Reference Dependence and Monetary Incentive

-Evidence from Major League Baseball-

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Abstract

- Empirical research that specifies the existance of reference point dependence observed in field setting:
  We pick up evidence of Major League Baseball (MLB)
- Players take some round numbers of the batting performance indexes as reference points, and adjust their effort level to meet the goals
- There are NOT observed any evidence for the monetary incentives that is paid to the players if they achieve these internal goals

Contents

Introduction

- Reference dependence is one of the two main charactaristics of the Tversky and Kahneman (1992)'s prospect theory: Individuals evaluate outcomes by the relative value to their internal benchmarks, or reference point, not by their absolute ones.
- Prospect theory enabled us to interpret some inconsistent empirical decision making with the traditional microeconomic theory, by applying additional assumptions.
- There are a lot of following researches that tests the reference dependence in field or laboratory settings, including about athletes' decision making (Allen et al, 2016)

Literature

Pope and Simonsohn (2011)

- presents three empirical evidences that verify the reference dependence, with the reference points "round numbers."
- One of them picked up Major League Baseball (MLB) players, about the observed attitude to their performance indexes.
- MLB position players manipulate their batting-average (AVG), in order to meet their internal goals: .300
- As a results, there is observed excess mass, or "bunching" around .300 of AVG.

Contribution

- Professional athletes receive monetary rewards according to the contracts they signed.
- Their contracts might include some incentivesed parts, which pay them additional bonus when their AVG reaches a certain cutoff point.
- If so, the observed behavior might be caused by the discontinuity of their profit function, not by the reference dependence.
- The contribution of our research is to examine this: examine if there exists any monetary incentives that make players make effort to the cutoff point.

Theoretical Frameworks

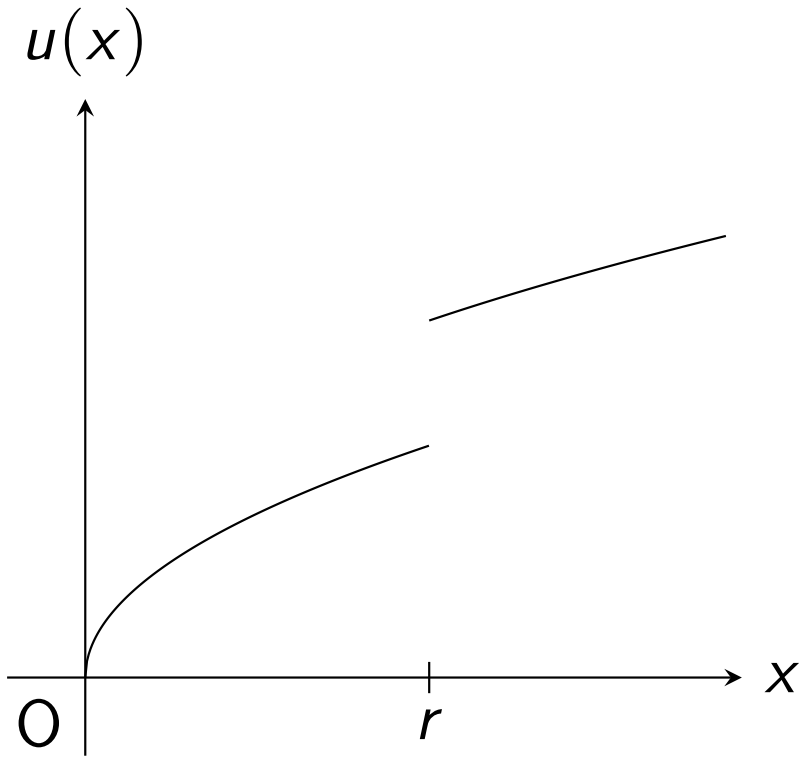

Figure: discontinuous utility function

- Following Allen et al. (2016) assume utility function $u(x)$ that jumps at the cutoff point, or the reference point.

  x stands for the performance index.

- This disconituity generates excess mass, or "bunching" around the possible reference point.

- We consider the possibility that this type of utility is derived by the descontinuous design of the monetary reward of the players.

Specification: Manipulation

- We exploit the McCrary (2007)'s manipulation test, which is used in regression discontinuity design.
- Local-linear regression of undersmoothed histgram around (bandwidth is optimized) the given cutoff point: .300 of AVG, 20 homeruns, ...

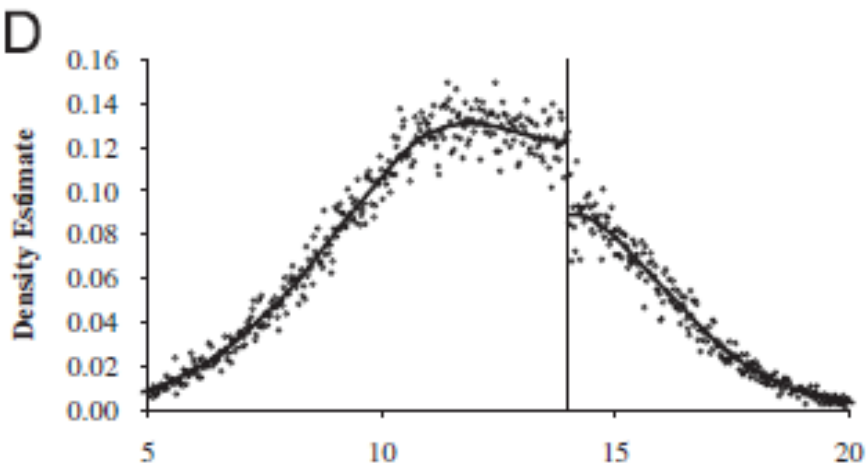

Figure: Discontinuous frequency (quated from McCrary(2007))

Specification: Contract Design

- Discontinuity of the contract design is tested by RDD methodology:

$$w_{it} = \beta_0 X_{it} + \beta_1 \text{ABOVE}_{it}$$

  We also conduct analysis including other performance and other player specific charactaristics.
- To check the robustness of our results, we also conduct the same local regression including the interaction term of X_{it} and ABOVE_{it}.

$$w_{it} = \beta_0 X_{it} + \beta_1 \text{ABOVE}_{it} + \beta_2 X_{it} \times \text{ABOVE}_{it}$$

Data

We obtain information about the players' stats (indexes) and annual salary.

- Stats Data
  - From *fangraphs*
  - Play stats from 1957 to 2018
  - We restrict the sample to the players with at least 200 plate-appearances $N = 18143$
- Salary Data
  - From *USA TODAY* and *Baseball References*
  - Salary information from 1987 to 2017 $N = 8915$

Results: Manipulation

Figure: Histgram of Batting-Average

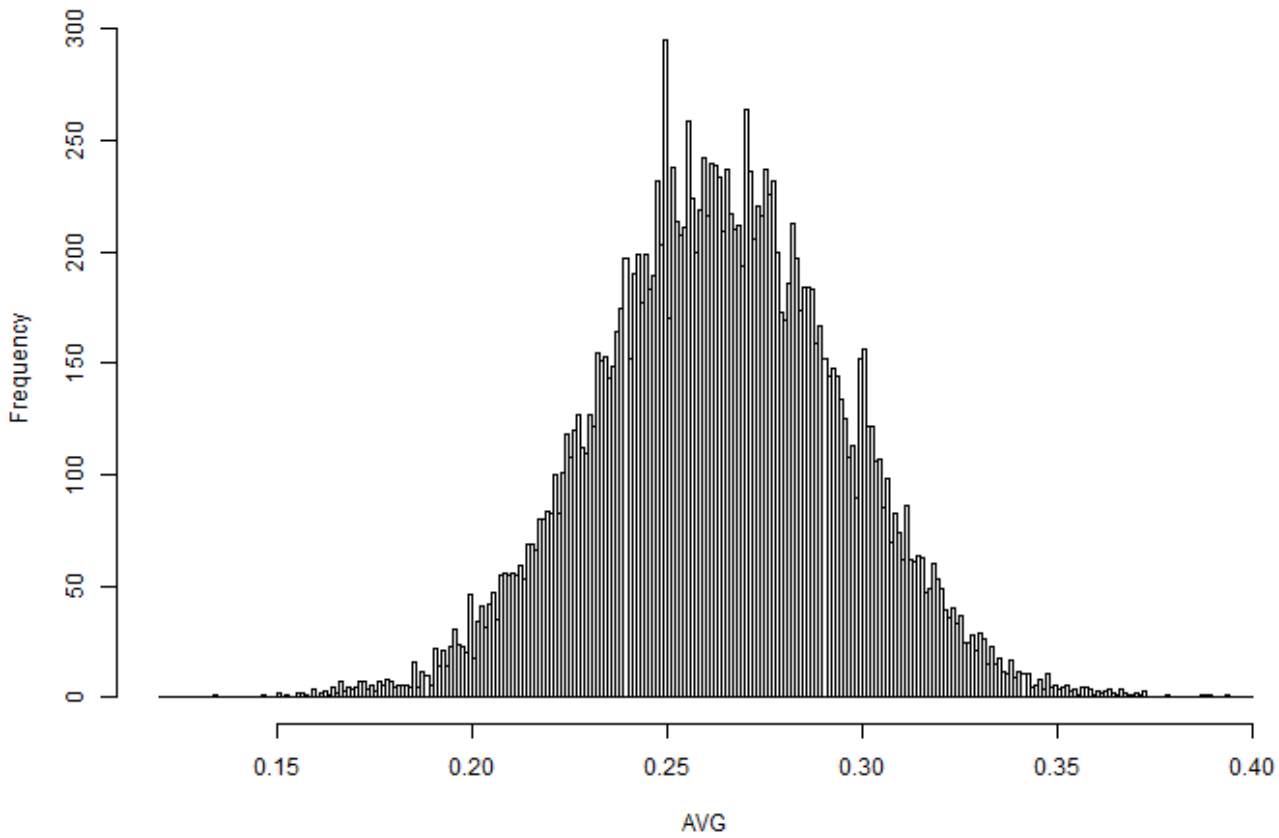

Figure: Discontinuity at .300 of AVG

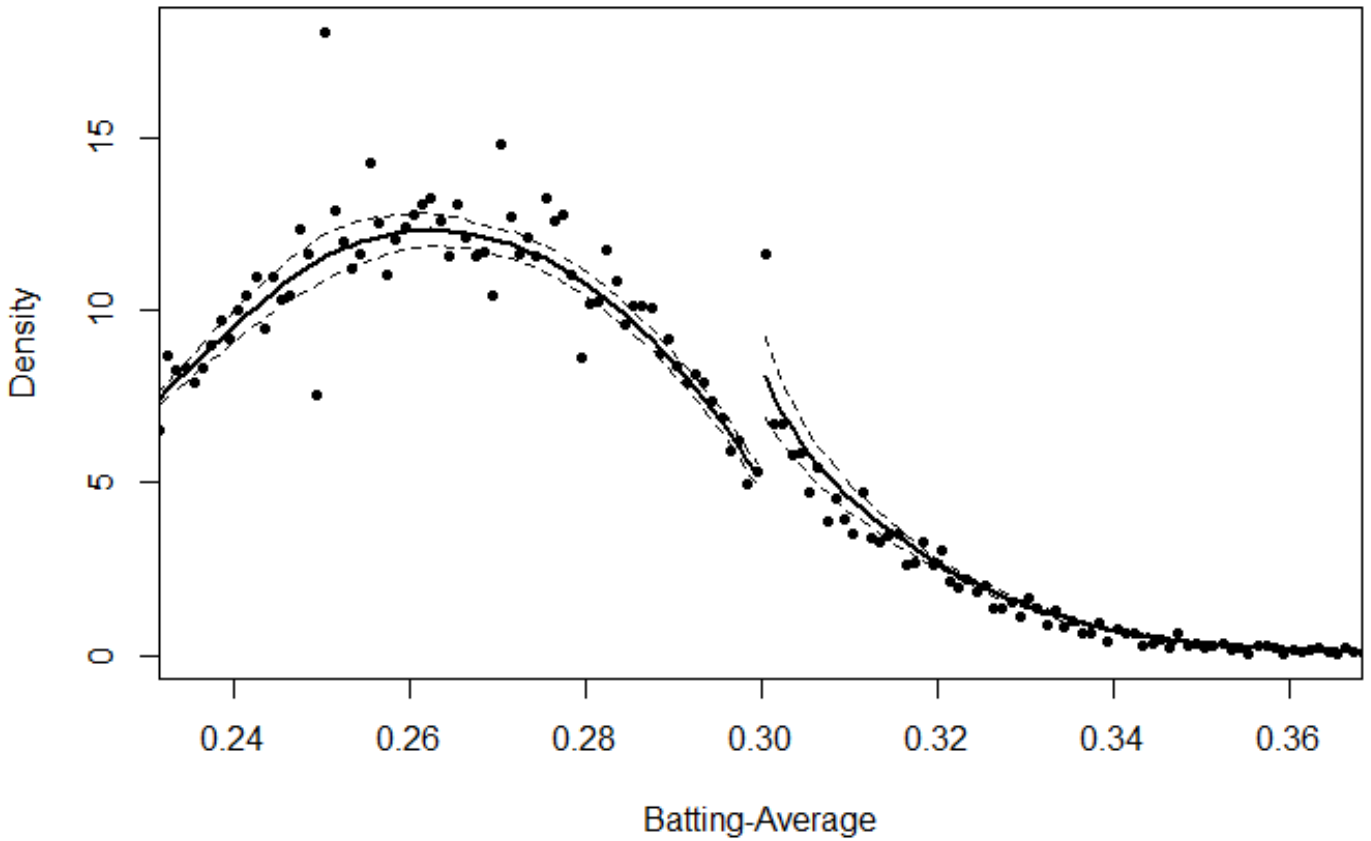

Table: Test for Manipulation, leastPA = 200

index	type	cutpoint	binsize	bandwidth	θ	z
AVG	rate	.300	.001	.019	.499	7.442***
					(.067)	
		.250	.001	.024	.212	5.061***
					(.042)	
OBP	rate	.350	.001	.024	.139	2.854**
					(.049)	
HR	cumulative	20	1	5.309	.259	3.465***
					(.075)	
RBI	cumulative	100	4	15.423	.311	3.295***
					(.094)	
SB	cumulative	30	1	10.000	.529	4.274***
					(.124)	
		40	1	11.505	.481	2.764**
					(.174)	
PA	cumulative	500	1	.003	.160	2.515*
					(.063)	
H	cumulative	200	1	18.922	.453	2.547 *
					(.178)	

Note ***: $p < 0.1\%$, **: $p < 1\%$, *: $p < 5\%$.
Bandwidth is optimized following the method of McCrary(2008).

Results: Manipulation

- In .300 of batting-average, there in fact exists manipulation by the players.
- Also in .250 of AVG and some of other round numbers of indexes, there were observed discontinuity:
  Players consider these numbers as referene points and adjust their aspiration levels.
- In contrast to Allen et al (2016), manipulation were not observed in all the round numbers:
  They are likely to be kinds of "per," the well-known benchmarks of a certain sports.

Table: RDD Test for Monetary Incentives

index,cutpoint	Other Control	bw type	bandwidth	Observations	Estimate	Std. Error	z
AVG, .300	No	LATE	.084	8514	.047	.061	.773
		Half-BW	.042	5599	.088	.075	1.174
		Double-BW	.170	8915	.067	.056	1.184
	Yes	LATE	.045	5930	.034	.056	.615
		Half-BW	.023	3005	.061	.077	.788
		Double-BW	.090	8605	.016	.045	.354
AVG, .250	No	LATE	.036	6110	.019	.068	.286
		Half-BW	.018	3496	.015	.092	.161
		Double-BW	.072	8539	.034	.054	.636
	Yes	LATE	.048	7271	.070	.052	1.340
		Half-BW	.024	4402	.066	.069	.953
		Double-BW	.096	8810	.075	.044	1.713
HR, 20	No	LATE	3.32	1315	.071	.175	.406
		Half-BW	1.66	562	.073	.127	.576
		Double-BW	6.64	2582	-.004	.109	-.034
	Yes	LATE	3.30	1307	-.002	.141	-.015
		Half-BW	1.65	560	.030	.102	.299
		Double-BW	6.61	2558	-.032	.088	-.364
OBP, .350	No	LATE	.044	6440	-.038	.065	-.592
		Half-BW	.021	3542	-.076	.089	-.849
		Double-BW	.087	8656	-.029	.051	-.570
	Yes	LATE	.045	6525	-.013	.049	-.272
		Half-BW	.022	3673	-.055	.069	-.807
		Double-BW	.089	8637	.004	.039	.107

Note: ***: $p < 0.1\%$, **: $p < 1\%$, *: $p < 5\%$.
Bandwidth is optimized following the method of Imbens-Kalyanaraman.

Table: RDD Test for Monetary Incentives

index,cutpoint	Other Control	bw type	bandwidth	Observations	Estimate	Std. Error	z
RBI, 100	No	LATE	4.08	393	.072	.289	.250
		Half-BW	2.04	228	.282	.400	.707
		Double-BW	8.16	714	.008	.185	.043
	Yes	LATE	4.04	390	.018	.209	.086
		Half-BW	2.02	227	-.042	.324	.130
		Double-BW	8.07	708	.056	.127	.435
H, 200	No	LATE	3.173	75	-.786	.396	-1.985*
		Half-BW	1.587	35	.386	.271	-1.421
		Double-BW	6.347	137	-.061	.309	-.199
	Yes	LATE	3.175	75	-.420	1.042	-.403
		Half-BW	1.587	35	-4.779	.576	-8.288**
		Double-BW	6.349	137	-.109	.413	-.265
SB, 30	No	LATE	3.39	282	.962	.372	2.585**
		Half-BW	1.70	134	.920	.263	3.492***
		Double-BW	8.16	714	.008	.185	2.941**
	Yes	LATE	3.40	282	.379	.297	1.271
		Half-BW	1.70	134	.290	.249	1.163
		Double-BW	6.79	533	.408	.180	2.260*
SB, 40	No	LATE	3.16	134	-1.276	.453	-2.818**
		Half-BW	1.58	56	-.736	.383	-1.924
		Double-BW	6.32	245	-.712	.313	-2.274*
	Yes	LATE	3.16	134	-.346	.396	-.875
		Half-BW	1.58	56	-.313	.429	-.730
		Double-BW	6.33	245	-.115	.244	-.472

Note: ***: $p < 0.1\%$, **: $p < 1\%$, *: $p < 5\%$.
Bandwidth is optimized following the method of Imbens-Kalyanaraman.

Table: Regression on Log-Salary, Including Interaction Term: around .300

	Dependent variable:					
	Sal					
	OLS					*felm*
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	11.166***	−6.616***	−5.203***	−5.319***	−5.319***	
	(.423)	(.665)	(.671)	(.667)	(.667)	
AVG	11.513***	11.620***	4.361***	4.221***	4.221***	3.808**
	(1.537)	(1.209)	(1.209)	(1.201)	(1.201)	(1.189)
AVG_300	−.169	−.413	−.191	−.142	−.142	−.069
	(1.050)	(.821)	(.785)	(.780)	(.780)	(.706)
FLD		.006***	.008***	.007***	.007***	.008***
		(.002)	(.002)	(.002)	(.002)	(.002)
BsR		.009*	.002	.003	.003	.020***
		(.005)	(.005)	(.005)	(.005)	(.005)
AVG:AVG_300	.663	1.428	.681	.540	.540	.160
	(3.429)	(2.681)	(2.566)	(2.549)	(2.549)	(2.312)
WPA		X	X	X	X	
AGE (quadratic)		X	X	X	X	
FA dummy			X	X	X	
Season dummies		X	X	X	X	X
Position dummies			X	X	X	
Fixed effects						Individual
Observations	5,960	5,930	5,930	5,930	5,930	5,930
R^2	.035	.420	.470	.478	.478	.744
Adjusted R^2	.035	.416	.466	.473	.473	.660
Residual Std. Error	1.286 (df = 5956)	1.001 (df = 5892)	.957 (df = 5881)	.950 (df = 5880)	.950 (df = 5880)	.764 (df = 4459)
F Statistic	71.983*** (df = 3; 5956)	115.152*** (df = 37; 5892)	108.865*** (df = 48; 5881)	109.753*** (df = 49; 5880)	109.753*** (df = 49; 5880)	

Note: *p<0.05; **p<0.01; ***p<0.001
The bandwidth is same as RDD for .300 of AVG.
FLD and BsR stands for the contribution of the player to the team, expressed by the runs they earned.
WPA is "win-percentage added."

Results: Monetary Incentives

- As a whole, there are not observed clear evidence for additional bonuses achieving some these round numbers.
- Including interaction term with the index does not present important changes.
  $\Rightarrow$ Players manipulate their performance indexes, even though there are little or no monetary incentives to do so.
- For 30 stolen-bases, our analysis does not show determinant results, so we should further results.
- Restricting the sample to the players with the right of free agency yields essentially the same results.

Extention

- By-Time analysis
  - Replicate the same examination, but now we devide the sample by histrical terms:
    1. Before the system of free agency regulated (-1975)
    2. Before the Strike of Players Association (-1994)
    3. Before *Moneyball* (Lewis) was published (-2003)
    4. Afterward (2004-)

    * Note that because we obtain the sample of contract design only after '87, we cannot conduct the second analysis for before '86.
  - Hakes and Sauer (2006) aregued that after the publication of *Moneyball*, team managers regard on-base percentage as more important index to measure the players' contribution to the team they belong to.

Table: Manipulation Test for the Grouped Sample by Time

index, cutpoint		'57-'75	'76-'94	'95-2003	2004-	full sample
AVG, .300	bw	.023	.020	.022	.019	.019
	θ	.573	.566	.310	.403	.499
		(.146)	(.120)	(.130)	(.120)	(.067)
	z	3.934***	4.732***	2.393*	3.376***	7.442***
AVG, .250	bw	.028	.028	.032	.027	.024
	θ	.250	.151	.306	.121	.212
		(.080)	(.069)	(.094)	(.076)	(.042)
	z	3.149**	2.188*	3.242**	1.595	5.061***
OBP, .350	bw	.031	.030	.036	.030	.024
	θ	.137	.149	-.035	.137	.139
		(.089)	(.081)	(.093)	(.082)	(.049)
	z	1.538	1.846	-.380	1.672	2.854**
HR, 20	bw	6.313	6.677	10.165	7.273	5.309
	θ	.222	.214	.145	.315	.259
		(.150)	(.123)	(.129)	(.112)	(.075)
	z	1.479	1.751	1.117	2.819**	3.465***

Note ***: $p < 0.1\%$, **: $p < 1\%$, *: $p < 5\%$.
Bandwidth is optimized following the method of McCrary(2008).

Table: RDD for the Grouped Sample by Time

index, cutpoint	bw, type		'87-'94	'95-2003	2004-	full sample
AVG, .300	LATE	bw	.024	.042	.030	.045
		Obs.	697	1806	1872	5930
		estimate	-.034	.064	.066	.034
			(.137)	(.092)	(.103)	(.056)
		z	-.250	.697	.637	.615
AVG, .250	LATE	bw	.036	.043	.075	.048
		Obs.	1482	1806	3991	7271
		estimate	.154	.064	.076	.070
			(.084)	(.092)	(.060)	(.052)
		z	1.825	.697	1.277	1.340
HR, 20	LATE	bw	4.183	3.685	2.46	3.30
		Obs.	341	371	475	1307
		estimate	-.255	-.348	.343	-.002
			(.228)	(.218)	(.264)	(.141)
		z	-1.122	-1.600	1.300	-.015
OBP, .350	LATE	bw	.031	.025	.027	.045
		Obs.	1098	1281	2042	6525
		estimate	.109	-.151	-.030	-.013
			(.106)	(.120)	(.093)	(.049)
		z	1.031	-1.262	-.323	-.272

Note: ***: $p < 0.1\%$, **: $p < 1\%$, *: $p < 5\%$.
Bandwidth is optimized following the method of Imbens-Kalyanaraman.

- About manipulation, players seems to be affected by the historical changes.
- However, .300 of batting-average has been a solid benchmarks for the players.
- On the other hand, team managers (since '87) does not propose any discontinuous form of contracts to the players.
  $\Rightarrow$ Again, we argure there does not exists no monetary incentive that leads them to manipulate indexes.
- Including interaction terms, and restricting the sample to the FA players also show the same.

Conclusion

Main Findings

1. Players manipulate their performance indexes to meet them with some round numbers.
2. There exist no monetary incentives in their contracts that makes players to do so.
3. Tendency of the manipulation changes through the history of baseball.
   - Among them, especially, .300 of AVG shows consistent results, which shows it is solid benchmarks for the players.

Note that some indexes require following research.

Reference

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Contract Length

- Krautmann and Oppenheimer (2002) pointed out that the longer the contract duration extend, the lower return to their performance is obtained:
  Players show the risk-aversion.

$$\ln(SAL_{it}) = \beta_1 + \beta_2 PERF_{it} + \beta_3(PERF_{it} * LENGTH_{it}) + \beta_4 LENGTH_{it}$$

* The model is quoted from Krautmann and Oppenheimer (2006).

Estimated value of β_3 was negative.

Incentivised Contracts

- Ichiro Suzuki, Outfielder, 4-year contract with Seattle Marinars (2004-'07)
  - signing bonus- $6M
  - fixed payment- 04:$5M, 05:$11M, 06:$11M, 07:$11M
  - performance bonuses- $1.25M in performance bonuses for plate appearances
    - $50,000 each for 400 PAs, 2004-06
    - $0.1M each for 500 & 600 PAs, 2004-06
    - $0.1M for 400 PAs, 2007
    - $0.2M each for 500 & 600 PAs, 2007
  - award bonuses: $50,000 each for Gold Glove, All Star selection
  - trade-Protection (Veto for moving the team without his acceptance): limited no-trade clause (may block deals to 10 clubs)
  - Other
    - housing allowance: $28,000 in 2004, $29,000 in 2005, $30,000 in 2006, $31,000 in 2007
    - interpreter, trainer, transportation for spring & regular season
    - 4 annual round-trip airline tickets from Seattle to Japan

Incentivised Contracts

- Eric Sogard, 2nd-baseman, single-year contract with Milwaukee Brewers (2018)
  - fixed Payment- $2.4M
  - performance bonuses- : $0.15M each for 30, 50, 70, 90 games. $50,000 for 120 games
- Alex Avila, Catcher, two-year contract with Arizona Diamondbacks (2018, 2019)
  - Fixed Payment- 18:$4M, 19:$4.25M
  - annual performance bonuses: $25,000 each for 350, 400 plate appearances. $50,000 each for 450, 500 PA. $0.1M for 550 PA.

Table: RDD for the Grouped Sample by Time, Only Including FA Players

index, cutpoint	bw, type		'87-'94	'95-2003	2004-	full sample
AVG, .300	LATE	bw	.060	.032	.039	.026
		Obs.	218	229	354	509
		estimate	-.026	-.309	-.186	-.253
			(.247)	(.182)	(.182)	(.138)
		z	-.108	-1.700	-1.020	-1.832
AVG, .250	LATE	bw	.018	.023	.078	.058
		Obs.	123	227	716	1367
		estimate	.425	.293	.047	.084
			(.281)	(.230)	(.103)	(.082)
		z	1.512	1.272	-.448	1.020
HR, 20	LATE	bw	5.35	3.504	3.566	3.50
		Obs.	47	70	102	206
		estimate	.004	-.701	-.337	-.273
			(.284)	(.492)	(.513)	(.296)
		z	-1.600	-1.423	-.657	-.924
OBP, .350	LATE	bw	.034	.042	.031	.043
		Obs.	154	344	395	1044
		estimate	.080	-.174	.115	.021
			(.291)	(.179)	(.188)	(.107)
		z	.276	-.971	.616	.196

Note: ***: $p < 0.1\%$, **: $p < 1\%$, *: $p < 5\%$.
Bandwidth is optimized following the method of Imbens-Kalyanaraman.