Examining the Effects of NCAA Aluminum Bat Restrictions on Offensive Team Performance, 2010—2011

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Aluminum bats in NCAA baseball

- Non-wood bats used exclusively since 1974
- Various changes to date
- 1986:
  - Length-to-weight ratio reduced from -3 oz. to -5 oz.
  - Increased bat speed, ball exit speed

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Aluminum bats in NCAA baseball

- 1998:
  - Impose upper limit on ball exit speed ratio (BESR)
  - Reduce the diameter of the barrel from 2.75 in. to 2.50 in.
  - Increase length-to-weight ratio back to -3 oz.
  - Impose lower limit on bat's moment of inertia (MOI)

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Aluminum bats in NCAA baseball

- 2008:
  - NCAA College Baseball Rules Committee issued mandatory restrictions on non-wood bat construction
  - Effective in 2011
  - Previous bats were too dangerous
  - Teams were modifying the structure to improve performance

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Aluminum Bats in NCAA Baseball

- Ball exit speed ratio (BESR)
  - Ratio of inbound and rebound speeds of the ball
    - Min. = 0.712 (29 in. bat)
    - Max. = 0.754 (36 in. bat)
- Bat-ball coefficient of restitution (BBCOR)
  - Manufactured to perform similarly to wood
  - Max. limit = 0.500

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Questions

- Will team strategy and performance be influenced by NCAA aluminum bat regulations?
  - Will teams hit fewer homeruns as a result of bat regulations?
  - If so, will teams decide to employ more sacrifice bunts and/or stolen bases to compensate for the decline in bat performance?

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Hypotheses

- NCAA baseball teams will, on average, hit fewer home runs as a result of bat restrictions.
- Similarly, teams will employ a variety of game- and strategy-related decisions such as increasing sacrifice bunts and stolen bases as a result of bat restrictions.

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Data

- NCAA Div. I baseball team statistics for years 2010– 2011
- 2010: Bat = BESR
- 2011: Bat = BBCOR
- Data location:

  http://www.ncaa.com/stats/baseball/d1

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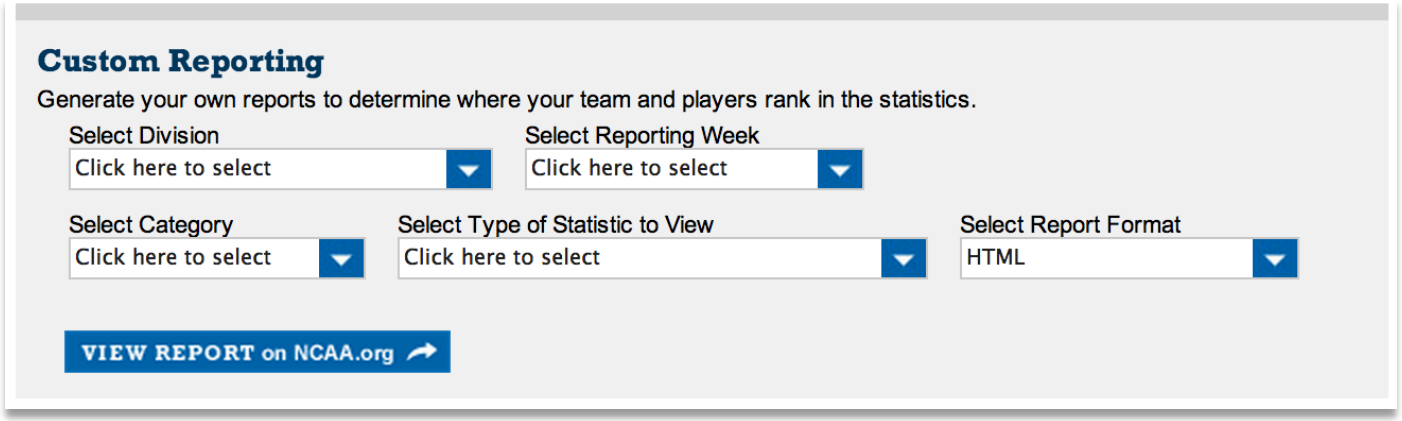
Data

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 bat   yr gms o.ab o.h o.ba o.r o.rpg o.2b o.2b.pg o.3b o.3b.pg o.hr o.hr.pg o.tb o.slg o.sb o.cs
  1 2011  58 1948 656 0.34 541   8.9  146    2.70   36    0.73   86    1.51 1109  0.52  159   34
  1 2011  55 1923 622 0.32 495   8.5  130    2.45   29    0.64   80    1.36  965  0.50  155   47
  1 2011  60 2083 666 0.32 509   8.2  149    2.40   27    0.64   81    1.33 1036  0.49  134   35
  1 2011  61 2145 685 0.32 382   8.0  132    2.40   28    0.51   80    1.31 1028  0.49  117   30
  1 2011  53 1992 635 0.32 455   7.7  136    2.39   27    0.48   60    1.09  933  0.49   93   23
  1 2011  63 2158 687 0.32 453   7.4  152    2.34   24    0.48   64    1.05 1034  0.48  116   40
---
bat   yr gms o.ab o.h o.ba o.r o.rpg o.2b o.2b.pg o.3b o.3b.pg o.hr o.hr.pg o.tb o.slg o.sb o.cs
  0 2010  54 1860 553 0.30 394   6.7  112    1.93   12    0.23   41    0.87  657  0.45   58   40
  0 2010  56 2011 607 0.30 344   6.9  123    1.98   15    0.27   46    0.88  823  0.45   64   20
  0 2010  60 2111 682 0.32 407   8.0  134    2.31   17    0.34   60    1.30 1081  0.51  100   24
  0 2010  53 1855 505 0.27 309   5.3   73    1.52    7    0.13   25    0.48  717  0.38   27   21
  0 2010  54 1918 585 0.31 436   7.0  112    2.04   15    0.25   49    0.91 1077  0.46   65   25
  0 2010  62 2125 675 0.32 393   7.7  116    2.19   17    0.31   71    1.16  928  0.49   81   26
```

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Variables

- Predictor
  - Bat type
    - `BESR`
    - `BBCOR`
- Outcomes
  - Home runs (`o.hr`)
  - Sacrifice bunts (`o.sh`)
  - Stolen bases (`o.sb`)

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Procedures

- MANOVA
- Shapiro-Wilk tests for multivariate normality
- Multivariate effect sizes ($\eta^2 = 1 - \Lambda_W$)
- Univariate effect sizes (Cohen's *d*)
- Post-hoc univariate 95% CIs about each mean difference

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Descriptives

- Home runs (2010/2011)
  - Min. = 7/7
  - Max. = 117/86
- Sacrifice bunts (2010/2011)
  - Min. = 4/9
  - Max. = 77/89
- Stolen Bases (2010/2011)
  - Min. = 19/15
  - Max. = 216/160

Descriptives

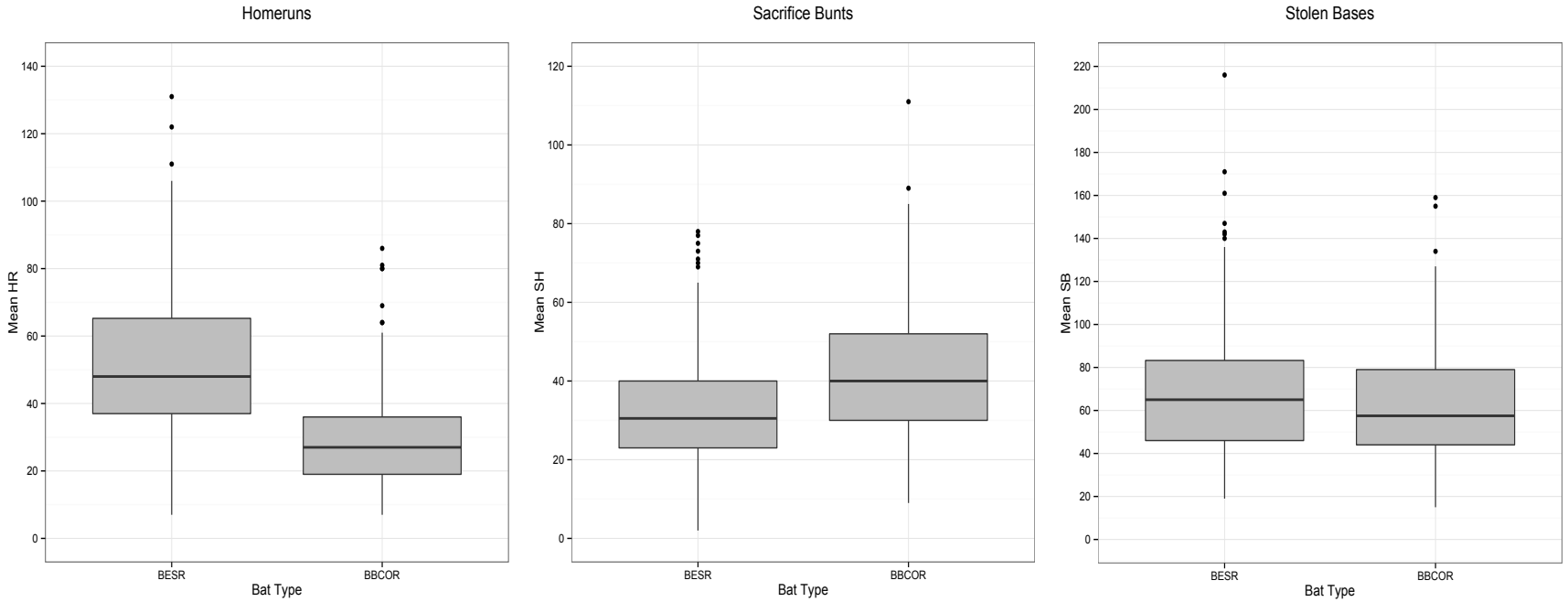
Table 1

Mean Scores and Standard Deviations for Measures of Offensive Production as a Function of Bat Type

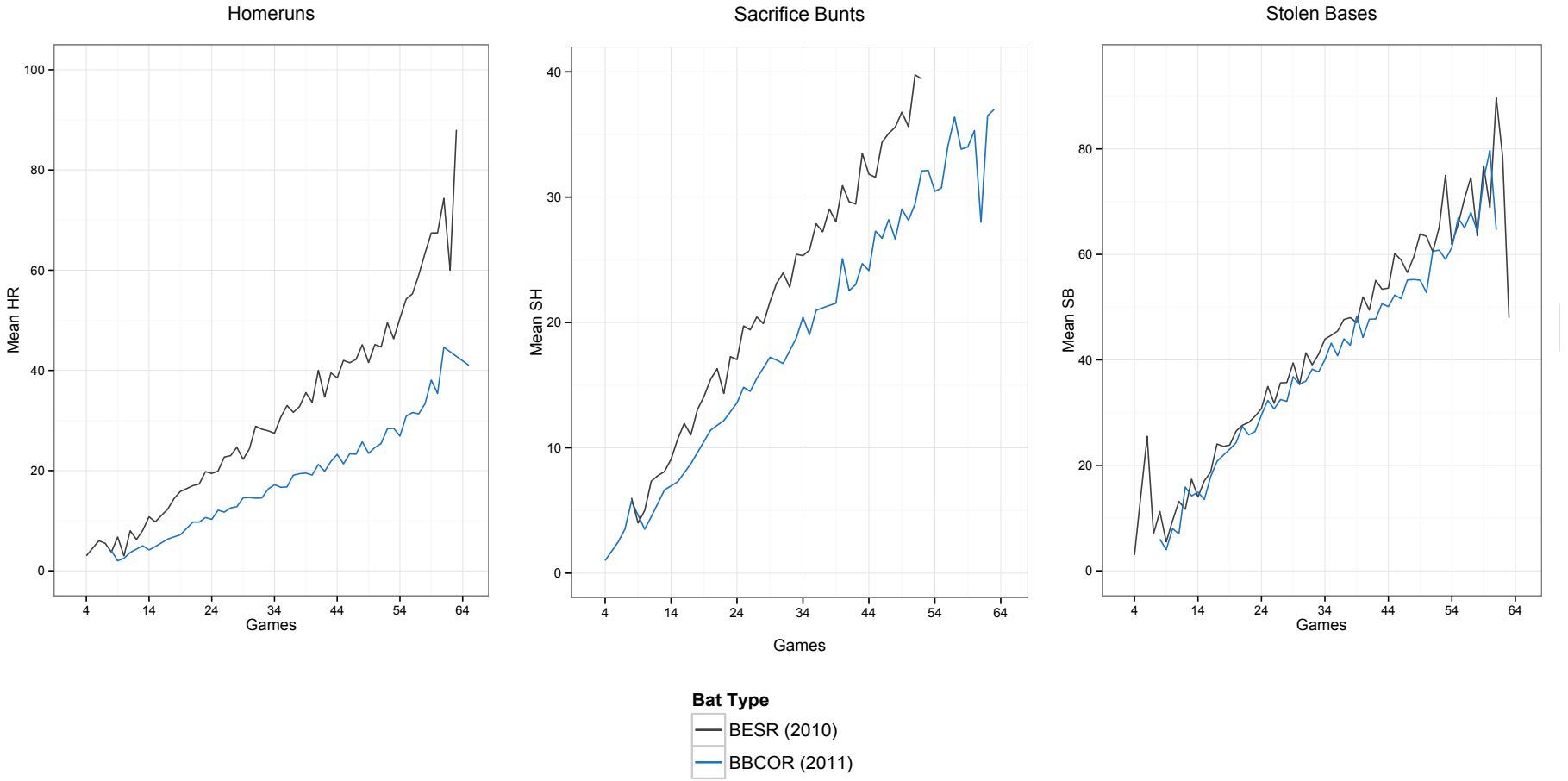
	Home Runs		Sacrifice Bunts		Stolen Bases	
Bat Type	μ	σ	μ	σ	μ	σ
BESR	50.91	20.66	32.28	13.32	66.81	28.33
BBCOR	28.44	13.40	41.03	15.58	61.40	24.44

Note. BESR = ball exit speed ratio, BBCOR = ball-bat coefficient of restitution, $N = 292$.

Mean Predictor Visualization



Season Trends among Predictors



Multivariate & Univariate Analyses

Table 2

Multivariate and Univariate Analyses of Variance for BBCOR Bats

	Multivariate			Univariate				
	T^2	Λ_W	η^2		F	Int. [95% CI]	B [95% CI]	ΔR^2
BBCOR	--	--	--	HR	241.44***	50.91[48.91, 52.91]	-23.45 [-25.31, -19.63]	0.293
	0.51	0.66	0.34	SH	52.74***	32.28[30.60, 33.96]	8.87[6.39, 11.12]	0.082
	--	--	--	SB	6.23*	66.81[63.77, 69.85]	-5.40[-9.71, -1.10]	0.014

Note. Λ_W = Wilks' lambda, T^2 = Hotelling's T, η^2 = Eta squared, Int. = Intercept, B = Unstandardized beta, ΔR^2 = Adjusted R square, HR = home runs, SH = sacrifice bunts, SB = stolen bases,
*** $p < 0.001$, *** $p < 0.01$, * $p < 0.05$.

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Variability

- Wilks' lambda (Λ_W) indicates approximately 66% of variability among differences between years remains unexplained
- Conversely, approximately 34% of variability among differences between years is explained by predictors

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Home Runs

- As expected, declined sharply in 2011
- As a result, teams predicted to hit 20 – 26 fewer HRs per season
- Strongest effect observed ($d = 1.3$)
- No surprise since many NCAA teams may have been accustomed to utilizing BESR bats

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Sacrifice Bunts

- As expected, teams executed more sacrifice bunts
- As a result, teams predicted to execute 6 – 11 more SHs per season
- Moderate effect observed ($d = 0.68$)
- Likely a result of teams attempting to manufacture runs

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Stolen Bases

- Stolen bases actually declined in 2011
- Hypothesized they would increase
- Lack of practical significance in model results

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Conclusions

- Findings indicate sizable main effects of bat type on team home run and sacrifice bunt totals
- Variability among stolen bases not meaningful
- Future studies should include subsequent years, pitching and defensive predictors

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Thanks y'all!

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http://github.com/aaronbaggett/NCAA

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