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Post-contract Performance Evaluation: Analysis of Factors Related to Free Agency in the Korean Professional Baseball

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Abstract

This study examines factors affecting player performance after signing a new multi-year free agent contract in the Korean professional baseball. Various baseball performance measures are analyzed for players who signed a contract from 2013 to 2018. The signed contract length does not affect player performance. A player signing a second contract is productive enough. Players who move between teams as free agents perform better. The player's age is the most significant determinant of performance. Player performance in following years after a new contract is positively associated with a substantial signing bonus.

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Ⅰ. Introduction

Successes and failures in recruiting and retaining free agents determine the team's competitiveness in professional sports leagues. The team's standings in the league are possibly altered by free agents' performance, and thus teams need to determine whether the aggressive investment for securing the best available free agents is

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worth investing in. Eligibility for free agency in the Korea Baseball Organization (KBO) is based on service time. Players qualify for free agency once they have accumulated nine years in KBO. Players who qualify for eligibility are able to declare free agency and negotiate all teams including their current team. Given that the free agency eligibility period does not include compulsory military service, most players become eligible by the time only later at age 30s.

The winner-takes-all aspect of free agent market focuses on the free agency success story of either a few superstar players or veteran free agents. The KBO released a list of 19 players that filed for free agency for 2020 season. Of these, nine were requalified players. Article 164 of the KBO Rules is applied to the requalification of free agency. A player becomes free agent again upon reaching four seasons after exercising his first free agency.

Free-agency is reserved for late-career players, who have accumulated 9 years of KBO service. These free-agent contracts are entrusted with long-term contracts at higher salaries than non-free-agents. However, since these players are late in their careers, this may be the last contract they sign. Consequently, they may exert lower effort once they have signed their free-agent contract, a phenomenon known in the economics literature as shirking.

Krautmann and Donley (2009) define that shirking is inferred if the player's actual performance falls below expected performance in the year following a newly signed long-term contract. The discussion on shirking in professional athletes is traced back to agency theory in economics. Sappington (1991) presents the incentive problems that arise in principal-agent relationships, describing the design on monitoring and compensating incentives. Prendergast (1999) provides an overview on the provisions of incentives, addressing the trade-off of risk and incentive regarding compensating mechanism when pay is related to performance.

In this study, we assess the post-contract performance of free agent players in the KBO and address the impacts of player and contract characteristics on performance. The primary objective of this study is to investigate the determinants of player performance after signing a multi-year free agent contract. We further examine the relationship between player performance and the duration of the contract. The data period of this study covers the period from 2013 to 2018. The 2013 was the first season when the eight-team system that lasted for 22 years ended.

The remainder of this study is organized as follows. A literature review is presented in Section 2. Section 3 outlines the empirical model specification of free agent player performance. In Section 4, data descriptions and estimation results are presented. Section 5 concludes the study.

Ⅱ. Literature Review

Early work on performance of free agents is the direct before-after comparison, examining differences in the levels of performance (Krautmann, 1990; Ahlstrom et al. 1999). Ahlstrom et al. (1999) compared performance statistics for the Major League Baseball (MLB) free agent non-pitchers the year before and after a new free agent contract signed. Five different batting performance measures such as batting average, slugging average (SA), home run, runs batted in, and at-bats, for free agents who changed teams after free agency were reviewed and some of them declined compared in the year before free agency filing. Krautmann (1990) compared the SA in the period preceding and following after signing a new long-term contract for the MLB non-pitchers. He introduced a view to deal with variability in professional baseball player performance in consideration of the

stochastic nature of productivity. The hypothesis that player productivity is affected by job security of more than 5 years in remaining years on contracts was tested.

Recent empirical literature has focused on identifying the causal impact of job security on the player performance. Maxcy (2004) presented a model of long-term contracts as means of risk management in the labor markets of professional sports. Long-term contracts were observed for the MLB star players, and uncertainty about player's future productivity was inversely related to long-term contracts. Krautmann and Donley (2009) importantly built on Krautmann (1990), explicitly measuring shirking as the deviations between expected performance and realized performance. The empirical findings for the MLB free agent hitters suggested that the length of contracts have no impact on shirking measured by player's on-base plus slugging (OPS). Shirking, however, was observed when measured with player's marginal revenue product rather player's offensive ability. Krautmann and Solow (2009) investigated the relationship between shirking and the long-term contracts for the MLB free agent hitters. They tested whether shirking occurs across the entire contract, especially in walk year. Greater shirking behavior as measured by the adjusted on-base plus slugging was found in the players with less probability of signing a new contract. O'Neill (2013) examined player performances in the last year of his current guaranteed contracts. The estimation results for the MLB free agent hitters suggested that players increase their offensive performance measured by OPS.

Previous studies have demonstrated that the contract duration is associated with compensation. Krautmann and Oppenheimer (2002) first specified compensating effect in salary equation, which had not been identified in the literature. They found a negative relationship between the duration of contract and returns to player performance

for the MLB free agent hitters. A long term contract reduced the monetary return to player productivity. Link and Yosifov (2012) presented an empirical investigation of salary determinants, examining trade-offs between monetary return to performance and additional year of contract duration for the MLB free agent hitters. They found an evidence of a negative relationship between contract length and salary when productivity is measured using SA over the 3 years prior to the signing contract, and this findings extended of previous studies of job security on free agent contracts (Krautmann and Oppenheimer, 2002).

Few studies compared the performances of free-agent players with those of players under the reserve clause. Marburger (2003) showed that players with either one year or two years free agent contracts outperformed than comparable reserve-era players with similar productivity to them. The net shirking impacts were not observed for the players with long term free agent contracts. Paulsen (2021) empirically showed that years remaining on contract substantially affect player performance for the MLB data. Performance measured by win above replacement (WAR) fell off for position players. A Short term contract led to improvement in performance than in the final year of a long term contract. Paulsen (2022) investigated shirking between games for all MLB hitters in games. An inverse relationship between the number of years remaining on contracts and performance measured using the weighted on-base average (wOBA) was found. Stronger productivity loss was estimated for players with greater job security guaranteed.

Recently, the selection of measures of player performance has received attention. Krautmann (2017) examined a relationship between the free agent contract duration and variability of player performance. Empirical findings from the MLB free agent hitters between suggested that a free agent's contract length is negatively related to the variability in a player's OPS across the 5 years prior to the new

contract. Player's performances were measured using WAR over 2 years prior to signing contract in Krautmann (2018).

The analysis of the non-linear relationship between the KBO player's age and ability has been illustrated and discussed in recent years. More specifically, the ages of peak performance for batting metrics are analyzed. Kang et al. (2019) investigate the performance of the KBO batters, and find evidence to support an inverted U-shaped relationship between age and performance. The peak ages for batters using the OPS/WAR measures are younger in the free agent group than in the total group. Oh and Han (2023) examine age-related performance among the KBO baseball players and also find the presence of an inverted U-shaped pattern in age. The findings show that significant group differences in peak age for batting average are evident among slugger and contact hitters. Sluggers peak near age 30.7, while contact hitters peak near age 34.

In this study, we extend prior research on shirking literature in professional athletes by examining player heterogeneity and contract information. We analyze free-agent players who either signed with a new team or who remained with the same team. In contrast, the scope of Ahlstrom et al. (1999) is limited to free-agent players who changed teams after free agency and the subject of Paulsen (2021) covers all new contracts signed regardless of free agency. This is the first study demonstrating whether veteran free agents who sign a second contract show better performances in the KBO.

Ⅲ. Model

1. Predictions

In order to examine the effect of the length of contract on player

performance, we need to control for other factors that influence player performance in the post-free agency period: Player characteristics, defensive positions, and signed contract information. Professional baseball player begins to decline after reaching a career performance peak. Productivity is assumed to decrease with respect to the player's age or experience.[1] Player performance declines progressively with age. The highest ability veteran players, however, can be productive even after signing a contract. Shirking can occur the following year after a new contract is signed if the productivity-diminishing effects of increasing age dominate.

Signing a new multi-year contract is viewed as guaranteed job security via long-term contracts. We address shirking effect whether free agent player performance is associated with contract length. Free agent players with short remaining years on the contract can better perform in order to either renew or extend the contract at the expiration of the contract period. A player in the final year of his multi-year free-agent contract plays hard to prove and maximize his value.

2. The Model

Specifically, we present an econometric model of player performance for free-agent non-pitchers. We observe $t = 1, ..., T$ years, each with $i = 1, ..., n$ individual free agent players. The year begins with the off-season and runs through the end of the regular season. The free-agent performance model is specified as:

$$performance_{i,t} = \beta_0 + \beta_1 Remain_{i,t} + \gamma_Z Z_{i,t} + \delta_K K_{i,t} + \epsilon_{i,t} \quad (1)$$

1) Solow and Krautmann (2020) present a model that accounts for the age-productivity relationship in consideration of the beneficial impact of experience and the negative consequences of aging.

where $performance_{i,t}$ includes several measures of baseball statistics to evaluate player performance. $OPS_{i,t}$ is the hitter's OPS; $SA_{i,t}$ is the hitter's SA; $wOBA_{i,t}$ is the hitter's wOBA; $WAR_{i,t}$ is the hitter's WAR. $Remain_{i,t}$ is remaining years on the free agent contracts. $Z_{i,t}$ is a vector of explanatory variables controlling for a free agent player i's characteristics at the end of the year t; $\mathrm{SecondFA}_{i,t}$ is a dummy variable, equal to 1 when the player is a qualified second-time free agent and 0 otherwise; $Newteam_i$ is a dummy variable equal to 1 if free agent player i transfers to another team on the free agent contract and 0 otherwise; $\mathrm{Left}_{i,t}$ is a dummy variable equal to 1 for a left-handed hitter and 0 otherwise; $\mathrm{Age}_{i,t}$ is the player's age at the end of year t; Player position variables include $1B_{i,t}$, $2B_{i,t}$, $3B_{i,t}$, $SS_{i,t}$, $CF_{i,t}$, $LF_{i,t}$, $RF_{i,t}$, $C_{i,t}$, and $DH_{i,t}$.

$K_{i,t}$ is a vector of explanatory variables controlling for a free agent i's signed contract information; $Bonus_i$ is the ratio of signing bonus to total size of the signed free-agent contract; $Incentive_i$ is the performance incentive on the free agent contract signed; The error term, $\epsilon_{i,t}$ is assumed to be $i.i.d.$.

We further investigate whether job security on the new contract substantially affects free agent player productivity. To illustrate, consider a model of shirking in professional baseball players similar to Paulsen (2021).

$$Shirking_{i,t} = \beta_0 + \beta_1 Remain_{i,t} + \gamma_Z Z_{i,t} + \delta_K K_{i,t} + \epsilon_{i,t} \qquad (2)$$

where $Shirking_{i,t}$ is measured by difference between the expected performance and actual performance: $OPS_{expected} - OPS_{realized}$. Expected performance is constructed as player's OPS for the prior three years using at-bats as the weights. Similarly, different measures of hitter's performance are used. We use his SA over the three years

prior to the signing of the contract in question: $SA_{expected} - SA_{realized}$; A player's wOBA for the prior three seasons are also used as a measure of player's performance: $wOBA_{expected} - wOBA_{realized}$. According to the free agency rating system implementation at the end of the 2020 season, new free agents were divided into grades based on average annual salary and option amount over the past three years, and compensation regulations for each grade were relaxed. Thus, the expected performance is calculated based on the previous three years.

Ⅳ. Data and Estimation

1. Data and Variable

The data on player performance records were collected from the Statiz website. The final dataset consisted of all 53 free-agent hitters who signed new free-agent contracts from 2013 to 2018.[2] The dataset is then supplemented with basic information on the player's age, left-handedness, defense position, and whether the player is a qualified second-time free agent or not. Finally, information on signed free-agent contracts, such as contract length, signing bonus, contract options, and the total amount of fully guaranteed salary for free-agent signing, was collected. We limit the sample to the 62 free agent hitter transactions, of which 4 contracts are one year contracts.[3] The data

2) For example, performance statistics for some free-agent players with long term contracts were collected up to 2011.

3) The observations with less than 10 plate appearances were dropped from sample. A total of 9 out of 52 free agent hitters appeared multiple times, being on their second free agent contract of their playing career: Min-Ho Kang (2014, 2018), Ju-Chan Kim (2013, 2018), Si-Heon Son (2014, 2018), Dae-Hyung Lee (2014, 2018), Jong-Wook Lee (2014, 2018), Jin-Yeong Lee (2013, 2017), Keun-Woo Jeong (2014, 2018), Seong-Hun Jeong (2013, 2017), Jun-Seok Choi (2014, 2018).

includes all the variables defined in Table 1 for free agent hitters.

〈Table 1〉 Variable description

Variable	Description
$OPS_{i,t}$	dependent variable; the hitter's on-base plus slugging (OPS)
$SA_{i,t}$	dependent variable; the hitter's slugging average (SA)
$wOBA_{i,t}$	dependent variable; the hitter's weighted on-base average (wOBA)
$WAR_{i,t}$	dependent variable; the hitter's win above replacement (WAR)
$Shirking\_OPS_{i,t}$	dependent variable; difference between expected OPS using weights prior three seasons and realized actual OPS
$Shirking\_SA_{i,t}$	dependent variable; difference between expected SA using weights prior three seasons and realized actual SA
$Shirking\_wOBA_{i,t}$	dependent variable; difference between expected wOBA using weights prior three seasons and realized actual wOBA
$Remain_{i,t}$	remaining years on the free agent contract
$\mathrm{SecondFA}_{i,t}$	a dummy variable, equal to 1 when the player is a qualified second-time free agent and 0 otherwise
$Newteam_i$	a dummy variable equal to 1 if free agent player i transfers to another team on the free agent contract and 0 otherwise
$\mathrm{Age}_{i,t}$	the player's age
$\mathrm{Left}_{i,t}$	a dummy variable equal to 1 for a left-handed hitter and 0 otherwise
$Bonus_i$	the ratio of signing bonus to total size of the signed free-agent contract
$Incentive_i$	the performance incentive on the free agent contract signed (unit: 1000,000 won); Bonuses received when a player achieves a certain performance level in addition to the guaranteed amount
$1B_{i,t}$	a dummy variable, 1 for first baseman and 0 otherwise
$2B_{i,t}$	a dummy variable, 1 for second baseman and 0 otherwise
$3B_{i,t}$	a dummy variable, 1 for third baseman and 0 otherwise
$SS_{i,t}$	a dummy variable, 1 for shortstop and 0 otherwise
$DH_{i,t}$	a dummy variable, 1 for designated hitter and 0 otherwise
$C_{i,t}$	a dummy variable, 1 for catcher and 0 otherwise
$CF_{i,t}$	a dummy variable, 1 for center fielder and 0 otherwise
$LF_{i,t}$	a dummy variable, 1 for left fielder and 0 otherwise
$RF_{i,t}$	a dummy variable, 1 for right fielder and 0 otherwise

4 contracts in our sample are one year contracts: Yong-Gwan Kwon in 2014, Seong-Hun Jeong in 2017, Jong-Wook Lee and Jun-Seok Choi in 2018.

Table 2 present summary statistics for free agent player characteristics and the signed contract information. $OPS_{i,t}$ had a mean value of 0.764. The average values for $SA_{i,t}$ and $wOBA_{i,t}$ are 0.414 and 0.342, respectively. The average value for $WAR_{i,t}$ is 1.679, implying that a higher value indicates a greater contribution to team wins. The average value of $Shirking\_OPS_{i,t}$, is 0.041, ranging from -0.431 to 0.543. The positive value of shirking means that the actual OPS falls short of the expected OPS forecasted by his prior three years' performance. The decrease in hitter's actual OPS in the year following a newly signed free agent contract compared than expected OPS is supported by sample data.

The average number of years remaining on player contracts at the start of the season is 2.344, ranging from 1 year to 4 years.[4] 38.6% of free-agent non-pitchers moved to another team. 31.2% of free agents are players who sign a second contract. The average signing age is 34.7 years, which is consistent with the strict eligibility requirement for being a free agent in the KBO.[5] 30.7% of free-agent non-pitchers are left-handed. The free agent hitters include 7.8% of catchers, 9.8% of first basemen, 8.3% of second basemen, 14.7% of third basemen, 9.3% of shortstops, 9.3% of left fielders, 9.8% of center fielders, 11.3% of right fielders, and 19.6% of designated hitters.

The average value of $Bonus_i$, 0.380, indicates that the ratio of signing bonus to fully guaranteed total value of the signed contract is, on average, over 38%. The contracts signed by free-agent players can be characterized by a considerable amount of bonus. The value of 0 means that sample data included the free agent transaction with no signing bonus.

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4) Link and Yosifov (2012) find that the average free-agent contract length for the MLB players has remained relatively constant from1984 to 2006 at between 1.58 and 1.89 years.

5) Kang et al. (2019) show that the age at peak performance for free agent batters using the OPS (WAR) measure is 31.6 (28.7) years.

〈Table 2〉 Summary statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
$OPS_{i,t}$	189	0.764	0.158	0.133	1.12
$SA_{i,t}$	189	0.414	0.105	0	0.684
$wOBA_{i,t}$	189	0.342	0.064	0.078	0.463
$WAR_{i,t}$	189	1.679	1.748	-1.360	6.660
$Shirking\_OPS_{i,t}$	189	0.041	0.132	-0.431	0.543
$Shirking\_SA_{i,t}$	189	0.023	0.088	-0.309	0.351
$Shirking\_wOBA_{i,t}$	189	0.020	0.055	-0.158	0.235
$Remain_{i,t}$	189	2.344	1.093	1	4
$\mathrm{SecondFA}_{i,t}$	189	0.312	0.465	0	1
$Newteam_i$	189	0.386	0.488	0	1
$\mathrm{Age}_{i,t}$	189	34.709	2.588	28	42
$\mathrm{Left}_{i,t}$	189	0.307	0.462	0	1
$Bonus_i$	189	0.380	0.137	0	0.600
$Incentive_i$	189	0.019	0.028	0	0.120
$1B_{i,t}$	189	0.090	0.287	0	1
$2B_{i,t}$	189	0.085	0.279	0	1
$3B_{i,t}$	189	0.127	0.334	0	1
$SS_{i,t}$	189	0.101	0.302	0	1
$DH_{i,t}$	189	0.206	0.406	0	1
$C_{i,t}$	189	0.085	0.279	0	1
$CF_{i,t}$	189	0.106	0.308	0	1
$LF_{i,t}$	189	0.090	0.287	0	1
$RF_{i,t}$	189	0.111	0.315	0	1

2. Estimation Results

(1) Baseline Model Results

We examine the relationship between long-term contracts and player performance.[6] Model specifications that differ in dependent

6) The review raises a concern for potential multicollinearity among the variables. Perfect multicollinearity problems may arise between the age and remaining contract year variables. The correlation coefficient between $Remain_{i,t}$ and $\mathrm{Age}_{i,t}$ is -0.4627, ruling out the existence of extreme pairwise correlations. The player shares in our data range from 0.53% (player with only one observation) to 4.53% (player with eight observations). Since there is a serious imbalance

variables, four measures of different aspects of player performance, are compared in Table 3: OPS in Columns (1)-(2), SA in Columns (3)-(4), wOBA in Columns (5)-(6), and WAR in Columns (7)-(8). We implement the year-fixed effects in all models to control for unobserved time-invariant attributes. The estimates of the coefficients for $Remain_t$ are all positive, but are not statistically significant. The estimated impacts of the years remaining on free-agent contracts and player performance are ambiguous when measured with offensive performance measures. Since the lengths of the contract years vary across players, the incentive for better performance may work in the opposite direction. A player with contract of shorter length may not exert greater effort to renew his contract when the probability of contract extension is low. Or a player in the last year of the contract may increase effort to be rewarded with a lucrative new contract or contract renewal.

The estimated coefficients for $\mathrm{SecondFA}_t$ are positively significant across all specifications at the 5% level. In a following year after a new contract signed, player who signed the second free agency contract shows improvement in offensive-play and has a greater contribution to team wins. We find that players who have signed a second free-agent contract perform better measured as hitting production. This is likely a result of the fact that players who sign a second free-agent contract are those who survive in the market to do so. In other words, the players signing a second contract are the players who are productive enough to be signed again.

The coefficients for $Newteam_{i,t}$ are positive and are statistically significant under Specifications (2), (4), (6), and (8). A free-agent player moves to a team from which he can extract the best offer. Leaving his original team and moving to a new team following free

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in the distribution of individual players, which are the units of analysis for cross-sectional data, we do not consider the player-level fixed effects model.

agency takes time to adjust to the team-specific environment. Adjusting to a new situation can cause player to suffer at the start of a new contract. The estimated positive impacts of signing with new teams as a free agent on performance imply that the work environment do not differ substantially among the KBO teams.

The relationship between player productivity and age is reviewed. The significant coefficients of $\mathrm{Age}_{i,t}$ are negative across all Specifications, implying that the player's offensive ability appears to be inversely related to his age. Player's contribution to team wins also declines continuously with age. The estimated coefficients for $\mathrm{Left}_{i,t}$ alter in signs, and not statistically significant. The point estimate results suggest that the rarity of left-handed hitters is not the primary determinant in either the offensive performance measures or WAR after free agency.

Turning to the effect of free agent contract information on player performance, the coefficients for $Bonus_i$ are positive and statistically significant across specifications. Free agent player performance in the years after signing a new contract is positively associated with a substantial signing bonus compared to a contract size. The coefficients for $Incentive_i$ are negative, but are not statistically significant at the 5% level. We find no evidence that a free-agent performance incentive in addition to a guaranteed amount upon the new contract induces a free-agent hitter to perform well in the post-free agency.

The coefficients for dummies on either infielder positions or center fielder position are negative and statistically significant in Specifications (1)-(6). A player at infielder position is bad when the player's performance is measured in offensive abilities. This finding is attributed to the fact that some positions among infielders, for example, shortstop or third baseman, are known to be one of the hardest defensive positions in baseball. The position coefficients on the infielders, however, changed to insignificant in Specifications (7)-(8).

〈Table 3〉 Player performance model estimation results

Dependent variable	(1) OPS	(2) OPS	(3) SA	(4) SA	(5) $wOBA$	(6) $wOBA$	(7) WAR	(8) WAR
$Remain$	0.00355	0.00889	0.00326	0.00676	0.00131	0.00355	0.154	0.221
	(0.012)	(0.012)	(0.008)	(0.008)	(0.005)	(0.005)	(0.152)	(0.155)
$\mathrm{SecondFA}_{i,t}$	0.126***	0.119***	0.0721***	0.0672***	0.0551***	0.0523***	1.168***	1.081***
	(0.028)	(0.029)	(0.019)	(0.020)	(0.011)	(0.011)	(0.317)	(0.330)
$Newteam_i$	0.0173	0.0586**	0.00832	0.0350**	0.0078	0.0255***	0.379	0.900***
	(0.027)	(0.023)	(0.018)	(0.016)	(0.011)	(0.009)	(0.307)	(0.275)
$\mathrm{Age}_{i,t}$	-0.0361***	-0.0370***	-0.0215***	-0.0222***	-0.0153***	-0.0156***	-0.332***	-0.342***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.002)	(0.002)	(0.070)	(0.075)
$\mathrm{Left}_{i,t}$	-0.0089	-0.0214	-0.0083	-0.0168	-0.002	-0.0071	0.28	0.123
	(0.024)	(0.024)	(0.017)	(0.016)	(0.009)	(0.009)	(0.318)	(0.314)
$Bonus_i$	0.301***		0.194**		0.129***		3.792***	
	(0.112)		(0.079)		(0.043)		(0.956)	
$Incentive_i$		-0.533		-0.383		-0.200		-6.540
		(0.370)		(0.242)		(0.154)		(4.923)
$1B_{i,t}$	-0.0425	-0.0186	-0.0198	-0.0049	-0.0208	-0.0101	-0.782*	-0.478
	(0.042)	(0.034)	(0.031)	(0.025)	(0.016)	(0.013)	(0.406)	(0.397)
$2B_{i,t}$	-0.101***	-0.101***	-0.0698***	-0.0694***	-0.0409***	-0.0411***	0.166	0.165
	(0.032)	(0.032)	(0.022)	(0.022)	(0.01)	(0.01)	(0.478)	(0.501)
$3B_{i,t}$	-0.149***	-0.136***	-0.0838***	-0.0760**	-0.0674***	-0.0617***	-0.233	-0.0711
	(0.046)	(0.047)	(0.031)	(0.031)	(0.02)	(0.02)	(0.437)	(0.447)

〈Table 3〉 Player performance model estimation results (cont')

Dependent variable	(1) OPS	(2) OPS	(3) SA	(4) SA	(5) $wOBA$	(6) $wOBA$	(7) WAR	(8) WAR
$SS_{i,t}$	-0.117***	-0.124***	-0.0905***	-0.0952***	-0.0473***	-0.0496***	-0.335	-0.414
	(0.036)	(0.036)	(0.024)	(0.024)	(0.01)	(0.01)	(0.443)	(0.465)
$C_{i,t}$	-0.215***	-0.224***	-0.124***	-0.131***	-0.0941***	-0.0971***	-0.658	-0.764
	(0.041)	(0.047)	(0.028)	(0.031)	(0.02)	(0.02)	(0.462)	(0.516)
$CF_{i,t}$	-0.150***	-0.123***	-0.113***	-0.0956***	-0.0580***	-0.0465***	-0.794	-0.457
	(0.039)	(0.039)	(0.027)	(0.027)	(0.02)	(0.02)	(0.484)	(0.476)
$LF_{i,t}$	-0.0436	-0.0513	-0.0238	-0.029	-0.0202	-0.0234	0.00994	-0.0861
	(0.043)	(0.041)	(0.030)	(0.029)	(0.02)	(0.02)	(0.603)	(0.588)
$RF_{i,t}$	-0.0445	-0.0337	-0.0376*	-0.0313	-0.0171	-0.012	-0.0889	0.0498
	(0.032)	(0.032)	(0.022)	(0.022)	(0.01)	(0.01)	(0.457)	(0.437)
Constant	1.849***	1.955***	1.036***	1.107***	0.818***	0.861***	10.64***	11.97***
	(0.226)	(0.230)	(0.164)	(0.163)	(0.08)	(0.09)	(2.658)	(2.885)
No. observations	189	189	189	189	189	189	189	189
Reference player position	DH	DH	DH	DH	DH	DH	DH	DH
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
adj.R^2	0.360	0.317	0.316	0.278	0.391	0.343	0.261	0.206

Notes: 1) Robust standard errors in parentheses; 2) Significance levels: * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

The estimation results using WAR suggest defensive positions are not associated with players' performances during the free-agent contracts.[7)]

(2) Player Shirking Model Results

Table 4 shows the free-agent player shirking estimation results from each of the six specifications. To compare the magnitude of the shirking, alternative model specifications that use the expected performance based on the previous five years are tested, and the results are qualitatively similar. The positive coefficients for $Remain_{i,t}$ are not statistically significant at the 5% level. We find that shirking behaviors are not affected by the contract lengths. This insignificance could be attributed to two opposing effects caused by the incentive to renew the existing contract in the final year and productivity loss due to aging. On the contrary, players either in the last year of their contract or with under short-term contracts are less likely to prove their values and boost performance if the probability of extending existing contract at the expiration of the contract is low.

The estimation results confirm several interesting findings on the players on a second free-agent contract. The coefficients for $Second_t$ are negative and statistically significant across all specifications, providing an evidence of an improvement in performance than expected performance based on the previous years. Player who signed a second free-agent contract exhibits greater offensive performance than the average over the three years using at bats as the weights. From the pool of players who sign a contract in free agency, only the best is likely to survive to sign a second. As a result, the better performance for those players on a second contract is likely not

7) Jeong et al. (2022) assess the defense efficiency of individual players and find that first basemen have low efficiency, while either catcher or shortstop position players have high efficiency.

related to shirking. The estimated coefficients for $Newteam_{i,t}$ are negative and statistically significant under Specifications (2) and (4). This finding suggests that players who changed teams via free-agent contracts outperform expected performance levels in the year following a new contract signed.

The coefficients of $\mathrm{Age}_{i,t}$ have the expected sign; the estimated impacts of age on shirking are positive and statistically significant across all specifications, implying that the realized offensive ability of older player appears to fall below the expected productivity. We find that the player's productivity measured in offensive play ability decreases with age. The estimated coefficients for $\mathrm{Left}_{i,t}$ are not statistically significant.

The coefficients for $Bonus_i$ are negative, but not statistically significant. The coefficients for $Incentive_i$ are positive, but not statistically. Shirking in performance in the year during a free-agent contract is not associated with either a signing bonus or incentive.

Finally, the impact of defensive positions in baseball players on shirking was estimated. Shirking occurs depending on the positions of defense. The coefficients for $C_{i,t}$ are positive and statistically significant at the 10% level. The empirical result indicates that player shirking in offensive hitting performance is observed in the player at the catcher position when a designated hitter position is set as the reference group.

A robustness analysis is conducted in order to evaluate the non-linear effects of age on player performance. Performance declines tend to be greater for older players. We further test whether the individual player's performance after signing a free agent contract would vary depending on the age of the player. The effect of adding the age-squared term to equation (1) does not qualitatively changes in the estimated results for the variable of interest: $\mathrm{Age}_{i,t}^2$ is the squared

〈Table 4〉 Player shirking model estimation results

Dependent variable	(1) $Shirking\_OPS$	(2) $Shirking\_OPS$	(3) $Shirking\_SA$	(4) $Shirking\_SA$	(5) $Shirking\_wOBA$	(6) $Shirking\_wOBA$
$Remain$	0.0042	0.00138	0.00571	0.00386	0.00177	0.000694
	(0.012)	(0.012)	(0.008)	(0.008)	(0.005)	(0.005)
$\mathrm{SecondFA}_{i,t}$	-0.0603**	-0.0555**	-0.0384**	-0.0353**	-0.0268**	-0.0252**
	(0.026)	(0.026)	(0.017)	(0.018)	(0.011)	(0.011)
$Newteam_i$	-0.0186	-0.0391*	-0.0108	-0.0242*	-0.00609	-0.0141
	(0.025)	(0.021)	(0.016)	(0.014)	(0.011)	(0.009)
$\mathrm{Age}_{i,t}$	0.0232***	0.0238***	0.0154***	0.0158***	0.00991***	0.0101***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.002)	(0.002)
$\mathrm{Left}_{i,t}$	-0.0179	-0.0105	-0.0128	-0.00783	-0.0117	-0.00893
	(0.021)	(0.021)	(0.014)	(0.014)	(0.009)	(0.010)
$Bonus_i$	-0.148		-0.0968		-0.0582	
	(0.108)		(0.073)		(0.043)	
$Incentive_i$		0.390		0.258		0.134
		(0.322)		(0.219)		(0.134)
$1B_{i,t}$	-0.0122	-0.0221	-0.00694	-0.0134	-0.00482	-0.00899
	(0.045)	(0.037)	(0.032)	(0.026)	(0.017)	(0.014)
$2B_{i,t}$	-0.0000489	-0.00125	-0.00193	-0.00273	-0.00221	-0.0025
	(0.031)	(0.031)	(0.022)	(0.022)	(0.012)	(0.012)
$3B_{i,t}$	0.0643	0.0593	0.0395	0.0363	0.0267	0.0246
	(0.044)	(0.043)	(0.027)	(0.027)	(0.018)	(0.018)

〈Table 4〉 Player shirking model estimation results (cont')

Dependent variable	(1) *Shirking_OPS*	(2) *Shirking_OPS*	(3) *Shirking_SA*	(4) *Shirking_SA*	(5) *Shirking_wOBA*	(6) *Shirking_wOBA*
$SS_{i,t}$	-0.044	-0.039	-0.0262	-0.0229	-0.0231	-0.0214
	(0.034)	(0.034)	(0.022)	(0.022)	(0.014)	(0.014)
$C_{i,t}$	0.0680*	0.0756*	0.0389	0.0439*	0.0272*	0.0297*
	(0.037)	(0.039)	(0.024)	(0.026)	(0.015)	(0.016)
$CF_{i,t}$	0.0309	0.0179	0.0266	0.0181	0.00977	0.00463
	(0.037)	(0.037)	(0.025)	(0.025)	(0.015)	(0.015)
$LF_{i,t}$	0.00718	0.0116	0.00277	0.00564	0.00454	0.00617
	(0.027)	(0.026)	(0.018)	(0.019)	(0.012)	(0.011)
$RF_{i,t}$	0.00981	0.00657	0.007	0.00491	0.012	0.0104
	(0.027)	(0.027)	(0.019)	(0.019)	(0.016)	(0.016)
Constant	-0.719***	-0.781***	-0.477***	-0.518***	-0.319***	-0.341***
	(0.216)	(0.205)	(0.150)	(0.142)	(0.090)	(0.085)
No. observations	189	189	189	189	189	189
Reference player position	DH	DH	DH	DH	DH	DH
Year fixed effects	yes	yes	yes	yes	yes	yes
adj.R^2	0.216	0.205	0.213	0.201	0.184	0.173

Notes: 1) Robust standard errors in parentheses; 2) Significance levels: * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

player's age. The coefficient of the quadratic term for age is negative, but insignificant, even generating upward biases in point estimation results for age and to lose significance. The results indicate that performance of player has no concave association with age. From the sign of the estimated coefficients on age and age-squared, one possible reason for this insignificance is the offsetting effects of aging on performance. Unlike previous results, the inverted U-shape hypothesis does not hold. Notably, our findings for the insignificance of non-linear effects of age on performance following free agency could be attributed to the fact that the KBO players achieve free agent status at some time after reaching their peak performance.

Ⅴ. Conclusion

The purpose of this study is to estimate the relationship between performance and the length of contract during the free-agent contract for KBO non-pitcher players. We attempted to evaluate whether KBO players shirk after signing a free-agent contract, by constructing a measure of shirking. First, we discussed whether a long-term contract leads to shirking in professional baseball. We do not find any strong evidence that the years remaining on contract substantially affect player performance for the KBO free-agents. Second, we further investigated the impacts of individual player characteristics on player performance. Empirical findings suggest that a requalified free agent who signed the second contract performs better in the post-free agent period. We find weak evidence that a player who moved to a new team via free agency is productive in the years after signing a new contract. The player's age is the main determinant of performance during the free-agent contract. Third, a player with a substantial

signing bonus compared to the size of the signed free-agent contract performs better.

Despite considerable interest, the conceptual and theoretic frameworks to analyze shirking behavior of veteran free agent players have not been established yet. This study contributes to the empirical shirking literature on baseball players by analyzing the KBO in which a longer qualification period is required. It is somewhat surprising that qualified second-time free agents show better performance. Player productivity begins to decline with age after reaching a career peak. A long-term contract is considered to be a guaranteed secured job, thus, reducing to improving productivity. Player contract options in the form of either compensation of cash salaries or contract renewal, however, provide incentives for free agents not to reduce work efforts. If compensations are valuable enough to encourage high-quality free agents, they are less likely to shirk.

This present paper has its limitations in the way that a measure of shirking is defined, interpreting that the player shirks when the player's actual performance falls below the expected performance. The player shirking was defined as the difference between the player's average offensive play measure in the previous three years and actual offensive play measure this year. We certainly hope further research will explore mechanisms explaining behaviors in them.

Finally, we conclude with a short discussion for future search. In 2020, the KBO announced a major revision of the free agency system for the first time in 21 years. The implementation of a free-agent rating system from the end of the 2020 season was announced. It was decided to shorten the acquisition of free agents by one year from the current 9 years for high school graduates and 8 years for college graduates to 8 years for high school graduates and 7 years for college graduates from the end of the 2022 season. The impact of relaxing free agent qualification requirements is expected to be an interesting

research topic.

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계약 이후 성적 결정 요인 분석: 한국프로야구 자유계약선수를 중심으로

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논문초록

본 연구는 한국프로야구에서 자유계약선수 계약을 체결한 이후 선수의 성적에 영향을 미치는 요인을 분석하였다. 2013년부터 2018년까지 신규 계약을 체결한 선수를 대상으로 분석한 결과, 선수 성적은 계약기간의 영향을 받지 않는 것으로 나타났다. 두 번째 자유계약을 체결한 선수나 새로운 팀으로 이적한 선수가 더 나은 성적을 내는 것을 보였다. 선수의 나이는 계약 기간 동안 성과를 결정하는 주요 요인인 것으로 분석되었다. 계약 규모에 비해 상당한 계약금을 받는 계약을 체결한 선수일수록 계약 이후 성적이 좋은 것으로 나타났다. 계약의 인센티브 내용은 계약 이후 선수 성적에 큰 영향을 미치지 않는 것으로 분석되었다. 본 연구는 계약기간과 자유계약선수 성적 간의 관계에 대해 처음으로 분석했다는 점에서 의미가 있다.

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