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ASSESSING THE CHARACTERISITICS OF THE MOST SUCCESSFUL PLAYOFF TEAMS IN MAJOR LEAGUE BASEBALL

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Abstract

With player performance data readily available, Major League Baseball provides an excellent opportunity to test the effects of talent dispersion on team performance. As increasing revenue disparities continue to allow large-market clubs to contract highly-skilled free agent players at rising annual salaries and inhibit small-market teams from doing so, clubs on either end of the revenue spectrum must employ differing management strategies in pursuit of the same goal: winning a championship. This paper identifies the characteristics of the most successful teams in Major League Baseball since 2000. The impact of talent distribution across a roster on team performance in both the regular season and postseason are analyzed. The results suggest that a wider spread of talent among batters and starting pitchers and a strong bullpen are strong determinants of success in each level of the postseason. In addition, the data indicates that a majority of teams to reach the Championship Series and World Series since 2000 are comprised of more than 50 percent free agents.

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I. Developments in Player Mobility and Compensation

From the time professional baseball leagues formed in the United States, the subject of player compensation and mobility has been widely disputed. After four failed attempts to unionize to secure more power from owners between 1885 and 1946, players formed the Major League Baseball Players Association in the late 1950's. Judge Robert Cannon of Milwaukee initially served as the initial negotiator for the players. Cannon's style emphasized mediation, something that irked players. In 1965, they hired Marvin Miller to serve as a full-time labor representative and the chief negotiator between MLBPA and the owners. Miller demanded a substantial raise in minimum salary, challenged the reserve clause and proposed arbitration procedures that would later bypass the Commissioner of Baseball, among other labor initiatives.

In 1969, Miller negotiated an increase in minimum salary to $13,500 in addition to an increase in pension payments by threatening a players' strike. In April 1972, players announced a strike against owners after owners refused to allow players to access income earned from investing portions of pension funds to increase pension payments. The strike ended 13 days later after the two sides reached a compromise under which $500,000 of investment earnings was turned over to the pension fund.

Following the players' strike in Major League Baseball in 1972, Scully (1974) develops a model in which he estimates player's marginal revenue product (MRP) as "the ability or performance that he contributes to the team and the effect of that performance on gate receipts." He finds that in the time before the institution of free agency, players are exploited and underpaid because of the reserve clause, which gave owners the monopsony power to retain players at salaries below their MRP once their contracts expired. Before the 1975 season, pitcher Andy Messersmith challenged the reserve clause by refusing to sign contracts, but playing through the season.[1] In December 1975, independent arbiter Peter Seitz ruled that the reserve clause granted a team only one additional year of service from a player, and not perpetual rights.[2] The reserve clause, which previously gave teams perpetual rights to all players, was abolished. Teams still retain reserve rights to players for up to six seasons of Major League service, but under the modern system of free agency, a player is granted the right to demand free agency after his sixth season.

Though owners profited tremendously from the advent of the television and the sale of broadcast rights throughout the 1980s, they repeatedly attempted to refute players' right to free agency. Following the 1985, 1986 and 1987 seasons, owners collectively chose not to pursue free agents. The MLBPA filed three collusion grievances against owners between January 1986 and January 1988. In all three cases, arbitrators ruled in favor of the players and awarded them $280 million in damages in November 1990. Zimbalist (1992) modifies Scully's method of estimating a player's MRP. He finds that players earned salaries much closer to their MRP's, but players who sought contracts in the free agent market earned in excess of their marginal revenue product. Likewise, Blass (1992) finds that a large percentage of older players that reach the free agent market are overpaid, and that players' earnings growth with seniority is largely independent of productivity.

In 1994, the Players Union again struck against the owners after they proposed a salary cap in an effort to narrow the growing revenue disparities between the league's richest and

[1] Messersmith was traded from the California Angels to the Los Angeles Dodgers in 1973. Messersmith refused to sign a new contract with the Dodgers before the 1975 season, and so the organization exercised its power to renew Messersmith's contract for one year under the terms of the reserve clause. Following the 1975 season, Messersmith claimed he was a free agent, because the Dodgers only renewed his contract for one season and did not retain an exclusive right to employ Messersmith.

[2] Previously, clubs retained the rights to every player on their roster after each season. Players could still be traded or sold for cash under the reserve clause, but teams ultimately reserved the right to renew a player's contract as many times as they wished.

poorest clubs. Players and owners eventually negotiated a new collective bargaining agreement without a salary cap. With no salary cap to limit the amount of money a team could allocate to payroll, player salaries began to explode through the end of the 1990s and even more so after 2000. Prior to the players' strike of 1994, Zimbalist (1992) first reports a low correlation coefficient between payroll and team performance, and finds that they are only "tenuously" related. Fort and Quirk (1999) test the correlation between club payroll and regular season winning percentage between 1990 and 1996 and find that payrolls are worthless in predicting team success. While player contracts inflated beyond $100 million in 2000, previous research demonstrates that there is no significant link between payroll and team performance.

II. Blue Ribbon Panel and the Issue of Revenue Sharing

After the 1999 season, Commissioner Bud Selig created the Blue Ribbon Panel on Baseball Economics to produce *The Blue Ribbon Panel Report*. The panel concluded in July 2000 that large and growing revenue disparities exist and are causing problems of competitive imbalance and that there is a strong correlation between high payrolls and success on the field, based on observations between the 1995 and 1999 seasons. In those five seasons, no club from payroll Quartiles III or IV won a Division Series or League Championship Series game. Additionally, no club from payroll Quartiles II, III, or IV won a World Series game. In the period between 1995 and 1999, the Yankees generated on average $130 million in annual local revenues, while small-market clubs like the Twins, Pirates Athletics and Brewers generated between $25 million and $35 million per year.

Unlike other revenue sharing structures in professional sports where broadcast revenues are evenly distributed across teams, MLB television and radio rights are negotiated and sold locally. In 1999, clubs in Revenue Quartile I earned an average of $120 million in local revenue, while teams in Quartiles III and IV earned $50 million and $30 million, respectively. Levin et. al (2000) find that the growing revenue disparity allows teams in the upper quartiles to sign high-salaried free agents and highly-sought-after players from foreign countries, as well as retain their own "home-grown" players before their rookie contracts expire. Ultimately, the panel concludes that the amount of revenue a club generates and the size of a club's payroll are both key factors in determining how competitive the club will be. In order to reform baseball's structure to produce reasonable competitive balance, the panel suggests the industry's revenues should be distributed more evenly to discourage disparities in local revenues inherently caused by varying market sizes across Major League Baseball.

Eckard (2001) finds that the premises of the Report, calling for "sweeping" changes to the game's economic landscape, are simply assumed and not demonstrated. Eckard widens the scope of his analysis compared to the Blue Ribbon Panel, measuring competitive balance in various ways in 5-year periods from 1975 to 1999, to find if competitive balance is indeed declining in the period the Report examines. He finds that in the American League, a majority of his measures indicate a decline in balance, but those interpretations are clouded by the success of the Cleveland Indians, New York Yankees and Seattle Mariners from 1995-1999. In the National League, Eckard finds competitive balance increases from 1995 to 1999, relative to previous time periods.

Lewis (2004)[3] critiques the Blue Ribbon Panel as well. In telling the story of how the Athletics remained competitive despite the growing revenue disparities highlighted by the Panel, he finds the question wasn't whether a club could generate the capital re-sign its stars after they completed six years of service at the Major League level. The question was, "how did a team

[3] Michael Lewis authored *Moneyball* profiling the strategies general manager Billy Beane and the Oakland Athletics employed to fight growing revenue disparities in the early 2000s.

find stars in the first place, and could it find new ones to replace the old ones it lost? How fungible were baseball players? The short answer was: a lot more fungible than the people who ran baseball teams believed" (126). In baseball's current economic landscape, smaller market clubs tend to compete by developing excellent farm systems. Prospects developed in these systems will blossom into Major League talents, but reach the free agent market after six seasons of service. At this time, a player will likely seek to maximize his annual salary by contracting with the team that offers the most lucrative contract.

III. Wage Disparity in the Workplace

Major League Baseball provides a unique opportunity to measure the effects of team cohesion. There is no other research setting in which worker productivity measures are readily available than in professional sports. In the case of MLB, measures of both player productivity and team performance are readily available. Individual players contribute as either batters or pitchers over the course of the season to win as many games as possible in the regular season, qualify for the postseason and compete for a championship. Individual player statistics are observable inputs that dictate the degree of team *i*'s success in year *t*. Team performance can be measured by regular season win percentage, as well as the degree of postseason success.

Previous research seeks to identify the relationship between pay equity and product quality. Levine & Cowherd (1992) develop a model with two types of labor (high-skill and low-skill) from a sample of 102 corporately manufactured units to explain the relationship between interclass pay equity and product quality. They find that a small pay differential between lower-skill and high-skill employees, or upper-level management, induces high product quality by increasing the low-skilled workers' commitment to management goals. As the tasks of these two classes of workers become more complementary, the negative effect of salary dispersion increases. Pfeffer & Langton (1993) survey faculty members from 303 colleges and universities to study the effects of wage inequality on satisfaction, productivity and collaboration. They find that the greater the degree of wage dispersion within academic departments, the lower an individual faculty member's satisfaction and research productivity. Salary dispersion has a significantly negative effect on current as well as long-term research productivity, and negatively affects job satisfaction. Wage dispersion has a smaller negative effect on satisfaction in private colleges and universities where salaries are less transparent.

Kahn (2000) acknowledges that labor issues in sports may seem distant from the rest of the economy, but the phenomenon of employer monopsony power between owners and players is a problem more widespread than just Major League Baseball. Employer monopsony power is an issue that affects public school teachers, nurses and university professors (Ehrenberg and Smith, 2000), and the effect of owner monopsony power on player performance suggests that athletes are motivated by similar forces that affect workers in general. When owners paid players below their marginal revenue products under the reserve clause, the players organized under a central union and demanded the opportunity to migrate freely between teams and negotiate salaries at their own discretion.

IV. The Rapid Expansion of Player Salaries

In the two decades since the players' strike of 1994 in which owners failed to introduce a salary cap, player salaries have increased dramatically. In 1998, the minimum salary in MLB was $170,000. The highest-paid player, Gary Sheffield, earned $10 million. Following the 1998 season, pitcher Kevin Brown signed the first contract in MLB history worth over $100 million, a 7-year contract worth $105 million with the Los Angeles Dodgers. In December 2000, third baseman Alex Rodriguez signed a free agent contract with the Texas Rangers worth $252 million over 10 years. Since Brown broke the $100 million barrier, 30 players have signed contracts over that threshold, and so the incentive for elite players to wait for their rookie contracts to expire and test the free agent market is high. In 2014, Phillies first baseman Ryan Howard earned the league's highest salary at $25 million, while the league minimum rose to just $500,000. In 2014, Howard batted .223 with 23 home runs, 95 RBIs, while 15 players on the Phillies roster earned $2 million or less.

Researchers have become increasingly interested in the relationship between intra-team salary disparity and performance. Richards and Guell (1999) provide evidence that MLB clubs with greater salary variance have lower winning percentages but that salary dispersion seems to have no effect on a team's probability of winning a championship. Likewise, Bloom (1999) finds that greater salary inequality is correlated with lower individual and team performance. Depken (2000) finds evidence that supports Levine's (1991) "fairness" claim that higher total salary levels improve team performance and greater wage disparity reduces team performance. Frick et. Al (2003) neither fully support nor fully reject competing hypotheses regarding wage inequality by testing across the four major professional sports leagues: MLB, NFL, NHL and NBA. Jewell & Molina (2004) find a strong, negative relationship between salary inequalities and win percentage in Major League Baseball between 1985 and 2000, using a stochastic production frontier to estimate how payroll inequality affects a team's ability to reach its efficiency frontier.

As revenue disparities increased and large-market clubs became more active in the expanding free agent market, small-market clubs looked for ways to operate more efficiently without having to pay the premium salaries top players demanded in free agency. Paul Depodesta, who worked as an assistant executive under Billy Beane with the Athletics, assigned specific values to players based on their production. With advanced analytics, Depodesta and the

Athletics worked under the assumption that a player's ability to hit the ball and get on base had a far greater impact on his team's performance than fielding abilities. Thus, Depodesta believed that the variance between the best and worst fielders on a team is far less meaningful on the outcome of the game than the variance between the best and the worst hitters.

Many clubs across Major League Baseball generate higher local revenues in larger markets and thus experience more propensity to spend more freely in the free agent market. In 2014, the Yankees, Dodgers, Phillies, Rangers, Angels, Mariners, Red Sox and Mets all generated over $100 million in revenue from local television deals alone.[4] In the last decade, the teams with the highest local broadcast revenues are among the most active clubs in free agency. These teams consistently open their checkbooks and bid for readily available talent to remain competitive on an annual basis. On the other end of the revenue spectrum are small-market clubs including the Royals, Pirates, Marlins, Cardinals, Brewers, Athletics and Braves, which all generated under $20 million per year in local television revenue.[5] These clubs rely more heavily on scouting operations, minor league development because their limited revenue streams restrict payroll spending. The development of a prosperous farm system is paramount when revenues are limited. Of course these clubs can afford to retain some talent in some cases. But in many instances, a player does not sign an extension and approaches his six years of Major League service, after which he will demand a premium salary on the open market. At this point, clubs like the Athletics, Pirates, Brewers and others among the bottom third of the payroll ranks will shop a top pitcher or a number of top batters before the final season of that player's contract or at the trade deadline, to extract some value in the form of Major League talent, prospects or cash. If

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[4] Christina Settimi, "MLB's Most Valuable Television Deals," *Forbes*, March 26, 2014, "http://www.forbes.com/sites/christinasettimi/2014/03/26/mlbs-most-valuable-television-deals/

[5] Wendy Thurm, "Dodgers Send Shock Waves Through Local TV Landscape, *FanGraphs*, November 27, 2012, http://www.fangraphs.com/blogs/dodgers-send-shock-waves-through-local-tv-landscape/

the club fails to secure any value for a player that will inevitably command a more competitive salary as a free agent, it risks being heavily outbid by the highest-earning franchises.

Krautmann and Ciecka (2008) identify the $2.8 million premium contending teams pay to players in the free agent market via the Over-the-Top Effect. The authors justify the premium teams pay to free agents by highlighting the $11 million in ticket revenues associated with hosting four playoff games. The analysis highlights the pecuniary benefit a marquee free agent can provide by improving a team's chances of contending for the playoffs and thus, selling more tickets. The authors conclude that teams in larger cities pay a higher salary and more productive players earn a significantly greater salary. Burger & Walters (2006) find that in that time, these high salaries exceed players' MRP.[6] Yet Krautmann and Ciecka find that for MLB owners, the marginal benefit of reaching the postseason outweighs the diminished marginal product associated with overpaying for scarce superstars in the free agent market.

V. Methodology

This model uses panel data from Major League Baseball between 2000 and 2014 to examine the characteristics of the most successful teams as a function of postseason success. In each season, clubs field 25-man rosters comprised of batters, starting pitchers and relief pitchers. Previous studies explore salary dispersion and its correlation with win percentage. A player's salary is a proxy for his production, as a club offers a contract to a player based on his performance in previous years. Depken (2000) estimates a fixed effects model in which he uses total team salary as a proxy for a team's total production. In his model, the dependent variable is the winning percentage of team *i* in year *t*, while the independent variables are the team's total player payroll and the intra-team salary disparity.

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[6] In 2006, Alex Rodriguez ($21.7 million), Derek Jeter ($20.6 million) and Jason Giambi ($20.4 million), who all played for the Yankees, earned the league's three highest salaries. The league's minimum salary was just $300,000.

Following Depken, I calculate coefficients of variation among batters and starting pitchers after measuring each player's Wins Above Replacement (WAR) in a given season.[7] While Depken uses player salary as a proxy for his production, I use a player's WAR in order to more directly measure production. I examine these coefficients from player production and not salary, as a player's production on the field is much more demonstrative of his value than the salary he earns. In order to be included in the sample of 770 batters and 553 starting pitchers, a player must have recorded at least 400 at-bats or pitched a minimum of 100 innings in a given season. In addition, I calculate the percentage of "home-grown"[8] players on team *i* in year *t* to gauge the ratio of "home-grown" players to free agents on a club.

Table 1. Variable Definitions

Abbreviation	Description	Source
$POSTFINISH_{it}$	*j* = 0 if team does not contend, 1 if team contends, 2 if team reaches Division Series, 3 if team reaches Championship Series, 4 if team reaches world Series	Major League Baseball
CVB_{it}	Coefficient of variation of Wins Above Replacement (WAR) among batters of team *i* in year *t*	FanGraphs
CVP_{it}	Coefficient of variation of Wins Above Replacement (WAR) among starting pitchers of team *i* in year *t*	FanGraphs
WPA_{it}	Wins Probability Added of bullpen – the sum of all contributing relief pitchers – of team *i* in year *t*	FanGraphs
$HGPERCENT_{it}$	Percent of "home-grown" players on team *i* in year *t*	Baseball Reference

[7] For a discussion regarding the use of sabermetric statistics, see Appendix IA.

[8] A player is classified as "home-grown" in seasons during which the player remains with team with which he exceeded his rookie limits (130 ABs, 50 IPs). Sixty-two batters were traded to another team before exceeding rookie limits. Sixty-four pitchers were traded to another team before exceeding rookie limits. Fourteen foreign players exceeded rookie limits at free agent salaries (above $1 million).

I use an ordinal logistic regression to examine the characteristics of teams in each tier. With a multinomial dependent variable measuring the degree of a team *i's* success in year *t*, I estimate an ordinal logistic regression such that,

$$Pr(POSTFINISH_{it} > j) = \frac{e^z}{1+e^z}, \quad j = 0, 1, 2, 3, 4, \qquad \textbf{(1)}$$

$$\text{Where } z = \beta_0 + \beta_1 CVB_{it} + \beta_2 CVP_{it} + \beta_3 WPA_{it} + \beta_4 HGPERCENT_{it} + \varepsilon_{it} \qquad \textbf{(2)}$$

A team's degree of postseason success in a given season is a function of the production of three inputs: batters, starting pitchers and relief pitchers. Based on the parameters of my sample selection, each team's coefficients of variation are calculated from the WARs of an average of 7.1 batters and 4.4 pitchers.[9] Over the course of a 162-game season, relief pitchers are much more interchangeable, and so the Wins Probability Added of a team's total relief pitching is a composite measure of the effectiveness of a team's bullpen.[10] In a given season, a middle relief pitcher can start the season on the Major League roster, and then rotate between minor league assignments and Major League appearances any number of times.

I classify each of the 770 batters and 553 starting pitchers as a "home-grown" prospect or a free agent in each season of his career. I then calculate a variable, from an average of 11 batters and starting pitchers, which measures the percentage of "home-grown" production at the Major League level across Major League Baseball. Theoretically, this captures a measure of the effectiveness of a franchise's minor league scouting operations from year to year, as well as a team's tendency to spend actively in the free agent market.

[9] Two teams (2012 Rockies and Twins) were dropped from the sample. The coefficients of variation among starting pitchers could not be computed for the Rockies or Twins, because only one starting pitcher logged at least 100 IP in each instance.

[10] For discussion regarding the use of the Wins Probability Added statistic, see Appendix 1A.

The results are displayed below. As a robustness check, I run a standard OLS regression in which the independent variables remain the same, and I substitute the team's regular season win percentage for the team's postseason finish. These results are displayed in Appendix 1B.

Table 2. Regression Output

Variable	Coefficient	Odds Ratio	Robust Standard Error
CVB	-1.2676***	0.2815	0.2584
CVP	-0.6654*	0.5141	0.3738
WPA	0.2972***	1.3461	0.0271
HGPERCENT	-1.75***	0.1738	0.5254
Prob > chi2 = 0.0000	Wald chi2 =153.29		

Ordinal Logistic Regression with robust standard errors after detecting heteroskedasticity, Panel Data from MLB 2000-2014, 30 panels with 15 observations each. 448 total observations after dropping 2012 Rockies & Twins, Significance levels: * p<0.10, ** p<0.05, ***p<0.01

These results indicate that the wider the distribution of talent among batters and starting pitchers, the better a team's chances of advancing in the postseason. Following Depken (2000), who finds a negative relationship between salary dispersion and team performance, I substitute production (in terms of WAR) for salary and find a significantly negative relationship between the distributions of talent among both batters pitchers on a roster and a team's level of postseason success. The more even the spread of talent and production across a team's batters and pitchers, the better a team's chances of contending for the postseason and advancing in each round. While there are of course teams (the 2002 Giants, 2006 Cardinals and 2012 Tigers) that have achieved great playoff success riding the talents of a select group of superstars, a larger number of teams which achieved great postseason success did so as a result of a more even distribution of production from the top of the lineup to the bottom. Elite starting pitchers, or aces, are certainly crucial, but they only appear once every five days. Teams must also rely on the efforts of the second, third and fourth best starting pitchers in the rotation to advance in a five or seven-game playoff series.

The relationship between a team's bullpen output and postseason performance is significantly positive. As the bottom two-thirds of teams are eliminated each season when postseason play begins, the level of competition among playoff teams increases dramatically. After 162 games of regular season action, the stakes are heightened in the postseason and the variance in team quality shrinks dramatically. It is the bullpen's job to minimize the runs scored in the most crucial points of the game – the late innings. A starting pitcher can throw seven shutout innings, but the effort is wasted if the bullpen falters in the eighth and ninth innings. The results indicate that relief pitching is particular critical in the postseason, and that the performance of a club's relief pitching is positively and significantly related to its chances to advance in the playoffs.

The variable measuring the percentage of "home-grown" production on a roster offers valuable insight regarding the makeup of the most successful teams in Major League Baseball over the last 15 seasons. The results indicate a significantly negative relationship between the percentage of "home-grown" talent and that club's postseason success. This result indicates that teams with a majority of free agent batters and starting pitchers are more likely to advance in the postseason. While teams such as the 2002 Twins, with 90 percent "home-grown" players, can still advance and compete in the postseason, teams with the financial capacity to contract free agents at competitive salaries in that labor market are more likely to achieve higher levels of success in the postseason on a more consistent basis.

Following this ordinal logistic regression, I run a series of three logistic regressions to observe the sensitivity of each component at each tier of the postseason. I estimate the following models:

$$Pr(Playoffs, Championship\ Series, World\ Series) = \frac{e^z}{1 + e^z} \qquad \textbf{(1)}$$

Such that:

$$z = \alpha_{it} + \beta_1 CVB_{it} + \beta_2 CVP_{it} + \beta_3 WPA_{it} + \beta_4 HGPERCENT_{it} + \varepsilon_{it}$$

In the first regression, I exclude teams that are not considered postseason “contenders” at the end of the season,[11] and so the number of teams included in the sample shrinks from 448 to 230. The dependent variable is binary, and so teams that only contend and do not reach the postseason earn a “0,” while teams that reach the playoffs earn a “1.” The results are displayed in Table 3. In the next regression, I include only teams that reach the postseason. Teams that are eliminated in the Division Series earn a “0”, and teams that advance to the Championship Series earn a “1.” The results of this regression are displayed in Table 4. In the final regression, I include only teams that reach the Championship Series, such that teams that are eliminated in the Championship Series earn a “0,” and teams that advance to the World Series earn a “1.” The results of this regression are displayed in Table 5. The mean values of each independent variable in each regression are displayed in Table 6.[12]

[11] Krautmann & Ciecka (2008) define “contending” teams as teams that finish within 10 games back of the final Wild Card spot at the end of each season.
[12] The probabilities of a team finishing at each level when all independent variables are set to their mean values are displayed in Appendix 1C.

Table 3. Regression Output – Contenders & Playoff Teams

Variable	Coefficient	Odds Ratio	Robust Standard Error
CVB	-1.4232**	0.2409	0.5826
CVP	-0.5961	0.5509	0.5672
WPA	0.1886***	1.2075	0.047
HGPERCENT	-0.6291	0.5331	0.7761
Constant	1.26*	2.4844	0.7047
Prob > chi2 = 0.0002	Wald chi2 = 21.63		

Logitistic Regression with robust standard errors after detecting heteroskedasticity, Panel Data from MLB 2000-2014, 230 observations including only teams that contend for and/or reach the playoffs. Significance levels: * p<0.10, ** p<0.05, ***p<0.01

Table 4. Regression Output – Playoff Teams

Variable	Coefficient	Odds Ratio	Robust Standard Error
CVB	0.2253	1.1522	0.9197
CVP	-0.2273	0.5689	0.7141
WPA	0.0112	0.0593	0.0586
HGPERCENT	-2.1835**	0.1175	1.0432
Constant	0.8385	2.342	1.0126
Prob > chi2 = 0.5565	Wald chi (4) =3.01		

Logistic Regression with robust standard errors after detecting heteroskedasticity, Panel Data from MLB 2000-2014, 126 observations including only teams that reach the postseason. Significance levels: * p<0.10, ** p<0.05, ***p<0.01

Table 5. Regression Output – Championship Series Teams

Variable	Coefficient	Odds Ratio	Robust Standard Error
CVB	0.5264	1.6929	1.2338
CVP	-0.0827	1.0861	1.0143
WPA	0.0186	1.0187	0.0899
HGPERCENT	-0.0445	0.9565	1.5318
Constant	-0.5	0.607	1.397
Prob > chi2 = 0.5565	Wald chi (4) =3.01		

Logistic Regression with robusted standard errors after detecting heteroskedasticity, Panel Data from MLB 2000-2014, 60 observations including only teams that reach the Championship Series. Significance levels: * p<0.10, ** p<0.05, ***p<0.01

Table 6. Mean Values of Independent Variables in Each Regression

No. Teams Included, No. Observations	All MLB teams, 448	Contending & Playoff Teams, 230	Playoff Teams, 126	Championship Series Teams, 60
CVB	0.9248	0.766	0.7248	0.734
CVP	0.6703	0.6104	0.5842	0.5827
WPA	1.6771	3.7177	4.5715	4.5905
HGPERCENT	0.5027	0.4726	0.4666	0.4315

The decline of the mean values of the coefficients of variation among both batters and starting pitchers from the sample of all MLB teams to only contending and playoff teams support the findings that a wider spread of talent is crucial for postseason contention. The increase of the mean value of bullpen production (WPA) in the same period indicates the importance of a strong bullpen in the playoffs.

After reducing the number of observations by 49 percent by excluding non-contending teams, the results in Table 3 still indicate that teams with a wider spread of production among batters advance in the postseason more often. Relief pitching remains essential. Though the variables measuring the variance in production among starting pitchers and the percentage of "home-grown" talent lose significance, the signs of the coefficients remain negative. In the table below, I extract the standard deviations of each variable to investigate if the segmented sample size is the reason for the higher p-values.

Table 7. Standard Deviations of Regression Coefficients

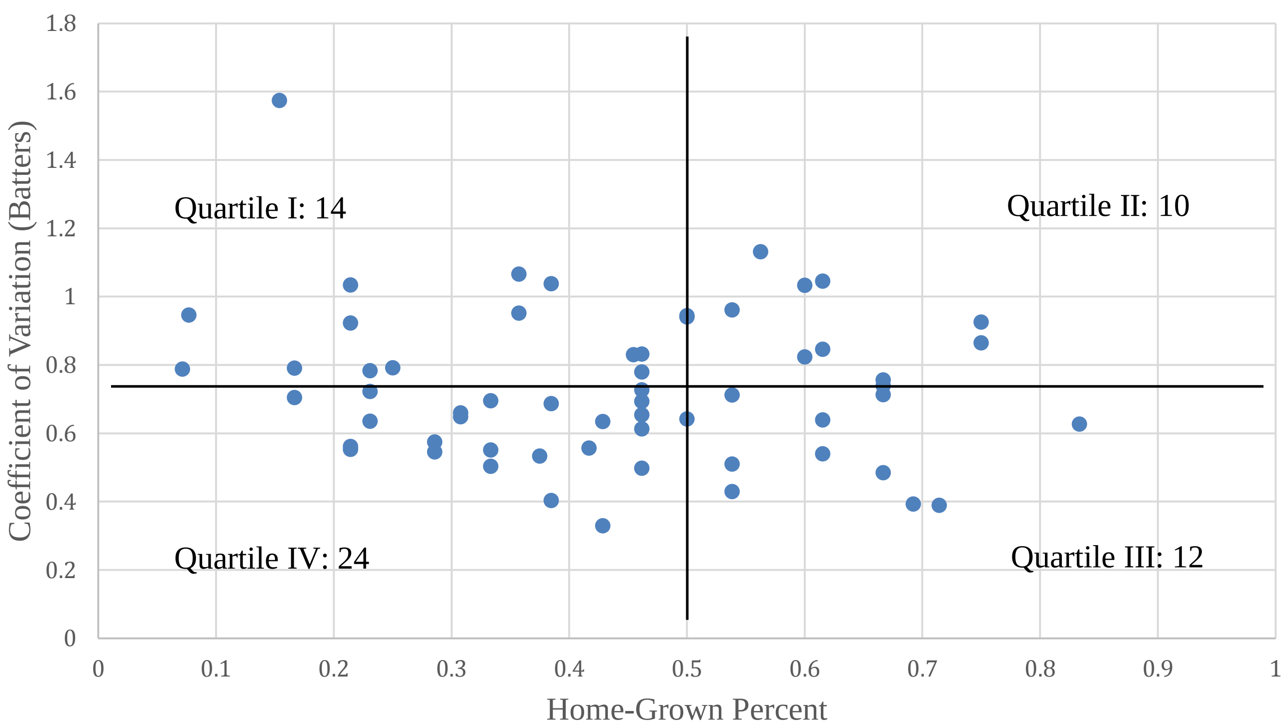
No. Teams Included, No. Observations	All MLB teams, 448	Contending & Playoff Teams, 230	Playoff teams, 126	Championship Series teams, 60
CVB	6.6143	8.1281	9.9127	9.8511
CVP	5.6323	7.959	8.0113	8.1858
WPA	0.6159	0.7098	0.6612	0.6803
HGPERCENT	11.3492	12.051	11.6448	11.485
Constant	N/A	10.6737	10.9174	10.88

While the standard deviations of *CVB* and *CVP* increase by about 50 percent between the largest and smallest samples, the standard deviations of *WPA* and *HGPERCENT* remain relatively constant.

The standard deviations listed above provide reasoning why the percentage of "home-grown" players on a team is still an explanatory variable through each of the three logistic regressions of the best teams. The variable loses significance after the sample is cut by 49 percent in the first logit regression, 72 percent in the second and 85 percent in the third, but the standard deviation of the coefficient remains relatively constant when the pool of Championship Series teams amounts (60) to 13 percent of the 450 teams sampled. The standard deviations calculated for the coefficient measuring the effect of the level of "home-grown" talent on a team's postseason performance do not fluctuate much, and thus we can conclude the variable lost significance as a result of a smaller number of observations in each logistic regression.

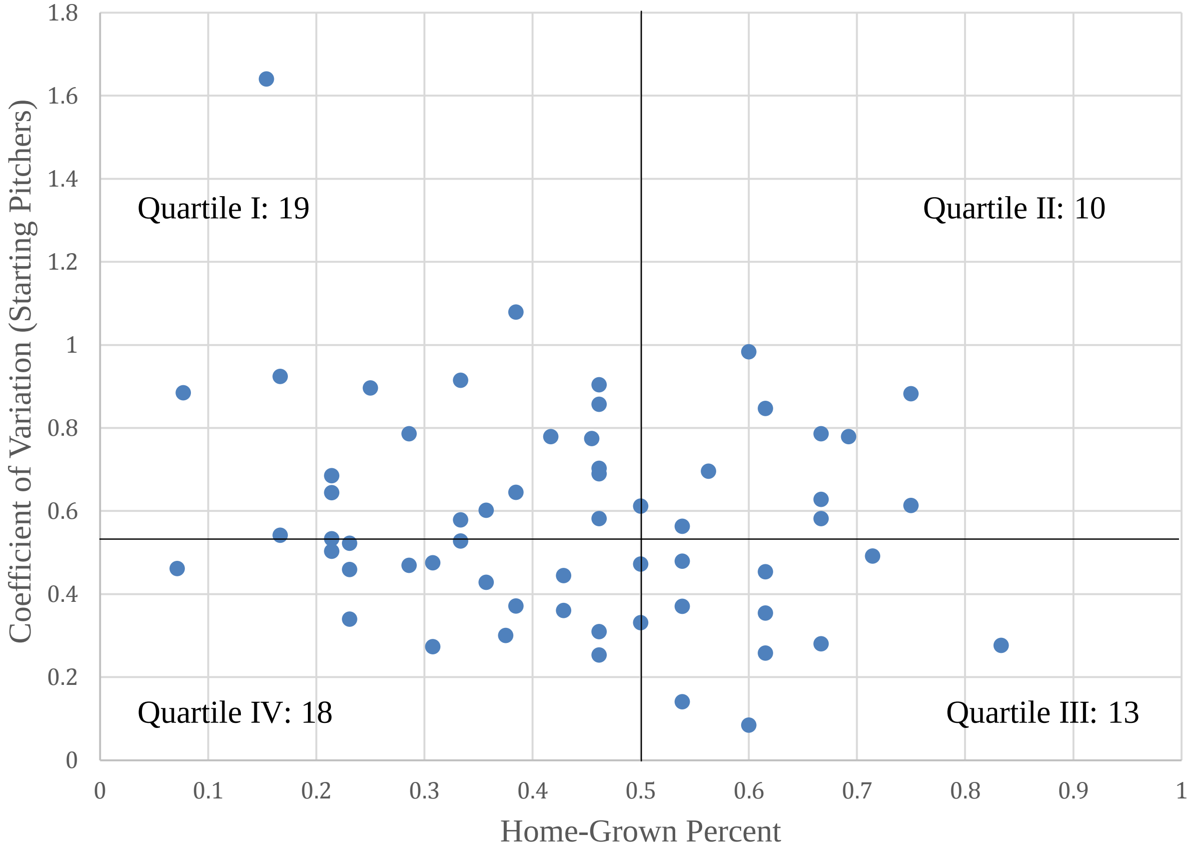
On the graph below, each of the last 60 teams to reach the Championship Series in the last 15 years are plotted, where the horizontal axis measures the percentage of "home-grown" talent, and the vertical axis scales teams based on the coefficient of variation among batters. I create axes at the means of each variable. With this, I group teams into categories that describe the team's composition. Located in Quartile I are fourteen teams with above average variation in production among batters and a roster comprised of a majority of free agents. In Quartile II are 10 teams with above average variation in production among batters, but more than half the

Chart 1. Coefficient of Varation among Batters vs. Percentage of "Home-Grown" Players among Championship Series Participants



players have been developed in the club's minor league system and are producing at the Major League level. In Quartile III, we observe 12 teams that reached the Championship Series with a wide spread of production among batters, with a roster in which a majority of the players are "home-grown." In Quartile IV we find the majority of Championship Series participants. Twenty-four teams reach the Championship Series with below average variation among batters and a roster of mostly free agents. This graph indicates that more than 63 percent of Championship Series are comprised of more than half free agents. Located in Quartiles I and IV are larger-market teams with the financial capacity to be active in the free agent market annually. In Quartiles II and III are teams that rely more heavily on scouting and player development in the minor leagues. Contrary to the findings of the Commissioner's Report in 2000, we many several instances of small-market teams that managed to reach the Championship Series, such as the 2002 Twins.

Chart 2. Coefficient of Variation among Starting Pitchers vs. Percentage of "Home-Grown" Players among Championship Series Participants



In Chart 2, all Championship Series teams are again plotted based on the coefficient of variation among starting pitchers and the percentage of "home-grown."[13] Again, the horizontal axis is created based on the mean of the coefficient of variation among the Championship Series teams. As in Chart I, the majority of Championship Series teams is located to the left of the vertical axis and thus, are comprised of mostly free agents. Located in Quartile I are teams with above average variation among starting pitchers. While the results of the ordinal logistic regression indicate a negatively significant relationship between the spread of talent among starting pitchers and a team's regular season and postseason performance, 19 teams reached the Championship Series with above average variation among starting pitchers. This suggests the particular value of

[13] Charts I & II are displayed with Data Labels in Appendix 1E.

a top pitcher in the postseason. In Quartiles I and IV are over 60 percent of Championship Series teams, which suggests that teams that advance deeper into the playoffs are more often comprised of free agents with at least one or two dominant starting pitchers which drive up the team's coefficient of variation.

VI. Conclusions

The purpose of this analysis is to identify the characteristics of the most successful teams in Major League Baseball's postseason. In the case of MLB, the results indicate that teams with a wider spread of talent among both batters and starting pitchers are more likely to contend for the playoffs and advance in each round of postseason play. In addition, the results highlight the importance of relief pitching in the postseason play. The negative significance of the variable measuring the percentage of "home-grown" indicates that teams which contract players in the free agent market more frequently achieve higher levels of postseason success. Since 2000, I find that just under 48 percent of the teams that reach the Championship Series do so with a wider spread of production from batters and starting pitchers; more than half of the players on each of these rosters are free agents.

At the beginning of each season, a club fields a team comprised of a combination of 25 batters and pitchers. These 25 individuals work together over the course of a 162-game season to maximize team performance and qualify for the postseason. They perform highly complementary tasks on a day-to-day basis for six months of the year. Batters step to the plate one after the other. Starting pitchers alternate appearances in a five-man rotation. Relief pitchers site aside each other in the bullpen. Each of these players is on call based on the circumstances of the game. Thus, for team i in year t, we observe 25 measurable inputs in terms of WAR. Team i's performance in year t is a function of these 25 inputs. Club owners can seek to improve their team each offseason either in the free agent market by contracting players at competitive market salaries or by developing prospects in the club's minor league system.

This information is particularly valuable in identifying the varying strategies MLB clubs on either end of the revenue spectrum employ in pursuit of a postseason berth. A club with high annual revenues can contract high-salaried free agents on a more frequent basis than a club that experiences low annual revenues. But in the wider realm of industrial organization, these results suggest that, in the case of MLB, a team of equally-skilled workers is more productive than a group of workers whose skill levels vary more greatly. Previous research (Cowherd & Levine, Pfeffer & Langton) finds that a small pay differential between lower-skill and high-skill employees induces higher worker cohesion and better team performance. Though Major League Baseball players earn salaries that are much higher than college professors or manufacturing laborers, the implications of testing in Major League Baseball are similar. While previous research measures a worker's skill in terms of his or her wage or salary, the availability of player production measures (Wins Above Replacement) allows for more direct testing of these hypotheses in Major League Baseball. Previous research finds that teams of manufacturing laborers in which pay equity is low produce higher quality products. Similarly, teams in MLB with lower degrees of production disparity among both batters and starting pitchers experience higher levels of success in both the regular season and postseason. Though it may seem impractical to compare the outputs of manufacturing workers, who earn hour wages or middle-class salaries, and professional baseball players, who in 2014 earned an average of more than $3 million, the results of this analysis suggest that Major League Baseball players are motivated by similar forces that affect workers in general. Players work alongside each other each day to win games. Though they earn inflated salaries as professional athletes, they face similar pressures to perform on a daily basis as a laborer in the general workforce. Teams of players in which all or most players perform at a similar rate tend to be the most successful teams in both the regular season and the postseason.

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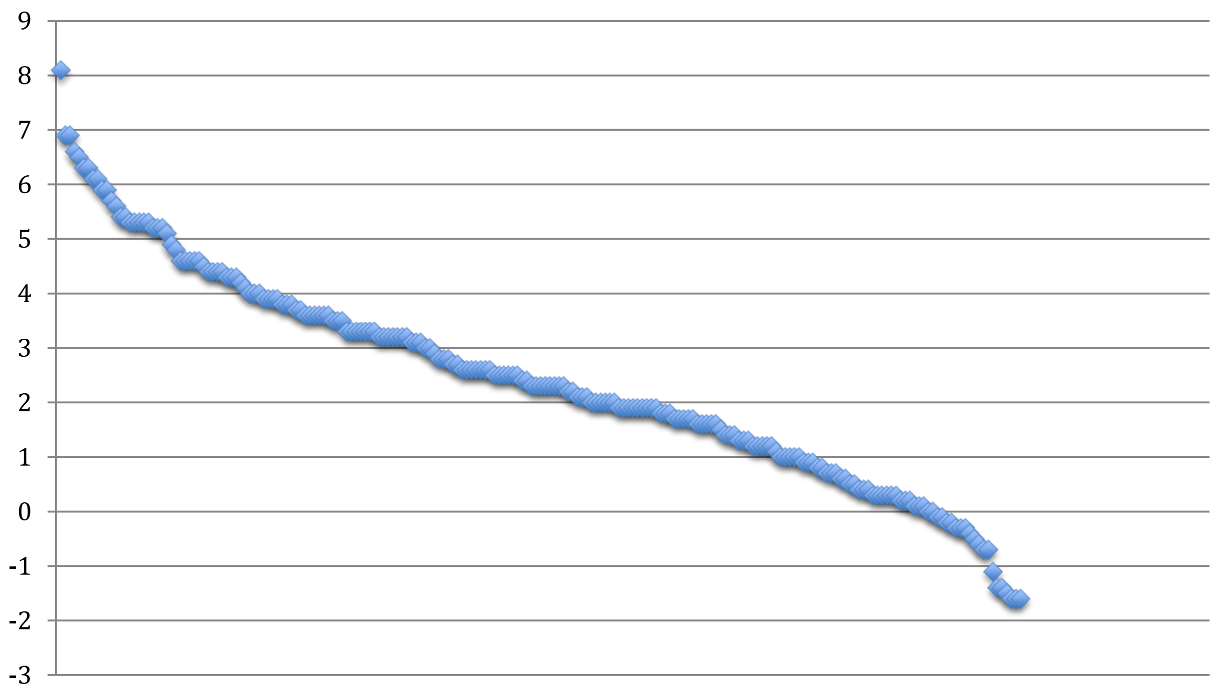
Appendix 1A. Sabermetric Explanations

Wins Above Replacement (WAR) is an attempt by the sabermetric community to summarize all of a player's contributions to his team in one statistic. It is an especially useful reference point when comparing players. It answers the question, "If Player X suffered an injury and was replaced with a freely available minor leaguer or a player off the bench, how much value would the team be losing?"

Chart III. Wins Above Replacement: 2014
Distribution and Rarity of Position Players at Each Level of WAR



The equation used to calculate WAR for position players is displayed below:

WAR = (Batting Runs + Base Running Runs + Fielding Runs + Positional Adjustment + League Adjustment +Replacement Runs) / (Runs Per Win)

The WAR calculation for pitchers is more complex, but accomplishes the same task that the WAR calculation for position players does. Per FanGraphs, statisticians first use Fielding

Independent Pitching (FIP) to strip away the influences of team defense and focus solely on the pitcher's contribution, then calculate a replacement level adjusted for the National League and American League to account for the presence of the Designated Hitter in the American League. They then focus on earned runs (runs a starting pitcher allows in the absence of fielding errors) and adjust for the different dimensions of ballparks across Major League Baseball. After factoring all of these things into a single equation, we can extract the estimated value of a starting pitcher.

Because relief pitchers are relatively interchangeable throughout the season and a bullpen consists of a combination of seven relievers, the Win Probability Added (WPA) statistic measuring a bullpen's total contributions is particularly valuable in gauging the effectiveness of a team's relief pitchers as a whole. It is a measure of how much a player's actions changed the likelihood of his team winning that particular game. I use a team's bullpen's WPA to find the overall effectiveness of that team's relief pitching in a given season.

Appendix 1B. Standard OLS Model

As a robustness check, I run a standard OLS regression by using a dependent variable that measures a team's regular season winning percentage. The results of this regression are displayed below in Table 7.

Table 8. Regression Output

Variable	Coefficient	Standard Error
CVB	-0.026***	0.0028
CVP	-0.0155**	0.0072
WPA	0.0104***	0.0006
HGPERCENT	-0.0356***	0.0121
Constant	0.5353***	0.0089
F (4 , 443) = 139.5	Prob > F = 0.000	R-squared = 0.514

Standard OLS regression with robusted standard errors after detecting heteroskedasticity, Panel Data from MLB 2000-2014, 448 observations after dropping 2012 Rockies and Twins. Significance levels: * p<0.10, ** p<0.05, ***p<0.01.

Appendix 1C. Predicted Probabilities at Mean Values

Displayed in Table 7 are the predicted probabilities of a team finishing the regular season at each tier of success when independent variables are set to their mean values.

Table 9. Predicted Probabilities

Pr(y= 0, Not Contending | x)	0.5083
Pr(y=1 , Contending | x)	0.302
Pr(y=2 , Playoffs | x)	0.122
Pr(y=3 , Championship Series | x)	0.0381
Pr(y=4 , World Series | x)	0.0297

Appendix 1D. Model Specification & Anomaly Testing

The tests below indicate there is no multicollinearity or first-order autocorrelation in the ordinal logistic model:

VIF Test

Table 10.

Variable	VIF
CVB	1.07
CVP	1.05
WPA	1.02
HGPERCENT	1.01
Mean VIF	1.04

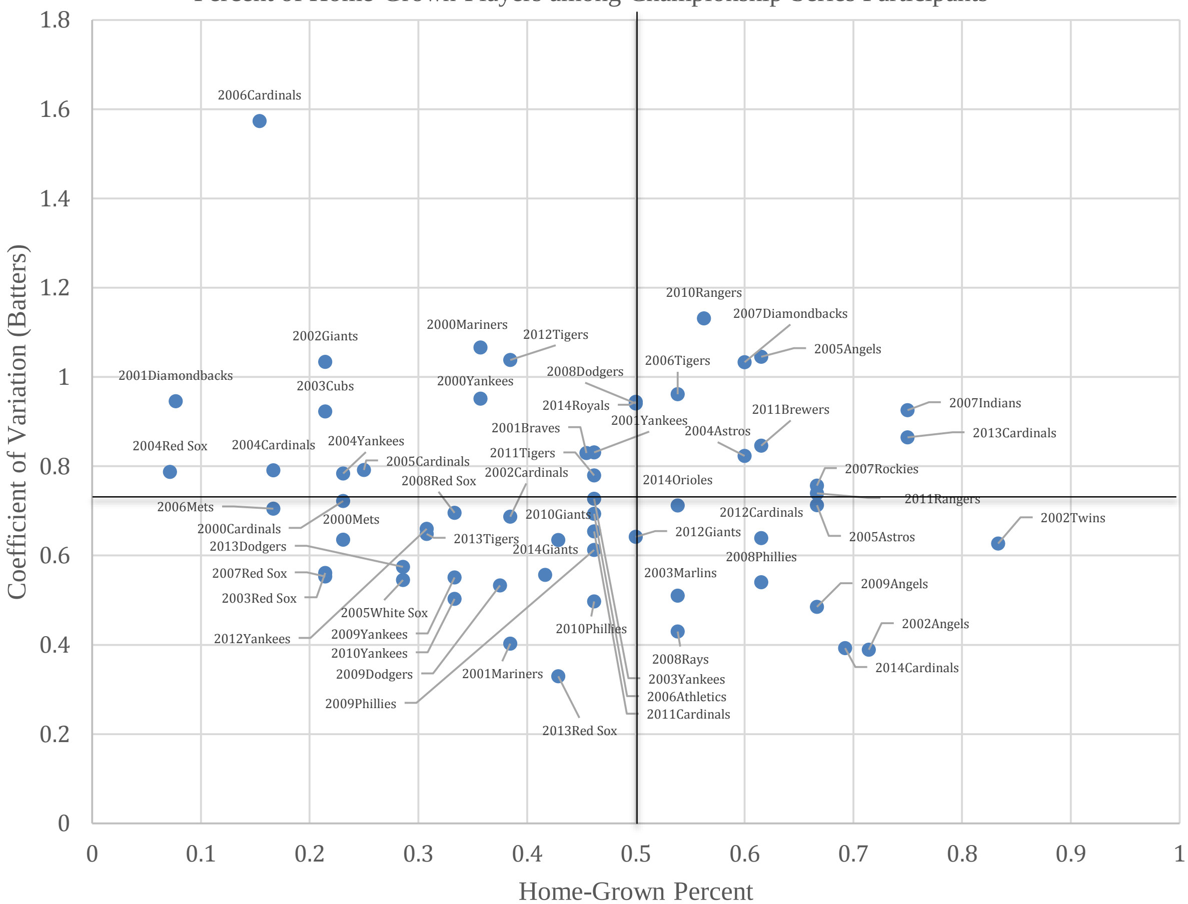
Woolridge test for autocorrelation in panel data
H_0: no first-order autocorrelation
$F(1, 29) = 0.567$
Prob > F = 0.4575

The test below indicates the presence of heteroskedasticity in the ordinal logistic model:

Breusch-Pagan test for heteroskedasticity
H_0: Constant Variance
Variables: fitted values of *POSTFINISH*
Chi2(1) = 37.31
Prob > chi2 = 0.0000

Appendix 1E. Charts with Data Labels

Chart I. Coefficient of Variation of Batters vs.
Percent of Home-Grown Players among Championship Series Participants



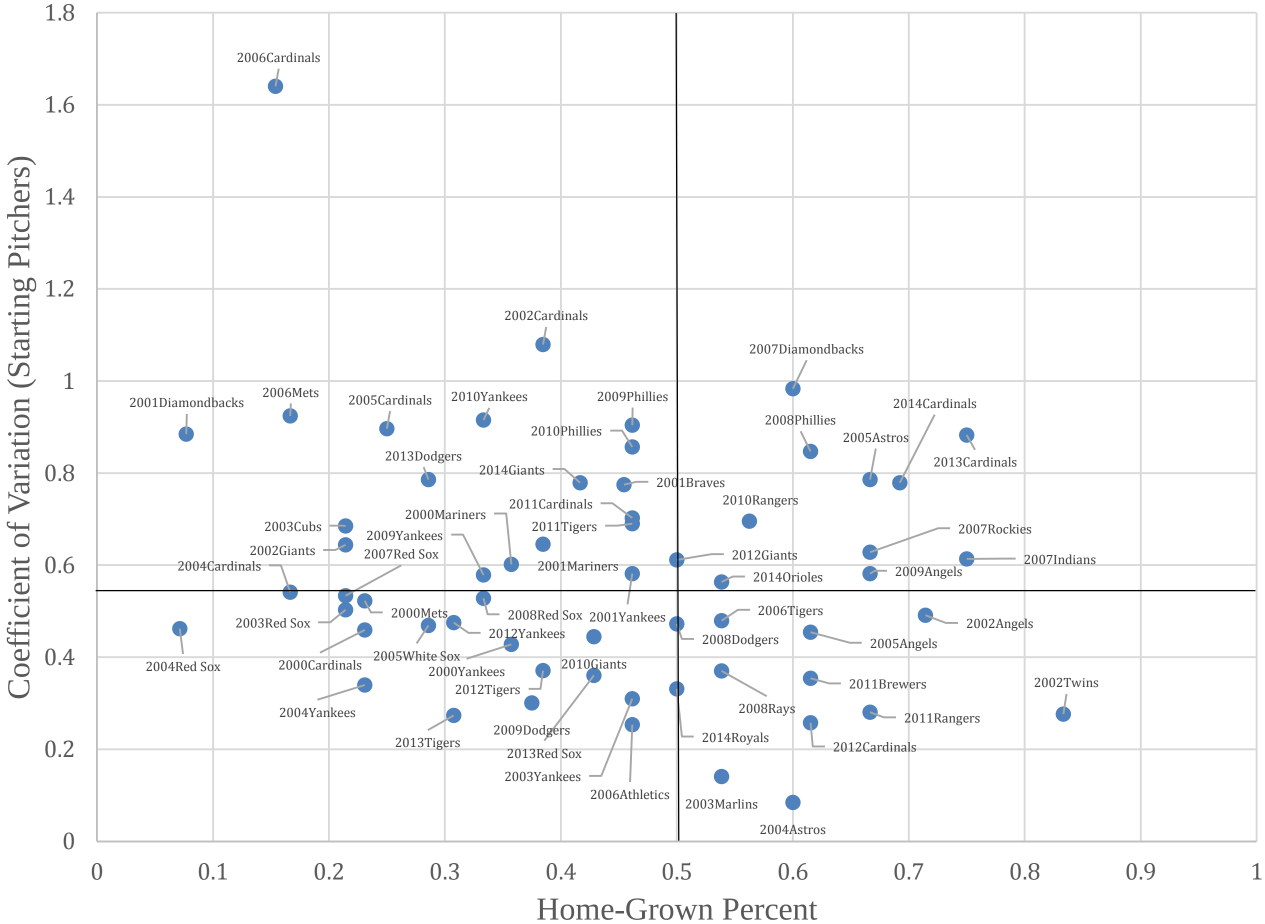


Chart II. Coefficient of Variation among Starting Pitchers vs.
Percent of Home-Grown Players among Championship Series Participants