Resource Optimization Under Asymmetric Spillovers in the NFL

Satyam Anand Jeremy Rosen

Georgetown University

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Motivation

- How do we value an individual's contribution to a team?
  - Performance matters, but so does their influence on their colleagues
  - Leadership: Jensen Huang, Jeff Bezos, etc. How to quantify their value?
  - See also "glue employee" (Levy 2025), who quietly boosts others
- Resource optimization under critical position-driven asymmetric spillovers
  - To allocate resources, decision-maker (DM) must identify each position's marginal productivity, which requires identifying any spillovers
  - Spillovers occur when some positions' observed qualities depend on other positions' true qualities. Distinct from complementarities
  - Challenge steepens when productivity of many positions depends disproportionately on ex-ante known critical position (e.g. supervisor)
  - We provide framework, but how to estimate parameters with public data?

NFL as Laboratory

- Sports are "beautiful" laboratory for economics (Palacios-Huerta 2025)
  - NFL teams allocate resources across diverse set of positions
  - Positional performances observable & team objectives transparent
  - Quarterback is critical position, exerting greater influence over teammates than vice versa (Groysberg, Hecht & Naik 2019)
- National Football League (NFL) is multi-billion dollar industry
  - Every team worth $\geq$\$5.25B & salary cap = \$279.2M
- Teams have changed their valuation of critical position
  - Since 2018, expensive veteran QB contracts have grown faster than cap: "QB salary explosion. . . over past several years" (Corry 2024)

Research Questions

1. How should representative NFL team allocate its salary cap?
   - 53 players across 18 positions: 8 offense, 7 defense, 3 special teams
   - Cheaper rookie (i.e. 1st 4 years) & more expensive veteran salary scales
   - Teams maximize wins since they aren't allowed to maximize profits over wins by spending less on players (Coates, Ivanov & Parshakov 2024)
2. How much does QB performance contribute to wins?
   - To find optimal allocation, must identify importance (performance $\Rightarrow$ wins) & cost effectiveness (spending $\Rightarrow$ performance) for each position
   - **Problem:** Asymmetric QB spillovers (Groysberg, Hecht & Naik 2019)
   - **Solution:** To identify QB's marginal win productivity, use in-season QB changes (e.g. injuries) to isolate contribution from teammates

⏩ Football Positions

Economics Literature

Contribution: Asymmetric spillovers framework & empirical application[1]

- **Spillover Effects:** Moretti (2004); Falk & Ichino (2006); Gould & Winter (2009); Guryan, Kroft & Notowidigdo (2009); Mas & Moretti (2009); Nguyen & Nielsen (2014); Lazear, Shaw & Stanton (2015); Arcidiacono, Kinsler & Price (2017)
- **Production Functions:** Scully (1974); Frank (1984); Herkenhoff, Lise, Menzio & Phillips (2024); Collard-Wexler & De Loecker (2025)
- **Sports as a Laboratory:** Rottenberg (1956); Fort & Quirk (1995); Romer (2006); Vrooman (2009); Massey & Thaler (2013); Coates, Ivanov & Parshakov (2024); Palacios-Huerta (2025)

[1] Sports papers highlighted in yellow

Football Literature

- **Mulholland & Jensen (2019):** How to allocate cap across positions?
  - Identify importance & cost effectiveness. Solve constrained optimization
  - **Conclusion:** Some positions correctly valued, others misvalued
- **Gregory-Smith (2021):** Does QB pay match productivity?
  - Use injuries to identify how much QB pay yields 1 more win/season
  - How much revenue does 1 more win/season generate?
  - **Conclusion:** $\sim$\$10M for both $\Rightarrow$ Teams correctly value QBs

Outline

Asymmetric Spillovers Definition

- Let $y =$ output, $q =$ observed quality, $Q =$ true quality, and $p =$ position:

$$y = f(q_1(Q_1, \ldots, Q_P), \ldots, q_P(Q_1, \ldots, Q_P))$$

- Jacobian of q with respect to Q is $J_q = \begin{bmatrix} \frac{\partial q_1}{\partial Q_1} & \cdots & \frac{\partial q_1}{\partial Q_P} \\ \vdots & \ddots & \vdots \\ \frac{\partial q_P}{\partial Q_1} & \cdots & \frac{\partial q_P}{\partial Q_P} \end{bmatrix}$

Definition 1

Spillovers if J_q is not diagonal. Asymmetric spillovers if J_q is asymmetric.

- Hessian of f with respect to q is $H_f = \begin{bmatrix} \frac{\partial^2 f}{\partial Q_1^2} & \cdots & \frac{\partial^2 f}{\partial Q_1 \partial Q_P} \\ \vdots & \ddots & \vdots \\ \frac{\partial^2 f}{\partial Q_P \partial Q_1} & \cdots & \frac{\partial^2 f}{\partial Q_P^2} \end{bmatrix}$

Definition 2

Complementarities if H_f is not diagonal. If f is $\mathcal{C}^2$, then H_f is symmetric.

Asymmetric Spillovers Misattribution

- **Example:** Suppose 2 positions with convex combination spillovers:

$$q_{1i} = \theta_{10} + \theta_{11} Q_{1i} + (1 - \theta_{11}) Q_{2i} + u_{1i}$$
$$q_{2i} = \theta_{20} + \theta_{21} Q_{2i} + (1 - \theta_{21}) Q_{1i} + u_{2i}$$

- Suppose f is linear in parameters (Cobb-Douglas if variables in logs)

$$y_i = \beta_0 + \beta_1 q_{1i} + \beta_2 q_{2i} + \epsilon_i$$

- We can also model complementarities with an interaction term:

$$y_i = \beta_0 + \beta_1 q_{1i} + \beta_2 q_{2i} + \beta_{12} q_{1i} q_{2i} + \epsilon_i$$

Theorem 1 (Proof)

Suppose $0 \leq \theta_{21} < \theta_{11} \leq 1$ *and* $0 < \text{AME}_{q_1} \leq \text{AME}_{q_2}$.
Then $\text{AME}_{q_1} - \text{AME}_{Q_1} < 0$ *and* $\text{AME}_{q_2} - \text{AME}_{Q_2} > 0$.

Constrained Least Squares

- Without loss of generality, suppose data only let us identify AME_{Q_1}, such as by selection on unobservables. Can we recover AME_{Q_2}?
  - **Example:** Position 1 is critical position with ample performance data. Other positions numerous, interchangeable, and/or hard to measure
  - With 2 regressors, constrained least squares (CLS)'s formula is:

$$\beta_2^C = \beta_2 + \frac{\text{Cov}(q_1, q_2)}{\text{Var}(q_2)}(\beta_1 - \beta_1^C)$$

Theorem 2 (Proof)

The slope coefficient from regressing q_1 on $(1, q_2)$ is strictly positive. If it equals 1, then $\beta_2^C = \text{AME}_{Q_2}$. That is, CLS perfectly recovers AME_{Q_2}.

★ **Upshot:** In more complicated settings, CLS is a reasonable approach

Asymmetric Spillovers Evidence

Table 1: Asymmetric Spillovers Results, 1,788 Fixed Effects ($N = 14,476$)

DV = Standardized Fantasy Points	Quarterback	Skill Position
Standardized Log Quarterback Injured Money	-.1529***	**-.1515*** **
	(.0353)	**(.0351)**
Standardized Log Skill Position Injured Money	**-.0209**	-.0264*
	(.0148)	(.0145)
Standardized Log Non-Skill Position Injured Money	.0060	-.0195
	(.0147)	(.0150)
Standardized Log Opponent Injured Money	.0042	.0216
	(.0143)	(.0146)
Home	.1442***	.1541***
	(.0186)	(.0186)
P-Value: QB → Skill = Skill → QB		**.0007**
R^2		.3166
Adjusted R^2		.2211

*p<0.10, **p<0.05, ***p<0.01. Game-clustered standard errors are in parentheses.

- Effect of QB injuries on skill position fantasy points several times the magnitude of skill postion injuries on QB fantasy points

⏩ Full Results ⏩ Asymmetric Spillovers Summary Statistics

Outline

Cap Optimization Model

- Let i = team, j = season, p = position, & c = contract type. Then:

$$\text{Wins}_{ij} = \sum_{p \in P} \beta_p \left(\text{AV}_{ijp,c=\text{Rook}} + \text{AV}_{ijp,c=\text{Vet}} \right) + x_{ij}\delta + \xi_i + \eta_j + \epsilon_{ij},$$

where $\forall$ positions & contract types (by diminishing returns to *Cap%*):

$$\text{AV}_{ijpc} = \alpha_{pc} \log(\text{Cap\%}_{ijpc}) \mathbb{1}(\text{Cap\%}_{ijpc} > 0) + \alpha'_{pc} \mathbb{1}(\text{Cap\%}_{ijpc} = 0) + x_{ij}\delta_{pc} + \xi_{ipc} + \eta_{jpc} + \nu_{ijpc}.$$

- In each season, each representative (not individual) team solves:

$$\max_{\text{Cap\%}_{ijpc}} \widehat{\text{Wins}}_{ij}, \text{ where } \forall c \in \{\text{Rook}, \text{Vet}\} : \sum_{p \in P} \text{Cap\%}_{ijpc} = 100\%,$$

with optimal interior positional & contract type allocations:

$$\text{Cap\%}^*_{ijpc} = \text{Cap\%}^*_{pc} = \frac{100\% \hat{\beta}_p \hat{\alpha}_{pc}}{\sum_{p \in P} \hat{\beta}_p \hat{\alpha}_{pc}}.$$

▸▸ General Model

What Is an Equilibrium?

- Representative team can't change rookie vs. veteran allocation
  - Rookie budget = non-negotiable 4-year contracts based on draft position
  - Therefore, Veteran Budget = Salary Cap − Rookie Budget
  - Individual team can $\uparrow$ ($\downarrow$) rookie budget by trading for (away) picks, but representative team can't since every buyer requires seller
- Representative team can change allocation within contract type
  - Can increase veteran QB allocation by paying QB more
  - Can increase rookie QB allocation by drafting QB higher
- **Upshot:** Markets clearing are: $\forall c \in C$, $\sum_{(p,c)\in P\times C} a^*_{pc} = 100\%$

Cap Optimization Data

- Cap from *Spotrac* (2025), all else from *Pro Football Reference* (2025)
- Data start in 2011 since 2011 CBA set up modern rookie contracts
  - Used to be much more expensive (Clayton 2011), e.g. Sam Bradford
  - Data end in 2024, so 14 years total (7 pre-2018 & 7 post-2018)
- Industry-standard performance statistic is Approximate Value (AV)
  - Exists for all positions on same scale at season level (Drinen 2008)
  - MVP $\approx$ 20, average starter $\approx$ 10, worst starter $\approx$ 0
- Controls x are *Vegas Wins O/U* & *2011 Indianapolis Colts*
  - *Coach of the Year* votes dummy is function of *Wins*, so omit for now
  - Use *17 Game Season* or *Season* instead of *Season FEs* to preserve df

⏩ Cap Optimization Summary Statistics

Cap Optimization Results

- Importance coefficients reasonable, except QB's importance $<$ WR's
  - Most offense AVs positively correlated (e.g. QB & WR/TE)
  - QB may have asymmetric positive spillovers on teammates (Groysberg, Hecht & Naik 2019) that interactions can't identify (Calvetti 2023)
- Could Table 3's optimal QB allocations be too low as a result?
  - Overdrafted by 2.4%pt & overpaid by 3.5%pt (not significant)
  - QB's bootstrap CIs (1,000 iterations) wide due to multicollinearity
- 1.6%pt mean absolute difference between actual & optimal allocations
  - Still, some positions significantly over/underallocated
  - Also, optimal LS allocation (not significantly) $<0\%$ since $\hat{\beta}_{LS} < 0$

⏩ AV Correlations

QB Importance Coefficient Low

Table 2: Baseline Importance & Cost Effectiveness Results ($N = 448$)

	Importance (DV = Wins) Coefficient	Cost Effectiveness: Rookies (DV = Position AV) log(Cap%)	R^2 [Adj R^2]	Cost Effectiveness: Veterans (DV = Position AV) log(Cap%)	R^2 [Adj R^2]
Quarterbacks AV	**.0966****	1.8601***	.3961	3.3879***	.5762
	(.0417)	(.2144)	[.3432]	(.2962)	[.5390]
Running Backs AV	**.1198*****	3.7807***	.3467	3.4248***	.4915
	(.0266)	(.4996)	[.2895]	(.2385)	[.4469]
Wide Receivers AV	**.1325*****	6.1095***	.3999	4.9145***	.4631
	(.0278)	(.5842)	[.3489]	(.3873)	[.4161]
Tight Ends AV	.0785**	1.1534***	.2788	1.9266***	.4727
	(.0319)	(.1500)	[.2156]	(.2010)	[.4265]
Left Tackles AV	.0729***	1.3365***	.4773	1.8242***	.5267
	(.0218)	(.1195)	[.4315]	(.1021)	[.4852]
Guards AV	.0822***	2.4859***	.4655	3.2490***	.4688
	(.0208)	(.3566)	[.4187]	(.3481)	[.4223]
Centers AV	.0854**	1.2721***	.4845	2.0915***	.4941
	(.0377)	(.1214)	[.4394]	(.1668)	[.4498]
Right Tackles AV	.0877	1.5697***	.4895	1.8328***	.4624
	(.0283)	(.1168)	[.4448]	(.1877)	[.4153]
Long Snappers AV	**-.0429**	.1679***	.7537	.4281***	.4952
	(.0895)	(.0137)	[.7322]	(.0586)	[.4510]
R^2	.8231				
Adjusted R^2	.7998				

*p<0.10, **p<0.05, ***p<0.01. Team-clustered standard errors are in parentheses.

- Asymmetric spillovers $\Rightarrow \hat{\beta}_{QB} = .0966 < .1325 = \hat{\beta}_{WR}$
- Simultaneity (teams run more when ahead) $\Rightarrow \hat{\beta}_{RB} = .1198$
- Cost effectiveness coefficients >0 & significant at 1% level

⏩ Full Results ⏩ Cost Effectiveness Graphs ⏩ $\sqrt{\text{Cap\%}}$ Cost Effectiveness

Optimal QB Allocations Low

Table 3: Actual vs. Baseline Optimal Allocations, Team-Clustered Bootstrap Confidence Intervals

	Rookies				Veterans			
	Actual	Optimal	95% CI	Difference	Actual	Optimal	95% CI	Difference
Quarterbacks	**6.8%**	**4.5%**	**(1.1%, 9.1%)**	**2.4%**	**11.0%**	**7.5%**	**(1.9%, 14.1%)**	**3.5%**
Running Backs	7.1%	11.2%	(5.7%, 18.4%)	-4.1%	5.2%	9.5%	(5.6%, 14.1%)	-4.3%
Wide Receivers	12.3%	20.1%	(12.2%, 27.6%)	-7.8%	11.3%	15.0%	(9.3%, 21.5%)	-3.7%
Tight Ends	4.9%	2.2%	(0.2%, 4.0%)	2.7%	5.0%	3.5%	(0.4%, 5.7%)	1.6%
Left Tackles	4.8%	2.4%	(0.9%, 3.8%)	2.4%	5.1%	3.1%	(1.2%, 4.7%)	2.1%
Guards	6.9%	5.1%	(2.3%, 7.8%)	1.9%	6.0%	6.2%	(2.9%, 9.2%)	-0.2%
Centers	2.6%	2.7%	(0.6%, 5.0%)	-0.1%	3.4%	4.1%	(0.9%, 7.9%)	-0.7%
Right Tackles	4.0%	3.4%	(1.3%, 5.5%)	0.5%	3.3%	3.7%	(1.4%, 5.8%)	-0.4%
Defensive Ends	9.1%	6.4%	(4.0%, 10.0%)	2.7%	8.9%	7.3%	(4.9%, 10.2%)	1.6%
Defensive Tackles	7.3%	6.9%	(4.0%, 9.8%)	0.4%	7.4%	5.9%	(3.8%, 8.2%)	1.5%
Inside Linebackers	5.8%	5.3%	(2.9%, 7.8%)	0.5%	5.2%	6.4%	(3.8%, 9.2%)	-1.2%
Outside Linebackers	8.3%	9.1%	(6.6%, 12.0%)	-0.8%	7.9%	8.1%	(5.8%, 11.0%)	-0.2%
Cornerbacks	11.4%	12.4%	(7.7%, 18.1%)	-0.9%	9.8%	9.0%	(6.3%, 12.3%)	0.8%
Free Safeties	3.9%	5.3%	(3.1%, 7.3%)	-1.4%	3.6%	6.3%	(3.7%, 8.9%)	-2.7%
Strong Safeties	3.6%	2.3%	(1.1%, 3.7%)	1.3%	3.2%	3.4%	(1.6%, 5.8%)	-0.2%
Kickers	0.4%	0.2%	(-0.6%, 1.1%)	0.2%	1.8%	0.3%	(-0.9%, 1.4%)	1.5%
Punters	0.6%	0.7%	(-0.6%, 1.9%)	-0.1%	1.2%	1.1%	(-0.9%, 2.8%)	0.1%
Long Snappers	0.3%	-0.2%	(-0.9%, 0.6%)	0.5%	0.7%	-0.4%	(-2.3%, 1.2%)	1.1%

⏩ Delta-Method CIs ⏩ $\sqrt{\text{Cap\%}}$ Allocations

Complementarities

- Using Calvetti (2023)'s interactions, we test for complementarities
  - QB×WR, RB×OL, QB×TE, LT×(OL−LT), QB×(Off−QB), Off×Def
  - Find that offense & defense submodular (Billick & Dale 2020)
- Must still identify QB's marginal win productivity. How to proceed?
  - Recall interactions can't identify *asymmetric* QB spillovers
  - *Pro Football Focus* (2025) player grades theoretically exogenous, but private & subjective. Other statistics not available for all positions
  - **Approach:** Exploit teams' within-season QB changes

⏩ Interactions ⏩ Restricted Translog

Outline

QB Valuation Overview

- **Goal:** Identify QB's marginal win productivity using game-level data
  - 32 teams, 14 seasons, 16–17 games/season $\Rightarrow N \approx 7,296$
  - QB stats: passer rating, Adjusted Net Yards per Attempt (Stuart 2012), Total ANY/A, & Fantasy Points per Attempt (NFL Support 2025)
    - Include game-level fantasy points for non-QB skill positions
    - FP unavailable for some positions $\Rightarrow$ also select on unobservables
- **Identification Strategy:** Teams changing QBs within season
  - **Example:** 2014 Cardinals 6–0 with Carson Palmer (95.6 passer rating), but 5–5 with Drew Stanton (78.7) & Ryan Lindley (56.8)
  - Teams may change QBs for non-injury reasons (e.g. benching), but biases from unfair benchings generally cancel out
  - $\sim$60% of our observations from teams with $>$1 QB/season

⏩ QB Statistics ⏩ QB Valuation Summary Statistics

QB Valuation Assumption 1

- **Goal:** Control for QB's teammates & opponents

Assumption 1

Teammate & opponent abilities stable for team within season

- 448 team-season FEs control for QB's teammates & opponents
  - Is Assumption 1 valid? Enough for FEs to purge most endogeneity
- How about within-season unobservables FEs don't control for?
  - Include *Home*, *Rest Days*, *Log Injured Money*, *Starter Gini*, & *Starter/Non-Starter* (Gregory-Smith 2021), plus *Non-QB Fantasy Points*
  - *Non-QB Fantasy Points* control for teammate & opponent quality

QB Valuation Assumptions 2 & 3

Assumption 2

Each QB's ability constant within season

Assumption 3

Any other unobservables constant across QBs within season

- We construct proxy variables (e.g. *Season Passer Rating*):
  1. For each game, identify QBs with ≥ 1 passing attempt (*Att*)
  2. Proxy variable weighted (by *Att*) average of QBs' season values
  - ★ Proxy reflects ability, not unobservables, & helps identify asymmetric spillovers, as proxy on QB-season level but fantasy points on game level
- Are Assumptions 2 & 3 valid? Robustness checks:
  - **A2:** Drop rookie (Year 1) primary QBs who may improve in season ✓
  - **A3:** Drop primary QBs who weren't primary QB ≥ 4 games ✓

QB Valuation Model

- **Goal:** Estimate game win probability conditional on team & opponent
- Team i's quality in game t of season j is $Win^*_{ijt} = x_{ijt}\beta + \xi_{ij} + \epsilon_{ijt}$
  - Similarly, opponent k's quality is $Win^*_{kjt} = x_{kjt}\beta + \xi_{kj} + \epsilon_{kjt}$
  - x_{ijt} contains *QB Statistic*, *Non-QB Fantasy Points*, & other controls
  - ξ_{ij} is team-season fixed effect ($I \times J = 448$, but drop 2017 Browns)
  - ϵ_{ijt} has Type 1 extreme value distribution
- Then $PWin_{ijt} = \frac{\exp(x_{ijt}\beta+\xi_{ij})}{\exp(x_{ijt}\beta+\xi_{ij})+\exp(x_{kjt}\beta+\xi_{kj})}$ (and $PWin_{kjt} = 1 - PWin_{ijt}$)
  - Estimate with ML: $\mathcal{L} = \prod_{ijt} PWin_{ijt}^{Win_{ijt}}(1 - PWin_{ijt})^{1-Win_{ijt}}$
  - Marginal effects of β are $ME_{ijt} = PWin_{ijt}(1 - PWin_{ijt})\beta$

Why Season Proxy, Not Instrument?

- Ordinarily, we'd use *Season Passer Rating* as instrument. However:
- Logit incompatible with instruments due to T1EV error distribution
  - Still, we try IV on linear analogue (could also try probit)
- Season variable same scale as game variable, so can use it as proxy
  - Can interpret its coefficient as if it were game variable
- Most importantly, exclusion restriction is violated!
  - Season variable affects *PWin* via additional channel
    - More likely to win if starter's game passer rating is 90 than backup's since starter more likely to play well in important moments
  - When used as proxy, season variable uncorrelated with error

Why Season Proxy, Not Season/Game Control?

- Despite being confounder, season variable insufficient as control
  - **Problem:** $\exists$ many other unobservables (e.g. non-QB statistics)
  - **Result:** Season control barely changes game variable's AME
- Can't use game variable as control for season variable either
  - **Problem:** Game variable mediator for season variable
  - **Result:** Game control drops season variable's AME too low
- We try removing Q4 from instrument to eliminate "clutch factor"
  - Borusyak & Hull (2022) eliminate endogenous part of instrument
  - **Problem:** Starters better at executing 2 minute drill at end of 1st half, avoiding failed completions, not padding stats in Q3 garbage time, etc.
  - **Result:** Coefficient drops from .0077 to .0066, but still too high

⏩ Directed Acyclic Graph

Season AME Most Accurate

Table 4: QB Valuation Results, Passer Rating, 447 Fixed Effects ($N = 7,238$)

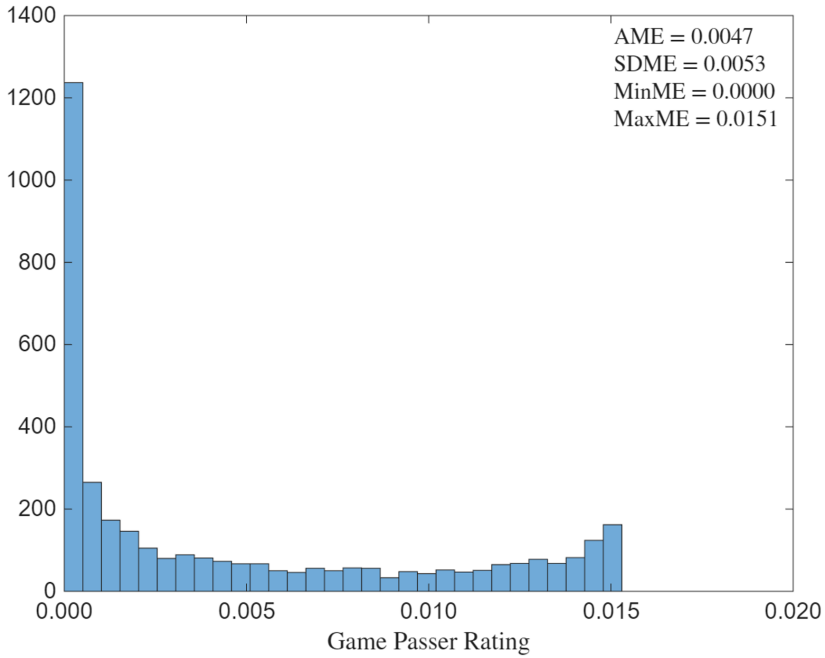
DV = Win	Game		Season		Game, Season IV	
	Logit	AME	Logit	AME	Q1-Q4	Q1-Q3
Passer Rating	.0603***	.0047***	.0352***	**.0035*** **	.0077***	.0066***
	(.0037)	(.0002)	(.0081)	**(.0008)**	(.0014)	(.0017)
Non-QB Fantasy Points	.1098***	.0085***	.1331***	.0133***	.0038**	.0050***
	(.0065)	(.0004)	(.0056)	(.0003)	(.0016)	(.0018)
Home	.2593***	.0201***	.2473***	.0247***	.0163***	.0169***
	(.0684)	(.0052)	(.0563)	(.0056)	(.0057)	(.0057)
Pseudo-R^2 | R^2	.6424		.5452		.5492	.5606
Adjusted Pseudo-R^2 | R^2	.6410		.5439		.5200	.5322

*p<0.10, **p<0.05, ***p<0.01. Game-clustered standard errors are in parentheses.

- *Season*'s .0035 AME implies 10.98 pt (1 SD) ↑ in season passer rating ⇒ 3.87%pt ↑ in win probability ⇒ .63 more wins/season
- Worst to best QB = 5.58 SD ↑ ⇒ 3.52 more wins/season

▸▸ Full Results ▸▸ ANY/A, TANY/A, & FP/A ▸▸ No Rookies, ≥4 Games

Marginal Effects, Passer Rating



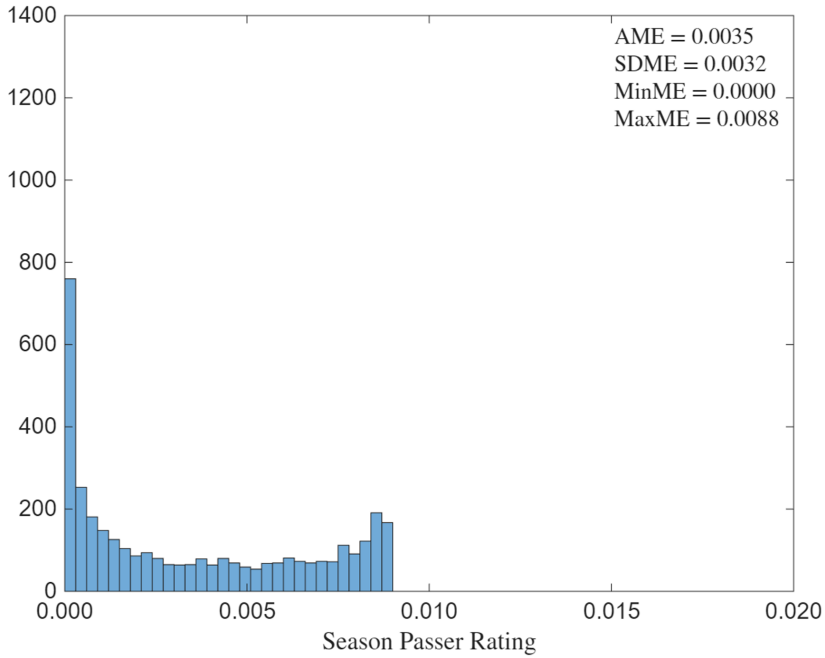


Figure 1: Distributions of Marginal Effects, Passer Rating

- QB ability matters more when teams evenly matched
  - *Season Passer Rating* has less predictive power than *Game Passer Rating*
  - But *Non-QB Fantasy Points* has enough predictive power for *Season* to yield fitted values far enough from .5 to retain *Game*'s right skew

▸▸ ANY/A, TANY/A, & FP/A

Counterfactual Simulations

- Use QB valuation model to simulate each team's season 10,000 times
- **Counterfactuals:** Change value of *Season Passer Rating*:
  1. **2019 Buccaneers:** What if they had 2020 Tom Brady?
  2. **2019 Redskins:** What if they had 2020 Tom Brady?
  3. **2015 Broncos:** What if Peyton Manning were still elite?
  4. **2014 Cardinals:** What if Carson Palmer didn't get hurt?
- **Upshot:** Due to logit model, QB effect (correctly) largest for teams neither too weak (e.g. 2019 Redskins) nor strong (e.g. 2015 Broncos)
  - **Outlier:** 2020 Buccaneers went 11–5 (not 8–8) & won Super Bowl
  - But Brady improved QB play *and* changed team culture (Giardi 2021)

.500 Teams Gain Most from Better QB

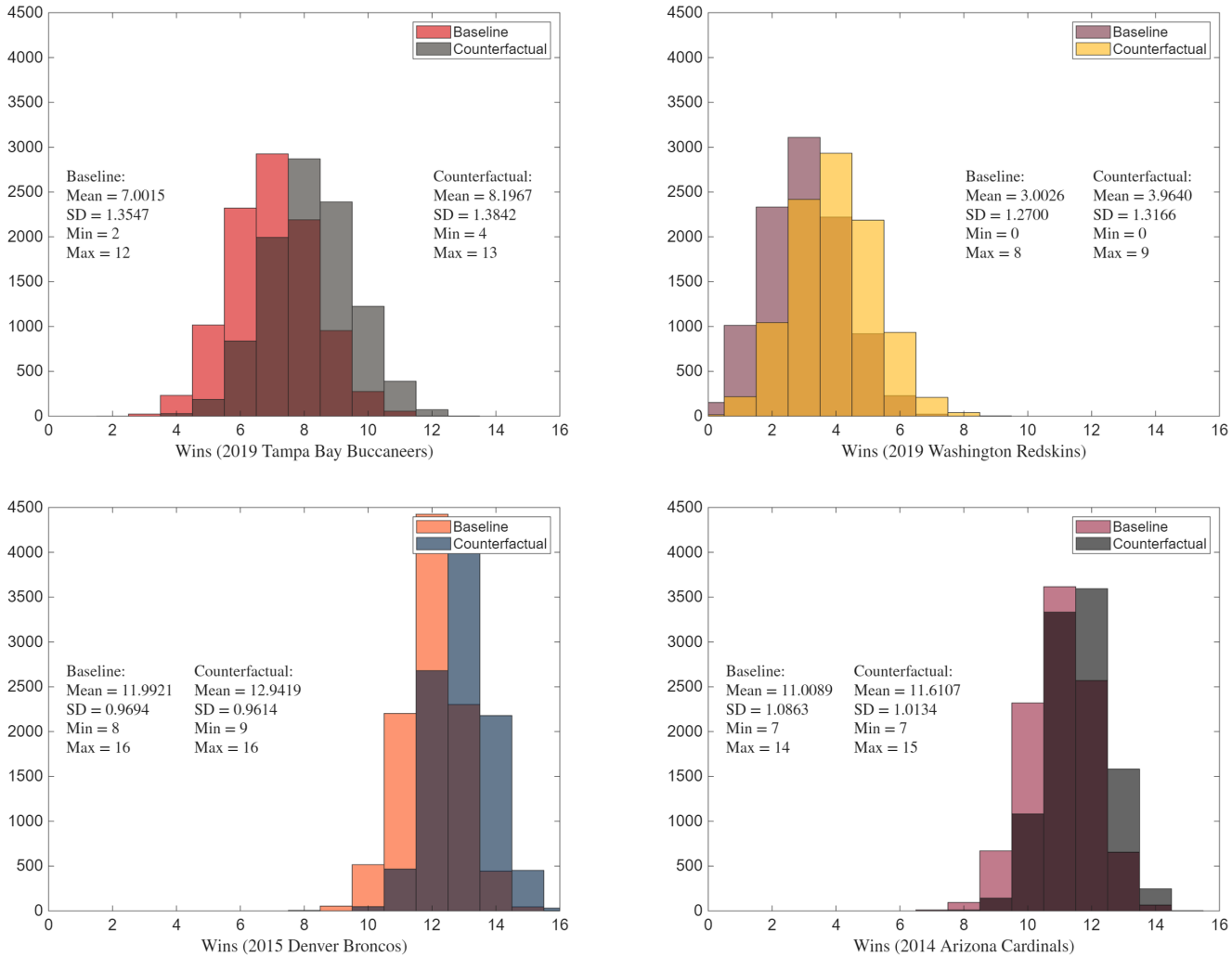


Figure 2: Distributions of Simulated Wins, Season Passer Rating

▶▶ Game Passer Rating

Outline

Calibrating Importance Regression

- **QB:** Use QB MWP estimates to calibrate optimal allocations
  - Constrain *QBAV* coefficient in importance regression with optimal weights
  - $\hat{\beta}^{C}_{QB} = \overline{T}\left[\widehat{\text{AME}} \circ \frac{\sigma}{\sigma_{\text{QBAV}}}\right]' \frac{\hat{\Sigma}^{-1}\iota}{\iota'\hat{\Sigma}^{-1}\iota}$, where $\overline{T} \approx 16.3$ games per season
- **RB**: Recall *RBAV* is function of *Wins*, inflating $\hat{\beta}_{\text{RB}}$ (simultaneity)
  - *Coach of the Year* controls for coaching, but is also function of *Wins*
  - Including *COTY* decreases $\hat{\beta}_{\text{RB}} \Rightarrow$ benefits of inclusion $>$ costs
- **LS:** Sometimes $\hat{\beta}_{p} < 0$ (e.g. $\hat{\beta}_{LS}$) $\Rightarrow$ optimal allocation $<0\%$
  - $\text{Wins}_{ij} = \hat{\beta}^{C}_{QB}\text{AV}^{\text{QB}}_{ij} + \text{AV}^{\neg\text{QB}}_{ij} e^{\log(\beta_{\neg\text{QB}})} + x_{ij}\delta + \xi_i + \eta_j + \epsilon_{ij}$
- **Results:** Calibrated QB coefficient & allocations higher
  - Per Table 5, calibrated QB coefficient $>$ baseline coefficient
  - Per Tables 3 & 6, baseline QB allocations outside calibrated's 95% CIs
  - 1.4%pt mean absolute difference between actual & optimal allocations
  - LT, rookie TE, & veteran K significantly overallocated

Calibrated QB Coefficient Higher

Table 5: Baseline vs. Calibrated Importance Results, Team Fixed Effects ($N = 448$)

DV = Wins	Baseline	Calibrated	Calibrated COTY
Quarterbacks AV	**.0966****	**.1538*****	**.1538*****
	(.0417)	**(.0364)**	**(.0364)**
Running Backs AV	**.1198*****	**.1139*****	**.0867*****
	(.0266)	**(.0260)**	**(.0259)**
Wide Receivers AV	.1325***	.1163***	.1015***
	(.0278)	(.0228)	(.0222)
Tight Ends AV	.0785**	.0615**	.0580**
	(.0319)	(.0281)	(.0271)
Left Tackles AV	.0729***	.0617***	.0541***
	(.0218)	(.0217)	(.0206)
Guards AV	.0822***	.0739***	.0674***
	(.0208)	(.0199)	(.0209)
Centers AV	.0854**	.0790**	.0692**
	(.0377)	(.0351)	(.0346)
Right Tackles AV	.0877***	.0777***	.0597**
	(.0283)	(.0284)	(.0270)
Long Snappers AV	**-.0429**	**.0000**	**.0000**
	(.0895)	**(.0379)**	**(.0342)**
Coach of the Year			**1.4936*****
			(.2475)
R^2	.8231	.8221	.8441
Adjusted R^2	.7998	.8164	.8391
Standard Errors	Team-Clustered	TC Bootstrap	TC Bootstrap

*p<0.10, **p<0.05, ***p<0.01. Standard errors are in parentheses.

- $\hat{\beta}^{C}_{QB} = .1538 > .1015 = \hat{\beta}_{WR}$
- $\hat{\beta}_{RB} \downarrow$ with $COTY$ included
- $COTY$ votes $\Leftrightarrow$ 1.5 more wins
- $\hat{\beta}_{LS}$ now 0, not < 0

⏩ Full Results ⏩ Cost Effectiveness Results, COTY ⏩ $\sqrt{\text{Cap\%}}$ Cost Effectiveness Results, COTY

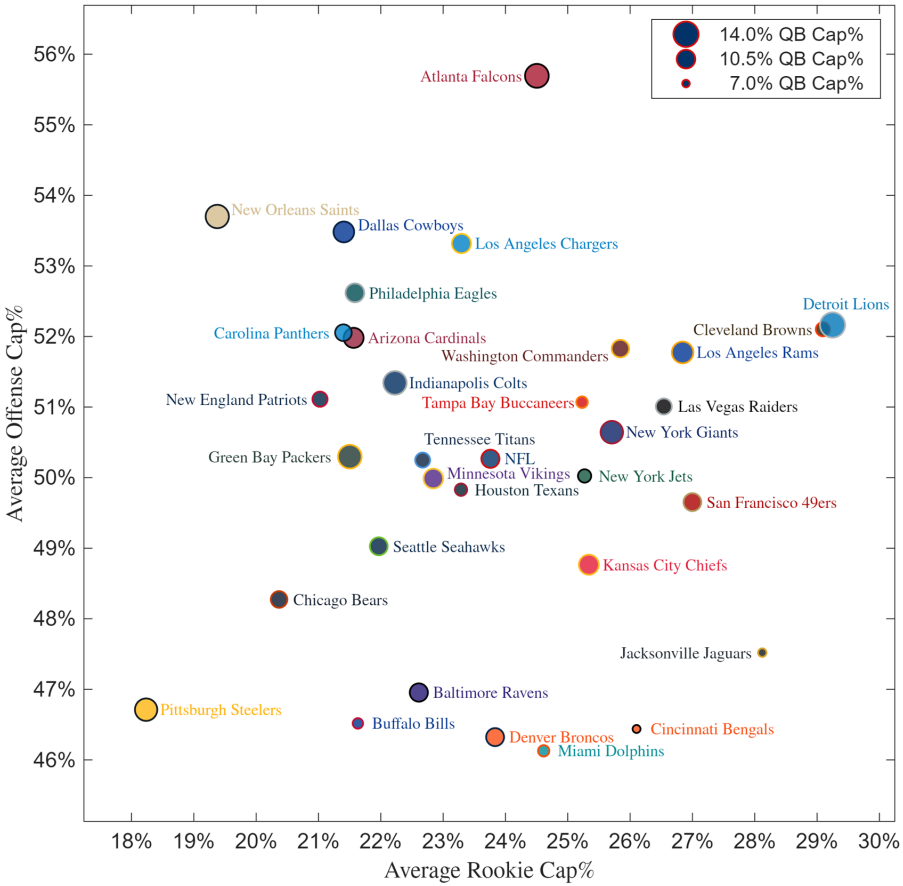
Calibrated QB Allocations Higher

Table 6: Actual vs. Calibrated Optimal Allocations, Team-Clustered Bootstrap Confidence Intervals

	Rookies				Veterans			
	Actual	Optimal	95% CI	Difference	Actual	Optimal	95% CI	Difference
Quarterbacks	**6.8%**	**8.2%**	**(4.5%, 13.9%)**	**-1.4%**	**11.0%**	**13.7%**	**(8.1%, 22.1%)**	**-2.6%**
Running Backs	7.1%	9.7%	(3.7%, 16.6%)	-2.6%	5.2%	7.8%	(3.6%, 12.7%)	-2.7%
Wide Receivers	12.3%	18.3%	(9.5%, 26.4%)	-6.1%	11.3%	12.9%	(7.0%, 18.1%)	-1.7%
Tight Ends	4.9%	2.0%	(0.0%, 3.9%)	2.9%	5.0%	2.9%	(0.0%, 5.2%)	2.2%
Left Tackles	4.8%	2.1%	(0.4%, 3.6%)	2.7%	5.1%	2.5%	(0.5%, 4.2%)	2.6%
Guards	6.9%	4.9%	(1.7%, 8.2%)	2.0%	6.0%	5.8%	(2.0%, 9.7%)	0.2%
Centers	2.6%	2.6%	(0.0%, 5.1%)	0.0%	3.4%	3.8%	(0.0%, 7.7%)	-0.4%
Right Tackles	4.0%	2.7%	(0.1%, 5.2%)	1.2%	3.3%	2.9%	(0.1%, 5.4%)	0.4%
Defensive Ends	9.1%	6.3%	(3.9%, 9.7%)	2.8%	8.9%	6.9%	(4.4%, 9.9%)	1.9%
Defensive Tackles	7.3%	7.2%	(4.6%, 10.1%)	0.1%	7.4%	6.0%	(3.9%, 8.4%)	1.4%
Inside Linebackers	5.8%	5.9%	(3.4%, 8.6%)	-0.2%	5.2%	7.0%	(4.3%, 9.6%)	-1.8%
Outside Linebackers	8.3%	9.7%	(7.1%, 12.8%)	-1.4%	7.9%	8.5%	(5.9%, 11.8%)	-0.6%
Cornerbacks	11.4%	11.8%	(7.0%, 17.6%)	-0.4%	9.8%	8.3%	(5.5%, 11.6%)	1.5%
Free Safeties	3.9%	4.9%	(2.5%, 7.0%)	-1.0%	3.6%	5.7%	(2.9%, 8.4%)	-2.1%
Strong Safeties	3.6%	2.5%	(1.0%, 4.0%)	1.1%	3.2%	3.6%	(1.3%, 6.1%)	-0.3%
Kickers	0.4%	0.2%	(0.0%, 1.1%)	0.2%	1.8%	0.3%	(0.0%, 1.4%)	1.5%
Punters	0.6%	1.0%	(0.0%, 2.3%)	-0.4%	1.2%	1.4%	(0.0%, 3.2%)	-0.2%
Long Snappers	0.3%	0.0%	(0.0%, 0.6%)	0.3%	0.7%	0.0%	(0.0%, 1.3%)	0.7%

⏩ $\sqrt{\text{Cap\%}}$ Allocations

Heterogeneity Across Teams



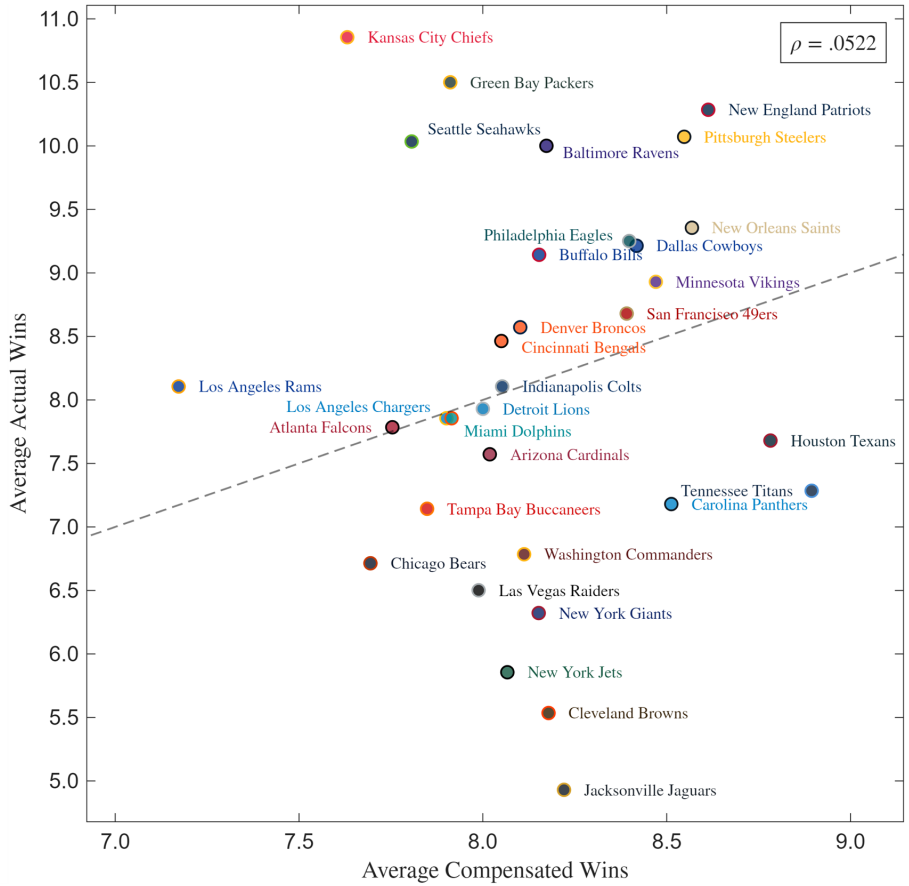


Figure 3: Actual Allocations & Actual vs. Compensated Wins

$$\text{CompWins}_i = \frac{1}{14}\sum_{j=2011}^{2024}\Big\{\sum_{p\in P}\hat{\beta}_p \sum_{c\in\{\text{Rook},\text{Vet}\}}[\hat{\alpha}_{pc}\log(\text{Cap\%}_{ijpc})\mathbb{1}(\text{Cap\%}_{ijpc}>0)+\hat{\alpha}'_{pc}\mathbb{1}(\text{Cap\%}_{ijpc}=0)+\hat{\eta}_{jpc}]+\hat{\eta}_j\Big\}$$

Evolution of QB Market

- **Goal:** Track changes in critical position's value & NFL's valuation of it
- Was there actually post-2018 "QB salary explosion" (Corry 2024)?
  - Rerun entire analysis restricting sample to pre-2018 vs. post-2018
  - Per Table 6, actual rookie & veteran QB allocations ↑, but by <1.5%pt
  - Rookie QBs underdrafted post-2018 (25th vs. 7th pick)
- Was explosion limited to expensive veteran QBs?
  - "The **top** of the quarterback market has more than doubled over the last seven years. . . . Cousins broke new ground with the NFL's first lucrative fully guaranteed **veteran** contract during free agency." (Corry)
  - Per difference in differences, post-2018, expensive veteran QB pay significantly increased by 4.31%pt more than other players

⏩ Post-2018 Allocations ⏩ Difference in Differences

Conclusion

1. How should representative NFL team allocate its salary cap?
   - 1.4%pt mean absolute difference between actual & optimal allocations, even though optimal allocations not estimated with choice data
   - LT, rookie TE, & veteran K significantly overallocated
   - Rookie QBs underdrafted post-2018 (risk aversion, slow to adapt?)
2. How much does QB performance contribute to wins?
   - 1 SD $\uparrow$ in performance $\Rightarrow \sim \frac{3}{5}$ additional win per season
   - Worst to best QB $\sim$5.5 SDs $\Rightarrow$ 3.5 additional wins
   - Difference between top 10/32 (i.e. likely playoff) & bottom 10 team

★ **Contribution:** Asymmetric spillovers framework & empirical application
   - Application is NFL due to its vast public data & quarterback position
   - **Future Research:** Apply framework to other settings using internal data

Appendix A: Football Positions

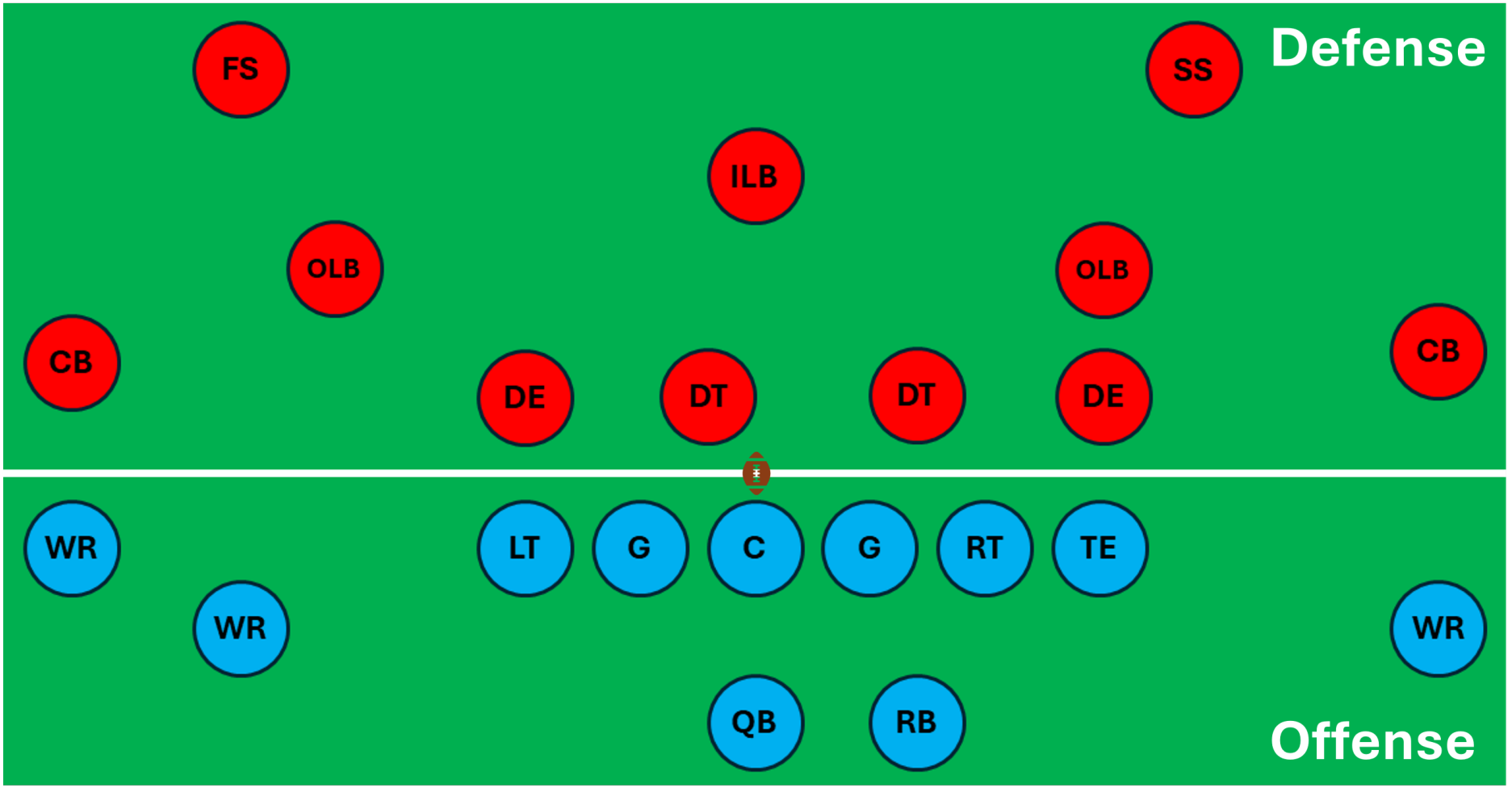


Figure 4: Shotgun Offense vs. Cover 2 Defense

▸▸ Research Questions

Appendix A: Importance & Cost Effectiveness

- Let i = DM, j = long-run optimization period, y = gross objective, q = performance, x = controls/interactions, a = allocation, (ξ, η) = fixed effects, p = position, & p^* = critical position:

$$y_{ij} = \beta_{p^*} q_{ijp^*} + q_{ij\neg p^*} \beta_{\neg p^*} + x_{ij}\delta + \xi_i + \eta_j + \epsilon_{ij},$$

$$\text{where } \forall p \in P,\ q_{ijp} = \alpha_p \frac{a_{ijp}^{1-\gamma}}{1-\gamma} + x_{ij}\delta_p + \xi_{ip} + \eta_{jp} + \nu_{ijp}.$$

- y_{ij}, q_{ijp}, x_{ij}, & a_{ijp} normalized by budget $\bar{a}_{ij}$ (e.g. a = allocation share)
  - Can model single DM with variation in normalized variables across j
- 2-stage model identifies each p's importance & cost effectiveness
  - 1-stage model, or all a_p in 2nd stage $\Rightarrow$ near-perfect multicollinearity
  - Let allocation of $p' \neq p \perp\!\!\!\perp$ performance of p (Mulholland & Jensen 2019)

▸▸ Cap Optimization Model

Appendix A: Resource Optimization

- **Definition:** Equilibrium is set of allocations $\{a_p^*\}_{p \in P}$ such that:
  1. **Optimization:** In each representative j, each representative i solves:

$$\max_{a_{ijp}} \hat{y}_{ij}, \text{ where } \sum_{p \in P} a_{ijp} = 100\%, \text{ and } \forall p \in P, \ a_{ijp} \geq 0\%,$$

     with (if no interactions) optimal interior positional allocations:

$$a_{ijp}^* = a_p^* = \frac{100\%(\hat{\beta}_p \hat{\alpha}_p)^{\frac{1}{\gamma}}}{\sum_{p \in P}(\hat{\beta}_p \hat{\alpha}_p)^{\frac{1}{\gamma}}}.$$

  2. **Market Clearing:** $\frac{1}{IJ} \sum_{(i,j,p) \in I \times J \times P} a_{ijp}^* = \sum_{p \in P} a_p^* = 100\%$

- **Example:** Static competitive market $\Rightarrow$ allocation $= f$(marginal product):
  1. **Optimization:** $\max_{a_{ijp}} \left(\hat{y}_{ij} - \sum_{p \in P} a_{ijp} \right) \Rightarrow a_p^* = (\hat{\beta}_p \hat{\alpha}_p)^{\frac{1}{\gamma}}$
  2. **Market Clearing:** $\sum_{p \in P} a_p^* = \sum_{p \in P} (\hat{\beta}_p \hat{\alpha}_p)^{\frac{1}{\gamma}}$

▸▸ Cap Optimization Model

Appendix A: Asymmetric Spillovers Identification

- What if critical position has *asymmetric* spillovers on other positions?
  - DM will undervalue critical position & overvalue other positions
  - Interactions insufficient, as they can only identify symmetric spillovers
- To identify asymmetric spillovers, first let t = short-run period:

$$y_{ijt} = \tilde{\beta}_{p^*} \tilde{q}_{ijtp^*} + \tilde{x}_{ijt}\tilde{\delta} + \tilde{\xi}_{ij} + \tilde{\epsilon}_{ijt}.$$

- For consistent importance estimate $\hat{\tilde{\beta}}_{p^*}$, need within ij pairs:
  - Short-run critical position performance measure $\tilde{q}$
    - **Assumption 1:** Aggregate stability of other positions' quality $\Rightarrow$ FEs $\tilde{\xi}_{ij}$
    - Controls $\tilde{x}_{ijt}$ account for some instability but may be insufficient
  - If still endogenous, need changes in availabilities of critical resources n
    - **Assumption 2:** Within ij, each n's quality constant across t
    - **Assumption 3:** $\neg p^*$'s quality constant across n (weaker than across t)
    - Use each critical resource's average quality across t within ij as proxy/IV

⏩ Cap Optimization Model

Appendix A: Importance Calibration

- Transform $\hat{\tilde{\beta}}_{p^*}$ to $\hat{\beta}_{p^*}$'s scale, where τ = period conversion factor:

$$\hat{\beta}^C_{p^*} = \tau \hat{\tilde{\beta}}_{p^*} \frac{\sigma_{\tilde{q}_{ijp^*}}}{\sigma_{q_{ijp^*}}}.$$

  - Short-run objective must sum to long-run objective across t within ij
  - Don't need τ if short-run performance sums to long-run performance
  - Don't need σ ratio if short-run performance measure same as long-run

- Finally, use $\hat{\beta}^C_{p^*}$ to calibrate importance equation & re-estimate:

$$y_{ij} = \hat{\beta}^C_{p^*} q_{ijp^*} + q_{ij\neg p^*} \beta_{\neg p^*} + x_{ij}\delta + \xi_i + \eta_j + \epsilon_{ij}.$$

  - **2 Regressor Case:** $\hat{\beta}^C_{\neg p^*} = \hat{\beta}_{\neg p^*} + \rho \frac{\sigma_{q_{p^*}}}{\sigma_{q_{\neg p^*}}} (\hat{\beta}_{p^*} - \hat{\beta}^C_{p^*})$

- Model both general & simple $\Rightarrow$ add features as necessary

▸▸ Cap Optimization Model

Appendix A: p^*'s Relative CE ↑ ⇒ Level Shift Toward $a^*_{p^*}$ ↑

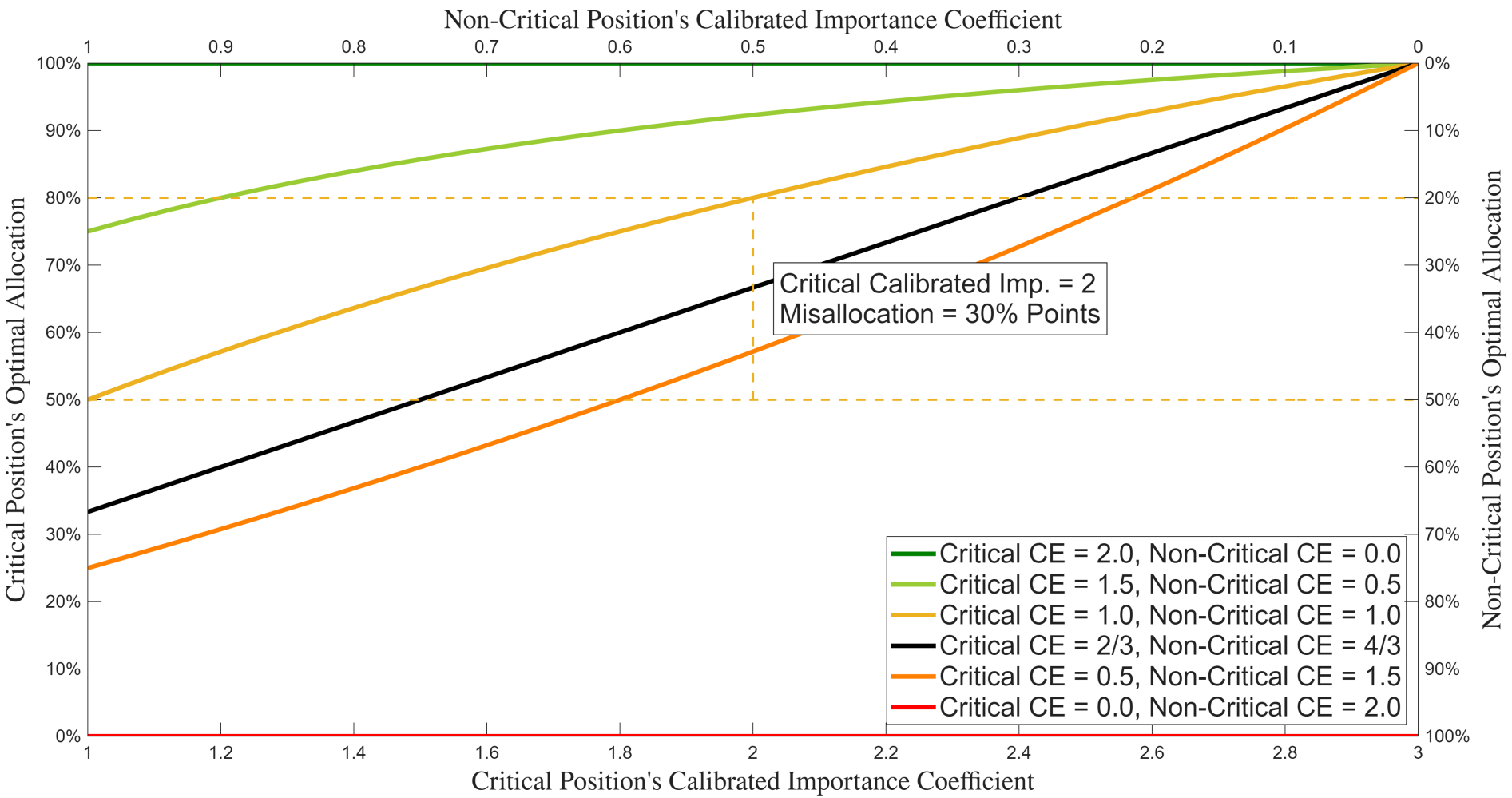


Figure 5: Comparative Statics for $(\alpha_{p^*}, \alpha_{\neg p^*})$

Primitives: $\gamma \to 1$, $\hat{\beta}_{p^*} = \hat{\beta}_{\neg p^*} = 1$, $\sigma^2_{q_{p^*}} = \sigma^2_{q_{\neg p^*}} = 1$, $\rho = 0.5$

⏩ Cap Optimization Model

Appendix A: $\text{Corr}(q_{p^*}, q_{\neg p^*}) \uparrow \Rightarrow$ Marginal Shift Toward $a^*_{p^*} \uparrow$

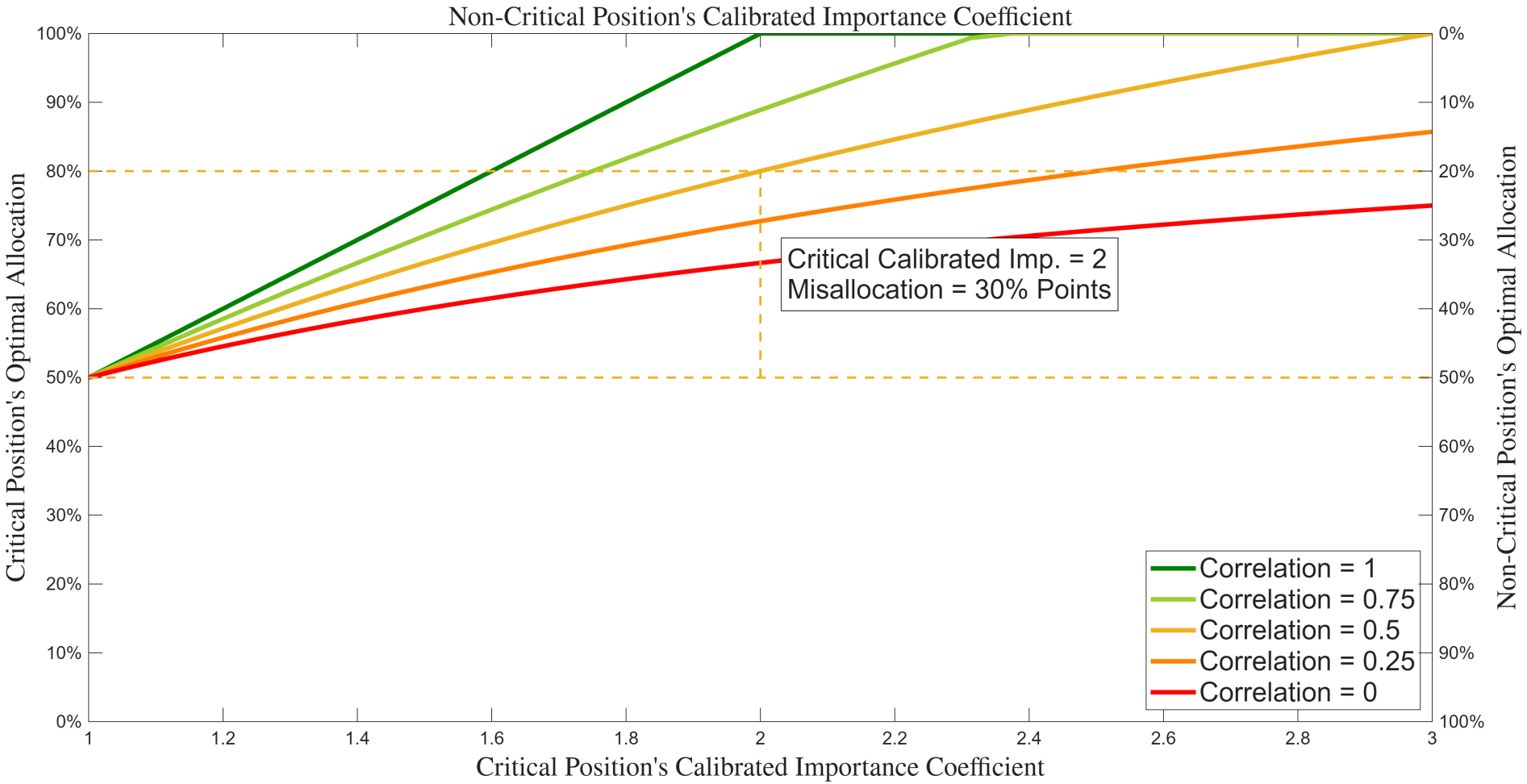


Figure 6: Comparative Statics for ρ

Primitives: $\gamma \to 1$, $\hat{\beta}_{p^*} = \hat{\beta}_{\neg p^*} = 1$, $\sigma^2_{q_{p^*}} = \sigma^2_{q_{\neg p^*}} = 1$, $\alpha_{p^*} = \alpha_{\neg p^*} = 1$

⏩ Cap Optimization Model

Appendix A: Full Asymmetric Spillovers Results

Table 7: Asymmetric Spillovers Results, 1,788 Fixed Effects ($N = 14,476$)

DV = Standardized Fantasy Points	Quarterback	Skill Position
Standardized Log Quarterback Injured Money	-.1529***	**-.1515*** **
	(.0353)	**(.0351)**
Quarterback Injured Money = 0	.1842***	**.1023** **
	(.0406)	**(.0403)**
Standardized Log Skill Position Injured Money	**-.0209**	-.0264*
	(.0148)	(.0145)
Skill Position Injured Money = 0	**.0623**	.0701
	(.0634)	(.0592)
Standardized Log Non-Skill Position Injured Money	.0060	-.0195
	(.0147)	(.0150)
Non-Skill Position Injured Money = 0	.5217**	.2563
	(.2315)	(.2133)
Standardized Log Opponent Injured Money	.0042	.0216
	(.0143)	(.0146)
Home	.1442***	.1541***
	(.0186)	(.0186)
P-Value: QB → Skill = Skill → QB	**.0007**	
R^2	.3166	
Adjusted R^2	.2211	

*p<0.10, **p<0.05, ***p<0.01. Game-clustered standard errors are in parentheses.

⏩ Highlighted Results

Appendix A: Asymmetric Spillovers Summary Statistics

Table 8: Asymmetric Spillovers Summary Statistics, 2011–2024 ($N = 7,238$)

	Mean	SD	Min	Max
Quarterback Fantasy Points	16.25	7.67	0	51.88
Skill Position Fantasy Points	58.24	16.14	0	145.20
Quarterback Injured Money	$2,042,115	$5,778,160	$0	$46,174,540
Skill Position Injured Money	$5,382,689	$5,750,469	$0	$48,465,476
Non-Skill Position Injured Money	$16,110,983	$11,474,997	$0	$82,276,928
Opponent Injured Money	$23,535,787	$15,710,266	$84,022	$133,936,848
Home	0.5	0.5	0	1

⏩ Asymmetric Spillovers Results

Appendix B: Cap Optimization Summary Statistics

Table 9: Cap Optimization Summary Statistics, 2011–2024 ($N = 448$)

	Mean	SD	Min	Max
Wins	8.14	3.11	0	15
Vegas Wins O/U	8.27	1.76	4	13
Coach of the Year	0.21	0.41	0	1
Approximate Value (AV)	206.44	26.82	144	282
Cap Spending	$170,181,777	$40,567,335	$87,714,296	$261,363,792
Rookie AV	85.84	17.64	39	147
Veteran AV	120.60	24.30	61	214
Rookie Cap%	23.76%	6.51%	9.72%	53.86%
Veteran Cap%	76.24%	6.51%	46.14%	90.28%
Offense AV	100.21	21.50	47	170
Quarterbacks AV	12.73	4.00	-3	27
Running Backs AV	14.93	4.15	5	31
Wide Receivers AV	22.42	5.65	8	47
Tight Ends AV	7.09	2.88	1	24
Left Tackles AV	9.03	4.00	0	23
Guards AV	16.56	5.78	3	53
Centers AV	8.61	3.65	0	22
Right Tackles AV	8.85	3.98	0	23
Defense AV	99.54	15.28	61	169
Defensive Ends AV	17.09	7.65	0	41
Defensive Tackles AV	16.44	6.22	2	38
Inside Linebackers AV	14.55	6.67	0	43
Outside Linebackers AV	16.95	6.66	4	48
Cornerbacks AV	18.43	4.84	7	39
Free Safeties AV	8.62	4.17	0	25
Strong Safeties AV	7.46	4.06	0	27
Special Teams AV	6.68	1.80	2	14
Kickers AV	3.14	1.40	-2	8
Punters AV	2.30	0.90	0	6
Long Snappers AV	1.25	0.74	0	6
Offense Cap%	50.27%	5.86%	29.35%	71.52%
Quarterbacks Cap%	10.28%	4.65%	0.64%	26.18%
Running Backs Cap%	5.60%	2.61%	1.54%	14.91%
Wide Receivers Cap%	11.48%	3.76%	3.50%	23.72%
Tight Ends Cap%	5.01%	2.16%	1.27%	15.58%
Left Tackles Cap%	5.10%	2.95%	0.00%	15.37%
Guards Cap%	6.15%	2.82%	0.70%	18.78%
Centers Cap%	3.19%	1.94%	0.00%	10.06%
Right Tackles Cap%	3.45%	2.08%	0.00%	12.22%
Defense Cap%	46.67%	5.82%	27.37%	67.09%
Defensive Ends Cap%	8.94%	4.83%	0.23%	22.88%
Defensive Tackles Cap%	7.40%	4.11%	0.38%	24.22%
Inside Linebackers Cap%	5.28%	2.93%	0.39%	16.00%
Outside Linebackers Cap%	7.98%	4.54%	0.41%	24.63%
Cornerbacks Cap%	10.08%	3.96%	2.19%	22.15%
Free Safeties Cap%	3.66%	2.32%	0.32%	11.99%
Strong Safeties Cap%	3.33%	2.25%	0.15%	12.01%
Special Teams Cap%	3.06%	1.16%	0.90%	9.58%
Kickers Cap%	1.45%	0.83%	0.00%	4.16%
Punters Cap%	1.04%	0.69%	0.00%	4.58%
Long Snappers Cap%	0.57%	0.19%	0.00%	1.20%

⏩ Cap Optimization Data

Appendix B: Strong Correlations Within Offense

Table 10: Correlations of AV Across Positions ($N = 448$)

	QB	**RB**	**WR**	**TE**	**LT**	**G**	**C**	**RT**	DE	DT	ILB	OLB	CB	FS	SS	K	P	LS
Quarterbacks	**1**																	
Running Backs	**.6311**	**1**																
Wide Receivers	**.7379**	**.4555**	**1**															
Tight Ends	**.5202**	**.3713**	**.1758**	**1**														
Left Tackles	**.4213**	**.3315**	**.3245**	**.2574**	**1**													
Guards	**.4587**	**.4344**	**.4020**	**.2860**	**.0450**	**1**												
Centers	**.4161**	**.3452**	**.3276**	**.2800**	**.2388**	**-.0833**	**1**											
Right Tackles	**.3762**	**.2619**	**.3261**	**.2357**	**-.1812**	**-.0769**	**.2105**	**1**										
Defensive Ends	-.0170	.0493	-.0499	-.1022	.0394	-.0227	-.0191	-.1039	1									
Defensive Tackles	.0613	.0503	.0602	.0334	-.0692	-.0044	.0425	.1203	-.2425	1								
Inside Linebackers	-.0440	.0140	-.0777	.0211	.1258	-.0544	-.0309	-.0822	-.1069	-.0008	1							
Outside Linebackers	.0538	.0624	.0539	.1178	.0198	-.0113	.1540	.1200	-.2624	.0051	-.1481	1						
Cornerbacks	-.0079	-.0068	-.0178	-.0566	-.0351	-.0299	-.0607	.0127	.1562	.1836	.1559	.1585	1					
Free Safeties	-.0360	.0303	-.1131	.0612	.0622	-.0322	.0457	-.1619	.0903	.1608	.1925	.0486	.0849	1				
Strong Safeties	.1255	.0625	.1410	-.0360	.0692	-.0230	.0932	.0716	.0160	-.0067	.0116	.0892	-.0317	-.4530	1			
Kickers	.0983	.1159	.0465	.1121	.0712	-.0116	.1109	.0650	-.0444	-.0572	.0194	.0315	.0441	.0182	.0105	1		
Punters	-.2322	-.1267	-.1937	-.0625	-.0744	-.1127	-.1651	-.0883	.0796	-.0866	.0185	-.0172	-.0405	.0168	-.0036	-.0535	1	
Long Snappers	-.0125	.0219	.0032	-.0520	-.0365	.0136	.0621	.0281	.0362	.0184	-.1210	.0492	-.1055	.0052	.0054	.0471	-.0274	1

⏩ Cap Optimization Results

Appendix B: Full Importance & Cost Effectiveness Results

Table 11: Baseline Importance & Cost Effectiveness Results ($N = 448$)

	Importance (DV = Wins)	Cost Effectiveness: Rookies (DV = Position AV)						Cost Effectiveness: Veterans (DV = Position AV)					
	Coefficient	**log(Cap%)**	Cap% = 0	Vegas Wins	2011 Colts	Season	R^2 [Adj R^2]	**log(Cap%)**	Cap% = 0	Vegas Wins	2011 Colts	Season	R^2 [Adj R^2]
Quarterbacks AV	**.0966****	**1.8601*****	-2.6043***	-.0127	-4.1832***	-.0559	.3961	**3.3879*****	-1.4979	1.1076***	-7.9127***	-.0085	.5762
	(.0417)	**(.2144)**	(.3663)	(.1994)	(.5986)	(.0851)	[.3432]	**(.2962)**	(1.3686)	(.1776)	(.5228)	(.0698)	[.5390]
Running Backs AV	**.1198*****	**3.7807*****	-2.4636**	.0811	-5.8766***	.0405	.3467	**3.4248*****	-1.0088**	.4185***	-5.4264***	.0331	.4915
	(.0266)	**(.4996)**	(1.0190)	(.1789)	(.5197)	(.0575)	[.2895]	**(.2385)**	(.4769)	(.1236)	(.4557)	(.0550)	[.4469]
Wide Receivers AV	**.1325*****	**6.1095*****		.0087	-1.1949**	-.0287	.3999	**4.9145*****	.7413	.7676***	-4.9893***	-.0370	.4631
	(.0278)	**(.5842)**		(.1412)	(.4910)	(.0713)	[.3489]	**(.3873)**	(.9078)	(.2225)	(.6741)	(.0932)	[.4161]
Tight Ends AV	**.0785****	**1.1534*****	-.6011***	-.0447	-3.0052***	-.0087	.2788	**1.9266*****	-1.3245***	.3571***	-5.0502***	.0159	.4727
	(.0319)	**(.1500)**	(.1937)	(.1015)	(.3818)	(.0538)	[.2156]	**(.2010)**	(.4127)	(.0916)	(.3846)	(.0462)	[.4265]
Left Tackles AV	**.0729*****	**1.3365*****	-3.0069***	-.0851	-1.7852***	-.0586	.4773	**1.8242*****	-4.0006***	.3742***	1.6398***	.0042	.5267
	(.0218)	**(.1195)**	(.3901)	(.0932)	(.3829)	(.0534)	[.4315]	**(.1021)**	(.3179)	(.1147)	(.4389)	(.0559)	[.4852]
Guards AV	**.0822*****	**2.4859*****	-2.7690***	.3271**	-4.3781***	-.1040*	.4655	**3.2490*****	-5.4888***	.4054***	-1.0670	-.1239	.4688
	(.0208)	**(.3566)**	(.7031)	(.1397)	(.6500)	(.0541)	[.4187]	**(.3481)**	(.6317)	(.1560)	(.6654)	(.0853)	[.4223]
Centers AV	**.0854****	**1.2721*****	-3.0244***	.0758	-.3065	-.0294	.4845	**2.0915*****	-4.5578***	.0806	.0805	-.1121**	.4941
	(.0377)	**(.1214)**	(.2552)	(.1083)	(.3262)	(.0412)	[.4394]	**(.1668)**	(.3586)	(.0954)	(.4563)	(.0477)	[.4498]
Right Tackles AV	**.0877*****	**1.5697*****	-2.9120***	.1865*	1.2033***	-.0475	.4895	**1.8328*****	-4.0504***	.1624	2.9601***	-.0169	.4624
	(.0283)	**(.1168)**	(.3219)	(.1130)	(.2573)	(.0371)	[.4448]	**(.1877)**	(.4294)	(.1195)	(.5478)	(.0590)	[.4153]
Defensive Ends AV	**.0811*****	**3.2037*****	-1.0690	.0210	-.2812	-.0965	.4912	**3.9095*****	-3.5915***	.4044**	-1.7965**	-.0389	.5193
	(.0138)	**(.4376)**	(.8327)	(.1507)	(.4553)	(.0649)	[.4466]	**(.2986)**	(.6171)	(.1868)	(.7049)	(.0813)	[.4772]
Defensive Tackles AV	**.0880*****	**3.1745*****	-2.5036*	-.2246	-.0267	-.1092*	.4798	**2.9213*****	-.5875	.4463***	-1.4581***	.2684***	.4834
	(.0146)	**(.3412)**	(1.4669)	(.1474)	(.5382)	(.0579)	[.4342]	**(.3554)**	(2.4300)	(.1522)	(.4748)	(.0739)	[.4382]
Inside Linebackers AV	**.0905*****	**2.3579*****	-2.2986***	.2096*	6.0805***	-.0681	.4837	**3.0794*****	-3.4558***	.1974	-7.7645***	.0568	.4732
	(.0178)	**(.2911)**	(.5093)	(.1177)	(.3612)	(.0546)	[.4385]	**(.3229)**	(.6633)	(.1762)	(.4627)	(.0641)	[.4270]
Outside Linebackers AV	**.1110*****	**3.2974*****		.0555	-2.2312***	-.0516	.4055	**3.1841*****	-4.2268***	.1972	.5474	.0103	.4403
	(.0144)	**(.4455)**		(.1365)	(.4372)	(.0651)	[.3550]	**(.3234)**	(.8644)	(.1349)	(.7850)	(.0855)	[.3913]
Cornerbacks AV	**.1073*****	**4.6463*****		-.1750	6.9461***	.0542	.3712	**3.6465*****		.4207**	-.1931	-.0056	.4150
	(.0189)	**(.4810)**		(.1522)	(.6406)	(.0792)	[.3178]	**(.3007)**		(.1841)	(.9141)	(.0774)	[.3653]
Free Safeties AV	**.1267*****	**1.6911*****	-2.7087***	.0057	-3.6104***	-.0575	.4208	**2.1529*****	-3.8411***	.2600**	-3.4035***	-.0552	.5155
	(.0285)	**(.1668)**	(.5756)	(.1059)	(.3661)	(.0520)	[.3701]	**(.1795)**	(.3273)	(.1269)	(.4705)	(.0465)	[.4730]
Strong Safeties AV	**.0777*****	**1.1836*****	-2.6172***	-.0267	.6130*	-.0081	.3903	**1.9068*****	-3.3502***	.2613***	-4.2103***	-.0022	.5083
	(.0239)	**(.1236)**	(.3750)	(.1191)	(.3285)	(.0424)	[.3369]	**(.1942)**	(.2370)	(.0919)	(.2634)	(.0383)	[.4652]
Kickers AV	**.0260**	**.3656*****	-1.6991***	.0017	.0733	-.0189	.5062	**.5502*****	-2.5193***	-.0203	.8098***	.0204	.3622
	(.0486)	**(.0414)**	(.1984)	(.0366)	(.1178)	(.0141)	[.4629]	**(.0714)**	(.1302)	(.0500)	(.1062)	(.0154)	[.3064]
Punters AV	**.0831**	**.3377*****	-1.7708***	-.0268	1.0194***	.0081	.7104	**.5497*****	-1.9227***	-.0195	.1752	.0269**	.5804
	(.0815)	**(.0239)**	(.1046)	(.0255)	(.1076)	(.0101)	[.6851]	**(.0705)**	(.0706)	(.0295)	(.1206)	(.0133)	[.5437]
Long Snappers AV	**-.0429**	**.1679*****	-.7781***	-.0032	-.2527***	-.0087***	.7537	**.4281*****	-1.4438***	-.0007	-.4785***	-.0410***	.4952
	(.0895)	**(.0137)**	(.0596)	(.0057)	(.0230)	(.0030)	[.7322]	**(.0586)**	(.1032)	(.0209)	(.0625)	(.0123)	[.4510]
Vegas Wins O/U	**.1172*****												
	(.0437)												
2011 Indianapolis Colts	**-1.6478*****												
	(.3298)												
17 Game Season	**.2212**												
	(.1621)												
R^2	.8231												
Adjusted R^2	.7998												

*p<0.10, **p<0.05, ***p<0.01. Team-clustered standard errors are in parentheses.

▶▶ Highlighted Results

Appendix B: Cost Effectiveness by Position, Rookies

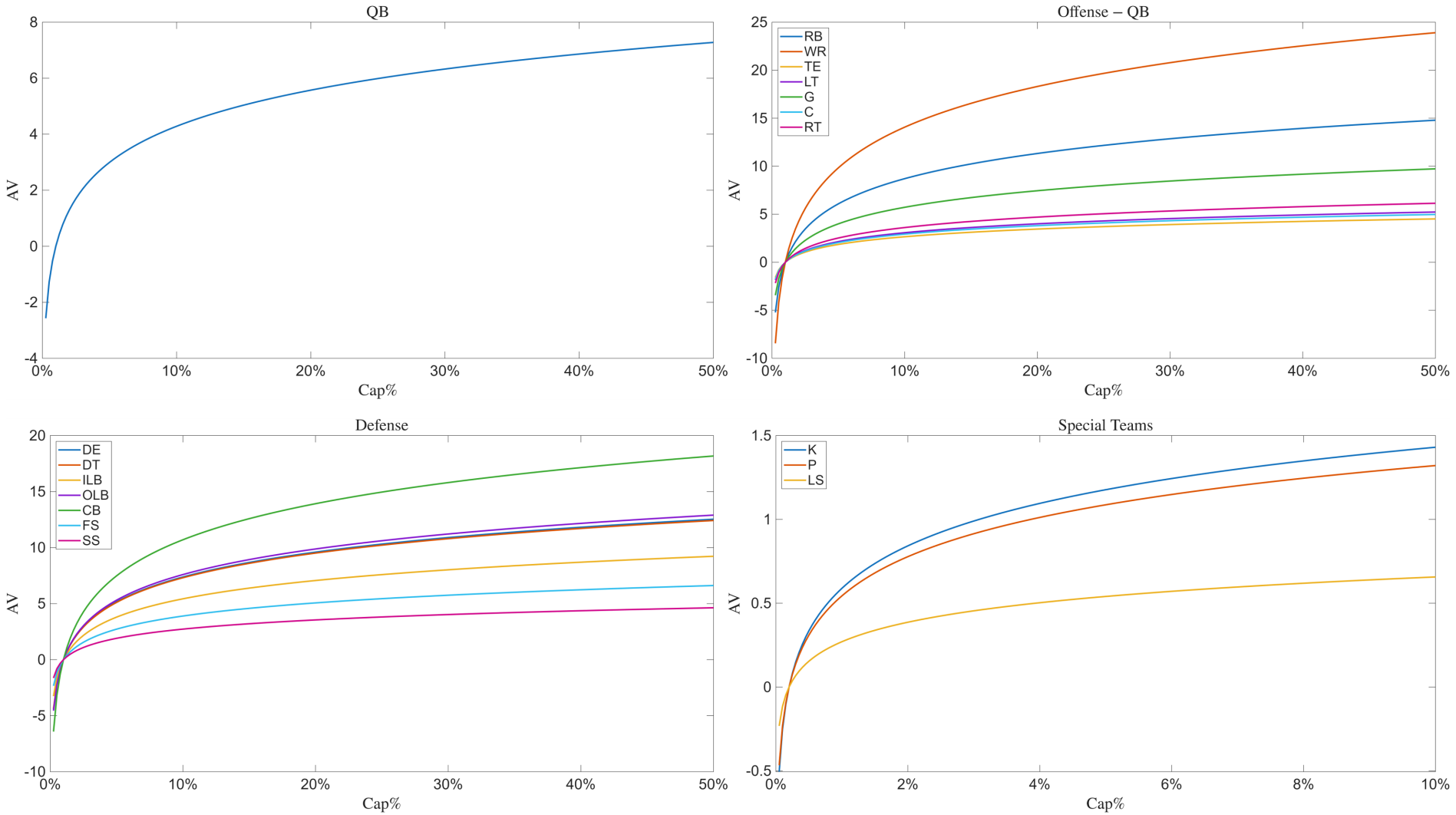


Figure 7a: Cost Effectiveness by Position, Rookies

⏩ Cost Effectiveness Coefficients

Appendix B: Cost Effectiveness by Position, Veterans

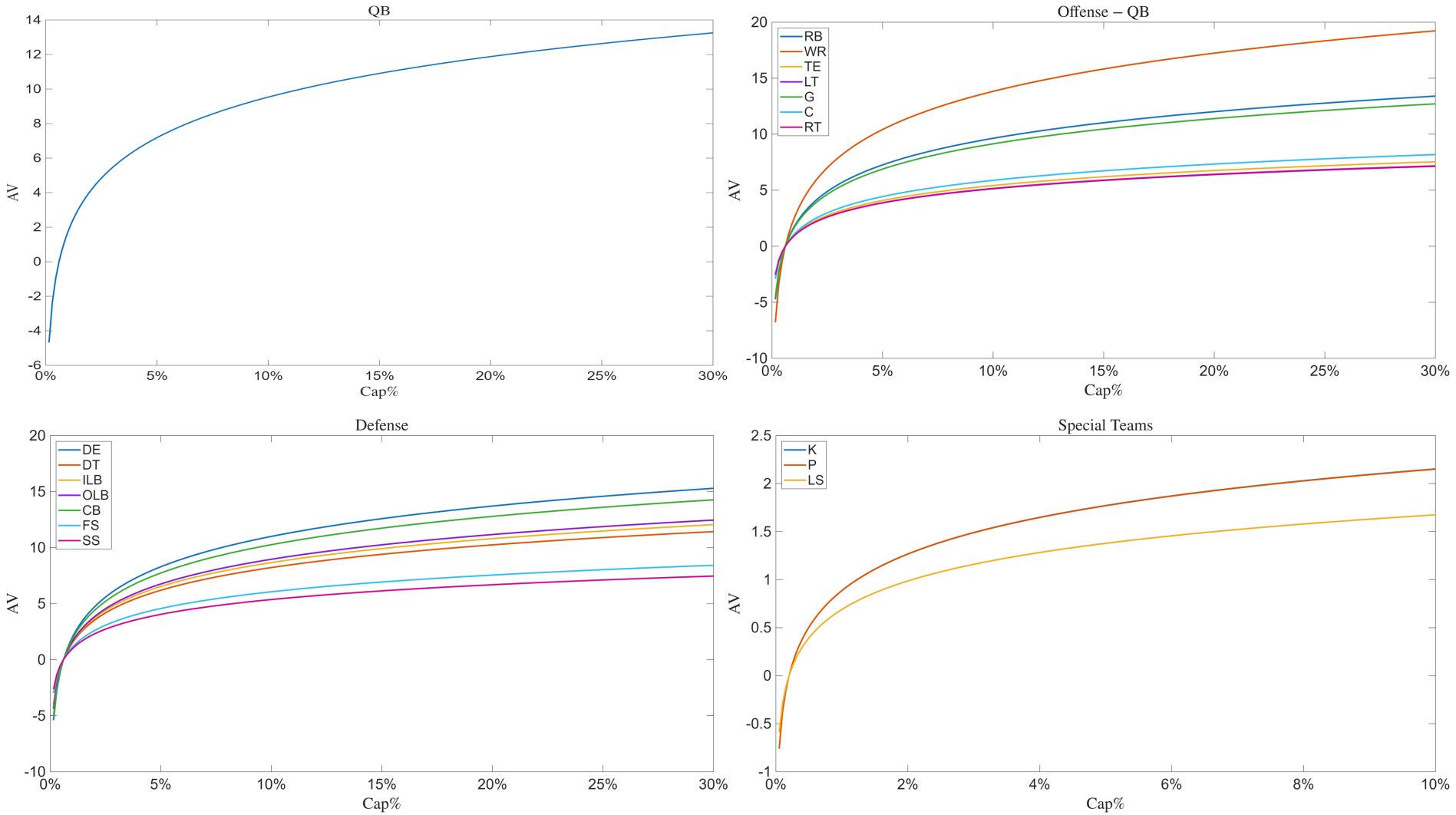


Figure 7b: Cost Effectiveness by Position, Veterans

▶▶ Cost Effectiveness Coefficients

Appendix B: $\sqrt{\text{Cap\%}}$ Cost Effectiveness

Table 12: $\sqrt{\text{Cap\%}}$ Cost Effectiveness Results ($N = 448$)

	Rookies					Veterans				
	$\sqrt{\text{Cap\%}}$	Vegas Wins	2011 Colts	Season	R^2 [Adj R^2]	**$\sqrt{\text{Cap\%}}$**	Vegas Wins	2011 Colts	Season	R^2 [Adj R^2]
Quarterbacks AV	**2.7705*** **	-.0065	-3.5072***	-.0145	.5030	**2.9989*** **	1.1193***	-8.9760***	-.0276	.5780
	(.2006)	(.1586)	(.5610)	(.0781)	[.4607]	**(.1925)**	(.1746)	(.4832)	(.0644)	[.5422]
Running Backs AV	**3.2853*** **	.0845	-5.7588***	.0606	.3380	**3.9022*** **	.4299***	-4.7676***	.0758	.5008
	(.3944)	(.1863)	(.5367)	(.0569)	[.2818]	**(.2830)**	(.1230)	(.4581)	(.0541)	[.4584]
Wide Receivers AV	**3.7418*** **	-.0116	-.8550*	-.0122	.3923	**3.8460*** **	.7693***	-4.9375***	-.0444	.4706
	(.3892)	(.1380)	(.5006)	(.0734)	[.3406]	**(.2617)**	(.2229)	(.6764)	(.0935)	[.4256]
Tight Ends AV	**1.9843*** **	-.0439	-2.4590***	-.0344	.3491	**2.4302*** **	.3383***	-5.1899***	.0212	.4911
	(.1530)	(.0978)	(.3338)	(.0491)	[.2938]	**(.1842)**	(.0896)	(.4059)	(.0443)	[.4478]
Left Tackles AV	**2.5061*** **	-.0417	-1.4687***	-.0013	.6144	**2.8582*** **	.3887***	1.8941***	-.0187	.5459
	(.1925)	(.0859)	(.3655)	(.0464)	[.5817]	**(.1236)**	(.1275)	(.3565)	(.0474)	[.5074]
Guards AV	**3.0057*** **	.2964**	-2.8049***	-.0812	.5071	**4.1376*** **	.3590**	-.4905	-.0948	.4881
	(.2415)	(.1250)	(.5699)	(.0528)	[.4652]	**(.3842)**	(.1509)	(.5673)	(.0832)	[.4446]
Centers AV	**2.7683*** **	.0845	-3.0221***	-.0338	.5916	**3.3839*** **	.0781	-.0355	-.1140**	.4827
	(.1886)	(.0916)	(.3949)	(.0369)	[.5569]	**(.2330)**	(.0993)	(.4690)	(.0468)	[.4387]
Right Tackles AV	**2.8501*** **	.1911*	1.1543***	-.0677*	.5710	**3.4181*** **	.2358**	3.7430***	-.0278	.5235
	(.2175)	(.1076)	(.2527)	(.0351)	[.5346]	**(.1886)**	(.1112)	(.3735)	(.0482)	[.4831]
Defensive Ends AV	**3.4095*** **	-.0580	-.0775	-.1201*	.5918	**4.0227*** **	.3601**	-1.6188**	-.0004	.5442
	(.2153)	(.1379)	(.4416)	(.0631)	[.5571]	**(.2526)**	(.1639)	(.6342)	(.0771)	[.5055]
Defensive Tackles AV	**3.7418*** **	-.3381***	.1758	-.0688	.5756	**3.9678*** **	.4757***	.4891	.2365***	.5442
	(.2255)	(.1202)	(.3944)	(.0522)	[.5395]	**(.2722)**	(.1367)	(.4624)	(.0752)	[.5055]
Inside Linebackers AV	**3.2367*** **	.0814	6.7969***	-.0869**	.5284	**3.9806*** **	.1984	-6.2965***	.0891	.5054
	(.3638)	(.1099)	(.3010)	(.0443)	[.4884]	**(.2565)**	(.1794)	(.4484)	(.0644)	[.4634]
Outside Linebackers AV	**3.2267*** **	.0117	-1.6140***	-.0376	.4506	**3.7837*** **	.3491***	-2.6645***	.0019	.4823
	(.2878)	(.1383)	(.4621)	(.0654)	[.4040]	**(.2332)**	(.1215)	(.5723)	(.0789)	[.4383]
Cornerbacks AV	**3.0240*** **	-.1861	7.3080***	.0546	.3613	**3.3976*** **	.4068**	-2.7342***	.0211	.4346
	(.3407)	(.1588)	(.6348)	(.0801)	[.3070]	**(.2794)**	(.1831)	(.8256)	(.0765)	[.3865]
Free Safeties AV	**2.7575*** **	.0139	-2.9823***	-.0423	.5038	**3.6377*** **	.2407**	-4.7333***	-.0633	.5696
	(.2564)	(.0965)	(.3217)	(.0454)	[.4617]	**(.1995)**	(.1188)	(.4638)	(.0422)	[.5330]
Strong Safeties AV	**2.3800*** **	.0405	.3735	-.0059	.4883	**3.0795*** **	.2684***	-3.8608***	-.0072	.5429
	(.1605)	(.1151)	(.3152)	(.0436)	[.4448]	**(.2661)**	(.1009)	(.2883)	(.0411)	[.5040]
Kickers AV	**1.7003*** **	-.0029	.1185	-.0133	.5827	**1.4575*** **	-.0156	.7466***	.0360**	.3115
	(.1581)	(.0333)	(.1153)	(.0132)	[.5473]	**(.1364)**	(.0526)	(.1162)	(.0161)	[.2530]
Punters AV	**1.5093*** **	-.0117	1.1886***	.0110	.7385	**1.5802*** **	-.0064	.1836	.0372***	.5631
	(.1139)	(.0213)	(.1336)	(.0101)	[.7163]	**(.0849)**	(.0312)	(.1180)	(.0134)	[.5260]
Long Snappers AV	**.7058*** **	-.0072	-.2407***	-.0073**	.7856	**1.4339*** **	.0015	-.4784***	-.0348***	.4866
	(.0601)	(.0059)	(.0226)	(.0029)	[.7674]	**(.1091)**	(.0211)	(.0601)	(.0119)	[.4430]

*p<0.10, **p<0.05, ***p<0.01. Team-clustered standard errors are in parentheses.

▸▸ log(Cap%) Cost Effectiveness

Appendix B: Delta-Method Confidence Intervals

Table 13: Actual vs. Baseline Optimal Allocations, Delta-Method Confidence Intervals

	Rookies				Veterans			
	Actual	Optimal	95% CI	Difference	Actual	Optimal	95% CI	Difference
Quarterbacks	**6.8%**	**4.5%**	**(0.4%, 8.5%)**	**2.4%**	**11.0%**	**7.5%**	**(1.0%, 14.1%)**	**3.5%**
Running Backs	7.1%	11.2%	(5.8%, 16.6%)	-4.1%	5.2%	9.5%	(5.2%, 13.7%)	-4.3%
Wide Receivers	12.3%	20.1%	(11.7%, 28.5%)	-7.8%	11.3%	15.0%	(8.2%, 21.8%)	-3.7%
Tight Ends	4.9%	2.2%	(0.4%, 4.1%)	2.7%	5.0%	3.5%	(0.6%, 6.4%)	1.6%
Left Tackles	4.8%	2.4%	(0.9%, 3.9%)	2.4%	5.1%	3.1%	(1.2%, 4.9%)	2.1%
Guards	6.9%	5.1%	(2.2%, 7.9%)	1.9%	6.0%	6.2%	(3.0%, 9.3%)	-0.2%
Centers	2.6%	2.7%	(0.3%, 5.0%)	-0.1%	3.4%	4.1%	(0.6%, 7.6%)	-0.7%
Right Tackles	4.0%	3.4%	(1.2%, 5.7%)	0.5%	3.3%	3.7%	(1.3%, 6.1%)	-0.4%
Defensive Ends	9.1%	6.4%	(3.7%, 9.2%)	2.7%	8.9%	7.3%	(4.7%, 9.9%)	1.6%
Defensive Tackles	7.3%	6.9%	(4.1%, 9.7%)	0.4%	7.4%	5.9%	(3.5%, 8.3%)	1.5%
Inside Linebackers	5.8%	5.3%	(2.9%, 7.7%)	0.5%	5.2%	6.4%	(3.7%, 9.1%)	-1.2%
Outside Linebackers	8.3%	9.1%	(5.9%, 12.2%)	-0.8%	7.9%	8.1%	(5.6%, 10.7%)	-0.2%
Cornerbacks	11.4%	12.4%	(7.8%, 16.9%)	-0.9%	9.8%	9.0%	(5.7%, 12.3%)	0.8%
Free Safeties	3.9%	5.3%	(2.8%, 7.8%)	-1.4%	3.6%	6.3%	(3.5%, 9.1%)	-2.7%
Strong Safeties	3.6%	2.3%	(0.9%, 3.7%)	1.3%	3.2%	3.4%	(1.3%, 5.5%)	-0.2%
Kickers	0.4%	0.2%	(-0.6%, 1.1%)	0.2%	1.8%	0.3%	(-0.9%, 1.5%)	1.5%
Punters	0.6%	0.7%	(-0.7%, 2.0%)	-0.1%	1.2%	1.1%	(-1.0%, 3.1%)	0.1%
Long Snappers	0.3%	-0.2%	(-0.9%, 0.6%)	0.5%	0.7%	-0.4%	(-2.2%, 1.3%)	1.1%

⏩ Bootstrap CIs

Appendix B: $\sqrt{\text{Cap\%}}$ Baseline Optimal Allocations

Table 14: $\sqrt{\text{Cap\%}}$ Actual vs. Baseline Optimal Allocations, Team-Clustered Bootstrap Confidence Intervals

	Rookies				Veterans			
	Actual	Optimal	95% CI	Difference	Actual	Optimal	95% CI	Difference
Quarterbacks	**6.8%**	**5.2%**	**(0.3%, 17.3%)**	**1.7%**	**11.0%**	**4.4%**	**(0.3%, 15.2%)**	**6.6%**
Running Backs	7.1%	11.2%	(2.8%, 24.9%)	-4.0%	5.2%	11.6%	(3.5%, 22.1%)	-6.4%
Wide Receivers	12.3%	17.7%	(5.9%, 31.3%)	-5.4%	11.3%	13.7%	(4.9%, 23.9%)	-2.5%
Tight Ends	4.9%	1.7%	(0.0%, 4.8%)	3.1%	5.0%	1.9%	(0.0%, 4.8%)	3.1%
Left Tackles	4.8%	2.4%	(0.3%, 5.3%)	2.4%	5.1%	2.3%	(0.3%, 5.2%)	2.8%
Guards	6.9%	4.4%	(0.8%, 9.1%)	2.5%	6.0%	6.1%	(1.1%, 12.5%)	-0.2%
Centers	2.6%	4.0%	(0.2%, 11.8%)	-1.5%	3.4%	4.4%	(0.2%, 14.0%)	-1.0%
Right Tackles	4.0%	4.5%	(0.5%, 11.1%)	-0.5%	3.3%	4.8%	(0.7%, 10.5%)	-1.5%
Defensive Ends	9.1%	5.5%	(2.1%, 10.3%)	3.6%	8.9%	5.6%	(2.0%, 10.0%)	3.2%
Defensive Tackles	7.3%	7.8%	(2.6%, 13.9%)	-0.5%	7.4%	6.4%	(2.3%, 11.6%)	1.0%
Inside Linebackers	5.8%	6.2%	(1.9%, 12.9%)	-0.4%	5.2%	6.9%	(2.6%, 12.1%)	-1.6%
Outside Linebackers	8.3%	9.2%	(4.7%, 13.3%)	-1.0%	7.9%	9.3%	(4.6%, 14.4%)	-1.4%
Cornerbacks	11.4%	7.6%	(2.7%, 15.9%)	3.8%	9.8%	7.0%	(2.7%, 13.8%)	2.8%
Free Safeties	3.9%	8.8%	(3.0%, 15.5%)	-4.9%	3.6%	11.2%	(3.9%, 18.8%)	-7.7%
Strong Safeties	3.6%	2.5%	(0.5%, 6.0%)	1.1%	3.2%	3.0%	(0.6%, 7.7%)	0.2%
Kickers	0.4%	0.1%	(0.0%, 2.5%)	0.3%	1.8%	0.1%	(0.0%, 1.4%)	1.7%
Punters	0.6%	1.1%	(0.0%, 7.1%)	-0.5%	1.2%	0.9%	(0.0%, 6.0%)	0.3%
Long Snappers	0.3%	0.1%	(0.0%, 1.8%)	0.2%	0.7%	0.2%	(0.0%, 4.9%)	0.5%

⏩ log(Cap%) Allocations

Appendix B: Interactions

Table 15a: Baseline Importance Results, Interactions ($N = 448$)

DV = Wins	G_0	G_1	G_2	G_3
Quarterbacks AV	.0966**	.1284*	.1326*	.1807***
	(.0417)	(.0667)	(.0745)	(.0671)
Running Backs AV	.1198***	.0765	.0758	.1823***
	(.0266)	(.1051)	(.1174)	(.0441)
Wide Receivers AV	.1325***	.1561***	.1555***	.1844***
	(.0278)	(.0594)	(.0578)	(.0472)
Tight Ends AV	.0785**	.0795**	.0881	.1335***
	(.0319)	(.0331)	(.0740)	(.0493)
Left Tackles AV	.0729***	.0556	.0489	.1338***
	(.0218)	(.0475)	(.0954)	(.0422)
Guards AV	.0822***	.0657	.0636	.1408***
	(.0208)	(.0483)	(.0554)	(.0371)
Centers AV	.0854**	.0703	.0682	.1423***
	(.0377)	(.0506)	(.0562)	(.0375)
Right Tackles AV	.0877***	.0717	.0699	.1480***
	(.0283)	(.0493)	(.0551)	(.0431)
Defensive Ends AV	.0811***	.0811***	.0811***	.1340***
	(.0138)	(.0139)	(.0142)	(.0307)
Defensive Tackles AV	.0880***	.0879***	.0878***	.1401***
	(.0146)	(.0147)	(.0148)	(.0266)
Inside Linebackers AV	.0905***	.0907***	.0906***	.1440***
	(.0178)	(.0178)	(.0180)	(.0340)
Outside Linebackers AV	.1110***	.1109***	.1107***	.1660***
	(.0144)	(.0144)	(.0147)	(.0315)
Cornerbacks AV	.1073***	.1064***	.1065***	.1641***
	(.0189)	(.0190)	(.0190)	(.0264)
Free Safeties AV	.1267***	.1265***	.1265***	.1857***
	(.0285)	(.0286)	(.0286)	(.0376)
Strong Safeties AV	.0777***	.0780***	.0780***	.1366***
	(.0239)	(.0237)	(.0241)	(.0353)
Kickers AV	.0260	.0259	.0258	.0204
	(.0486)	(.0484)	(.0486)	(.0473)
Punters AV	.0831	.0807	.0804	.0805
	(.0815)	(.0826)	(.0830)	(.0837)
Long Snappers AV	-.0429	-.0433	-.0425	-.0411
	(.0895)	(.0882)	(.0893)	(.0895)
Vegas Wins O/U	.1172***	.1186***	.1188***	.1173***
	(.0437)	(.0439)	(.0441)	(.0442)
2011 Indianapolis Colts	-1.6478***	-1.6895***	-1.6752***	-1.2889***
	(.3298)	(.3549)	(.3456)	(.3317)
17 Game Season	.2212	.2169	.2139	.2286
	(.1621)	(.1646)	(.1643)	(.1631)
$AV_{QB} \times AV_{WR}$		**-.0015**	**-.0015**	
		(.0029)	**(.0028)**	
$AV_{RB} \times AV_{OL}$		**.0010**	**.0010**	
		(.0022)	**(.0024)**	
$AV_{QB} \times AV_{TE}$			**-.0006**	
			(.0041)	
$AV_{LT} \times AV_{OL-LT}$			**.0002**	
			(.0023)	
$AV_{QB} \times AV_{Off-QB}$				**-.0003**
				(.0007)
$AV_{Off} \times AV_{Def}$				**-.0006****
				(.0003)
R^2	.8231	.8233	.8233	.8253
Adjusted R^2	.7998	.7990	.7980	.8013

*p<0.10, **p<0.05, ***p<0.01. Team-clustered standard errors are in parentheses.

▶▶ Complementarities

Appendix B: Restricted Translog

Table 15b: Baseline Importance Results, Restricted Translog ($N = 448$)

DV = Wins	G_0	G_1	G_2	G_3
Log Quarterbacks AV	.0558	.4981	.5307	.5101
	(.0525)	(.5523)	(.4968)	(.4056)
Log Running Backs AV	.3629***	-.3754	-.2846	.0680
	(.0817)	(.2878)	(.6151)	(.1011)
Log Wide Receivers AV	.6235***	.9825	.7822	.2174
	(.1228)	(.6553)	(.7169)	(.1847)
Log Tight Ends AV	.1245***	.0960**	.3791*	.0180
	(.0356)	(.0381)	(.2244)	(.0513)
Log Left Tackles AV	.0286	-.0111	-.1742	.0016
	(.0311)	(.0347)	(.6501)	(.0324)
Log Guards AV	.0601	-.0491	-.0561	.0102
	(.0555)	(.0646)	(.0651)	(.0523)
Log Centers AV	.0645**	.0145	.0114	.0168
	(.0317)	(.0314)	(.0313)	(.0292)
Log Right Tackles AV	-.0067	-.0375*	-.0364*	-.0183
	(.0212)	(.0205)	(.0209)	(.0207)
Log Defensive Ends AV	.1000***	.1005***	.0988***	-.0561**
	(.0331)	(.0342)	(.0356)	(.0277)
Log Defensive Tackles AV	.1414***	.1389***	.1351***	-.0645*
	(.0385)	(.0404)	(.0398)	(.0350)
Log Inside Linebackers AV	.0800***	.0772***	.0765***	-.0446
	(.0288)	(.0285)	(.0278)	(.0277)
Log Outside Linebackers AV	.1954***	.1977***	.1954***	-.0310
	(.0410)	(.0419)	(.0415)	(.0388)
Log Cornerbacks AV	.3604***	.3590***	.3592***	.0166
	(.0615)	(.0633)	(.0625)	(.0678)
Log Free Safeties AV	.1188***	.1257***	.1256***	.0250
	(.0310)	(.0324)	(.0331)	(.0297)
Log Strong Safeties AV	.0754***	.0763***	.0768***	-.0081
	(.0264)	(.0267)	(.0275)	(.0265)
Log Kickers AV	.0042	.0013	.0016	.0091
	(.0242)	(.0254)	(.0255)	(.0204)
Log Punters AV	.0125	.0188	.0184	.0050
	(.0361)	(.0360)	(.0354)	(.0328)
Log Long Snappers AV	-.0112	-.0107	-.0095	-.0145
	(.0326)	(.0299)	(.0302)	(.0284)
Vegas Wins O/U	.0317***	.0317***	.0323***	.0213**
	(.0100)	(.0104)	(.0105)	(.0098)
2011 Indianapolis Colts	-.6857***	-.7262***	-.6786***	-.5795***
	(.0665)	(.0752)	(.0994)	(.0601)
17 Game Season	.0096	.0271	.0255	.0356
	(.0267)	(.0277)	(.0280)	(.0270)
Log AV_{QB} × Log AV_{WR}		**-.1361**	**-.0789**	
		(.1717)	**(.1899)**	
Log AV_{RB} × Log AV_{OL}		**.1555*** **	**.1328**	
		(.0535)	**(.1345)**	
Log AV_{QB} × Log AV_{TE}			**-.0914**	
			(.0719)	
Log AV_{LT} × Log AV_{OL-LT}			**.0368**	
			(.1443)	
Log AV_{QB} × Log AV_{Off-QB}				**-.1218**
				(.0886)
Log AV_{Off} × Log AV_{Def}				**.2962*** **
				(.0347)
R^2	.7134	.7195	.7205	.7602
Adjusted R^2	.6756	.6810	.6805	.7273

*p<0.10, **p<0.05, ***p<0.01. Team-clustered standard errors are in parentheses.

Log-supermodularity robust to dropping observations with zeros

⏩ Complementarities

Appendix C: QB Statistics

Passer Rating

Let $a = 5\left(\frac{\text{CMP}}{\text{ATT}} - .3\right)$, $b = .25\left(\frac{\text{YDS}}{\text{ATT}} - 3\right)$, $c = \frac{20\times\text{TD}}{\text{ATT}}$, $d = 2.375 - \frac{25\times\text{INT}}{\text{ATT}}$.

Let $X = \min\{\max\{x, 0\}, 2.375\} \Rightarrow$ Passer Rating $= \frac{100}{6}(A + B + C + D)$.

Adjusted Net Yards per Attempt (ANY/A)

$$\text{ANY/A} = \frac{\text{YDS}+20\times\text{TD}-45\times\text{INT}-\text{SKYDS}}{\text{ATT}+\text{SK}}$$

Total Adjusted Net Yards per Attempt (TANY/A)

$$\text{TANY/A} = \frac{\text{YDS}+\text{RYDS}+20\times(\text{TD}+\text{RTD})-45\times(\text{INT}+\text{FL})-\text{SKYDS}}{\text{ATT}+\text{SK}+\text{RATT}}$$

Fantasy Points per Attempt (FP/A)

$$\text{FP/A} = \frac{.04\times\text{YDS}+4\times\text{TD}-2\times\text{INT}+.1\times\text{RYDS}+6\times\text{RTD}-2\times\text{FL}+2\times\text{2PM}}{\text{ATT}+\text{RATT}+\text{2PA}}$$

▸▸ QB Valuation Overview

Appendix C: QB Valuation Summary Statistics

Table 16: QB Valuation Summary Statistics, 2011–2024 ($N = 7,238$)

	Mean	SD	Min	Max
Game Passer Rating	89.94	26.09	0.00	158.33
Season Passer Rating	89.23	12.60	0.00	128.76
Game ANY/A	6.21	2.83	-7.80	19.61
Season ANY/A	6.07	1.29	-7.80	10.15
Game TANY/A	5.82	2.63	-10.81	16.96
Season TANY/A	5.73	1.22	-5.92	9.49
Game FP/A	0.43	0.21	-0.48	1.43
Season FP/A	0.43	0.10	-0.25	0.76
Non-QB Fantasy Points	66.88	17.32	4	155
Home	0.50	0.50	0.00	1.00
Rest Days	6.94	2.81	3	17
Log Injured Money	16.65	0.75	11	18
Starter Gini	0.48	0.06	0	1
Starter/Non-Starter	1.21	0.49	0.10	4.10
Game Passer Rating (Win = 1)	102.26	23.60	2.78	158.33
Season Passer Rating (Win = 1)	92.74	11.55	31.25	128.76
Game ANY/A (Win = 1)	7.56	2.60	-3.41	19.61
Season ANY/A (Win = 1)	6.45	1.16	0.76	10.15
Game TANY/A (Win = 1)	7.03	2.36	-1.19	16.96
Season TANY/A (Win = 1)	6.07	1.09	0.84	9.49
Game FP/A (Win = 1)	0.52	0.21	0.03	1.43
Season FP/A (Win = 1)	0.45	0.09	0.07	0.76
Non-QB Fantasy Points (Win = 1)	74.44	15.52	4.00	155.20
Home (Win = 1)	0.56	0.50	0.00	1.00
Rest Days (Win = 1)	6.96	2.84	3.00	17.00
Log Injured Money (Win = 1)	16.61	0.74	11.34	18.35
Starter Gini (Win = 1)	0.48	0.06	0	1
Starter/Non-Starter (Win = 1)	1.25	0.49	0.18	4.10
Game Passer Rating (Win = 0)	77.63	22.39	0.00	150.48
Season Passer Rating (Win = 0)	85.72	12.62	0.00	122.46
Game ANY/A (Win = 0)	4.86	2.36	-7.80	13.13
Season ANY/A (Win = 0)	5.70	1.31	-7.80	9.39
Game TANY/A (Win = 0)	4.62	2.30	-10.81	14.22
Season TANY/A (Win = 0)	5.39	1.26	-5.92	8.98
Game FP/A (Win = 0)	0.35	0.17	-0.48	1.19
Season FP/A (Win = 0)	0.40	0.10	-0.25	0.72
Non-QB Fantasy Points (Win = 0)	59.33	15.64	6.00	122.30
Home (Win = 0)	0.44	0.50	0.00	1.00
Rest Days (Win = 0)	6.93	2.78	3.00	17.00
Log Injured Money (Win = 0)	16.70	0.75	12.80	18.38
Starter Gini (Win = 0)	0.48	0.06	0	1
Starter/Non-Starter (Win = 0)	1.17	0.49	0.10	3.90

▸▸ QB Valuation Overview

Appendix C: Full QB Valuation Passer Rating

Table 17: QB Valuation Results, Passer Rating, 447 Fixed Effects ($N = 7,238$)

DV = Win	Game			Season			Game, Season IV	
	Logit	AME	Linear	Logit	AME	Linear	Q1-Q4	Q1-Q3
Passer Rating	.0603***	.0047***	.0050***	.0352***	**.0035*** **	.0034***	.0077***	.0066***
	(.0037)	(.0002)	(.0002)	(.0081)	**(.0008)**	(.0007)	(.0014)	(.0017)
Non-QB Fantasy Points	.1098***	.0085***	.0067***	.1331***	.0133***	.0118***	.0038**	.0050***
	(.0065)	(.0004)	(.0004)	(.0056)	(.0003)	(.0003)	(.0016)	(.0018)
Home	.2593***	.0201***	.0177***	.2473***	.0247***	.0212***	.0163***	.0169***
	(.0684)	(.0052)	(.0057)	(.0563)	(.0056)	(.0061)	(.0057)	(.0057)
Rest Days	.0095	.0007	.0004	.0082	.0008	.0006	.0002	.0003
	(.0281)	(.0022)	(.0024)	(.0235)	(.0023)	(.0026)	(.0024)	(.0024)
Log Injured Money	-.0559	-.0043	-.0025	-.0221	-.0022	-.0023	-.0037	-.0032
	(.1316)	(.0102)	(.0112)	(.1049)	(.0105)	(.0118)	(.0112)	(.0110)
Starter Gini	3.1143*	.2415*	.2185	2.8606*	.2861*	.2650	.1917	.2025
	(1.7440)	(.1354)	(.1621)	(1.5826)	(.1586)	(.1731)	(.1593)	(.1583)
Starter/Non-Starter	.2440	.0189	.0180	.2135	.0214	.0124	.0196	.0189
	(.2471)	(.0192)	(.0213)	(.2069)	(.0207)	(.0226)	(.0210)	(.0207)
Pseudo-R^2 | R^2	.6424		.5669	.5452		.5087	.5492	.5606
Adjusted Pseudo-R^2 | R^2	.6410		.5389	.5439		.4769	.5200	.5322

*p<0.10, **p<0.05, ***p<0.01. Game-clustered standard errors are in parentheses.

▸▸ Highlighted Results

Appendix C: QB Valuation ANY/A

Table 18a: QB Valuation Results, ANY/A, 447 Fixed Effects ($N = 7,238$)

DV = Win	Game			Season			Game, Season IV	
	Logit	AME	Linear	Logit	AME	Linear	Q1-Q4	Q1-Q3
ANY/A	.6064***	.0472***	.0460***	.3199***	**.0320*** **	.0292***	.0723***	.0582***
	(.0365)	(.0022)	(.0022)	(.0734)	**(.0073)**	(.0063)	(.0150)	(.0172)
Non-QB Fantasy Points	.1034***	.0080***	.0064***	.1328***	.0133***	.0118***	.0032*	.0049**
	(.0066)	(.0004)	(.0004)	(.0056)	(.0003)	(.0003)	(.0019)	(.0022)
Home	.2533***	.0197***	.0186***	.2464***	.0247***	.0213***	.0177***	.0182***
	(.0669)	(.0052)	(.0058)	(.0561)	(.0056)	(.0061)	(.0057)	(.0056)
Rest Days	-.0124	-.0010	-.0003	.0090	.0009	.0006	-.0009	-.0006
	(.0279)	(.0022)	(.0024)	(.0235)	(.0024)	(.0026)	(.0024)	(.0024)
Log Injured Money	-.1306	-.0102	-.0035	-.0288	-.0029	-.0025	-.0053	-.0043
	(.1305)	(.0101)	(.0112)	(.1042)	(.0104)	(.0118)	(.0112)	(.0110)
Starter Gini	3.4221*	.2662*	.2569	2.8083*	.2812*	.2702	.2504	.2539
	(1.7499)	(.1360)	(.1632)	(1.6031)	(.1608)	(.1735)	(.1595)	(.1580)
Starter/Non-Starter	.1025	.0080	.0139	.1891	.0189	.0115	.0132	.0136
	(.2409)	(.0187)	(.0214)	(.2058)	(.0206)	(.0226)	(.0211)	(.0207)
Pseudo-R^2 | R^2	.6424		.5619	.5448		.5081	.5434	.5579
Adjusted Pseudo-R^2 | R^2	.6410		.5335	.5434		.4763	.5138	.5293

*p<0.10, **p<0.05, ***p<0.01. Game-clustered standard errors are in parentheses.

⏩ Passer Rating

Appendix C: QB Valuation TANY/A

Table 18b: QB Valuation Results, TANY/A, 447 Fixed Effects ($N = 7,238$)

DV = Win	Game			Season			Game, Season IV	
	Logit	AME	Linear	Logit	AME	Linear	Q1-Q4	Q1-Q3
TANY/A	.6434***	.0508***	.0466***	.3397***	**.0340*** **	.0335***	.0823***	.0700***
	(.0368)	(.0024)	(.0024)	(.0734)	**(.0073)**	(.0063)	(.0157)	(.0174)
Non-QB Fantasy Points	.1097***	.0087***	.0070***	.1334***	.0133***	.0119***	.0030*	.0044**
	(.0066)	(.0004)	(.0004)	(.0056)	(.0003)	(.0003)	(.0018)	(.0020)
Home	.2150***	.0170***	.0164***	.2471***	.0247***	.0215***	.0136**	.0146**
	(.0655)	(.0051)	(.0058)	(.0562)	(.0056)	(.0061)	(.0059)	(.0059)
Rest Days	-.0182	-.0014	-.0004	.0090	.0009	.0006	-.0013	-.0010
	(.0269)	(.0021)	(.0024)	(.0236)	(.0024)	(.0026)	(.0025)	(.0024)
Log Injured Money	-.1037	-.0082	-.0028	-.0363	-.0036	-.0034	-.0047	-.0041
	(.1265)	(.0100)	(.0112)	(.1041)	(.0104)	(.0118)	(.0113)	(.0111)
Starter Gini	2.3569	.1862	.2326	2.6284	.2629	.2527	.2052	.2146
	(1.7870)	(.1410)	(.1653)	(1.6026)	(.1605)	(.1732)	(.1636)	(.1616)
Starter/Non-Starter	.0349	.0028	.0117	.1651	.0165	.0087	.0091	.0100
	(.2429)	(.0192)	(.0216)	(.2067)	(.0207)	(.0226)	(.0216)	(.0212)
Pseudo-R^2 | R^2	.6372		.5540	.5451		.5088	.5254	.5417
Adjusted Pseudo-R^2 | R^2	.6358		.5251	.5437		.4770	.4946	.5120

*p<0.10, **p<0.05, ***p<0.01. Game-clustered standard errors are in parentheses.

⏩ Passer Rating

Appendix C: QB Valuation FP/A

Table 18c: QB Valuation Results, FP/A, 447 Fixed Effects ($N = 7,238$)

DV = Win	Game			Season			Game, Season IV	
	Logit	AME	Linear	Logit	AME	Linear	Q1-Q4	Q1-Q3
FP/A	7.8925***	.6018***	.5096***	5.1542***	**.5133*** **	.5208***	.8479***	.7240***
	(.4635)	(.0275)	(.0265)	(.9374)	**(.0924)**	(.0829)	(.1351)	(.1424)
Non-QB Fantasy Points	.1405***	.0107***	.0087***	.1345***	.0134***	.0119***	.0064***	.0073***
	(.0068)	(.0003)	(.0003)	(.0056)	(.0003)	(.0003)	(.0010)	(.0010)
Home	.1817***	.0139***	.0132**	.2487***	.0248***	.0213***	.0087	.0104*
	(.0671)	(.0051)	(.0058)	(.0564)	(.0056)	(.0061)	(.0060)	(.0060)
Rest Days	-.0148	-.0011	-.0002	.0076	.0008	.0005	-.0009	-.0007
	(.0281)	(.0021)	(.0025)	(.0236)	(.0024)	(.0026)	(.0024)	(.0024)
Log Injured Money	-.1795	-.0137	-.0049	-.0416	-.0041	-.0039	-.0080	-.0069
	(.1271)	(.0097)	(.0112)	(.1040)	(.0104)	(.0118)	(.0112)	(.0110)
Starter Gini	2.4764	.1888	.1963	2.3720	.2362	.2266	.1486	.1661
	(1.8280)	(.1396)	(.1640)	(1.5891)	(.1585)	(.1724)	(.1614)	(.1603)
Starter/Non-Starter	-.0486	-.0037	.0107	.1326	.0132	.0056	.0079	.0090
	(.2469)	(.0188)	(.0215)	(.2070)	(.0206)	(.0226)	(.0213)	(.0210)
Pseudo-R^2 | R^2	.6502		.5547	.5469		.5102	.5330	.5460
Adjusted Pseudo-R^2 | R^2	.6488		.5259	.5455		.4785	.5027	.5166

*p<0.10, **p<0.05, ***p<0.01. Game-clustered standard errors are in parentheses.

⏩ Passer Rating

Appendix C: QB Valuation, No Rookies

Table 19a: QB Valuation Results, No Rookies, 432 Fixed Effects, ($N = 5,798$)

DV = Win	Game			Season			Game, Season IV	
	Logit	AME	Linear	Logit	AME	Linear	Q1-Q4	Q1-Q3
Passer Rating	.0608***	.0046***	.0049***	.0330***	**.0032*** **	.0036***	.0088***	.0081***
	(.0043)	(.0003)	(.0003)	(.0104)	**(.0010)**	(.0008)	(.0019)	(.0023)
Non-QB Fantasy Points	.1190***	.0090***	.0071***	.1418***	.0138***	.0121***	.0027	.0035
	(.0075)	(.0004)	(.0005)	(.0067)	(.0004)	(.0003)	(.0021)	(.0026)
Home	.2065***	.0156***	.0108*	.1683***	.0164***	.0134*	.0094	.0096
	(.0793)	(.0060)	(.0065)	(.0640)	(.0062)	(.0069)	(.0065)	(.0065)
Rest Days	.0301	.0023	.0011	.0144	.0014	.0009	.0012	.0012
	(.0356)	(.0027)	(.0029)	(.0282)	(.0028)	(.0030)	(.0029)	(.0028)
Log Injured Money	-.0212	-.0016	-.0018	.0268	.0026	-.0018	-.0036	-.0032
	(.1591)	(.0120)	(.0126)	(.1237)	(.0121)	(.0131)	(.0129)	(.0127)
Starter Gini	4.0246*	.3046*	.2407	3.6818*	.3594*	.2834	.2015	.2091
	(2.0859)	(.1579)	(.1825)	(1.8831)	(.1842)	(.1935)	(.1821)	(.1807)
Starter/Non-Starter	.2515	.0190	.0181	.1672	.0163	.0099	.0223	.0215
	(.2829)	(.0215)	(.0234)	(.2356)	(.0230)	(.0248)	(.0235)	(.0232)
Pseudo-R^2 | R^2	.6504		.5696	.5557		.5167	.5327	.5456
Adjusted Pseudo-R^2 | R^2	.6486		.5356	.5540		.4784	.4957	.5096

*p<0.10, **p<0.05, ***p<0.01. Game-clustered standard errors are in parentheses.

⏩ Full Sample

Appendix C: QB Valuation, $\geq$4 Games

Table 19b: QB Valuation Results, $\geq$4 Games, 447 Fixed Effects ($N = 6,496$)

DV = Win	Game			Season			Game, Season IV	
	Logit	AME	Linear	Logit	AME	Linear	Q1-Q4	Q1-Q3
Passer Rating	.0601***	.0046***	.0050***	.0247**	**.0025****	.0035***	.0083***	.0067**
	(.0039)	(.0002)	(.0002)	(.0123)	**(.0012)**	(.0011)	(.0025)	(.0033)
Non-QB Fantasy Points	.1143***	.0088***	.0067***	.1380***	.0138***	.0119***	.0031	.0049
	(.0075)	(.0004)	(.0004)	(.0064)	(.0003)	(.0003)	(.0027)	(.0036)
Home	.3163***	.0244***	.0205***	.2986***	.0299***	.0243***	.0182***	.0193***
	(.0757)	(.0058)	(.0062)	(.0610)	(.0060)	(.0066)	(.0064)	(.0064)
Rest Days	.0151	.0012	.0012	.0103	.0010	.0012	.0011	.0012
	(.0296)	(.0023)	(.0026)	(.0239)	(.0024)	(.0027)	(.0025)	(.0025)
Log Injured Money	-.0611	-.0047	-.0050	-.0353	-.0035	-.0027	-.0075	-.0063
	(.1443)	(.0111)	(.0121)	(.1120)	(.0112)	(.0127)	(.0123)	(.0121)
Starter Gini	5.0420**	.3896**	.3021*	3.9788**	.3988**	.3470*	.2970*	.2995*
	(2.0341)	(.1569)	(.1783)	(1.7752)	(.1780)	(.1939)	(.1749)	(.1723)
Starter/Non-Starter	.3054	.0236	.0141	.1874	.0188	.0083	.0188	.0165
	(.2755)	(.0213)	(.0235)	(.2278)	(.0229)	(.0251)	(.0237)	(.0233)
Pseudo-R^2 | R^2	.6437		.5661	.5456		.5077	.5384	.5590
Adjusted Pseudo-R^2 | R^2	.6421		.5346	.5440		.4719	.5048	.5269

*p<0.10, **p<0.05, ***p<0.01. Game-clustered standard errors are in parentheses.

⏩ Full Sample

Appendix C: Directed Acyclic Graph

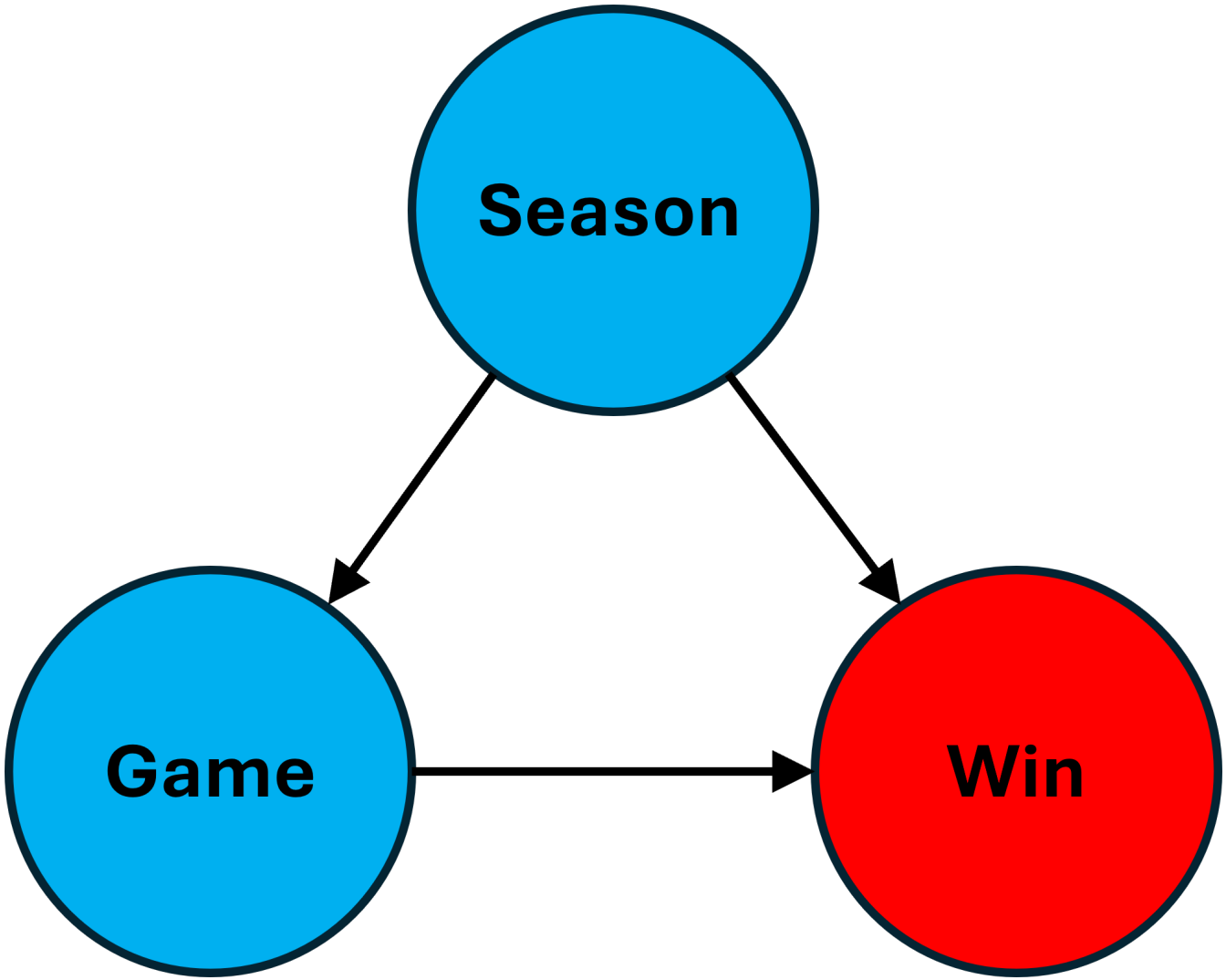


Figure 7: Win, Game, & Season DAG

⏩ Why Not Control?

Appendix C: Marginal Effects, ANY/A, TANY/A, & FP/A

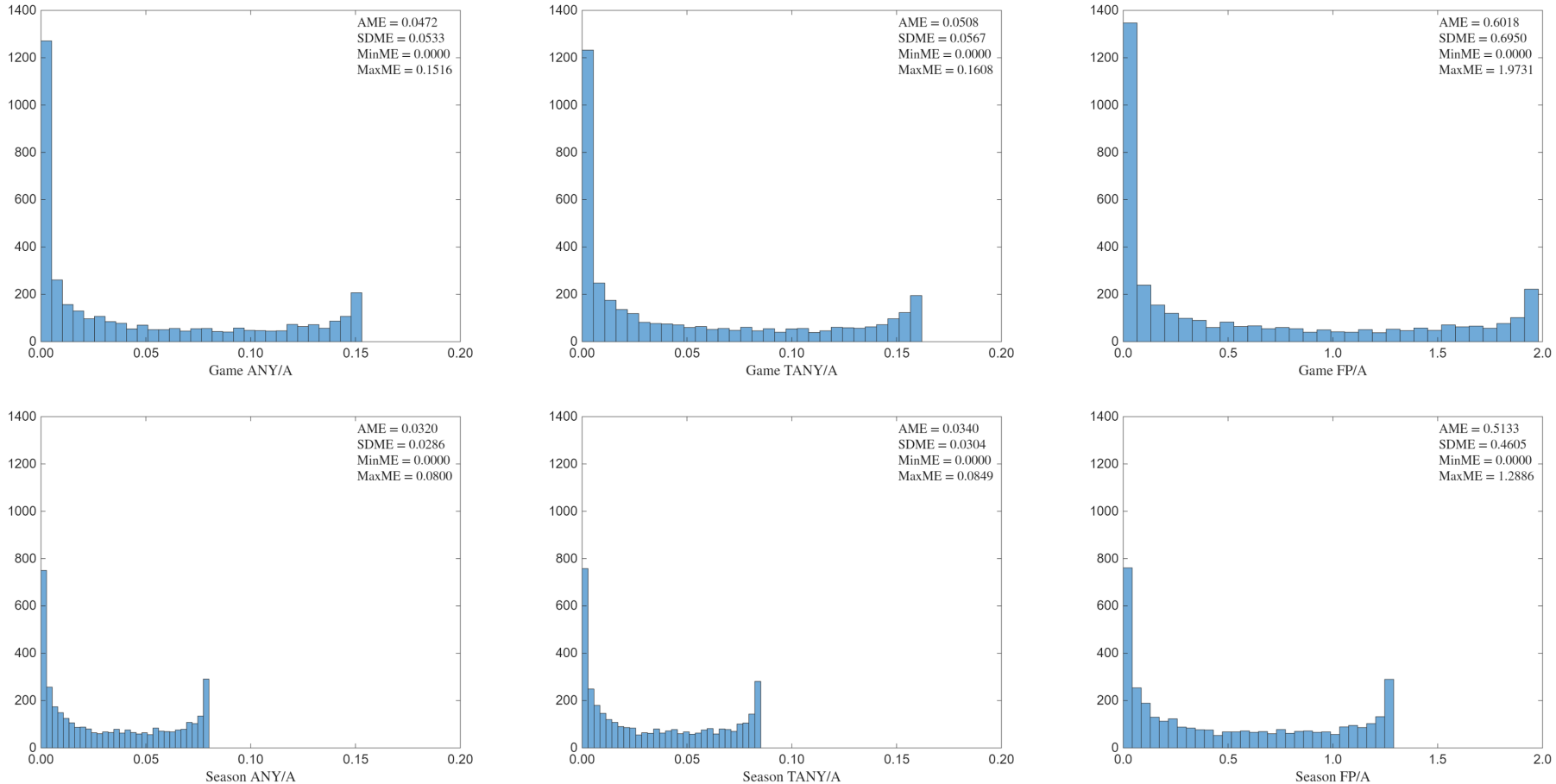


Figure 8: Distributions of Marginal Effects, ANY/A, TANY/A, & FP/A

⏩ Passer Rating

Appendix C: Simulated Wins, Game Passer Rating

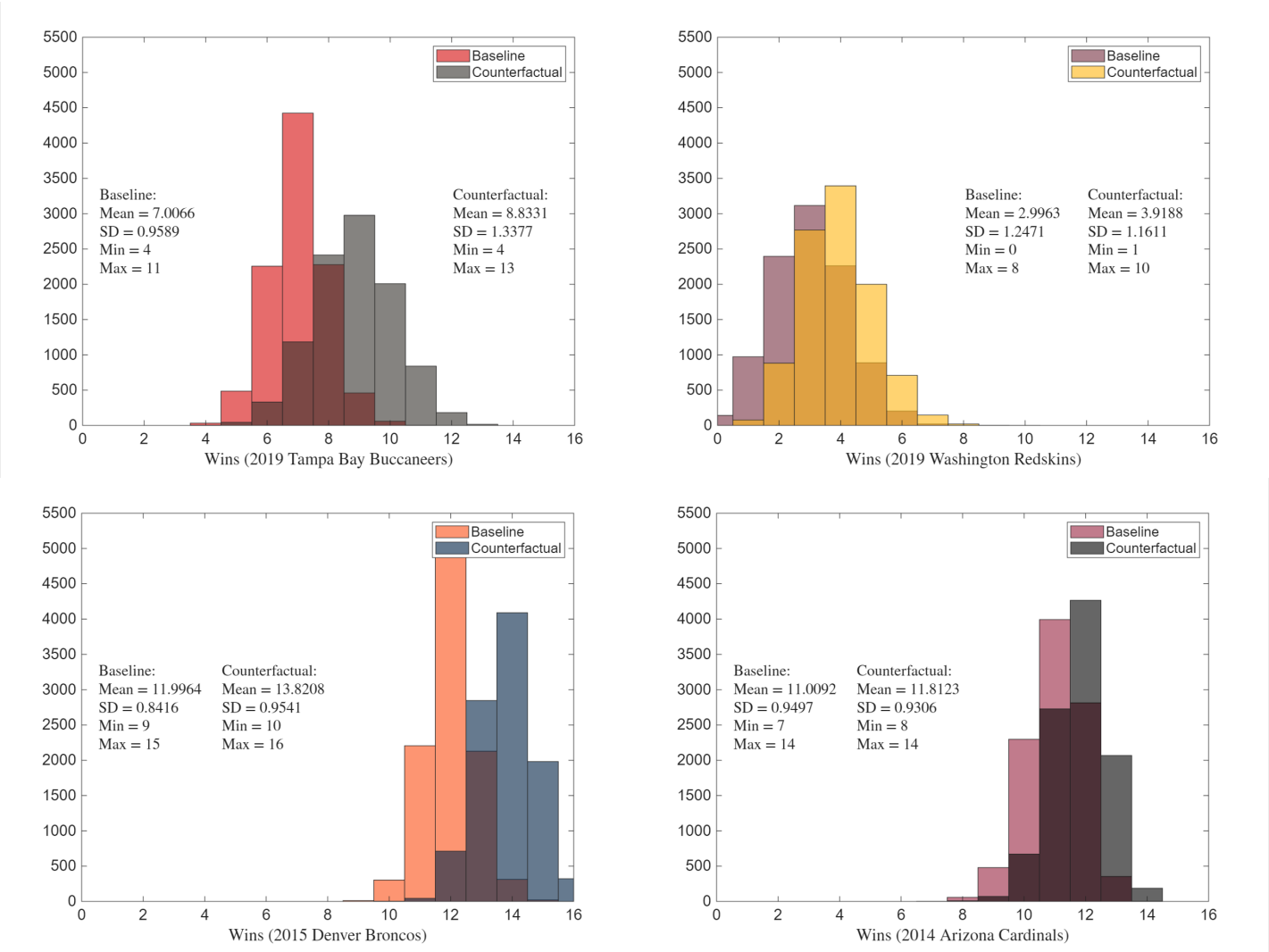


Figure 9: Distributions of Simulated Wins, Game Passer Rating

▸▸ Season Passer Rating

Appendix D: Full Baseline vs. Calibrated Results

Table 20: Baseline vs. Calibrated Importance Results, Team Fixed Effects ($N = 448$)

DV = Wins	Baseline	Calibrated	Baseline COTY	Calibrated COTY
Quarterbacks AV	**.0966****	**.1538*****	**.0936*****	**.1538*****
	(.0417)	**(.0364)**	**(.0328)**	**(.0364)**
Running Backs AV	**.1198*****	**.1139*****	**.0929*****	**.0867*****
	(.0266)	**(.0260)**	**(.0263)**	**(.0259)**
Wide Receivers AV	.1325***	.1163***	.1183***	.1015***
	(.0278)	(.0228)	(.0263)	(.0222)
Tight Ends AV	.0785**	.0615**	.0756***	.0580**
	(.0319)	(.0281)	(.0287)	(.0271)
Left Tackles AV	.0729***	.0617***	.0660***	.0541***
	(.0218)	(.0217)	(.0203)	(.0206)
Guards AV	.0822***	.0739***	.0762***	.0674***
	(.0208)	(.0199)	(.0217)	(.0209)
Centers AV	.0854**	.0790**	.0760**	.0692**
	(.0377)	(.0351)	(.0376)	(.0346)
Right Tackles AV	.0877***	.0777***	.0704***	.0597**
	(.0283)	(.0284)	(.0268)	(.0270)
Defensive Ends AV	.0811***	.0802***	.0684***	.0674***
	(.0138)	(.0133)	(.0129)	(.0124)
Defensive Tackles AV	.0880***	.0888***	.0777***	.0784***
	(.0146)	(.0137)	(.0128)	(.0122)
Inside Linebackers AV	.0905***	.0922***	.0851***	.0869***
	(.0178)	(.0166)	(.0157)	(.0145)
Outside Linebackers AV	.1110***	.1122***	.0999***	.1012***
	(.0144)	(.0139)	(.0138)	(.0130)
Cornerbacks AV	.1073***	.1060***	.0875***	.0864***
	(.0189)	(.0191)	(.0171)	(.0174)
Free Safeties AV	.1267***	.1248***	.1019***	.1001***
	(.0285)	(.0261)	(.0273)	(.0251)
Strong Safeties AV	.0777***	.0750***	.0739***	.0711***
	(.0239)	(.0232)	(.0239)	(.0231)
Kickers AV	.0260	.0267	.0187	.0190
	(.0486)	(.0330)	(.0435)	(.0293)
Punters AV	.0831	.0978	.0814	.0965
	(.0815)	(.0688)	(.0731)	(.0642)
Long Snappers AV	**-.0429**	**.0000**	**-.0609**	**.0000**
	(.0895)	**(.0379)**	**(.0964)**	**(.0342)**
Vegas Wins O/U	.1172***	.1152***	.1928***	.1903***
	(.0437)	(.0429)	(.0414)	(.0405)
2011 Indianapolis Colts	-1.6478***	-1.4578***	-1.9970***	-1.7714***
	(.3298)	(.2819)	(.3206)	(.2914)
17 Game Season	.2212	.2128	.1843	.1816
	(.1621)	(.1558)	(.1513)	(.1447)
Coach of the Year			**1.4999*****	**1.4936*****
			(.2568)	**(.2475)**
R^2	.8231	.8221	.8453	.8441
Adjusted R^2	.7998	.8164	.8245	.8391
Standard Errors	Team-Clustered	TC Bootstrap	Team-Clustered	TC Bootstrap

*p<0.10, **p<0.05, ***p<0.01. Standard errors are in parentheses.

⏩ Highlighted Results

Appendix D: Cost Effectiveness Results, COTY

Table 21: Cost Effectiveness Results, COTY, Team Fixed Effects ($N = 448$)

	Rookies							Veterans						
	log(Cap%)	Cap% = 0	Vegas Wins	2011 Colts	Season	COTY	R^2 [Adj R^2]	**log(Cap%)**	Cap% = 0	Vegas Wins	2011 Colts	Season	COTY	R^2 [Adj R^2]
Quarterbacks AV	**1.8323*** **	-2.6545***	-.0088	-3.8744***	-.0659	2.3657***	.4174	**3.3884*** **	-1.5102	1.1079***	-7.9045***	-.0089	.0745	.5762
	(.2122)	(.4118)	(.1994)	(.5856)	(.0840)	(.8341)	[.3649]	**(.2973)**	(1.3984)	(.1772)	(.5173)	(.0705)	(.7368)	[.5379]
Running Backs AV	**3.8340*** **	-3.8624***	.0929	-5.6279***	.0293	2.3556***	.3733	**3.4444*** **	-.7949	.4247***	-5.2554***	.0261	1.5414**	.5029
	(.4849)	(1.0129)	(.1736)	(.4898)	(.0567)	(.6958)	[.3167]	**(.2311)**	(.5013)	(.1220)	(.4731)	(.0532)	(.7307)	[.4581]
Wide Receivers AV	**6.1771*** **		.0140	-1.0101**	-.0375	1.6127**	.4085	**4.8516*** **	.7801	.7765***	-4.7723***	-.0438	1.6115*	.4707
	(.5919)		(.1426)	(.4784)	(.0717)	(.7296)	[.3567]	**(.3791)**	(.9158)	(.2187)	(.6648)	(.0926)	(.9234)	[.4229]
Tight Ends AV	**1.1528*** **	-.5398***	-.0459	-3.0408***	-.0072	-.3010	.2800	**1.8947*** **	-1.4587***	.3597***	-4.9306***	.0119	.7215*	.4783
	(.1496)	(.1754)	(.1027)	(.3908)	(.0535)	(.3616)	[.2151]	**(.2027)**	(.4418)	(.0934)	(.3789)	(.0454)	(.4308)	[.4312]
Left Tackles AV	**1.3340*** **	-3.0364***	-.0864	-1.8289***	-.0572	-.3597	.4783	**1.7918*** **	-4.0837***	.3792***	1.7173***	-.0029	1.3413***	.5370
	(.1187)	(.3840)	(.0929)	(.3888)	(.0530)	(.4964)	[.4312]	**(.0985)**	(.3288)	(.1131)	(.4454)	(.0578)	(.4900)	[.4952]
Guards AV	**2.4894*** **	-2.6660***	.3301**	-4.2689***	-.1084**	.8737	.4692	**3.2733*** **	-5.1789***	.4100***	-.9108	-.1282	.9941	.4722
	(.3664)	(.6869)	(.1433)	(.6984)	(.0532)	(.6370)	[.4214]	**(.3504)**	(.7032)	(.1525)	(.6962)	(.0839)	(.6955)	[.4245]
Centers AV	**1.2778*** **	-3.0189***	.0772	-.2587	-.0319	.4855	.4868	**2.0824*** **	-4.4758***	.0860	.1593	-.1174**	1.2063***	.5037
	(.1217)	(.2578)	(.1090)	(.3289)	(.0408)	(.4181)	[.4405]	**(.1595)**	(.3442)	(.0881)	(.4736)	(.0462)	(.4589)	[.4589]
Right Tackles AV	**1.5620*** **	-2.9977***	.1900*	1.3130***	-.0523	.9085	.4955	**1.8265*** **	-4.1092***	.1642	3.0027***	-.0206	.5550	.4644
	(.1178)	(.3585)	(.1114)	(.2625)	(.0369)	(.5559)	[.4500]	**(.1847)**	(.4278)	(.1200)	(.5474)	(.0582)	(.4102)	[.4160]
Defensive Ends AV	**3.1927*** **	-1.3038	.0225	-.1929	-.1002	.7404	.4934	**3.9106*** **	-4.4845***	.4100**	-1.5540**	-.0515	2.1335***	.5314
	(.4355)	(.8499)	(.1491)	(.4631)	(.0652)	(.5697)	[.4476]	**(.2874)**	(.9370)	(.1788)	(.6823)	(.0809)	(.6193)	[.4891]
Defensive Tackles AV	**3.1476*** **	-2.5027*	-.2201	.0441	-.1139*	.8154	.4824	**2.9223*** **	-.5855	.4471***	-1.4308***	.2672***	.2232	.4836
	(.3436)	(1.4765)	(.1444)	(.5424)	(.0583)	(.4962)	[.4357]	**(.3575)**	(2.4592)	(.1540)	(.4584)	(.0753)	(.6185)	[.4370]
Inside Linebackers AV	**2.3314*** **	-2.4224***	.2118*	6.1791***	-.0718	.7310*	.4863	**3.0752*** **	-3.4455***	.1966	-7.7855***	.0576	-.1774	.4733
	(.2940)	(.3354)	(.1180)	(.3669)	(.0536)	(.4415)	[.4399]	**(.3206)**	(.6683)	(.1768)	(.4381)	(.0654)	(.7216)	[.4257]
Outside Linebackers AV	**3.2705*** **		.0624	-2.0560***	-.0589	1.4860*	.4146	**3.2063*** **	-4.2992***	.2033	.6316	.0058	1.0846	.4442
	(.4309)		(.1300)	(.4460)	(.0642)	(.7887)	[.3633]	**(.3188)**	(.8576)	(.1307)	(.7926)	(.0854)	(.6945)	[.3940]
Cornerbacks AV	**4.6613*** **		-.1704	7.0837***	.0477	1.2157*	.3785	**3.6619*** **		.4273**	.0678	-.0143	1.7936***	.4275
	(.4908)		(.1531)	(.6267)	(.0796)	(.7101)	[.3240]	**(.3017)**		(.1810)	(.9436)	(.0765)	(.6110)	[.3773]
Free Safeties AV	**1.6680*** **	-2.6432***	.0092	-3.4941***	-.0626	.9851*	.4298	**2.1528*** **	-3.8287***	.2603**	-3.3902***	-.0556	.0974	.5155
	(.1616)	(.5551)	(.1051)	(.3524)	(.0513)	(.5136)	[.3784]	**(.1800)**	(.3266)	(.1274)	(.4701)	(.0468)	(.2792)	[.4718]
Strong Safeties AV	**1.1831*** **	-2.6351***	-.0262	.6326*	-.0089	.1594	.3906	**1.9047*** **	-3.3656***	.2600***	-4.2469***	-.0008	-.3004	.5091
	(.1239)	(.3629)	(.1207)	(.3580)	(.0415)	(.5167)	[.3356]	**(.1943)**	(.2485)	(.0925)	(.2775)	(.0380)	(.3868)	[.4648]
Kickers AV	**.3679*** **	-1.6962***	.0024	.0952	-.0198	.2166	.5101	**.5517*** **	-2.5220***	-.0198	.8236***	.0198	.1226	.3629
	(.0413)	(.1975)	(.0359)	(.1186)	(.0140)	(.1676)	[.4659]	**(.0712)**	(.1315)	(.0504)	(.0995)	(.0157)	(.2326)	[.3054]
Punters AV	**.3378*** **	-1.7709***	-.0270	1.0121***	.0084	-.0605	.7108	**.5496*** **	-1.9224***	-.0195	.1732	.0270**	-.0136	.5804
	(.0241)	(.1044)	(.0256)	(.1098)	(.0100)	(.0869)	[.6847]	**(.0702)**	(.0706)	(.0296)	(.1200)	(.0133)	(.1302)	[.5426]
Long Snappers AV	**.1679*** **	-.7784***	-.0031	-.2513***	-.0088***	.0109	.7538	**.4283*** **	-1.4456***	-.0004	-.4670***	-.0415***	.0881	.4966
	(.0136)	(.0591)	(.0057)	(.0223)	(.0029)	(.0263)	[.7316]	**(.0592)**	(.1058)	(.0206)	(.0663)	(.0122)	(.1146)	[.4511]

*p<0.10, **p<0.05, ***p<0.01. Team-clustered standard errors are in parentheses.

⏩ Importance Results

Appendix D: $\sqrt{\text{Cap\%}}$ Cost Effectiveness Results, COTY

Table 22: $\sqrt{\text{Cap\%}}$ Cost Effectiveness Results, COTY, Team Fixed Effects ($N = 448$)

	Rookies						Veterans					
	$\sqrt{\text{Cap\%}}$	Vegas Wins	2011 Colts	Season	COTY	R^2 [Adj R^2]	**$\sqrt{\text{Cap\%}}$**	Vegas Wins	2011 Colts	Season	COTY	R^2 [Adj R^2]
Quarterbacks AV	**2.7485*** **	-.0006	-3.2063***	-.0261	2.4263***	.5254	**2.9999*** **	1.1196***	-8.9652***	-.0282	.1013	.5781
	(.2051)	(.1588)	(.5418)	(.0753)	(.7733)	[.4838]	**(.1931)**	(.1740)	(.4784)	(.0651)	(.7413)	[.5411]
Running Backs AV	**3.3316*** **	.0925	-5.5190***	.0504	2.2588***	.3626	**3.9186*** **	.4358***	-4.5957***	.0689	1.5043**	.5118
	(.3898)	(.1803)	(.5299)	(.0559)	(.6793)	[.3068]	**(.2787)**	(.1214)	(.4829)	(.0520)	(.7072)	[.4690]
Wide Receivers AV	**3.7885*** **	-.0065	-.6625	-.0211	1.6506**	.4013	**3.8011*** **	.7781***	-4.7167***	-.0515	1.6690*	.4787
	(.3898)	(.1388)	(.4932)	(.0735)	(.7477)	[.3489]	**(.2536)**	(.2195)	(.6601)	(.0930)	(.9321)	[.4331]
Tight Ends AV	**1.9815*** **	-.0447	-2.4851***	-.0333	-.2186	.3498	**2.4050*** **	.3410***	-5.0648***	.0173	.7781*	.4977
	(.1548)	(.0985)	(.3487)	(.0487)	(.3985)	[.2928]	**(.1735)**	(.0908)	(.3779)	(.0434)	(.4582)	[.4537]
Left Tackles AV	**2.5040*** **	-.0429	-1.5000***	.0000	-.2699	.6150	**2.8265*** **	.3944***	2.0056***	-.0231	1.1776***	.5539
	(.1921)	(.0858)	(.3602)	(.0464)	(.4580)	[.5812]	**(.1227)**	(.1255)	(.3450)	(.0490)	(.4553)	[.5149]
Guards AV	**3.0159*** **	.3006**	-2.6626***	-.0862	1.0453*	.5124	**4.1523*** **	.3626**	-.3573	-.0996	.9682	.4913
	(.2441)	(.1271)	(.6078)	(.0525)	(.6271)	[.4697]	**(.3825)**	(.1483)	(.5760)	(.0823)	(.6423)	[.4468]
Centers AV	**2.7766*** **	.0861	-2.9739***	-.0365	.5288	.5943	**3.3457*** **	.0825	.0223	-.1186***	.9473**	.4885
	(.1908)	(.0917)	(.3984)	(.0366)	(.3769)	[.5588]	**(.2255)**	(.0945)	(.4697)	(.0456)	(.4516)	[.4437]
Right Tackles AV	**2.8455*** **	.1948*	1.2744***	-.0724**	.9874*	.5781	**3.4163*** **	.2377**	3.8025***	-.0303	.5105	.5252
	(.2155)	(.1069)	(.2574)	(.0349)	(.5244)	[.5411]	**(.1824)**	(.1122)	(.3792)	(.0477)	(.4351)	[.4837]
Defensive Ends AV	**3.4096*** **	-.0545	.0353	-.1247*	.9424*	.5954	**4.0339*** **	.3671**	-1.3666**	-.0104	2.0015***	.5550
	(.2132)	(.1363)	(.4421)	(.0637)	(.5384)	[.5600]	**(.2495)**	(.1566)	(.6266)	(.0770)	(.6647)	[.5160]
Defensive Tackles AV	**3.7177*** **	-.3334***	.2429	-.0733	.7419*	.5778	**3.9717*** **	.4770***	.5368	.2345***	.3689	.5447
	(.2295)	(.1174)	(.3953)	(.0521)	(.4334)	[.5408]	**(.2730)**	(.1384)	(.4614)	(.0763)	(.5871)	[.5048]
Inside Linebackers AV	**3.2116*** **	.0858	6.9156***	-.0916**	.9748**	.5330	**3.9753*** **	.1976	-6.3216***	.0900	-.1914	.5056
	(.3626)	(.1111)	(.3023)	(.0429)	(.4210)	[.4921]	**(.2545)**	(.1802)	(.4267)	(.0655)	(.6690)	[.4623]
Outside Linebackers AV	**3.1983*** **	.0186	-1.4604***	-.0444	1.3527**	.4582	**3.8014*** **	.3546***	-2.5939***	-.0023	.9702	.4854
	(.2779)	(.1328)	(.4725)	(.0646)	(.6843)	[.4107]	**(.2419)**	(.1184)	(.5885)	(.0786)	(.6474)	[.4403]
Cornerbacks AV	**3.0325*** **	-.1817	7.4454***	.0483	1.1970*	.3683	**3.4126*** **	.4133**	-2.4800***	.0124	1.8117***	.4473
	(.3425)	(.1600)	(.6246)	(.0803)	(.7185)	[.3129]	**(.2717)**	(.1793)	(.8358)	(.0757)	(.6138)	[.3988]
Free Safeties AV	**2.7233*** **	.0169	-2.8910***	-.0468	.8399*	.5103	**3.6374*** **	.2420**	-4.6916***	-.0650	.3441	.5704
	(.2511)	(.0962)	(.3217)	(.0452)	(.4540)	[.4674]	**(.1999)**	(.1197)	(.4624)	(.0429)	(.2834)	[.5327]
Strong Safeties AV	**2.3830*** **	.0417	.4051	-.0073	.2824	.4892	**3.0770*** **	.2676***	-3.8902***	-.0060	-.2418	.5434
	(.1612)	(.1172)	(.3355)	(.0428)	(.4422)	[.4445]	**(.2659)**	(.1015)	(.2986)	(.0410)	(.3792)	[.5034]
Kickers AV	**1.7001*** **	-.0022	.1418	-.0143	.1956	.5859	**1.4583*** **	-.0153	.7561***	.0356**	.0817	.3118
	(.1575)	(.0327)	(.1135)	(.0133)	(.1401)	[.5496]	**(.1363)**	(.0530)	(.1111)	(.0166)	(.2467)	[.2515]
Punters AV	**1.5091*** **	-.0118	1.1848***	.0112	-.0319	.7386	**1.5797*** **	-.0065	.1796	.0374***	-.0280	.5631
	(.1139)	(.0215)	(.1364)	(.0100)	(.0676)	[.7157]	**(.0850)**	(.0314)	(.1186)	(.0134)	(.1208)	[.5249]
Long Snappers AV	**.7058*** **	-.0072	-.2402***	-.0073**	.0043	.7856	**1.4349*** **	.0019	-.4682***	-.0352***	.0806	.4877
	(.0599)	(.0060)	(.0217)	(.0029)	(.0216)	[.7668]	**(.1105)**	(.0209)	(.0629)	(.0119)	(.1158)	[.4428]

*p<0.10, **p<0.05, ***p<0.01. Team-clustered standard errors are in parentheses.

⏩ Importance Results

Appendix D: $\sqrt{\text{Cap\%}}$ Calibrated Optimal Allocations

Table 23: $\sqrt{\text{Cap\%}}$ Actual vs. Calibrated Optimal Allocations, Team-Clustered Bootstrap Confidence Intervals

	Rookies				Veterans			
	Actual	Optimal	95% CI	Difference	Actual	Optimal	95% CI	Difference
Quarterbacks	**6.8%**	**16.8%**	**(5.7%, 34.7%)**	**-10.0%**	**11.0%**	**14.9%**	**(4.8%, 31.5%)**	**-3.9%**
Running Backs	7.1%	7.9%	(1.1%, 20.9%)	-0.7%	5.2%	8.1%	(1.5%, 19.1%)	-2.9%
Wide Receivers	12.3%	13.9%	(3.3%, 26.9%)	-1.6%	11.3%	10.5%	(2.7%, 19.0%)	0.8%
Tight Ends	4.9%	1.2%	(0.0%, 4.1%)	3.7%	5.0%	1.4%	(0.0%, 4.1%)	3.7%
Left Tackles	4.8%	1.7%	(0.0%, 4.6%)	3.1%	5.1%	1.6%	(0.0%, 4.5%)	3.5%
Guards	6.9%	3.9%	(0.4%, 9.5%)	3.0%	6.0%	5.5%	(0.5%, 13.6%)	0.4%
Centers	2.6%	3.5%	(0.0%, 11.6%)	-0.9%	3.4%	3.8%	(0.0%, 14.0%)	-0.4%
Right Tackles	4.0%	2.7%	(0.0%, 8.7%)	1.2%	3.3%	2.9%	(0.0%, 8.6%)	0.4%
Defensive Ends	9.1%	5.0%	(1.7%, 9.4%)	4.1%	8.9%	5.2%	(1.8%, 9.5%)	3.7%
Defensive Tackles	7.3%	8.0%	(3.1%, 13.8%)	-0.7%	7.4%	6.8%	(2.6%, 12.1%)	0.6%
Inside Linebackers	5.8%	7.3%	(2.3%, 14.4%)	-1.6%	5.2%	8.4%	(3.2%, 13.9%)	-3.2%
Outside Linebackers	8.3%	9.8%	(4.9%, 14.2%)	-1.6%	7.9%	10.4%	(4.9%, 16.3%)	-2.4%
Cornerbacks	11.4%	6.5%	(2.0%, 13.6%)	5.0%	9.8%	6.1%	(2.3%, 12.2%)	3.7%
Free Safeties	3.9%	7.0%	(1.7%, 13.7%)	-3.1%	3.6%	9.3%	(2.3%, 16.6%)	-5.8%
Strong Safeties	3.6%	2.7%	(0.3%, 6.7%)	0.9%	3.2%	3.4%	(0.4%, 8.8%)	-0.1%
Kickers	0.4%	0.1%	(0.0%, 2.4%)	0.3%	1.8%	0.1%	(0.0%, 1.3%)	1.7%
Punters	0.6%	2.0%	(0.0%, 9.7%)	-1.4%	1.2%	1.6%	(0.0%, 8.4%)	-0.4%
Long Snappers	0.3%	0.0%	(0.0%, 0.7%)	0.3%	0.7%	0.0%	(0.0%, 2.2%)	0.7%

⏩ log(Cap%) Allocations

Appendix D: Pre-2018 QB Allocations < Post-2018

Table 24a: Pre-2018 Actual vs. Calibrated Optimal Allocations, Team-Clustered Bootstrap Confidence Intervals

	Rookies				Veterans			
	Actual	Optimal	95% CI	Difference	Actual	Optimal	95% CI	Difference
Quarterbacks	**6.6%**	**4.5%**	**(0.8%, 11.1%)**	**2.1%**	**10.5%**	**11.9%**	**(2.1%, 24.8%)**	**-1.4%**
Running Backs	7.4%	5.1%	(0.0%, 12.3%)	2.3%	5.9%	5.9%	(0.0%, 12.9%)	0.0%
Wide Receivers	12.2%	18.7%	(5.7%, 28.1%)	-6.5%	10.7%	11.1%	(2.9%, 18.0%)	-0.4%
Tight Ends	4.6%	2.8%	(0.0%, 5.9%)	1.8%	5.2%	4.5%	(0.0%, 9.5%)	0.7%
Left Tackles	5.5%	2.8%	(0.5%, 5.2%)	2.6%	4.5%	3.7%	(0.7%, 6.5%)	0.8%
Guards	7.5%	3.9%	(1.0%, 8.6%)	3.6%	6.0%	5.2%	(1.2%, 10.2%)	0.8%
Centers	2.6%	2.9%	(0.4%, 5.7%)	-0.2%	3.2%	4.9%	(0.7%, 9.8%)	-1.6%
Right Tackles	3.5%	1.9%	(0.0%, 5.1%)	1.6%	2.9%	2.1%	(0.0%, 5.5%)	0.8%
Defensive Ends	8.8%	8.2%	(4.3%, 13.6%)	0.6%	8.8%	7.6%	(4.5%, 11.6%)	1.2%
Defensive Tackles	8.0%	7.9%	(3.0%, 13.7%)	0.1%	7.0%	6.4%	(2.4%, 11.3%)	0.6%
Inside Linebackers	5.4%	6.0%	(2.1%, 10.4%)	-0.6%	5.5%	6.5%	(2.5%, 11.7%)	-0.9%
Outside Linebackers	8.5%	10.8%	(6.7%, 15.8%)	-2.3%	8.8%	8.5%	(4.9%, 13.4%)	0.3%
Cornerbacks	10.3%	14.4%	(5.8%, 23.3%)	-4.1%	10.3%	8.0%	(3.5%, 12.6%)	2.3%
Free Safeties	4.2%	5.7%	(2.7%, 9.3%)	-1.5%	3.4%	5.7%	(2.8%, 9.4%)	-2.3%
Strong Safeties	3.5%	2.5%	(0.7%, 5.2%)	1.0%	3.3%	4.5%	(1.2%, 8.2%)	-1.2%
Kickers	0.5%	0.8%	(0.0%, 2.0%)	-0.4%	1.9%	1.3%	(0.0%, 3.6%)	0.6%
Punters	0.6%	1.2%	(0.0%, 3.3%)	-0.6%	1.4%	2.3%	(0.0%, 6.8%)	-0.9%
Long Snappers	0.4%	0.0%	(0.0%, 0.8%)	0.4%	0.7%	0.0%	(0.0%, 1.9%)	0.7%

⏩ Evolution of QB Market

Appendix D: Post-2018 QB Allocations > Pre-2018

Table 24b: Post-2018 Actual vs. Calibrated Optimal Allocations, Team-Clustered Bootstrap Confidence Intervals

	Rookies				Veterans			
	Actual	Optimal	95% CI	Difference	Actual	Optimal	95% CI	Difference
Quarterbacks	**7.1%**	**14.4%**	**(7.4%, 24.6%)**	**-7.3%**	**11.6%**	**17.5%**	**(9.6%, 29.1%)**	**-5.9%**
Running Backs	6.9%	20.1%	(8.3%, 28.0%)	-13.2%	4.4%	12.0%	(5.3%, 18.0%)	-7.6%
Wide Receivers	12.3%	13.8%	(2.5%, 23.1%)	-1.5%	11.9%	11.2%	(2.1%, 17.7%)	0.7%
Tight Ends	5.2%	0.0%	(0.0%, 2.0%)	5.2%	4.9%	0.0%	(0.0%, 3.2%)	4.9%
Left Tackles	4.1%	0.4%	(0.0%, 3.5%)	3.7%	5.7%	0.5%	(0.0%, 4.0%)	5.2%
Guards	6.4%	3.1%	(0.0%, 7.2%)	3.3%	5.9%	3.5%	(0.0%, 7.9%)	2.4%
Centers	2.5%	2.1%	(0.0%, 5.4%)	0.4%	3.5%	3.2%	(0.0%, 7.9%)	0.3%
Right Tackles	4.4%	2.4%	(0.0%, 7.0%)	2.0%	3.7%	3.0%	(0.0%, 8.7%)	0.6%
Defensive Ends	9.4%	3.8%	(0.2%, 8.8%)	5.6%	9.0%	5.3%	(0.3%, 10.7%)	3.6%
Defensive Tackles	6.7%	3.2%	(0.0%, 7.7%)	3.5%	7.9%	3.6%	(0.0%, 8.3%)	4.3%
Inside Linebackers	6.1%	5.0%	(2.0%, 8.6%)	1.1%	4.9%	6.0%	(2.4%, 9.3%)	-1.1%
Outside Linebackers	8.0%	10.0%	(5.9%, 15.4%)	-2.0%	7.1%	9.1%	(5.4%, 12.9%)	-2.0%
Cornerbacks	12.5%	13.1%	(5.9%, 21.6%)	-0.6%	9.4%	10.5%	(4.5%, 16.7%)	-1.1%
Free Safeties	3.6%	4.9%	(2.3%, 7.2%)	-1.3%	3.7%	8.6%	(3.8%, 12.6%)	-4.9%
Strong Safeties	3.6%	3.0%	(1.0%, 5.4%)	0.6%	3.2%	5.0%	(1.8%, 8.3%)	-1.8%
Kickers	0.3%	0.0%	(0.0%, 0.2%)	0.3%	1.7%	0.0%	(0.0%, 0.3%)	1.7%
Punters	0.6%	0.4%	(0.0%, 2.5%)	0.2%	1.0%	0.5%	(0.0%, 3.4%)	0.5%
Long Snappers	0.2%	0.2%	(0.0%, 1.3%)	0.0%	0.6%	0.5%	(0.0%, 2.5%)	0.1%

Optimal RB, TE, & LT allocations implausible, but 95% bounds reasonable

⏩ Evolution of QB Market

Appendix D: QB Valuation Pre-2018 Season

Table 25a: QB Valuation Results, Pre-2018 Season, 223 Fixed Effects ($N = 3,542$)

DV = Win	Passer Rating			ANY/A			TANY/A			FP/A		
	Logit	AME	Linear	Logit	AME	Linear	Logit	AME	Linear	Logit	AME	Linear
Quarterback Statistic	.0354***	**.0035*** **	.0035***	.3045***	**.0298*** **	.0303***	.3007***	**.0294*** **	.0330***	3.8494***	**.3771*** **	.4720***
	(.0118)	**(.0011)**	(.0010)	(.1067)	**(.0104)**	(.0099)	(.1084)	**(.0105)**	(.0098)	(1.4845)	**(.1447)**	(.1328)
Non-QB Fantasy Points	.1351***	.0132***	.0117***	.1347***	.0132***	.0116***	.1353***	.0132***	.0117***	.1359***	.0133***	.0118***
	(.0080)	(.0004)	(.0004)	(.0080)	(.0004)	(.0004)	(.0080)	(.0004)	(.0004)	(.0079)	(.0004)	(.0004)
Home	.3544***	.0347***	.0294***	.3533***	.0346***	.0296***	.3528***	.0345***	.0297***	.3535***	.0346***	.0295***
	(.0846)	(.0081)	(.0088)	(.0840)	(.0080)	(.0088)	(.0841)	(.0080)	(.0088)	(.0842)	(.0081)	(.0088)
Rest Days	-.0373	-.0037	-.0028	-.0357	-.0035	-.0027	-.0360	-.0035	-.0026	-.0377	-.0037	-.0029
	(.0327)	(.0032)	(.0036)	(.0327)	(.0032)	(.0036)	(.0328)	(.0032)	(.0036)	(.0326)	(.0032)	(.0036)
Log Injured Money	-.1516	-.0148	-.0163	-.1577	-.0154	-.0168	-.1574	-.0154	-.0171	-.1505	-.0147	-.0167
	(.1663)	(.0162)	(.0192)	(.1655)	(.0162)	(.0192)	(.1652)	(.0161)	(.0191)	(.1642)	(.0160)	(.0191)
Starter Gini	.4689	.0459	.0085	.6094	.0597	.0345	.3460	.0339	.0099	.0690	.0068	-.0278
	(2.4668)	(.2416)	(.2675)	(2.4791)	(.2432)	(.2663)	(2.4699)	(.2420)	(.2668)	(2.4698)	(.2420)	(.2686)
Starter/Non-Starter	.0581	.0057	-.0062	.0379	.0037	-.0073	.0258	.0025	-.0090	.0260	.0025	-.0097
	(.3106)	(.0304)	(.0337)	(.3093)	(.0303)	(.0336)	(.3081)	(.0302)	(.0336)	(.3080)	(.0302)	(.0338)
Pseudo-R^2 | R^2	.5559		.5149	.5553		.5144	.5552		.5149	.5550		.5152
Adjusted Pseudo-R^2 | R^2	.5531		.4823	.5524		.4818	.5524		.4823	.5521		.4827

*p<0.10, **p<0.05, ***p<0.01. Game-clustered standard errors are in parentheses.

⏩ Evolution of QB Market

Appendix D: QB Valuation Post-2018 Season

Table 25b: QB Valuation Results, Post-2018 Season, 224 Fixed Effects ($N = 3,696$)

DV = Win	Passer Rating			ANY/A			TANY/A			FP/A		
	Logit	AME	Linear	Logit	AME	Linear	Logit	AME	Linear	Logit	AME	Linear
Quarterback Statistic	.0380***	**.0038*** **	.0035***	.3531***	**.0358*** **	.0292***	.3998***	**.0404*** **	.0347***	6.5194***	**.6522*** **	.5676***
	(.0111)	**(.0011)**	(.0009)	(.0989)	**(.0100)**	(.0082)	(.0989)	**(.0099)**	(.0084)	(1.2255)	**(.1207)**	(.1072)
Non-QB Fantasy Points	.1329***	.0134***	.0120***	.1329***	.0135***	.0120***	.1335***	.0135***	.0120***	.1357***	.0136***	.0121***
	(.0081)	(.0005)	(.0004)	(.0082)	(.0005)	(.0004)	(.0082)	(.0004)	(.0004)	(.0082)	(.0004)	(.0004)
Home	.1442*	.0146*	.0135	.1428*	.0145*	.0136	.1437*	.0145*	.0137	.1433*	.0143*	.0136
	(.0761)	(.0077)	(.0086)	(.0761)	(.0077)	(.0086)	(.0761)	(.0077)	(.0086)	(.0767)	(.0076)	(.0086)
Rest Days	.0631*	.0064*	.0044	.0630*	.0064*	.0044	.0643*	.0065*	.0044	.0668*	.0067*	.0045
	(.0339)	(.0034)	(.0037)	(.0339)	(.0034)	(.0037)	(.0340)	(.0034)	(.0037)	(.0346)	(.0034)	(.0037)
Log Injured Money	.0941	.0095	.0080	.0838	.0085	.0080	.0687	.0070	.0066	.0511	.0051	.0051
	(.1359)	(.0137)	(.0149)	(.1354)	(.0137)	(.0149)	(.1353)	(.0137)	(.0149)	(.1360)	(.0136)	(.0149)
Starter Gini	4.4005**	.4453**	.4283*	4.1919**	.4248**	.4177*	4.1051*	.4152*	.4071*	4.0018*	.4004*	.3957*
	(2.0803)	(.2098)	(.2284)	(2.1209)	(.2143)	(.2299)	(2.1200)	(.2136)	(.2288)	(2.1037)	(.2096)	(.2257)
Starter/Non-Starter	.3164	.0320	.0211	.2843	.0288	.0208	.2461	.0249	.0166	.1635	.0164	.0101
	(.2854)	(.0289)	(.0311)	(.2850)	(.0289)	(.0311)	(.2873)	(.0291)	(.0311)	(.2872)	(.0287)	(.0311)
Pseudo-R^2 | R^2	.5395		.5046	.5391		.5039	.5399		.5048	.5445		.5073
Adjusted Pseudo-R^2 | R^2	.5367		.4726	.5364		.4718	.5372		.4728	.5418		.4756

*p<0.10, **p<0.05, ***p<0.01. Game-clustered standard errors are in parentheses.

⏩ Evolution of QB Market

Appendix D: Pre-2018 Calibrated Importance & CE

Table 26a: Pre-2018 Calibrated Importance & Cost Effectiveness Results ($N = 224$)

	Importance (DV = Wins) Coefficient	Cost Effectiveness: Rookies (DV = Position AV)							Cost Effectiveness: Veterans (DV = Position AV)						
		log(Cap%)	Cap% = 0	Vegas Wins	2011 Colts	Season	COTY	R^2 [Adj R^2]	**log(Cap%)**	Cap% = 0	Vegas Wins	2011 Colts	Season	COTY	R^2 [Adj R^2]
Quarterbacks AV	**.1252****	**1.2919*****	-4.3189***	-.1140	-8.1778***	-.3536	2.5883*	.5105	**3.4909*****	-.8374	.9451***	-5.1140***	-.0328	.4210	.6276
	(.0595)	**(.2707)**	(1.4874)	(.2906)	(.8433)	(.2185)	(1.4835)	[.4131]	**(.4014)**	(1.4233)	(.2165)	(.8846)	(.2170)	(1.4399)	[.5535]
Running Backs AV	**.0628***	**2.8926*****	-6.9594***	.1094	-1.3278*	.2599	1.4199	.4005	**3.4762*****	-.4887	.4098**	-5.2555***	.0355	2.2158**	.6092
	(.0363)	**(.4931)**	(1.2899)	(.3908)	(.7348)	(.1685)	(.9495)	[.2812]	**(.3787)**	(.7447)	(.1946)	(.5432)	(.1555)	(1.0425)	[.5314]
Wide Receivers AV	**.1039*****	**6.4857*****		-.0579	-2.6106***	-.5205**	2.0305*	.5051	**3.9173*****	-1.9198	.0920	-5.4436***	-.0082	-.1517	.6574
	(.0331)	**(.9158)**		(.3815)	(.8626)	(.2383)	(1.1456)	[.4098]	**(.6119)**	(1.2584)	(.2880)	(.6244)	(.1843)	(1.2850)	[.5893]
Tight Ends AV	**.0871***	**1.1679*****	-.8390*	-.0923	-4.9550***	-.2819**	-.2192	.3728	**1.8847*****	-1.1695	.3600**	-5.1048***	.2162*	.1118	.5809
	(.0451)	**(.2470)**	(.4310)	(.1678)	(.4704)	(.1306)	(.8348)	[.2481]	**(.3895)**	(.7359)	(.1555)	(.9748)	(.1218)	(.5434)	[.4976]
Left Tackles AV	**.0805****	**1.2722*****	-3.4942***	-.1167	-2.5220***	-.2341*	-.4158	.6023	**1.6894*****	-3.7591***	.4525**	1.0744	.0523	.8049	.6533
	(.0342)	**(.1919)**	(.5757)	(.1612)	(.5493)	(.1377)	(.7670)	[.5232]	**(.2357)**	(.5960)	(.2006)	(.8199)	(.1258)	(.7964)	[.5843]
Guards AV	**.0614****	**2.2711*****	-3.5051**	.7308***	-3.5419***	-.0889	1.9348	.5015	**3.1284*****	-4.2764***	.3962	-.3420	.0232	-.8283	.6132
	(.0249)	**(.6681)**	(1.6509)	(.2321)	(1.0795)	(.2045)	(1.2499)	[.4023]	**(.4800)**	(1.3001)	(.3438)	(.7302)	(.2092)	(1.2511)	[.5363]
Centers AV	**.0820****	**1.2648*****	-3.2918***	.0997	-.1489	.1476	.9193*	.5432	**2.1788*****	-4.2153***	-.2095	-.0115	-.1115	1.1495	.5408
	(.0358)	**(.1800)**	(.5823)	(.2096)	(.4486)	(.1231)	(.5363)	[.4524]	**(.2995)**	(.5546)	(.1855)	(.8312)	(.1688)	(.7752)	[.4495]
Right Tackles AV	**.0470**	**1.4357*****	-3.5726***	.1234	2.0749***	-.1259	.2812	.5638	**1.6606*****	-3.3858***	-.0166	3.7413***	.2161	.8434	.5603
	(.0340)	**(.1728)**	(.6234)	(.1610)	(.4549)	(.1535)	(.8484)	[.4770]	**(.2709)**	(.5944)	(.2080)	(.8035)	(.1687)	(.8221)	[.4729]
Defensive Ends AV	**.0845*****	**3.4847*****	-1.5826	.0382	.0869	-.3119*	1.0817	.5684	**3.3069*****	-5.4454***	.2970	-.7006	.0787	3.7352***	.6304
	(.0145)	**(.8043)**	(1.5771)	(.2267)	(.7259)	(.1843)	(.8542)	[.4826]	**(.4214)**	(1.3387)	(.3139)	(.6831)	(.1913)	(1.3930)	[.5568]
Defensive Tackles AV	**.0919*****	**3.0944*****	-5.9204**	-.2888	-.9004	-.0576	1.0267	.5438	**2.5642*****	.9939	.3035	2.4146***	.3768*	.5592	.5336
	(.0249)	**(.5877)**	(2.9150)	(.3207)	(.8545)	(.2028)	(.7184)	[.4531]	**(.3981)**	(3.7094)	(.2240)	(.8374)	(.2163)	(.9594)	[.4408]
Inside Linebackers AV	**.0901*****	**2.3921*****	-4.6071***	.1468	9.0208***	.0969	1.0835	.5055	**2.6337*****	-3.4929***	.7032*	-9.8302***	.0722	-.2849	.5758
	(.0258)	**(.5365)**	(1.3502)	(.2541)	(.5988)	(.1716)	(1.1143)	[.4071]	**(.5905)**	(.7794)	(.4266)	(.7755)	(.2104)	(1.4804)	[.4914]
Outside Linebackers AV	**.0922*****	**4.2191*****		-.1798	.9930	-.3390*	.6863	.5040	**3.3870*****	-4.6211***	.2386	.1655	.0000	.5868	.4409
	(.0194)	**(.6084)**		(.2780)	(.6529)	(.1780)	(1.5044)	[.4085]	**(.5197)**	(.7117)	(.3103)	(.7304)	(.2008)	(.9768)	[.3297]
Cornerbacks AV	**.0956*****	**5.4152*****		-.3161	5.7924***	-.2709	2.3868	.4577	**3.0875*****		.4173	-.6813	.1331	1.2317	.4752
	(.0298)	**(.6760)**		(.2284)	(.8331)	(.1900)	(1.4886)	[.3533]	**(.3847)**		(.3379)	(1.5362)	(.2080)	(.9626)	[.3742]
Free Safeties AV	**.1172*****	**1.7414*****	-1.4134**	-.1455	-2.1880***	-.0425	.4433	.5369	**1.7953*****	-3.0867***	.7168***	-2.8272***	.1508	1.1979**	.6431
	(.0358)	**(.2127)**	(.6179)	(.2162)	(.5099)	(.1564)	(.6474)	[.4447]	**(.2719)**	(.6160)	(.1767)	(.4246)	(.1330)	(.5920)	[.5721]
Strong Safeties AV	**.0899****	**1.0017*****	-3.1650***	-.0852	1.2687**	-.1141	-.4453	.4905	**1.8243*****	-3.4099***	.5413***	-4.9461***	-.0330	1.2709*	.5725
	(.0390)	**(.2045)**	(.6757)	(.2411)	(.5344)	(.1072)	(.6139)	[.3892]	**(.2771)**	(.5193)	(.1690)	(.3463)	(.1013)	(.7210)	[.4875]
Kickers AV	**.0773**	**.3755*****	-2.0267***	.0269	-.0289	-.0453	.0873	.6277	**.6265*****	-2.2745***	-.0868	.1905	.0955	-.0411	.4774
	(.0576)	**(.0562)**	(.2860)	(.0478)	(.1400)	(.0367)	(.2496)	[.5537]	**(.1724)**	(.1935)	(.0948)	(.2530)	(.0760)	(.2649)	[.3735]
Punters AV	**.1461**	**.2955*****	-1.7284***	-.0492	1.1491***	.0396*	.1200	.7792	**.5902*****	-1.8340***	-.0091	-.0075	-.0353	.0363	.6361
	(.1193)	**(.0257)**	(.1525)	(.0480)	(.1435)	(.0229)	(.1290)	[.7352]	**(.1303)**	(.1425)	(.0616)	(.1592)	(.0435)	(.2168)	[.5637]
Long Snappers AV	**.0000**	**.1726*****	-.7844***	-.0151	-.5455***	-.0350***	-.0457	.7949	**.4548*****	-1.2891***	-.0007	.0103	-.0247	.1698	.6796
	(.0462)	**(.0172)**	(.0795)	(.0117)	(.0582)	(.0104)	(.0480)	[.7541]	**(.0760)**	(.1010)	(.0201)	(.0857)	(.0224)	(.1946)	[.6158]
Vegas Wins O/U	**.1045**														
	(.0796)														
2011 Indianapolis Colts	**-2.0992*****														
	(.4270)														
Coach of the Year	**1.4917*****														
	(.3394)														
R^2	**.8683**														
Adjusted R^2	**.8640**														
Standard Errors	**TC Bootstrap**	Team-Clustered							Team-Clustered						

*p<0.10, **p<0.05, ***p<0.01. Standard errors are in parentheses.

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Appendix D: Post-2018 Calibrated Importance & CE

Table 26b: Post-2018 Calibrated Importance & Cost Effectiveness Results ($N = 224$)

	Importance (DV = Wins)	Cost Effectiveness: Rookies (DV = Position AV)						Cost Effectiveness: Veterans (DV = Position AV)					
	Coefficient	**log(Cap%)**	Cap% = 0	Vegas Wins	Season	COTY	R^2 [Adj R^2]	**log(Cap%)**	Cap% = 0	Vegas Wins	Season	COTY	R^2 [Adj R^2]
Quarterbacks AV	**.1990*** **	**2.5147*** **	-2.0767**	.0215	-.1253	2.1200***	.5794	**3.0905*** **		1.1647***	.2307	.4500	.6267
	(.0505)	**(.3440)**	(.9505)	(.2616)	(.2127)	(.7734)	[.4984]	**(.4131)**		(.2499)	(.1927)	(.6902)	[.5573]
Running Backs AV	**.1372*** **	**5.1002*** **		.0006	-.2115	2.7485***	.5096	**3.0737*** **		.2965**	.1497	.9656	.5318
	(.0348)	**(.5665)**		(.1942)	(.2238)	(.9761)	[.4183]	**(.3631)**		(.1503)	(.1328)	(.9118)	[.4447]
Wide Receivers AV	**.0793*** **	**6.0634*** **		-.1491	.0905	.9948	.4293	**4.9462*** **		.9144***	-.0590	2.8380***	.4875
	(.0296)	**(.8743)**		(.2680)	(.2729)	(1.0712)	[.3231]	**(.5146)**		(.2813)	(.1875)	(.9853)	[.3920]
Tight Ends AV	**.0000**	**1.0448*** **	.0583	-.1923	.0416	-.4159	.4506	**1.6149*** **	-1.2065	.2213	.0660	.9099**	.5672
	(.0185)	**(.2321)**	(.3735)	(.1455)	(.1289)	(.6031)	[.3448]	**(.3763)**	(.7646)	(.1545)	(.1217)	(.4140)	[.4838]
Left Tackles AV	**.0107**	**1.3632*** **	-2.0615***	-.2036	.1326	-.0858	.4895	**1.6808*** **	-3.9152***	.4988**	-.0788	2.2781***	.5535
	(.0250)	**(.1851)**	(.5609)	(.1517)	(.1289)	(.7778)	[.3912]	**(.1088)**	(1.0603)	(.1961)	(.1569)	(.6726)	[.4676]
Guards AV	**.0437**	**2.4539*** **	-1.4890***	.2198	-.1055	.4486	.5531	**2.8326*** **	-1.9075***	.0995	-.2874*	2.4680**	.5042
	(.0281)	**(.3477)**	(.3540)	(.2015)	(.1818)	(.8008)	[.4670]	**(.4341)**	(.6554)	(.1994)	(.1509)	(.9615)	[.4087]
Centers AV	**.0551**	**1.3295*** **	-2.7157***	.0564	-.0109	.0856	.5525	**2.0707*** **	-4.6185***	.2703	-.1742	1.3283**	.5552
	(.0376)	**(.1776)**	(.3459)	(.1113)	(.1222)	(.6441)	[.4664]	**(.2009)**	(.6059)	(.1731)	(.1379)	(.6121)	[.4696]
Right Tackles AV	**.0545**	**1.5595*** **	-2.7204***	.1333	-.1341	1.3076	.5190	**1.9483*** **	-3.1823***	.2000	-.0130	.3693	.4810
	(.0426)	**(.1626)**	(.5872)	(.1901)	(.1461)	(.9427)	[.4264]	**(.2542)**	(.5973)	(.1715)	(.1439)	(.5369)	[.3810]
Defensive Ends AV	**.0441** **	**3.0024*** **	-2.6859***	-.0386	-.1344	.6255	.5535	**4.2612*** **		.3033	.0968	.3500	.5261
	(.0224)	**(.5670)**	(.6729)	(.2703)	(.1692)	(.8686)	[.4675]	**(.4347)**		(.2277)	(.2312)	(1.0607)	[.4379]
Defensive Tackles AV	**.0416***	**2.7079*** **	.1803	-.2209	-.1637	.6649	.5126	**3.0341*** **	-2.9100***	.7903***	.1893	.4899	.5287
	(.0235)	**(.4197)**	(.6430)	(.1884)	(.1792)	(.6649)	[.4188]	**(.6503)**	(.9003)	(.2720)	(.2337)	(.8809)	[.4379]
Inside Linebackers AV	**.0719*** **	**2.4254*** **	-.9703	.1898	-.2050	-.4242	.5940	**2.9117*** **	-3.0672*	.3665	.1305	1.0294	.5143
	(.0216)	**(.3252)**	(1.6263)	(.1777)	(.1526)	(.8524)	[.5159]	**(.4186)**	(1.7198)	(.2696)	(.1960)	(1.1023)	[.4208]
Outside Linebackers AV	**.1063*** **	**3.2786*** **		.0274	-.3368	1.0318	.5215	**3.0020*** **	-4.2745***	.2256	.1337	1.5191	.5397
	(.0174)	**(.7125)**		(.1760)	(.2261)	(.9327)	[.4324]	**(.4291)**	(1.4624)	(.2274)	(.2255)	(1.1336)	[.4511]
Cornerbacks AV	**.0935*** **	**4.8832*** **		-.1220	.1059	-.0690	.4920	**3.9397*** **		.2367	-.0037	1.8842*	.5800
	(.0270)	**(.5523)**		(.2466)	(.1920)	(.7314)	[.3974]	**(.4870)**		(.3265)	(.1797)	(1.0112)	[.5018]
Free Safeties AV	**.1272*** **	**1.3535*** **	-3.3618***	.1282	-.1595	1.1662*	.4847	**2.3711*** **	-3.2763***	.0475	-.1093	-.5068	.5141
	(.0316)	**(.2217)**	(1.2918)	(.1744)	(.1323)	(.6219)	[.3855]	**(.3333)**	(.4196)	(.2037)	(.1526)	(.6679)	[.4206]
Strong Safeties AV	**.0848*** **	**1.2395*** **	-2.0740***	.2150	-.0130	.8247	.4416	**2.0563*** **	-3.4614***	.0463	.1709	-1.5198***	.5933
	(.0286)	**(.2564)**	(.3992)	(.1812)	(.1359)	(.7267)	[.3341]	**(.2138)**	(.3311)	(.1515)	(.1242)	(.4418)	[.5150]
Kickers AV	**.0000**	**.3521*** **	-1.5567***	.0158	.0154	.3211	.5177	**.4448*** **	-2.5277***	-.0222	.0092	.0812	.3221
	(.0080)	**(.0553)**	(.2835)	(.0489)	(.0409)	(.2121)	[.4249]	**(.0906)**	(.2132)	(.0693)	(.0728)	(.3733)	[.1916]
Punters AV	**.0345**	**.3922*** **	-1.7420***	-.0337	.0205	-.1578	.7182	**.5319*** **	-2.0440***	-.0562*	.0858**	.0040	.6118
	(.0691)	**(.0469)**	(.1211)	(.0366)	(.0298)	(.1591)	[.6639]	**(.0947)**	(.1194)	(.0325)	(.0421)	(.2117)	[.5371]
Long Snappers AV	**.0551**	**.1511*** **	-.6907***	-.0012	-.0065	.0021	.7709	**.3157*** **	-1.2574***	-.0121	-.0555**	.0174	.3843
	(.0902)	**(.0159)**	(.0819)	(.0078)	(.0068)	(.0356)	[.7268]	**(.0801)**	(.1434)	(.0259)	(.0234)	(.1155)	[.2658]
Vegas Wins O/U	**.2302*** **												
	(.0727)												
17 Game Season	**.3706** **												
	(.1561)												
Coach of the Year	**1.5581*** **												
	(.3363)												
R^2	**.8605**												
Adjusted R^2	**.8560**												
Standard Errors	**TC Bootstrap**	Team-Clustered						Team-Clustered					

*p<0.10, **p<0.05, ***p<0.01. Standard errors are in parentheses.

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Appendix D: Pre-2018 Baseline Allocations

Table 27a: Pre-2018 Actual vs. Baseline Optimal Allocations, Team-Clustered Bootstrap Confidence Intervals

	Rookies				Veterans			
	Actual	Optimal	95% CI	Difference	Actual	Optimal	95% CI	Difference
Quarterbacks	**6.6%**	**2.9%**	**(-1.1%, 8.1%)**	**3.6%**	**10.5%**	**8.0%**	**(-2.6%, 19.8%)**	**2.5%**
Running Backs	7.4%	6.9%	(1.1%, 14.1%)	0.5%	5.9%	8.7%	(1.3%, 15.9%)	-2.7%
Wide Receivers	12.2%	19.3%	(6.5%, 28.8%)	-7.1%	10.7%	11.7%	(3.5%, 20.0%)	-1.1%
Tight Ends	4.6%	2.4%	(-0.3%, 5.0%)	2.2%	5.2%	3.9%	(-0.4%, 8.7%)	1.3%
Left Tackles	5.5%	2.6%	(0.3%, 4.6%)	2.9%	4.5%	3.5%	(0.5%, 6.3%)	1.0%
Guards	7.5%	3.9%	(0.7%, 8.6%)	3.6%	6.0%	5.4%	(1.1%, 9.9%)	0.6%
Centers	2.6%	2.9%	(0.5%, 5.5%)	-0.2%	3.2%	5.2%	(0.9%, 10.2%)	-2.0%
Right Tackles	3.5%	2.2%	(-0.4%, 5.2%)	1.3%	2.9%	2.6%	(-0.5%, 5.7%)	0.3%
Defensive Ends	8.8%	7.9%	(4.0%, 14.1%)	1.0%	8.8%	7.6%	(4.7%, 11.5%)	1.1%
Defensive Tackles	8.0%	7.5%	(2.7%, 14.0%)	0.5%	7.0%	6.2%	(2.3%, 11.1%)	0.7%
Inside Linebackers	5.4%	5.5%	(1.8%, 9.8%)	-0.1%	5.5%	6.0%	(2.3%, 11.1%)	-0.5%
Outside Linebackers	8.5%	9.9%	(6.0%, 14.3%)	-1.4%	8.8%	8.1%	(4.6%, 12.7%)	0.7%
Cornerbacks	10.3%	15.9%	(8.2%, 23.7%)	-5.6%	10.3%	9.2%	(5.3%, 13.3%)	1.1%
Free Safeties	4.2%	6.2%	(3.3%, 9.2%)	-2.0%	3.4%	6.4%	(3.5%, 10.3%)	-3.0%
Strong Safeties	3.5%	2.7%	(1.0%, 5.2%)	0.9%	3.3%	4.9%	(1.8%, 8.6%)	-1.6%
Kickers	0.5%	0.6%	(-0.7%, 1.8%)	-0.2%	1.9%	1.1%	(-1.1%, 3.4%)	0.8%
Punters	0.6%	1.2%	(-0.6%, 3.1%)	-0.7%	1.4%	2.5%	(-1.4%, 6.7%)	-1.1%
Long Snappers	0.4%	-0.4%	(-1.6%, 0.8%)	0.7%	0.7%	-1.0%	(-4.8%, 2.1%)	1.7%

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Appendix D: Post-2018 Baseline Allocations

Table 27b: Post-2018 Actual vs. Baseline Optimal Allocations, Team-Clustered Bootstrap Confidence Intervals

	Rookies				Veterans			
	Actual	Optimal	95% CI	Difference	Actual	Optimal	95% CI	Difference
Quarterbacks	**7.1%**	**9.6%**	**(1.5%, 17.9%)**	**-2.5%**	**11.6%**	**11.7%**	**(1.8%, 21.6%)**	**-0.1%**
Running Backs	6.9%	21.3%	(8.6%, 31.0%)	-14.4%	4.4%	12.6%	(5.3%, 19.4%)	-8.2%
Wide Receivers	12.3%	16.0%	(4.4%, 26.5%)	-3.7%	11.9%	14.2%	(4.4%, 22.9%)	-2.3%
Tight Ends	5.2%	0.1%	(-2.6%, 2.8%)	5.1%	4.9%	0.1%	(-4.0%, 4.4%)	4.8%
Left Tackles	4.1%	1.2%	(-1.5%, 4.8%)	2.9%	5.7%	1.5%	(-2.2%, 5.4%)	4.2%
Guards	6.4%	4.2%	(-0.3%, 8.6%)	2.2%	5.9%	4.9%	(-0.4%, 9.4%)	1.0%
Centers	2.5%	2.4%	(-0.7%, 5.8%)	0.1%	3.5%	3.8%	(-1.1%, 8.5%)	-0.2%
Right Tackles	4.4%	2.9%	(-1.3%, 7.8%)	1.5%	3.7%	3.6%	(-1.6%, 9.9%)	0.0%
Defensive Ends	9.4%	4.3%	(0.7%, 9.6%)	5.1%	9.0%	6.1%	(1.1%, 11.7%)	2.8%
Defensive Tackles	6.7%	3.7%	(0.3%, 8.0%)	3.0%	7.9%	4.1%	(0.4%, 8.4%)	3.7%
Inside Linebackers	6.1%	4.7%	(2.1%, 8.3%)	1.4%	4.9%	5.8%	(2.8%, 9.6%)	-1.0%
Outside Linebackers	8.0%	9.9%	(5.9%, 16.6%)	-1.9%	7.1%	9.0%	(5.8%, 13.3%)	-1.9%
Cornerbacks	12.5%	12.7%	(5.7%, 20.9%)	-0.2%	9.4%	10.2%	(4.8%, 17.5%)	-0.8%
Free Safeties	3.6%	4.9%	(2.2%, 7.4%)	-1.3%	3.7%	8.6%	(3.9%, 12.4%)	-4.9%
Strong Safeties	3.6%	2.5%	(0.5%, 4.7%)	1.1%	3.2%	4.1%	(0.7%, 7.4%)	-0.9%
Kickers	0.3%	-0.6%	(-1.6%, 0.5%)	1.0%	1.7%	-0.8%	(-2.4%, 0.6%)	2.5%
Punters	0.6%	0.3%	(-1.9%, 2.3%)	0.3%	1.0%	0.4%	(-2.7%, 3.1%)	0.6%
Long Snappers	0.2%	-0.1%	(-2.2%, 0.9%)	0.3%	0.6%	-0.1%	(-4.7%, 1.8%)	0.7%

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Appendix D: Pre-2018 Baseline Importance & CE

Table 28a: Pre-2018 Baseline Importance & Cost Effectiveness Results ($N = 224$)

	Importance (DV = Wins)	Cost Effectiveness: Rookies (DV = Position AV)						Cost Effectiveness: Veterans (DV = Position AV)					
	Coefficient	**log(Cap%)**	Cap% = 0	Vegas Wins	2011 Colts	Season	R^2 [Adj R^2]	**log(Cap%)**	Cap% = 0	Vegas Wins	2011 Colts	Season	R^2 [Adj R^2]
Quarterbacks AV	**.0925**	**1.3100*** **	-4.3800***	-.1953	-8.5382***	-.3236	.4895	**3.4754*** **	-.7431	.9311***	-5.1458***	-.0250	.6272
	(.0734)	**(.2675)**	(1.4908)	(.3006)	(.8385)	(.2242)	[.3912]	**(.4044)**	(1.3482)	(.2133)	(.8769)	(.2131)	[.5554]
Running Backs AV	**.0994** **	**2.8622*** **	-6.5061***	.0606	-1.5148**	.2732	.3930	**3.5172*** **	-1.0932*	.3405*	-5.5819***	.0613	.5920
	(.0444)	**(.5196)**	(1.2436)	(.3826)	(.7270)	(.1733)	[.2761]	**(.3947)**	(.6591)	(.1860)	(.5350)	(.1547)	[.5134]
Wide Receivers AV	**.1210*** **	**6.5522*** **		-.1236	-2.9053***	-.4994**	.4952	**3.9127*** **	-1.9057	.0972	-5.4215***	-.0099	.6574
	(.0436)	**(.9156)**		(.3794)	(.8591)	(.2462)	[.4013]	**(.6175)**	(1.2480)	(.2970)	(.6454)	(.1811)	[.5914]
Tight Ends AV	**.0831***	**1.1672*** **	-.7681***	-.0852	-4.9247***	-.2843**	.3724	**1.8878*** **	-1.1528	.3564**	-5.1249***	.2175*	.5808
	(.0459)	**(.2458)**	(.2828)	(.1663)	(.4362)	(.1319)	[.2515]	**(.3935)**	(.7442)	(.1575)	(.9986)	(.1212)	[.5002]
Left Tackles AV	**.0830** **	**1.2743*** **	-3.5048***	-.1025	-2.4674***	-.2392*	.6014	**1.7110*** **	-3.7587***	.4278**	1.0173	.0623	.6504
	(.0370)	**(.1930)**	(.5803)	(.1576)	(.5050)	(.1387)	[.5247]	**(.2343)**	(.5955)	(.1943)	(.8261)	(.1252)	[.5831]
Guards AV	**.0690** **	**2.3000*** **	-3.8517**	.6701***	-3.7700***	-.0636	.4884	**3.1671*** **	-4.0676***	.4235	-.1813	.0162	.6118
	(.0274)	**(.6358)**	(1.5698)	(.2259)	(1.0111)	(.2187)	[.3900]	**(.5056)**	(1.3330)	(.3462)	(.7745)	(.2087)	[.5371]
Centers AV	**.0947** **	**1.2563*** **	-3.3157***	.0711	-.2637	.1581	.5375	**2.2175*** **	-4.1341***	-.2463	-.1978	-.0941	.5350
	(.0426)	**(.1770)**	(.5558)	(.2110)	(.4397)	(.1227)	[.4485]	**(.3151)**	(.5332)	(.1895)	(.7566)	(.1723)	[.4454]
Right Tackles AV	**.0623**	**1.4407*** **	-3.5364***	.1139	2.0382***	-.1220	.5633	**1.6728*** **	-3.2565***	-.0412	3.6958***	.2324	.5571
	(.0392)	**(.1682)**	(.5983)	(.1542)	(.4969)	(.1468)	[.4793]	**(.2732)**	(.5851)	(.2050)	(.8189)	(.1701)	[.4719]
Defensive Ends AV	**.0933*** **	**3.4642*** **	-1.4703	.0020	-.0504	-.2979	.5649	**3.2975*** **	-3.9503***	.2004	-1.2151	.1208	.6049
	(.0163)	**(.8010)**	(1.4706)	(.2213)	(.7229)	(.1841)	[.4812]	**(.4409)**	(.7480)	(.3352)	(.7408)	(.1960)	[.5288]
Defensive Tackles AV	**.0983*** **	**3.1273*** **	-6.0379**	-.3273	-1.0118	-.0441	.5412	**2.5635*** **	.9160	.2859	2.3371***	.3831*	.5327
	(.0284)	**(.5997)**	(2.9153)	(.3054)	(.8447)	(.2063)	[.4528]	**(.3963)**	(3.6627)	(.2260)	(.8234)	(.2156)	[.4427]
Inside Linebackers AV	**.0921*** **	**2.4501*** **	-4.9600***	.1115	8.8829***	.1105	.5016	**2.6505*** **	-3.5007***	.7134*	-9.7778***	.0707	.5756
	(.0288)	**(.5264)**	(1.2274)	(.2489)	(.6165)	(.1689)	[.4057]	**(.6138)**	(.7794)	(.4126)	(.8255)	(.2074)	[.4939]
Outside Linebackers AV	**.0963*** **	**4.2420*** **		-.2035	.8967	-.3321*	.5025	**3.3925*** **	-4.5345***	.2197	.0825	.0068	.4399
	(.0214)	**(.6334)**		(.2814)	(.6065)	(.1791)	[.4099]	**(.5136)**	(.6610)	(.3079)	(.7159)	(.1980)	[.3321]
Cornerbacks AV	**.1207*** **	**5.4226*** **		-.3929	5.4613***	-.2433	.4365	**3.0924*** **		.3778	-.8336	.1476	.4711
	(.0296)	**(.6321)**		(.2435)	(.8861)	(.1997)	[.3316]	**(.3717)**		(.3287)	(1.4578)	(.2043)	[.3726]
Free Safeties AV	**.1447*** **	**1.7536*** **	-1.4038**	-.1583	-2.2509***	-.0371	.5357	**1.7913*** **	-3.1610***	.6782***	-2.9939***	.1636	.6363
	(.0383)	**(.2125)**	(.5624)	(.2174)	(.5491)	(.1503)	[.4463]	**(.2637)**	(.6109)	(.1837)	(.4370)	(.1351)	[.5663]
Strong Safeties AV	**.1078** **	**1.0166*** **	-3.2420***	-.0652	1.3003**	-.1195	.4885	**1.8283*** **	-3.4856***	.5006***	-5.1197***	-.0182	.5611
	(.0442)	**(.2032)**	(.6287)	(.2395)	(.5417)	(.1055)	[.3900]	**(.2800)**	(.4863)	(.1632)	(.3627)	(.1024)	[.4766]
Kickers AV	**.0691**	**.3756*** **	-2.0257***	.0241	-.0411	-.0443	.6273	**.6258*** **	-2.2745***	-.0855	.1960	.0950	.4774
	(.0798)	**(.0566)**	(.2868)	(.0486)	(.1371)	(.0358)	[.5556]	**(.1724)**	(.1932)	(.0970)	(.2515)	(.0756)	[.3767]
Punters AV	**.1734**	**.2952*** **	-1.7103***	-.0543	1.1417***	.0402*	.7779	**.5903*** **	-1.8376***	-.0105	-.0098	-.0350	.6360
	(.1489)	**(.0257)**	(.1522)	(.0444)	(.1411)	(.0230)	[.7352]	**(.1303)**	(.1370)	(.0573)	(.1587)	(.0434)	[.5659]
Long Snappers AV	**-.0874**	**.1731*** **	-.7864***	-.0137	-.5379***	-.0355***	.7940	**.4640*** **	-1.2992***	-.0057	-.0106	-.0229	.6767
	(.1573)	**(.0174)**	(.0793)	(.0112)	(.0575)	(.0105)	[.7543]	**(.0778)**	(.0997)	(.0214)	(.0712)	(.0225)	[.6145]
Vegas Wins O/U	**.0295**												
	(.0931)												
2011 Indianapolis Colts	**-2.2441*** **												
	(.4070)												
R^2	**.8520**												
Adjusted R^2	**.8081**												

*p<0.10, **p<0.05, ***p<0.01. Team-clustered standard errors are in parentheses.

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Appendix D: Post-2018 Baseline Importance & CE

Table 28b: Post-2018 Baseline Importance & Cost Effectiveness Results ($N = 224$)

	Importance (DV = Wins) Coefficient	Cost Effectiveness: Rookies (DV = Position AV) **log(Cap%)**	Cap% = 0	Vegas Wins	Season	R^2 [Adj R^2]	Cost Effectiveness: Veterans (DV = Position AV) **log(Cap%)**	Cap% = 0	Vegas Wins	Season	R^2 [Adj R^2]
Quarterbacks AV	**.1578****	**2.5426*****	-2.1045**	-.0156	-.1270	.5633	**3.0860*****		1.1553***	.2303	.6261
	(.0650)	**(.3323)**	(.8998)	(.2532)	(.2066)	[.4820]	**(.4107)**		(.2566)	(.1924)	[.5588]
Running Backs AV	**.1733*****	**5.1588*****		-.0599	-.2117	.4740	**3.0300*****		.2767*	.1511	.5271
	(.0489)	**(.6212)**		(.2058)	(.2457)	[.3794]	**(.3511)**		(.1511)	(.1302)	[.4421]
Wide Receivers AV	**.1128*****	**5.9713*****		-.1663	.0930	.4258	**5.2444*****		.8581***	-.0610	.4616
	(.0419)	**(.8690)**		(.2679)	(.2709)	[.3226]	**(.5428)**		(.2861)	(.1904)	[.3647]
Tight Ends AV	**.0032**	**1.0513*****	-.1518	-.1832	.0413	.4481	**1.6476*****	-.7265	.2062	.0642	.5579
	(.0494)	**(.2292)**	(.2210)	(.1409)	(.1294)	[.3453]	**(.3835)**	(.7577)	(.1521)	(.1211)	[.4756]
Left Tackles AV	**.0369**	**1.3644*****	-2.0518***	-.2016	.1327	.4894	**1.7314*****	-3.0817***	.4594**	-.0825	.5245
	(.0494)	**(.1812)**	(.5568)	(.1506)	(.1294)	[.3944]	**(.1315)**	(.9727)	(.2020)	(.1683)	[.4360]
Guards AV	**.0714***	**2.4462*****	-1.4899***	.2104	-.1053	.5520	**2.8754*****	-2.3448***	.0465	-.2864*	.4760
	(.0394)	**(.3449)**	(.3508)	(.1950)	(.1810)	[.4686]	**(.4027)**	(.6222)	(.2211)	(.1658)	[.3784]
Centers AV	**.0761**	**1.3275*****	-2.7200***	.0545	-.0109	.5525	**2.0672*****	-4.9491***	.2446	-.1743	.5423
	(.0508)	**(.1797)**	(.3497)	(.1104)	(.1219)	[.4692]	**(.2275)**	(.5529)	(.1715)	(.1377)	[.4571]
Right Tackles AV	**.0772**	**1.5586*****	-2.6293***	.1069	-.1339	.5076	**1.9452*****	-3.2138***	.1924	-.0130	.4800
	(.0635)	**(.1650)**	(.6635)	(.1867)	(.1479)	[.4159]	**(.2577)**	(.5885)	(.1710)	(.1455)	[.3831]
Defensive Ends AV	**.0597****	**3.0160*****	-2.4732***	-.0504	-.1346	.5519	**4.2593*****		.2962	.0965	.5258
	(.0280)	**(.5653)**	(.3970)	(.2732)	(.1698)	[.4685]	**(.4326)**		(.2286)	(.2296)	[.4405]
Defensive Tackles AV	**.0566****	**2.7325*****	.1943	-.2339	-.1630	.5103	**3.0309*****	-2.5915***	.7805***	.1899	.5280
	(.0268)	**(.4179)**	(.6600)	(.1952)	(.1800)	[.4192]	**(.6454)**	(.7348)	(.2645)	(.2323)	[.4401]
Inside Linebackers AV	**.0823*****	**2.4153*****	-1.1327	.1982	-.2067	.5931	**2.9473*****	-3.0793**	.3443	.1277	.5101
	(.0229)	**(.3262)**	(1.5211)	(.1781)	(.1534)	[.5174]	**(.4336)**	(1.4569)	(.2579)	(.1947)	[.4189]
Outside Linebackers AV	**.1260*****	**3.3033*****		.0061	-.3381	.5171	**2.9681*****	-4.3550***	.1936	.1337	.5333
	(.0225)	**(.7166)**		(.1785)	(.2274)	[.4302]	**(.4434)**	(1.3597)	(.2318)	(.2286)	[.4464]
Cornerbacks AV	**.1096*****	**4.8809*****		-.1206	.1060	.4919	**3.8622*****		.2009	-.0065	.5652
	(.0320)	**(.5511)**		(.2516)	(.1921)	[.4005]	**(.4646)**		(.3444)	(.1810)	[.4870]
Free Safeties AV	**.1512*****	**1.3659*****	-3.5116***	.1046	-.1598	.4694	**2.3610*****	-3.1781***	.0568	-.1090	.5125
	(.0350)	**(.2368)**	(1.3539)	(.1718)	(.1354)	[.3706]	**(.3301)**	(.4627)	(.2020)	(.1524)	[.4217]
Strong Safeties AV	**.0823****	**1.2644*****	-2.0388***	.1981	-.0146	.4347	**2.0691*****	-3.4545***	.0783	.1715	.5725
	(.0346)	**(.2574)**	(.5268)	(.1750)	(.1381)	[.3294]	**(.2201)**	(.4717)	(.1541)	(.1307)	[.4929]
Kickers AV	**-.0775**	**.3416*****	-1.5614***	.0097	.0143	.5077	**.4419*****	-2.5337***	-.0237	.0091	.3218
	(.0745)	**(.0544)**	(.2862)	(.0492)	(.0409)	[.4161]	**(.0927)**	(.2042)	(.0674)	(.0727)	[.1955]
Punters AV	**.0315**	**.3930*****	-1.7354***	-.0306	.0207	.7160	**.5318*****	-2.0439***	-.0563*	.0858**	.6118
	(.1195)	**(.0469)**	(.1196)	(.0352)	(.0300)	[.6631]	**(.0949)**	(.1201)	(.0316)	(.0420)	[.5395]
Long Snappers AV	**-.0146**	**.1511*****	-.6906***	-.0013	-.0065	.7709	**.3148*****	-1.2570***	-.0124	-.0555**	.3842
	(.1651)	**(.0158)**	(.0822)	(.0078)	(.0068)	[.7282]	**(.0805)**	(.1432)	(.0266)	(.0234)	[.2696]
Vegas Wins O/U	**.1140**										
	(.0806)										
17 Game Season	**.4042****										
	(.1768)										
R^2	**.8395**										
Adjusted R^2	**.7920**										

*p<0.10, **p<0.05, ***p<0.01. Team-clustered standard errors are in parentheses.

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Appendix E: DID Data & Variables

- **Data:** 31,688 player-season-contract level observations from 2011–2024
  - **Groups:** *Post-2018* vs. *Pre-2018*, *QB* vs. *Non-QB*, *Veteran* vs. *Rookie*
  - **Alternative Groups:** *Expensive* (starter-level $) vs. *Non-Expensive*
- **Dependent Variables:** *Cap Hit/Cap* & *APY/Cap*
  - **Cap Hit:** Cap spending by team on player in season
  - **APY:** *Average per Year* of contract across seasons
- **Control Variables:** $Pre\text{-}2011 \times (1 - Veteran)$ & *Length* (*APY* only)
  - **Pre-2011:** Debuted before 2011 (control for pre-CBA rookie contracts)
  - **Length:** Contract duration (long high-*APY* contracts cheap in future)
- **Fixed Effects:** 2-way season & position FEs, plus team FEs

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Appendix E: DID Summary Statistics

Table 29: DID Summary Statistics, 2011–2024 ($N = 31,688$)

	Mean	SD	Min	Max
Post-2018	.5235	.4995	0	1
QB	.0440	.2051	0	1
Veteran	.5531	.4972	0	1
Expensive (Cap Hit/Cap)	.3419	.4744	0	1
Expensive (APY/Cap)	.3424	.4745	0	1
QB × Veteran	.0283	.1659	0	1
QB × Veteran × Expensive (Cap Hit/Cap)	.0071	.0840	0	1
QB × Veteran × Expensive (APY/Cap)	.0071	.0842	0	1
Post-2018 × QB × Veteran	.0156	.1238	0	1
Post-2018 × QB × Veteran × Expensive (Cap Hit/Cap)	.0035	.0593	0	1
Post-2018 × QB × Veteran × Expensive (APY/Cap)	.0036	.0599	0	1
Cap Hit/Cap	.0123	.0191	0	.2088
Cap Hit/Cap (Post-2018 × QB × Veteran = 1)	.0337	.0483	0	.2088
Cap Hit/Cap (Post-2018 × QB × Veteran = 0)	.0119	.0180	0	.1687
Cap Hit/Cap (Post-2018 × QB × Veteran × Expensive = 1)	.1132	.0367	0	.2088
Cap Hit/Cap (Post-2018 × QB × Veteran × Expensive = 0)	.0119	.0180	0	.1687
APY/Cap	.0150	.0232	0	.2466
APY/Cap (Post-2018 × QB × Veteran = 1)	.0500	.0705	0	.2466
APY/Cap (Post-2018 × QB × Veteran = 0)	.0144	.0212	0	.1780
APY/Cap (Post-2018 × QB × Veteran × Expensive = 1)	.1687	.0384	0	.2466
APY/Cap (Post-2018 × QB × Veteran × Expensive = 0)	.0144	.0212	0	.1780
Pre-2011 × (1 − Veteran)	.0423	.2012	0	1
Length	2.7870	1.4098	1	10

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Appendix E: DID Model & Results

$$\text{Salary/Cap} = \beta_1 \text{Post-2018} + \beta_2 \text{Treatment} + \boldsymbol{\beta_3 (\text{Post-2018} \times \text{Treatment})} +$$
$$\delta_1 (\text{Pre-2011} \times (1 - \text{Veteran})) + \delta_2 \text{Length} + \eta_j + \psi_p + \xi_i + \epsilon$$

- *Salary* = *CapHit* or *APY*
- *Treatment* = *QB* × *Veteran* or *QB* × *Veteran* × *Expensive*

- Table 30 verifies post-2018 explosion in expensive veteran QB market
  - Due to delayed large cap hits, *APY/Cap*'s effect > *Cap Hit/Cap*'s
  - Post-2018, expensive veteran QB *APY/Cap* ↑ by 4.31%pt > others

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Appendix E: Expensive Veteran QB Salaries ↑ Post-2018

Table 30: DID Results, Season + Position + Team Fixed Effects ($N = 31,688$)

	QB × Veteran		QB × Veteran × Expensive	
	Cap Hit/Cap	APY/Cap	Cap Hit/Cap	APY/Cap
Post-2018	-.0051***	-.0010*	-.0052***	-.0017***
	(.0004)	(.0006)	(.0004)	(.0005)
Treatment	.0254***	.0414***	.0925***	.0996***
	(.0023)	(.0021)	(.0030)	(.0028)
Post-2018 × Treatment	**-.0049****	**.0032**	**.0084***	**.0431*****
	(.0025)	**(.0027)**	**(.0045)**	**(.0042)**
Pre-2011 × (1 − Veteran)	-.0014*	-.0086***	-.0014*	-.0083***
	(.0008)	(.0006)	(.0007)	(.0006)
Length		.0067***		.0056***
		(.0001)		(.0001)
R^2	.0775	.2439	.2160	.3768
Adjusted R^2	.0756	.2424	.2144	.3755

*p<0.10, **p<0.05, ***p<0.01. Team-season clustered standard errors are in parentheses.

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Appendix E: Triple & Quadruple DID Results

Table 31: Triple & Quadruple DID Results, Season + Position + Team FEs ($N = 31,688$)

	Triple		Quadruple	
	Cap Hit/Cap	APY/Cap	Cap Hit/Cap	APY/Cap
Post-2018	-.0015***	.0003	-.0003	.0001
	(.0004)	(.0006)	(.0003)	(.0004)
QB	.0170***	.0198***	.0184***	.0204***
	(.0013)	(.0012)	(.0007)	(.0009)
Veteran	.0130***	.0248***	.0045***	.0116***
	(.0003)	(.0003)	(.0002)	(.0002)
Expensive			.0102***	.0064***
			(.0002)	(.0003)
Post-2018 × QB	.0008	.0025*	.0002	.0011**
	(.0017)	(.0014)	(.0002)	(.0005)
Post-2018 × Veteran	-.0052***	.0043***	-.0023***	-.0003
	(.0004)	(.0004)	(.0002)	(.0002)
Post-2018 × Expensive			-.0005	-.0005
			(.0003)	(.0004)
QB × Veteran	.0147***	.0227***	.0076***	.0109***
	(.0026)	(.0021)	(.0010)	(.0013)
QB × Expensive			.0141***	.0146***
			(.0027)	(.0022)
Veteran × Expensive			.0230***	.0216***
			(.0005)	(.0005)
Post-2018 × QB × Veteran	**-.0032**	**.0000**	-.0027**	-.0037**
	(.0035)	**(.0031)**	(.0013)	(.0017)
Post-2018 × QB × Expensive			-.0008	-.0009
			(.0033)	(.0026)
Post-2018 × Veteran × Expensive			.0008	.0087***
			(.0007)	(.0008)
QB × Veteran × Expensive			.0444***	.0531***
			(.0040)	(.0036)
Post-2018 × QB × Veteran × Expensive			**.0116****	**.0391****
			(.0058)	**(.0051)**
Pre-2011 × (1 − Veteran)	.0061***	.0032***	.0048***	.0040***
	(.0007)	(.0006)	(.0005)	(.0005)
Length		.0107***		.0044***
		(.0001)		(.0001)
R^2	.1436	.4879	.6414	.7489
Adjusted R^2	.1418	.4868	.6405	.7483

*p<0.10, **p<0.05, ***p<0.01. Team-season clustered standard errors are in parentheses.

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