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The Overlooked Element: An Empirical Analysis of Team Chemistry and Winning Percentage in Major League Baseball

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Abstract

This paper explores the relationship between team chemistry and winning percentage in Major League Baseball. Team chemistry or cohesion, is an unobservable property that is applied to multiple group settings that can have a positive or negative effect on productivity. I have identified several group faultlines that have deterred team chemistry, specifically the formation of subgroups based on birth location, salary and years of experience. In addition, I analyze team salary disparity as another measure of team chemistry based on the team cohesion hypothesis. (Levine 1991) For the empirical analysis, I analyzed all 30 MLB teams during the 2010-2015 seasons to examine the relationship between different measures of team chemistry and winning percentage. The results suggest that there is a negative relationship between the percent of international players on a roster and winning percentage. The same conclusion is consistent with the effect of intra-team salary disparity measured as the coefficient of variation and winning percentage. Finally, there is a positive relationship between years of experience and winning percentage.

Keywords: ***Team Chemistry, Winning Percentage, Major League Baseball, Salary Disparity***

Motivation

Growing up in the suburbs of New York city has provided me with the opportunity to visit the historic Yankee Stadium. I recall the first time I saw the Yankees took the field, led by shortstop and team captain, Derek Jeter. As a kid, I watched Jeter compete each day as if it were the last time he would step on the field. Throughout the up and downs of the game, Derek not only led by example, but supported his teammates from the first pitch to the final pitch of the game. It wasn't Derek's all-star performance that I admired the most, it was how he approached the game each day for twenty consecutive seasons, achieving five World Series Championships.

I have had the opportunity to play baseball since a young age. Over the past decade, I have been a part of very talented and successful teams. I've competed at some of the highest levels in high school baseball, traveling to Georgia, Texas, Arizona etc. to face the country's top prospects. Post high school, I was lucky enough to play college baseball and travel the country. I have played on teams that had of all the talent to win, but never could achieve a record of .500. When I reflect on my experiences, it is made clear that team chemistry is a major factor in team success. The term team chemistry, it is not as simple as players getting along and sharing a beer after a game. Team chemistry is a force that pushes a team to not only perform well, but to reach their maximum potential. When I reflect on teams that struggled in my career, I can say that cultural, language, and age differences disrupted team cohesion.

I. Introduction

Research has been conducted in a diverse pool of academic fields to explore the relationship between team chemistry and team performance. Team chemistry goes beyond sports, as political scientists incorporate team chemistry when building campaign and cabinet staff. Team "chemistry" is not defined in the traditional sense as it is not created with beakers or test tubes. Instead, team chemistry involves strategically recruiting players that complement each other. Hence, the task of building a successful team requires a team of diversity; different life experiences, talents, personalities, and attitudes. With that being said, it is very difficult to artificially create team chemistry. In the social sciences, there is not a uniform measure to define chemistry. Unlike traditional baseball statistics such as batting average[1], E.R.A[2], and homeruns per 9 innings, there is no formula to calculate team chemistry as team chemistry does not have a single input. Therefore, this study aspires to generate a model of team chemistry by employing diversity, salary disparity, age among other variables as measures of team chemistry. What is the relationship between team chemistry and winning percentage in Major League Baseball? Team cohesion is used as a mechanism for team chemistry as it can be applied to any group work settings, (political, military, sports). Team cohesion is defined as, "a dynamic process that is reflected in the tendency of a group to stick together and remain united in the pursuit of its instrumental objectives and/or for the satisfaction of member affective needs." (Gammage et al. 2001) Along with this definition is the assumption that team cohesion facilitates performance

[1] Batting average is calculated by the number of hits divided by the total number of at bats. A batting average of .300 or higher is considered all-star caliber. Baseball is a game of failure; the best players fail to get a hit 7/10 times!

[2] E.R.A. (earned run average) is calculated by dividing the number of earned runs allowed by number of innings pitched, multiplied by 9 innings. Top pitchers in baseball have E.R.A. below 3.00.

and group achievement. Team cohesion indicates the level in which players of a team are motivated to remain on the team. Actions of "highly cohesive" teams include widespread involvement in team activities and member collaboration. The framework of team chemistry can be broken down by inputs (team payroll), processes (cohesion efforts), and outcomes (player performance). A group of individuals that work in a team in pursuit of a common goal (winning) is known as teamwork. Teamwork entails interpersonal processes such as communication, addressing conflict, and cohesion. Team performance can be represented by the quality of these interpersonal relationships. Team cohesion has been shown to exist across multiple group settings, as well as across multiple sports. Perhaps more intriguingly, cohesion has also been bi-directionally linked to performance: when teams perform better, they are more cohesive; and when they are more cohesive, they perform better. And while research on this relationship is clear, it has mostly been conducted with non-professional teams. Indeed, team cohesion is one of the many other unobservable properties that are untapped within professional sports. With this being said, there is a plethora of exogenous and endogenous factors that influence team performance. Team cohesion and team ability are only two of the many factors that contribute to performance. To name a few, weather, ballpark attendance, and home field advantage can influence game outcomes in Major League Baseball.

This sequence of this paper will occur as follows: Section II discusses what team chemistry is, the implications of team payroll on team chemistry, Major League Baseball's scope of diversity and finally, a review of previous literature that explore relationship between team chemistry and team success. Section III discusses the analytical framework of this paper, followed by section IV which describes the data used in this study. Section V discusses the methodology employed into this study including the econometric models I use, along with

variable definitions and sign expectations. Moving forward, section VI discusses the empirical results and the implications of team chemistry on team success. Finally, section VII summarizes and concludes the paper.

II. Literature Review

1. What is Team Chemistry?

Based on previous studies regarding team cohesion, there are several key findings about indications of strong team cohesion. "Team cohesion is related to the extent that members accept their roles on their team (captain, motivator, follower)." (Carron et al. 2012) "Charismatic leaders will refer to their teams more often that referring to themselves." "The higher level of team cohesion, the better the team performance." (Shamir et al. 1994) Great teams require a leader to keep clashing views together. In Major League Baseball, the majority of teams do not have an official captain. Instead, younger players tend to look up to veteran players with a track record of success both on the field and off. In recent years, there have been a couple official team captains recognized by their organization. Derek Jeter, a future Hall of Famer, was elected as the New York Yankees[3] captain during his tenure, in addition to David Wright, an infielder for the New York Mets. Moreover, as few teams have elected captains to facilitate team chemistry in the clubhouse, practice, and on the field, the team manager[4] oversees and controls the actions of a team. The manager allows his players to have fun, play loose, and support each other. Playing loose and having fun reduces the amount of pressure a player feels. Teams do things differently, beginning with the manager and what he allows his players to do. This

[3] The New York Yankees have won 27 World Series Championships. This is the most championships of any organization in all four major sports leagues.
[4] The term "manager" and "head coach" should be considered the same. In Major League Baseball, the on-field leader is called the "manager," while the other three major sports, NFL, NHL, and NBA use the term "head coach."

includes pregame routine, practice, and of course, off the field conduct. Some managers choose to have a hands-off approach which allows players to go about their individual routine. Other managers, such as Joe Maddon of the Chicago Cubs who is famous for his clubhouse antics, takes his job a step further by holding team events to spark team chemistry. For some teams, chemistry is based on happiness level. "Manager Joe Maddon runs his clubhouse like a camp counselor, bringing in live penguins to help the club "chill," mandating group dress-up days to build camaraderie and taking the entire team out for drinks (on his dime) to get their minds off losing streaks." (Miller 2013)

Veteran players do have a significant impact on team chemistry as they complement the manager. When a leader of a team holds himself accountable for a loss, or attributes a win to a rookie, mutual respect is built in the clubhouse. In mid-August 2013 the Oakland Athletics, a low payroll team that started the sabermetric movement[5], lost an extra inning game to the Houston Astros. Sean Doolittle, a second year relief pitcher gave up the winning run on a ball hit to centerfield in the bottom of the 11th inning. Chris Young, the Oakland's highest paid and star outfielder, committed an error on this play and ultimately cost his team the win. After the game, the clubhouse was silent as players went about their post-game routine. Amidst the silence, Chris Young appeared from the shower and approached Sean Doolittle – "Hey, man, I messed that ball up. There would have been a play at the plate. I'm sorry." Sean Doolittle response, "I appreciate it, but I threw a thigh-high fastball right down the middle." (Miller 2013) Neither Doolittle or Young can be solely blamed for the loss but within the quiet clubhouse, they picked

[5] Advanced statistical methods used by organizations to more efficiently evaluate players. New statistics like wins-above-replacement (WAR), fielding independent pitching (FIP), and weighted on-base average (wOBA) allows teams to evaluate player performance more efficiently.

each other up to show that they have each other's back. The following day, Chris Young lead off the game by hustling and beating out a ground ball to short stop. The Athletics went on to win that game as Chris Young was recognized by his teammates for leading the team after a devastating late night loss.

Every athlete talks about that feeling of being on a team and what that means to him/her. Depending on if and when a team "clicks", players share the feeling of unity that drives teammates to compete. In Major League baseball, every year a team "clicks" in August and September as the race for the playoffs becomes more prevalent, for example the 2015 World Series champions Kansas City Royals. In previous years, the Royals struggled to achieve a winning record as the majority of this low payroll team was comprised of young players. 2013 marked the first year the Royals achieved a winning record since the 2003 season. This speaks volumes as ten players from the 2015 world championship team experienced adversity to begin their careers. These players, Wade Davis, Yordano Ventura, Salvatore Perez, Eric Hosmer, Mike Moustakis, Lorenzo Cain, Kelvin Herrerra, Jarrod Dyson, and Alcides Escobar, suffered through losing seasons and built on their progress. After many years of underperformance, the 2015 World Series winner learned how to win together. The idea of "growing up together" in baseball is seen amongst many low payroll teams. Teams like the Kansas City Royals, Tampa Bay Rays, and the Houston Astros rely heavily on their farm system[6], (minor leagues) to produce Major League caliber players. Since these teams do not have equal access to elite players due to salary demands, the players drafted by their respective team are invested heavily into. Years of development within an organization, as seen in the 2015 World Series champions Kansas City

[6] Each MLB team has a "farm system" otherwise known as the minor leagues consists primarily of young players in the process of getting MLB ready. In many cases, minor league players never reach the Major Leagues.

Royals, fueled team cohesion as this team "clicked" are the right time and raced to the world series.

It has been debated whether team chemistry weighs more than performance in terms of success and vice versa. A roster constructed primarily of veteran players known to be "club house guys"[7] that produce a negative WAR, will have a difficult time winning. Conversely, building a roster based on advanced on the field metrics[8] can have a hard time winning without evaluating each players' human capital. "The central premise of the baseball season is that only the strongest clubs survive the grind of a 162-game schedule. That survival is a heck of a lot easier when guys get along, and the clubs are at their strongest when guys are committed to their role and to each other." This point relates

Former Major League Baseball player and manager Davey Johnson once said, "Chemistry is when everyone is in a role where they know their own role, and they're prepared to do their role mentally and they do their role." (Castrovince 2015) This example provides context for the definition of team cohesion stated by (Gammage et al. 2001). With this being said, there will be situations where a veteran player doesn't want to share his secrets with a rising young player. Or in some cases, veterans force rookies to dress up as cheerleaders or even female fictional characters as a form of hazing. The 2008 San Diego Padres required rookie players to dress up as staff members from a Hooters restaurant. (Associated Press 2016) Moreover, not every star player will attribute his teammates to the team's success. However, for team chemistry to be present, players must respect each other, invest in each other, and do whatever is necessary to put the team in the optimal position to succeed. Chemistry should maximize talent,

[7] "Club house players" can facilitate the chemistry in the locker room and on the field.
[8] Examples: WAR, Batter Exit Velocity, Pitch Value

not suddenly create talent. An organization, starting with administrators to managers to players can achieve higher success when working in harmony, than talent level alone achieves.

2. *How does payroll effect team chemistry?*

Major League Baseball is the only sport not to have a team salary cap in the four major sports which brings up a debate regarding competitive balance. MLB commissioner Rob Manfred suggests that baseball has great competitive balance with the additions of luxury tax, free agency and draft selection. However, this is generally not true as the 5 out of the last 6 world series winners were amongst the highest payroll teams, the 2015 Royals being the lone low payroll team. The more money a team has, the more likely they will be competitive in August and September as the playoff hunt heats up. High payroll teams are at an advantage when recruiting free agents in addition to having a safety net to protect teams from injuries and poor playing. High payroll teams have more room for error compared to low payroll teams. Additionally, compared to other sports with a salary cap such as basketball and football, teams are forced to assemble a team that complies with the salary cap. Every year, sport fans tell themselves this is the year for their team. However, this phenomenon is short lived in baseball as many low payroll teams, comprised mainly of young farm system players or former stars past their prime, are simply not ready for world series competition. Yet, there are exceptions of high payroll teams that flop, but more often than not, the world series teams come from the top 10 highest payroll teams. The following are previous world series winners: 2011 St. Louis Cardinals $130 million payroll (6th overall)[9], 2012 San Francisco Giants $131 million (8th overall), 2013 Boston red sox $184 million (3rd overall), 2014 San Francisco Giants $178 million

[9] The ranking in parenthesis is out of all 30 MLB teams. In 2011, the St. Louis Cardinal's payroll was $130 million, the 6th highest in MLB.

(3rd overall), 2015 Kansas City Royals $116 million (15th overall), 2016 Chicago Cubs $168 million (6th overall). (Fangraphs)

High payroll teams often donate the 25th sport on the roster to a veteran presence, perceived to be a chemistry guru, even if the on-field utility of the players diminishes. For example, the 2013 World Series champion Boston Red Sox, acquired veteran outfielder Jonny Gomes. Gomes posted a net WAR of 0.6 in 2013, but his influential and positive clubhouse presence was worth $5 million dollars for 1 year with the Red Sox. (baseball-reference) General Managers and team scouts are always looking for ways to maximize their teams' performance. When GM's are given the task to assemble a winning roster, the goal is to generate an extra win, or two, or three. Often, the difference between playing in October[10] and going home is a single win. In a season of 162 games, each game is significant. Teams typically spend $5 million to add a single win when searching for players on the free agent market. This brings us to the question of why the MLB does not have a payroll cap system in place. Unlike the other major three sports, Major League Baseball has not adopted a salary cap system to promote greater parity. However, baseball's salary structure is in favor of the players' association. Without a salary restriction, a team can sign multiple players with high salaries. In 1994, MLB owners attempted to implement a salary cap to promote competitive balance. The suggestion was rejected by the MLBPA and has not been brought up in recent collective barging agreements. Since 1994, baseball has tripled its gross revenue, therefore there are no signs of a salary-cap system in the near future. (Schmuch 2010) With this being said, the lack of competitive balance in Major League baseball can have mixed effects on team chemistry. High payroll teams with the ability to sign veteran players benefit in terms of team chemistry. On the other hand, low

[10] MLB playoffs continue into October

payroll teams who cannot sign a veteran player in free agency are stuck writing a lineup card with the same players. However, just like the 2015 world series champions Kansas City Royals, young players can learn from their mistakes and achieve a winning serious.

The relationship between team-payroll, organizational faultlines, and organizational performance has been studied. It was determined that demographic diversity in high ranked management teams upon strategic structural change is moderately effected by pay levels. (Bezrukova et al. 2015) Moreover, the size of an organizations payroll can cause increased pressure as players with big contracts are expected to perform. Since 1999, there have been 48 MLB contracts of ten or more years valued over $100 million dollars. Studies have shown that nearly two thirds of players with these extreme contracts fail to meet expectations. (Bezrukova et al. 2015) As high profile players begin to show signs of diminished performance, this causes tensions within an organization as teams are "stuck" with these players. "So the harmful effects of organizational-level faultlines are especially and strongly related to lower performance under these high payroll conditions." (Bezrukova et al. 2015) In contrast, low payroll team do not experience the same conflicts as most low payroll teams have a "nothing to lose" culture. There is a strong relationship between high payroll teams and success, which in turn suggests that low payroll teams have a much lower expectation for winning than high payroll teams.

3. Major League Baseball Scope of Diversity

Today, diversity in the workplace, social settings, and in sports is recognized as an essential part of success. Professional baseball in the United States began in the late 1880s as the first World Series was in 1903. At this time, a handful of teams located in the same geographic region competed, as this marked the beginning of professional paid baseball players. At this

time, baseball was only a white man's sport. It wasn't until roughly forty years later that Jackie Robinson broke the color barrier as he was signed to the Brooklyn Dodgers. Jackie Robinson went on to have a hall of fame career and is now recognized every year in April as all 32 major league teams wear Jackie's number, 42. Furthermore, the number 42 has been retired for all Major League teams to respect one of the greatest second basemen to play the game of baseball. Since Robinson's entrance into the MLB, black and Latino players signed with teams. According to the Society for American Baseball Research, the share of black players in the MLB peaked at 18.7% in 1981. This already low percentage fell to 8.3% in 2014. Baseball continues to be a white man's sport as 60 percent of all 32 MLB teams starting lineups in 2016 were comprised of white players – 8 percent being black. With this being said, there has been an influx of Latino and Asian professional baseballs. Latin America is notorious for producing very talented baseball players. In some cases, baseball is a part of culture.

My intuition regarding the impact of English speaking players and team chemistry extends from academic claims about the hardships Latino players face in the major and minor leagues. Latin American players have experienced prejudice in which they are treated with tougher standards than American players. Furthermore, "Latino players face cultural obstacles that do not confront American players making the cultural transition from the Dominican Republic or Venezuela to life in the United States is very difficult for Latino players because they often do not have the language and other skills to make a successful transition." (Vargas, 2000) From these statements regarding Latin American players, it can be assumed that players from Japan, Taiwan, and South Korea experience similar hardships. The language and cultural differences between teammates causes difficulty with team assimilation. These claims support

my hypothesis of a positive relationship between team chemistry, team success on English speaking players.

As mentioned earlier, the influx of international players has forced teams to higher interpreters for communication between coaches and players. The major issue of utilizing an interpreter is often miscommunication between managers and players. The 2016 World Series winner, the Chicago Cubs led by the decorated manager Joe Maddon faced scrutiny from the Cuban superstar, Aroldis Chapman. Chapman, arguably Chicago's best pitcher in 2016 felt he was overworked and abused. Maddon's defense, "Every game I put him in, I talked to him and his interpreter to make sure that he was OK because this season he did not like pitching multiple innings so we stopped doing it." (Marchand, 2016) Even though Chapman told manager Joe Maddon that he was fine with his decisions, clearly, he wasn't. If Chapman was able communicate with his manager without an interpreter, there is a possibility that Maddon would not have played him based on Chapman's response.

Furthermore, the percent of native players on a roster is an interesting variable to be used in the study of team chemistry and team success. This variable will be used to quantify the amount of diversity on a team. Building on the significance of diversity on team success, recruiting for maximum diversity is imperative as a team should consist of players than complement each other. With that being said, diverse teams are volatile as conflicting opinions and views can clash. However, this can be facilitated by having a strong and active leader.

4. Literature

In any group setting, conflicts tend to arise based on differences between team members. When observing a team, often people seek factions among similar members within the group leading to intensified conflicts. These factions, or faultlines occur when group member

form alliances with people with similar backgrounds including race, age, and experience level. A team is therefore divided into multiple homogenous subgroups which negatively effects performance. To test the theory of faultlines and performance, (Bezrukova et al. 2015) used multilevel data on thirty MLB teams from 2004 to 2008. The dataset included information regarding race, nationality or country of origin, and age since there is significant variation of these characteristics in Major League Baseball. Furthermore, the authors identified four distinct groups on each team based on position: starting pitchers, relief pitchers, starting position players, and backup players. Baseball requires a team of 25 players to have specific roles as the sport presents an innumerable amount of situations that a single player cannot address. For example, a starting pitcher cannot do the same job as an outfielder or even a relief pitcher. The four groups used in this study covers the different roles players fill.

"Faultlines are hypothetical dividing lines that split a group into relatively homogenous subgroups based on group members' demographic alignment along one or more attributes. For example, a sports team would have faultline when all the white players are under 25 years old and all the black players are about 40 years old." (Bezrukova et al. 2015) To combat subgroups, the concept of cross-cutting dilutes outgroup bias on race and therefore the faultline will be weaker. Imagine if the white players and some of the black players are under the age of 25, the category of age cross-cuts that of race.

Identifying the source of conflict is imperative for teams to overcome to be successful. An internal conflict is defined as "environments in which people act upon the discrepant views among group members directed inside the organization." (Bezrukova et al. 2015) The 2011 Boston Red Sox is an example of an organization that dealt with internal conflicts and as a result missed the playoffs. "Dissention within the team, directed at the coach as well as players who

were involved in infractions (eating chicken and drinking beer during games) led to finger pointing and factions forming within functional groups, particularly within the group of starting pitchers." (Bezrukova et al. 2015) It is believed that this conflict contributed to Red Sox blowing a nine game lead, costing them a bid at the postseason. As a result, several players were traded in order to dismantle negative stereotypes associated with this team. In contrast, external conflicts are defined as "shared norms of expressions of "nonrealistic conflict" or diffuse aggression directed outside the team." (Bezrukova et al. 2015) In baseball, on field fights can occur between opposing players based on a violation of baseball's unwritten rules. A "bench-clearing brawl" involves all players from both teams even if they were not playing in the game. It is argued that when the expression of violence and anger is directed outside the organization, there can be benefits to the team; a sense of shared purpose and trust can be built from this situation. The subgroup in which a player belongs is eliminated in cases of external conflicts.

In 1991, Levine conducted a study on the effects of wage dispersion on cohesiveness in a professional work environment. Levine suggests that productivity depends on group cohesiveness which is determined by intra-firm wage dispersion. (Levine 1991) Levine employs the ratio of WL to the WH as a measure of wage dispersion. Levine argues that a firm with high wage disparity will negatively affect team cohesion, reducing the firm's productivity. Furthermore, Levine (1991) states that productivity in firms that are dependent on a team effort, rather than an individual effort, should stress the importance of reducing intra-firm disparity. He claims that if low skill workers are aware of wage dispersion within a firm, there is an incentive for them to not collaborate with high skilled workers resulting in a significant decline in firm productivity.

Building upon Levine (1991), Depken (2000) applied the team cohesion hypothesis to Major League Baseball to explain the effect of salary disparity within Major League Baseball teams on team performance from the 1985 to 1998 seasons. Depken (2000) employed panel data and utilized the following regression model.

(1) $$WINPER_{it} = \alpha_i + \beta_1 TOTSAL_{it} + \beta_2 SALHHI_{it} + \beta_3 TIME_{it} + \varepsilon_{it}$$

Where WINPER is the win percentage of team i for year t; TOTSAL is the total salary expenditure of team i for year t; SALHHI is the salary Hirschman-Herfindahl Index of team i for year t, which is a measure of salary dispersion within a team; TIME represents the time trend. In addition, Depken 2000, utilized a fixed effects model because all of the teams in the dataset are used. However, Depken also employs a random effects model due to the random, unmeasurable, and unknown factors that affect team performance. (Depken 2000) The empirical results found a negative relationship between intra-team salary dispersion and winning percentage, supporting Levine's (1991) team cohesion hypothesis.

The following literature explored the relationships between a variety of variables and their effect on winning percentage, and individual success. A study conducted by Brian Fields (2001) investigated the value of individual Major League baseball players. Using data from 1990 to 1999, Fields explored the relationship between team revenues and team winning percentage. Based on Fields (2001) I adapted this model to incorporate team payroll instead of team revenue as an explanatory variable. Team payroll is the sum of player salaries in a given year and team revenue is the amount of money a team receives after expenses such as stadium operations, payroll, etc. There is no salary cap in Major League Baseball and as as expected, there is high variance in payroll each year. Each teams' payroll variance can be used to

quantify a teams' payroll relative to the league average. (Cyrenne, 2014) By implementing team payroll instead of team revenue, I can analyze player salaries, specifically dispersion, as a measure of team cohesion.

In addition, Fields (2001) explored the relationship between team winning percentage and team statistics. From this model, I again adapted the variables to be more modern and simplistic. Fields (2001) used traditional team statistics such as team batting average, homeruns, etc. to represent players on the field performance. I decided to use the non-traditional modern baseball statistic WAR (wins above replacement), to substitute team statistics in the model. By using WAR, this is a more holistic representation of a player's contributions to a team's success. As I continued my research, I identified a piece of literature that attempts to identify the most important baseball statistic when determining team success. A study conducted by Adam Houser (2005), utilized multiple regressions to test multiple hypotheses. In short, Houser determined that WHIP and on base percentage are the most effective statistics to determine team success. By using Woods and Houser's results in addition to incorporating my own intuition, I was able to substitute traditional baseball statistics with a modern-day sabermetrics statistic, WAR.

My study of WAR led me to an article published by a popular sports website, Bleacherreport.com. Within this site, I identified a statement from FanGraphs (a popular baseball statistic website) explaining the significance of WAR. "Wins Above Replacement (WAR) is an attempt by the sabermetric baseball community to summarize a player's total contributions to their team in one statistic. You should always use more than one metric at a time when evaluating players, but WAR is pretty darn all-inclusive and provides a handy reference

point." WAR basically looks at a player and asks the question, "If this player got injured and their team had to replace them with a minor leaguer or someone from their bench, how much value would the team be losing?" This value is expressed in a wins format, so we could say that Player X is worth +6.3 wins to their team while Player Y is only worth +3.5 wins." (Fangraphs.com) This explanation is a very clear in defining WAR and providing an example.

For organizations that perform poorly during the regular reason, Coaches, players, front office personnel, and fans ask themselves what needs to be done to start winning? Often, a team just needs a new look to them. When teams get complacent, things start to go bad. The term "flat" applies here. Teams come off as "flat" when mental mistakes are made due to a lack of focus. Both the 2004 Red Sox and 2015 Kansas City Royals displayed team chemistry that contributed to their success. Even though they have their fun, once they stepped onto the field, it was all business. There is a difference between having fun and team chemistry. Today, many teams have special celebration antics – special handshakes with players, or throwing a pie into the face of the player of the game. This fun aspect of playing baseball comes after games won. The celebration is to celebrate the hard work and the adversities teams have been forced to overcome.

III. Analytical Framework

In 1991, Levine conducted a study on the effects of wage dispersion on cohesiveness in a professional work environment. Levine's (1991) productivity function is as follows:

$$(1)\quad q=C(w/w)*f(H,L)\,LH$$

Where q is output per worker; C measures cohesiveness; WL and WH are the wage levels of low skill and high skill workers respectively; H and L represents the two types of workers, high skill and low skill workers. Levine suggests that productivity depends on group cohesiveness which is determined by intra-firm wage dispersion. (Levine 1991) Levine employs the ratio of WL to the WH as a measure of wage dispersion. Levine argues that a firm with high wage disparity will negatively affect team cohesion, reducing the firm's productivity. Furthermore, Levine (1991) states that productivity in firms that are dependent on a team effort, rather than an individual effort, should stress the importance of reducing intra-firm disparity. He claims that if low skill workers are aware of wage dispersion within a firm, there is an incentive for them to not collaborate with high skilled workers resulting in a significant decline in firm productivity. Based on Levine's 1991 study, I adapt his team cohesion hypothesis to Major League Baseball. The Major League baseball season consists of 162 games over roughly 6 months. Winning is highly dependent upon players' cohesiveness, simply because of the amount of time spent together. If teammates don't get along, how are they expected to reach their peak performance?

Based on Levine (1991) and Depken (2000) and my intuition, I adapted their models of team cohesion. Several authors have quantified salary disparity with HHI, Gini coefficient, and the coefficient of variation. (Tao et al 2015), (Breunig et al 2012) Based on its simplistic nature, I use the coefficient of variation as a measure of salary disparity based on the results from (Cyrenne 2014) in which it was determined that salary dispersion has a negative effect on team performance. My contribution to the study of salary dispersion and team performance is that I included the average years of service, average age, percentage of players suspended on a team, and racial markup (percent International, percent American) as factors affecting team cohesion.

My theory is based on the literature highlighting the difficulty foreign players have assimilating with a team.

IV. Data

Major League Baseball consists of 30 teams, equally divided between American and National Leagues. The data used in my analysis is a panel consisting of all 30 teams from the years 2010-2015. The dataset is comprised of all eleven independent variables. The data was obtained through several sources including, baseball-reference.com, spottrac.com, and retrosheet.org. I decided to incorporate the regular season statistics and not post season statistics because in baseball, the outcome of a game can be a coin flip. There is a plethora of different factors that determine the outcome of a single game, or five game series. Hence, the Major League Baseball season consists of 162 games, significantly more than any other major sport. Furthermore, the dependent variable regular season winning percentage, is an accurate representation of how well, or poorly a team performed due to the large sample size of games played.

V. Methods

The dependent variable used in my model is *team winning percentage* from the regular season. This variable is calculated by dividing the number of games won by the total games played during the season (162). (baseball-reference.com) I use team payroll as an instrument for the production function because of the significant team payroll has on winning percentage. A goal of mine throughout my research was to implement a diverse pool of input variables to cover multiple perspectives as to the determinants of winning percentage. In my model, I include inputs from both team and player, to more accurately capture the qualitative and quantitative

perspectives of a teams' makeup. To clarify, I seek to cover all relevant bounds when analyzing team performance. Based on previous literature, team payroll (Bezrukova et al. 2015), team WAR (Woods 2005), managerial efficiency (Clarke 2016), and team salary disparity (Depkin 2001) have all been found to have a significant effect on team performance. In reference to the team cohesion hypothesis (Levine 1991), salary disparity negatively affected performance. Based on these result, have added additional inputs including percentage of players on a team that were born internationally, average age, and years of experience to further support the team cohesion theory. There is no uniform measure of cohesiveness, so I attempt to portray team cohesion, (chemistry) by including age, years of service, and racial markup. Different from Levine (2011), I am employing the coefficient of variation as a measure of salary disparity. The coefficient of variation (CV) of players' salaries on a team in a given season is the ratio of the standard deviation of salaries on a given team to the team's average salary. (Breuing 2011) To understand the variable CV, the higher the coefficient of variance, the more inequality is present on a team. Shown in Graphs 3 and 4, there is a clear relationship between success and a teams' salary coefficient of variation. The 2015 World Series champions Kansas City Royals finished with a 95-67 record with a coefficient of variation of 0.86. In contrast, the 2015 Philadelphia Phillies finished the season with a 63-99 record and double the CV of the Royals. Jardin et al (2012) conducted a study regarding wage dispersion and team performance by utilizing the Gini coefficient. In addition, Bruing, Jardin et al. (2012) introduced a contest success function (CSF) to determine the probability of each team winning as a function of their own and their opponent efforts. Moreover, this 2012 study concluded that there is a negative relationship between inequality and performance. In contrast to baseball, Coates, Frick et al. (2012), performed an empirical analysis of salary disparity and team performance in Major League Soccer. This study

used a Gini coefficient and the coefficient of variation to measure salary inequality in American soccer. The results indicated a statistically significant negative relationship between performance and salary disparity when measured as the coefficient of variation. Using these inputs in addition to salary disparity, I have come closer to effectively defining cohesion.

1. *Defining Variables | Variable Expectations*

Based on Levine's (1991) production function, and Depkin's (2000) empirical model, I utilized *winning percentage* as a dependent variable to measure performance. Winning percentage is calculated by dividing the number of games won by the total games played during the season (162). In order to test the effects of team chemistry on winning percentage, the following independent variables are used. Data from all 30 MLB teams from 2010-2015 is used. (1) *Team payroll,* the combined salaries of all players in a given year is subject to change during the course of the season due to trades and other roster transactions, therefore each team's opening day payroll was selected for this study. The basis of incorporating team payroll into my study stems from the study conducted by (Bezrukova et al. 2015) that examines the relationship between team-payroll, organizational faultlines, and organizational performance. Bezrukova et al. (2015) concluded winning percentages is positively affected by team payrolls, as wealthy teams can afford the best players on the market. Team payroll data was collected from baseball-reference.com. (2) *Managerial efficiency,* is calculated by the ratio of actual winning percentage to the expected winning percentage[11]. All data for this variable was provided by Jeb Clarke from his 2016 study, "Analyzing Managerial Efficiency in Major League Baseball: A Sabermetric Approach." The significance of this variable provides context on how well a coach manages his

[11] The expected winning percentage is calculated in an equation that includes the following variables: loghWAR, logpWAR, logyearsexp, logmanwpct, award dummy, MLB player dummy, change in manager mid-season dummy, and a National League dummy.

team[12]. I expect this variable to have a positive sign simply because a team with an efficient coach will win more games. (3) *Team WAR,* is calculated by adding the total defensive and offensive WAR on a specific team in a given year. Data was acquired from fangraphs.com. By using WAR[13] instead of traditional baseball statistics such as batting average or strikeouts per 9 innings, WAR provides a more complete measure of player performance. Studies conducted by Houser (2005) and Fields (2001) tested different traditional baseball statistics as a function of winning percentage. Based on this studies, WAR is a more accurate representation of player performance and I expect WAR to have a positive relationship to winning percentage. (4) *Percent of players suspended on a team is* calculated by identifying which players on a specific team in a specific year violated any of MLB policies. This includes drug suspensions, domestic violence abuse, on the field penalties such as cheating, and the involvement with on the field brawls. All of this information was collected from spottrac.com. By using a variable to measure suspensions goes back to the study conducted by (Bezrukova et al. 2015) in which the formation of subgroups results in a less cohesive overall group. Based off this study, I expect the percent of players suspended on a team to have a negative relationship to winning percentage. Drug abuse, domestic violence and other punishable offenses can cause alienation within a clubhouse as cheating is frowned upon heavily. (5) *Average player age* data was collected from baseball-reference.com and is used to measure how young or old a team is on average. (6) *Average years of player service* data was also collected from baseball-reference. Often, veteran players with experience in the Major Leagues can have a profound positive effect on team chemistry. (Castrovince, 2015) Therefore, I expect there to be a positive relationship between average years

[12] Writing a winning batting order, strategical midgame lineup adjustments etc.
[13] Wins Above Replacement

of player service and winning percentage. (7) *Team payroll variance* is calculated by dividing team payroll by the league average. The purpose of this variable is to standardize each team's payroll relative to the average payroll spending of all teams during a season. (Hall, Syzmanski, 2002). Since Major League Baseball does not have a salary cap, teams located in wealthy markets (New York Yankees, Los Angeles Dodgers) have higher revenues compared to low market teams such as the Houston Astros. If wealthy teams can buy success, the most accurate method to depict team spending is to calculate the ratio of team spending and league average. Teams with greater payroll variance (greater than 1) will perform better as it has been determined that larger payrolls positively affect performance. (Hall, Syzmanski, 2002) Therefore, I expect payroll variance to have a positive relationship to winning percentage. Payroll data was collected from baseball-reference. (8) *Team salary disparity (teamCV)* is calculated by dividing the Standard deviation by the Team average, CV is the coefficient of variance. Data regarding player salary was collected from retrosheet.com. There have been many studies analyzing wage disparity and its effect on team performance. Specifically, (Depkin 2000) uses the HHI index and coefficient of variation as a measure of salary inequality. Depkin (2000) determined salary disparity has a negative effect on winning percentage. I expect to obtain the same results, a negative sign. A high CV value indicates a team has large salary dispersion. (9) *Percent international born players on a roster (pctinternational)* is number of internationally born players/total roster. Data regarding player birth location was collected from baseball-reference.com. (Vargas 2000) discusses the difficulties Latin American's have assimilating with their American teammates. Therefore, I expect this variable to have a negative relationship to winning percentage. The variable, Percent International, is an original contribution to the study of team chemistry and team success in Major League Baseball. (10)

National League dummy variable (NL) is equal to 1 if the team competes in the National League, 0 for the American League. It is hypothesized that National League teams, on average, will produce fewer wins than American league teams due to NL-specific rules. There is no designated hitter in the NL and pitchers hit. Because of this, American league teams produce more runs per game, equating to more wins over a season. As a result, I expect NL to produce a negative sign. Data was collected from baseball-reference.com.

2. *Models*

The following production functions is used to estimate OLS regressions.

$$(1) wpct_{it} = \propto_1 + B_1 teamWAR_{it} + + \propto_2 NL_{it} + \epsilon_{it}$$

$$(2) wpct_{it} = \propto_1 + B_1 pctinternational_{it} + B_2 avgservicetime_{it} + B_3 teampayrollvariance_{it} + \epsilon_{it}$$

$$(3) wpct_{it} = \propto_1 + B_1 pctinternational_{it} + B_2 teamCV_{it} + B_3 avgservicetime_{it} + B_4 teampayrollvariance_{it} + \epsilon_{it}$$

$$(4)\ wpct_{it} = \propto_1 + B_1 managerialefficency_{it} + B_2 teamCV_{it} + B_3 teamWAR_{it} + B_4 pctsuspended_{it} + B_5 pctinternational_{it} + B_6 avgage_{it} + B_8 avgservicetime_{it} + B_9 teampayrollvariance_{it} + \propto_2 NL_{it} + \epsilon_{it}$$

VI. Results

I estimate four different regressions on winning percentage, the dependent variable. The results from the models described in the previous section can be found in Table 1 below. Descriptive statistics for all variables described in above appear in Table 2. As noted in the previous section, the data set ranges from 2010-2015. During this time period, Major League Baseball consisted of 30 MLB teams, resulting in 180 observations. The signs of the variable coefficients are consistent across all four models suggesting that the results do not vary when additional variables are added. Model 1 is a fixed effects regression that analyzes winning

percentage on teamWAR and NL dummy. As expected, the results in Table 1 show that teamWAR is positive NL is negative and is statistically significant at the 1% level. It should be noted that model 1 had a R^2 value of .7971. This is interpreted as the independent variables, teamWAR and NL used in the model explain over 79.71% of the variation in winning percentage. This supports (Fields, 2001) that the better statistical teams (on the field metrics) perform better in terms of winning percentage. Moreover, I find this very intriguing as variables such as percent international, salary disparity (CV), years of experience and payroll variance are all factors that can explain winning percentage and were not included in regression (1). Therefore, I adapted regression (2) in an effort to understand the significance of specific inputs of team cohesion on winning percentage. My original contribution to the study of team chemistry and team success is incorporating average service time, percentage of players suspended, and the variable quantifying diversity on a team roster (percent international). The results from regression (2) show average years of service, percent international, and and team payroll variance are statistically significant at the 1%, 1%, and 10% level of significance, respectively. Moreover, of the statistically significant variables in regression (2), they all met the sign expectation: team payroll variance and average years of service had positive coefficients, and percent international had a negative coefficient. In regression (3), I added salary disparity measured by the coefficient of variation. The results found a statistically significant, negative relationship between CV and winning percentage at the 5% level, consistent with my sign expectation. Similar to regression (2), the coefficient signs for average service time, team payroll variance and percent of international players maintained consistent. Regression (3) therefore supports the team cohesion hypothesis on the basis of salary disparity, originally presented by (Levine 1991). Regression (4) contains all of the independent variables mentioned

in previous sections. Again, similar to regressions (1), (2) and (3), the coefficient signs of percent international, average service time, teamWAR and NL, remained consistent in regression (4). Unlike the previous three regression equations, regression (4) included the variables managerial efficiency and percent of players suspended. Managerial efficiency produced a positive sign and is significant at the 1% level, confirming my expectation that a more efficient manager has a positive effect on winning percentage. The percent of players suspended had a positive sign, which goes against my expectation of a negative relationship between players suspended and winning percentage. In regression (4) team payroll variance produced a positive sign, meeting my expectation that high payroll teams are expected to perform better.

Of the variables of my original contribution, (percent players international, average years of experience, percentage of players suspended) this study determined that percent of players born international and average years of experience have statistically significant effects on winning percentage. In regression (2) and (3), the percent of international players had a negative relationship with winning percentage. In regression (2) holding other variables constant, a one-unit increase in international players on a roster is associated with a 0.167 percentage point decline in the percentage of games won. Moreover, regression (3) holds a similar impact as a one-unit increase in percentage of international players on a roster results in a 0.153 percentage point decline in percentage of games won.

The proper robustness checks for panel data was conducted and appears in Table 4 and Table 5. After conducting the Hausman test, regression (4) is consistent with a fixed effects model. This significance of a fixed effects equation is the GLS estimates it produces. Therefore, based on the results from the Hausman test, I had to change the estimation technique from OLS to GLS for regression regression (4) in Table 1. Table 5 shows the results of the

multicollinearity test, variance inflation factor (VIF) of the four regressions. Since the VIF of each variable in each equation are less than 5, no variables were omitted.

1. Limitations

The conclusions above are subject to a number of limitations. First, it is unclear to what extend the results of percent international, average service time, and salary disparity (CV) can be interpreted by the front office of Major League Baseball teams. This study showed statistical evidence of the negative impacts international players and salary disparity has on winning percentage. However, this study did not analyze productivity of players from specific countries as it is possible that certain countries produce more productive players. Furthermore, to provide a more comprehensive understanding of the effects international players have on team chemistry, future research should include language proficiency and education status.

VII. Discussion

When exploring the relationship between team success and team chemistry, the first question asked is how do you quantify team chemistry? From the perspective of a baseball player, there are multiple understandings and representations of team chemistry. From my experience, the best way to define team chemistry is how players come together in moments of adversity. Other definitions may include discussions about how well teammates get along, the interactions behind the scenes in the locker room and after players leave the field. From an economist point of view, there is no clear way to quantify team chemistry. Yet, based on previous literature of team cohesion, (Levine 1991) and the conflicts that arise with international players assimilating into an American baseball team, I implemented variables that quantify this. (Bezrukova et al. 2015) (Vargas 2000) I attempted to further understand team chemistry by

analyzing salary disparity on teams similar to methods employed by (Depkin, 2000), generating racial markups based on birth location, and gathering information on player experience. Based on my results, I can conclude that the percentage of international players on a roster does effect winning percentage. Moreover, I determined that teams consisting of more international players perform worse than teams with a larger majority of American born players. This speaks volumes that even though players from Latin America and Asia are extremely talented and can prove to be significant contributors to a team, international players face hardships when first coming to America. Not only can this present a problem for the player, but the team as a whole. Young players, specifically from Latin America are drafted or signed by Major League teams as early as age 15. Picture yourself as a young pitcher from the Dominican Republic. You have grown up near the poverty line as you watch MLB players, also from the Dominican Republic shine at baseball's highest level. You are then notified that a MLB team has offered you a contract to play in their minor league system. These young adults are then sent to states across the country to play the simple game of baseball. Just one problem, you don't speak English well or at all, and you do not know how to assimilate into American culture. Regardless of how talented a player may be, if that player does not feel comfortable in his environment, how can you expect that player to succeed?

So is there a tipping point in percentage of international player's and the effect on winning percentage? After generating percent of international players squared, I created a scatter plot to identify a U or N shaped data trend. According to Graph 6, there is no clear U or N shaped relationship between winning percentage and the percentage of international players squared.

The results from the regression equations used in this research study also showed average age of experience has a positive and significant effect on winning percentage. Again, a team of 25 players with all the talent in the world but no Major League experience will not reach their peak performance. Veteran players help shape the younger generation of players by teaching and leading by example. In reference to Graph 2, there is a clear positive relationship between average years of experience and winning percentage. Based on this simple scatter plot, the optimal amount of average years of experience on a team are between 6 and 8 years.

In reference to Graph 5, my hypothesis that the prevalence of international players would have a negative relationship with winning percentage is true. Even though there is not overwhelming statistical evidence of the negative effect international players have on winning percentage, Graph 5 depicts a clear downward trend. That is, as the percentage of international players rises, the worse a team performs.

The results from the model used in this research study also showed that salary disparity (CV) has a significant negative relationship to winning percentage. This supports previous economic studies of the impact wage inequality has on performance. (Levine 1991) Baseball is the only major sport without a salary cap; meaning there is a lack of competitive advantage as high payroll teams such as the L.A. Dodgers or New York Yankees may spend twice as much on players per year than low payroll teams such as the Houston Astros or Oakland Athletics. With that being said, being a high payroll team does not mean there is a high salary disparity. From Graph 1, teams with a CV between 0.9 and 1.5 have experienced both winning and losing seasons. In Graph 4, I look at three of the most recent World Series winners and how they fared in salary disparity. The 2015 Kansas City Royals, 2014 San Francisco Giants, and 2013 Boston Red Sox all had CV values under 1. This is extremely significant and telling of how recent MLB

World Series Champions have structured their roster to reduce wage disparity. Clearly, it has paid off.

The goal of this paper was to discover a more comprehensive definition of team chemistry. Chances are, there will never be a uniform formula to assess team chemistry in the future. Yet, this study proved that birth location, years of experience and salary disparity within a team affects performance. Future studies may choose to employ other potential measures of team chemistry. More in-depth player information such as English proficiency, education status, and team turnover rate may prove to be significant contributions to the understanding of team chemistry. To conclude, this paper has made it apparent that there is an innumerable amount of inputs in team performance. With that being said, common sense indicates that ability level and teams with expensive players should win more games, holding all other inputs of game outcomes constant. However, the results suggest that even though team WAR and team payroll variance is positive and statistically significant as inputs of performance, the magnitude of these effects are not as great as one would expect. To my understanding, this indicates that even the most talented and expensive teams can lose baseball games they are expected to win. I wonder why some high payroll/talented teams fail to achieve their potential. A lack of team chemistry?

VIII: List of Tables

Table 1: Panel Model Regression Results: Dependent Variable *wpct*

	Model 1	Model 2	Model 3	Model 4
Percent International		-0.167*** (0.061)	-0.153*** (0.061)	-0.023 (0.029)
Average Service Time		0.026*** (0.006)	0.025*** (0.0063602)	0.0002 (0.003)
Team Payroll Variance		0.024* (0.013)	0.023* (0.01110357)	0.012* (0.006)
CV			-0.047** (0.024)	0.003 (0.011)
Players suspended (%)				0.027 (0.038)
TeamWAR	0.006*** (0.0003)			0.006*** (0.006)
Managerial Efficiency				0.672*** (0.0001)
Average age				0.026 (0.002)
NL	-0.129 (0.024235)			-0.000123 (0.021)
Constant	0.313*** (0.015)	0.360*** (0.003)	0.425*** (0.0463)	-0.386*** (0.0859)
Fixed Effects	No	No	No	Yes
R^2	79.71%	20.44%	22.34%	92.33%
N	180	180	180	180

All standard errors are in parentheses
* indicates significance at 10% level of significance
** indicates significance at 5% level of significance
*** indicates significance at 1% level of significance

Table 2: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Season	180	2012.5	1.712589	2010	2015
CVdisparity	180	1.231515	.1988453	.837867	1.94772
Wpct	180	.50001	0.0678217	.315	.63
PayrollVariance	180	1	.4213418	.1789491	2.514192
teamWAR	180	33.38278	10.35798	3	54.1
International	180	.2743246	0.0794453	0.0612245	0.5531915
Playerssuspended	180	0.0317778	0.0415772	0	.24
Avgyearsexp	180	6.207945	0.9021611	4.34783	9.94444
Avgage	180	28.65889	1.267681	25.5	33

Table 3: Comparison of American and National League Teams

League	CV disparity	wpct	payroll	teamWAR	%International	Avgyrsexp
American	1.21737125	0.50448276	102325217	33.5	0.27073765	6.09847451
National	1.24506565	0.49611828	95007496	33.2731183	0.27768007	6.31035281

Table 4: Multicollinearity Tests (VIF)

	Model 1	Model 2	Model 3	Model 4
Percent international		1.38	1.07	1.20
Average Service Time		1.36	1.39	1.89
Team Payroll Variance		1.05	1.37	1.94
CV			1.03	1.14
Team WAR	1.0			1.29
NL	1.0			1.10
Average Age				2.27
Managerial Efficiency				1.06
Players Suspended				1.07

Table 5: Hausman Test Results

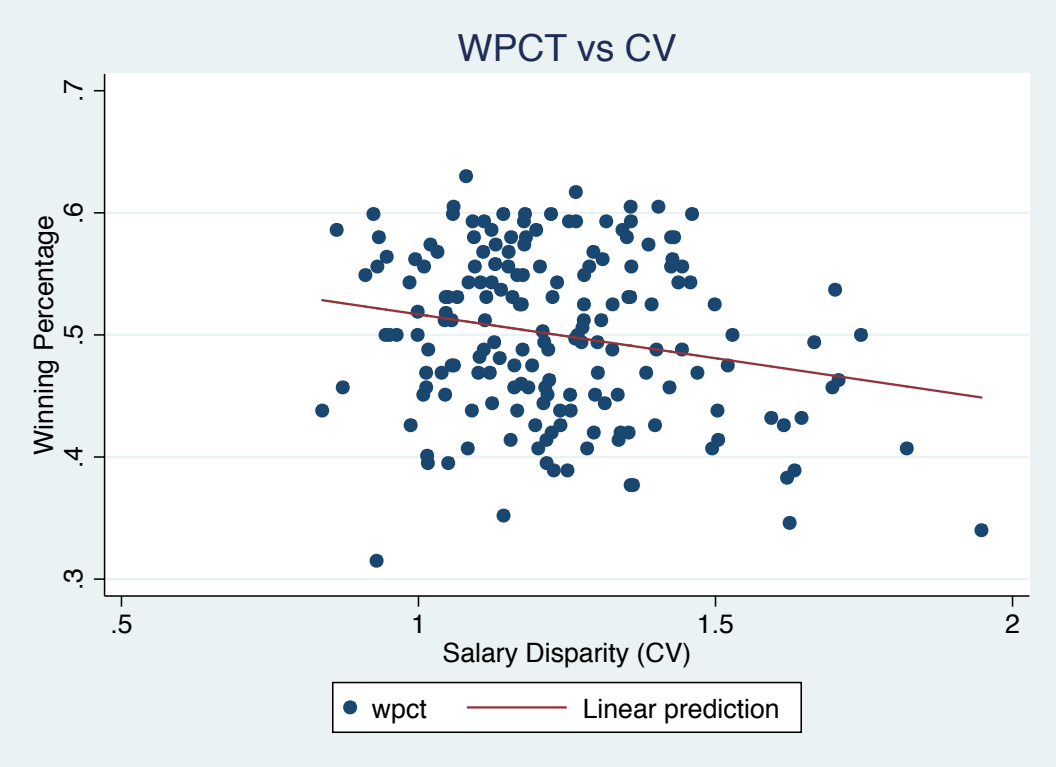
H_0: FE = RE

	Model 1	Model 2	Model 3	Model 4
chi2(2)	0.07	3.58	2.60	14.71
Prob > chi2	0.9665	0.3109	0.6270	0.0991

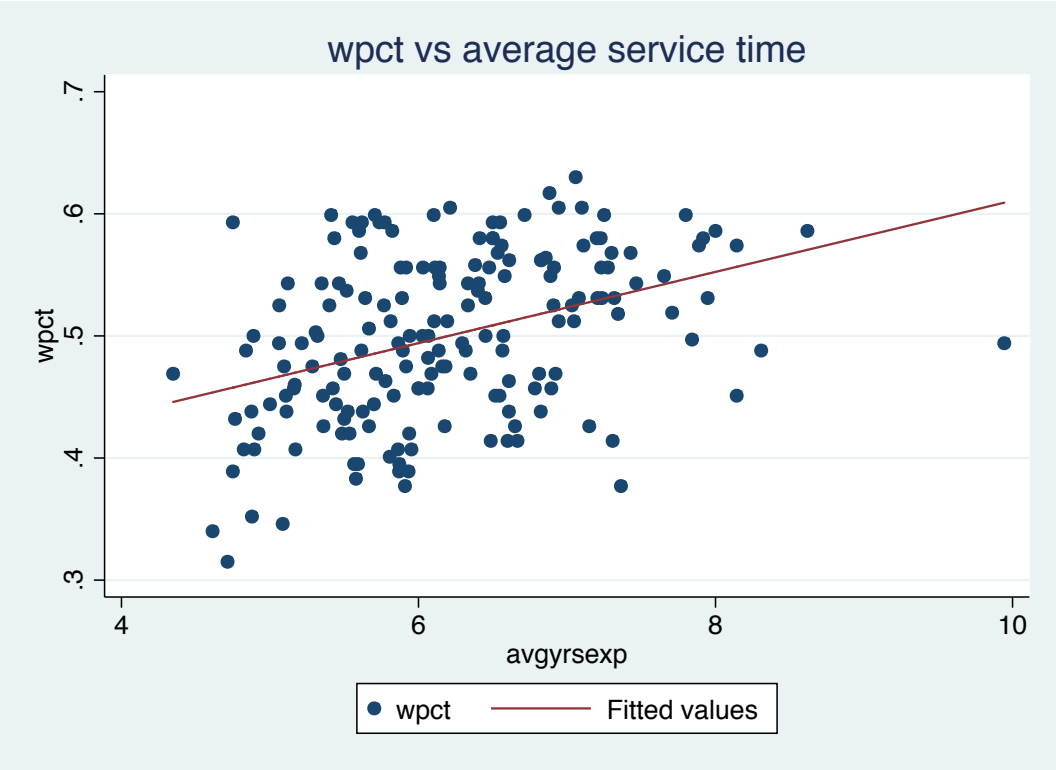
Ha: FE ≠ RE

IX. List of Graphs

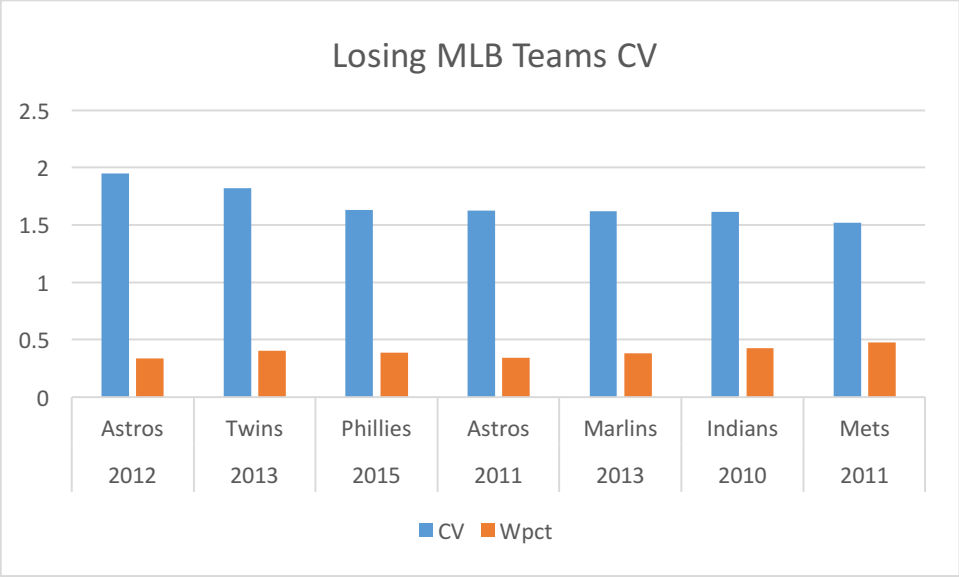
Graph 1: Relationship between WPCT and CV



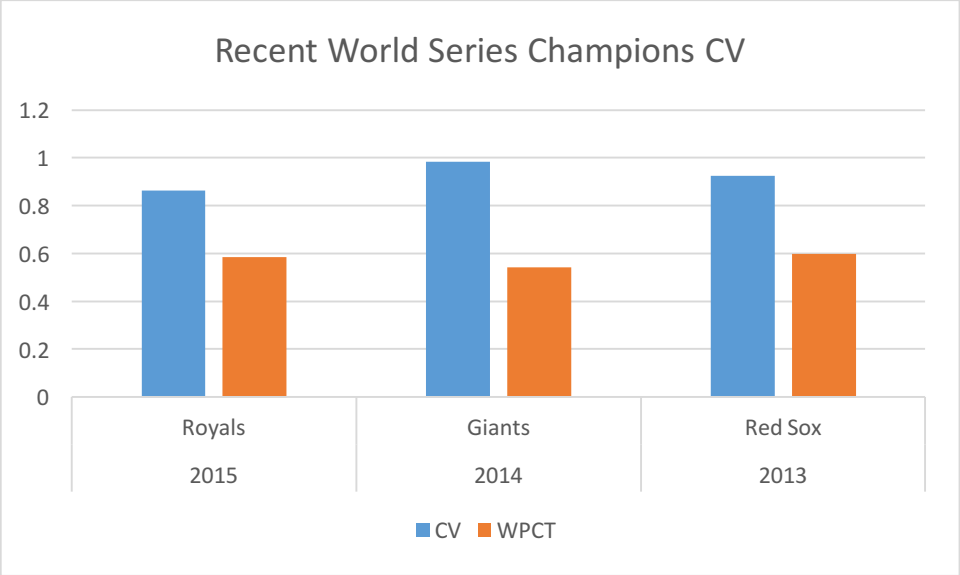
Graph 2: Relationship between WPCT and Average Service Time



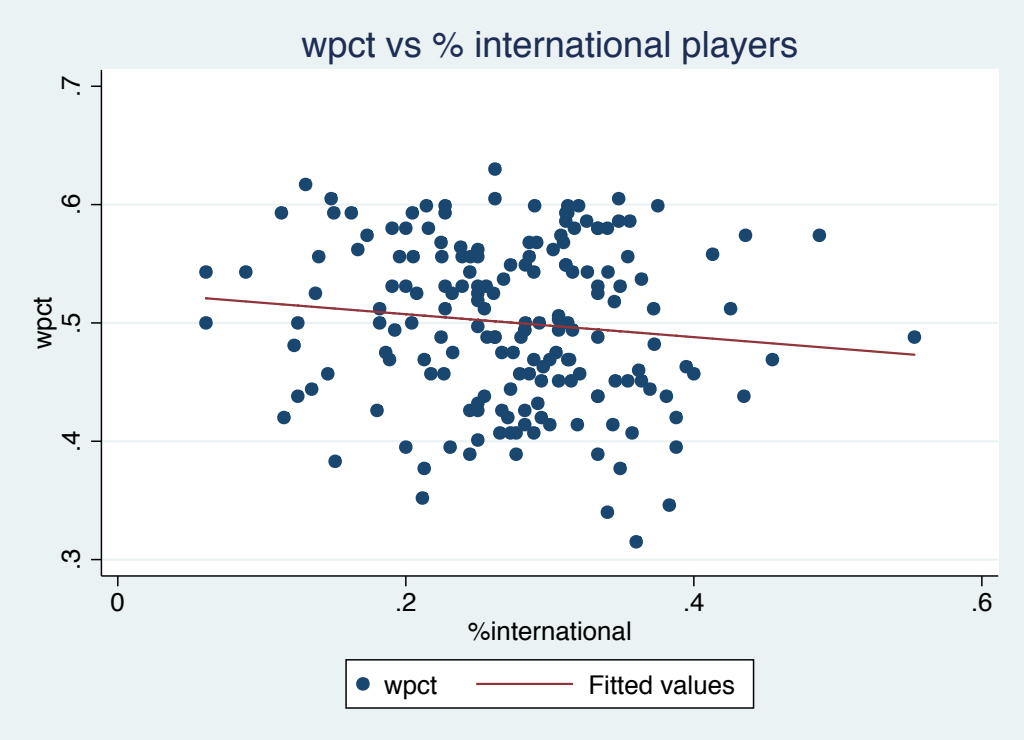
Graph 3: Comparison of Low Performing Teams and Salary Disparity



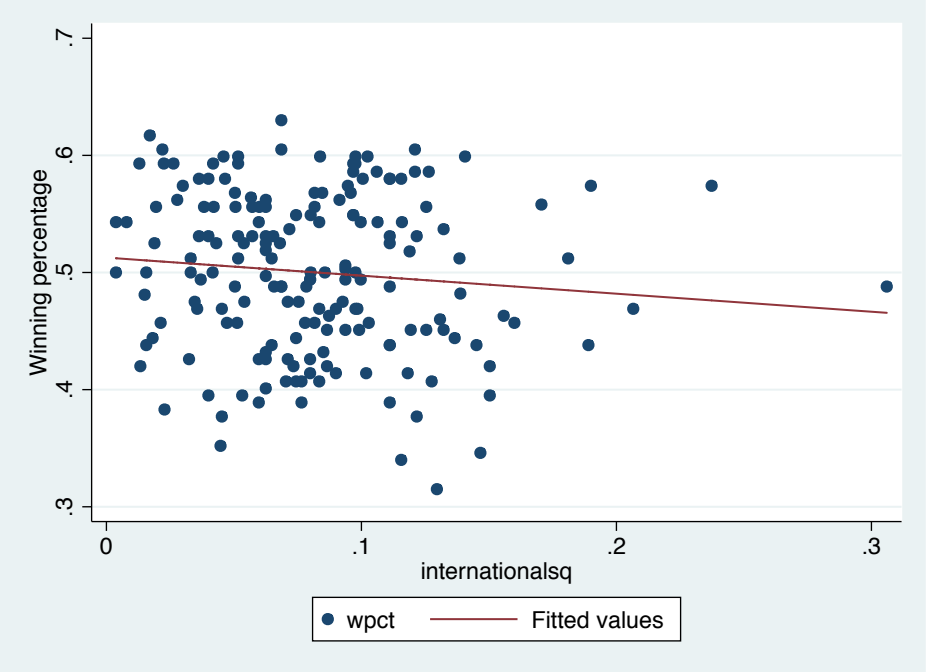
Graph 4: Comparison of World Series Winning Teams and Salary Disparity



Graph 5: Relationship between WPCT and Percent International Players



Graph 6: Relationship between Winning Percentage and International Players Squared



X. References

1. Associate Press. (2016, December 13). Baseball Outlaws Hazing Ritual That Forces Rookies to Dress as Women. *New York Times*
2. Bezrukova, K., Spell, C. S., Caldwell, D., & Burger, J.M. (2015, July 13). A Multilevel Perspective on Faultlines: Differentiating the Effects Between Group- and Organizational-Level Faultlines. *Journal of Applied Psychology*. Advance online publication.
3. Breunig, R., Garrett-Rumba, B., Jardin, M., & Rocaboy, Y. (2012). Wage dispersion and team performance: a theoretical model and evidence from baseball. *Applied Economics, 46*(3), 271-281.
4. Carron, A.V., Colman, M.M., Wheeler, J., & Stevens D. (2002). Cohesion and Performance in Sport: A Meta Analysis. *Journal of Sport & Exercise Psychology, 24,* 168-188.
5. Castrovince, Anthony. (2015, August 26) More than a feeling? Chemistry tough to quantify. MLB.com
6. Cyrenne, Philippe. "Salary Inequality, Team Success, League Policies, And The Superstar Effect." *Contemporary Economic Policy* (2014): n. pag. Web.
7. Depken, Craig A. "Wage Disparity and Team Productivity: Evidence from Major League Baseball." *Economics Letters* 67.1 (2000): 87-92. Web
8. Fields, Brian. "Estimating the Value of Major League Baseball Players." Master's thesis, East Carolina University, 2001.
9. Gammage, K. L., Carron, A. V., & Estabrooks, P. A. (2001). Team Cohesion and Individual Productivity: The Influence of the Norm for Productivity and the Identifiability of Individual Effort. Small Group Research, 32(1), 3-18.
10. Houser, Adam. "Which Baseball Statistic Is the Most Important When Determining Team Success? ." *The Park Place Economist* XIII (2005). Accessed December 20, 2016. https://www.iwu.edu/economics/PPE13/houser.pdf.
11. Levine, B. (2015, October 27). Measuring Team Chemistry with Social Science Theory. Retrieved March 04, 2017, from http://www.fangraphs.com/community/measuring-team-chemistry-with-social-science-theory/
12. Levine, David I. "Cohesiveness, Productivity, and Wage Dispersion." *Journal of Economic Behavior & Organization* 15.2 (1991): 237-55. Web.
13. Marchand, Andrew "Maddon defends usage of Chapman in playoffs." ESPN.com. December 19, 2016. http://www.espn.com/mlb/story/_/id/18296617/chicago-cubs-

manager-joe-maddon-defends-usage-new-york-yankees-closer-aroldis-chapman-world-series-run.
14. Meer, T. V., & Tolsma, J. (2014). Ethnic Diversity and Its Effects on Social Cohesion. Annual Review of Sociology, 40(1), 459-478.
15. Miller, Sam. (2013, October 4) MLB: A's success due to player chemistry. *ESPN The Magazine*
16. Schmuck, P. (n.d.). Is a salary cap necessary in Major League Baseball? *Baltimore Sun*. Retrieved August 29, 2010.
17. Shamir, B., Arthur, M.B., & House, R.J. (1994). The rhetoric or charismatic leadership: A theoretical extension, a case study, and implications for research. *The Leadership Quarterly, 5(*1*),* 25-42.
18. Tao, Y., Chuang, H., & Lin, E. S. (2015). Compensation and performance in Major League Baseball: Evidence from salary dispersion and team performance. *International Review of Economics & Finance, 43*, 151-159
19. Vargas, Angel (2000) "The Globalization of Baseball: A Latin American Perspective,"Indiana Journal of Global Legal Studies: Vol. 8: Iss. 1, Article 3
20. "Baseball Statistics and Analysis | FanGraphs Baseball." *Baseball Statistics and Analysis | FanGraphs Baseball*. N.p., n.d. Web. 20 Dec. 2016.