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Vertical Integration and Competitive Balance in Professional Sports: Evidence from Minor League Baseball

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Abstract: Major League Baseball (MLB) teams regularly call up players from their Minor League Baseball (MiLB) affiliates to fulfill roster needs. This paper utilizes a manually collected panel of player call-ups between 1946 and 2019 and studies their impact on competitive balance in the minor leagues. Our results indicate an overall positive relationship between call-ups and competitive balance in the MiLB, with the pro-competitive effect primarily driven by the AA leagues and not AAA leagues. We also find suggestive evidence of the effect being likely explained by the promotion of MiLB players to MLB, rather than the demotion of MLB players to MiLB. Our findings provide important policy implications regarding vertical relationships and human capital development in professional sports.

Keywords: vertical integration, human capital development, competitive balance, minor league baseball
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1 Introduction

A key line of inquiry in the theory of the firm concerns boundaries of firm activities, in other words whether transactions are more effective within firms or through markets (Coase, 1937). One strand of this research analyzes firm's make-or-buy decisions, which can affect competitive dynamics along supply chains. Economists and policy makers both share interests in understanding vertical relationships in markets and assessing their impact on competitive dynamics.

Despite a rich body of theoretical literature on the topic (Riordan, 2005), empirical evidence on the competitive effects of firm boundary decisions tends to be limited, possibly because of a lack of empirical settings containing well-defined outcome measures combined with an inability to adequately address the endogeneity of ownership structures (Forbes and Lederman, 2010).

Make-or-buy decisions can involve both human capital integration/development and physical inputs. The organization and strategy literature posits that integration of human capital development can help enhance organizational effectiveness and boost financial performance (Bendickson and Chandler, 2019). However, much less evidence about how the extent of human capital integration affects competition along the entire supply chain. Our study extends this area of research by developing empirical evidence on supply chain dynamics using data from professional baseball that features both comprehensive measures of competitive outcomes, well-defined vertical relationships, and channels for player development between the major and minor leagues.

Minor League Baseball (MiLB) consists of a hierarchy of developmental leagues for Major League Baseball (MLB) teams classified as AAA, AA, A, or Rookie Leagues in descending order of competition quality. Each team currently in the AAA and AA leagues have a designated MLB parent team. Although this arrangement does not necessarily imply direct ownership of minor league teams by major league teams, affiliation agreements require major league teams to provide minor league affiliates with players and pay a portion of their salaries.

In return, major league teams may call up players from their minor league affiliates to meet roster needs or to further develop players. The number of minor league call-ups varies by season and differs across the minor leagues. Our study takes advantage of these institutional features and employs the total number of player call-ups from each minor league as a proxy for the degree of vertical integration in human capital with their major league parent team.

As feeder leagues for MLB, the minor leagues often face the challenge of both facilitating player development for their major league partners and maintaining a high level of competition in their own league games in order to attract fans and ensure financial viability. Our analysis focuses on competitive intensity, measured by the degree of competitive balance, in the minor leagues, rather than the downstream major leagues.[1] Since major league teams typically only call up top-performing players from their minor league affiliates, primarily to meet MLB roster needs due to unexpected injuries, call-ups can impact competitive balance in minor leagues by changing the relative level of talent on minor league teams.

Utilizing a manually collected panel of MLB team call-ups of players from their minor league affiliates between 1946 and 2019, this paper examines how vertical relationships, in the form of human capital flows between leagues and talent development, affect competition in minor leagues. In line with the existing literature on competitive balance in professional sports, we measure competitive balance using the dHHI measure (Depken 1999) and the Noll-Scully ratio (Quirk and Fort 1997), which respectively measure deviations from the idealized league parity based on the Herfindahl-Hirschman Index (HHI) and the standard deviation of winning percentage. We also estimate models that instrument for the number of MiLB call-ups with MLB parent teams' injury counts proxied by the total number of placements on and activations from the MLB disabled list to address a potential endogeneity issue.

Our panel data analysis consistently finds an overall positive relationship between major league call-ups and competitive balance in MiLB leagues, confirming the pro-competitive effect of vertical human capital related integration. We also find the effect to be mainly driven

[1] See Horowitz (1997) and Schmidt and Berri (2001) for reviews of factors affecting competitive balance in MLB.

by outcomes in lower level AA leagues, as opposed to AAA leagues where more developed players perform. Our findings are robust to different measures of call-ups and competitive balance as well as alternative specifications that control for MLB parent's performance and payroll, or the performance of call-ups during their time in the minor leagues.

We re-estimate our main model specifications capturing the distribution of call-ups, proxied by the standard deviation of call-ups within each minor league, to shed light on potential mechanisms. These results indicate that, while the variability of call-ups across minor leagues does not seem to play a role in the AAA league competitive balance, it is positively correlated with competitive balance in AA leagues. This in turn suggests that competitive balance is likely to suffer (improve) when call-ups are spread across (concentrated within) teams in a league, which supports the explanation that the positive competitive balance effect is likely driven by top players in the minor leagues being called up by their MLB parent teams.

We make two contributions to the literature. First, our work is closely related to the growing empirical literature on the impact of firm's make-or-buy decisions on competitive dynamics along the supply chain, and is among the first to explore its implications in the professional sports context. Novak and Stern (2008) and Forbes and Lederman (2010) focused on the automobile and airline industries, respectively, and examined the impact of upstream firms integration on the performance of downstream firms. More akin to our study in terms of empirical context is Bendickson and Chandler (2019) who examined the relationship between the effectiveness of an MLB team's player farm system and its operational and financial performance of their MLB parent teams.[2]

Our study extends existing research by examining the overall impact on competitive balance in the *upstream* feeder leagues generated by variation in the degree of integration between upstream and downstream leagues. In addition, rather than using ownership structures to proxy vertical integration status like Novak and Stern (2008) and Forbes and Lederman (2010), our measure of integration employs player call-up count variables that not

[2]Note that Bendickson and Chandler (2019) focus on the quality of player farm systems rather than the degree of vertical integration between major league teams and their minor league affiliates.

only offer rich industry-level variation over time but also capture the flow of human capital between the upstream and downstream industries. The focus on human capital integration and development also helps extend the literature on make-or-buy decisions of physical inputs to the development and training of labor inputs. In addition, we are the first in the large existing literature on competitive balance in professional sports to analyze competitive balance in feeder leagues.

While previous research on MiLB analyzed game attendance (Gitter and Rhoads, 2010; Tainsky et al., 2020), ownership structure (Winfree, 2005), and the economic impact of stadiums and teams (Agha, 2013), little prior research focused on competitive balance in MiLB. Prior research on MiLB tended to focus on the economic impact of minor leagues in isolation, without accounting for the vertical relationship with the major leagues. Our study extends the MiLB literature to include this key vertical relationship.

Our results supporting a pro-competitive effect of vertical integration between the major and minor leagues also suggests important policy implications, for communities that rely on minor league teams as economic development projects and for sports leagues in terms of the make-or-buy choice. For example, Agha (2013) reported a positive impact of minor league baseball teams and stadiums on per capita income in surrounding communities. Our results imply that these communities may further benefit from a higher level of integration between the major and minor leagues that generates more competitive competitions and, potentially, generate higher gate revenues. This insight can be especially relevant given the financial crisis facing developmental leagues across different sports and around the world are experiencing.

2 Institutional Context

2.1 Make-or-Buy Decisions in Professional Sports

Professional sports contains a rich variety of responses to the classic make-or-buy input decision facing firms. This decision involves the training and development of young athletes in order to raise their ability to the level required to compete at the highest level in different sports. These choices are typically made at the league level in order to insure uniformity in operating conditions across teams. Leagues choosing the make approach develop young players in training academies operated by teams in top leagues, or in minor leagues with teams directly affiliated with teams in the top league, as in MLB. Leagues choosing the buy approach outsource the development of young players to independent organizations.

Some leagues, including the National Football League (NFL) and the National Basketball Association (NBA) adopted the buy approach, outsourcing player development to colleges and universities. In an interesting development, the NBA took steps toward the make approach by establishing the National Basketball Development League (NBDL) in 2001. The National Hockey League adopted a mixed approach with colleges and universities, amateur minor leagues, and semi-professional minor leagues developing and training players.

Professional football in Europe contains an especially rich variety of approaches to the make-or-buy decision. Many top level teams operate their own training academies and field teams in the UEFA Youth League, founded in 2013. The young players in these academies receive salaries, lodging, and general education, in addition to athletic development and experience. Youth academies often produce large numbers of players who participate in top-level club competitions. But not all top level European football teams operate youth academies. The European football approach also includes aspects of the buy approach in the form of transfers of young players between teams for cash payments, called transfer fees. Some teams simultaneously operate training academies and acquire players on the transfer market.

Sports league and team make-or-buy decisions have received little attention in the literature. To our knowledge, this paper is the first to explicitly link the make-or-buy decision to the training and development of professional athletes. Major League Baseball operates a long-standing make approach to this decision, establishing affiliated minor leagues as far back as the 1880s. The next section contains a detailed discussion of the organization of affiliated minor league baseball. Although we focus on one aspect of the make-or-buy choice in professional baseball, our results have broader implications for understanding the economic implications of this decision.

2.2 The Structure and Evolution of Minor League Baseball

As feeder leagues for MLB, the structure of MiLB primarily reflects the 1962 Player Development Plan (PDP) between MLB and MiLB, an agreement that remains largely unchanged through today. Under the PDP, major league teams are required to provide their minor league affiliates with players and pay a portion of their salaries. In addition, every time a player is promoted or demoted from a minor league roster, the MLB parent team must pay a transaction fee to the minor league club.[3]

The minor leagues are classified into AAA, AA, A, or Rookie Leagues in descending order of competitiveness and player experience and ability. Each major league team typically partners with one team at each of the AAA and AA levels (Land et al., 1994).[4] The affiliation between major and minor league teams does not necessarily imply ownership. In fact, approximately 80% of minor league teams are independently owned by non-baseball organizations or private investors (Winfree, 2005).[5]

We focus on AAA and AA leagues because of their clearly defined partnership with

[3]Source: "A Complete History Of The Working Agreement Between Major And Minor Leagues" by J.J. Cooper, *Baseball America*, October 18, 2019, accessed [May 19, 2020], `https://www.baseballamerica.com/stories/a-complete-history-of-the-working-agreement-between-major-and-minor-leagues/`.

[4]MLB teams may also have additional affiliates in the A or Rookie Leagues but such partnership is less consistent.

[5]For instance, Mandalay Entertainment, a media conglomerate, had interests in ten different MiLB teams between 1996 and 2014. Source: *Ballpark Digest*, 2017, accessed [June 15, 2020], `https://ballparkdigest.com/mandalay-baseball-properties/`.

specific MLB teams. The MiLB highest class, AAA, currently contains three leagues: the International, the Mexican, and the Pacific Coast Leagues. Teams in the AAA leagues typically employ both young prospects and older players of borderline MLB ability. The 14 team International League and 16 team Pacific Coast League contain the top affiliate for all 30 MLB teams. The Mexican League, while of AAA quality has 16 teams and operates independently from the MLB.[6] We exclude the Mexican League from our sample and focus on the International and the Pacific Coast Leagues. Additionally, our sample for AAA also includes teams from the American Association, which played between 1946 and 1997.[7]

AA also contains three leagues: the Eastern (12 teams), Southern (10 teams), and Texas (eight teams) Leagues. The three AA leagues together contain the second-best affiliates for all 30 MLB teams. Players in these leagues, while typically not as ready for MLB play compared to their AAA counterparts, have usually played in affiliated minor league baseball for several years and are quite seasoned (Cronin, 2013). In addition to the three currently operating AA leagues, our AA sample also includes teams from the Southern Association, which existed between 1946 and 1961.

Figure 1 depicts the composition of AAA and AA leagues since World War II. From Panel (a), since the signing of the PDP of 1962, the number AAA and AA teams largely mirrored the number of MLB teams and followed MLB's expansion path. Panel (b) shows changes in the number of AAA affiliates per MLB team over time. Note that prior to the signing of the PDP in 1962, some MLB teams had more than one AAA affiliate while others had none.

For example, the Los Angeles Dodgers had three AAA affiliates during the 1960 season while the Washington Senators had no minor league affiliates during the 1963 season.

[6] While its teams are not affiliated with MLB clubs and do not help develop their players, the Mexican League is still part of MiLB and "organized baseball" (Cronin, 2013). Note that, like the agreements between MLB and professional leagues in Cuba, Japan, South Korea, and Taiwan, MLB reached a deal with the Mexican League in 2019 that allowed Mexican League players aged 25 or above with six years of professional baseball experience to become free agents.

[7] Note that the American Association also ceased operations multiple times during our sample period, during which its teams were absorbed by the International and the Pacific Coast Leagues. There is also a newly formed, independent minor league that bears the same name.

Similarly, as demonstrated in Panel (c), there was not necessarily a one-to-one affiliate to MLB-team ratio for AA teams prior to the signing of the PDP, e.g., at least one team had two affiliates for the first 16 seasons of the AA class's existence while 14 MLB teams had zero affiliates in the AA leagues during the 1962 season.[8]

Most empirical research on vertical integration measure vertical integration based on firm-level ownership structures (Forbes and Lederman, 2010), this approach does not apply to this setting because of a lack of consistent information on MiLB team ownership structure over our sample period and also because we focus on the vertical relationship between leagues not individual teams. Instead, we exploit the number of minor league player call-ups to MLB in each season as an alternative proxy for the degree of integration between the major and minor leagues. Compared to a discrete ownership-based vertical integration proxy, player call-up counts represent a continuous measure of integration that offers rich league-level variation over time. More importantly, utilizing call-up counts to measure vertical integration helps assess the impact of firm make-or-buy decisions through the channel of human capital integration and talent development, an understudied area in prior literature.

2.3 Player Call-Ups and Competitive Balance in Minor Leagues

An MLB team's 40-man roster consists of a 25-man (26-man beginning in 2020) active roster and 15 other players who typically play in the minor leagues or have been placed on the injured list. Minor league players on the 40-man roster are afforded protection from the Rule 5 Draft, an annual process through which minor league players with a certain service time can be claimed by other teams. When players from the minor leagues are placed on a major league team's 25-man active roster (and also on the 40-man roster), they are said to have been "called up" to the major league.

The reasons for call-ups can vary. Players may be called up based solely on their performance in the minor leagues, but more commonly they are promoted to meet an immediate

[8]This was because the Southern Association, one of the two AA leagues at the time, collapsed prior to the 1962 season.

roster need on an MLB team. Most roster moves arise from an MLB player injury or poor performance. Called-up players tend to be top-performers. The "September call-up," in which players are called up largely because rosters expand that month rather than purely based on their performance, represents an exception.[9] Because minor league seasons typically end before September, we posit that September call-ups have little, if any, impact on competitive balance in the minor leagues.

Since MLB teams generally choose to call up the best players from their minor league affiliates, we expect call-ups to generate a significant impact on competitive balance in the minor leagues, although the direction of the impact can be *a priori* ambiguous. When MiLB teams lose talented players to the majors due to call-ups, they may also gain demoted MLB players as well as MLB players on rehab assignment. If the competitive impact of MiLB call-ups prevails over that from demoted MLB players, we would expect MiLB affiliates contributing call-up more likely to be worse off, which could in turn make minor league games less likely to be dominated by only a few top teams.

The effects of call-ups on competitive balance (and the number of call-ups) may be moderated by various policy changes, such as Rule 5 draft revisions and updates to the Player Development Plan. We therefore include season fixed effects in our empirical specifications to control for season-level policy changes.

[9]Through the 2019 season, the active rosters of MLB teams could expand to include the entire 40-man roster during the month of September. Rather than promoting only top-performers, who might not yet need Rule 5 Draft protection, and removing other players from the 40-man roster, which would expose them to the Rule 5 Draft, teams often opt for the safer route of promoting all those who are already on the 40-man expanded roster. Any player on the 40-man roster can be sent to the minors and called up as needed over the course of three different seasons, or "option assignment" years.

3 Data and Empirical Strategy

3.1 Data Sources and Sample Construction

Our study analyzes outcomes in seven AAA and AA minor leagues, including the Pacific Coast League, the International League, the American Association, the Southern Association, the Texas League, the Eastern League, and the Southern League.[10] Our sample period spans from 1946, the first year of AAA baseball, through 2019. Since not all leagues existed for the entire 74 season period between 1946 and 2019, our data set contains 431 individual league-season observations. This period contains 3,958 team-season observations including 117 unique MiLB teams. Team-level performance data and final league standings were collected from the Baseball Reference and Stats Crew websites. Identification of unique MiLB franchises (across name, location, and league changes) came from data found on the Baseball Reference and Fun While It Lasted websites.

To identify players called-up in each season, we scraped the rosters for all 3,958 MLB team-seasons from Baseball Reference and cross-checked them with MLB leaderboard information from FanGraphs. During our sample period, a total of 16,474 hitters and 18,395 pitchers played in both the major and minor leagues in the same season. Note that while direction of the call-ups (promotion from or demotion to the minors) could represent a confounding factor, the majority of these call-up transactions were aimed at improving the roster of the major league team at the expense of the affiliated minor league team. We classify two-way players as pitchers if their number of innings pitched is greater than or equal to their number of at-bats, or as batters if their number of at-bats exceeded the number of innings pitched.[11]

[10] We exclude the Dixie Association, which only existed for the 1971 season.

[11] In addition, 231 of the 16,474 hitters are missing OPS and 108 and 102 of the 18,395 pitchers are missing ERA and innings pitched, respectively. Missing data was filled in using multiple imputation.

3.2 Descriptive Statistics

Table 1 contains summary statistics for the main variables of interest, broken down by league level. The average AAA league contained about one more team than the average AA league, and also played more games per sesason. Both AAA and AA exhibit a similar average level of competitive balance based on the dHHI measure and the Noll-Scully ratio, which respectively measure deviations from the idealized league parity using the HHI and standard deviation of winning percentage as the baseline measures.

Figure 2 shows the evolution of minor league competitive balance over the sample period. Figure 2 shows competitive balance over time based on the dHHI and the Noll-Scully ratio by league level. For both AAA and AA and across both competitive balance measures, there is no apparent visual evidence suggesting that competitive balance either improved or deteriorated over our sample period.

We quantify the number of MiLB players called-up in each season in two ways in order to capture different types of vertical integration. One call-up variable, which we call "Total Call-ups," reflects the total number of call-ups in each league by tier of play (AAA and AA). For example, the total number of call-ups for each of the three AAA tier leagues (Pacific Coast, International, and American Association) and the four AA tier leagues (Southern Association, Texas, Eastern, and Southern). This variable measures gross outflows of playing talent in each season.

The second call-up variable, which we call "Organization Level Call-ups," takes into account that different MLB teams may employ different call-up patterns in terms of affiliate tier. For example, one MLB team might call-up AA players more frequently and AAA players less frequently while another MLB team might rely more heavily on AAA call-ups. These differences would systematically impact the outflow of playing talent and capture a different type of vertical integration than total call-ups. The second call-up variable contains the total number of AA and AAA call-ups made by the MLB parent team in each season. This variable, like total call-ups, is aggregated to the league level by tier of play (AAA or AA).

While the AA and AAA affiliates of the same MLB team will have the same organization level call-up count in a given season, when aggregated to the league level, each minor league at each tier will have different total organization level call-up counts in each season.

Table 1 contains summary statistics for both call-up variables. In terms of the number of call-ups from each MiLB league level in each season, AAA leagues on average experienced over four times as many call-ups per season than AA leagues. Organization level call-ups are similar for AAA and AA leagues. Figure 3 shows changes in the call-up variables over time, where each observation is at the individual AAA or AA league level. From the left panel of Figure 3, the gap between call-ups from AAA and AA opened in the 1960s. The contraction of AAA leagues from three leagues to two leagues in 1998, combined with the expansion of MLB by two teams in the same year, generates the discrete jump in total call-ups in the late 1990s apparent on the left panel of Figure 3. The other apparent break and spike in call-ups in the early 1960s reflects MLB expansion by 2 teams in 1961 and an additional two teams in 1962.

In terms of organization level call-ups, the gap between AAA and AA leagues is significantly smaller. This is because for a given AA (AAA) team, the organization level call-ups would also capture the call-ups that the MLB parent made from its AAA (AA) affiliate. In addition to call-ups from its MLB parent team, an AA team may also contribute call-ups to an AAA team to replace a player called up from the AAA team to MLB.[12]

3.3 Empirical Strategy

Following prior empirical analysis of competitive balance in professional sports (see Gomez-Gonzalez et al. (2019) for a recent review), we first assess the impact of player call-ups on competitive balance in MiLB by estimating the following two-way fixed effects model:

$$CB_{it} = \alpha + \beta\ Callups_{it} + \kappa X_{it} + \rho_i + \delta_t + \varepsilon_{it}, \tag{1}$$

[12] Note that we also see similar visual patterns as on Panels (a) and (b) of Figure 3 after accounting for the number of teams in each league.

where our dependent variables of interest, CB_{it}, are competitive balance measure including the dHHI or Noll-Scully ratio for minor league i in season t. For the dHHI measure, we utilize its natural log form rather than levels in order to scale the potential outliers in our panel data as revealed in Figure 2. We acknowledge that some recent research identified bias in the Noll-Scully ratio (Lee et al., 2019; Sung et al., 2022). Unfortunately, because game-level data for minor leagues are not available for our sample period, we are unable to implement the bias-corrected estimator of competitive balance per Lee et al. (2019) and Sung et al. (2022) that exploits individual game outcomes between any two given teams. Since we undertake the first analysis of MiLB competitive balance, we use the Noll-Scully ratio to facilitate comparison of our results to previous competitive balance research.

As a robustness check, we also consider alternative competitive balance measures, such as the HHI (Humphreys 2002; Zimbalist 2002) and standard deviation of winning probability (Fort 2006; Owen et al. 2007), that do not take into account the idealized league parity level. $Callups_{it}$ measures the number of call-ups that minor league i contributed in season t; X_{it} includes minor league characteristics such as HHI in runs scored and allowed (Depken, 1999); ρ_i and δ_t capture league and season fixed effects, respectively. Note that compared to studies such as (Depken, 1999) that included time dummies to capture industry-wide policy changes, the inclusion of season fixed effects helps account for a broader range of season-specific factors coming from MLB, MiLB, or even the overall economy that could affect the competitive balance in MiLB.

Next, we follow Depken (1999) and augment Equation 1 by controlling for past lags of competitive balance measures. Specifically, we estimate the following dynamic panel model as our alternative specification:

$$CB_{it} = \alpha + \beta \; Callups_{it} + \gamma \; CB_{it-1} + \kappa X_{it} + \rho_i + \delta_t + \varepsilon_{it}, \tag{2}$$

where CB_{it-1} is the competitive balance measure in the $t-1$ season.[13]

[13]In Section 4.2, we discuss a robustness check that alleviates the concern for potential dynamic panel

Similar to the endogenous organizational form variables in a typical empirical model of firm performance (see Forbes and Lederman (2010) and Gibbons (2005) for related discussions), MiLB player call-ups, our proxy for the degree of vertical integration in Equations 1 and 2, could suffer from an endogeneity issue if they are made to optimize the performance of the involved players and minor league teams and can thus be endogenous. In our context, the endogeneity issue is likely mitigated because, as discussed in Section 2.3, the call-up decisions are aimed to further foster player development and/or fulfill immediate roster needs in the MLB parent teams. Nevertheless, one might still be concerned about unobserved factors that could affect both the MiLB team's performance and its decision to supply a top-performing player to the affiliated MLB team. To alleviate such concerns, we use an instrumental variable approach that instruments for the number of MiLB call-ups using MLB parent teams' injury counts, which are proxied by the total number of placed on and activated from each team's disabled list.

Specifically, for each MiLB team in a given season, we count the number of players who were placed on or activated from the affiliated major league team's disabled list during the same season.[14] We then leverage the team-level disabled list transactions as a proxy for the number of injuries experienced by the affiliated MLB team and aggregate them to the league-season level. The resulting variables are our instruments for the total number of call-ups for minor league i in season t.

Conceptually, MLB teams' injury counts (the total number of placements and activations from the disabled list) are likely correlated with their call-ups from MiLB affiliates since one of the main reasons for call-ups is to meet roster needs due to unexpected injuries to MLB players. Our instrument is plausibly exogenous because MLB players' injuries are unlikely to be correlated with unobservable factors affecting competitive balance in the minor leagues,

bias.

[14]Data on each MLB team's disabled list moves come from the Pro Sports Transactions Archive and are available only for 1964 and the period 1970 to 2019. Also note that the data come from only April through August each season to avoid September callups.

other than through the channel of call-ups.[15]

4 Results and Discussion

4.1 Baseline Findings

Table 2 reports our baseline estimates of Equations 1 and 2 based on the full sample of AAA and AA leagues. All specifications capture league and season fixed effects and control for talent distribution including concentration of runs scored and runs allowed measured in dHHI terms. In Column (1), we observe that the total number of call-ups that the minor leagues contribute in a given season is negatively correlated with the deviation of HHI to its idealized parity value. Specifically, the estimate indicates that each MiLB call-up is expected to be associated with a 0.18 percentage point decrease in the dHHI measure. This in turn suggests that the degree of human capital integration as measured by call-up counts is *positively* correlated with the level of competitive balance in the MiLB. We observe similar results in Column (2) after controlling for the lagged term of dHHI. On the other hand, when the competitive balance is measured by the Noll-Scully ratio, while the estimates continue to point to a positive competitive balance impact of call-ups, they are not statistically significant at conventional levels.

Next, we explore potential heterogeneity between the AAA and AA leagues. Table 3 reports the results by league tier. Here, we observe a clear contrast between the AAA and AA leagues in terms of the impact of call-up counts on competitive balance. In particular, for the AAA leagues, the number of call-ups does not seem to be correlated with either competitive balance measure. In contrast, for the AA leagues, call-up counts consistently exhibit negative and statistically significant correlation with either the dHHI measure or the Noll-Scully ratio, implying a *positive* relationship between call-up counts and competitive

[15]Note that it is rare for a minor league call-up to be promoted to the major league but subsequently placed on the disabled list and sent back to the minor leagues.

balance in the league. For instance, when using dHHI as the dependent variable, we observe that each call-up in an AA league in a given season generates, on average, a 1.6 percentage point reduction in dHHI. These results further suggest that the pro-competitive impact of call-ups as observed in Table 2 is likely driven by outcomes in AA leagues, not AAA leagues.

4.2 Robustness Checks

We next assess the robustness of our baseline findings. Firstly, as an effort to alleviate concerns about endogenous call-ups, we utilize the total number of placements and activations from the MLB disabled list to instrument for MiLB call-up counts. Table 4 shows the corresponding 2SLS estimates for our baseline specifications separated by league classes where the hat symbol identifies the instrumented endogenous second stage variable. We report the first stage estimates in Table A1 in the Appendix and find the parameter estimates to be statistically significant and take the expected signs. The first stage Cragg-Donald Wald F-statistics are within 10% of the maximal relative bias according to the Stock-Yogo weak instrument test. The instruments also pass the overidentifying restrictions test with p-values over 20%.

Overall, the 2SLS estimates here confirm our baseline findings presented in Table 3 and continue to document a negative correlation between call-up counts and competitive balance measures for the AA leagues, but not for the AAA leagues. It is worth noting that the magnitudes of the 2SLS estimates are also considerably larger than their counterparts in Table 3. For instance, the estimate in Column (1) indicates that each call-up in the AA leagues is associated with a 3.2 percentage point reduction in dHHI (as opposed to 1.6 percentage point in Table 3).

Next, by controlling for past lags of competitive balance measures, which are our dependent variables of interest, Equation 2 presents a dynamic panel specification. Nickell (1981) shows that when introducing lagged dependent variables as independent variables, the demeaning process in fixed effect estimation can potentially lead to biases as the demeaned error may still be correlated with the regressors. A practical solution in the literature is to employ dynamic panel techniques such as the Arellano-Bond (AB) GMM estimator (Arellano and Bond, 1991). We thus re-estimate our dynamic panel specifications using the Arellano-Bond (AB) estimator, and we find the results, as reported in Table A2 in the Appendix, analogous to our baseline estimates in Table 3.

We also re-estimate our baseline model specifications using alternative competitive balance measures such as the HHI (Humphreys 2002; Zimbalist 2002) and standard deviation of winning percentage (Fort 2006; Owen et al. 2007). Compared to the dHHI measure and the Noll-Scully ratio, these alternative measures do not account for the idealized league parity. Nevertheless, as shown in Table A3 in the Appendix, our main findings, particularly those pertaining to the AA leagues, remain qualitatively similar.

In addition, our call-up measure is based on the total number of call-ups that MiLB league i contributes to MLB in season t. As a robustness check, we employ the total organization level call-ups that MiLB league i experiences in season t as an alternative call-up measure. As described in Section 3.2, organization level call-ups account for the total number of call-ups made by a major league team from all of its AAA and AA affiliates in a given season. Table 5 reports the estimates based on this alternative call-up measure, and we observe similar overall patterns on the impact of call-ups compared to those reported in Table 3. Also note that while we continue to observe a negative correlation between the organization level call-ups and competitive balance measures for the AA leagues, the magnitudes of the impact are consistently smaller compared to those reported in Table 3.

Finally, we also assess the robustness of our findings with respect to the positions being called up. Specifically, we replace the total call-up counts from a specific MiLB league in a given season with the numbers of pitchers and hitters being called up (by MLB) and re-estimate Equations 1 and 2 by league tier. Table A5 in the Appendix presents the corresponding estimates. Overall, with the exception of hitter call-ups in the AAA leagues that seem to be correlated with a lower degree of competitive balance, we do not find consistent evidence supporting a heterogeneous competitive effect by call-up positions.[16]

4.3 Mechanisms

Overall, our findings reveal a positive impact of call-ups on competitive balance in the minor leagues, with the effect being mainly driven by AA leagues rather than the AAA leagues. As discussed in Section 2.3, when MiLB teams contribute players to the majors, they may also gain demoted MLB players as well as MLB players on injury rehab assignment. The overall competitive balance impact of call-ups depends on the relative strength of the impact of call-ups and demotions on team quality. One possible explanation for our findings is that AA leagues are less competitive and losing call-up players may in fact make AA leagues more competitive. The results from Table 5 based on the organization level call-up measure appear to corroborate this channel – compared to call-ups from AA to AAA (in order to replace a player called up from the AAA team to MLB), MLB call-ups are likely of higher quality and thus correspond to a larger magnitude of impact on competitive balance in the AA leagues.

To further assess the mechanisms at play, we also account for the direction of the callups and separately estimate our main model specifications based on player promotions versus demotions.[17] The estimates on Table 6 further confirm the pro-competitive impact of call-ups on AA leagues when call-ups reflect the number of MiLB players promoted to MLB.

On the other hand, as reported in Table A4 in the Appendix, when call-ups are measured based on the number of MLB players being demoted to MiLB leagues (including those on rehab assignment), we find the pro-competitive impact to be only marginally significant in select specifications. Taken together, we find suggestive evidence that part of the observed

[16]We also re-estimate our main model specifications controlling for MLB parent team's performance and payroll as well as the number of games that MiLB call-ups spent in the major and minor leagues and their performance in the respective leagues. The resulting estimates are reported in Tables A6 and A7 in the Appendix, respectively, and our main findings regarding the competitive balance impact of call-ups continue to hold.

[17]Again, data on the direction of call-ups (promotion/demotion) and rehab assignments come from the Pro Sports Transactions Archive for the 1964 and 1970 to 2019 seasons only. Also note that the data represent roster moves from April through August each year to avoid September call-ups.

pro-competitive impact of call-ups in the AA leagues is likely linked to MiLB players being promoted to MLB, rather than MLB players being demoted or placed on rehab assignment, in turn lending further support toward the aforementioned potential explanation.

An important caveat in interpreting the results from Tables 6 and A4 is that player promotions and demotions can often be one-to-one, making identification of their impact difficult at the league level. In another effort to shed light on the mechanisms, we circumvent this data limitation by re-estimating our main specifications by accounting for the distribution of call-ups, proxied by the standard deviation of the number of call-ups per team within each minor league in a given season.

Table 7 contains results from this model specification. Here, we observe that while the distribution of the call-ups does not seem to play a role in the AAA leagues, they are positively correlated with dHHI, or negatively correlated with the minor league's competitive balance, in the AA leagues. In other words, these results suggest that competitive balance is likely to suffer (improve) when call-ups are spread across (concentrated within) teams in the league, which provide additional support toward the explanation that the positive competitive balance effect is likely driven by top players in the minor leagues being called up by their MLB parent teams.[18]

5 Conclusions

This paper investigates the relationship between changes in vertical integration of human capital flows in professional sports leagues, in the form of call-ups of minor league players by major league teams, and the level of competitive balance in the contributing minor leagues. Our findings point to a positive impact of call-ups on competitive balance in the minor leagues, with the effect being mainly driven by outcomes in AA leagues rather than AAA leagues. We also find suggestive evidence that the effect likely being explained by the

[18]Note that if demoted MLB players are less productive than promoted MiLB players, our analysis here does not allow us to rule out an alternative explanation that the positive competitive balance impact is driven by demoted MLB players.

promotion of MiLB players to MLB, rather than the demotion of MLB players to MiLB.

Our findings suggest that, beyond providing a farm system that help develop future talent, the vertical integration between feeder leagues and the major league may have spillover impact on the level of competitive balance in the feeder leagues themselves. Agha (2013) finds a positive impact of minor league baseball teams and stadiums on per capita income in the local communities. Our results imply that these communities may further benefit from a higher level of integration between the major and minor leagues by more competitive games and, potentially more gate revenues. These insights can be especially relevant given the financial crisis facing minor leagues across different sports and around the world.

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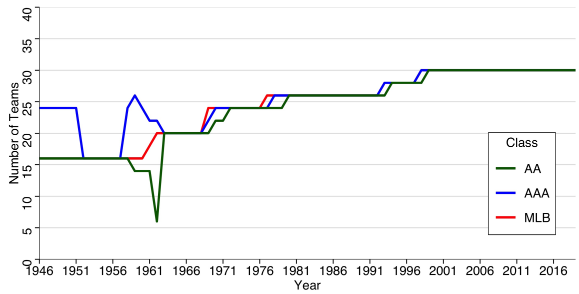
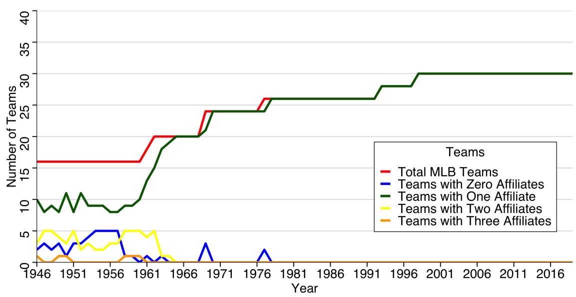
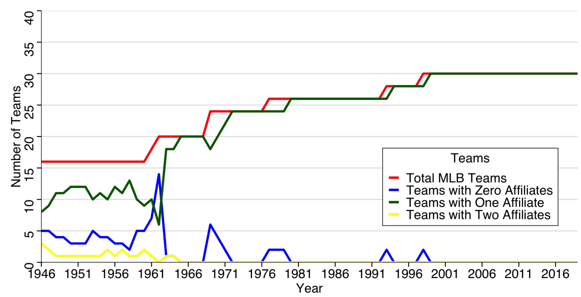
Figure 1: Evolution of MLB and MiLB Affiliates



(a) Number of MLB and MiLB Teams

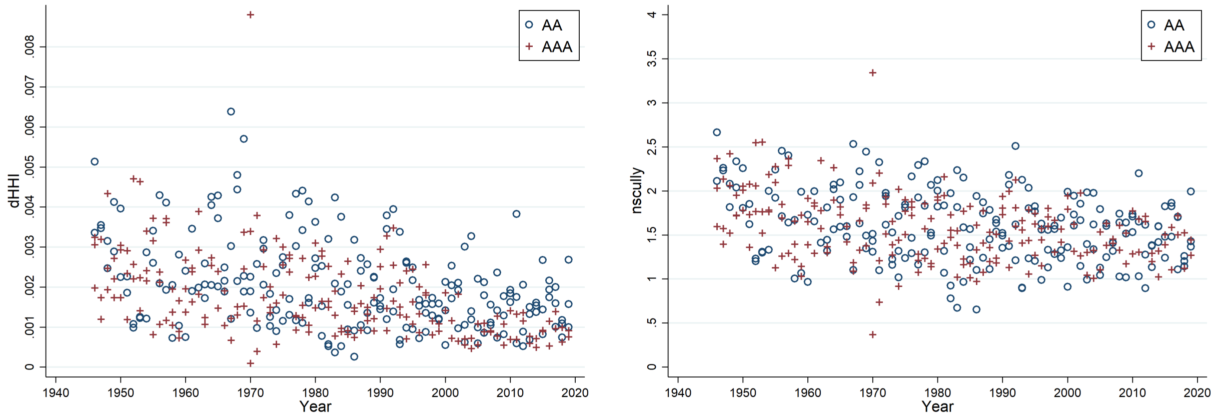


(b) Number of AAA Affiliates



(c) Number of AA Affiliates

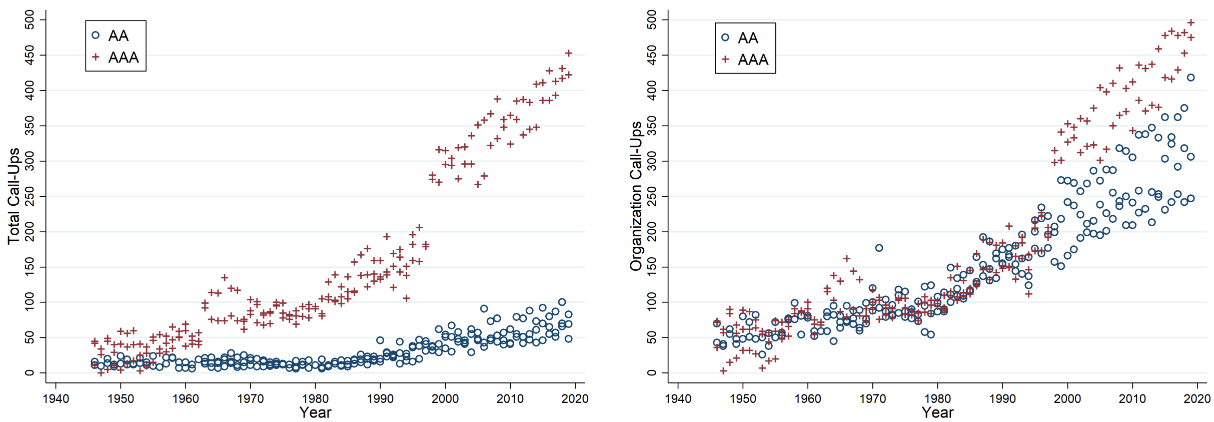
Figure 2: Competitive Balance of Minor Leagues Over Time



(a) dHHI Measure (b) Noll-Scully Ratio

Note: Each observation is at the individual AAA or AA league level.

Figure 3: Total Call-Ups vs. Organization Level Call-Ups Over Time



(a) Total Call-Ups (b) Organization Level Call-Ups

Note: Each observation is at the individual AAA or AA league level.

Table 1: Summary Statistics

	(1) Mean	(2) Median	(3) Std. Dev.	(4) Min	(5) Max
AAA Leagues ($N = 194$)					
Number of Games	1454	1232	409	840	2302
Number of Teams	9.9	8	2.9	6	16
Std. Dev. of Winning Percentage	0.065	0.065	0.015	0.016	0.138
Noll-Scully Ratio	1.583	1.571	0.380	0.369	3.341
HHI	0.110	0.126	0.026	0.063	0.170
dHHI	0.002	0.001	0.001	0.000	0.009
Total Call-Ups	148	102	119	0	453
Organization Level Call-Ups	169	110	129	3	496
AA Leagues ($N = 203$)					
Number of Games	1230	1120	235	826	1974
Number of Teams	8.7	8	1.6	6	14
Std. Dev. of Winning Percentage	0.067	0.067	0.017	0.027	0.107
Noll-Scully Ratio	1.596	1.597	0.402	0.653	2.665
HHI	0.121	0.127	0.023	0.074	0.173
dHHI	0.002	0.002	0.001	0.000	0.006
Total Call-Ups	29	20	22	6	100
Organization Level Call-Ups	155	134	87	26	418

Note: Each observation is at the league-season level. The sample period is from 1946 to 2019.

Table 2: Impact of Call-Ups: Full Sample

	(1) Log(dHHI)	(2) Log(dHHI)	(3) Noll-Scully	(4) Noll-Scully
Total Call-Ups	-0.0018***	-0.0016***	-0.0003	-0.0003
	(0.0004)	(0.0004)	(0.0003)	(0.0003)
Lagged Log(dHHI)		0.1130*		
		(0.0615)		
Lagged Noll-Scully				0.0676
				(0.0581)
Observations	379	376	379	373
R-squared	0.451	0.457	0.393	0.387
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

Note: The dependent variables are log HHI and standard deviation of winning percentage that account for the idealized league parity. Controls for talent distribution include concentration of runs scored and runs allowed measured in dHHI terms. Robust standard errors are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Impact of Call-Ups: AAA vs. AA

AAA Leagues	(1) Log(dHHI)	(2) Log(dHHI)	(3) Noll-Scully	(4) Noll-Scully
Total Call-Ups	0.0008	0.0012	0.0017	0.0020
	(0.0022)	(0.0022)	(0.0016)	(0.0016)
Lagged Log(dHHI)		0.0837		
		(0.1060)		
Lagged Noll-Scully				0.1110
				(0.1020)
Observations	183	181	183	180
R-squared	0.613	0.615	0.558	0.567
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

AA Leagues	(5) Log(dHHI)	(6) Log(dHHI)	(7) Noll-Scully	(8) Noll-Scully
Total Call-Ups	-0.0159***	-0.0147***	-0.0058**	-0.0057*
	(0.0040)	(0.0042)	(0.0028)	(0.0029)
Lagged Log(dHHI)		0.0948		
		(0.1020)		
Lagged Noll-Scully				0.0285
				(0.0959)
Observations	196	195	196	193
R-squared	0.531	0.534	0.513	0.503
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

Note: The dependent variables are log HHI and standard deviation of winning percentage that account for the idealized league parity. Controls for talent distribution include concentration of runs scored and runs allowed measured in dHHI terms. Robust standard errors are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Robustness Check: 2SLS Estimates

AAA Leagues	(1) Log(dHHI)	(2) Log(dHHI)	(3) Noll-Scully	(4) Noll-Scully
$\widehat{\text{Total Call-Ups}}$	-0.0004	-0.0006	-0.0005	-0.0007
	(0.0050)	(0.0049)	(0.0035)	(0.0034)
Lagged Log(dHHI)		0.0744		
		(0.0664)		
Lagged Noll-Scully				0.0690
				(0.0690)
Observations	127	127	127	127
R-squared	0.656	0.660	0.513	0.517
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

AA Leagues	(5) Log(dHHI)	(6) Log(dHHI)	(7) Noll-Scully	(8) Noll-Scully
$\widehat{\text{Total Call-Ups}}$	-0.0322***	-0.0316***	-0.0151***	-0.0155***
	(0.0074)	(0.0079)	(0.0051)	(0.0053)
Lagged Log(dHHI)		0.0213		
		(0.0869)		
Lagged Noll-Scully				-0.0146
				(0.0839)
Observations	148	147	148	145
R-squared	0.371	0.372	0.349	0.321
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

Note: The dependent variables are log HHI and standard deviation of winning percentage that account for the idealized league parity. Controls for talent distribution include concentration of runs scored and runs allowed measured in dHHI terms. The hat symbol denotes the use of instrumental variables, which are based on the total number of placements and activations from the MLB disabled list. Robust standard errors are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Robustness Check: Organization Level Call-Ups

AAA Leagues	(1) Log(dHHI)	(2) Log(dHHI)	(3) Noll-Scully	(4) Noll-Scully
Total Organization Level Call-Ups	0.0015	0.0019	0.0017	0.0021
	(0.0017)	(0.0017)	(0.0014)	(0.0014)
Lagged Log(dHHI)		0.0088		
		(0.1170)		
Lagged Noll-Scully				0.0151
				(0.1070)
Observations	183	181	183	180
R-squared	0.613	0.615	0.558	0.567
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

AA Leagues	(5) Log(dHHI)	(6) Log(dHHI)	(7) Noll-Scully	(8) Noll-Scully
Total Organization Level Call-Ups	-0.0059***	-0.0055***	-0.0022**	-0.0021**
	(0.0014)	(0.0014)	(0.0010)	(0.0010)
Lagged Log(dHHI)		0.0695		
		(0.0993)		
Lagged Noll-Scully				0.0191
				(0.0951)
Observations	196	195	196	193
R-squared	0.544	0.546	0.517	0.506
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

Note: The dependent variables are log HHI and standard deviation of winning percentage that account for the idealized league parity. Controls for talent distribution include concentration of runs scored and runs allowed measured in dHHI terms. Robust standard errors are in parenthesis. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 6: Robustness Check: Direction of Call-Ups – Promotions

AAA Leagues	(1) Log(dHHI)	(2) Log(dHHI)	(3) Noll-Scully	(4) Noll-Scully
Total Promotions	0.0010	0.0010	0.0008	0.0008
	(0.0033)	(0.0033)	(0.0021)	(0.0021)
Lagged Log(dHHI)		0.0722		
		(0.1220)		
Lagged Noll-Scully				0.1010
				(0.1250)
Observations	130	130	130	130
R-squared	0.560	0.562	0.493	0.499
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

AA Leagues	(5) Log(dHHI)	(6) Log(dHHI)	(7) Noll-Scully	(8) Noll-Scully
Total Promotions	-0.0234***	-0.0225***	-0.0104***	-0.0106***
	(0.0048)	(0.0053)	(0.0034)	(0.0036)
Lagged Log(dHHI)		0.0424		
		(0.1150)		
Lagged Noll-Scully				-0.0297
				(0.1110)
Observations	151	150	151	148
R-squared	0.451	0.450	0.404	0.381
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

Note: The dependent variables are log HHI and standard deviation of winning percentage that account for the idealized league parity. Controls for talent distribution include concentration of runs scored and runs allowed measured in dHHI terms. Robust standard errors are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Distribution of Call-Ups

AAA Leagues	(1) Log(dHHI)	(2) Log(dHHI)	(3) Noll-Scully	(4) Noll-Scully
Total Call-Ups	0.0002	0.0006	0.0014	0.0018
	(0.0022)	(0.0022)	(0.0016)	(0.0016)
Call-Up Std. Dev	0.0507	0.0469	0.0225	0.0169
	(0.0458)	(0.0467)	(0.0330)	(0.0329)
Lagged Log(dHHI)		0.0703		
		(0.1110)		
Lagged Noll-Scully				0.1040
				(0.1050)
Observations	183	181	183	180
R-squared	0.617	0.618	0.560	0.567
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes
AA Leagues	**(5) Log(dHHI)**	**(6) Log(dHHI)**	**(7) Noll-Scully**	**(8) Noll-Scully**
Total Call-Ups	-0.0184***	-0.0175***	-0.0070**	-0.0069**
	(0.0038)	(0.0040)	(0.0028)	(0.0029)
Call-Up Std. Dev	0.1350**	0.1250**	0.0635	0.0617
	(0.0630)	(0.0607)	(0.0469)	(0.0467)
Lagged Log(dHHI)		0.0579		
		(0.1010)		
Lagged Noll-Scully				0.0110
				(0.0961)
Observations	196	195	196	193
R-squared	0.548	0.549	0.521	0.510
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

Note: The dependent variables are log HHI and standard deviation of winning percentage that account for the idealized league parity. Controls for talent distribution include concentration of runs scored and runs allowed measured in dHHI terms. Robust standard errors are in parenthesis. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Appendix: Additional Tables

Table A1: Robustness Check: 2SLS Estimates – First Stage

AAA Leagues	(1) Total Call-Ups	(2) Total Call-Ups	(3) Total Call-Ups
Placements	0.5580***	0.5640***	0.5650***
	(0.1390)	(0.1380)	(0.1390)
Activations	-0.4770**	-0.4900**	-0.4940**
	(0.2340)	(0.2330)	(0.2350)
Lagged Log(HHI)		-4.1170	
		(2.9780)	
Lagged SD			-4.7180
			(4.5420)
Observations	127	127	127
R-squared	0.992	0.992	0.992
League FE	Yes	Yes	Yes
Season FE	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes

AAA Leagues	(4) Total Call-Ups	(5) Total Call-Ups	(6) Total Call-Ups
Placements	0.2220***	0.2180**	0.2210**
	(0.0830)	(0.0837)	(0.0840)
Activations	0.1210	0.1170	0.1210
	(0.1400)	(0.1400)	(0.1410)
Lagged Log(HHI)		-0.8960	
		(1.6230)	
Lagged SD			0.7570
			(2.3530)
Observations	148	147	145
R-squared	0.916	0.916	0.917
League FE	Yes	Yes	Yes
Season FE	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes

Note: This table reports the first stage estimates for Table 4. The dependent variable is the total number of call-ups. Controls for talent distribution include concentration of runs scored and runs allowed measured in dHHI terms. Robust standard errors are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Table A2: Robustness Check: Arellano-Bond Estimator

AAA Leagues	(1) Log(dHHI)	(2) Noll-Scully
Total Call-Ups	-0.0015	-0.0005
	(0.0024)	(0.0017)
Lagged Log(dHHI)	0.0503	
	(0.0845)	
Lagged Noll-Scully		0.0896
		(0.0662)
Observations	173	173
League FE	Yes	Yes
Season FE	Yes	Yes
Talent Distribution	Yes	Yes

AA Leagues	(3) Log(dHHI)	(4) Noll-Scully
Total Call-Ups	-0.0120***	-0.0042**
	(0.0028)	(0.0018)
Lagged Log(dHHI)	0.0362	
	(0.0557)	
Lagged Noll-Scully		-0.0199
		(0.0456)
Observations	182	182
League FE	Yes	Yes
Season FE	Yes	Yes
Talent Distribution	Yes	Yes

Note: The dependent variables are log HHI and standard deviation of winning percentage that account for the idealized league parity. All specifications are estimated using the Arellano-Bond GMM estimator to correct for potential dynamic panel bias. Controls for talent distribution include concentration of runs scored and runs allowed measured in dHHI terms. Robust standard errors are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Table A3: Robustness Check: Alternative Competitive Balance Measures

AAA Leagues	(1) Log(HHI)	(2) Log(HHI)	(3) SD	(4) SD
Total Call-Ups	-0.0026***	-0.0013***	0.0001	0.0001
	(0.0004)	(0.0004)	(0.0001)	(0.0001)
Lagged Log(HHI)		0.5710***		
		(0.1250)		
Lagged SD				0.1190
				(0.1020)
Observations	183	181	183	180
R-squared	0.960	0.976	0.535	0.546
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

AA Leagues	(5) Log(HHI)	(6) Log(HHI)	(7) SD	(8) SD
Total Call-Ups	-0.0086***	-0.0028***	-0.0003**	-0.0003**
	(0.0010)	(0.0010)	(0.0001)	(0.0001)
Lagged Log(HHI)		0.7300***		
		(0.0856)		
Lagged SD				0.0251
				(0.0950)
Observations	196	195	196	193
R-squared	0.819	0.916	0.501	0.492
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

Note: The dependent variables are log HHI and standard deviation of winning percentage without accounting for the idealized league parity. Controls for talent distribution include concentration of runs scored and runs allowed measured in dHHI terms. Robust standard errors are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Table A4: Robustness Check: Direction of Call-Ups – Demotions and Rehab Assignments

AAA Leagues	(1) Log(dHHI)	(2) Log(dHHI)	(3) Noll-Scully	(4) Noll-Scully
Total Demotions	-0.0040	-0.0035	-0.0025	-0.0022
	(0.0036)	(0.0036)	(0.0026)	(0.0026)
Total Rehab	0.0045	0.0040	0.0024	0.0022
	(0.0055)	(0.0056)	(0.0039)	(0.0040)
Lagged Log(dHHI)		0.0661		
		(0.1240)		
Lagged Noll-Scully				0.0632
				(0.1230)
Observations	127	127	127	127
R-squared	0.659	0.662	0.514	0.518
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

AA Leagues	(5) Log(dHHI)	(6) Log(dHHI)	(7) Noll-Scully	(8) Noll-Scully
Total Demotions	-0.0215*	-0.0203*	-0.0117	-0.0117
	(0.0110)	(0.0110)	(0.0077)	(0.0078)
Total Rehab	-0.0030	-0.0032	0.0020	0.0017
	(0.0148)	(0.0147)	(0.0101)	(0.0103)
Lagged Log(dHHI)		0.0544		
		(0.1190)		
Lagged Noll-Scully				-0.0217
				(0.1170)
Observations	148	147	148	145
R-squared	0.440	0.439	0.400	0.377
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

Note: The dependent variables are log HHI and standard deviation of winning percentage that account for the idealized league parity. Controls for talent distribution include concentration of runs scored and runs allowed measured in dHHI terms. Robust standard errors are in parenthesis. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A5: Robustness Check: Pitcher and Hitter Call-Ups

AAA Leagues	(1) Log(dHHI)	(2) Log(dHHI)	(3) Noll-Scully	(4) Noll-Scully
Hitter Call-Ups	0.0082*	0.0082*	0.0066**	0.0066**
	(0.0042)	(0.0042)	(0.0029)	(0.0029)
Pitcher Call-Ups	-0.0086	-0.0079	-0.0045	-0.0039
	(0.0055)	(0.0055)	(0.0038)	(0.0038)
Lagged Log(dHHI)		0.0742		
		(0.1020)		
Lagged Noll-Scully				0.1050
				(0.0988)
Observations	183	181	183	180
R-squared	0.627	0.628	0.573	0.580
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

AA Leagues	(5) Log(dHHI)	(6) Log(dHHI)	(7) Noll-Scully	(8) Noll-Scully
Hitter Call-Ups	-0.0146*	-0.0130*	-0.0032	-0.0031
	(0.0077)	(0.0078)	(0.0054)	(0.0057)
Pitcher Call-Ups	-0.0173*	-0.0165*	-0.0087	-0.0087
	(0.0091)	(0.0093)	(0.0063)	(0.0064)
Lagged Log(dHHI)		0.0955		
		(0.1020)		
Lagged Noll-Scully				0.0303
				(0.0963)
Observations	196	195	196	193
R-squared	0.531	0.534	0.514	0.504
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

Note: The dependent variables are log HHI and standard deviation of winning percentage that account for the idealized league parity. Controls for talent distribution include concentration of runs scored and runs allowed measured in dHHI terms. Robust standard errors are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Table A6: Robustness Check: Controlling for MLB Parent Team's Performance and Payroll

AAA Leagues	(1) Log(dHHI)	(2) Noll-Scully	(3) Log(dHHI)	(4) Noll-Scully
Total Call-Ups	0.0008	0.0017	-0.0046	-0.0028
	(0.0024)	(0.0017)	(0.0027)	(0.0019)
Observations	183	183	74	74
R-squared	0.613	0.558	0.792	0.642
MLB Parent Performance	Yes	Yes	No	No
MLB Parent Payroll	No	No	Yes	Yes
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

AA Leagues	(5) Log(dHHI)	(6) Noll-Scully	(7) Log(dHHI)	(8) Noll-Scully
Total Call-Ups	-0.0159***	-0.0058**	-0.0099*	-0.0040
	(0.0040)	(0.0028)	(0.0054)	(0.0039)
Observations	196	196	96	96
R-squared	0.531	0.514	0.379	0.326
MLB Parent Performance	Yes	Yes	No	No
MLB Parent Payroll	No	No	Yes	Yes
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

Note: The dependent variables are log HHI and standard deviation of winning percentage that account for the idealized league parity. Controls for talent distribution include concentration of runs scored and runs allowed measured in dHHI terms. Measures for the MLB parent team's performance and payroll are based on its average winning percentage and average payoll in a given season, respectively. Robust standard errors are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Table A7: Robustness Check: Controlling for Call-Ups' Time and Performance in MLB and MiLB

AAA Leagues	(1) Log(dHHI)	(2) Log(dHHI)	(3) Noll-Scully	(4) Noll-Scully
Total Call-Ups	-0.0004	-0.0004	0.0009	0.0011
	(0.0026)	(0.0027)	(0.0019)	(0.0019)
Lagged Log(dHHI)		0.0670		
		(0.1370)		
Lagged Noll-Scully				0.0679
				(0.1210)
Observations	176	174	176	173
R-squared	0.634	0.632	0.605	0.601
MLB Time/Performance	Yes	Yes	Yes	Yes
MiLB Time/Performance	Yes	Yes	Yes	Yes
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

AA Leagues	(5) Log(dHHI)	(6) Log(dHHI)	(7) Noll-Scully	(8) Noll-Scully
Total Call-Ups	-0.0164***	-0.0155***	-0.0062**	-0.0067**
	(0.0042)	(0.0046)	(0.0030)	(0.0031)
Lagged Log(dHHI)		0.0599		
		(0.0994)		
Lagged Noll-Scully				-0.0230
				(0.0979)
Observations	195	194	195	192
R-squared	0.562	0.563	0.540	0.536
MLB Time/Performance	Yes	Yes	Yes	Yes
MiLB Time/Performance	Yes	Yes	Yes	Yes
League FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Talent Distribution	Yes	Yes	Yes	Yes

Note: The dependent variables are log HHI and standard deviation of winning percentage that account for the idealized league parity. Controls for talent distribution include concentration of runs scored and runs allowed measured in dHHI terms. Measures for call-ups' performance in MLB (MiLB) include the average major (minor) league on-base plus slagg (OPS) and earned run average (ERA) for batters and pitchers being called up by MLB in a given season, respectively. Measures for call-ups' time spent in MLB (MiLB) include the average number of major (minor) league innings at bats and innings pitched for batters and pitchers being called up by MLB in a given season, respectively. Robust standard errors are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.