# If You Build It:

## Rethinking the Market for Major League Baseball Front Office Personnel

Lewis J. Pollis[1]

Senior Honors Thesis

Brown University

Department of Economics

April 2014

[1] The people who helped to shape this project are too numerous to list, but I would like to specifically single out and thank Kenneth Chay for advising me on this paper for more than a year; Brian Kenny and Michael Tesler for their early enthusiastic encouragement; Matt Swartz, Stephen Loftus, and Andy Andres for their comments on earlier drafts of this paper; Keith Woolner, Kevin Tenenbaum, and William Zimrin for their general advice and insight; and Andrew Pollis, Pavia Lewis, and Madeline Pollis for their love and support. In the interest of full disclosure I have worked for the Cleveland Indians and I will be starting an internship with the Cincinnati Reds shortly after this paper is published, but neither team has sponsored this paper and I do not believe my connections to them have affected my research in any way, save for my experiences giving me a better understanding of how Major League Baseball front offices operate.

## Abstract

Recent advances in research and technology have allowed teams and fans alike to quantify the values of Major League Baseball players in terms of concrete estimates of how many wins and how much money they are worth to their teams. Yet there has been no like movement to seriously study MLB teams' front offices and quantitatively evaluate the baseball operations employees whose research, advice, and decisions shape their teams' compositions and strategies long but whose salaries imply that their effects on their teams' win-loss records are generally insignificant. This paper begins by exploring and critiquing the theory behind and empirical manifestations of the labor markets for baseball operations employees and MLB players. I then test the most important assumption on which the rationality of the current non-player labor market hinges — that there is little meaningful variation in individual value among front office personnel — by using concrete transaction data and random effects modeling to estimate the variation in player-investing skill at the general manager level. I find that a single standard deviation of player-investing ability at the GM level (including the contributions of employees working under the GM) is worth nearly eight wins a year, which would have had a market value of $53 million in the 2013 free agent market. Given that the highest-paid executive in the game is paid less than $4 million, this suggests the existence of a massive inefficiency in the market for GMs. Finally, I explain how my findings could be generalized throughout the ranks of an MLB front office and how they change the way teams should conceive of and act in the non-player labor market.

"Your goal shouldn't be to buy players.

Your goal should be to buy wins."

— *Moneyball* (2011)

## I. Introduction

The rise of advanced statistics has fundamentally changed Major League Baseball. Though the quest for better numbers in our national pastime is more than a century old, the advances made in recent years have completely reshaped our understanding of how baseball works, from roster construction and in-game strategy to player development and evaluation.[2] A field of new baseball statistics known as "sabermetrics" — an homage to the Society for American Baseball Research, of which many of the field's leading thinkers are members — and the proliferation of data online have allowed teams and hobbyists alike to quantify the game in a way that previous generations of fans and baseball insiders could never have imagined (and many arithmophobic fans and insiders in the current generation still prefer not to imagine).

However, there is one major facet of the game that (to my knowledge) has never been the subject of serious public study: the front office. From the general manager down

[2] Though the rapid pace of statistical advances and their growing acceptance among the baseball are new phenomena, as Alan Schwarz (2004) observes, statisticians have been bemoaning the problems with common baseball statistics since long before the computerized age. "Would a system that placed nickels, dimes, quarters, and 50-cent pieces on the same basis be much of a system whereby to compute a man's financial resources?" sportswriter F.C. Lane wrote of batting average, the most popular statistic for judging hitters, in 1916. "Pretty poor system, isn't it, to govern the most popular department in the most popular of games?"

to the junior-level scouts, analysts, and player developers, the sheer quantity of time and effort that goes into building an MLB team is far larger than many fans realize. Among those who follow the game closely enough to care about the inner workings of a team, the best GMs are revered as forward-thinking visionaries who know how to game the rest of the league.[3] Yet the success or failure of any decision in baseball largely comes down to luck; there are far more bright baseball minds in and hoping to break into the industry than there are positions to fill; and, most concretely, the salaries paid to non-player MLB team employees imply that they are far less valuable to their teams than even a below-average player.[4] These competing notions reveal a fundamental tension in the way we perceive how baseball teams are built: Either some front office personnel truly have the ability how to run teams better than their peers, or it matters very little whom a team hires for these jobs.

Much of the recent literature about the values of employees in other industries has been criticized because workers' actions and their specific effects are not fully observable from the outside. When looking at a teacher's value-added scores, for example, it is difficult for researchers to convincingly establish the causal relationship between an instructor's teaching methods and the effect he or she had on his or her students' test

[3] "In any other industry the Oakland [Athletics] would have long since acquired most other baseball teams, and built an empire," Michael Lewis (2003) writes of the team's ability to field competitive teams year after year with one of the lowest payrolls in the league. "But this was baseball, so they could only embarrass other, richer teams on the field, and leave it at that."

[4] Dave Cameron (2011) is one of the most prominent baseball analysts to endorse these factors as the primary means for valuing front office personnel: "Smart, analytical baseball executives have essentially become commoditized — there are a few thousand Ivy-league graduates willing to work for peanuts and cracker jacks pounding on these team's doors every year, and there is a seemingly never-ending supply of wiz kids attempting to climb the ladders of Major League front offices."

scores because they cannot isolate a teacher's specific individual actions (or inactions) and assess how well each of them worked — not to mention the fundamental uncertainty about how well standardized test results reflect what children have learned. This applies to much of the work that MLB teams' front offices do as well. Even if none of the countless decisions that go into evaluating and developing players and strategies were proprietary, it would be nearly impossible to estimate the tangible effect that an internal action or decision a baseball operations employee took or made had on his or her team's final position in the standings.

Yet there is one category of MLB team employees' actions that can be isolated and assessed: player transactions. By looking at free agent signings and trades, we can identify specific decisions that MLB general managers have made and estimate the degree to which these investments added value to their respective teams. In so doing I estimate that a single standard deviation of player-investing ability at the GM level (if it manifests itself in both signing free agents and making trades) is worth approximately 7.6 wins per season to the average team. Based on my estimates of the cost of a win, a player who provided that production would have cost a team over $53 million in the 2013 league-market, yet the highest-paid baseball operations executive in the league made less than $4 million in 2013.[5] This suggests that an extra dollar spent on front office talent goes much further than a dollar spent on players in the current MLB labor market.

[5] Like most department and position designations within professional baseball organizations, "baseball operations" is an ambiguous term that depending on the context could mean anything from the totality of assembling and maintaining the active roster of players to the day-to-day management of the equipment in the team clubhouses. In this paper I use it as an umbrella term that encompasses amateur and professional scouting, player development, analytics and research, roster management and transactions, and everything else that non-player team employees do that is directly related to baseball.

The direction of this paper is as follows. Section II explores the current market for MLB front office employees and critiques the fundamental assumptions on which its rationality hinges. Section III describes the data I use for my research. Section IV explains my estimates of the price of a win on the free agent market (the only place where teams compete for players by bidding primarily with money) for each season in my sample and how that relates to the implied value of a win and teams' optimal hiring strategies. Section V describes my methodology for estimating the variation in player-investing ability at the general manager level and translating it into concrete value, and Section VI provides my results. Section VII discusses the implications of my findings and how they should affect teams' approaches to hiring baseball operations personnel. Section VIII suggests opportunities for future researchers to expand upon my work, and Section IX summarizes and concludes the paper.

## II. Background and Economic Theory of the MLB Non-Player Labor Market

At the end of the 2002 Major League Baseball season, Oakland Athletics General Manager Billy Beane arranged to trade himself to the Boston Red Sox, who were offering him both a higher salary for himself to be their new general manager and a larger payroll with which to build a roster. Beane's shrewd negotiating skills and willingness to rethink conventional baseball wisdom had helped him to shape one of the poorest teams in the game into a perennial playoff contender. So great was his ability to swindle his peers in trades, Michael Lewis (2003) writes in *Moneyball: The Art of Winning an Unfair Game*, that some of his counterparts from other teams were scared to deal with him. So when the Red Sox sought to hire a new general manager who would fundamentally change the way

the team was run, they tried to lure Beane away from the Athletics.

Paul DePodesta, Beane's right-hand man and acting successor, eventually agreed to trade his boss to Boston in exchange for two minor-league players. One of the players who were to go to Oakland was Kevin Youkilis, whose planned inclusion in the deal is particularly noteworthy. To most teams Youkilis was an unexceptional minor leaguer with an unathletic body and no outstanding skills, and it is probably fair to say that few in the game outside of Boston and Oakland saw any promise in him.[6] But Beane had long coveted Youkilis. To him and his advisors in the Athletics' front office, Youkilis was the "Greek God of Walks," an elite prospect with emerging power and plate discipline beyond his years. They were right: Youkilis ended up developing into a very good player and went on to thrive with the Red Sox for years.[7] But it is striking that the cost of a GM with the ability to identify a hidden gem like Youkilis was two minor league players in whom most of the rest of the league saw little value.

Though Beane ultimately decided to stay in Oakland, the episode remains a fascinating illustration of how MLB franchises value the people who put their teams together relative to the value of the players they acquire. Those inside the Athletics' front

---

[6] At one point in *Moneyball*, Beane realizes that Boston will never trade Youkilis to him, so he tries to convince another team's GM to demand Youkilis in a trade he was already negotiating with the Red Sox and then flip him to the Athletics. He soon discovers that the other GM has never even heard of Youkilis. "He's nobody," Beane tells his confused counterpart. "He's just a fat Double-A third baseman."

[7] As of the beginning of the 2014 season, after spending parts of 10 seasons in the majors (mostly with Boston) Youkilis has a career .281/.382/.478 batting line with 150 home runs, 618 RBI, and 28.4 wins above replacement (according to FanGraphs' model). He was also a key part of the Red Sox' 2007 World Series-winning team, hitting .388/.475/.755 with four home runs in the 2007 playoffs. He signed a contract with the Tohoku Rakuten Golden Eagles of the Nippon Professional Baseball league in Japan for the 2014 season.

office knew better than anyone how important Beane was to the organization, yet DePodesta agreed to receive a pair of unproven minor league players in exchange for the man who ran the entire operation. In other words, one of the game's then-premier experts on identifying and exploiting inefficiencies in the market for baseball players had no qualms about trading the goose for a single golden egg.[8]

Nine years later, Theo Epstein, whom Boston had promoted to General Manager after Beane backed out of the deal, found himself in a similar situation.[9] Faced with internal discord after the Red Sox suffered an historic collapse at the end of the 2011 season, Epstein left Boston to accept a job as President of Baseball Operations with the Chicago Cubs — again raising the question of a top baseball executive's value. Some speculated that Boston would demand the Cubs' then-top pitching prospect, Trey McNutt, in exchange for Epstein. However, the Red Sox eventually settled for two less-prestigious players, and at the time most analysts seemed to agree that Chicago did not need to give up a top prospect in exchange for a front office employee.[10] This sentiment is difficult to reconcile with the facts that Epstein was generally regarded as one of the best general managers in the game and that the Cubs were about to make him the highest-paid baseball operations executive in the history of the sport. Would not an elite GM be

---

[8] As the story is related in *Moneyball*, Beane was fully aware of the disconnect between his true value and perceptions of what a general manager was worth. "Billy was worth, easily, more than any player; his services were more dramatically undervalued than those of any player he'd ever acquired," Lewis writes. "He could see only one way to exploit this grotesque market inefficiency: trade himself."

[9] It was Epstein who, as Assistant General Manager, had convinced his bosses not to trade Youkilis to Oakland in at least one of Beane's earlier attempts to acquire him.

[10] Cubs fan and baseball writer Bradley Woodrum (2011) summed up the prevailing sentiment in the title of an analysis he wrote in the midst of the negotiations: "Trey McNutt for Theo Epstein: Eh, Maybe."

able to find and acquire several more players of McNutt's caliber to replace him?[11] If the perception that Beane's value was on par with Youkilis' raises some questions, the implication that Epstein was worth less than McNutt is downright baffling.[12]

Alternatively, one could express this potential undervaluation in terms of dollars. Below I estimate the cost of a win purchased by signing a player through free agency to have been $7,032,099 for the 2013 season. Yet the highest-paid baseball operations executive in the game (Epstein) made just $3.7 million in 2013, implying that there was not a single non-uniformed MLB team employee who was worth more than about half a win to his or her team— clearly out of line with popular perceptions of how much of a difference a single executive can make. "GMs are just on a different scale," Bradley Woodrum (2011) observes. But that such a phenomenon exists in the market does not mean that it represents rational behavior.

This possible market inefficiency could include lower-ranking team employees as well. If teams are willing to pay $7 million per additional win, that should hold no matter where those wins come from. Consider an advance scout who sees that an opposing

[11] McNutt, now 24 as of the start of the 2014 season, has seen his stock fall considerably since the Epstein compensation negotiations thanks to injuries and stalled development. Now a relief pitcher instead of a starter, he spent his third season at the Double-A level in 2013 and pitched to an unremarkable 4.60 ERA in 27 games. He is no longer considered a top prospect.

[12] After he accepted the position in Chicago, Epstein quickly hired San Diego Padres General Manager Jed Hoyer as the Cubs' GM. The Cubs originally agreed to send a minor league player to be named later to the Padres as compensation for Hoyer, but the Padres ended up dropping their compensation claim at the end of the 2012 season (a year after Hoyer went to Chicago). Hoyer did not have the same reputation as an elite GM that Beane and Epstein had at the times of their respective trade negotiations, but it is telling that the Padres let their GM go for nothing.

pitcher has a habit of tipping his pitches that no one else had noticed.[13] If the scout's team uses that knowledge to win a game that it otherwise would have lost, the effect of that observation on the team's win-loss record is equal to the boost it would expect to get from spending $7 million on a player.[14] However, this potential value does not line up with what baseball operations employees earn. Entry-level front office positions are extremely competitive — millions of people have dreamed about working for an MLB team and there are only 30 possible employers — yet even highly qualified, well-educated professionals usually start out as interns making close to the minimum wage with no guarantee of future advancement. Every team's hiring and salary structures are different, but Tom Tango (2010) estimates that junior front office executives generally make as little as half what they could get if they worked in another industry.[15]

---

[13] An MLB pitcher relies on deception to get hitters out, and his ability to fool a batter stems largely from an opposing hitter's uncertainty about what type of pitch he will throw. A pitcher is said to be tipping his pitches if he inadvertently reveals what pitch he is throwing before it leaves his hand through visible inconsistencies in his mechanics for throwing different pitches. A hitter will have a far easier time making solid contact if he knows to look for the pitcher's tells, so if a scout notices that an opposing pitcher is tipping his pitches, his or her team can use that to its advantage during the game.

[14] Expressing the expected outcome of a game as a binary is helpful for this thought experiment, but it is a gross oversimplification of how baseball actually works. Though it would be impossible to retroactively measure the concrete impact this way, a more realistic model for the value of the scout's observation would be to estimate the amount by which it increases his team's chances of winning and quantify it in terms of the added win expectancy. For example, if the team originally has a 40 percent chance of winning the game and the knowledge that the opposing pitcher is tipping his pitches increases the team's odds of winning to 70 percent, that observation is worth 0.3 wins (the projected wins added after the expected value of the game's outcome rose from 0.4 wins to 0.7 wins) or $2.1 million in the 2013 season. Ultimately it is only the final result that matters, but given that both teams had nonzero chances of winning with or without the scout's observation it is impossible to demonstrate causality.

[15] "A few years ago, when I quoted my price to a team, it wasn't even close to what [the prospective employer] was thinking," Tango, who now works for the Chicago Cubs,

The typical explanation for why wages are so low for front office jobs is the existence of large compensating differentials. Employees agree to take salary discounts because they receive substantial nonmonetary utility from working in baseball — or, in economic terms, the perks of working in baseball (material or otherwise) shift the supply curve for front office labor to the right. Perhaps more importantly, anecdotally speaking the supply curve seems almost perfectly inelastic around the current equilibrium point. That jobs in baseball pay relatively poorly has not squelched the competitiveness of the application processes for openings nor the zeal with which aspiring employees seek to break into the industry.[16] MLB player agent Joshua Kusnick (2014) sums up the current state of the market well: "Teams always have the advantage when hiring, because so many people are willing to work for next to nothing just to get their foot in the door." However, the rationality of this model hinges on three key assumptions that may be mistaken: i) there are no meaningful differences in ability and value between prospective hires; ii) any additional baseball operations employees hired beyond the current market equilibrium point would be essentially valueless to their teams; and iii) a potential hire's willingness to take a salary cut to work in baseball is unrelated to how qualified he or she is for the job.

The most important assumption for explaining the rationality of the predominant

---

recalls. Tango already had an established career as a professional in another industry, and the job offer was for "my salary when I came out of college."

[16] Jeb Lund's (2013) profile of job-seekers at the MLB Winter Meetings offers a glimpse into the competitiveness of the application process and the enthusiasm with which well-qualified young professionals pursue even menial, low-paying positions in baseball. For aspiring baseball operations employees, Lund writes, getting inside the game "already compensates you so much inwardly that the outward trappings of compensation, like actual money, are hardly necessary."

model for the MLB non-player labor market is that of relative homogeneity across the population of prospective hires. For MLB team employees, Kusnick notes, "At some point you price yourself out and end up getting replaced by people who are the same age you were when you started." From a team's standpoint this strategy makes sense only if the difference in value between the established employee and his or her replacement is smaller than the difference in their wages. "The supply of qualified candidates is so high that I'm not sure that throwing a lot of money at an established guy is actually going to bring you a significant upgrade," Dave Cameron (2011) writes in support of this viewpoint. However, anecdotally speaking the assumption that prospective front office employees are generally interchangeable seems dubious. It would be difficult, for example, to read *Moneyball* without prior prejudices and not come away with the impression that certain key members of the Oakland Athletics' baseball operations department were significantly better at their jobs than not just their counterparts with other teams but even some of their peers within the organization.[17]

Even if this potential heterogeneity were concentrated in a small proportion of potential baseball operations employees, its presence should affect the way organizations approach the labor market. Consider how teams think about players. In any given year there are hundreds of players who are plausible candidates to play outfield for an MLB

[17] The key phrase here is "without prior prejudices." *Moneyball* was a surprisingly controversial book in the baseball world, as its positive portrayals of statistical analysis in baseball elicited visceral anger not just from arithmophobic fans but from prominent sports analysts and even employees of other teams (some of whom were so outraged that they believed Beane had orchestrated the publication of or even written the book himself). Eleven years after its publication the hysteria has died down and it is probably fair to assume that most MLB teams' decision-makers at least have open minds about the new generation of baseball statistics, but while the field of sabermetrics has become more mainstream it has by no means gained unanimous acceptance among more traditionally oriented baseball insiders, media members, or fans.

team that season (plus millions more who would be willing but are unqualified). Looking at the vast majority of that population — say, after the best few dozen players — it matters very little whom among them a team promotes from the minors or acquires to fill an open outfield spot because the differences between their projected values are quite small. Yet the market for outfielders is defined not by the majority of players whose values are roughly interchangeable but by the minority of exceptional outfielders who stand above the rest. That the New York Yankees could have signed any number of inferior free agents to play center field for close to the league minimum did not stop them from signing Jacoby Ellsbury to a $153 million contract after the 2013 season.

It is unlikely that the best quantitative analyst or minor-league scout is worth as much to his or her team as an All-Star outfielder. But when teams spend several million dollars to win an extra game, even a very slight variation in skill among possible employees should lead to far greater competition in bidding for at least the best job candidates. The assumption of homogeneity (or small heterogeneity) across front office employees is the main hypothesis I test in this paper.

Relatedly, that teams do not take greater advantage of the inelastic supply of aspiring baseball operations employees makes sense only if the next employee hired by a team past the current equilibrium point would have no significant effect on his or her team's projected performance. This notion of drastically diminishing marginal productivity for front office labor works with the assumption of value homogeneity to keep wages down and discourage competition for job candidates between teams. When labor demand is nearly fixed, noncompetitive, and significantly lower than labor supply, the employers have all the leverage in hiring negotiations. However, this assumption is

questionable as well. Considering again the enormous sums of money teams are willing to spend to make themselves marginally better, if the next hire provides even a fraction of a win's worth of value each year while making standard market wages he or she would provide his or her employer with a phenomenal return on investment. An employee would have to be almost literally worthless in terms of his or her effect on his or her team's win-loss record for him or her to not be worth his or her salary. Further, this idea ignores the potential agglomeration effects of bringing multiple insightful baseball minds together, which would mitigate the impact of the decreasing marginal productivity of additional hires.[18]

Finally, the prevailing model also assumes that those who are willing to accept large, negative compensating salary differentials to work in baseball are just as qualified as the marginal applicants for whom substantially lower salaries are deal breakers, or at least that the difference would not be worth what it would cost to hire applicants with higher income demands. This assumption is more believable than the previous two. Presumably both being willing to take a large pay cut to work for an MLB team and being sufficiently knowledgeable about baseball to be a top candidate in a highly competitive job market require a strong passion for the game, so there is probably a correlation between a prospective hire's qualifications for a baseball operations job and the nonmonetary utility he or she would receive from it. However, if the job in question requires skills that are not specific to baseball operations work, the stronger a candidate is in terms of his or her broadly applicable credentials, the better the job he or she would be

[18] Based on personal experience ranging from doing casual independent research to working for an MLB team, I can say that the opportunity to discuss ideas and projects both with like-minded peers and baseball people with different perspectives on the game is invaluable to high-level baseball research and decision-marking.

able to obtain in another industry and the higher the opportunity cost he or she would face by working in baseball. The truthfulness of this assumption thus likely varies based on how marketable the requisite skills for the front office job in question would be outside of baseball — the difference between an elite hire and an ordinary candidate's willingness to work in baseball for less money might be relatively small among scouts or player developers but would probably be quite large among quantitative analysts.[19]

If instead there is substantial variation in value among baseball operations personnel, our conception of the labor market should be radically different. Each prospective employee should be seen as having his or her own market with a perfectly inelastic supply curve kinked from not working in baseball to working in baseball at his or her individual industry reservation wage. Every organization would be represented by its own discrete demand curve, which would be perfectly inelastic and kinked from hiring to not hiring at a wage equal to how much value the team thinks he or she would add. We would expect to see heterogeneity in the demand curves based on each team's needs and differing estimates of how qualified the prospective employee is. If at least one organization is willing to pay more than the individual's industry reservation wage, he or she will take a job with the team that offers the best combination of salary and non-material workplace perks. If not, he or she will go to work in another field.

Matt Swartz (2013) offers three good theories for why the inelastic-supply model is pervasive throughout the league beyond these assumptions, though from a team's

[19] Anecdotally speaking, this fits with what I have heard from several possible applicants about their decisions not to seek front office jobs. I know of several excellent sabermetricians who have chosen to remain hobbyists or freelance as part-time consultants rather than give up their careers and go to work for an MLB team full-time because of the large differences between the salaries they would be giving up by leaving another industry and what they would have gotten working in baseball operations.

perspective none is a rational explanation for the lack of demand-side competitiveness in the non-player labor market if there exists substantial heterogeneity in value among prospective hires. Two of Swartz' ideas seem like plausible approximations of how the people who run MLB teams think: i) teams fear internal capacity constraints that could render hiring additional analysts unhelpful beyond basic decreasing marginal product (i.e., the difficulty of coordinating projects among more employees and the possibility of confusing decision-makers with too many opinions and perspectives); and ii) they lack the means to accurately estimate the value of a prospective hire who is trying to break into the industry for the first time or whose previous work for other teams was confidential. However, capacity constraints would not be a problem in the long run if teams were willing to restructure their baseball operations departments to accommodate more employees — for example, most teams operate effectively with dozens of travelling scouts because they have been folded into the structure of the organization — and in the short term the issues could be minimized through teleworking and establishing clear chains of command for new hires.[20]

The uncertainty argument also fails to hold up under scrutiny. No employer in any industry knows exactly how much a job applicant is worth before he or she is hired; if MLB teams (or any firms) are unable to discern substantial differences between job applicants, how do they ever decide whom to hire? Even within baseball this problem is not unique to the front office. Though their work is admittedly more visible than baseball operations employees', projecting players' future performances is far from a perfect

[20] It is probably not a coincidence that the organization that is most known for hiring baseball outsiders to work on analytical projects remotely, the Tampa Bay Rays, is generally considered to have one of the best analytics departments in the game.

science, and the physical nature of a player's job means he is much more likely to be incapacitated due to an injury or other physical issue than a member of the front office staff. Not to mention that many aspiring baseball operations employees have active online presences in the baseball blogosphere so teams can get a decent idea of an applicant's ability by reading his or her record of published work.[21] Also, the uncertainty argument would not have made sense for someone like Beane or Epstein, who at the times of their respective self-trade negotiations were widely considered to be among the best general managers in baseball.

Swartz' third explanation is a better defense of the rationality of the current market: teams may see the choice of whether or not to bid up prices in the non-player labor market at any given time as part of a series of repeated cooperative games in which MLB teams are all better off not upsetting the status quo. "If say the [Houston] Astros decide they are going to pay a lot more than what everyone else is paying but everyone notices and starts bidding up analysts, they are worse off than when they started," Swartz writes. Yet just as Beane's Oakland Athletics famously benefitted from taking advantage of the undervalued market for players with high on-base percentages before the rest of the league caught on, if the popular conception of the non-player labor market is incorrect, the first team that begins to bid marginally more than the market price for undervalued front office personnel will end up having gained a relative advantage over its 29 competitors — especially if the organization can negotiate the inclusions of non-compete agreements in its new hires' contracts to prevent them from leaving for higher salaries

[21] Rob Neyer (2014) notes that the online world of public baseball research is a crucial component in teams' current approaches to the market for statistical analysts. "It's probably more efficient to let the internet serve as a sort of farm system," Neyer writes, "than lock up a bunch of wanna-be analysts straight out of college."

when the rest of the league catches on.[22] More importantly, this theory mistakenly assumes the existence of either a league-wide openness to change or a general awareness of the market inefficiency that seem uncharacteristic of the industry at large. That not every team has seriously integrated sabermetric analysis into its player evaluations and decision-making processes more than a decade after the publication of *Moneyball* speaks to baseball's slowness to conform to new ideas, and if teams thought they were getting such phenomenal returns on investment from their non-player employees they would expand their baseball operations departments substantially to take advantage of this vast supply of undervalued labor. Finally, the rationality of any one team's preference to maintain the status quo is contingent upon the assumption that none of the other 29 organizations will ever challenge it either. If a market correction of such an inefficiency is not wholly evitable, a team's best response is to be the first to take advantage of it.

As an unrealistic but theoretically possible example of this potential market inefficiency, consider a team that is deciding whether to spend $7 million on one or more players in a free agent market similar to the 2013 incarnation or on its front office. The expected returns from spending $7 million on free agent players would equal one win. But if those funds were put towards the front office, the team could offer to hire almost any non-uniformed baseball operations employee in the game (including highly respected incumbent general managers) as its GM for $7 million and have it represent at least double his or her current salary. If there were significant heterogeneity in skill among

[22] MLB teams are prohibited from negotiating with another team's employee without the prospective hire's current employer. But if the market changed and teams' willingness to pay for established front office personnel increased, without a non-compete agreement to stop him or her an underpaid executive might simply quit his or her job in search of a more lucrative opportunity with another organization.

general managers, one would think that adding one of the brightest baseball minds in the world would lead to more than one win on an annual basis. Or perhaps the team could hire the 100 best available or aspiring front office employees at the well-above-market entry-level salary of $70,000 per year. Would the collective fruits of their observations, research, and manpower be worth more than one win over the course of a 162-game season? If so, that represents an important inefficiency in the baseball labor market: the cost of a win is cheaper when it comes from a baseball operations employee than when it comes from a player, meaning that an extra dollar is better spent on hiring front office talent than on signing players.

**III. Data**

As with a worker in any industry, it is difficult to estimate the concrete value that a non-player MLB team employee adds to his or her organization. No two teams have the same organizational structure, so it is impossible to directly compare executives below the top level. And even if there were league-wide uniformity, a smart GM will consider the perspectives of several different scouts, analysts, and advisors before coming to a decision, making it hard to isolate any individual's impact.[23] More importantly, almost all of the work front offices do to build their teams happens out of the public eye, either because most outsiders would not care (ESPN does not run a special segment every time a marginal prospect makes a mechanical adjustment in the low levels of the minor leagues) or because they do not want anyone else inside the game to know — as Tom

[23] The exclusive use of masculine pronouns to describe general managers is unfortunately appropriate. No MLB team has ever had a female GM, and even as baseball operations employment has become more meritocratic it remains a heavily male-dominated field.

Verducci (2011) notes, Billy Beane found it much harder to exploit inefficiencies in the market for players after his methods were made public in *Moneyball*. Given these limitations, it would be impossible to identify the responsible decision-maker(s) and the concrete effect(s) for every internal action an MLB team takes.

With that in mind, I seek to estimate the impact of team-running skill by examining decisions that are observable: player transactions. Specifically, I look at trades and free agent signings, which can be seen as economic investments in the market for players. For a free agent signing, I define the team's investment as the player's salary and the return as the market value of the player's production over the life of the contract. For a trade, I define the investment as the market value of the post-trade production of the player(s) the team traded away and the post-trade salary it took on for the player(s) it acquired, and the return as the market value of the post-trade production it received from the player(s) it acquired plus the post-trade salary it avoided paying to the player(s) whom it traded away (adjusted for any money that changed hands as part of the deal). I measure the ability to run a team better than one's peers by estimating how much of the variation in returns on player investments can be attributed to individual GM skill and organizational infrastructure. Unlike other recent attempts to estimate individual value-added numbers with econometric methods for workers in other industries (teachers, CEOs, etc.), this approach is based on specific, analyzable decisions that GMs have made or authorized.[24]

[24] General managers delegate authority in different ways, with some leaning heavily on the recommendations of their advisors and assistants or even allowing them to make decisions on their own. Yet ultimately the buck stops with the GM: even if a transaction was not his initial decision, the surrogate is someone he chose to hire (or at least has

Transaction and salary information come from a manually edited database based on a data dump purchased from Gary Cohen of The Baseball Cube.[25] I examine transactions from November 1995 through September 2013 so as to cover all full seasons since the 1994-95 player strike. (Later, in building the models for attributing credit for variations in returns on player investments to general managers and teams, I limit this dataset to include only deals in which all involved players had subsequently been granted free agency, been released, or retired by the start of the 2013-14 MLB offseason.) I assume salaries for players involved in midseason deals to be prorated portions of their annualized values. After acquiring and formatting the data, I verified all the information against other sources and fixed errors, filled in missing transactions, and removed redundant entries to the best of my ability.[26] My supplementary sources included Baseball-Reference, Baseball Almanac, Baseball Prospectus, MLB Trade Rumors, *USA Today* and CBS Sports' salary databases, other reputable-seeming websites, contemporary news articles, and MLB team employees.

To measure player production I use a statistic called wins above replacement. WAR is an estimate of how many wins a player was worth over the course of the season

---

chosen not to fire) performing the responsibilities he delegated to him or her and has chosen not to take back.

[25] The data he provided me can be found on the player pages of thebaseballcube.com.

[26] The only aspect of the transactions I included that I believe includes systematic errors or omissions is the money transfers that are sometimes included in player trades. Major League Baseball and several individual teams consider the details of these cash transfers to be confidential, and in most cases the amounts are trivial by baseball standards (even as low as one dollar) so sportswriters do not usually pursue the information except in particularly high-profile trades. I used specific figures or made informed estimates when I could find them in credible media sources or get them from MLB team employees, but for the approximately 50 trades that I identified as involving cash transfers of unknown size the best I could do was assume the money was negligible and input it as zero.

relative to a hypothetical ubiquitous "replacement-level" player, a composite projection for the caliber of player one could recall from the minor leagues, costlessly acquire from another team, or sign via free agency for the league minimum salary at any time. Specifically, I use FanGraphs' typical offensive WAR model (a function of a player's hitting, fielding, and baserunning values) for position players and FanGraphs' RA9-WAR model for pitchers (calculated from a pitcher's innings pitched and neutralized earned run average) and add them together to include both sides of the game for pitchers who hit (as they do regularly in the National League) and position players who pitched.[27] Assuming the player in question's team did not have a high-quality replacement waiting in the wings, WAR can be described as a measure of how many more wins his team won with him there than it would have without him.[28]

For some perspective, a team of 25 replacement-level players (or some

---

[27] I use FanGraphs' WAR models instead of others' (Baseball-Reference and Baseball Prospectus' competing models are the most popular alternatives) for two main reasons. The first is that FanGraphs is the most transparent in its methodology, which allows for greater confidence in its results (see generally the FanGraphs *Saber Library* section on WAR). Second, FanGraphs' RA9-WAR is in my judgment the best publicly available measure of how valuable a pitcher is in terms of his results regardless of how much he was helped or hurt by the fielders behind him. My desire for this study to be based on actual empirical value led me to use the most results-based measures I could, and for the sake of internal consistency once I chose one of FanGraphs' models for pitchers I did not want to use a different source for position players.

[28] Though this assumption does not always hold empirically, it is a good rule of thumb that a team will make a trade from strength if its replacement level for a given player is significantly higher than it would be to the rest of the league. As an example, consider the Texas Rangers' November 2013 trade of second baseman Ian Kinsler to the Detroit Tigers. Kinsler probably projected to be worth approximately three wins above replacement for 2014, but he would have been worth less than that to the Rangers because they had top infield prospect Jurickson Profar, whom they expected to be substantially better than replacement-level in 2014, waiting in the wings. Kinsler was worth less to Texas than he would have been to another team, so the Rangers traded him to a team that valued him more highly than they did.

combination of 25 players whose combined WAR is equal to zero) would project to finish the season with a record of 48 wins and 114 losses. A league-average everyday position player or starting pitcher will finish with about two WAR over the course of a season. In 2013, Los Angeles Angels of Anaheim outfielder Mike Trout led all of baseball with 10.4 WAR. By RA9-WAR pitcher Walter Johnson's 16.3 wins in 1913 were the most any player has earned since what would become the twin-league Major League Baseball structure began to take shape in 1903, while Babe Ruth's 15.0 WAR in 1923 represents the most valuable season ever for a position player.

WAR does have its limitations. It does not take situational performance into account — it is generally accepted in the sabermetric community that what fans perceive to be certain players' abilities to come through in the clutch is mostly random variation from small sample sizes, but regardless of whether clutchness is a real skill, a home run is more valuable with the bases loaded in a close game than with the bases empty in a blowout.[29] WAR has no mechanism for measuring a player's leadership skills or his effect on clubhouse chemistry, and it does not include a player's performance in the games that matter most: the playoffs. Further, that there exist so many different methods for calculating WAR should give an analyst pause before fully trusting any single model. However, WAR is on the whole the best single statistic we have for estimating a player's value. A more detailed description of how WAR is calculated is offered in Appendix A.

In evaluating player transactions, I use actual observed WAR for players rather than projected estimates of what the GM and his team might have expected to get from

[29] "Producing wins at the plate is about 70 percent a matter of overall hitting ability, 28 percent dumb luck, and perhaps 2 percent clutch- or situational-hitting skill," Nate Silver (2007) concludes — and even an effect of that magnitude that, he notes, would be "more than previous research would indicate."

their players. There are a number of reasons for this, including that in-a-vacuum projections do not consider that a player's value may not be homogeneous across different teams and that it is impossible for an outsider to have access to all the proprietary information that a GM might have used to make his decisions. But the most salient motivation for using observed production over projected value is the importance of empiricism. If the goal is to assess a GM's actual concrete value, we must invert the typical framework for analyzing teams' decisions and look at the results instead of the process. If a team makes signings or trades that seem wise at the time but do not work out, do the reasons for the decisions ultimately matter? In judging the wisdom of a particular trade or signing what matters is how the decision-maker synthesized and used the information he or she had at the time, but in terms of tangible value, sound decision-making is important only insofar as it leads to better results.[30] For that reason (along with the paucity of reliable data for the specifics of rejected contract offers) I also make no attempt to account for free agents that teams pursued but were outbid for or trades that teams discussed but did not actually make — in terms of concrete results such unconsummated overtures are irrelevant because they led to no action and at least 28 other teams must have declined or failed to sign or trade for the player(s) in question too.

Finally, I use web resources and contemporary news articles to assess who the primary baseball decision-maker was for each team at the time of each transaction. This

[30] Consider as an example the Cleveland Indians' trade for starting pitcher Derek Lowe before the 2012 season. Lowe looked like a very good acquisition at the time but ended up struggling in Cleveland when he suddenly and unexpectedly saw his strikeout rate fall to less than half of his career average. "Even if you had made the irrational pre-season prediction that Lowe would lose his roster spot out of pure ineptitude," Lewis Pollis (2012)(a) writes, "you would have been basing it on a problem that didn't exist yet." It was still a smart trade given what the team knew about Lowe at the time, but ultimately the Indians were no better off for having made it.

is usually the general manager, but that is not always the case — for example, President of Baseball Operations Theo Epstein outranks General Manager Jed Hoyer in the Chicago Cubs organization. I then match every signing and trade with the executive responsible for the transaction.

## IV. The Market for Wins and its Implications

The ability to treat player transactions as economic investments requires the existence of a specific monetary value for how much teams are paying per win (as defined by WAR) across the league. I calculate the amount teams have paid to buy wins for each season from 1996 to 2013 in the one place where teams bid for players in something resembling an open and perfectly competitive market: the free agent market.

It is important to first define and distinguish between the price of a win and the value of a win. How much a win costs is a function of how much money teams spend on wins and how many wins are available to be purchased (or, in the context of a single transaction, how much the team spent to acquire the player and how many wins he ultimately provided). This is not the same as the marginal revenue a team would get from winning another game or how much wins are worth to teams (including nonmonetary utility). The cost of a win is related to the latter (as discussed below), but they are conceptually and empirically different.

It is also worth noting that the cost of a win should be homogeneous across the league. It is a common fallacy among baseball analysts to think that big-budget teams are justified in paying above-market prices for free agents because they have more money to spend or because an extra win would bring in more revenue than it would for some other

organizations. However, being willing to pay more than the market price for a win does not mean that doing so is a rational decision. Assuming each team is a price-taker in the market for wins (as in the conception I define below), if a win costs $1 million in a given year, any team that willfully pays $2 million per win is behaving irrationally even if it considers a win to be worth $3 million. This idea may seem obvious to an economist, but it is often misunderstood within the baseball community.[31] There is some evidence to support the oft-suggested notion that the cost of a win is nonlinear — a potentially rational phenomenon in specific circumstances — but this has not been conclusively demonstrated to be a consistent trend.[32]

The cost of a win is not how much teams are ultimately paying per games won. The lowest number of games that a team that is not willfully trying to lose could win is

[31] The belief that larger-market teams need not spend their money as efficiently as small-market teams manifests itself clearly in Charlie Wilmoth's (2014) offhand remark that the Atlanta Braves will "have to rely more on making smart moves than on spending money" as their payroll shrinks relative to the rest of the league. Though it is true that a low-payroll team must get better returns on investment than its wealthier competitors in order to have a chance of winning a playoff spot, it is hard to imagine that an owner of a large-market MLB team would react well to learning that his or her front office employees thought that having a high payroll meant that they did not need to use the organization's resources as efficiently as possible.

[32] The potential rationality of there the cost of a win being nonlinear stems from the capacity constraints of 25-man MLB rosters and nine- or 10-player starting lineups: the number of players who can contribute to a team at any given time is limited, meaning there is potential value in having several wins' worth of production concentrated in a single player. For example, in a vacuum a team with two open spots in its lineup would be indifferent between signing two one-WAR players and signing one two-WAR player and promoting a replacement-level player from the minors to fill the other position. But if the team's best in-house option projects as better than a zero-WAR player, it would be better off signing one two-WAR player instead of two one-WAR players. Dave Cameron (2014)(a) presents evidence that teams indeed paid more per win in making marquee signings than they did when signing lower-quality players in the 2013-14 MLB free agent market. However, he cautions that his findings are based on only one offseason's worth of data and that they contradict previous research (see generally Matt Swartz (2012)).

not zero. According to FanGraphs' and Baseball-Reference's WAR frameworks a team with zero aggregate WAR would be expected to win around 48 games. Similarly, an MLB team cannot have a payroll of zero. Even a team that fills its 25-man roster with cost-controlled players who have yet to earn raises through arbitration would have to pay each of its players the league minimum wage; for the 2014 season the league minimum wage is $500,000, so the theoretical floor for a team's Major League payroll is $12.5 million. Further, the structure of MLB player contracts gives teams monopolies on the rights to their players and keeps non-free-agent players' salaries well below what they would receive on the open market.[33] These constraints distinguish the relationship between teams' total payrolls and performance from the cost of a win on the free agent market, the only place where wins are directly purchased with unrestricted money. The value of a player's production in a given season can therefore be interpreted as the expected value of what a team would have to pay in order to buy the wins he produced on the free agent market.

Nor is the market price of a win the same as what an average win is worth to the average team. For any given offseason, the supply of free agent wins can be imagined as approximating perfect inelasticity. Except in rare and explicitly defined cases players are not allowed to opt out of their contracts in pursuit of greater paydays if the price of a win rises; on the other hand, though some free agents will retire or go to less-prestigious

[33] For the first three or four years of a player's MLB career (depending on how much service time he accrues in his first season), his team may renew his contract on a year-to-year basis at whatever salary it wants provided it is at or above the league minimum wage. For the next three or four years the player receives gradual raises through arbitration commensurate with his performance if his team continues to tender him contracts, but even in his final year before his team's rights to him expire he would expect to make significantly less than he would as a free agent.

independent or foreign leagues if they do not receive offers they are happy with from MLB teams, those who do so are generally unexceptional players whose impacts on the supply of wins are negligible. Meanwhile, each of the 30 teams has its own nonlinear utility function from which it derives its demand for wins.[34] Looking at the market as a whole, the equilibrium price in a market with *N* wins available would be somewhere between whatever the second-most-desiring team would be willing to pay for the *N*th win after $N - 1$ wins are already spoken for and what the team that values the last available win most highly would be willing to pay for it.[35] Assuming teams are projecting the values of the players they sign with reasonable accuracy, that means that organizations generally value the wins they purchase more than they are paying for them.

Despite these differences, for the purposes of this study I believe the price of a win is a fair proxy for the value of a win for each season. Though the cost of a win is likely less than the average value of a win, teams' tendencies to overrate their players should mitigate this underestimation — if teams believe that the players they sign will provide them with more wins than they actually produce, what the average win ends up costing may be less than what teams would have been willing to pay had they projected

[34] As Vince Gennaro (2007) and Graham Tyler (2012) (among others) have noted, the value of a marginal win can vary widely based on such factors as a team's media market, the responsiveness of its fans to winning, its results from previous seasons, and the nonmonetary utility of success to its owners. The nonlinearity of a team's utility function stems from the limited number of chances for which a marginal win makes a tangible difference: a win that takes a team from second place to first place, for example, matters significantly more than a win that lifts a team from fifth place to fourth or pads a division-winning team's preexisting lead.

[35] See generally Lewis Pollis (2014)(b) for more on this conception how the price of a win is derived.

their players more accurately.[36] However, it is important to note that using the cost of a win to represent the value of a win is a necessary shortcut, and in the context of this paper it should be seen as a means of relating a team's return on investment from a transaction to the opportunity cost of the investment, not as measuring the direct effect it had on the team's utility.

Using my database of player transactions, I identify all player-seasons purchased on the free agent market (the only place where all 30 teams can compete to sign available players) between November 1995 and September 2013. When considering multiyear deals I categorize each season by when it took place rather than when the contract was signed.[37] I include non-guaranteed option years if they were exercised, so long as the salaries for the option years had been set while the players were free agents, as distinguished from later contract extensions players sometimes sign after their new teams had gained exclusive negotiating rights with them.[38] I include players coming from

[36] It would be problematic to assume that teams experience diminishing marginal utility across the entire range of possible win totals. Instead, a typical team's utility function for wins probably contains at least one or two inflection points: that the usual goal for any given regular season is to make the postseason implies that the marginal utility of a win peaks at or near a number of wins that secures it a playoff spot, and the general desire not to get worse means that a team that won $v$ games the previous year probably values its $W$th win in the current season more than it would had it won $v - 10$ or $v + 10$ games a year ago. That said, the heterogeneity in how much a win is worth across teams and owner-mandated payroll constraints suggest that the cost of a win is lower in a market with some large number $N$ wins available than it would be if there were only one win for sale, meaning there is likely to be substantial consumer surplus in the market for wins.

[37] For example, Kenny Lofton signed a two-year contract with the New York Yankees before the 2004 season. In analyzing his deal, I include his salary and WAR produced in 2004 in the calculations for the cost of a win in 2004 and I include his salary and WAR produced in 2005 in the calculations for the cost of a win in 2005.

[38] For example, Edwin Encarnacion signed a one-year deal with the Toronto Blue Jays before the 2011 season with a team option for 2012; the Blue Jays exercised his 2012

Nippon Professional Baseball in Japan if they would have been free agents in the NPB anyway, but not if they were made available through the international posting system.[39] I include bonuses, buyouts of unexercised option years, and other such payments as part of players' salaries as appropriate based on when they were paid. I assume that players signed to minor-league deals earned their full MLB salaries if they were called up to the parent club at any point during the seasons they signed for and were costless otherwise, and that players released at midseason were paid prorated portions of the league minimum for their new deals, which were then deducted from what their previous teams paid them. I ignore the values of draft picks that teams cede for signing top-tier free agents because how teams draft and develop players is too different across the league and the draft is too unpredictable to construct a precise counterfactual for how much a given draft pick would have been worth to the team that surrendered it.[40] Finally, I input the

---

option and later extended Encarnacion's contract through 2015. I include both Encarnacion's 2011 and 2012 seasons in my calculations because his salaries were negotiated on the open market, but not his 2013 season because it was part of an extension he signed after Toronto had him under team control.

[39] Until the 2013-14 offseason, the international posting system for NPB players consisted of MLB teams offering posting fees to the player's team in exchange for exclusive rights to negotiate an MLB contract with the player, with the rights going to the highest bidder. If the MLB team and the player agreed to a deal, the MLB team would pay the posting fee to the NPB team in addition to paying the imported player's newly agreed-upon salary; if the two sides failed to come to an agreement, no money changed hands and the player stayed in the NPB. Though the posting system is open to every team, the deadweight loss of money paid to the NPB team, the MLB team's exclusive negotiating rights with the player, and the player's ability to turn down the offer and continue playing in Japan if he so chose rendered the market for posted players too restricted to compare with the open free agent market.

[40] In an attempt to protect small-market teams from having their core players poached by wealthier teams (or to compensate them when it happens), teams signing top-tier free agents sometimes lose an early draft pick in the upcoming year's amateur draft to the player's former team. Under the current system (implemented after the 2012 season), if a

seasonal league minimum salaries for signed free agents whose salaries I could not find (mostly minor-league signees between 2007 and 2013).

My calculated numbers for how much teams paid per win on the free agent market for each year from 1996 through 2013 are given below.

| Year | Free Agent Expenditures | Wins Purchased | Contracts | Cost per Win |
|---|---|---|---|---|
| 1996 | $207,167,061 | 198.0 | 290 | **$1,046,298** |
| 1997 | $355,415,062 | 214.8 | 305 | **$1,654,633** |
| 1998 | $458,021,198 | 234.5 | 354 | **$1,953,182** |
| 1999 | $549,339,825 | 246.9 | 363 | **$2,224,949** |
| 2000 | $583,700,980 | 162.4 | 371 | **$3,839,292** |
| 2001 | $663,627,223 | 178.4 | 358 | **$3,719,884** |
| 2002 | $711,157,954 | 205.0 | 355 | **$3,469,063** |
| 2003 | $803,632,837 | 244.9 | 411 | **$3,281,473** |
| 2004 | $883,569,736 | 247.0 | 462 | **$3,577,205** |
| 2005 | $1,021,231,178 | 261.5 | 428 | **$3,905,282** |
| 2006 | $1,089,561,363 | 239.7 | 387 | **$4,545,521** |
| 2007 | $1,215,995,822 | 193.5 | 352 | **$6,225,362** |
| 2008 | $1,313,207,704 | 202.7 | 347 | **$6,494,598** |
| 2009 | $1,216,584,507 | 169.0 | 323 | **$7,142,095** |
| 2010 | $1,167,433,651 | 192.8 | 301 | **$6,055,154** |
| 2011 | $1,170,691,737 | 164.6 | 353 | **$7,112,343** |
| 2012 | $1,107,009,996 | 176.4 | 287 | **$6,275,567** |
| 2013 | $1,310,080,008 | 186.3 | 350 | **$7,032,099** |

These findings are remarkably different from previous predominant conceptions of the market for wins, specifically regarding the cost of a win, teams' responsiveness to

---

team offers a pending free agent who has been in the organization for at least one full season a one-year deal worth at least the average salary of the 125 highest-paid players in baseball (approximately $14 million in the 2013-14 offseason) and the player eventually signs elsewhere, his new team must surrender its first-round draft pick to his former team (unless the team has one of the first 10 picks in the draft or it has already lost its first-round pick, in which case it must give up its second-round pick). Studies by Victor Wang (2009) and Matt Swartz (2014) are among the best work in generally estimating how much these draft picks are worth and how teams value them. However, given the volatility of even top prospects' development, the time it would take to fully assess the value of a specific pick (it could be more than a decade between when a player is drafted and when he first hits free agency), and the fact that draft picks are probably worth less to teams who give them up by signing free agents than they are to the rest of the league, using generalized estimates of the value of a draft pick did not seem appropriate.

changes in the supply of wins, and the rate of inflation in the market.[41] However, for the purposes of this paper only the results are of particular importance. Looking at the 2013 MLB season, for example, a win cost $7,032,099 on the free agent market. If a team paid less than $7,032,099 in money or player assets to acquire a win in 2013, it beat the market; if it cost a team more than $7,032,099 to purchase a win, it overpaid.

These numbers move us closer to being able to estimate an industry employee's value to his or her team in a season given the number of wins he or she added to the team's position in the standings. In a vacuum, the maximum amount $I_t$ that team $t$ should be willing to pay for any employee who affects the team's on-field performance in some way is given by:

$$I_t = U_t(v_t') - U_t(v_t) + O_t$$

where $U_t$ is team $t$'s utility as a function of wins (expressed in dollars), $v_t'$ is the number of games that team $t$ would win with that employee on its payroll, $v_t$ is the number of games that team $t$ would win without him or her, and $O_t$ is the value of the added revenue and nonmonetary utility that team $t$ would receive from an employee besides his or her direct effect on the outcomes of games, if applicable.[42] However, in a competitive market

[41] See generally Lewis Pollis (2013)(b) for a more detailed discussion of the implications of these results. See also Dave Cameron (2009) and (2014)(b), Matt Swartz (2014), and Sky Andrecheck (2009) for alternative methods of calculating the cost of a win.

[42] The value of $O_t$ is probably negligible for the vast majority of MLB team employees, but for a marquee player with a strong connection to an organization it can have a substantial impact on how much he is worth to his team. For example, the three-year, $51 million free agent contract that longtime New York Yankees shortstop and team captain Derek Jeter signed with the Yankees in December 2010 was generally seen as far larger than what any other team would have been willing to offer him. However, he is a fan favorite in New York and re-signing him presumably gave the Yankees significantly more revenue and internal utility than they would have realized by replacing Jeter with another equally talented player.

where spending the market price of a win has an expected opportunity cost of one win, the maximum salary $J_t$ that team $t$ should be willing to pay for an employee is given by:

$$J_t = P_y * (v_t' - v_t) + O_t$$

where $P_y$ is the cost of a win in year $y$. Thus a team considering signing a player or hiring or retaining a non-player employee at cost $K$ should do so if and only if $I_t \geq K$ and $J_t \geq K$. This should hold for any individual working in a baseball-related job for an MLB team, from the center fielder to the general manager to the advance scouting intern. In a competitive market with perfect information and general homogeneity of player and employee value across the league, free agent players would be signed and non-player employees would be hired at salaries equal to the market value of the production they provide to their teams such that $J_t = K$ (except in the possible cases of individuals who are significantly more valuable to their respective teams than they would be to any others), meaning teams should sign players and hire baseball operations personnel in accordance with their organizational needs so long as $I_t \geq J_t$.

However, the baseball labor market is not perfectly competitive and a team's information is limited by its inability to predict its position in the standings and its employees' future values with precision. Given imperfect information, the maximum amount $L_t$ that team $t$ would be willing to pay for a given employee is represented by:

$$L_t = U_t(E[v_t']) - U_t(E[v_t]) + E[O_t]$$

where $E[v_t']$ is the expected value of the number of games that team $t$ would win with the prospective employee, $E[v_t]$ is the expected value of the number of games that team $t$ would win without him or her, and $E[O_t]$ is the expected value of the employee's off-field worth to his or her team, if applicable. The consideration of an unknown opportunity

cost yields the further constraint on the maximum amount $M_t$ a team should be willing to pay for an employee:

$$M_t = E[P_y] * (E[v_t'] - E[v_t]) + E[O_t]$$

where $E[P_y]$ is the expected value of the price of a win in year $y$.[43] A team should therefore choose to hire or retain a player or other employee at cost $K$ if and only if $L_t \geq K$ and $M_t \geq K$.[44] Again, this model should apply to any MLB team employee with a job that directly pertains to baseball.

## V. Methodology

Using the database of free agent signings and trades I have compiled, I use random effects modeling to estimate the variance in player signing and trading ability among the population of MLB general managers, as measured by returns on investment from player transactions.[45]

---

[43] Most discussion of the uncertainty in what fair value for a team's signing or hire (rightly) focuses on the difficulty of anticipating how many wins the individual will be worth, but predicting what the cost of a win will end up to be is not an exact science either. For example, Lewis Pollis (2013)(c) notes that the San Francisco Giants paid $23 million over two years after the 2013 season to sign free agent starting pitcher Tim Hudson less than a month after they gave pending free agent Tim Lincecum a two-year, $35 million contract extension. Most analysts agreed that Hudson was both a better pitcher and less-risky investment than Lincecum, so the fact that the Giants paid significantly more to sign Lincecum when they had exclusive negotiating rights with him than they did to sign Hudson on the open market suggests that they overestimated how much a win would cost on the 2013-14 free agent market.

[44] See generally Lewis Pollis (2014)(a) for more on the relationships between the utility-based value of a win and the market value of a win, and the cost of a win.

[45] My use of return on investment instead of total profit to measure each transaction assumes that the number of transactions a team can make is limited by only the total value of its monetary and player assets. This assumption makes sense for free agent signings, in which all the team gives up is money, but it may not hold as well for trades,

Before beginning this analysis, it is worth noting that, for any given trade target or free agent, we should see substantial heterogeneity in teams' willingness to pay for him. Wealthier teams are generally more willing to acquire high-priced players, while teams with smaller budgets will not consider signing a player to a large contract or trading for a player who is already signed to one. Beyond that, not every team will have a need for every player.[46] We would also expect significant heterogeneity in how well a player would perform with different teams — a right-handed power hitter will be particularly valuable to a team with a close left field fence, and a pitcher against whom batters put the ball in play with great frequency will fare far better with a good defensive lineup behind him — as well as at the basic level of how good different teams think he is.[47] This last point means that the team that makes the most lucrative offer for a player (and thus usually ends up trading for or signing him) presumably does so partially because its decision-makers think more highly of him than their peers do, meaning that any given

---

in which teams give up specific players who have discrete (if somewhat unpredictable) values. I use return on investment for both categories of deals instead of transactional profit because it is more in line with the fundamental assumption that players and the wins they produce are fungible, but it is admittedly an imperfect fit for trades.

[46] For example, after the 2013 season, the Boston Red Sox were not seen as serious suitors for free agent second baseman Robinson Cano, the best-regarded and ultimately most expensive player on the market, because they already had All-Star second baseman Dustin Pedroia signed through 2021. Theoretically they could have traded Pedroia and then signed Cano if they had thought that doing so was the best use of their resources, but while it would have been irrational not to consider such an idea there was never any indication that the Red Sox had seriously entertained the possibility.

[47] See generally Lewis Pollis (2013)(a) for more on the heterogeneity of player value across teams.

deal is likely to look like an overpay to the rest of the league.[48]

I assess free agent signings and trades separately. For free agent signings I use the same data that I used to calculate the annual cost of a win, but with two modifications. First, I include all seasons the player in question played between signing his contract and becoming a free agent again, even those that were purchased via contract extension after he signed his original deal — one of the advantages of signing a player is gaining exclusive negotiating rights for future contracts until he hits free agency again, and we can infer from teams' actions that they consider this monopoly to have significant value.[49] Second, I analyze only those free agent contracts (including endogenously treated mid-contract extensions, where applicable) that were no longer in effect by the end of the 2013 season so as not to judge signings before they are completed.

I define the return on investment for a free agent signing as the market value of the player's production over his period of team control relative to how much he was paid over the life of the contract and any subsequent extensions based on his WAR and the

[48] Baseball blogger Carson Cistulli (2013) inadvertently demonstrated the salience of this effect when he asked his readers both to predict how much money each of the 47 best free agents of the 2013-14 offseason would sign for and to imagine how much money they would be willing to offer each player if they were GMs. For all 47 players the average expected contract was larger than what the average respondent would have been willing to pay.

[49] Perhaps the best recent demonstration of a team valuing this monopoly on contract negotiations highly was the Boston Red Sox' trade for San Diego Padres first baseman Adrian Gonzalez after the 2010 season. Gonzalez had only one year remaining on his contract at the time of the trade, yet the Red Sox gave up four players (including then-top prospect Casey Kelly and former first-round draft pick Reymond Fuentes) for him because they planned to sign him to a long-term extension before he had the chance to become a free agent. The Red Sox succeeded in extending Gonzalez, agreeing to a seven-year, $154 million contract, though they ended up trading him to the Los Angeles Dodgers less than two years later.

cost of a free agent win in each season for which he was under contract.[50] Expressing this mathematically yields the equation:

$$ROI = \frac{\sum_{y=1996}^{2013} W_y P_y}{\sum_{y=1996}^{2013} S_y}$$

where $W_y$ is the number of wins above replacement the player produced in year $y$, $P_y$ is the cost of a win in year $y$, and $S_y$ is the amount the player was paid in year $y$, for all $y$ that were included in the contract or subsequent extensions, including seasons after the player was traded but before he reached free agency again, if applicable. As with my calculations for the cost of a win, this does not penalize teams for the draft picks they gave up when signing players who had turned down qualifying offers or arbitration, where applicable.

I use similar guidelines for classifying trades, including all involved players' production and salary from the time they were traded through their becoming free agents or retiring (even if they were later traded again) and assessing only trades in which the players involved are no longer under the same period of team control that they were at the time of the trade. I exclude trades in which teams received non-player employees, only

[50] It is worth noting that, depending on the team, the general manager in question may not have based his decision to make a given transaction on anything like WAR, especially for older signings and trades. Though it may seem unfair to judge front office personnel by a metric they may not have considered, there is ample reason why WAR is an acceptable foundation of this model. On a basic level GMs are ultimately trying to acquire as many wins as they can with the resources they have no matter what considerations they use to come to their decisions. In his study of fan voting for the 2011 All-Star Game Lewis Pollis (2012)(b) finds that WAR correlated more closely with the voting results than any other statistic, suggesting that it is a reasonable instrument for perceptions of player value even among those who do not use sabermetrics. Further, it seems fair to assume that a GM who considers statistics like WAR before making player transactions is more likely to make smart deals than one who does not, so if analytically inclined GMs and teams consistently rank more favorably in this conception of returns on investment that would presumably indicate not a systematic bias towards sabermetric-friendly teams but that integrating advanced statistics into the decision-making process leads to better results.

cash, or nothing at all in return for a player and deals that took place in August or September, when the waivers process distorts the trade market.[51] I define the return on investment for a trade as the market value of the production the team received from its acquired player(s) plus the salary it did not have to pay to the player(s) it traded and any money it received from the other team relative to the market value of the production the team lost from its the player(s) it traded away plus the salary it paid to its newly acquired player(s) and any money it paid to the other team. For the purposes of avoiding negative ROI values I changed all seasons of negative wins above replacement value for traded players to zero.[52] Expressing this mathematically yields the equation:

$$ROI = \frac{\sum_{y=1996}^{2013}(\sum_{a=1}^{A} W_y^a P_y + \sum_{d=1}^{D} S_y^d) + R}{\sum_{y=1996}^{2013}(\sum_{d=1}^{D} W_y^D P_y + \sum_{a=1}^{A} S_y^a) + C}$$

where $W_y^a$ is the number of wins above replacement the *a*th player acquired produced in year *y*, $P_y$ is the cost of a win in year *y*, $S_y^d$ is the amount the *d*th player traded was paid in

[51] From August 1 through the end of the season, if a team wants to trade a player it must first place him on trade waivers and give all 29 other teams the chance to claim him. If at least one other team claims him, the claimant with the highest waiver priority (determined by the claimants' records and whether or not they are in the same sub-league as the team that placed its player on trade waivers) receives exclusive transactional rights to that player. At that point the original team can simply give the player and his contract to the claiming team, work out a trade with the claiming team, or (if this is the first time the player has been placed on trade waivers that season) recall him from waivers. Removing competition from the trade market fundamentally changes both sides' leverage in the negotiations and decisions about when it is worth making a trade, so it did not seem appropriate to categorize post-July 31 trades as comparable to those that take place at other times of year.

[52] A team that trades a package of players with positive value for a return with negative value has made a mistake that could be fairly represented by a negative ROI value. But on the other side of the deal, the team that acquires players with positive value while giving up a package with negative value has made a very good trade. It would be unfair to credit the latter team with a negative ROI in an environment where trade investments are usually assumed to have positive value and a high ROI is assumed to be better than a low one. Changing negative player production values to zero ensures that all trade ROIs are nonnegative.

year $y$, $R$ is the amount of money received from the other team(s) in the trade, $W_y^d$ is the number of wins above replacement the $d$th player traded produced in year $y$, $S_y^a$ is the amount the $a$th player acquired was paid in year $y$, and $C$ is the amount of money sent to the other team(s) in the trade for all years $y$ after the trade in which players involved in the trade were covered under the same periods of team control that they were in at the time of the deal, including seasons after they were traded again where applicable.[53] It is worth noting that such a conception of trade return on investment will likely underestimate the value of trading skill at the GM level to the extent that teams that trade for players may later trade them away. Implicit in the inclusions of all of a player's post-trade seasons' production values and salaries is that the expected return from trading him away in the future would be equal to his asset value at the time, yet we would expect an exceptional (or poor) GM to compound his profits (or losses) if he later flips the players he acquires.

I then construct random effects models and investment multipliers for free agent signings and trades to estimate the variation in player-investing skill among general

[53] One failing of this conception of return on investment for trades is that it treats players' salaries and on-field value as separate assets and liabilities, while in reality the players and their contracts are inextricably linked; a team trades and acquires both at the same time, so it may not be fair to place them on opposite sides of the fraction in the calculation. An arguably superior formula for trade ROI would be:

$$ROI = \frac{\sum_{y=1996}^{2013}(\sum_{a=1}^{A}(W_y^a P_y - S_y^a) + R}{\sum_{y=1996}^{2013}(\sum_{d=1}^{D}(W_y^d P_y - S_y^d) + C}$$

in which players' net values are traded for their net values rather than production traded and salary acquired being invested in production acquired and salary traded. However, with this formula, almost every trade in which the players acquired on one side failed to live up to their salaries was rendered unusable for this analysis as it led to negative ROI results for both sides (or, after my adjustments for negative values, indefinable ROI for the trading team and an automatic zero value for the acquiring team).

managers in terms of concrete value. For free agents my model for return on investment is given by:

$$ROI = G'\beta + T'\gamma + b + \varepsilon$$

where $G$ is a vector of general managers and $\beta$ is a vector of individual GM effects as fitted to the estimated distribution of GM investing ability; of most interest for this paper are the variance statistics for the assumed random effects distribution from which the values $\beta$ are drawn. I also include a vector of teams $T$ and a vector of individual team effects $\gamma$ as drawn from an estimated distribution of team investing ability to control for organizational factors that a GM cannot control, such as an owner who pressures the GM into signing overvalued players to ill-advised deals or the effects of playing in differently sized media markets. Though I believe it was important to account for these organization-specific influences, given that relatively few GMs in the sample have worked for multiple organizations and teams often promote from within to fill GM vacancies (establishing some degree of internal continuity), the inclusions of team effects may have led the model to underestimate the variance of investing ability at the GM level.[54] Finally, $b$ is a constant and $\varepsilon$ is an error term assumed to follow the distribution $N(0, \sigma^2_\varepsilon)$.

For trades my model for return on investment is given by:

$$ROI = G'\beta + b + \varepsilon$$

where $G$ is a vector of general managers, $\beta$ is a vector of individual GM effects as fitted

[54] In order to check whether I should include variables for teams, I ran fixed effects regressions of free agent ROI on general manager and team weighted by the denominator of the ROI equation and found statistically significant coefficients in both categories. I also ran a random effects regression without team effects as a check on my results. Though doing so increased the magnitude of the population variance of GM free agent-investing ability, it did not significantly change how the model rated individual GMs — there was a near-perfect correlation between the resulting estimated GM effects in both versions of the model.

to the estimated distribution of GM investing ability, $b$ is a constant, and $\varepsilon$ is an error term assumed to follow the distribution $N(0, \sigma^2_\varepsilon)$. I do not include team-specific variables for trades because there is too little diversity in GM-team pairings to avoid a singular convergence error. Disregarding organization-level effects may lead to a slight overestimate of the population variance in GMs' trading abilities, but it stands to reason that the effect of ownership influence would be smaller for multiplayer trades than it is for free agent signings — trading players for players makes for more complicated transactions requiring more specific knowledge of the players and teams involved, and unlike for signing free agents, owners' out-of-pocket expenses are usually not the primary investments in the deals.[55] On the other hand, this method may systematically underestimate the range of trading ability because disregarding incomplete trades means eliminating deals from the dataset going as far as back 2002, and the most impactful trades tend to be those in which at least one player stays with his new team for a long time.[56] Thus for a majority of years in the sample there is a correlation between the one-sidedness of the deal's result and the likelihood of it being included in the sample, and

[55] This assumption is seemingly validated by running fixed effects regressions of ROI on general manager and team weighted by the denominator of the ROI equation; multiple individual GMs and teams show some degree of statistical significance in their effect on free agent ROI, yet I found statistically significant coefficients for trade ROI at only the GM level.

[56] The earliest trade I eliminated due to incompleteness was the Cleveland Indians' trade of Bartolo Colon and Tim Drew to the Montreal Expos (now the Washington Nationals) for Cliff Lee, Brandon Phillips, Grady Sizemore, and Lee Stevens on June 27, 2002. This trade, which included four future All-Stars and two future Cy Young winners, is generally considered to be one of the most lopsided deals in recent memory and one of the best trades the Indians have ever made. But because the Cincinnati Reds (to whom the Indians later traded Phillips) took advantage of their monopoly in contract negotiations with Phillips to extend him (i.e., prolong his leaving via free agency) through at least 2017, it is too soon to pass judgment on exactly how good of a trade it was.

especially in the most recent seasons only the least-impactful trades that teams made were included in the calculations.

Random effects modeling seemed like the most appropriate method for estimating the impact of general managers for several reasons. First and foremost is the assumption that general managers are all drawn from the same population of possible candidates and that no GM is paradigmatically better at making player investments than his peers — even as *Moneyball* portrays certain members of the Oakland Athletics' front office as far better at their jobs than just about every other executive in baseball, Michael Lewis describes Billy Beane and Paul DePodesta not as omniscient and infallible but as "card counters at the blackjack tables." Random effects modeling also allows us to consider the variation in player-investing skill across the entire population of potential general managers and not just the 82 individuals whom I identified as having made at least one qualifying free agent signing or trade since November 1995. Finally, in fitting each individual GM into the broader quasi-normal distribution of general managers' player-investing skill, the random effects model regresses his estimated effect towards the mean rather than assuming that his history of player investments is perfectly reflective of his true ability.

It is important to note that this methodology treats everyone else who works in baseball operations as endogenous to the general manager. Barring a power struggle with team ownership or the CEO (or equivalent), it is ultimately up to the GM to decide how the front office is run. From the assistant general managers down to the interns, the GM decides whom to hire (or at least who decides whom to hire); even in the case of employees who predate his tenure as GM he could decide to fire them or to allow their

contracts to expire without renewing them. Within that group it is up to him whom he asks for advice before making a decision and whose counsel he trusts more than others'. In this paper, what a GM is worth should thus be interpreted not just as what he brings to his team himself but as including the value of the subordinates he hires, supervises, and listens to when he signs or trades players.

Further, the individual estimated effects for general managers should not necessarily be taken as accurate measures of their player-investing abilities. Eliminating signings and trades in which not every involved player has since hit free agency means leaving out deals from as far back as 2002, so many GMs cannot be judged by their full bodies of work. Because deals with longer-lasting impacts tend to be larger in eventual scope than those whose involved players all move on within a couple seasons of the transaction, this method has an unavoidable bias towards excluding GMs' most defining trades.[57] The estimates for relatively new GMs' effects are particularly untrustworthy because any major transactions they have made are likely still unfinished and many of their transaction sample sizes are too small to be reliable.[58] Finally, I was not able to

[57] Anecdotally speaking, as I went through my trade data to eliminate incomplete deals I noticed that this issue was particularly well illustrated for longtime Oakland Athletics GM Billy Beane. Several of the best trades Beane has made in his 17-year tenure as general manager — including trading Mark Mulder for Dan Haren, Daric Barton, and Kiko Calero in 2004; swapping Rich Harden and Chad Gaudin for a package including Josh Donaldson in 2008; and dealing Andrew Bailey and Ryan Sweeney for Josh Reddick and two other players in 2011 — were eliminated from the dataset because at least one of the players he acquired in each deal is still under team control. His ultimate ranking as one of the worst trade-investors in baseball probably reflects this sample bias more than his true trading ability.

[58] Take as an example Cleveland Indians General Manager Chris Antonetti, who was promoted to his post at the end of the 2010 season. In this model he does not get credit for signing Ryan Raburn, which was probably the best free agent investment Antonetti has made so far, nor for signing Nick Swisher and Michael Bourn, who signed the largest

weight the deals when I ran the regression models, so a $1 million free agent contract affects a GM's estimated effect just as much as a $100 million deal would. This methodology should produce reasonable estimates for the population variance in player-investment skill, but any individual GM's estimated effect should be interpreted with caution in light of these caveats.

I then calculate multipliers to convert the variance in player-investing ability into dollars and wins. For free agent signings I add up the 2013 salaries of every player who was playing under a contract he signed as a free agent or a subsequent extension, then divide by 30 to get the average amount that MLB teams had spent on players acquired via free agency. For the trade-investment multiplier I add up both the 2013 salaries and production (wins above replacement times valued at $7,032,099 per win) for players who have been traded in non-waiver deals since they last hit free agency and divide by 30; in keeping with my definition of ROI I change negative production values to zero and add salaries to production for my primary multiplier, but I also calculate alternate multipliers in which I leave production values unchanged and subtract salaries from production. These multipliers can be used to convert the abstract ROI variation into an expression of concrete value: multiplying one standard deviation of investment ability by the amount the average MLB team has invested in free agents or trades for a season provides a value for how many dollars (in the 2013 league market) a one-standard-deviation difference in free agent- or trade-investing ability at the general manager level is worth each season to the average team, from which we can estimate how many more wins a one-standard-deviation difference in player-investing ability will buy for a team that matches the

---

free agent deals he has negotiated, because none of them has hit free agency again since signing with Cleveland.

league-average levels of investment for free agent signings and trades.

It is important to note that this methodology is designed to estimate not the immediate impact of hiring a general manager but the influence a GM could have on his team after he has been on the job long enough to have fully shaped the team's roster and front office. As my multiplier calculations highlight, a transaction a GM makes can affect his team long after he has been dismissed, and a new GM is not responsible for the decisions of his predecessor. Assuming a team makes similarly scaled free agent and trade investments each year, one could also think of a GM effect as approximating the average annual value he adds to his team that includes the lagged effects of the deals he made that continued after he left in the numerator but not the in the denominator.

**VI. Results**

The random effects model estimates the population variance in expected return on investment for free agent signings among general managers to be 0.1613, meaning that one standard deviation in free agent-investing ability is worth 40.16 percent of the team's total investment in players signed via free agency. (The population variance for teams is 0.0727.) I calculate that MLB teams spent $1,417,177,646 on players acquired via or after free agency during the 2013 season, for an average of $47,239,255 per team. This means that one standard deviation in free agent-investing ability at the GM level would have been worth $18,971,285 per year to the average team in the 2013 league market. This is the approximate cost of purchasing 2.7 wins via free agency for the 2013 season, meaning that a one-standard deviation improvement in a GM's free agent-investing ability will lead to 2.7 more wins per year for a team that matches the league-average

level of free agent investment. A two-standard-deviation difference, probably a reasonable estimate for the improvement a team seeks when it fires its general manager and hires a new one, is thus worth 5.4 wins per season ($37,942,570 in the 2013 league market); a four-standard-deviation difference, seemingly a fair approximation of the gap between the single best and worst GMs in the game, is worth 10.8 wins annually ($75,885,140); and a six-standard deviation difference, which could be seen as representing the hypothetical range of abilities between the best and worst plausible GM candidates, is worth 16.2 wins a year ($113,827,710).[59] Looking at the specific estimates that the model fits to the distribution, the projected difference between the best free agent-investor, Brian Sabean (1.35 standard deviations above average) and the worst free agent-investor, Jim Beattie (-0.92 standard deviations below average) to the average team would be 6.1 wins ($42,931,906) per year.[60] It should be noted that these ranges may actually be underestimates if the limited overlapping of different teams and GMs causes the model to be too conservative in isolating the impact of the GM. The individual estimated GM effects for free agent investments are offered in Appendix B.

For trades, the random effects model estimates the variance in individual GMs' investing ability to be 0.0954, so one standard deviation equals 30.88 percent of the team's trade investments. I estimate that MLB teams paid $947,395,218 in salary to players who had been part of an offseason or pre-August 1 trade more recently than they

[59] Because of the asymmetry of the ROI metric the estimated distribution of GM investing ability is not perfectly normal, but assuming quasi-normality should suffice for calculating ballpark estimates of the range of GM effects.

[60] That all but two individual GMs (Sabean and Walt Jocketty) are estimated to be within one standard deviation of the mean highlights the impreciseness of the individual estimated effects.

had been free agents in 2013 while receiving $2,396,539,339 (340.8 wins) of non-negative production from them. Adding the two and dividing by 30 puts the average team's 2013 trade investments at $111,464,485 and pegs one standard deviation of trade-investing ability for a typical organization as having been worth $34,422,462, about the cost of 4.9 wins. This implies that a one-standard-deviation improvement in trade-investing ability is worth 4.9 wins a team that invests in trades at the league-average rate. A two-standard-deviation improvement in trading ability at the GM level is thus worth 9.8 wins per season ($68,844,924 in the 2013 league-market), a four-standard-deviation gap equates to 19.6 wins annually ($137,689,848), and the full six-standard-deviation range would represent 29.4 wins a year ($206,534,772) to the average team. (Changing whether negative production values are included or not and whether salary is added or subtracted in the multiplier in a way that is different from how ROI is calculated can lower the value of a standard deviation significantly, though even using the more conservative calculations the value of trade-investing skill at the GM level is worth substantially more than the range of salaries would imply.[61]) Looking at the specific estimated effects, the difference between the best trade-investor, Kevin Towers (1.55 standard deviations above average) and the worst trade-investor, Bob Gebhard (-0.70 standard deviations below average) equates to 11.0 wins ($77,259,074) per year. The

[61] Adding unadjusted production values (league-wide total: $1,992,896,857) to salary for the multiplier yields a standard deviation value of 4.3 wins ($30,673,367 in the 2013 league market). Subtracting salary from zero-floor production values yields a standard deviation value of 2.1 wins ($14,917,490). Subtracting salary from unadjusted production values yields a standard deviation value of 1.5 wins ($10,762,394). Though this latter figure is substantially smaller than that on which I base my analysis, even in this conservative calculation one standard deviation of ability in a single facet of a GM's responsibilities is worth approximately triple the salary of the highest-paid front office executive in baseball.

individual estimated GM effects for trade investments are offered in Appendix C.

Combining both sides of deal-making, one standard deviation of player-investing ability is worth 7.6 wins ($53,393,747 in the 2013 league market) to a team that matches the league-average investment in both free agent signings and trades. Two- and four-standard-deviation differences equal 15.2 wins ($106,787,494) and 30.4 wins ($213,574,988), respectively, if they manifest themselves in both free agent-signing and trading abilities. And the theoretical six-standard-deviation range of GM player-investing ability would be worth approximately 45.6 wins ($320,362,482) to the average team. These larger values are implausible expectations for any general manager's value and it is important to remember that they endogenize everyone working under the GM, but given that the latter figure represents approximately 100 times the salary differential for general managers, even if the true range of value were but a small fraction of that size it would imply that the best GMs are worth substantially more to their teams than their wages would suggest. Combining the specific individual estimates for both categories, the difference between the best player-investor, Larry Beinfest, and the worst player-investor, Beattie, equates to 12.2 wins ($86,071,824) of annual value to the average team.[62] The combined individual estimated GM effects for free agent and trade investments are offered in Appendix D.

It is worth noting that the variances of the residuals were quite high for both models, with $\sigma_\varepsilon = 7.54$ and $\sigma_\varepsilon = 3.86$ in the regressions for returns on investment from free agent signings and trades, respectively. These large variances reflect the fact that the general manager and (for free agent signings) team are not in themselves accurate

[62] For some perspective, the last player to be worth at least 12.2 WAR in a season was Barry Bonds in 2002 for the San Francisco Giants.

predictors of how a given transaction will work out. However, they do call the precision of the variance estimates for the population of general managers into question, and they should serve to further weaken our confidence in the models' ability to accurately assess the values of individual GMs.

Another complication for these results is that the potential impact of a general manager would be different for every team — just as a given player would not be equally valuable to every team, a GM's value would not be homogeneous across the league. Each organization has its own distinct utility function for wins and each is starting from a different place on the win curve, so even if several teams agreed upon how many wins a GM were worth each would have a different maximum bid for hiring him. Further, most baseball analysts seem to agree that front office personnel are more valuable to smaller-market teams because organizations with fewer resources must make intelligent investments in order to compete with teams with larger payrolls: "If we do what the [New York] Yankees do," Billy Beane is quoted as saying in *Moneyball*, "we lose every time, because they're doing it with three times more money than we have." Yet if GMs are valued in terms of the returns they realize from investments they make on behalf of their teams, the range of a GM's impact is directly proportional to the amount of money and player assets he can use to acquire players. There is no obvious connection between a team's payroll and its propensity for trading, but looking at Jeff Todd's (2014) tabulations of free agent expenditures in the 2013-14 MLB offseason, an elite free agent-investor would have been far more valuable to the high-payroll Yankees, who spent $471 million on free agents, than to the Pittsburgh Pirates, who committed only $7 million to free agent signees. An elite GM may be more important to a small-market team than to a

large-market team in terms of his team's chances of making the playoffs — the only way a team with a low payroll can be better than a team with a high payroll is if it uses its resources more efficiently — but the more money a GM has to invest in players, the more surplus value he can generate for (and thus the greater his worth to) his employer.

Though any individual general manager's results are too unreliable to be taken at face value, looking at the population as a whole we see some noteworthy trends. Generally speaking the GMs with the highest estimated individual values are held in higher regard than those at the bottom of the list, which seemingly affirms the model's ability to differentiate real player-investing skill from statistical noise. However, subjectively speaking, the individual rankings seem more closely aligned with how well the GMs' teams performed than with outsiders' views of their decision-making processes. This could be a function of noisy data, but it may also suggest that analysts on the outside do not fully appreciate the extent of the proprietary information and internal considerations on which GMs base their decisions when they form opinions about teams' front offices. Of note also is the near-zero and statistically insignificant correlation between GMs' estimated effects for free agent and trade investments ($R = 0.0473$, $R^2 = 0.0022$). This likely reflects the general unreliability of the individual estimates more than it suggests a true disconnect between the two main types of player transactions, but it is plausible that finding the most efficient ways to purchase wins on the open market requires a different set of skills than does evaluating both one's own players and every other organization's and assessing who among the former would be worth more to another team and which of the latter are undervalued.

Finally, I find evidence that one's player-investing ability is mostly developed

before one is promoted to general manager rather than it being the product of experience. For both free agent signings and trades I run fixed-effect regressions of the form:

$$ROI = G'\beta + \alpha x + b + \varepsilon$$

where $G$ is a vector of general managers, $\beta$ is a vector of GM fixed effects, $x$ represents the deal's chronological rank among deals the involved GM has made that were included in my database, $b$ is a constant, and $\varepsilon$ is an error term assumed to follow the distribution $N(0, \sigma^2_\varepsilon)$, weighted by the ROI denominator. The coefficient $\alpha$ was statistically insignificant at any standard $p$-value for both types of transactions and remained so in alternate regressions in which $x$ was replaced with its square root. Anecdotally speaking a GM may feel that he is learning on the job, but it is unlikely that the experience will fundamentally improve his ability to make fruitful player transactions. It should be noted that the typical GM spends several years working in baseball operations before he is offered a GM position, so the insignificance of GM experience as a predictor of future success probably reflects the diminishing marginal impact of experience across the whole span of one's front office career more than it suggests that player-investing ability is an innate skill.

## VII. Implications and Recommendations for Teams

The most critical justification for why MLB front office employees take salary discounts to work in baseball when teams are willing to spend millions of dollars to win one more game per season is the assumption that there is very little difference between how much value any two serious candidates for a baseball operations job would provide to the team. That a single standard deviation of player-investing ability in both free agent

signings and trades at the general manager level is worth as much as 7.6 wins per season is a strong rebuke to the assumption of non-player employee homogeneity.[63] Even the 4.2-win estimate for a single standard deviation of combined GM transaction-making ability one would get by using the most conservative trade-investment multiplier is worth eight times more than the annual salary of the highest-paid baseball operations employee in the league — and that includes only two specific categories of decisions a GM makes that we can observe and identify from the outside. These findings should have a profound effect on how teams and prospective employees alike conceive of and approach the MLB non-player labor market.

The first and most direct consequence of this information is that demand for elite general managers should skyrocket. Once teams come to a better understanding of how much an exceptional player-investor can be worth, an elite GM nearing the end of his contract should not feel pressured to sign an extension at or near his current salary. If his current employer does not make him an offer commensurate with his worth, then just like a player he should hit the open market and allow teams with GM vacancies or inferior incumbents to bid his salary up to its fair-market value. The equilibrium wage for even a proven GM would likely be somewhat less than his true worth thanks to the uncertainty of his true value and the varying abilities of the incumbent GMs whom he could be replacing, but even with these discounts a rational market for elite player-investors would be far more competitive than it is now. Returning to the hypothetical I posed earlier, almost every team would probably be better off spending $7 million to lure an

[63] For some perspective, only six players were worth 7.6 WAR or better in 2013: Mike Trout, Clayton Kershaw, Andrew McCutchen, Josh Donaldson, Carlos Gomez, and Miguel Cabrera.

exceptional GM away from his current employer than using it to sign a one-win free agent player.

Relatedly, these findings suggest that teams should be more responsive to past performance in deciding when to replace their general managers and whom to hire to replace them. In today's game team owners typically give underachieving GMs a season or two to improve the team before they overhaul their baseball operations departments. However, if even a moderately below-average GM can cost his team several wins a season, by the time a subpar incumbent has performed poorly enough for his job to be in jeopardy, giving him an extended last chance to prove himself is probably not worth the considerable risk of continuing to trust the team to someone who is not running it very well. Similarly, teams sometimes hire former GMs who had already been fired by other organizations because of their previous experience — as Michael Lewis observes, "When a big league baseball team…loses, heads may roll, but they don't roll very far." Given the great potential impact of a GM's innate player-investing ability on his team and the statistical insignificance of experience on improving GM performance, the strategy of hiring GMs who have already performed poorly with other teams also seems ill advised.

The implications of these findings go beyond the general manager. That there is such substantial heterogeneity in skill at the GM level suggests that there is likely also significant (though smaller) variation in individual value among his subordinates. To look at it from another perspective, since my estimates of GM-level variation in skill endogenize the information and advice the general manager receives from the people he chooses to hire and listen to, the incalculable difference between my findings and what the variation would be for GMs if they did not have hiring and firing authority for their

staffs would represent the range of value of the contributions of the rest of the office — and given that most other baseball operations employees spend much (if not most) of their time on work that is not directly applicable to free agent signings and trades, that would be an extremely conservative estimate for their potential impact.

Consider the next-highest level of front office employees. For most teams this includes one or more assistant general managers and the directors of specific departments, which usually include some combination of baseball operations, scouting, player development, and baseball analytics (or their equivalents). If the variation in skill at the secondary executive level is worth even 10 percent of what it is at the GM level, then the best assistant GM or scouting director could conceivably provide eight figures more of annual value to his or her team than a readily available replacement. Given this scale it is easy to imagine an exceptional lower-level employee like a scout or a department assistant providing millions of dollars in value to his or her team each year. Even among inexperienced interns the difference between two potential hires could be worth several hundred thousand dollars over the course of the apprenticeship.

These inferences cast serious doubt on each of the three major assumptions underlying the supposed rationality of the current MLB non-player labor market. First and foremost, they directly refute the notion that the difference between the values that any two serious candidates for a baseball operations job would provide to their prospective employer is negligible. In a similar vein, the implied effect of the diminishing marginal productivity of front office personnel would need to be on par with the likely considerable value of the best currently unemployed aspiring baseball operations employee for the relative inelasticity of teams' demand for labor to be rational — a

notion that seems difficult to rationalize. Finally, assuming the existence of substantial heterogeneity in value among possible hires, if there is an inverse correlation between a prospective applicant's qualifications for a front office job and his or her willingness to accept a substantial negative compensating salary differential to enter the industry (as we would expect for certain positions requiring skills not exclusive to baseball operations work), teams are probably turning significantly more valuable potential employees away by adhering to the industry's unwritten salary standards. Thus, that the supply of aspiring front office employees far exceeds the demand despite the low wages does not mean teams are acting rationally by using their leverage to purchase cheap labor. On the contrary, any team that thinks of prospective employees as generally interchangeable and declines to actively compete for the best baseball operations talent is demonstrating a fundamental misunderstanding of the value of an exceptional baseball mind.

Given the substantial heterogeneity in value among possible front office hires, the only way for teams to approach the market rationally is to conceive of it as 30 employers competing for each individual and not as a mass of interchangeable applicants competing for some nearly fixed number of jobs. Once a team appreciates how much a non-player employee can be worth, the ceiling of what it should offer an established baseball operations staffer looking for a new job or a new applicant looking to break into the industry should be defined not by what employees in his or her position have typically made but by how much value he or she would provide to the team if it would be creating a position for him or her, or how much more valuable he or she would be than whomever else the team would hire instead if the team is trying to fill a specific job vacancy. If the prospective employee is worth more to an organization than whatever the best offer from

among the other 29 teams is, it should bid up his or her salary either until the rest of the league stops competing — given the current market for front office employees, that probably would not take much — or until his or her wages would exceed his or her projected value. These findings do not offer concrete answers to the questions of whom or how many people teams should hire to fill which positions or how much they should pay them in this rethinking of the non-player labor market, but a rational league-wide equilibrium would probably be characterized by larger front office staffs making nonuniform but generally higher salaries.

With that in mind, it is easy to imagine how an owner reluctant to start spending significantly more money on his or her team's front office might latch on to Matt Swartz' proposed repeated cooperative games rationale for keeping baseball operations costs down, but its intuitive appeal exceeds its practical utility. Aside from the collusive implications of teams potentially refusing to compete for the best employees in order to keep costs down — a phenomenon that would lead to a national controversy if teams were doing it with players — sticking to the traditional pay scale instead of reconceiving the non-player labor market in light of these findings is almost certainly not a team's best response from a game theory perspective. In the short term, the strategy of actively competing for elite baseball operations employees dominates that of maintaining the status quo: if most organizations are still stuck in the old ways a team could exploit the market inefficiency by hiring significantly undervalued front office employees at slightly above-market prices, while if most of the other organizations have adjusted their hiring strategies a team must adapt in order to attract premier baseball operations personnel. In addition, the inclusions of non-compete agreements in employees' contracts would help

to insulate a team that hires front office employees at above-market wages from having to further inflate its salary costs if and when league-wide demand for baseball operations personnel becomes more competitive and individualized. In the long run the choice is less clear depending on how much teams and owners care about passing increased hiring costs on for the open-ended future, but a collective decision not to compete more actively for job candidates would still hinge on trusting that the other 29 teams will all cooperate indefinitely. Empirically, some owners have demonstrated that they care more about short-term success than long-term financial obligations in signing marquee free agents to overpriced deals; if a team willfully overpays for players who will make it significantly better right away, presumably it would also be amenable to paying front office personnel what they are worth despite the increased long-term costs.

## VIII. Questions for Further Research

The clearest immediate opportunity to follow up on this study would be to replicate it with alternate versions of the wins above replacement statistic. An outsider would not have access to the proprietary models that teams may use, but it is possible that using FanGraphs' normal WAR for pitchers instead of RA9-WAR or replacing both hitting and pitching WAR with Baseball-Reference's WAR or Baseball Prospectus' WARP could change the results. The price of a win estimates for each season may be slightly different if they were calculated with Baseball-Reference's WAR or the normal version of FanGraphs' WAR instead of RA9-WAR for pitchers despite their sharing a common replacement level and could be significantly different if it the calculations based

on Baseball Prospectus' WARP.[64] More importantly, if there is any correlation between the discrepancies between the different systems' assessments of players' values and those between how different teams value players, switching to another version of WAR could change the individual rankings. This could also lead to different specific estimates of the potential value of a general manager's player-investing ability, but I doubt that the generally small differences between the different WAR models' valuations of players would be enough to change the fundamental conclusion that there exists a substantial market inefficiency in how teams value their front office employees.

On a deeper level, one of the biggest obstacles to properly estimating the values of MLB front office personnel is the difficulty of understanding how each team's operations work from the outside. Identifying specific decisions that teams have made beyond free agent signings and trades and who was directly responsible for them (both directly and ultimately), constructing counterfactuals for what might have happened otherwise, and separating skill from luck in the results would all require far more information about how teams operate than they would be willing to (or could practicably) share. I have used public information about player transactions to estimate the variation in skill and value at the general manager level, but such transactions represent just one facet of a GM's responsibilities and my results do not distinguish between a GM's own ability to game the league market and the quality of information and advice he gets from

[64] That both versions of FanGraphs' WAR and Baseball-Reference's WAR are based on the same replacement level means that both systems assign the same number of total wins across the league (1,000), but the different inputs and formulas mean that the wins are distributed differently among players. The total number of wins provided by players playing under contracts they had signed as free agents would therefore probably be slightly different in each system, which could lead to marginally divergent estimates of the price of a win.

the subordinates he chooses to hire — and this is for the category of front office executives whose work is the most visible from the outside. This paper is by no means an authoritative analysis of the potential impact of baseball operations employees based on publicly available information, but its limitations are probably representative of any potential study into how teams operate unless the researchers have greater access to MLB organizations' internal workings. If it were possible, the best way to expand upon these findings in terms of how much impact different types of baseball operations personnel can have on their teams would be to gather more specific data on the specific responsibilities of teams' front office employees and the decisions they have made.

Though it may not be possible without first finding better estimates for the ranges of different front office employees' impacts on their teams, another way to build upon this research would be to design a better method for assessing individual employees' values. The estimated effects for general managers' player-investing skills in this model do appear to be correlated with their reputed abilities, but its exclusions of regression weights and significant but incomplete trades and its inability to distinguish between the contributions of each GM and of his subordinates render the individual assessments too noisy to be reliable — not to mention that it focuses on only two facets of a GM's job responsibilities. But even if this method produced reliable estimates for individual effects and were generally replicable for lower-level baseball operations personnel, it has another constraint that significantly limits its potential usefulness to organizations evaluating their staffs and prospective hires: the time it takes to properly evaluate a baseball operations decision. Everything a front office employee does is with the goal of making his or her team better, so it is unfair to judge a decision at the time it is made without knowing

exactly what information he or she used to make it and what the consequences of each possible choice would be; only those close to the process would know the former and the nonuniformity of teams' internal operations demonstrates that there is no universally accepted best strategy for acquiring and developing players. This delay in assessment capability poses a problem for organizations, as sticking with a particularly bad general manager a year too long could have an opportunity cost in the hundred-million-dollar range in the current league market. As with players, teams can probably assess the quality of their own employees reasonably well without specific numbers and the best-reputed baseball operations personnel are known as such throughout the game, but teams would likely be more comfortable with the idea of investing significantly more heavily in their front offices if they had more reliable and faster-working models for objectively assessing their baseball operations employees' performances.

Further research could also be directed towards the other underlying assumptions of the current non-player labor market. Based on my findings about the potential value of front office executives I believe the assumptions that it is not worth it for a team to hire past the current point of employment or to meet the wage demands of a prospective employee who is unwilling to take a salary cut to work in baseball are also untrue, but future studies could test them more directly. Modeling the effects of diminishing marginal productivity for employees in different front office positions and estimating the relationship between one's value to a team and his or her industry reservation wage would be important steps towards determining teams' and prospective employees' optimal strategies in approaching the MLB non-player labor market.

It would also be interesting to see the results of an empirical study of the supply

side of the baseball operations labor market. Of particular interest would be a detailed exploration of the nonmonetary utility that characterizes applicants' decisions to enter and choices within the market. The question of how much the opportunity to work in baseball is worth to the average serious candidate for a job is an important one no matter how the market is conceived, as is how it varies according to personal characteristics, the specifics of the job perks, and the specific types of work inside (or potentially even outside) baseball operations. Accurately constructing a model for the MLB non-player labor market would require understanding both the supply of and demand for employees who put the teams together.

Finally, there is the question of how both sides' optimal strategies in the non-player labor market are affected by the league restriction on hiring another team's employee without the permission of his or her current employer. Generally teams are willing to allow their employees to pursue better opportunities with other organizations and those who do not are seen as acting inappropriately.[65] An employer that allows an employee to apply for a job with its competitor when it has the power to stop him or her from doing so is acting in good faith, but doing so also betrays an assumption that the individual is easily replaceable. Draconian as it sounds, given the potential value of an

[65] The most recent high-profile example of a team not allowing an employee to apply for a job with another team was in November 2013, when the Chicago Cubs asked to interview Boston Red Sox bench coach Torey Lovullo in their search for a new manager and the Red Sox refused, citing an agreement that Cubs President of Baseball Operations and former Red Sox General Manager Theo Epstein had allegedly made not to hire anyone else away from Boston when he left for Chicago in 2011. "Organizations rarely prevent employees from seeking clear-cut promotions with other teams, especially in the case of a coach and a manager vacancy," Cubs beat writer Gordon Wittenmyer (2013) noted at the time. Wittenmyer attributed the Red Sox' unwillingness to let Lovullo apply for a better job to their "two-year-old grudge with Theo Epstein and the Cubs" and suggested that Boston may have been "trying to make the Cubs squirm."

elite baseball operations executive, even lower-level employees who are special enough to be poached by other organizations are probably too valuable for their current teams to allow them to leave unless they receive compensation, as the Boston Red Sox did from the Chicago Cubs for Theo Epstein in 2011 and the Oakland Athletics would have from the Red Sox for Billy Beane in 2002. If the market for front office personnel does become more competitive, exceptional employees whose teams deny them the chances to pursue better opportunities may be better off quitting their current jobs and creating a parallel free agent market for front office employees; this, in turn, could make non-compete agreements valuable bargaining chips in contract negotiations. If teams' demand for baseball operations personnel becomes more rational, there would be ample opportunity for a game theory analysis of how this quirk of the non-player labor market affects employers' and employees' best-response strategies both at the initial point of hiring and as employees advance in their careers.

## IX. Conclusions

In this paper I have explored the labor market for Major League Baseball teams' baseball operations employees and questioned the fundamental assumptions on which the rationality of its predominant conception and current equilibrium — characterized by low wages and an inelastic supply of aspiring employees that considerably exceeds the uncompetitive labor demand — hinges. Based on an analysis of the most public decisions — free agent signings and trades — made by the most prominent and highest-level front office employees — general managers — I estimate the potential value of elite player-investing talent in a team's upper management to be on the order of tens (if not hundreds)

of millions of dollars per year, with a single standard deviation of player-investing ability at the general manager level equating to nearly 7.6 wins or $53 million in value if it manifests itself both in signing free agents and making trades. Even a conservative generalization of these results down through the ranks of an organization's baseball operations department suggests that there exists substantial and economically significant variation in skill and value among prospective and incumbent employees at every level of the front office. These findings directly refute the most important assumption behind the rationality of the current MLB non-player labor market — that there is no substantial heterogeneity in value among serious candidates for a given front office position — meaning that the prevailing conception of the market is incorrect and teams' approaches to hiring baseball operations employees are irrational.

It is beyond the scope of this paper to offer concrete estimates for how much individual front office employees are worth to their teams or how much organizations should be willing to spend on top candidates for different front office positions; the limitations of my models and the dearth of public information about MLB teams' internal operations preclude my ability to feel confident in making such specific assertions. However, I believe I have established that the best baseball operations employees are paid substantially less than they are worth to their teams; that the MLB non-player labor market must be conceived as a series of heterogeneous individualized markets for potential employees rather than a single mass of interchangeable job candidates to ensure a rational equilibrium; and that, in the current league market, an extra dollar put towards acquiring front office talent will go further than an extra dollar spent on players.

Lost in the continuous search for the so-called "next *Moneyball*" is that the

greatest market inefficiency in baseball is in fact the systematic undervaluation of the people who put the teams together — the watchmen have failed to appreciate their own value because they have not been watching themselves. “What begins as a failure of the imagination ends as a market inefficiency,” Michael Lewis writes. In this case, the first teams to conceive of the MLB non-player labor market in terms of what their employees and prospective hires are truly worth and invest in undervalued front office personnel will hit one out of the park.

**Appendix A: How WAR is Calculated**

For position players, the biggest factor in a player's WAR is his hitting ability. This is calculated through weighted on-base average (wOBA), which is like a smarter version of the ubiquitously known batting average in that knows the difference between a single and a home run and it weights each possible outcome of a plate appearance by the expected value of how many runs it creates.[66] Given the number of plate appearances the hitter accumulates, comparing his wOBA to the league average (after adjusting for the possible offense-boosting or –dampening effects of his home stadium) gives us an estimate of how many runs he created with his bat relative to an average hitter. The model then applies a replacement-level adjustment of one extra run created per 20 plate appearances — the approximate difference between a league-average hitter and the expected production of a replacement player — to change the baseline from "runs above average" to "runs above replacement."

Fielding is measured by a probabilistic model that compares the batted balls the player did and did not get to to the league average at that position, weighted by the expected run value of each hit when the fielder could not make the play; these defensive statistics are less consistent and reliable than the offensive components, but they are generally considered to be the best publicly available statistics for measuring fielding

[66] These are derived from the average change in a team's run expectancy that each possible outcome causes. For example, imagine a hypothetical run environment in which teams scored an average of .25 runs in an inning starting from the point of having the bases empty with one out and .75 when there is a runner on first and one out. If every single in the league that year were hit with one out and the bases empty, the average single would have been worth .5 runs (.75 runs minus .25 runs).

skill.[67] There is also a baserunning component (values for stolen bases and caught stealings are calculated similarly to linear weights for hitting, while taking extra bases on balls in play is measured like fielding) and an adjustment for how difficult each field position is to play. A replacement-level player is assumed to be average both in the field (after adjusting for difficulty of position) and on the basepaths. Finally, the sum of these hitting, fielding, baserunning, and positional values (all expressed in runs) is divided by a constant denominator to convert the numbers into wins.[68]

The calculation for pitchers is more straightforward. After calculating the replacement level for the given league, season, and home ballpark (with different values for starting pitchers and relief pitchers because the latter group's job is significantly easier), the model subtracts the number of runs the pitcher in question allowed per inning from the replacement player's projection, then multiplies that by the number of innings

[67] Imagine that a ball hit at angle *x* with velocity *y* to *z* location in center field (the data is not always this complete, depending on the season) gets caught by the center fielder 50 percent of the time and falls for a hit 50 percent of the time. When the ball falls for a hit, based on the chances of it turning into a single, double, and triple it has an expected run value of one run (as calculated the same way as for wOBA). The batted ball would thus have an overall average run value of .5 runs (.5 probability times one run). If the center fielder makes the catch, the run value becomes zero and he is credited with having saved .5 runs (.5 runs minus zero runs). If he fails to make the catch, the run value becomes one and his runs saved total is debited by .5 runs (one run minus .5 runs).

[68] Baseball writer Bill James famously discovered that a team's winning percentage could be closely approximated by a function of its runs scored and runs allowed: the "Pythagorean Theorem" of baseball, so named for the quadratic relationships between the variables in its first incarnation. The runs-to-wins conversion is determined by how many more runs an average team would need to score to improve its Pythagorean-projected record by one game. Usually this number is around 10 runs per win, depending on the league run environment and the quirks of the player's home ballpark.

the player pitched.[69] In this case, however, the runs-to-wins conversion factor is partially a function of the individual player — if opposing teams scored significantly fewer (or more) runs when he was on the mound, his own team would have needed fewer (or more) runs to win an extra game.

[69] This differs from FanGraphs' default model of pitcher WAR, in which the number of runs a pitcher allows per inning is replaced with an estimate of how many runs he would be expected to allow in a vacuum based solely on his strikeouts, walks, and home runs allowed. This estimator, called "Fielding Independent Pitching," is based on the idea (first proposed by Voros McCracken (1999)) that pitchers ultimately have very little control over what the outcome of an at-bat will be when the batter hits the ball within the confines of the field. This theory has become more nuanced over time, but the basic principle is commonly accepted in the sabermetric community and has influenced the way many baseball insiders think about the game. As such, it is worth noting that a given pitcher's results as measured by the RA9-WAR model are more susceptible to random variation and other factors beyond his control than one based on FIP. In addition, the use of both a fielding-dependent metric for pitching and a defensive component in position-player WAR means that fielding may be double-counted in this analysis. However, given this research's focus on empiricism, the still-not-fully understood nuances of defense-independent pitching theory, the limited impact any single fielder can have on how many of a pitcher's batted balls are turned into outs, and the nonrandom assignment of pitchers and fielders by comparative advantage (see generally Lewis Pollis (2013)(a)), RA9-WAR seemed more appropriate.

**Appendix B: Individual General Manager Estimated Effects, Free Agent-Investing Ability**

My model for predicting free agent ROI is designed to estimate the general population variance in player-investing ability at the GM level, not to estimate individual executives' values with maximum accuracy. I offer these results for completeness sake, but they should not be interpreted as reliable estimates of how valuable each GM is to his team.

Only general managers whom I credited with having made at least one qualifying free agent signing between November 1995 and September 2013 were included in this table.

| General Manager | z-Score | Annual Wins Above Average GM | Annual Value Above Average GM (2013 League Market) |
|---|---|---|---|
| Brian Sabean | 1.35 | 3.64 | $25,566,428 |
| Walt Jocketty | 1.22 | 3.29 | $23,126,382 |
| Ed Lynch | 0.98 | 2.65 | $18,614,213 |
| John Mozeliak | 0.69 | 1.87 | $13,116,513 |
| Jon Daniels | 0.58 | 1.56 | $10,956,322 |
| Dan Evans | 0.57 | 1.53 | $10,785,467 |
| Andrew Friedman | 0.55 | 1.49 | $10,477,508 |
| Omar Minaya | 0.43 | 1.16 | $8,134,059 |
| Larry Beinfest | 0.43 | 1.15 | $8,100,314 |
| Billy Beane | 0.42 | 1.13 | $7,928,136 |
| Pat Gillick | 0.38 | 1.03 | $7,240,964 |
| Gerry Hunsicker | 0.37 | 1.00 | $7,041,595 |
| Brian Cashman | 0.32 | 0.87 | $6,086,578 |
| Ned Colletti | 0.31 | 0.85 | $5,948,574 |
| Sal Bando | 0.28 | 0.74 | $5,221,510 |
| Lee Thomas | 0.22 | 0.58 | $4,110,407 |
| Doug Melvin | 0.13 | 0.36 | $2,521,823 |
| Jed Hoyer | 0.12 | 0.32 | $2,240,392 |
| Dan Duquette | 0.10 | 0.26 | $1,826,815 |
| Kevin Malone | 0.09 | 0.26 | $1,799,944 |
| Joe McIlvaine | 0.08 | 0.22 | $1,545,112 |
| Dave Wallace | 0.07 | 0.19 | $1,343,993 |
| Terry Ryan | 0.07 | 0.19 | $1,321,677 |
| Josh Byrnes | 0.06 | 0.17 | $1,181,893 |
| Bill Smith | 0.06 | 0.16 | $1,107,340 |
| Ron Schueler | 0.06 | 0.15 | $1,064,093 |
| Bill Bavasi | 0.05 | 0.14 | $1,015,897 |
| Tony Reagins | 0.04 | 0.10 | $682,981 |
| Dan O'Dowd | 0.04 | 0.10 | $678,090 |
| Syd Thrift | 0.03 | 0.09 | $626,423 |

| | | | |
|---|---|---|---|
| Dave Littlefield | 0.02 | 0.06 | $429,669 |
| Gord Ash | 0.02 | 0.05 | $326,719 |
| Lee Pelekoudas | 0.00 | -0.01 | -$37,147 |
| Mike Port | 0.00 | -0.01 | -$88,028 |
| John Schuerholz | -0.01 | -0.03 | -$201,930 |
| Ben Cherington | -0.02 | -0.05 | -$334,501 |
| Rick Hahn | -0.02 | -0.05 | -$361,787 |
| Bob Quinn | -0.03 | -0.08 | -$579,972 |
| Jack Zduriencik | -0.03 | -0.09 | -$633,887 |
| Sandy Alderson | -0.05 | -0.12 | -$861,896 |
| Allard Baird | -0.07 | -0.18 | -$1,258,872 |
| Woody Woodward | -0.07 | -0.18 | -$1,274,447 |
| Alex Anthopoulos | -0.07 | -0.20 | -$1,383,550 |
| Fred Claire | -0.08 | -0.21 | -$1,493,891 |
| Chuck LaMar | -0.08 | -0.21 | -$1,495,173 |
| Cam Bonifay | -0.08 | -0.22 | -$1,530,951 |
| Herk Robinson | -0.09 | -0.24 | -$1,719,147 |
| Steve Phillips | -0.09 | -0.25 | -$1,760,944 |
| Paul DePodesta | -0.10 | -0.26 | -$1,821,490 |
| David Dombrowski | -0.11 | -0.28 | -$2,003,565 |
| Mike Rizzo | -0.14 | -0.38 | -$2,650,752 |
| Bill Stoneman | -0.14 | -0.38 | -$2,679,568 |
| Bob Watson | -0.15 | -0.41 | -$2,882,539 |
| Andy MacPhail | -0.16 | -0.42 | -$2,975,532 |
| Chris Antonetti | -0.17 | -0.46 | -$3,202,557 |
| Theo Epstein | -0.17 | -0.46 | -$3,206,760 |
| Jim Hendry | -0.18 | -0.50 | -$3,498,970 |
| Bob Gebhard | -0.19 | -0.51 | -$3,557,864 |
| Jerry Dipoto | -0.20 | -0.54 | -$3,764,693 |
| Kenny Williams | -0.21 | -0.56 | -$3,909,176 |
| Tim Purpura | -0.21 | -0.58 | -$4,072,774 |
| Mark Shapiro | -0.22 | -0.58 | -$4,100,327 |
| Jim Duquette | -0.23 | -0.61 | -$4,275,544 |
| Wayne Krivsky | -0.24 | -0.65 | -$4,562,989 |
| Frank Wren | -0.24 | -0.65 | -$4,593,212 |
| Dan O'Brien | -0.27 | -0.72 | -$5,066,293 |
| Ed Wade | -0.30 | -0.80 | -$5,646,217 |
| Jeff Luhnow | -0.30 | -0.82 | -$5,743,469 |
| Ruben Amaro | -0.32 | -0.86 | -$6,067,420 |
| Mike Flanagan | -0.32 | -0.87 | -$6,140,729 |
| J.P. Ricciardi | -0.33 | -0.88 | -$6,195,941 |
| Jim Bowden | -0.33 | -0.89 | -$6,247,512 |
| Joe Garagiola | -0.34 | -0.91 | -$6,411,718 |
| Kevin Towers | -0.37 | -1.01 | -$7,109,085 |
| Neal Huntington | -0.44 | -1.18 | -$8,283,675 |

| | | | |
|---|---|---|---|
| Dayton Moore | -0.44 | -1.20 | -$8,409,346 |
| Randy Smith | -0.47 | -1.26 | -$8,864,280 |
| John Hart | -0.48 | -1.30 | -$9,128,908 |
| Dean Taylor | -0.53 | -1.42 | -$9,977,134 |
| Jim Beattie | -0.92 | -2.47 | -$17,365,479 |

**Appendix C: Individual General Manager Estimated Effects, Trade-Investing Ability**

My model for predicting trade ROI is designed to estimate the general population variance in player-investing ability at the GM level, not to estimate individual executives' values with maximum accuracy. I offer these results for completeness sake, but they should not be interpreted as reliable estimates of how valuable each GM is to his team.

Only general managers whom I credited with having made at least one qualifying trade between November 1995 and September 2013 were included in this table.

| General Manager | z-Score | Annual Wins Above Average | Annual Value Above Average GM (2013 League Market) |
|---|---|---|---|
| Kevin Towers | 1.55 | 7.58 | $53,321,404 |
| Larry Beinfest | 1.31 | 6.39 | $44,931,570 |
| Tommy Lasorda | 0.95 | 4.66 | $32,758,902 |
| Randy Smith | 0.74 | 3.60 | $25,316,632 |
| Doug Melvin | 0.61 | 3.00 | $21,114,875 |
| David Dombrowski | 0.58 | 2.84 | $19,972,277 |
| Cam Bonifay | 0.41 | 2.03 | $14,261,002 |
| Jack Zduriencik | 0.37 | 1.79 | $12,587,639 |
| Sal Bando | 0.32 | 1.59 | $11,159,925 |
| Mark Shapiro | 0.29 | 1.41 | $9,891,138 |
| Joe McIlvaine | 0.26 | 1.29 | $9,046,575 |
| Sandy Alderson | 0.23 | 1.11 | $7,824,689 |
| Ron Schueler | 0.22 | 1.06 | $7,480,404 |
| Frank Wren | 0.18 | 0.86 | $6,035,022 |
| Paul DePodesta | 0.16 | 0.78 | $5,514,518 |
| Andrew Friedman | 0.16 | 0.78 | $5,498,559 |
| John Hart | 0.12 | 0.59 | $4,151,708 |
| Dave Littlefield | 0.12 | 0.59 | $4,120,440 |
| Terry Ryan | 0.11 | 0.52 | $3,686,944 |
| Omar Minaya | 0.10 | 0.49 | $3,434,170 |
| Brian Sabean | 0.10 | 0.48 | $3,375,486 |
| Mike Flanagan | 0.08 | 0.38 | $2,696,950 |
| Syd Thrift | 0.07 | 0.34 | $2,422,514 |
| Roy Smith | 0.05 | 0.24 | $1,652,611 |
| John Schuerholz | 0.03 | 0.16 | $1,130,902 |
| Walt Jocketty | 0.03 | 0.15 | $1,075,857 |
| Josh Byrnes | 0.01 | 0.06 | $391,001 |
| Dean Taylor | 0.01 | 0.05 | $341,799 |
| Ruben Amaro | 0.00 | 0.01 | $64,004 |
| Kevin Malone | 0.00 | -0.02 | -$135,006 |

| | | | |
|---|---|---|---|
| Wayne Krivsky | -0.01 | -0.04 | -$274,324 |
| Jim Duquette | -0.01 | -0.04 | -$297,683 |
| Dayton Moore | -0.01 | -0.05 | -$327,979 |
| Dan Evans | -0.02 | -0.08 | -$545,359 |
| Tim Purpura | -0.02 | -0.09 | -$626,260 |
| Ed Lynch | -0.02 | -0.10 | -$700,905 |
| Jerry Dipoto | -0.02 | -0.11 | -$754,090 |
| Bill Smith | -0.02 | -0.11 | -$801,019 |
| Jed Hoyer | -0.02 | -0.12 | -$835,017 |
| Alex Anthopoulos | -0.03 | -0.15 | -$1,070,164 |
| Lee Pelekoudas | -0.04 | -0.19 | -$1,314,766 |
| Bob Watson | -0.04 | -0.20 | -$1,408,805 |
| J.P. Ricciardi | -0.04 | -0.21 | -$1,469,781 |
| Ben Cherington | -0.05 | -0.22 | -$1,557,854 |
| Dave Wallace | -0.05 | -0.24 | -$1,667,937 |
| Tony Reagins | -0.05 | -0.25 | -$1,757,427 |
| Dan O'Brien | -0.06 | -0.27 | -$1,906,520 |
| Pat Gillick | -0.06 | -0.28 | -$1,992,435 |
| Bill Stoneman | -0.07 | -0.37 | -$2,579,121 |
| Bob Quinn | -0.08 | -0.38 | -$2,672,056 |
| Lee Thomas | -0.08 | -0.38 | -$2,686,943 |
| Mike Port | -0.08 | -0.39 | -$2,738,603 |
| Andy MacPhail | -0.08 | -0.41 | -$2,861,901 |
| Chris Antonetti | -0.09 | -0.44 | -$3,095,319 |
| Woody Woodward | -0.09 | -0.45 | -$3,139,923 |
| Mike Rizzo | -0.10 | -0.48 | -$3,397,607 |
| Gerry Hunsicker | -0.11 | -0.56 | -$3,924,679 |
| John Mozeliak | -0.12 | -0.60 | -$4,228,872 |
| Jon Daniels | -0.14 | -0.67 | -$4,678,990 |
| Jim Bowden | -0.17 | -0.82 | -$5,788,831 |
| Theo Epstein | -0.19 | -0.93 | -$6,518,785 |
| Dan O'Dowd | -0.20 | -0.99 | -$6,926,867 |
| Fred Claire | -0.21 | -1.02 | -$7,166,846 |
| Bill Bavasi | -0.23 | -1.13 | -$7,937,037 |
| Ned Colletti | -0.25 | -1.22 | -$8,572,896 |
| Neal Huntington | -0.30 | -1.47 | -$10,317,988 |
| Gord Ash | -0.33 | -1.63 | -$11,458,290 |
| Ed Wade | -0.34 | -1.68 | -$11,821,532 |
| Chuck LaMar | -0.37 | -1.82 | -$12,771,440 |
| Herk Robinson | -0.37 | -1.82 | -$12,805,836 |
| Brian Cashman | -0.40 | -1.98 | -$13,923,920 |
| Billy Beane | -0.42 | -2.05 | -$14,384,947 |
| Allard Baird | -0.44 | -2.15 | -$15,107,577 |
| Jim Beattie | -0.46 | -2.23 | -$15,674,460 |
| Dan Duquette | -0.47 | -2.29 | -$16,070,689 |

| | | | |
|---|---|---|---|
| Jim Hendry | -0.55 | -2.67 | -$18,770,211 |
| Steve Phillips | -0.58 | -2.83 | -$19,900,786 |
| Kenny Williams | -0.59 | -2.89 | -$20,332,512 |
| Bob Gebhard | -0.70 | -3.40 | -$23,937,670 |

**Appendix D: Individual General Manager Estimated Effects, Total Player-Investing Ability**

My models for predicting transaction ROI are designed to estimate the general population variance in player-investing ability at the GM level, not to estimate individual executives' values with maximum accuracy. I offer these results for completeness sake, but they should not be interpreted as reliable estimates of how valuable each GM is to his team.

Only general managers whom I credited with having made at least one qualifying free agent signing and at least one qualifying trade between November 1995 and September 2013 were included in this table.

| General Manager | Free Agent Wins Above Average | Trade Wins Above Average | Total Wins Above Average | Annual Value Above Average GM (2013 League Market) |
|---|---|---|---|---|
| Larry Beinfest | 1.15 | 6.39 | 7.54 | $53,031,884 |
| Kevin Towers | -1.01 | 7.58 | 6.57 | $46,212,319 |
| Brian Sabean | 3.64 | 0.48 | 4.12 | $28,941,913 |
| Walt Jocketty | 3.29 | 0.15 | 3.44 | $24,202,240 |
| Doug Melvin | 0.36 | 3.00 | 3.36 | $23,636,698 |
| David Dombrowski | -0.28 | 2.84 | 2.56 | $17,968,712 |
| Ed Lynch | 2.65 | -0.10 | 2.55 | $17,913,308 |
| Randy Smith | -1.26 | 3.60 | 2.34 | $16,452,352 |
| Sal Bando | 0.74 | 1.59 | 2.33 | $16,381,436 |
| Andrew Friedman | 1.49 | 0.78 | 2.27 | $15,976,067 |
| Cam Bonifay | -0.22 | 2.03 | 1.81 | $12,730,051 |
| Jack Zduriencik | -0.09 | 1.79 | 1.70 | $11,953,752 |
| Omar Minaya | 1.16 | 0.49 | 1.65 | $11,568,229 |
| Joe McIlvaine | 0.22 | 1.29 | 1.51 | $10,591,687 |
| Dan Evans | 1.53 | -0.08 | 1.46 | $10,240,108 |
| John Mozeliak | 1.87 | -0.60 | 1.26 | $8,887,641 |
| Ron Schueler | 0.15 | 1.06 | 1.22 | $8,544,497 |
| Sandy Alderson | -0.12 | 1.11 | 0.99 | $6,962,793 |
| Jon Daniels | 1.56 | -0.67 | 0.89 | $6,277,333 |
| Mark Shapiro | -0.58 | 1.41 | 0.82 | $5,790,811 |
| Pat Gillick | 1.03 | -0.28 | 0.75 | $5,248,529 |
| Terry Ryan | 0.19 | 0.52 | 0.71 | $5,008,621 |
| Dave Littlefield | 0.06 | 0.59 | 0.65 | $4,550,109 |
| Paul DePodesta | -0.26 | 0.78 | 0.53 | $3,693,028 |
| Gerry Hunsicker | 1.00 | -0.56 | 0.44 | $3,116,916 |
| Syd Thrift | 0.09 | 0.34 | 0.43 | $3,048,936 |
| Kevin Malone | 0.26 | -0.02 | 0.24 | $1,664,938 |
| Josh Byrnes | 0.17 | 0.06 | 0.22 | $1,572,894 |

| | | | | |
|---|---|---|---|---|
| Frank Wren | -0.65 | 0.86 | 0.21 | $1,441,810 |
| Lee Thomas | 0.58 | -0.38 | 0.20 | $1,423,464 |
| Jed Hoyer | 0.32 | -0.12 | 0.20 | $1,405,375 |
| John Schuerholz | -0.03 | 0.16 | 0.13 | $928,972 |
| Bill Smith | 0.16 | -0.11 | 0.04 | $306,321 |
| Dave Wallace | 0.19 | -0.24 | -0.05 | -$323,944 |
| Tony Reagins | 0.10 | -0.25 | -0.15 | -$1,074,446 |
| Lee Pelekoudas | -0.01 | -0.19 | -0.19 | -$1,351,912 |
| Ben Cherington | -0.05 | -0.22 | -0.27 | -$1,892,355 |
| Alex Anthopoulos | -0.20 | -0.15 | -0.35 | -$2,453,714 |
| Ned Colletti | 0.85 | -1.22 | -0.37 | -$2,624,322 |
| Mike Port | -0.01 | -0.39 | -0.40 | -$2,826,631 |
| Bob Quinn | -0.08 | -0.38 | -0.46 | -$3,252,029 |
| Mike Flanagan | -0.87 | 0.38 | -0.49 | -$3,443,779 |
| Bob Watson | -0.41 | -0.20 | -0.61 | -$4,291,343 |
| Woody Woodward | -0.18 | -0.45 | -0.63 | -$4,414,370 |
| Jerry Dipoto | -0.54 | -0.11 | -0.64 | -$4,518,784 |
| Jim Duquette | -0.61 | -0.04 | -0.65 | -$4,573,227 |
| Tim Purpura | -0.58 | -0.09 | -0.67 | -$4,699,034 |
| Wayne Krivsky | -0.65 | -0.04 | -0.69 | -$4,837,313 |
| John Hart | -1.30 | 0.59 | -0.71 | -$4,977,200 |
| Bill Stoneman | -0.38 | -0.37 | -0.75 | -$5,258,689 |
| Andy MacPhail | -0.42 | -0.41 | -0.83 | -$5,837,433 |
| Ruben Amaro | -0.86 | 0.01 | -0.85 | -$6,003,417 |
| Mike Rizzo | -0.38 | -0.48 | -0.86 | -$6,048,358 |
| Dan O'Dowd | 0.10 | -0.99 | -0.89 | -$6,248,777 |
| Chris Antonetti | -0.46 | -0.44 | -0.90 | -$6,297,876 |
| Billy Beane | 1.13 | -2.05 | -0.92 | -$6,456,811 |
| Bill Bavasi | 0.14 | -1.13 | -0.98 | -$6,921,140 |
| Dan O'Brien | -0.72 | -0.27 | -0.99 | -$6,972,813 |
| J.P. Ricciardi | -0.88 | -0.21 | -1.09 | -$7,665,722 |
| Brian Cashman | 0.87 | -1.98 | -1.11 | -$7,837,341 |
| Fred Claire | -0.21 | -1.02 | -1.23 | -$8,660,737 |
| Dayton Moore | -1.20 | -0.05 | -1.24 | -$8,737,325 |
| Dean Taylor | -1.42 | 0.05 | -1.37 | -$9,635,335 |
| Theo Epstein | -0.46 | -0.93 | -1.38 | -$9,725,545 |
| Gord Ash | 0.05 | -1.63 | -1.58 | -$11,131,571 |
| Jim Bowden | -0.89 | -0.82 | -1.71 | -$12,036,343 |
| Dan Duquette | 0.26 | -2.29 | -2.03 | -$14,243,875 |
| Chuck LaMar | -0.21 | -1.82 | -2.03 | -$14,266,613 |
| Herk Robinson | -0.24 | -1.82 | -2.07 | -$14,524,983 |
| Allard Baird | -0.18 | -2.15 | -2.33 | -$16,366,450 |
| Ed Wade | -0.80 | -1.68 | -2.48 | -$17,467,749 |
| Neal Huntington | -1.18 | -1.47 | -2.65 | -$18,601,664 |
| Steve Phillips | -0.25 | -2.83 | -3.08 | -$21,661,730 |

| | | | | |
|---|---|---|---|---|
| Jim Hendry | -0.50 | -2.67 | -3.17 | -$22,269,181 |
| Kenny Williams | -0.56 | -2.89 | -3.45 | -$24,241,689 |
| Bob Gebhard | -0.51 | -3.40 | -3.91 | -$27,495,534 |
| Jim Beattie | -2.47 | -2.23 | -4.70 | -$33,039,939 |

Works Cited

Andrecheck, Sky. “WAR, Salary, and Service: Estimating Dollars Per Win.” Web log post. *Baseball Analysts*. 30 Nov. 2009. Web.

Cameron, Dave. “The Assumptions and Linearity of the Cost of a Win.” Web log post. *FanGraphs*. 4 Mar. 2014. Web. Cited as “Cameron (2014)(a).”

Cameron, Dave. “The Cost of a Win in the 2014 Off-Season.” Web log post. FanGraphs. 4 Mar. 2014. Web. Cited as “Cameron (2014)(b).”

Cameron, Dave. "What Is Theo Epstein Worth?" Web log post. *FanGraphs*. 3 Oct. 2011. Web.

Cameron, Dave. “Win Values Explained: Part Six.” Web log post. *FanGraphs*. 2 Jan. 2009. Web.

Cistulli, Carson. “FanGraphs Crowd: The Top 47 Free Agents.” Web log post. *FanGraphs*. 22 Oct. 2013. Web.

Gennaro, Vince. *Diamond Dollars: The Economics of Winning in Baseball*. Purchase, NY: Diamond Analytics, 2007. Print.

Kusnick, Joshua. “An Agent's Take: Three Ways to Work in Baseball.” Web log post. *Baseball Prospectus*. 11 Feb. 2014. Web.

Lewis, Michael. *Moneyball: The Art of Winning an Unfair Game*. New York: W. W. Norton &, 2003. Print.

Lund, Jeb. “I Believe (some) Children Are Our Future: Job-hunters of the MLB Winter Meetings.” Web log post. *SB Nation*. Vox Media, 23 Dec. 2013. Web.

McCracken, Voros. “Defense Independent Pitching Stats (Intro).” *Rec.sport.baseball.analysis*. UseNet, 18 Nov. 1999. Web.

*Moneyball*. Dir. Bennett Miller. Perf. Brad Pitt. Columbia Pictures, 2011. Film.

Neyer, Rob. “How Does All This New Baseball Technology Affect Real-life Scouting?” Fox Sports. Fox Sports Interactive Media, LLC, 5 Mar. 2014. Web.

Pollis, Lewis. “DIPS, Springsteen, and Why Offense Is Declining.” Web log post. *Beyond the Box Score*. SB Nation, 4 Nov. 2013. Web. Cited as "Pollis (2013)(a)."

Pollis, Lewis. "Explaining Spending: Deriving Teams' Optimal Spending Strategies." *Baseball Prospectus*. Prospectus Entertainment Ventures, LLC, 24 Apr. 2014. Web. Cited as “Pollis (2014)(a).”

Pollis, Lewis. “Explaining Spending: How the Market Sets the Price of a Win.” Web log post. *Baseball Prospectus*. Prospectus Entertainment Ventures, LLC, 10 April 2014. Web. Cited as “Pollis (2014)(b).”

Pollis, Lewis. “How Much Does a Win Really Cost?” Web log post. *Beyond the Box Score*. SB Nation, 15 Oct. 2013. Web. Cited as "Pollis (2013)(b)."

Pollis, Lewis. “Was Derek Lowe’s Implosion Predictable?” Web log post. *Wahoo's on First*. FanSided, 2 Aug. 2012. Web. Cited as "Pollis (2012)(a)."

Pollis, Lewis. “What Stats Correlate Best With MLB All-Star Votes?” Web log post. *Beyond the Box Score*. SB Nation, 27 June 2012. Web. Cited as "Pollis (2012)(b)."

Pollis, Lewis. “Winners, Losers of a down Market.” *ESPN Insider*. ESPN, 24 Nov. 2013. Web. Cited as "Pollis (2013)(c)."

*Saber Library*. FanGraphs. Web.

Silver, Nate. “Is David Ortiz a Clutch Hitter?” *Baseball Between the Numbers: Why Everything You Know About the Game Is Wrong*. Ed. Jonah Keri. Basic, 2007. 14-34. Print.

Swartz, Matt. “Methodology and Calculations of Dollars per WAR.” Web log post. The Hardball Times. 27 Mar. 2014. Web.

Swartz, Matt. “Re: Thesis Proposal.” Message to the author. 29 Dec. 2013. E-mail.

Swartz, Matt. “A Retrospective Look at the Price of a Win, Part Two.” Web log post. *FanGraphs*. 15 Feb. 2012. Web.

Tango, Tom. “#16.” Weblog comment. *The Book--Playing the Percentages in Baseball*. 9 Feb. 2010. Web.

Todd, Jeff. “2013-14 Free Agent Spending By Team To Date.” *MLB Trade Rumors*. 16 Mar. 2014. Web.

Tyler, W. Graham. “New Approaches to Player Valuation: Analyzing How Wins Generate Revenue for Major League Baseball Teams.” Thesis. Brown University, 2012. *Economics Department*. Brown University. Web.

Verducci, Tom. “Game's Shifting Strategies Leaves Beane, Sage of Moneyball, behind.” SI.com. Sports Illustrated, 2 Aug. 2011. Web.

Wang, Victor. “Valuing the Draft (Part 1).” Web log post. The Hardball Times. 13 Jan. 2009. Web.

Wilmoth, Charlie. "East Notes: Braves, Rays, Berry, Red Sox." MLB Trade Rumors. 3 Jan. 2014. Web.

Wittenmyer, Gordon. “Red Sox Could Prevent Cubs from Interviewing Torey Lovullo.” *Chicago Sun-Times*. Sun-Times Media, LLC, 4 Nov. 2013. Web.

Woodrum, Bradley. “Trey McNutt for Theo Epstein: Eh, Maybe.” Web log post. *FanGraphs*. 18 Oct. 2011. Web.