hockenberry and Helmchen (2014) demonstrate similar results in Pennsylvania. Both of these studies focus on changes in worker productivity resulting from day-to-day variation in work tasks. In the present study, we likewise objectively measure the productivity of high-skill workers but focus instead on a much larger career interruption, military conscription risk, which can lead to longer times away from the career track and induce workers to rearrange their training regimen. In that manner, we study the effects of a major life event more similar to those typically considered in the career interruption literature. The circumstances of modern female CEOs and male professional baseball players during the Vietnam era differ in obvious ways. However, both face the prospect that early career disruptions could derail their progress in high-skilled professions. Thus, our present study provides useful insight into how career disruptions can affect high-skilled workers.

C. Labor Market Structure of Professional Baseball

Professional baseball exhibits the features of a tournament labor market. It features a highly structured training process progressing in stages. Players begin on amateur teams often affiliated with high schools and colleges and then participate in a formal first-year player draft that assigns a particular team the rights to a player. Players then compete in several lower levels of professional baseball, the minor leagues. Successful players ultimately graduate to MLB; however, very few make it to this point. Table 1 draws on the Lahman baseball database (see below) and first-year player

TABLE 1
Tournament Structure of Professional Baseball

	Baseball Players (Born in 1952)	
	Number	Percentage
Multiple-year All Stars	5	.5%
All Stars	16	1.7%
Major league players	146	15.7%
First-year player draft	929	100.0%
	Baseball Players (Current)	
	Pay	
Maximum	$33 million	
Average major league player	$3.3 million	
Upper-level minor league player	$32,500–$125,000	
Lower-level minor league player	$3,000–$7,500	

Source.—Data on MLB players, salaries, and All-Star appearances are from the Lahman baseball database (http://www.seanlahman.com/baseball-archive/statistics/). First-year player draft numbers are from Baseball-Reference.com (http://www.baseball-reference.com/). Minor league salary information is from Broshuis (2010) and McCann (2014).

draft data from Baseball-Reference.com. A total of 929 players were selected in the 1970 first-year player draft of professional baseball. Of these, only 146 eventually made it to MLB. Less than 2 percent achieved the stardom of being named to MLB's All-Star Game, and only five players were consistent stars, reaching the All-Star Game more than once. This relatively rigid structure, which progresses from a large number of low-pay competitors to a small number of very well-compensated players, makes professional baseball a classic case of a tournament labor market.

The external validity of our results depends on whether other superstar professions tend to share the tournament structure and short career duration evident in MLB. If the career path of a professional athlete differs dramatically from other superstar professions, then empirical evidence regarding career interruptions for baseball players would be less useful when considering superstar labor markets more generally. However, the striking features of MLB make it appear similar to other superstar labor markets of policy interest. In particular, career progress in high-skill professions tends to involve a trade-off between huge rewards for those few who make it to the top but high attrition on the way up the ladder. The tournament proceeds quickly in baseball and other superstar professions leading to careers that advance rapidly with short stays at the top. Of course, baseball differs from other fields in some manners. It places heavy emphasis on physical rather than mental ability. In spite of this obvious difference, professional baseball provides an interesting window into how career interruptions affect productivity in a superstar profession with a relatively rigid training structure.

III. Theoretical Mechanisms

Why might players randomly selected by the Vietnam-era military draft be underrepresented in MLB? We will divide the potential theoretical mechanisms into two categories: those that do not affect baseball skills and those that do.

Even if the draft leaves baseball skills unchanged, men born on drafted birth dates could be underrepresented in MLB if the draft makes careers outside professional sports more attractive. Participation in war may affect preferences for risk and working in high-pressure situations, which could push men to prefer alternatives to professional sports. Veterans may also obtain skills from their time in the military that transfer to market employment outside professional sports. Educational decisions could also play a role. The draft encouraged selected men to obtain higher education, both because men could sometimes avoid military service by attending school and because those who completed military service were eligible for subsidized education through the GI Bill. Angrist and Chen (2011) find that men drafted during our sample period obtain more schooling than undrafted men. Whether incentivized by subsidies or military service exceptions, higher schooling levels would raise the nonbaseball skills of drafted men. At the margin, these men may be more likely to choose other professions over professional sports. Under this mechanism, the draft would not affect baseball skills of individual players, but it may still change average observed productivity through a selection effect. Marginal players exiting MLB for other professions would most likely be average or below-average players. Productivity of drafted players observed in MLB would then either equal or exceed that of players not selected in the military draft. Thus, a mechanism by which the draft does not affect individual baseball skill has a pair of clear empirical predictions. Drafted men should be underrepresented in professional sports, but those who do arrive should not be observably less productive.

Drafted men could also be underrepresented in MLB if the draft causes players to have worse baseball skills. Being drafted could reasonably shift the entire distribution of baseball productivity downward. Drafted players would be less common in MLB as players on the edge of the major leagues fail to make the cut when drafted. More talented players would remain in MLB but would be less productive. Selection effects may push in the other direction as low-quality drafted players fail to reach MLB; but if the draft sufficiently decreases productivity of the best players, average observed productivity of drafted players will be lower than that of undrafted players. Empirically, if we observe lower productivity for drafted men, we can conclude that diminished baseball skills explain the underrepresentation of drafted men in MLB.

Finally, we will aim to disentangle why being drafted leads to lower productivity. The simplest explanation is that participating in war lowers baseball productivity. Those dying in war will not subsequently be observed playing professional sports, and physical or mental injuries may degrade baseball skills. A more nuanced explanation is that incentives pushing drafted men toward increased formal schooling could undermine optimal baseball training.[1] Professional baseball in North America recruits players from amateur teams affiliated with various levels of education including high schools, 2-year colleges, and 4-year colleges. A given player will choose optimally among these training options depending on his academic skills and the timing of his athletic development. As noted above, the Vietnam conflict provided incentives for drafted men to increase their educational attainment. Potential baseball players who would otherwise exit from education to professional baseball after high school or 2-year college might continue through 2-year and 4-year college, respectively. Deviating from optimal education and training would then lead to lower baseball productivity. Either the direct effects of war or changes in training decisions incentivized by the draft could explain both underrepresentation and lower productivity of drafted players.

Empirically, we can distinguish between the effects of participating in war and altered training decisions in a pair of ways. First, we can observe school attendance for MLB players. If the draft incentivizes more formal education, we should observe men switching away from high school and 2-year college. Underrepresentation of drafted men in MLB should be more extreme among those with less formal education. Second, we can compare MLB to other sports leagues. The National Football League (NFL) recruits almost exclusively players attending 4-year colleges. The draft cannot shift a football player from his optimal training path without also removing him from the NFL because he has only one option. Thus, if the draft reduced productivity by affecting training decisions, drafted men should be underrepresented in baseball but not in football. Altogether, data on the representation, productivity, and education decisions of MLB players can be paired with data from the NFL to determine the mechanisms by which the Vietnam-era draft affected professional baseball players.

IV. Data and Empirical Strategy

A. *Vietnam Draft*

We follow Angrist (1990) and use data from the US compulsory military service during the Vietnam War. From 1970 to 1975, the United States held random drawings to determine eligibility for compulsory military service. The first such lottery in 1970 covered 19–26-year-old men at the time of the draft. Only 19–20-year-olds were drafted from 1971 to 1973 to prevent subjecting men to draft risk more than once. Draft lotteries were also held from 1973 to 1975, but no men were drafted. A Random Sequence Num-

[1] We have formalized these observations in a simple model similar to that in Rossi and Ruzzier (2015), which we can make available on request.

ber (RSN) was assigned to each date of birth for each draft year, and individuals with low numbers were at risk of conscription. We will follow Angrist (1990) by matching men to draft numbers according to their birth date's RSN in the draft year in which they turn 19 years of age and assigning an individual as "drafted" if he has a draft number below 195 in 1970, 125 in 1971, 95 in 1972, and 95 in 1973.

Being assigned a low number could matter for labor market outcomes through multiple channels. Lower numbers were more likely to serve in the military. However, some men volunteer for military service, and some men avoid military service because of ineligibility from health conditions or service deferments for schooling. The rules allowing men to defer military service while in school also likely affected schooling choices. Altogether, men born on dates we categorize as "drafted" are only 16 percent more likely to be veterans and attained greater levels of schooling (Angrist and Chen 2011). Even in years in which no men were actually conscripted, having a low draft number may have an effect. For instance, while no one was actually drafted in 1973, low draft numbers in 1973 still interrupted careers by altering school and volunteering choices as these men anticipated that they had some chance of being drafted. Thus, we follow Angrist (1990) in assigning a cutoff of 95 in 1973. Throughout the paper, we will refer to individuals and birth dates with RSNs below these cutoffs as "drafted."

B. Major League Baseball—Birthdays

We use data covering the universe of MLB players in the Lahman database (http://www.seanlahman.com/baseball-archive/statistics/). This database includes, among other things, exact birthdays for every person who has played MLB. For a robustness check we also use birthday data on NFL players obtained from http://www.pro-football-reference.com. As in Angrist (1990), we limit our attention to individuals born between 1950 and 1953, matching each player to the draft year in which he reached 19 years of age. We include players of all nationalities as over 90 percent of MLB players came from the United States, and immigrants are not exempt from US selective service. Using exact birth dates, we match each individual to an RSN for the appropriate draft year and thus classify each player as having been drafted or not. Using this information, we can relate draft status to any player's baseball statistics. Similarly, we can also calculate the eventual number of MLB players born on any given birth date and relate this to the birth date's associated draft RSN.

C. Major League Baseball—Productivity

One main advantage of studying professional athletes is that we can observe and use a widely accepted productivity measure. We measure productivity using Wins above Replacement (WAR) from Baseball Reference (http://www.baseball-reference.com/). There are different WAR measures produced by different analysts, though all have the same basic framework. All our references to calculations refer to the version produced by Baseball Reference. The WAR measure we use has four components: batting, base running, defense, and pitching. Batting productivity is measured using a linear combination of offensive outcomes (e.g., home runs). The weights in the linear combination depend on the expected number of runs caused by the event, accounting for runs scored and changes in the state of the world (runners on base, number of outs) as in a simple dynamic programming framework. In this way, one can calculate the number of runs caused by a player's batting over the course of a season. Base running similarly measures how many runs a player adds by stealing bases or taking additional bases on a teammate's hit. Data on whether a player is more likely to field a ball or throw a runner out can be used to measure defensive productivity. Finally, pitching productivity can be measured rather directly using runs allowed data.

WAR then provides a comprehensive measure of a player's productivity by combining batting, base running, defense, and pitching into one measure. Since each component is measured in runs, they can simply be added up to obtain the total numbers of runs caused by a player. One difficulty in simple addition is that a player would not receive credit for being in a difficult defensive position (e.g., shortstop). To account for this, WAR adds a positional adjustment to a player depending on his defensive position. Players in more difficult positions are credited with more such runs. With a player's total number of runs (batting, running, fielding, pitching, and positional adjustment), WAR converts runs to wins according to the empirical relationship between the two (roughly 10 runs to one win). Finally, as the WAR acronym implies, player productivity is measured relative to "replacement level." To account for the opportunity cost of putting a player on the roster or in the game, WAR compares a player's total runs to those of replacement players, who are assumed to be abundant. In the end, we have a productivity measure that is widely used, accurate, and comparable across players and measures all main aspects of the job.

The WAR measure correlates strongly with both team-level productivity and subjective measures of player quality. In figure 1, we sum the total wins above replacement across players for each team for each season from 1997 to 2012 and compare that to the actual number of games won by that team. Though WAR directly uses only game events attributable to individuals (e.g., walk, home run), it correlates strongly with the ultimate goal of the team: winning games. A simple regression of team wins on team WAR explains 80 percent of the variation in team wins. Thus, WAR provides a useful measure of how particular players contribute to a team winning games.

While developed as an alternative to more "traditional" expert opinion measures of player productivity such as participation in the All-Star Game and membership in the Hall of Fame, WAR also correlates strongly with these subjective measures. Fans, players, and coaches vote for the participants in the All-Star Game, while members of the Baseball Writers Associ-

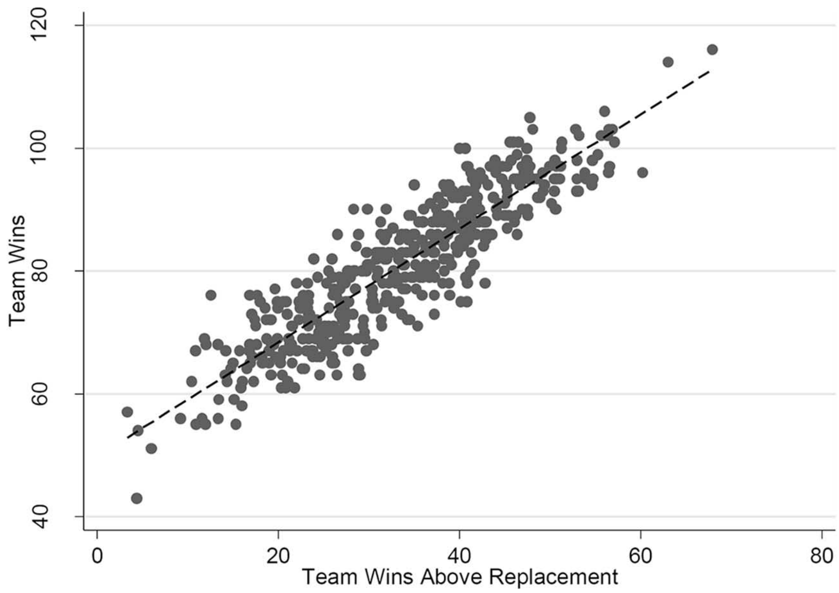

Figure 1.—Wins above replacement and actual wins, by team, 1997–2012. Each point shows one team during the 1997–2012 MLB seasons. The horizontal axis measures the sum of wins above replacement produced by players on the team during that season. The vertical axis shows how many games the team actually won. Actual win totals are compiled from Retrosheet data (http://www.retrosheet.org/).

ation of America select inductees into the Baseball Hall of Fame. Using data from the Lahman baseball database, figure 2 shows the relationship between Hall of Fame membership and career wins above replacement. Players accumulating fewer than 50 WAR almost never make the Hall of Fame. The probability of being voted into the hall increases through about 100 WAR. Above this cutoff of measured productivity, all players have made the Hall of Fame. Career WAR also correlates strongly with All-Star Game participation (results available on request). We will use WAR as our measure of productivity, and this measure correlates with both team-level productivity and more traditional measures when evaluating the productivity of baseball players' entire careers.

D. *Empirical Strategy*

Our analysis will compare birthdays that were drafted versus those that were not drafted for compulsory service during the Vietnam War. We build our analysis on two main facts. First, people born on drafted birth dates were at greater risk of compulsory military service. Angrist (1990) and others confirm this fact empirically. While such service was not certain, the probability of military service was higher for those born on dates selected in the draft. All of our analysis will compare drafted and undrafted days, measuring the effect of being drafted rather than only the effect of mili-

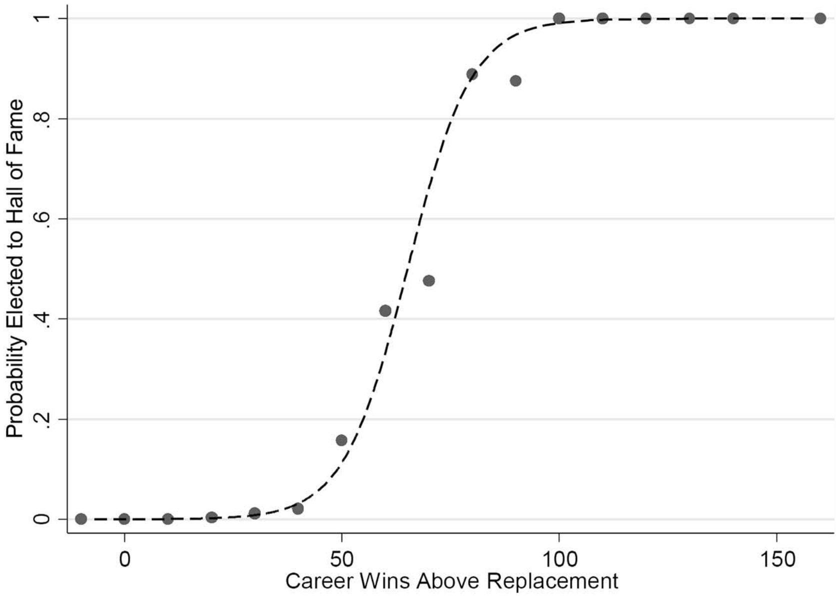

Figure 2.—Wins above replacement and Hall of Fame membership. Plotted points show the fraction of players in the Hall of Fame. Each point represents the fraction for a group of players with career WAR in the same 10-win bin. The curve shows the fitted values of a logistic regression of Hall of Fame membership on career WAR. The figure includes all MLB players born after 1914 and finishing their careers by 2000. This sample thus excludes earlier players for whom there was no All-Star Game and recent players who have not yet exhausted eligibility to be voted into the Baseball Hall of Fame.

tary service. Second, the days drafted were chosen at random each year. Differences in career outcomes between those participating in military service and those not (or more generally between those experiencing career interruptions and those not) may reflect not only the causal effect of the interruption but also bias from ex ante differences between the two groups. Because the Vietnam draft randomly assigned draft status, we avoid this source of bias.[2] Thus, if being drafted has no long-run effects, then the number and quality of MLB players born on a drafted day should not differ from those of an undrafted day. Any difference must be due to the effect of being drafted because days were chosen at random. If we should observe either that fewer players born on drafted days reach the major league or that players who do make it have lower productivity, then we would conclude that being drafted lowers the productivity of potential players.

Figure 3 displays the basic outline of our empirical strategy graphically. The first bar in each group shows how many players we would expect to have been born on drafted days if being drafted had no effect. For birth

[2] Randomization is conditional on year of birth and potentially also month of birth (see Fienberg 1971; Rosenblatt and Filliben 1971). Thus, we will also present results with year and month fixed effects.

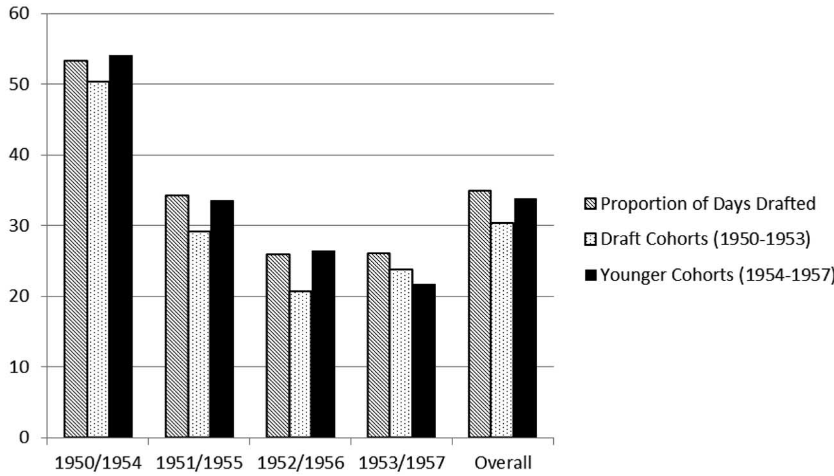

Figure 3.—Percentage of players born on drafted birth dates, by birth year. Each bar displays the percentage of the relevant outcome variable corresponding to days drafted for service in the Vietnam War draft. The first bar in each group is a simple count of the number of birthdays called for the draft, while the second bar counts percentages of MLB players born on those days during the draft years of 1950–53 and the third bar counts MLB players born on those same days in later years when the draft was not in effect.

year 1950, 53.3 percent of all birthdays were drawn for compulsory service. These days were chosen at random. Thus, we would expect 53.3 percent of all MLB players born in 1950 to have been born on these days if the draft has no effect on player productivity.[3] However, the second bar shows that only 50.4 percent of MLB players born in 1950 were born on drafted days, 2.9 percent lower than expected. Similar differences can be observed in each draft year. Aggregating over all 4 years, the percentage of players born on drafted days is 4.5 percent lower than would be expected. MLB appears to be missing players born on drafted days. Our analysis below will formalize this analysis statistically and extend it to more outcomes.

While the use of the Vietnam draft as a natural experiment has been well established, the third bar of each group in figure 3 provides some justification in the context of MLB that there is nothing systematically different about the days chosen by the draft. The third bar for each draft year calculates the percentage of players born exactly 4 years after drafted days. Since there were no drafts 4 years later, the particular days drafted should not be different from other days, and the percentage of players born on such a day should simply correspond to the percentage of days drafted. For example, the third bar for 1954 demonstrates that 54.0 percent of MLB players born in 1954 were born on birthdays corresponding

[3] Some days may have higher birth rates than others (e.g., because of seasonal differences in fertility). But random selection of drafted dates ensures that the drafted and undrafted days have the same average birth rates. Thus, the proportion of people born on drafted days equals the proportion of days drafted.

to 1950 drafted days. This bears close similarity to the expected value of 53.3 percent. Pooling over all 4 years, the younger cohorts who were not subject to the draft do not show the same tendency to be dramatically underrepresented. The draft provides a valid experiment in which any difference observed regarding players born on drafted versus undrafted days can be attributed to the effect of the draft itself.

V. Results

A. *Frequency and Production by Date of Birth*

We can confirm statistically that birth dates randomly drawn in the Vietnam draft are underrepresented in MLB. For any date of birth, we count the number of players born on that day. We can then weight each player by productivity, adding up the total number of wins for all players born on a particular day. Column 1 of panel A in table 2 shows that the average drafted birth date provided players with an aggregate productivity of 1.51 wins above replacement. On the other hand, column 2 shows that players born on undrafted days produced 2.44 wins above replacement. Columns 3 and 4 measure the difference between drafted and undrafted days. Column 3 shows the simple difference, and column 4 shows our

TABLE 2
Frequency and Productivity by Draft Status

	Drafted (1)	Not Drafted (2)	Difference (3)	Difference with Year and Month Fixed Effects (4)
	A. Sample: Dates of Birth			
Career WAR	1.51	2.44	−.93**	−1.09***
			(.41)	(.41)
Number of players	.34	.42	−.08**	−.08**
			(.03)	(.03)
Observations	510	951		
	B. Sample: Players (Conditional on Playing in MLB)			
Career WAR	4.44	5.85	−1.41	−1.72*
			(.97)	(.96)
Years played	6.66	6.82	−.16	−.35
			(.45)	(.46)
Wins per year	.33	.39	−.06	−.09
			(.07)	(.07)
Debut date	Feb. 24, 1975	Aug. 21, 1975	−178**	34
			(82)	(72)
Observations	173	396		

Note.—Robust standard errors are in parentheses. Columns 1 and 2 display means while cols. 3 and 4 report the coefficient on a draft eligibility dummy from a linear regression with the outcome defined as the variable in the left column. The unit of observation in panel A is a birth date while the unit of observation in panel B is the player.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.

preferred estimates, which use year and month fixed effects to adjust for the changing probability of being drafted over time and potential “mechanical problems” with the draft that may have made the probability of being drafted vary by month. In both cases, birth dates chosen for the draft generate one fewer win than birth dates not chosen for the draft, a very large decrease of 45 percent.

A significant portion of the decrease in production on drafted birth dates comes from a decrease in the number of players who successfully enter the top league, MLB. The second row of table 2 shows that drafted days produce 0.08 fewer major league players than undrafted days. Given that the typical undrafted day produces only 0.42 MLB players, this represents a large decrease of 19 percent. The measured decrease in MLB players born on drafted days could overestimate the true treatment effect. MLB teams have a fixed number of roster spots. Thus, drafted players may simply be replaced by undrafted players, increasing the number of players born per day in our control group. If we assume this most extreme case, then we can quantify the extent of this bias. Following the standard potential outcomes framework, define $\overline{N}_i^j$ as the average number of players born to a group of birth dates j that are either drafted or undrafted ($j \in \{D, U\}$). The subscript i then denotes whether the group of birth dates is “treated” by being drafted. Thus, $\overline{N}_1^D$ denotes the observed average number of players born on drafted days, while $\overline{N}_0^D$ denotes the number of players from those birth dates who would have played if they had not been drafted. Our goal is to measure the treatment effect of the draft, $\delta = \overline{N}_1^D - \overline{N}_0^D$. As in the standard framework, we can measure only the difference between two groups, which can be separated into the treatment effect and selection bias:

$$\overline{N}_1^D - \overline{N}_0^U = \overline{N}_1^D - \overline{N}_0^D + \overline{N}_0^D - \overline{N}_0^U,$$

$$\overline{N}_1^D - \overline{N}_0^U = \delta + \overline{N}_0^D - \overline{N}_0^U.$$

If we assume the most extreme spillovers, that every player lost from drafted days is replaced by a player from an undrafted day, then

$$\overline{N}_0^U = \overline{N}_0^D - \delta \times \frac{\text{number of drafted days}}{\text{number of undrafted days}}.$$

As a result,

$$\overline{N}_1^D - \overline{N}_0^U = \delta + \overline{N}_0^D - \left(\overline{N}_0^D - \delta \times \frac{\text{number of drafted days}}{\text{number of undrafted days}}\right),$$

$$\overline{N}_1^D - \overline{N}_0^U = \delta\left(1 + \frac{510}{952}\right),$$

$$\delta = \frac{\overline{N}_1^D - \overline{N}_0^U}{1.54} = \frac{0.08}{1.54} = 0.052.$$

Thus, 0.052 represents a lower bound for the true decrease in the number of players born per day on drafted days relative to the number of players who would have played on those days in the absence of the draft. Similar deflation of the measured effects would apply to our results for productivity by birth date. Still, with 510 drafted days in our data, we estimate that 27 players, slightly more than the full roster of one team, would have played in MLB in the absence of the draft.

B. Productivity Conditional on Playing in MLB

Those players who do make it to MLB despite being born on drafted days are less productive than their undrafted counterparts. Panel B of table 2 shows drafted versus undrafted comparisons in which the sample is now composed of all players who reach MLB. Players born on drafted days produce an average 4.44 WAR level throughout their careers compared to 5.85 for players born on undrafted days. This difference of about 1.5 wins increases to a 1.7-win difference in our preferred estimates controlling for year and month fixed effects. Again, this effect is very large relative to average productivity. Lower aggregate productivity over the course of a career could be caused either by playing fewer (above replacement level) seasons or by being less productive each year. The second and third rows of panel B in table 2 provide these results. Drafted players work for 0.35 fewer seasons, a decrease of 5 percent. Drafted players produce 0.09 fewer wins per year, a drop of 23 percent. While both of the measured effects are statistically insignificant, the results suggest that while both may be at play, most of the drop in aggregate productivity comes from productivity per year rather than number of seasons played.

Of course, players observed in MLB represent only the selected sample of players able to obtain employment at the top of their profession. As demonstrated previously, draft status certainly affected this selection process, and this fact will generate bias in measuring the effect of being drafted on productivity in the selected sample of players. We cannot observe the productivity of players who would have played in MLB if undrafted but who did not ultimately play. However, our combined results point to a complete leftward shift of the productivity distribution for drafted players. In this case, marginal major league players would no longer make it to the major leagues when drafted, and the remaining major league players would be less productive than if not drafted. In this case, selection bias would actually cause us to underestimate the true effect of being drafted on productivity as the unobserved players born on drafted days represent the lower tail of the productivity distribution. Our results could also be rationalized by the draft causing the disappearance of a few very productive players and leaving the productivity of other drafted players untouched, but a shift in productivity affecting all players seems more plausible. Thus, we interpret our results as indicating that being drafted shifts the entire productivity distribution to the left, causing some players to still play while being less productive and causing others to miss the major leagues entirely.

C. *Effects across the Productivity Distribution*

The reduction in productivity also appears to be concentrated at the top of the productivity distribution. Figure 4 shows the cumulative distribution function of career productivity for players born on drafted and undrafted birth dates. The two lines mirror each other closely for the bottom 60 percent of players. Above this point, the solid line corresponding to undrafted days falls below the dashed line corresponding to drafted days. This gap widens particularly among the 10 percent most productive players, indicating that drafted days are particularly unlikely to produce the very best players. For instance, all of the top 10 players by career WAR were born on

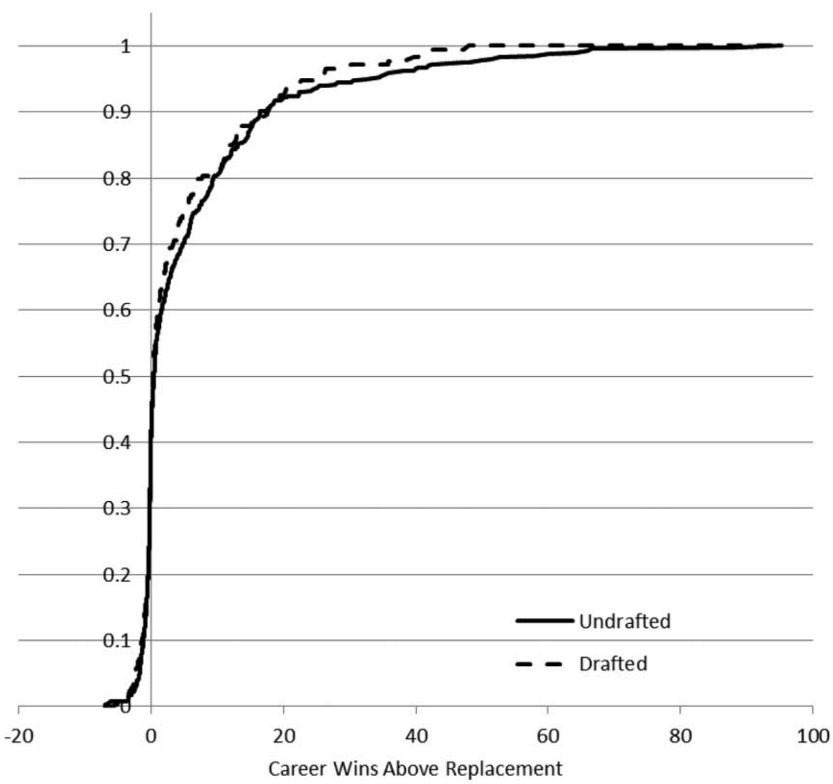

Figure 4.—Distribution of career productivity. Cumulative distribution function of career WAR produced for the sample of MLB players born between 1950 and 1953, split by draft status.

undrafted days.[4] We can formalize the effects at the top of the distribution using quantile regression. Table 3 displays the results for a quantile regression of career WAR on a draft status dummy. For the quantiles we use, column 1 displays the level of WAR associated with that quantile, and columns 2 and 3 show the coefficient on the draft status dummy in the relevant quantile regression along with its standard error for quantile regressions without and with year and month dummies. For instance, the 40th percentile of career WAR is 0.0. Being drafted has a small effect, reducing this quantile by 0.1 WAR. We observe similarly small effects for most of the productivity distribution. On the other hand, the 90th percentile of productivity decreases by 3.0 wins (after controlling for year and month fixed effects) from a level of 17.5 wins. An even stronger decrease of roughly six to seven wins occurs for the most productive players. Traditional means of identifying the very best players, such as Hall of Fame membership, show similar results. In our sample, six out of 951 players born on undrafted dates were voted into the Hall of Fame. On the other hand, zero out of 510 players born on drafted days made the Hall of Fame, making the difference in probability of Hall of Fame membership statistically significant ($p = .008$). Estimating effects at the very top of the distribution leads to large standard errors and at times statistical insignificance, so the results should be interpreted with some caution. However, these results suggest that within an already select group of stars, the draft has its largest effects on superstars.

D. *Effects by Player Age*

The leftward shift in the distribution of productivity caused by being drafted appears to be persistent throughout a player's career. An important question in the literature regards whether the effects of being drafted are persistent or whether drafted individuals eventually catch up. Angrist and Chen (2011) and Angrist et al. (2011) document that the earnings of drafted men catch up to those of undrafted men by the early 1990s. On the other hand, Siminski (2013) finds evidence that Australian draftees do not catch up with the undrafted. Similarly, those interested in career interruptions for high-skilled workers may wish to know whether workers can recover from early career shocks. We can check whether the effect of being drafted fades for potential superstars. For this analysis, we construct similar frequency counts and aggregate productivity by birth date but limit each measure to players of a certain age. Then, we can run comparisons between drafted and undrafted birth dates as in table 2, panel A, but now splitting out the effects by player age. Figure 5 shows the results for the number of players born per birth date. The solid line plots the number of

[4] The players in order of career WAR are Bert Blyleven, George Brett, Dwight Evans, Buddy Bell, Dave Winfield, Keith Hernandez, Frank Tanana, Cesar Cedeno, Brian Downing, and Fred Lynn.

TABLE 3
Effect of Being Drafted across the Productivity Distribution

Quantile	Percentile WAR (1)	No Year Fixed Effects (2)	Year and Month Fixed Effects (3)
10	−1.2	−.1 (.3)	−.4 (.3)
20	−.5	−.0 (.2)	−.0 (.2)
30	−.2	−.1 (.1)	−.0 (.1)
40	.0	−.1 (.1)	−.1 (.2)
50	.4	−.3 (.4)	−.1 (.5)
60	1.3	−.5 (.9)	−.6 (1.0)
70	4.3	−1.5 (1.6)	−1.7 (1.4)
80	9.3	−1.7 (2.3)	−3.5 (2.3)
90	17.5	1.1 (4.0)	−3.0 (5.0)
95	28.2	−8.4 (9.4)	−7.5 (10.6)
99	60.1	−24.3 (17.3)	−6.6*** (.4)

Note.—Standard errors are in parentheses. All quantile regressions use the sample of players who make it to the major leagues. Each row corresponds to a particular quantile listing the number of the quantile, the unconditional percentile of wins above replacement in the data, and coefficients and standard errors from two separate quantile regressions.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.

players of a certain age born per birth date for undrafted days. The dashed line plots similar averages for drafted days. As expected, fewer players are born on drafted days. Perhaps of greater interest, this relationship is true for all ages of players. Figure 6 demonstrates that a similar pattern holds when weighting by productivity. Figure 7 expresses the differences in the

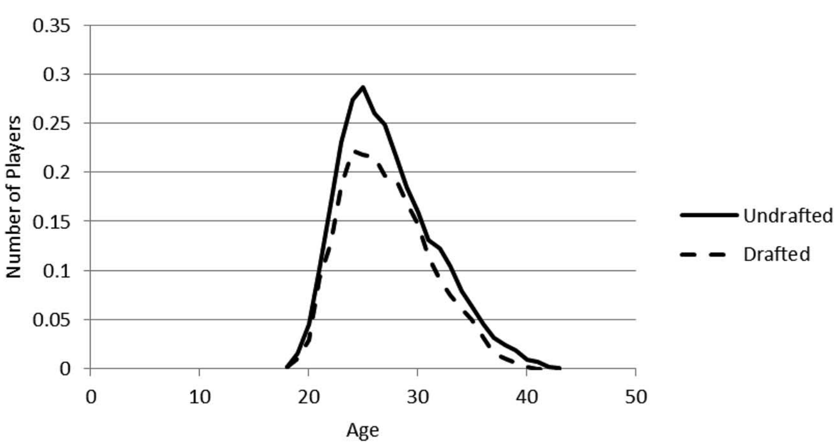

Figure 5.—Effect on number of players per birth date, by player age. The solid line shows simple counts of the number of major league seasons played by players of a given age who were born on undrafted days divided by the number of such days; similarly for the dashed line and drafted days.

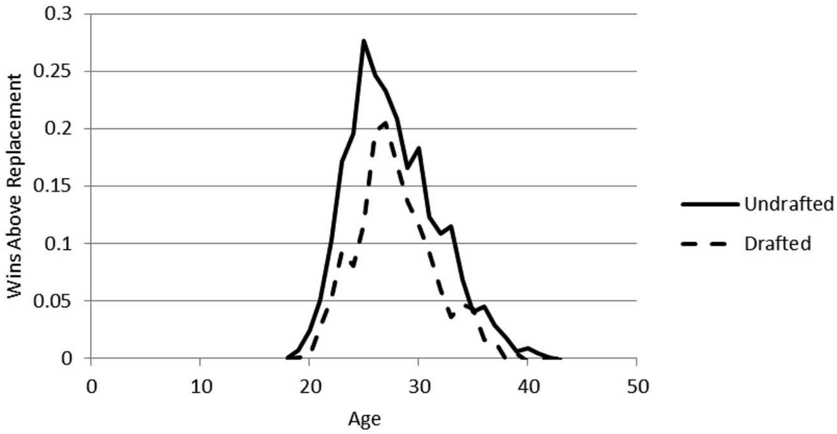

Figure 6.—Effect on production per birth date, by player age. The solid line shows total career WAR for major league seasons played by players of a given age who were born on undrafted days divided by the number of such days; similarly for the dashed line and drafted days.

number of players and the productivity of those players using the ratio of drafted to undrafted players. This ratio remains below one for both frequency and productivity of players, indicating underrepresentation of drafted days. At age 19, drafted days are dramatically underrepresented and particularly so when weighting by productivity. Through the 20s, drafted birth dates catch up somewhat, achieving 80 percent of the repre-

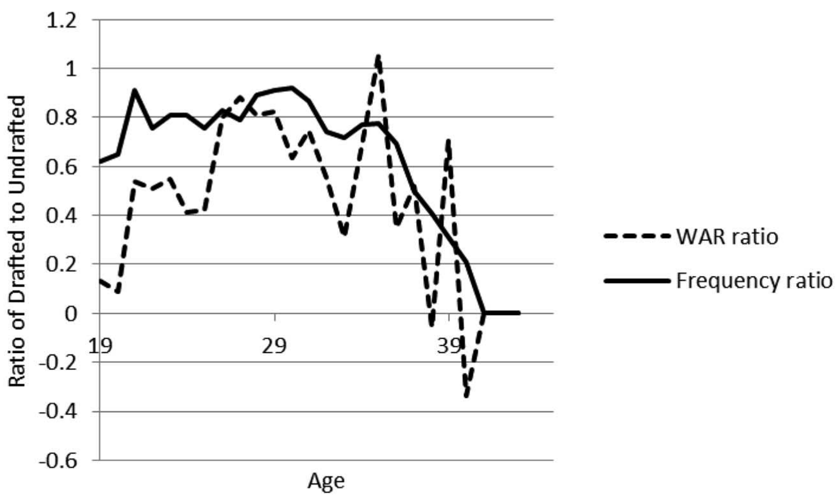

Figure 7.—Ratio of drafted to undrafted by player age. The figure shows the ratio of drafted to undrafted number of players and productivity using data from figures 3 and 4. The graph has been trimmed at age 18 because of the very small number of players age 18 or below.

sentation and productivity of undrafted birth dates. However, the catch-up of drafted birth dates stalls prior to total parity. During the latter parts of players' careers (median player age is 27), drafted days become less represented with less productive players. In sum, drafted players are able to make up some ground on undrafted players but never fully close the gap, and drafted players are significantly underrepresented among players with the greatest longevity who play into their late 30s.

E. Mechanisms: Military Service and School Choice

Why are players born on drafted dates less common and less productive on average? Several mechanisms that could plausibly lead to underrepresentation of players without harming baseball productivity conflict with our results. For instance, drafted men might plausibly accumulate market skills that pull them toward nonsports activities. However, these dynamics would likely remove marginal baseball players from MLB. This selection effect would increase the observed average productivity of players born on drafted days, contrary to our main results. Thus, we focus on mechanisms by which the draft directly decreased the productivity of individual players. Two primary candidate mechanisms emerge to explain lower productivity of drafted men. Participation in military service may lead to death, physical injury, or mental injury, or the education incentives provided by the draft or veterans' benefits may affect education decisions in a manner that lowers baseball productivity.

Of course, military service itself may directly harm a player's prospects in professional sports through lost training time and worse health. Angrist et al. (2011) report that, given draft carve-outs and the option to volunteer, being drafted raises the probability of military service by 16 percent, about one in six. As noted above, we find that the number of players born on drafted days is 0.08 lower than an average of 0.42 players per birth date on undrafted days. Combining these two estimates, a hypothetical draft that raises the probability of military service from zero to one would drop the number of MLB players born on those days by $0.08/0.16 \approx 0.50$ from a mean of 0.42. In other words, the direct effects of military service could completely drive our results only if military service completely eliminates the probability that a player reaches professional baseball. While possible, this explanation is difficult to reconcile with the fact that we observe lower productivity for drafted players conditional on reaching MLB.[5] Some

[5] Nonrandom selection into military service could in principle explain this fact. While the draft is random, the option to volunteer or avoid conscription is not; and if military service selects positively on baseball skill, then selection effects could drive productivity conditional on arriving in MLB. However, the simplest models would predict negative selection into military service. More intuitively, overestimating productivity effects due to selection requires that military service selects men with better baseball ability out of the already very elite group of athletes who can make MLB, i.e., that future Hall of Fame players would be more likely to volunteer or less likely to avoid conscription than future bench players.

players appear to have been affected by the draft without its completely eliminating their prospects in professional baseball. Given the magnitude of the effects we observe, the draft would then appear to affect productivity not only through military service but also through other channels.

The data provide direct evidence that the draft affects productivity through schooling choices. As noted above, the draft could affect schooling choices either because higher education allowed men to avoid military service or because veterans gain access to subsidized schooling via the GI Bill. Card and Lemieux (2001) empirically confirm the popular notion that, at least during the early part of the Vietnam War, young men went to college to avoid the draft via educational deferments. Angrist and Chen (2011) find that drafted men from our late-war sample period attain more education than undrafted men, which they argue results from the GI Bill. While the return to schooling may be positive for the average man, more formal schooling may not be the best way to accumulate baseball skills. Players who would have optimally entered professional baseball immediately after high school or 2-year college may extend their formal schooling, interrupt their natural accumulation of baseball skills, and become less productive players. In our data, we can test this theory. We observe whether an MLB player attended college or not. For those attending college, we can observe whether the college is labeled as a junior/community college. Thus, we can measure whether being drafted provided incentives for players to rearrange their early career training and education.

Being drafted generates no gaps in player frequency for those educated at 4-year colleges but large gaps for those with no college or junior college. Panel A of table 4 displays differences in the frequency of players born on drafted versus undrafted birth dates for the three different education groups. Drafted and undrafted birth dates produce similar numbers of players who attended 4-year colleges. Drafted days produce 0.13 college-educated players per day, while undrafted days produce 0.16 such players. However, even this statistically insignificant difference mostly disappears when controlling for year and month fixed effects. Drafted days produce 0.010 fewer players per day, a decrease of only 6 percent, which is statistically insignificant and small. On the other hand, the draft generates a dramatic drop of −0.28 (45 percent) in the number of players from 2-year colleges and a large though statistically insignificant gap of −0.38 players per day (19 percent) for players with no college. Whether through educational deferments for military service or GI Bill education subsidies, drafted players had incentives to accumulate more formal schooling. Shifting toward formal schooling could lower baseball productivity in a context in which most eventual MLB players do not attend 4-year college. Consistent with this mechanism, we find greater underrepresentation of drafted birth dates among players with less formal schooling.

We can confirm the importance of interrupting early career experience and training by examining the NFL, a similar superstar profession in which the early career training and sorting process differs from that of MLB. As

TABLE 4
Number of Players by Birth Date, by Education and Sport

	Drafted (1)	Not Drafted (2)	Difference (3)	Difference with Year and Month Fixed Effects (4)
	A. By Level of Education			
4-year college	.13	.16	−.022	−.010
			(.021)	(.021)
Junior/community college	.03	.06	−.035***	−.028**
			(.011)	(.011)
No college	.18	.20	−.020	−.038
			(.024)	(.025)
	B. By Sport			
All MLB players	.34	.42	−.077**	−.076**
			(.034)	(.035)
All NFL players	.71	.72	−.009	.010
			(.048)	(.049)
Observations	510	951		

Note.—Robust standard errors are in parentheses. Columns 1 and 2 display means while cols. 3 and 4 report the coefficient on a draft eligibility dummy from a linear regression with the outcome defined as the variable in the left column.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.

has already been seen, professional baseball players may spend their early career training at formal colleges, or they may skip college and begin immediate on-the-job training at minor league teams affiliated with major league clubs. In football, though, all players must be 3 years removed from high school, and thus nearly all players attend 4-year college. Neither military service deferments for college nor education subsidies for veterans should affect the careers of football players attending 4-year schools on scholarships. Panel B of table 4 confirms that the draft does not restrict potential NFL players. Drafted days produce 0.71 eventual NFL players per birth date, while undrafted days produce 0.72. Even the small 0.01 players per day difference disappears (and becomes positive) when controlling for year and month fixed effects. The Vietnam draft did not impede the established early career path of football players playing for amateur college football teams. Without such an early career disruption, players born on drafted and undrafted days are equally represented in the NFL. This observed parity contrasts with MLB, in which being drafted prevents the natural progression of superstar careers, leading to underrepresentation of those who were drafted.

VI. Conclusion

We study Major League Baseball players subject to the Vietnam War draft lottery and find that being drafted dramatically reduces the probability that a player will succeed as a professional baseball player. Drafted birth dates produce 19 percent fewer major league players. Such early career shocks appear to matter because they make drafted men less productive. Drafted players who do make the major leagues produce 29 percent fewer wins above replacement over the course of their careers than undrafted players. Productivity per season rather than longevity of career drives most of this gap, and the difference in productivity persists throughout players' careers. We also find suggestive evidence that the draft diminishes productivity most dramatically at the very top of the distribution. All 10 of the 10 most productive players in our sample were born on undrafted days. Altogether, the data indicate that drafted men were underrepresented among the superstars of MLB because being drafted led them to be less productive.

Two pieces of evidence indicate that the draft creates such negative productivity effects at least in part because the draft pushed potential baseball players away from vocational training for baseball and toward formal education. First, we find no evidence of underrepresentation of drafted birth dates in a similar profession, the National Football League, in which nearly all players attend 4-year college. Second, we find that the largest decrease in MLB representation among drafted men occurs for men who exit education after high school and 2-year college. Potential players appear to shift away from optimal baseball training in favor of options with draft-related benefits, interrupting the natural progress of their careers, diminishing their baseball productivity, and lowering their chances to make the major leagues. Altogether, we can attribute part of the underrepresentation and reduced productivity of players born on drafted days to career interruptions more generally rather than just military service.

Our study provides useful insights for understanding the effects of military drafts and career interruptions. Most narrowly, our study provides an opportunity to dig deeper into why military drafts matter for labor market outcomes. The reduced productivity that we measure can help explain previously measured wage effects of being drafted (e.g., Angrist 1990). Also, such productivity losses and labor market penalties can result not only from the direct effects of participating in war but also from incentives embedded in the draft that rearrange early career training and experience. This latter result connects to the broader literature on career interruptions. We demonstrate that a temporary shock to early career training and experience can have persistent negative effects on long-term labor market outcomes because interrupting the natural course of the career lowers productivity. In high-skill labor markets, rigid structures of early career experience may exist because such rigidity assists in the accumulation of human capital. In this context, labor market penalties for career interruptions simply reflect the penalty on productivity that such interruptions entail. Overall, we extend the study of the Vietnam War draft to professional baseball. We find that interrupting a player's career with the draft lowers his productivity, making him less likely to arrive in MLB.

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