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Joshua Congdon-Hohman
College of the Holy Cross, jcongdon@holycross.edu

Jonathan A. Lanning

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Joshua M. Congdon-Hohman†
College of the Holy Cross
&
Jonathan A. Lanning
Bryn Mawr College

Abstract

This study examines ways in which workers respond to implicit incentives. Specifically, we examine the extent to which workers shift their effort to activities that are measured and which have been previously rewarded in the labor market. To examine this question, we examine the changes in the performance measures of professional baseball players in the season prior to the opportunity to freely negotiate their contract (free agency). We will examine different eras in baseball to examine if we can identify changes in behavior in this pivotal year based on changes to the current premium outputs for each time period.

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†Contact information: Department of Economics and Accounting, College of the Holy Cross, Worcester, MA 01610. Email: jcongdon@holycross.edu. Website: http://college.holycross.edu/faculty/jcongdon/.

1 Introduction

Whether and how workers respond to wage incentives is a topic of great interest to labor economists. This is because a worker's effort is virtually impossible to observe, and even direct measures of worker's output are uncommon. This makes empirical analysis of attempts to solve the principle-agent problem (by setting incentives that will encourage workers to increase their efforts) difficult. Thus, an opportunity to explore whether an industry provides appropriate incentives via their wage offers, and whether these incentive induce the desired behavior amongst their workers, is both rare and economically intriguing.

In this paper, we explore these questions by analyzing whether the compensation incentives in Major League Baseball evolve as teams learn about their production process, and whether players adjust effort in response to these incentives. Major League Baseball provides researchers with a rare opportunity to explore these questions as there are numerous and excellent data on both compensation and individual-level productivity. We use data from three distinct eras to assess whether free agent salaries adjust to changes in the understanding and emphasis of the production process, and whether the free agents themselves adjust their efforts in response to these incentives.

Our results are highly consistent with the hypothesis that teams adjusted their compensation strategies in response to the contemporary understanding of baseball's production process (with the output being measured in a team's wins). Moreover, we find evidence that, where possible, players adjusted their individual output measures prior to free agency in order to capture the rewards made available at that time. That is, as teams adjusted the productivity measures that players were rewarded for, players in turn adjusted their efforts to improve these measures. Given that there is little reason to believe that players withhold effort in the steady-state, any significant or substantial adjustment of their productivity measures in response to incentives represents strong evidence that they are reallocating efforts towards those activities that yield the greatest returns and returning to the original allocation following the period of salary determination. This finding may have implications for

the productivity gains possible by better understanding the contributions of worker efforts to output and providing strong incentives for these efforts, both with Major League Baseball and in industries with less apparent productivity measures.

Section 2 provides some background on previous research in this area, as well as information about the free agent market in professional baseball. We then identify the data used, and present some summary statistics, in Section 3. In Section 4, we present the hedonic model we will use to identify the marginal valuations of various statistics and present our method for identifying changes in perceived effort. Section 5 presents our results, and Section 6 concludes.

2 Background

Research regarding agency theory has examined in great detail the relationship between principle and agent. The problem of unaligned incentives is one that has been analyzed in a number of contexts including CEO compensation (see Abowd 1990, Jensen and Murphy 1990, and Kaplan 1994 for examples) and piece rates (see Lazear 1986, Lazear 2000, Paarsch and Shearer 2000, Shearer 2004, and Heywood et al. 2011). The labor market in professional sports offers a particularly strong opportunity to examine issues involving the principle-agent problem due to the meticulously kept measures of output.[1] Baseball is especially appropriate for this pursuit as the game can be generally analyzed as a series of individual feats rather than coordinated effort amongst teammates. This characteristic allows baseball executives to directly observe the contribution of an individual to the production process. Employment contracts are thus signed with both parties possessing a great deal of information about a worker's past productivity.

Due to the nature of sports, there have been a number of studies examining the performance statistics ("stats") of players in relation to their contracts. Scully (1974) used this relationship to estimate the marginal revenue product of baseball players and compared that

[1] See Fort (2003) for a more thorough discussion.

value to their salaries in the period before players were granted the freedom to negotiate with all teams during "free agency". Other economists have expanded on this early work and examined whether there is any evidence that players use strategic performance by increasing their effort in the year prior to signing a new contract or opportunistic behavior by reducing their effort (or "shirking") in the year following a new contract. Evidence indicating the connection between statistics and contract values, as well as changes in output prior to (or after) signing a contract has been mixed. However, most studies have focused on a single, composite statistic of a player's output. The specific statistic used by a study is typically reflective of the time period's "conventional wisdom" as to which indicator correlates best with production (as defined by increasing a team's chances of producing more runs and/or winning). While many of these measure do correlate with production, the "conventional wisdom" has evolved in stages since the mid-1980s. Krautmann (1990) first used slugging percentage (total bases divided by number of at bats) to examine this issue using data from the 1976 through 1983 seasons and found no statistical evidence of an improvement in performance before a contract expired or of a decrease in performance in the first year of a new contract. In a comment on Krautmann (1990), Scoggins (1993) extends the analysis on the same data to also examine days on the disabled list (meaning that the player is unavailable to play due to injury) and found some possible statistical evidence of reduced performance in the year following a new contract. Similarly, Sommers (1993) found evidence of shirking following arbitration hearings (where salary is determined through binding arbitration) when examining a player's batting average (hits divided by at bats) and slugging percentage between 1980 and 1990 while Woolway (1997) found a decline in marginal revenue product (as estimated using batting average, slugging percentage, on-base percentage, and stolen bases) in the season following a long-term contract (based on data from the 1992 and 1993 seasons). Maxcy et al. (2002) rejected the hypothesis of strategic performance when examining slugging percentage (though they find evidence of a shift in time on the disabled list based on a player's contract status). Krautmann and Solow (2009) found evidence of shirking among

free agents between 1997 and 2007 using adjusted OPS (on-base plus slugging percentages adjusted for home ballparks and league effects) only when a player had a very low probability of signing another contract after their current contract expired. Krautmann and Donley (2009) found evidence of shirking among players signing a new contract following the 2005 and 2006 seasons when comparing a player's estimated marginal revenue product (based on Bradbury (2007) which uses on-base percentage, slugging percentage and a league identifier) and his wage, but not when examining individual performance measures (OPS).[2]

These previous studies have been very narrow in their examination of athletes' response to economic incentives. That is, they only look at a few, composite measures, and focus on indicators that players should already be emphasizing. We hope to broaden this literature by examining whether pending free agents change the focus of their efforts to activities that are currently being rewarded, and away from those activities that are not. Specifically, we will use a hedonic model to examine the monetary benefit to individual statistics and examine whether players shift their effort to those statistics with higher marginal valuations at the expense of those with lower marginal valuations. For example, slugging percentage will be the same if a player has two singles or 1 double in two at bats and his on-base percentage will be the same whether a player walks or singles. That said, their method of reaching these statistics could lead to different expected salary offers which previous models would not identify. With this approach, we can measure a reallocation of effort rather than an overall change in the effort level. We will also examine two alternative hypotheses for why performance might drop off following a new contract: the stress of changing teams which may distract a player from performing well and whether the drop off is the result of free agents that were not resigned due to an anticipated decline in performance.

We analyze the statistics of pending free agents from three sets of three year periods: 1988 through 1990, 1998 through 2000, and 2008 through 2010. We chose these sets of

[2]Similar examinations have been done using data from professional basketball and have also found mixed results in regard to shirking by professional athletes. Two prominent examples are Berri and Krautmann (2006) and Stiroh (2007).

years for two important reasons. First, the time separation of these data should allow for variation in the statistics which are rewarded in free agency. As can be seen from the previously referenced research, there have been changes over time in what is commonly considered to have greatest impact on winning. In the early 1990s, slugging percentage and batting average were in favor and were the metrics chosen by Krautmann (1990) and Sommers (1993). At the turn of the 21st century, a new importance was placed on reaching base (as exemplified by the recount of Billy Beane's work as the general manager of the Oakland Athletics in the book *Moneyball* (Lewis, 2003)). Thus, on-base percentage became a target for researchers exploring productivity and the returns to measurable output. Hakes and Sauer (2006) have examined the changing value of on-base percentage following the publication of *Moneyball*, though on a more constrained basis than we will examine here. By focusing on a limited set of productivity measures, these studies may miss any evolution in the salary rewards or productivity returns to specific outputs. Over the time periods explored in this paper, we expect to find variation in the marginal valuation of particular statistics, and will test whether players respond to the change in incentives accordingly. Second, these periods generally exhibit relative stability both for labor relations,[3] and which measures of performance were emphasized by talent evaluators and analysts. For example, the number of league-wide home runs increased dramatically in the early-to-mid 1990s, and there was a shift of focus from batting average to on-base performance in the early-to-mid 2000s. By avoiding the transition periods, we hope to more carefully identify the impact of the various measures and player's responses to those measures when there is more stability in the market.

In addition to the previous literature, it is also important to understand some of the restrictions placed on Major League Baseball's labor market. Under all collective bargaining agreements since 1976, players are only able to freely negotiate with all teams at certain times

[3]This is actually in stark contrast to many adjacent years. For example, collusion amongst teams inhibited the movement and salaries of free agents from (at least) 1985-87, a labor strike disrupted play in the 1994 season, etc.

during their career.[4] The period where players are free to negotiate with all teams is known as "free agency" and occurs primarily between seasons. Players can first become free agents only after they have accumulated 6 years of service for Major League Baseball teams (time spent in the minor leagues–effectively in training or development–does not count towards this service time, with very few exceptions). Their salary prior to free agency is determined either without negotiation through contract renewal or through a binding arbitration process in the final three years of their restricted service period. When a player is a free agent, there is currently no direct restrictions on their movement between teams. Prior to the 1985 collective bargaining agreement, there were restrictions on which teams could negotiate with a free agent (determined by a draft process) and how many free agent players a team could employ in a particular year. Limits since have only been applied to the number of highly talented free agents a team can sign and that limit is dependent on the size of the free agent pool.[5] In the period we examine in this paper, the rules of free agency have remained relatively stable. The 2012 collective bargaining agreement has made significant changes to the compensation teams receive for losing a player to another team through free agency.

3 Data

Professional baseball provides excellent data describing both productivity (as meticulously recorded and analyzed indicators of production having been collected almost since its inception) and wages (as salaries are widely reported in the popular press, and regularly published by the MLBPA, the players' union). With knowledge of both the output and the wages of players throughout their careers, we can examine carefully the incentives and productivity of players. Unfortunately, effort is not something we can observe directly. But, by observing

[4]The terms of the collective bargaining agreements can be found both on the Major League Baseball website (mlb.com) and on a website devoted to the business of baseball, bizofbaseball.com. What follows is a brief summary.

[5]Discussed at `http://mlb.mlb.com/news/article.jsp?ymd=20090130&content_id=3785640&vkey=news_nyy&fext=.jsp&c_id=nyy` and `http://www.purplerow.com/2009/4/2/819477/mlb-transactions-part-eight-free`. Note also that teams may sacrifice draft picks in order to sign particularly talented free agents, though this represents a fairly weak restriction on player movement.

changes to the output we do observe, we may be able to reasonably infer some changes to a player's underlying effort. While previous studies have attempted to measure changes to the level of effort as measured in particular composite statistics, we instead look for shifts in effort from some types of output to others. That is, as opposed to looking for changes within a measure of productivity, we will look for changes across multiple measures.

To explore this question, we use productivity and salary data on players who were part of the free agent cohorts from 1988-90, 1998-2000, and 2008-10 (free agents were identified via annual lists provided by the Associated Press). As discussed in Section 2, we believe the selection of these years should allow for relative stability within each three-year cohort, but allow for an evolution of the returns to various skills across the cohorts. By focusing on free agents, we believe we are capturing the current market reward for specific statistics rather than rewards when a long-term contract was signed or based on the very different process of contract renewal or through arbitration. For each player, we collect data on the three years prior to, and the year immediately following, free agency. This will allow us to better identify any changes in a player's output leading up to and after free agency. The productivity and salary data used for this research is available from Baseball-Reference (`http://baseball-reference.com`). This website is an expansive source for all baseball related data one might need including output statistics, league transactions, and player salaries. Unfortunately, salary data for all players is available only on a year-to-year basis as that is what is typically released by the player's union. Therefore, when looking at salaries we will not be able to look at the length or total value of the free agent contract, only the wage in the first year.[6]

In the analysis that follows, we will focus on a number of particular statistics. We will examine the aggregate statistics used in previous literature as well as more traditional

[6]More contract data–including length, incentives, etc.–are available for some players, often via popular press. However, as these data are not available for all players, and there are numerous concerns about selective availability (e.g. higher-profile players are more likely to be high productivity, high salary, and have more expansive data available), we chose to focus our analysis on the year-to-year data available for all players.

"counting stats" (those stats that are naturally measured in totals, and not rates). Amongst counting stats, we will be examining totals for offensive events that are accumulated over the course of a season such as plate appearances, hits, home runs, doubles, walks, etc. Since these stats are simply counted, the more plate appearances a player has, the higher we would expect the other values to be. For this reason, we will use the number of plate appearances as a direct value and convert all other counting stats to a rate. We will project all stats to the level they would be for a season, which we set to 502 plate appearances. This number represents the minimum number of plate appearances necessary to qualify for the annual batting title, or 3.1 plate appearances in each of the 162 games scheduled in Major League Baseball's regular season.

Table 1 displays a summary of the data, and illustrates some clear differences across cohort. First, the number of free agents has increased over time, and those free agents have seen significant increases in their average salary in the year following free agency. The increase in the number of free agents is likely due partially to an expansion of the league, and partially due to a higher likelihood that a player will not negotiate new contracts with their current team prior to free agency. We can also see that offensive statistics have skewed towards a more power based games after the 1980s cohort. The on-base plus slugging percentage (OPS) and slugging percentage (SLG) both showed large increases between the 1980s cohort and the 1990s cohort, which continued into the 2000s cohort. This change can also be seen in the cohorts doubles and home run rates (measured in per 502 plate appearance levels). While power numbers have gone up among free agents, on-base percentage (OBP) has stayed relatively level over the three cohorts, which reflects a similar trend in the hit and walk rates. Finally, stolen bases have steadily fallen across the cohorts while strikeouts (SO) have steadily increased.

The remaining statistics in Table 1 are presented to show the make-up of the free agent cohorts. The percentage of players playing any games at defensive positions that we consider "premium" has increased over the cohorts. These positions, which include catchers, second

basemen, and shortstops, appear slightly more likely to reach free agency in the later cohorts.[7] The differences in percentage of American League games declined between the 1980s cohort and later cohorts, which is likely due to an expansion of the National League in the 1990s. The age of free agents has also risen by a year between the 1980s and 1990s cohorts, possibly reflecting the higher demands for major league players following the league's expansions. Finally, the distribution of free agents by year within each cohort is relatively even with no year making up more than 40.4 percent of a cohort.

4 Empirical Methodology

The first stage of our analysis attempts to estimate the financial returns to particular statistics. To do this, we use a Rosen (1974) hedonic price model to examine the wage components of the free agent classes in each cohort. As Hakes and Sauer (2006) found with on-base percentages between 2000 and 2004, we expect that the valuation of individual statistics will change between examination periods. As such, we estimate the salary returns to our productivity statistics separately for each era. Specifically, we will estimate the following model using ordinary least squares:

$$\log(W_i) = \theta_0 + \beta \mathrm{X}_i + \theta_1 \mathrm{Age}_i + \theta_2 \mathrm{Age}_i^2 + \theta_3 \mathrm{Premium}_i + \theta_4 \mathrm{AL}_i + \varepsilon_i \quad (1)$$

In Specification 1, log W_i represents the log of the wage of player i, X_i represents a vector of output statistics, Age_i and Age_i^2 represents the age of player i and its squared value, $\mathrm{Premium}_i$ represents an identifier for whether player i has played a defensive position that is considered especially important (catcher, second base, and shortstop), and AL represents the share of player i's games that were played for an American League team.[8]

[7] We have tested the robustness of the results that follow to other definitions of premium defensive positions, including identifying only players that played fifty percent of their games at one or more of these positions, including third basemen or centerfielders, etc. None of these alternative definitions led to substantive differences in the results we report below.

[8] For players who remain in the same league for the full season, this variable will be valued at either be

The X_i variables are a subset of those statistics discussed in Section 3. In all specifications, plate appearances are included to capture the role of a player as a regular, regular substitute, or infrequent contributor. We then move through a number of specifications that progress from a single aggregate measure of performance to multiple, less aggregated measures.

After identifying the relative salary values of the statistics included in X_i, we attempt to identify whether players respond to the incentives these values imply. Specifically, we examine whether pending free agents increase their production in areas with high marginal valuation at the expense of areas with relatively low valuations. Additionally, we examine players' performances in the year following free agency to address the question of shirking. To examine this, we use a four-year span of data for each player. The examination period includes the three years prior to a player's free agency and the one year following. To analyze this data, we examine a number of output measures and identify whether a player's performance changes around his free agent season. To identify this, we will use the following empirical model:

$$\mathrm{x}_{i,t} = \theta_0 + \sigma_1 \mathrm{FA}_{i,t}^{-3} + \sigma_2 \mathrm{FA}_{i,t}^{-2} + \sigma_3 \mathrm{FA}_{i,t}^{+1} + \theta_1 \mathrm{Age}_{i,t} + \theta_2 \mathrm{Age}_{i,t}^2 + \theta_3 \mathrm{Premium}_{i,t} + \theta_4 \mathrm{AL}_{i,t} + \varepsilon_{i,t} \quad (2)$$

In Specification 2, $\mathrm{x}_{i,t}$ represents individual statistics for player i in year t from X_i above. The next three variables are indicators for the number of years that year t is before or after free agency. The year prior to free agency is the omitted category while FA^{-3} represents three years prior to free agency, FA^{-2} represents two years prior to free agency, and FA^{+1} is the year after free agency. A significantly negative value for σ_2 would suggest an increase in focus on a particular statistic in the year prior to free agency since this would indicate that the player did significantly worse two years before free agency than one year before

a 1 or a 0. For those who are traded to a team in a different league within season, the variable will take a fractional value between 0 and 1.

free agency. A significantly negative value for σ_3 would be evidence of shirking in the year following a new contract. All other variables are as they were in Specification 1, and are included to capture any age patterns, positional differences, and differences between leagues. Standard errors are clustered at the player level and reflect the Huber-White corrections for robustness if there is heteroscedasticity.

5 Empirical Results

First, we examine the value of the most common aggregate stats. OPS and slugging percentage have been used in the aforementioned literature because they are generally considered good overall measures of batting performance. We add on-base percentage to this list as well, as the added attention to plate discipline in the last decade has been well-publicized, and may have changed the emphasis (both by general managers and players) on that statistic. Table 2 presents the results of Specification 1 for each free agent cohort, first using OPS and then including the two components of OPS separately. In the case of OPS (columns 1 through 3), this measure of output is significant in all eras. That said, the size of the valuation appears to increase in the 1990s and 2000s cohorts. This may be due to a shift toward more statistical driven evaluation in baseball that began in the 1990s. When OPS is broken up into its two components, we see a slightly different story. Neither component has a statistically significant impact on log wages in the 1980s cohort. When we look at the 1990s cohort, slugging percentage is a highly significant contributor to log wages while on-base percentage is not. This may be due to an increased focus on home runs in what we now consider the "steroid era" of baseball. This period is also prior to the "Moneyball revolution" in baseball, so the insignificance of on-base percentage is not surprising (and similar to the findings of Hakes and Sauer 2006). By the late 2000s, plate discipline has become an important trait emphasized by most teams and, as a result, we see that OBP is rewarded more significantly and substantially through free agency. On-base percentage in the 2000s

is not only a significant predictor of log wages, it has a larger estimated coefficient than slugging percentage that, due to the difference of the scales of these two measures, implies a similar impact on log wages. In all specifications, plate appearances have a significantly positive impact of about a 0.3 percent increase in wages per plate appearance, though the impact of this measure seems to diminish with each era, as other included measures rise in relative prominence.

As discussed earlier, the composite productivity indicators discussed above may not illustrate the full story. While these statistics simplify analysis by representing overall performance in a compact manner, they may mask more subtle adjustments players make in order to focus on more rewarded counting stats. To identify the rewarded stats, we again use Specification 1, but omit composite statistics and add individual counting stats (measured as rates and projected to 502 plate appearances).[9] The results from this analysis can be found in Table 3. In the 1980s cohort (column 1), only hits and RBI per 502 plate appearances have statistically significant impacts on log wages. Hits are not a surprise, but the case of RBI is moderately surprising given the statistic's dependence on teammates and situations that the player finds himself in. This is another case where generational differences may be important, as more emphasis has been put on non-team based statistics in more recent years. Not surprisingly, RBI are not statistically significant in the later two cohorts. In the 1990s cohort, hits, doubles, home runs and bases-on-balls are all statistically significant. Given the earlier discussed surge in power in this era, the increasing importance of doubles and home runs is not surprising. In contrast, the importance of walks in this era is a little surprising, since on-base percentage was not a significant contributor to wages, and this era pre-dates much of the "Moneyball" shift. However, this is at least partially explained in a subsequent specification. Finally, the 2000s cohort looks similar to the 1990s cohort, but with an even greater emphasis on walks and a somewhat reduced emphasis on doubles and

[9]The omission of the composite statistics is necessitated by their high degree of collinearity with the counting stats. Not only would the inclusion of the rate stats complicate the interpretation of the returns to the component counting stats, but in many cases it would make estimation impossible without the omission of one or more counting stats.

home runs. Perhaps the biggest surprise in this cohort's results is that runs (another team dependent statistic) is a significant predictor of log wages. But this could simply reflect the increased focus on reaching base, as reaching base at higher rates necessarily increases a player's opportunity to score more runs. It is also interesting to note that in no cohort were players rewarded for stolen bases or penalized for strikeouts, as this is in mild contrast to the "conventional wisdom" that these are indicators of "good baseball." For each cohort, the overall fit of the regressions (as measured by R-squared) are improved by using the full complement of counting statistics in place of the composite statistics.

To further examine the role of walks and to specifically isolate the potential increased emphasis on batter patience, we replace the walks per 502 plate appearances with only those which were unintentional (simple base-on-balls minus intentional base-on-balls).[10] This change has little impact on the coefficients of the other statistics, but does change the story surrounding walks. Unintentional walks are not significant in either the 1980s or 1990s cohort but are statistically significant in the 2000s cohort. This change relative to total walks in the 1990s is likely due to a high correlation between home runs and intentional base-on-balls. In other words, the total walks measure was serving as an additional proxy for power which the coefficients on counting power statistics have shown was highly rewarded in this period. As expected, patience at the plate (as measured with unintentional base-on-balls) is rewarded with an increase in expected salary during the "post-Moneyball" era.

One concern with the specifications thus far is that the types of productivity that are rewarded may differ at different points in the income distribution. That is, it might be that high dollar free agents are rewarded for different skill than are free agents who command a lower salary. To explore this possibility we repeat the analysis reported in Table 4, but using quantile regression in place of ordinary least squares. Quantile regression analysis allows us to identify the value of a higher production rate for different levels of players.

[10] An intentional base-on-balls occurs when a pitcher intentionally walks a player for strategic purposes. This is in contrast to an unintentional base-on-balls, which results from a batter's "plate discipline" in allowing more difficult pitches to hit to pass without offering a swing.

Table 5 presents the results for players at the twenty-fifth percentile, the median, and at the seventy-fifth percentile of the salary distribution for each cohort. In the 1980s cohort, plate appearances and RBI have a similar salary implication at all three points in the distribution. Hits for the low end of the distribution and unintentional base-on-balls at the median also have a significant impact on free agent salaries. The patterns are a little more pronounced in the 1990s cohort. Though doubles are statistically significant at all points in the salary distribution, home runs are only significant for those at the twenty-fifth percentile and unintentional base-on-balls has significant impacts at the low end and median. RBI, on the other hand, have more impact for those earning the median or higher salaries. The 2000s cohort yields a particularly interesting pattern. Homeruns seem to be primarily rewarded at the top end of the salary distribution, along with doubles and hits. The significance for runs observed in the OLS regression appears to be primarily due to rewards at the median, and not at the other quartiles. This suggests that there are some differences in the skills rewarded across salary groups, though the high correlation between RBI, runs, and home runs may mute some of these apparent patterns. Most interestingly, the patterns of rewards for unintentional bases-on-balls in the 1990s and 2000s cohorts are quite similar, and show a decreasing return to batting patience as players' salaries increase.

We now turn our attention to whether player efforts appear to change in response to these incentives. To this end, we present the results of estimates of Specification 2 in Table 6. Results are presented separately for nine statistics for the same three free agent cohorts as above. These statistics are intended to capture any changes to effort by players (either by changing the level of effort, or by shifting effort between competing activities), and include on-base plus slugging percentage (OPS), slugging percentage (SLG), on-base percentage (OBP), hits (H), home runs (HR), unintentional base-on-balls (UBB), doubles, stolen bases (SB), and strikeouts (SO). For all of the counting statistics, we continue to use the rates per 502 plate appearances. The coefficients represent the difference between the year prior

to free agency (the omitted category) and the year indicated.[11] Recall that a significantly negative coefficient for a year prior to free agency suggests strategic behavior by the player in his free agency season, while a significantly negative coefficient for the year after free agency could be interpreted as evidence of shirking following their free agent season.

The top panel of Table 6 examines the composite statistics of interest, OPS, SLG, and OBP. Despite the fact that OPS was a statistically significant contributor to free agent salaries in all free agent cohorts, only the 1990s cohort shows statistical evidence of an improvement in performance leading up to free agency. That said, there is evidence of shirking in the year following free agency in all cohorts, though only statistically significant in the 2000s cohort. A similar pattern can be seen for slugging percentage. This is not surprising given the OPS results, as slugging percentages are usually higher than on-base percentages, and therefore make up a larger portion of OPS. If players are able to adjust their efforts, our hedonic analysis would suggest that OPS should have exhibited changes around free agency (e.g either an increase in the year of free agency, or a drop off the year after). But the fact that players in the latter two cohorts do appear to adjust their SLG efforts around free agency is consistent with players adjusting effort in response to salary incentives. Also consistent with a hypothesis of effort adjustments are the OPB results. These results suggest manipulation in all cohorts, though with higher levels of statistical significance following free agency in the 1990s and 2000s cohorts. The latter finding is a little surprising, as on-base percentage was a only a significant predictor of future wages for the 2000s cohort, though this again may reflect the high correlation between intentional base-on-balls and power statistics. To explore this further, we look at individual components of each of these aggregate measures to more carefully separate what might be driving this result.

Direct comparison of these composite indicator results with those of previous studies is difficult, due to the differences in the examination periods, and our focus only on free agents.

[11] For the sake of brevity, the table only presents results from the time to free agency indicators. However, all variables listed in Specification 2 are included in the estimates.

Of those studies with an overlapping examination period, we find mixed support. Though Sommers (1993) found evidence of shirking in regard to slugging percentage in a sample of players from the 1980s, we found no evidence of this among free agents between 1988 and 1990. Similarly, we find evidence of strategic behavior in regard to slugging percentage among free agents from 1998 to 2000, which contradicts the findings of Maxcy et al. (2002). Finally, we find evidence of shirking in regard to OPS in the 1998 to 2000 sample (though only statistically significant at the eleven percent level), which is a subset of the 1997-2007 data used by Krautmann and Solow (2009) that found similar results, but primarily for players not expecting a future contract.

In the next panel of Table 6, we look at hits, home runs, and unintentional base-on-balls per 502 at-bats. If players have some control over these outputs and are responding to market wage incentives, we would expect them to try to raise their hit totals in all cohorts, their home run rate prior to free agency in the 1990s and 2000s cohorts, and their unintentional base-on-ball rates in the 2000s cohort. However, we find evidence of changes in effort, as evidenced by statistically significant increases in the year prior to free agency, only for hits and home runs in the 1990s cohort. In the year after free agency, we see a decline in all statistics and across all cohorts, with the lone exception of home runs in the 1990s cohort. This decline is statistically significant at the one percent level in the last cohort for all three statistics and at the five percent level for hits in the 1990s cohort. More generally, players' performance as measured by these statistics appears to be declining with each year in the 1980s cohort, but there appears to be some evidence of manipulation in the 1990s and 2000s cohorts. The fact that hits and home runs appear to be manipulated in both of the later cohorts, but walks only in the final cohort, is consistent with the production incentives documented in Table 4.

In the bottom panel of Table 6, we present the results when doubles, stolen bases and strikeouts are used as the dependent variable in Specification 2. Doubles have a particularly high potential for manipulation by players. Doubles can often be "manufactured" much more

easily than home runs, as the former often result from increased running effort after a single. Additionally, a failed attempt to extend a single into a double does not cost the player a hit, and therefore results in no penalty (or decrease in measured productivity) for the player. However, our wage analysis shows that doubles were only rewarded for free agents in the 1990s cohort, implying that a focus on changes to doubles amongst free agents in this era would be particularly indicative of players adjusting effort in response to market incentives. For the 1980s cohort, the results in Table 6 provide no evidence of enhanced performance in the year before free agency or shirking following free agency with respect to doubles. This changes for the 1990s and 2000s cohorts. In both cohorts, players' statistics show a surge in doubles in the year prior to free agency that is significantly different from the previous two years' values for the 1990s cohort and from the previous year's value for the 2000s cohort. There is also evidence of shirking in the year following free agency which is significant at the 10 percent level for the 1990s cohort and the 1 percent level for the 2000s cohort. In other words, it appears that players are indeed increasing their production of doubles when they are rewarded for doing so, and decrease this production when they are not. These findings represents particularly strong evidence of players responding to financial incentives through adjustments to their efforts.

Lastly, stolen bases and strikeouts have been included in Table 6 to test whether players will limit their effort in areas that are not directly rewarded in the free agent market (as neither are a significant predictor of future salaries in the wage models above). The results for stolen bases do not provide any evidence of decreased performance prior to free agency or improved performance after free agency. We might have expected a decline in stolen bases in the year prior to free agency in order to reallocated the effort used to produce those statistics towards measures of productivity that are better rewarded by the market. This could then have been followed by a rebound in stolen bases after free agency, when the players would have returned to their steady-states. But the pattern observed here is not consistent with that story. The pattern we observe may suggest no shift in focus or

simply that effort in stealing bases is not at the cost of effort in other areas (though one might expect players that are adept at stealing bases and aware of market incentives to be particularly capable of increasing doubles at the expense of stolen bases). The pattern of strikeouts in the 1990s and 2000s cohorts does show some weak evidence of an increase in the free agent season, based on negative (but not statistically significant) coefficients for the year indicators in prior years. In the year after free agency, strikeouts for these cohorts show a statistically significant increase. This change could be related to the relationship between strikeouts and walks. If a player's plate discipline diminishes due to shirking, or if a player is simply following the general trend of increasing his strikeouts with each additional year in the league, this pattern could result.[12]

Given that much of the strategic behavior suggested in the above analysis is following free agency, one alternative explanation for this pattern could be that players who change teams suffer productivity declines because they have to adjust to new teammates, staff, press corps, city, ballpark, etc. These changes could lead to a period of adjustment that would explain the poor performance that we document follows free agency, without indicating shirking or other changes to effort. To examine this possibility, we repeat our analysis, this time including an indicator for whether a player has changed teams. We define changing teams as playing for a team in the current season that a player did not play for in the previous season. Table 7 presents the results.

When looking directly at the indicator for whether a player has changed teams in Table 7, it does appear that changing teams has a negative impact on the performance of a player in most categories, but not to the level of statistical significance. There are a few exceptions. First, unintentional walks in the 2000s cohort drop significantly if a player has changed teams. This is consistent with the theory that a player may be pressing to "live up" to their contract, though we have shown that part of that contract was dictated by the amount

[12]One may be concerned that we have not controlled for ballpark effects in the above analysis. Appendix Table 1 presents the results when controls for a player's home ballpark are included (using ratios when a player plays for more than one team in a season and using separate indicators after a new ballpark is built or an existing ballpark is significantly renovated). The results are very similar to those presented in Table 6.

of walks a player in this cohort was able to draw in the previous season. Similarly, the statistically significant spike in strikeouts when a player changed teams in the 1990s cohort could be related to players swinging more aggressively to try to perform better for their new team. On the other hand, changing teams leads to an increase in stolen bases in the 1990s and 2000s cohorts. This could be explained by an increase in effort in an area that is easily translated into improved statistics. Alternatively, this could simply reflect a redistribution of talent to where it is most beneficial (i.e. a speedy player signing or being traded to a team whose strategy is more aggressive when players reach base).

For the most part, the addition of this explanatory variable does not have a large impact on the productivity patterns that surround free agency (though it does have a minor impact on statistical significance in a couple of estimates). Most importantly, our key findings–that strategic behavior is occurring in regards to doubles, home runs, and walks in cohorts where those statistics are financially rewarded on the free agent market–remain strong.

Another possible explanation for the general decline in production during the year after free agency is that the free agent market presents something of a lemons problem. This could result if a player's current team can observe indicators of a player's current and future productivity that are not observable to other teams (for example, the medical treatments a player is receiving, whether or not the player is working out, following a healthy diet, etc.). As players are free to resign with their current teams at any point prior to free agency, it could be that players who enter free agency are more likely to be those that are primed for a drop off in production. A counter to this argument is that players often want to enter the free agent market in order to spark a bidding war, and/or make themselves available to the team with the greatest ability to pay for their services. This drive to test the market may also reflect a current team's inability to pay a salary close to market value as much as a player's interest in getting the maximum salary or disinterest from the team. Still, we must view the trends in post free agency productivity declines in the aggregate data as possible evidence of a lemons problem.

In order to address this possibility, we repeat the analysis of our key player productivity findings separately for players that are resigned by a team they played for in the previous season and those that are signed by a new team. If teams possess private information that allows them to better predict the future performance of their current players, we would expect those players that are resigned by their original team to exhibit a smaller decline in post-free agency productivity compared to those who sign with a new team. Though not found above, the possibility that players who switch teams may experience a productivity-diminishing "adjustment period" only increases the likelihood of finding that stayers experience less of a drop off than movers. However, this is not what our results imply. The results of this analysis for slugging percentage, home runs, doubles, and unintentional base-on-balls are presented in Table 8. In general, there is no clear divergence in the pattern between the two groups in most cohorts and statistics. In fact, the results suggest that players who later resign with their previous team after free agent are more likely to exhibit a pattern consistent with strategic behavior than those players who sign with new teams in regard to power statistics. All in all, these results do not imply that we should be concerned about the potential lemon problem in the market for free agents, as there is no evidence that teams have an advantage in predicting the future performance of their own players.

6 Conclusion

In this study, we set out to explore two questions about free agency in Major League Baseball. First, are the shifts in strategic importance of particular outputs in baseball reflected in the free agent salaries that players receive? Second, do players respond to these shifts by changing their performance in the years around free agency to respond to these implicit incentives? While there are certainly limits to our analysis, we have found strong evidence that the answer to both of these questions appears to be "yes."

Baseball provides an ideal case study for exploring incentives and effort, as salaries and

numerous individual-level productivity indicators are available for all players. But, as is to be expected in any analysis of worker effort and compensation, there are factors confounding our analysis. Individual contracts are necessarily idiosyncratic, depending on the teams' needs and budgets, other players in the market, general economic fluctuations, and numerous other factors that are specific to each free agent class. Even if we could generate ideal compensation models, we cannot observe player efforts directly, let alone how these efforts might adjust to changing incentives. As such, any general patterns of financial rewards changing in response to a better understanding of baseball's "production process," or changes in players' outputs in response to these incentives constitutes strong evidence in support of our questions. And while we do not observe statistically significant evidence of these patterns at every opportunity, what we find is persuasive.

The 1990s were seen as an era in baseball when power hitting became an extremely important part of the game, both in winning and for drawing fans to the ballpark. The marginal value of power statistics for free agents (as measured by their impact on log salary) increased dramatically between the late 1980s and the late 1990s. For example, a home run per 502 plate appearances increased free agent salaries by 2 percent in the 1990s compared to only 0.3 percent in the 1980s. In apparent response to these changing incentives, we find evidence of an increase in slugging percentage in the year prior to free agency in the 1990s cohort, and a commensurate increase in home runs. We also found that doubles increased significantly in a player's free agent year and returned to normal levels in the year after free agency, evidence that players may have been trying to boost statistics that were rewarded in the free agent market, then shifted their efforts away from these activities after reaping the rewards.

Following the success of the Oakland Athletics in the late 1990s and early 2000s, there was an increased emphasis on drawing walks and driving opposing pitchers to high pitch counts. Again, our wage regressions show that market incentives reflected this change, as on-base percentage and unintentional base-on-balls became significant predictors of a free

agent's salary. Though we found no evidence of players increasing these statistics prior to free agency, we did find a significant drop-off following the signing of a new contract. This suggests that players may be directing their efforts to maintaining high levels of walks prior to free agency, and then change their plate approach following their new contract (possibly because of the effort required to have a disciplined approach when batting).

The external implications of these findings are not explored here, but might be a fruitful avenue for future research. Baseball provides wage-setters with a rare opportunity to observe numerous measures of individual-level productivity, so whether other industries or firms are able to offer as targeted incentives for desirable actions is an open question. That said, that their productivity is so visible implies that players are likely to work hard even in the absence of well-targeted incentives. The fact that players who are likely to already be expending near maximum effort do appear to shift efforts in response to productivity enhancing incentives illustrates the potential gains that can be made in industries where baseline worker effort is not as visible. That is, while other industries may have even greater difficulty in identifying or providing targeted incentives for workers' efforts, they may well have more to gain by this pursuit than Major League Baseball.

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Table 1

Means for each free agent cohort in year before free agency

	1980s Cohort	1990s Cohort	2000s Cohort
Salary following free agency	$ 922,675	$ 2,479,573	$ 3,179,881
OPS	0.686	0.765	0.741
OBP	0.321	0.341	0.331
SLG	0.366	0.424	0.410
Plate Appearances (PA)	359.3	401.3	394.0
R's per 502 PAs	53.8	62.2	57.6
H's per 502 PAs	112.7	120.7	115.5
2B's per 502 PAs	19.1	24.4	23.7
3B's per 502 PAs	2.1	2.0	1.8
HR's per 502 PAs	9.0	13.3	13.1
RBI's per 502 PAs	49.9	60.6	57.0
SB per 502 PAs	9.9	7.6	5.7
BB's per 502	44.4	45.8	45.2
Unintentional BB's per 502 PAs	40.1	42.9	41.9
SO's per 502 PAs	75.2	79.8	86.9
Premium Position	43.3%	47.4%	51.0%
Percent of Games in AL	57.0%	49.9%	50.0%
Age	31.6	32.9	32.8
Age Squared	1005.9	1091.9	1087.6
1988/1998/2008	34.6%	40.4%	27.7%
1989/1999/2009	32.7%	24.4%	37.4%
1990/2000/2010	32.7%	35.3%	35.0%
Number of Free Agents	104	156	206

1980s cohort is made up of free agents following the 1988, 1989, and 1990 seasons. 1990s cohort is made up of free agents following the 1998, 1999, and 2000 seasons. 2000s cohort is made up of free agents following the 2008, 2009, and 2010 seasons.

Table 2

Regression of log player salary on aggregate statistics

	1	2	3	4	5	6
VARIABLES	1988-90	1998-2000	2008-2010	1988-90	1998-2000	2008-2010
PA	0.004***	0.003***	0.003***	0.004***	0.003***	0.003***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
OPS	1.115***	3.736***	3.175***			
	[0.370]	[0.544]	[0.604]			
OBP				1.087	0.617	3.727**
				[1.334]	[1.416]	[1.578]
SLG				1.131	4.866***	2.962***
				[0.923]	[0.634]	[0.716]
Premium position	-0.146	0.078	0.195*	-0.145	0.063	0.194*
	[0.105]	[0.110]	[0.108]	[0.114]	[0.109]	[0.108]
AL games (ratio)	-0.402***	0.046	0.078	-0.402***	0.04	0.08
	[0.107]	[0.097]	[0.092]	[0.109]	[0.096]	[0.092]
Age	0.835***	-0.122	-0.171	0.835***	-0.185	-0.164
	[0.274]	[0.274]	[0.179]	[0.276]	[0.274]	[0.177]
Age^2	-0.012***	0.001	0.002	-0.012***	0.002	0.002
	[0.004]	[0.004]	[0.003]	[0.004]	[0.004]	[0.003]
Constant	-2.245	12.799***	14.065***	-2.239	14.302***	13.862***
	[4.514]	[4.683]	[2.920]	[4.538]	[4.751]	[2.904]
Observations	104	156	206	104	156	206
R-squared	0.749	0.698	0.564	0.749	0.708	0.564

Robust standard errors in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3

Regression of log player salary on counting statistics

	1	2	3
VARIABLES	1988-90	1998-2000	2008-2010
PA	0.003***	0.003***	0.003***
	[0.000]	[0.000]	[0.000]
R's per 502 PAs	0.003	0.004	0.009*
	[0.004]	[0.004]	[0.005]
H's per 502 PAs	0.005***	0.008*	0.009*
	[0.002]	[0.004]	[0.005]
2B's per 502 PAs	-0.005	0.021***	0.013
	[0.006]	[0.006]	[0.008]
3B's per 502 PAs	-0.019	0.018	0.023
	[0.016]	[0.021]	[0.022]
HR's per 502 PAs	0.003	0.020**	0.017*
	[0.007]	[0.010]	[0.009]
RBI's per 502 PAs	0.011***	0.006	-0.002
	[0.004]	[0.004]	[0.004]
SB's per 502 PAs	0.006	0.005	-0.006
	[0.005]	[0.007]	[0.007]
BB's per 502 PAs	0.004	0.006**	0.009***
	[0.003]	[0.003]	[0.003]
SO's per 502 PAs	-0.002	0	-0.001
	[0.002]	[0.002]	[0.002]
Premium position	0.000	0.096	0.184
	[0.138]	[0.112]	[0.115]
AL games (ratio)	-0.462***	0.037	0.078
	[0.116]	[0.097]	[0.090]
Age	1.014***	-0.128	-0.233
	[0.335]	[0.293]	[0.205]
Age^2	-0.015***	0.001	0.003
	[0.005]	[0.004]	[0.003]
Constant	-5.505	12.969**	15.159***
	[5.487]	[5.115]	[3.344]
Observations	104	156	206
R-squared	0.783	0.721	0.58

Robust standard errors in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4

Regression of log player salary on counting statistics using unintentional base-on-balls

	1	2	3
VARIABLES	1988-90	1998-2000	2008-2010
PA	0.003***	0.003***	0.003***
	[0.000]	[0.000]	[0.000]
R's per 502 PAs	0.003	0.005	0.009**
	[0.004]	[0.004]	[0.005]
H's per 502 PAs	0.005***	0.007*	0.008*
	[0.002]	[0.004]	[0.005]
2B's per 502 PAs	-0.005	0.020***	0.013
	[0.006]	[0.006]	[0.008]
3B's per 502 PAs	-0.019	0.017	0.023
	[0.016]	[0.021]	[0.022]
HR's per 502 PAs	0.003	0.020**	0.018*
	[0.007]	[0.010]	[0.009]
RBI's per 502 PAs	0.012***	0.006	-0.002
	[0.004]	[0.004]	[0.004]
SB's per 502 PAs	0.006	0.005	-0.007
	[0.005]	[0.007]	[0.007]
UBB's per 502 PAs	0.004	0.005	0.009**
	[0.003]	[0.003]	[0.003]
SO's per 502 PAs	-0.002	0	-0.001
	[0.002]	[0.002]	[0.002]
Premium position	0	0.087	0.173
	[0.138]	[0.113]	[0.113]
AL games (ratio)	-0.469***	0.024	0.058
	[0.117]	[0.098]	[0.090]
Age	1.029***	-0.145	-0.256
	[0.341]	[0.295]	[0.207]
Age^2	-0.016***	0.002	0.004
	[0.005]	[0.004]	[0.003]
Constant	-5.678	13.348**	15.604***
	[5.561]	[5.152]	[3.361]
Observations	104	156	206
R-squared	0.783	0.718	0.577

Robust standard errors in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5

Quantile regression analysis of log player salary using unintentional base-on-balls

VARIABLES	1 1988-90 At 25%	2 1988-90 At 50%	3 1988-90 At 75%	4 1998-2000 At 25%	5 1998-2000 At 50%	6 1998-2000 At 75%	7 2008-2010 At 25%	8 2008-2010 At 50%	9 2008-2010 At 75%
PA	0.003***	0.003***	0.004***	0.003***	0.003***	0.003***	0.003***	0.004***	0.003***
	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
R's per 502 PAs	0.002	0.005	-0.001	0.007	0.005	0.004	0.007	0.010*	0.007
	[0.005]	[0.004]	[0.005]	[0.008]	[0.006]	[0.007]	[0.009]	[0.006]	[0.007]
H's per 502 PAs	0.006*	0.004	0.001	0.007	0.005	0.003	0.008	0.005	0.016***
	[0.003]	[0.003]	[0.003]	[0.006]	[0.005]	[0.005]	[0.007]	[0.005]	[0.006]
2B's per 502 PAs	-0.004	-0.009	-0.008	0.026***	0.019**	0.023***	-0.002	0.009	0.017*
	[0.009]	[0.008]	[0.010]	[0.010]	[0.008]	[0.008]	[0.012]	[0.008]	[0.010]
3B's per 502 PAs	-0.005	-0.02	-0.044	0.002	0.007	0.026	0.019	0.001	-0.005
	[0.027]	[0.023]	[0.030]	[0.036]	[0.027]	[0.030]	[0.036]	[0.024]	[0.029]
HR's per 502 PAs	0.006	0.003	0.001	0.035**	0.004	0.008	0.025	0.017	0.031**
	[0.011]	[0.009]	[0.012]	[0.016]	[0.012]	[0.014]	[0.017]	[0.012]	[0.014]
RBI's per 502 PAs	0.012**	0.013***	0.015***	0.002	0.010*	0.012**	0.001	-0.002	-0.005
	[0.005]	[0.005]	[0.006]	[0.007]	[0.005]	[0.006]	[0.008]	[0.005]	[0.006]
SB's per 502 PAs	0.007	0.006	0.005	0.007	0.007	0.008	-0.006	-0.011	-0.007
	[0.006]	[0.005]	[0.007]	[0.010]	[0.007]	[0.008]	[0.012]	[0.008]	[0.010]
UBB's per 502 PAs	0.003	0.005*	0.004	0.010**	0.007*	0.004	0.012**	0.007*	0.006
	[0.003]	[0.003]	[0.004]	[0.005]	[0.004]	[0.004]	[0.006]	[0.004]	[0.005]
SO's per 502 PAs	0	-0.004	0	-0.002	0.002	0	-0.002	0	-0.002
	[0.003]	[0.002]	[0.003]	[0.004]	[0.003]	[0.003]	[0.003]	[0.002]	[0.003]
Observations	104	104	104	156	156	156	206	206	206

Robust standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Other covariates include age, squared age, league, premium position indicator, and an intercept term.

Table 6

Analysis of performance around free agency

	1 1988-90	2 1998-2000	3 2008-10	4 1988-90	5 1998-2000	6 2008-10	7 1988-90	8 1998-2000	9 2008-10
Dependent Var	OPS	OPS	OPS	SLG	SLG	SLG	OBP	OBP	OBP
3 Years Prior to FA	0.025	-0.014	0.011	0.020*	-0.011	0.009	0.004	-0.004	0.002
	[0.017]	[0.010]	[0.009]	[0.011]	[0.007]	[0.006]	[0.007]	[0.004]	[0.003]
2 Years Prior to FA	0.014	-0.026***	-0.01	0.013	-0.020***	-0.007	0.001	-0.007*	-0.002
	[0.014]	[0.009]	[0.008]	[0.009]	[0.006]	[0.005]	[0.006]	[0.004]	[0.003]
Year After FA	-0.03	-0.021	-0.054***	-0.017	-0.008	-0.034***	-0.013*	-0.013***	-0.020***
	[0.018]	[0.013]	[0.009]	[0.012]	[0.009]	[0.007]	[0.008]	[0.005]	[0.003]
Dependent Var	H	H	H	HR	HR	HR	UBB	UBB	UBB
3 Years Prior to FA	1.931	-1.938	1.455	1.905*	-0.44	0.869	0.923	-0.431	-1.317
	[2.935]	[1.430]	[1.390]	[1.021]	[0.742]	[0.662]	[2.325]	[1.514]	[1.162]
2 Years Prior to FA	1.33	-3.066*	-1.313	0.959	-1.230**	-0.431	-0.09	0.444	-0.426
	[2.705]	[1.586]	[1.308]	[0.743]	[0.529]	[0.469]	[1.795]	[1.135]	[0.957]
Year After FA	-4.717	-4.749**	-5.816***	-0.927	0.867	-1.888***	-1.205	-2.006	-2.910***
	[3.100]	[2.015]	[1.447]	[0.744]	[0.725]	[0.568]	[1.910]	[1.250]	[1.059]
Dependent Var	Doubles	Doubles	Doubles	SB	SB	SB	SO	SO	SO
3 Years Prior to FA	1.121	-1.555**	-0.334	0.891	0.701	-0.386	-3.337	-1.49	-4.551**
	[1.071]	[0.702]	[0.585]	[1.507]	[0.869]	[0.720]	[3.029]	[1.881]	[1.987]
2 Years Prior to FA	1.931*	-1.856**	-0.981*	-0.14	0.093	-0.188	1.247	-0.148	-2.303
	[1.155]	[0.746]	[0.499]	[1.053]	[0.659]	[0.453]	[2.345]	[1.751]	[1.501]
Year After FA	-0.137	-1.648*	-2.272***	-2.129**	-0.787	0.23	1.984	6.637**	5.430***
	[1.110]	[0.977]	[0.546]	[1.000]	[0.798]	[0.399]	[3.619]	[2.679]	[1.590]
Observations	410	617	816	410	617	816	410	617	816

Robust standard errors in brackets, clustered at the player level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Other covariates include age, squared age, league, premium position indicator, and an intercept term. Omitted category is year prior to free agency.

Sample limited to 3 years before through 1 year after free agency.

Table 7

Analysis of performance around free agency controlling for team changes

	1 1988-90	2 1998-2000	3 2008-10	4 1988-90	5 1998-2000	6 2008-10	7 1988-90	8 1998-2000	9 2008-10
Dependent Var	OPS	OPS	OPS	SLG	SLG	SLG	OBP	OBP	OBP
3 Years Prior to FA	0.024	-0.013	0.009	0.019*	-0.01	0.008	0.004	-0.003	0.001
	[0.017]	[0.010]	[0.009]	[0.011]	[0.007]	[0.006]	[0.007]	[0.004]	[0.003]
2 Years Prior to FA	0.012	-0.024**	-0.011	0.011	-0.018***	-0.008	0.001	-0.006	-0.003
	[0.014]	[0.009]	[0.008]	[0.010]	[0.006]	[0.005]	[0.006]	[0.004]	[0.003]
Year After FA	-0.029*	-0.016	-0.049***	-0.017	-0.004	-0.032***	-0.012*	-0.011**	-0.017***
	[0.017]	[0.012]	[0.009]	[0.011]	[0.009]	[0.007]	[0.007]	[0.004]	[0.003]
Changed Team	-0.006	-0.015	-0.011	-0.003	-0.01	-0.005	-0.002	-0.005	-0.007
	[0.019]	[0.011]	[0.011]	[0.012]	[0.007]	[0.007]	[0.008]	[0.004]	[0.004]
Dependent Var	H	H	H	HR	HR	HR	UBB	UBB	UBB
3 Years Prior to FA	3.09	-1.738	1.476	1.728	-0.442	0.798	-0.146	-0.56	-1.779
	[2.221]	[1.435]	[1.413]	[1.061]	[0.744]	[0.651]	[2.292]	[1.505]	[1.167]
2 Years Prior to FA	2.372	-2.832*	-1.221	0.742	-1.195**	-0.431	-0.873	0.518	-0.887
	[2.234]	[1.592]	[1.363]	[0.767]	[0.537]	[0.470]	[1.807]	[1.130]	[0.973]
Year After FA	-4.387	-3.921**	-5.736***	-1.029	0.986	-1.562**	-1.239	-2.16	-1.889*
	[3.170]	[1.908]	[1.525]	[0.801]	[0.733]	[0.638]	[1.872]	[1.469]	[1.137]
Changed Team	0.908	-1.805	0.029	-0.068	-0.38	-0.672	-1.704	-0.072	-3.083**
	[2.948]	[1.877]	[1.842]	[1.094]	[0.734]	[0.775]	[2.772]	[1.891]	[1.460]
Dependent Var	Doubles	Doubles	Doubles	SB	SB	SB	SO	SO	SO
3 Years Prior to FA	0.62	-1.504**	-0.317	1.257	0.751	-0.178	-3.614	-1.757	-4.406**
	[1.026]	[0.708]	[0.593]	[1.539]	[0.836]	[0.704]	[2.901]	[1.932]	[2.043]
2 Years Prior to FA	1.325	-1.766**	-0.985*	0.226	0.097	-0.038	0.984	-0.446	-2.165
	[1.151]	[0.746]	[0.501]	[1.080]	[0.636]	[0.453]	[2.248]	[1.791]	[1.594]
Year After FA	-0.302	-1.264	-2.516***	-1.785	-1.437	-0.351	-1.105	4.784*	4.786**
	[1.162]	[0.898]	[0.541]	[1.345]	[1.008]	[0.536]	[3.013]	[2.557]	[1.950]
Changed Team Since	-0.471	-0.999	0.485	-0.096	2.174*	1.514**	6.598	4.686*	1.604
Previous Season	[1.356]	[0.960]	[0.561]	[2.055]	[1.189]	[0.677]	[5.984]	[2.599]	[2.736]
Observations	407	615	814	407	615	814	407	615	814

Robust standard errors in brackets, clustered at the player level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Other covariates include age, squared age, league, premium position indicator, and an intercept term. Omitted category is year prior to free agency.

Sample limited to 3 years before through 1 year after free agency.

"Team change" is defined as playing for no teams in the current year that a player also played for in the previous year.

Table 8

Analysis of performance separately based on whether a player resigned with a previous team or moved to a new team following free agency

	1	2	3	4	5	6
	1988-90		1998-2000		2008-2010	
	New Team	Resigned	New Team	Resigned	New Team	Resigned
Slugging Percentage						
3 Years Prior to FA	0.018	0.019	-0.01	-0.013	0.019***	-0.022*
	[0.017]	[0.014]	[0.010]	[0.011]	[0.007]	[0.012]
2 Years Prior to FA	0.018	0.002	-0.016**	-0.027**	0.005	-0.044***
	[0.014]	[0.011]	[0.008]	[0.012]	[0.006]	[0.013]
Year After FA	-0.012	-0.024	-0.001	-0.021	-0.029***	-0.049***
	[0.017]	[0.015]	[0.012]	[0.014]	[0.008]	[0.013]
Home runs						
3 Years Prior to FA	1.543	2.284*	-0.444	-0.475	1.348*	-0.768
	[1.436]	[1.275]	[0.951]	[1.164]	[0.739]	[1.235]
2 Years Prior to FA	1.664*	-0.132	-0.909	-1.933**	0.221	-2.543**
	[0.975]	[1.151]	[0.673]	[0.823]	[0.520]	[1.141]
Year After FA	-0.399	-1.653*	1.625*	-0.629	-1.656**	-2.601*
	[1.072]	[0.965]	[0.929]	[1.180]	[0.657]	[1.295]
Doubles						
3 Years Prior to FA	1.245	0.718	-0.717	-3.445**	0.581	-2.780**
	[1.462]	[1.477]	[0.769]	[1.501]	[0.686]	[1.090]
2 Years Prior to FA	3.196*	0.000	-1.691**	-2.317	-0.208	-3.054***
	[1.793]	[1.226]	[0.834]	[1.487]	[0.595]	[0.932]
Year After FA	-0.843	0.935	-1.275	-2.359	-1.673**	-4.079***
	[1.564]	[1.589]	[1.237]	[1.463]	[0.654]	[1.076]
Unintentional Base-on-balls						
3 Years Prior to FA	0.187	1.403	1.658	-3.997*	-2.299*	1.837
	[3.106]	[3.121]	[1.869]	[2.346]	[1.289]	[2.345]
2 Years Prior to FA	1.652	-3.11	2.511*	-3.378*	-1.796*	3.627
	[2.262]	[3.067]	[1.420]	[2.007]	[1.018]	[2.221]
Year After FA	0.132	-2.912	-2.145	-2.595	-3.745***	-0.916
	[2.498]	[2.797]	[1.411]	[2.353]	[1.197]	[2.460]
Observations	243	167	420	197	611	205

Robust standard errors in brackets, clustered at the player level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Other covariates include age, squared age, league, premium position indicator, and an intercept term. Omitted category is year prior to free agency.

Sample limited to 3 years before through 1 year after free agency.

A player is identified as "Resigned" if he plays for a team following free agency that he also played for in the year before free agency.

Appendix Table 1

Analysis of performance around free agency controlling for home ballpark

	1 1988-90	2 1998-2000	3 2008-10	4 1988-90	5 1998-2000	6 2008-10	7 1988-90	8 1998-2000	9 2008-10
Dependent Var	OPS	OPS	OPS	SLG	SLG	SLG	OBP	OBP	OBP
3 Years Prior to FA	0.027	-0.014	0.012	0.022*	-0.01	0.01	0.005	-0.004	0.003
	[0.018]	[0.011]	[0.009]	[0.011]	[0.008]	[0.007]	[0.008]	[0.004]	[0.003]
2 Years Prior to FA	0.014	-0.028***	-0.008	0.013	-0.020***	-0.006	0.001	-0.008*	-0.002
	[0.014]	[0.010]	[0.008]	[0.009]	[0.007]	[0.006]	[0.006]	[0.004]	[0.003]
Year After FA	-0.029	-0.023*	-0.053***	-0.016	-0.01	-0.034***	-0.013	-0.013***	-0.019***
	[0.020]	[0.013]	[0.010]	[0.013]	[0.009]	[0.007]	[0.008]	[0.005]	[0.004]
Dependent Var	H	H	H	HR	HR	HR	UBB	UBB	UBB
3 Years Prior to FA	2.141	-0.926	0.886	1.760*	-0.829	1.005	1.036	-1.763	-0.093
	[2.881]	[1.562]	[1.510]	[0.985]	[0.816]	[0.654]	[2.624]	[1.626]	[1.088]
2 Years Prior to FA	1.224	-2.714	-1.611	0.84	-1.473**	-0.262	0.027	-0.517	0.302
	[2.675]	[1.700]	[1.354]	[0.747]	[0.614]	[0.510]	[2.032]	[1.164]	[1.014]
Year After FA	-4.07	-4.271**	-6.014***	-0.864	0.516	-1.790***	-1.742	-1.972	-2.712**
	[3.168]	[2.037]	[1.561]	[0.923]	[0.763]	[0.589]	[2.050]	[1.328]	[1.132]
Dependent Var	Doubles	Doubles	Doubles	SB	SB	SB	SO	SO	SO
3 Years Prior to FA	1.623	-1.276	-0.518	0.84	0.844	-0.224	-4.512	-2.67	-2.834
	[1.185]	[0.770]	[0.607]	[1.640]	[0.960]	[0.750]	[3.088]	[2.279]	[2.048]
2 Years Prior to FA	2.319**	-1.723**	-0.935*	-0.147	0.247	-0.089	0.592	-0.799	-1.686
	[1.149]	[0.812]	[0.543]	[1.277]	[0.750]	[0.503]	[2.547]	[2.083]	[1.629]
Year After FA	0.233	-1.707*	-2.221***	-1.677	-0.602	0.412	2.655	5.470*	4.699**
	[1.236]	[0.993]	[0.594]	[1.245]	[0.874]	[0.403]	[3.943]	[2.989]	[1.800]
Observations	410	617	816	410	617	816	410	617	816

Robust standard errors in brackets, clustered at the player level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Other covariates include age, squared age, league, premium position indicator, home ballpark ratio, and an intercept term. Omitted category is year prior to free agency.

Sample limited to 3 years before through 1 year after free agency.

Home ballpark effects are captured using the ratio of a player's total games with a particular home ballpark in any season that a player appeared for a particular team..