

Optimal Run/Pass Ratios in the NFL



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Summary of data

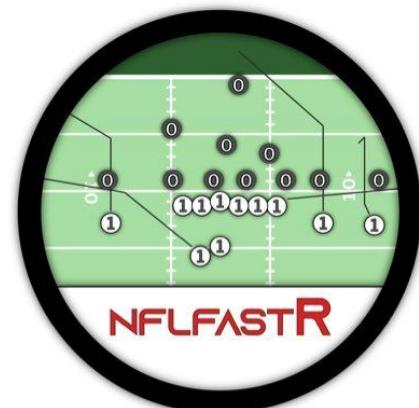
Pro Football Focus play-by-play data from 2014-2020 NFL seasons

Pro Football Focus team season grades data from 2014-2020 NFL seasons

- Join in play-by-play data from **nflfastR**
 - ◆ Time outs remaining

nflfastR data allows us to:

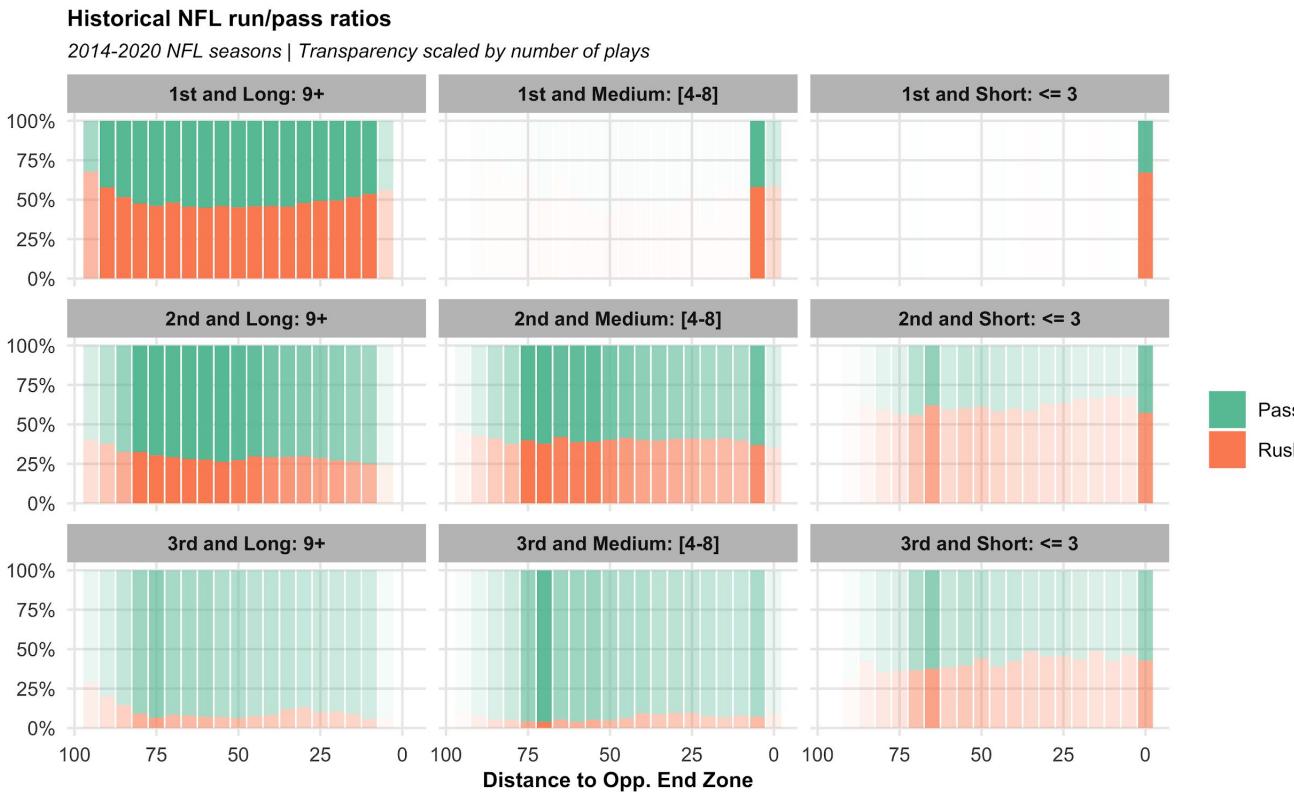
- Calculate **win probability**
- Calculate **expected pass percentage** given situation



Exploring historical run/pass ratios

NFL teams are historically **most** run-heavy on:

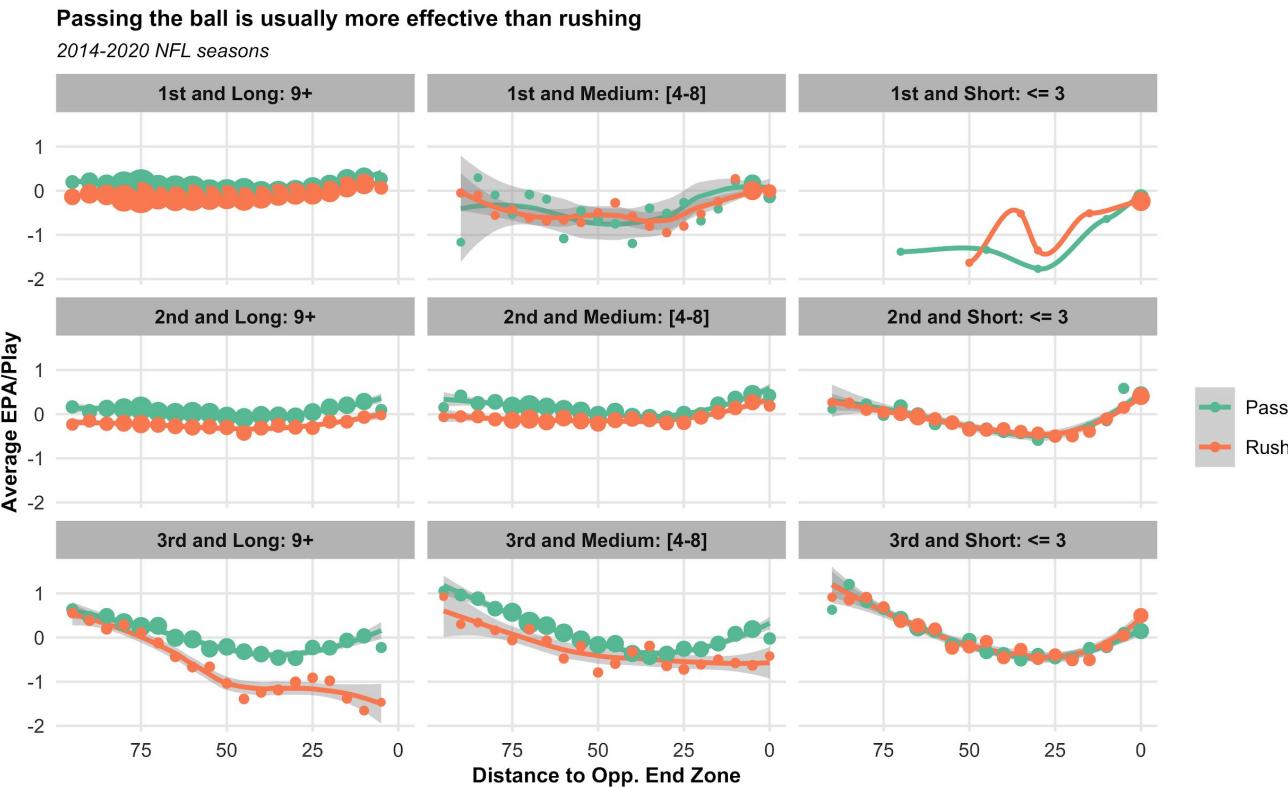
- 1st & 10
- 2nd & short
- 3rd & short



What play types are most effective and where?

Rushing the ball is only efficient in short yardage situations

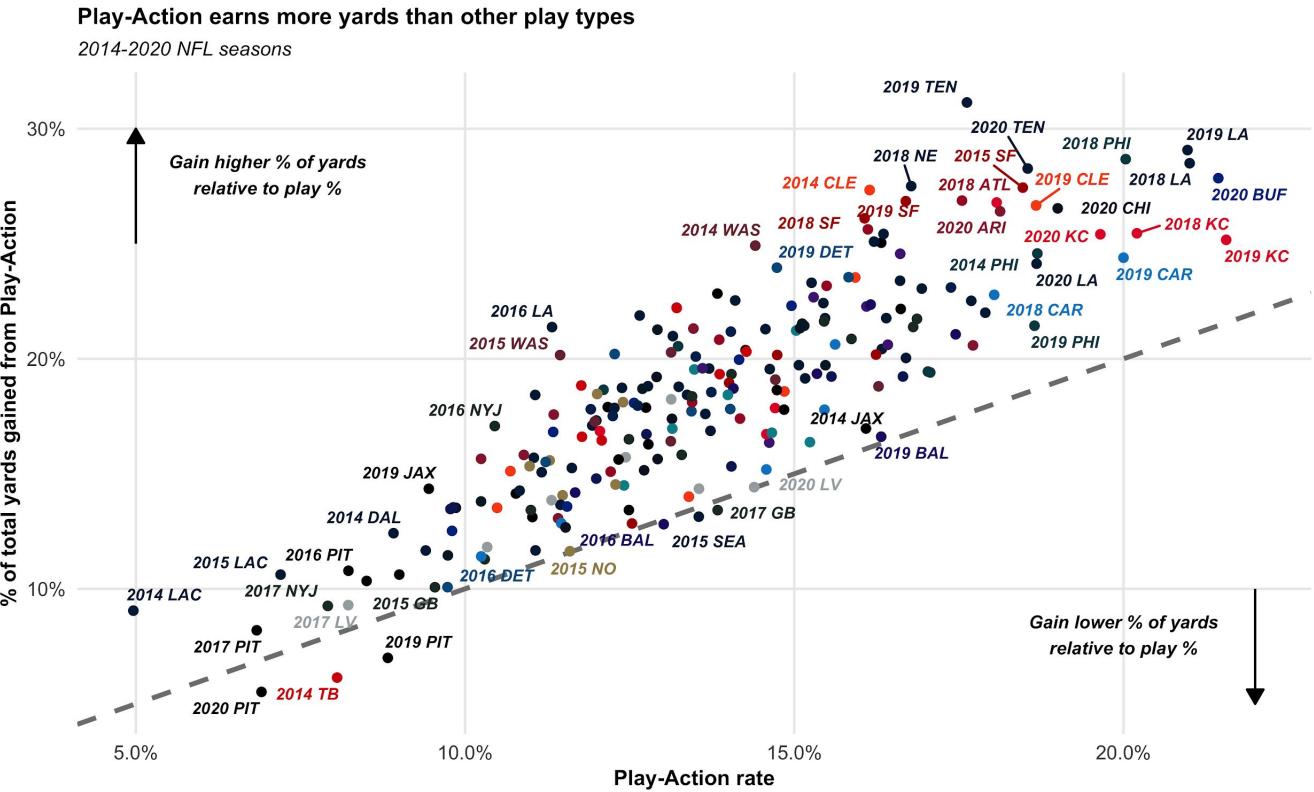
- 2nd & short
- 3rd & short



Data: @nflfastR + PFF

Play-action gains more yards than other plays

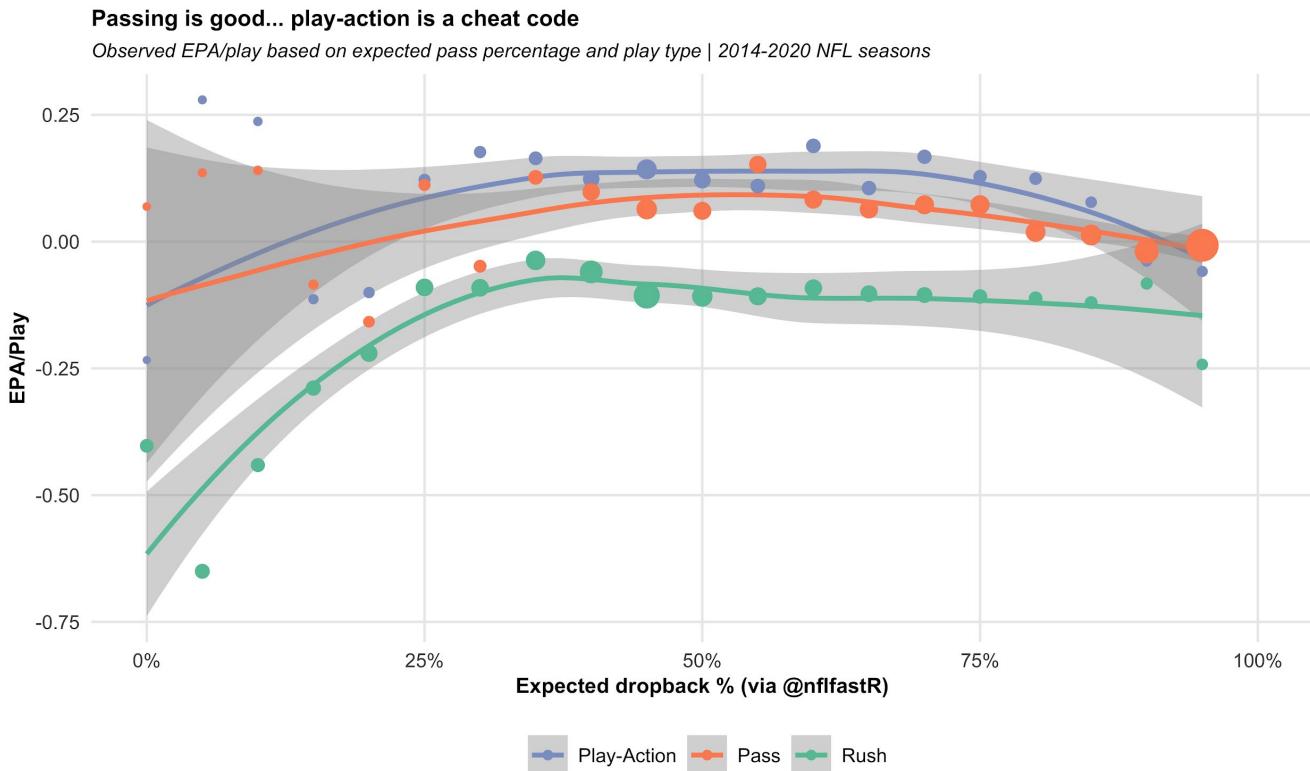
NFL teams gain
more yards on play-
action relative to
how often they call it



Play-action is good almost regardless of situation

Only when teams are **sure** an offense must pass is play-action inefficient

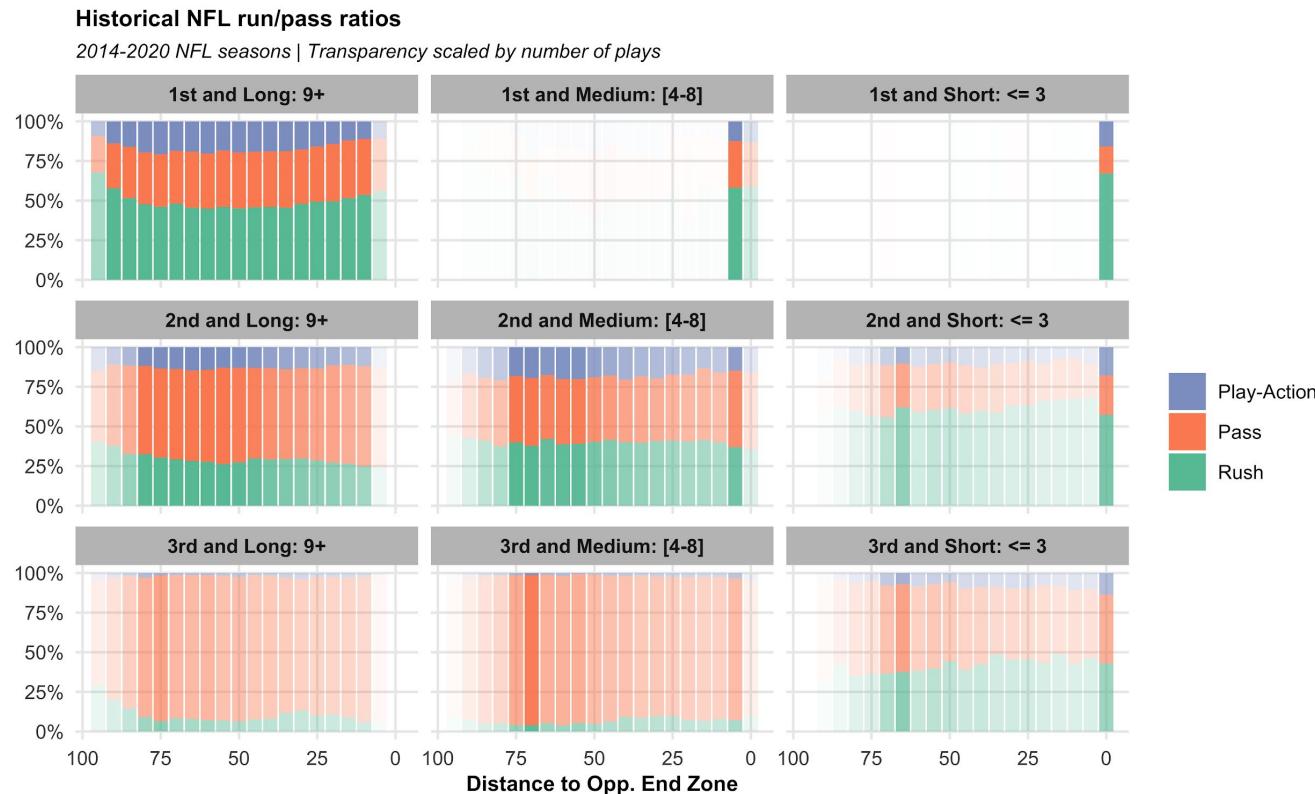
Running is least efficient when it is **expected**



Exploring historical run/pass ratios with play-action

Teams run **play-action** on only **about 15%** of plays, despite its effectiveness

→ Teams **rarely** run play-action on **3rd** down



Data: @nflfastR + PFF

Determining Optimal Run/Pass Ratios in the NFL

Methodology:

Train a model to **predict EPA/play** based on a number of features:

- PFF season grades for the offense and defense
- Game situation
 - ◆ Down
 - ◆ Yards to go for 1st down
 - ◆ Yardline
 - ◆ Game seconds remaining
 - ◆ Whether possession team is home
 - ◆ Whether the play is a run, pass or play-action pass
 - ◆ Expected dropback percentage
 - ◆ Win probability

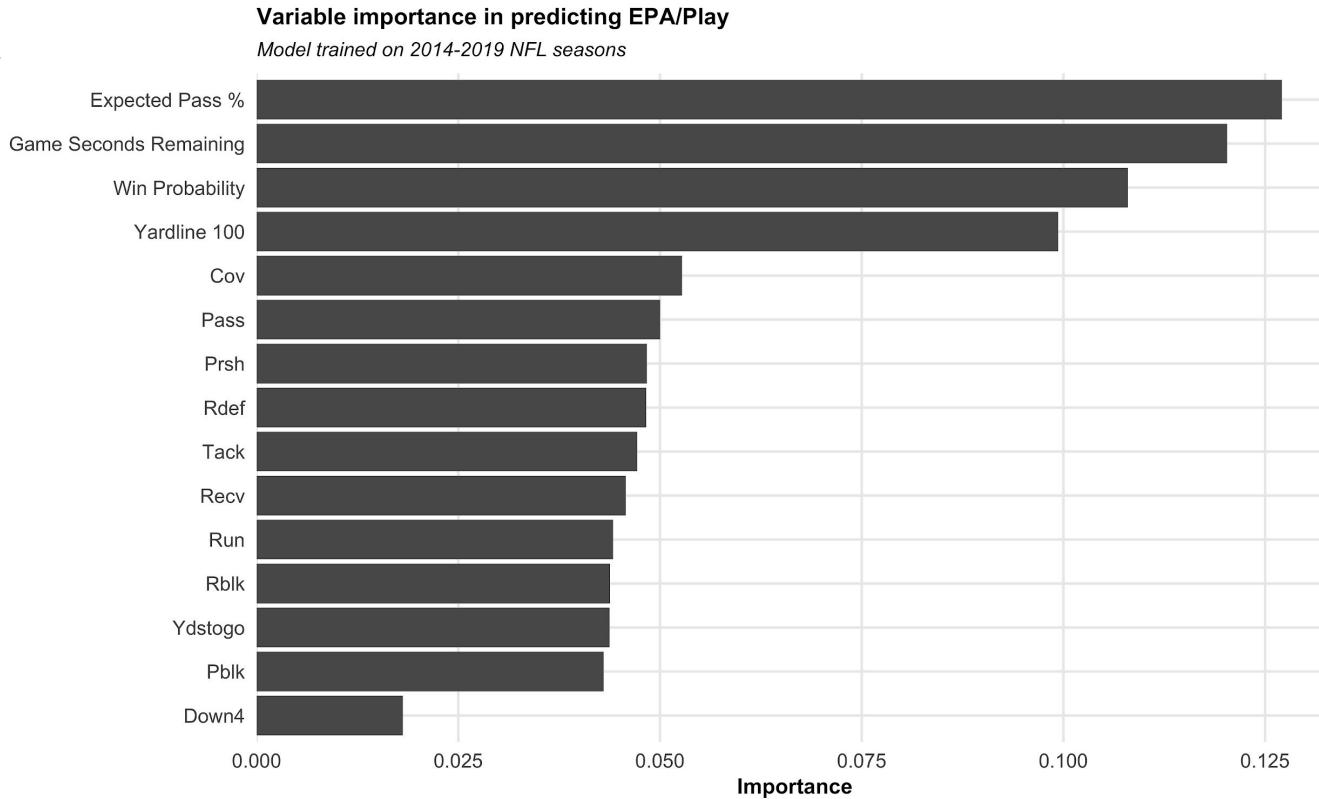
Simulate all combinations of game situations to determine optimal play types

Model variable importance

The **best predictors** of EPA/play have to do with the current **game situation**

→ **PFF season grades** help explain EPA/play

Demonstrates the importance of **passing offense and defense**



Optimal NFL Run/Pass Ratios

Model trained on 2014-2019 NFL play-by-play data

DIST FROM ENDZONE	% OF PLAYS	RUN %	PASS %	% OF PASSES PA
Goal Line	0-9	6.2%	25.2%	74.8% 99.8%
Red Zone	10-19	7.2%	2.4%	97.6% 94.2%
Field Goal range	20-39	17.9%	11.5%	88.5% 98.9%
No man's land	40-75	56.1%	4.8%	95.2% 93.1%
Deep in own territory	>75	12.6%	1.1%	98.9% 76.6%

Data: @nflfastR + PFF

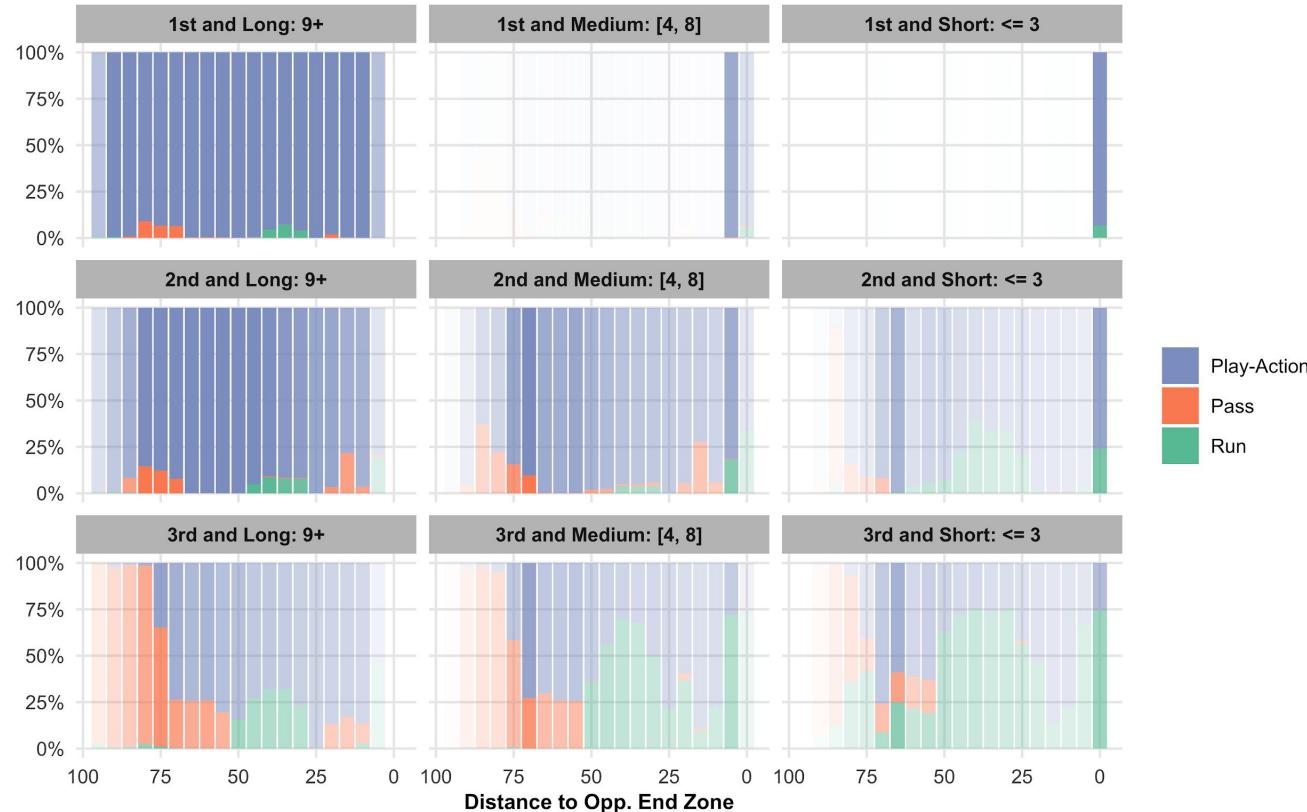
Simulation results

Rush the ball in short yardage situations

- 2nd & short
- 3rd & short

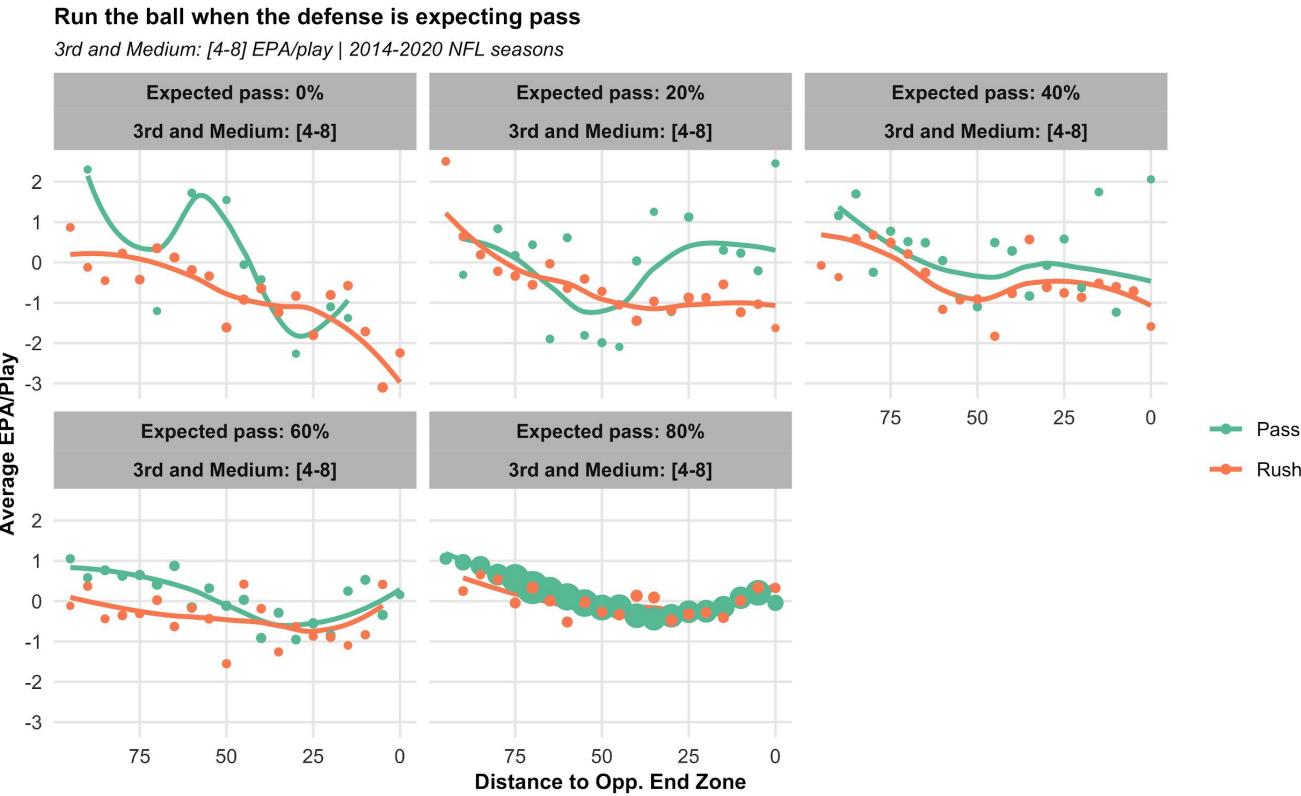
Play-action otherwise!

Surprise Finding:
Running is preferred on **3rd and medium** and **closer** while in **deep field goal range**



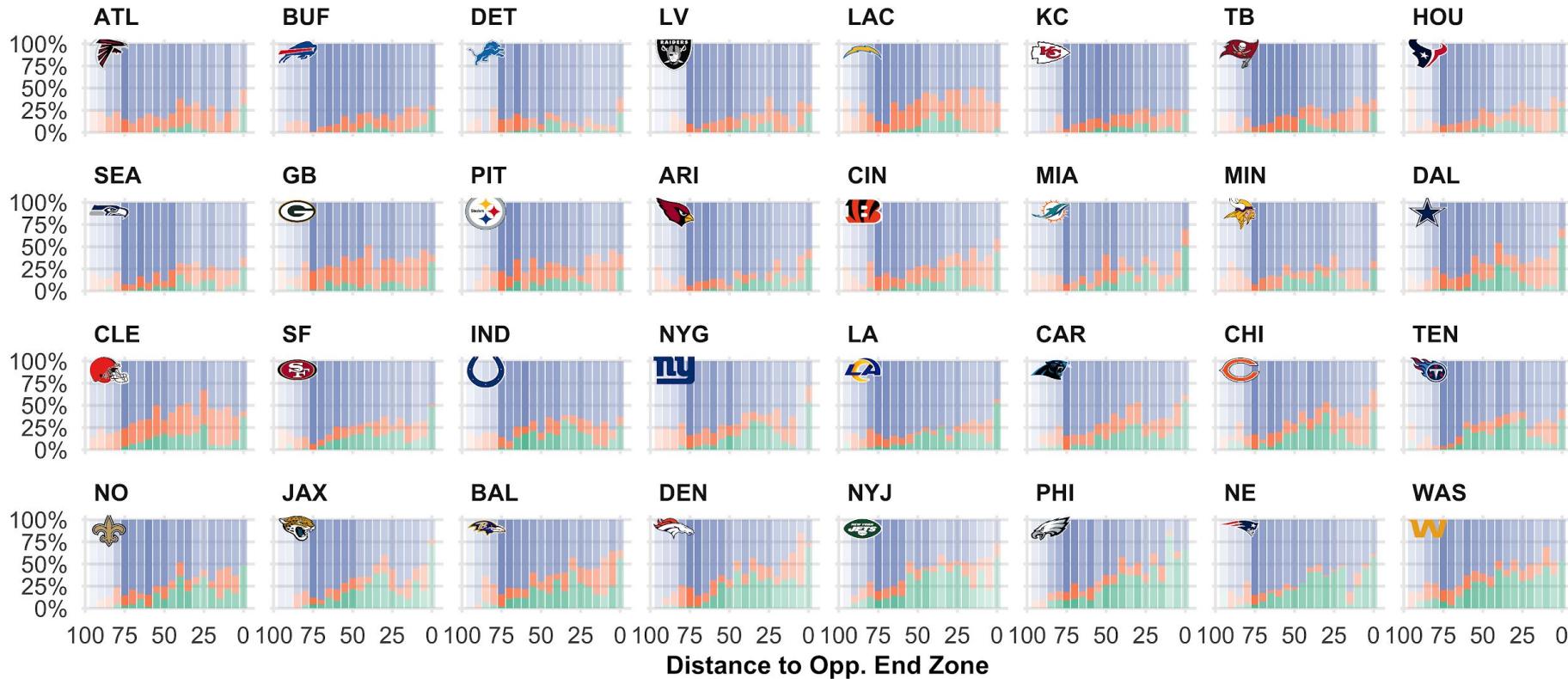
Looking at those 3rd and mediums...

Teams have had
success rushing the
ball in field goal range
when a **defense is**
expecting pass



Optimal run/pass ratios for each NFL team in 2020

Based on predicting EPA/play for run or pass | Transparency scaled by number of plays



Play-Action Pass Run

Case study:

Buffalo Bills

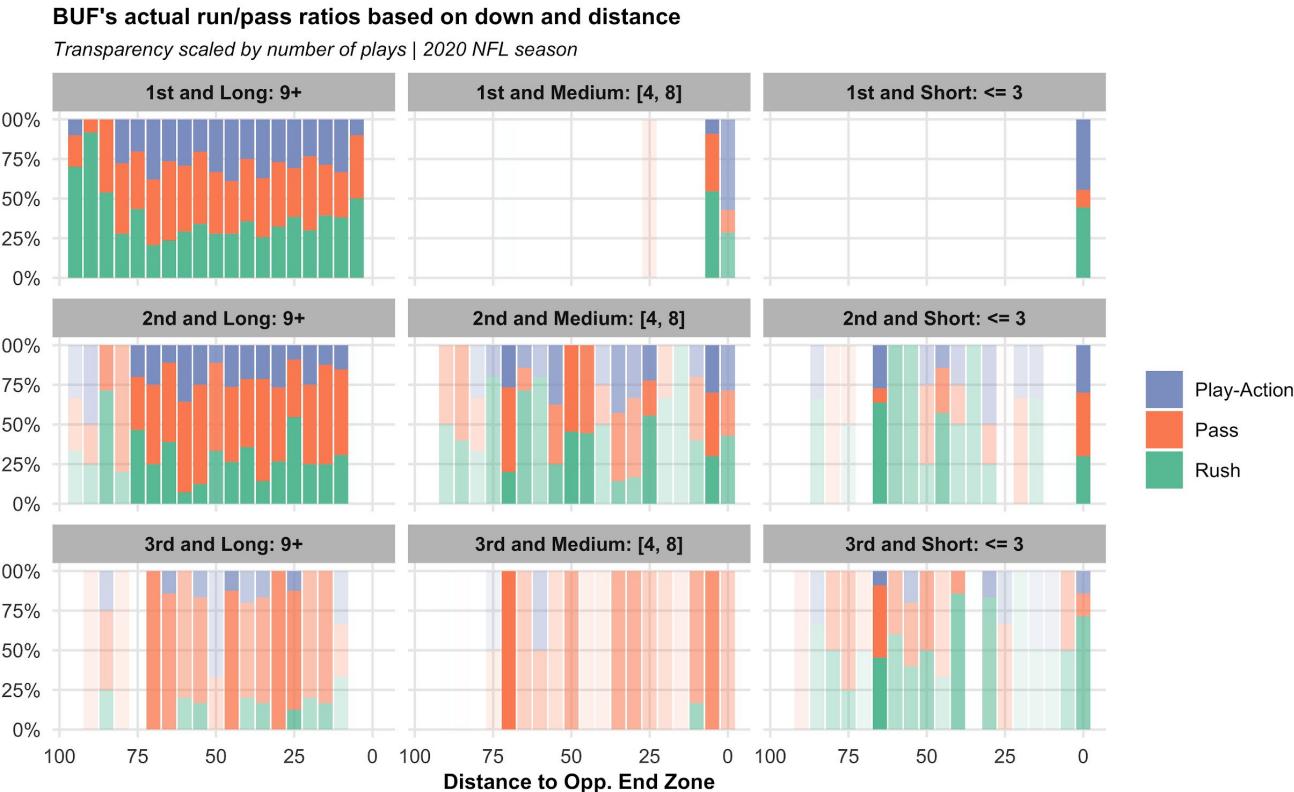


Buffalo Bills actual run/pass ratio

Finished **13-3** and
won the AFC East

Ranked **5th** in
EPA/play on offense
according to PFF

Ranked **5th in PFF**
offensive grade on
the season



Buffalo Bills optimal run/pass ratio

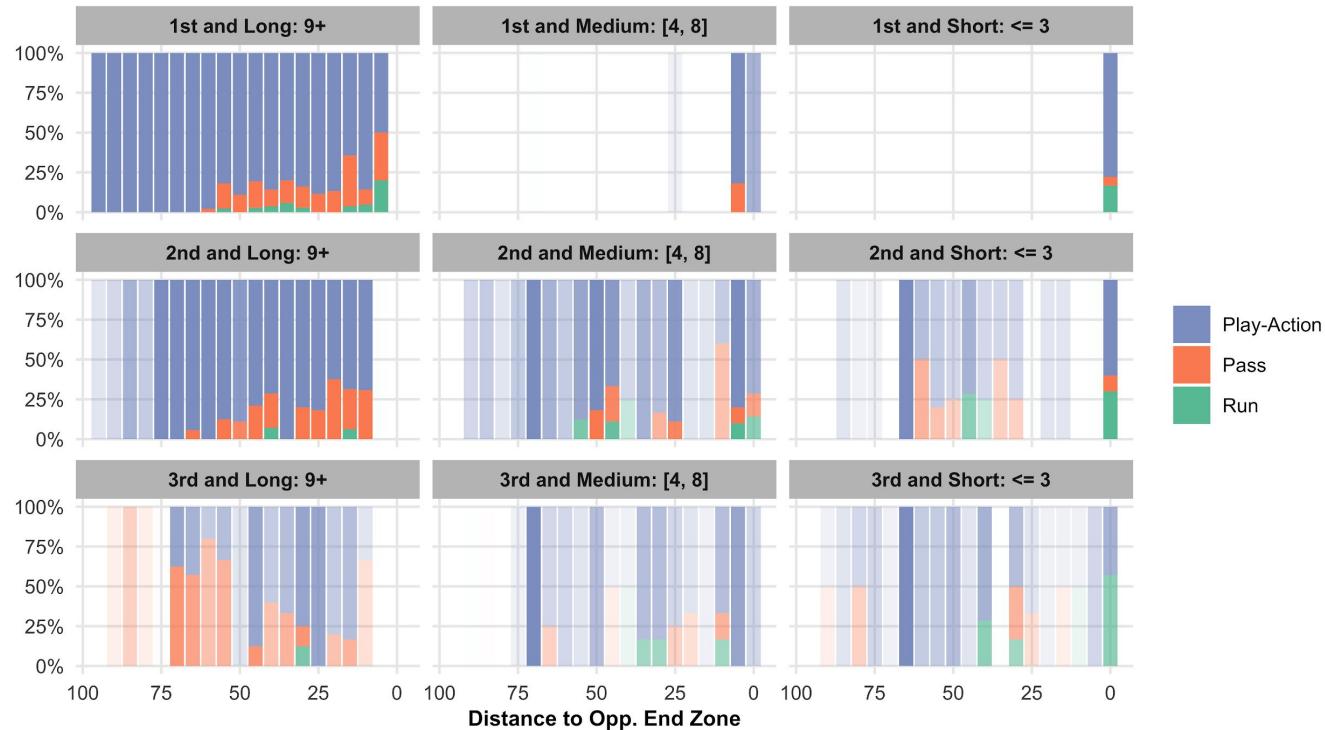
Bills should have been the **2nd pass heaviest** team according to our model

Ranked **6th** in PFF **passing** grade

Ranked **3rd** in PFF **receiving** grade

BUF's theoretical run/pass ratios based on down and distance

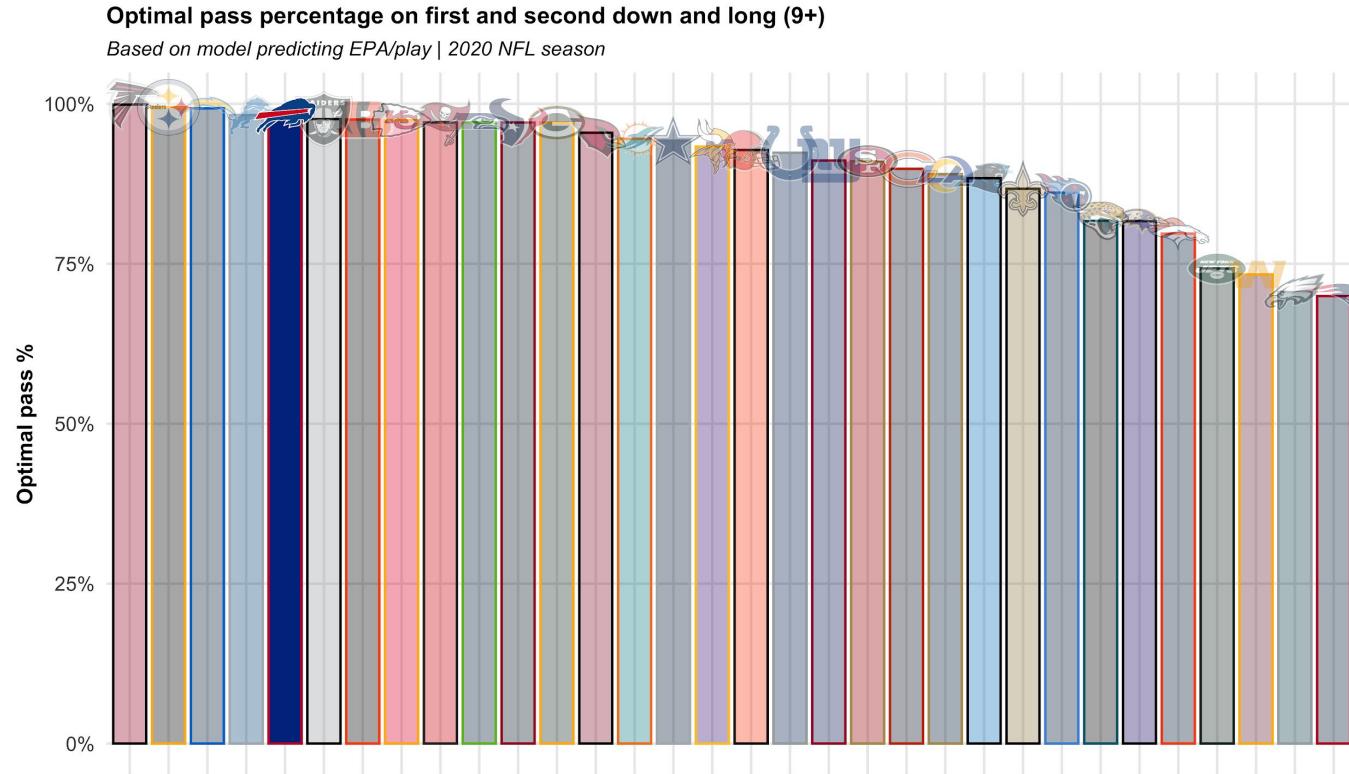
Transparency scaled by number of plays | 2020 NFL season



Data: @nflfastR + PFF

The Bills should have passed a lot

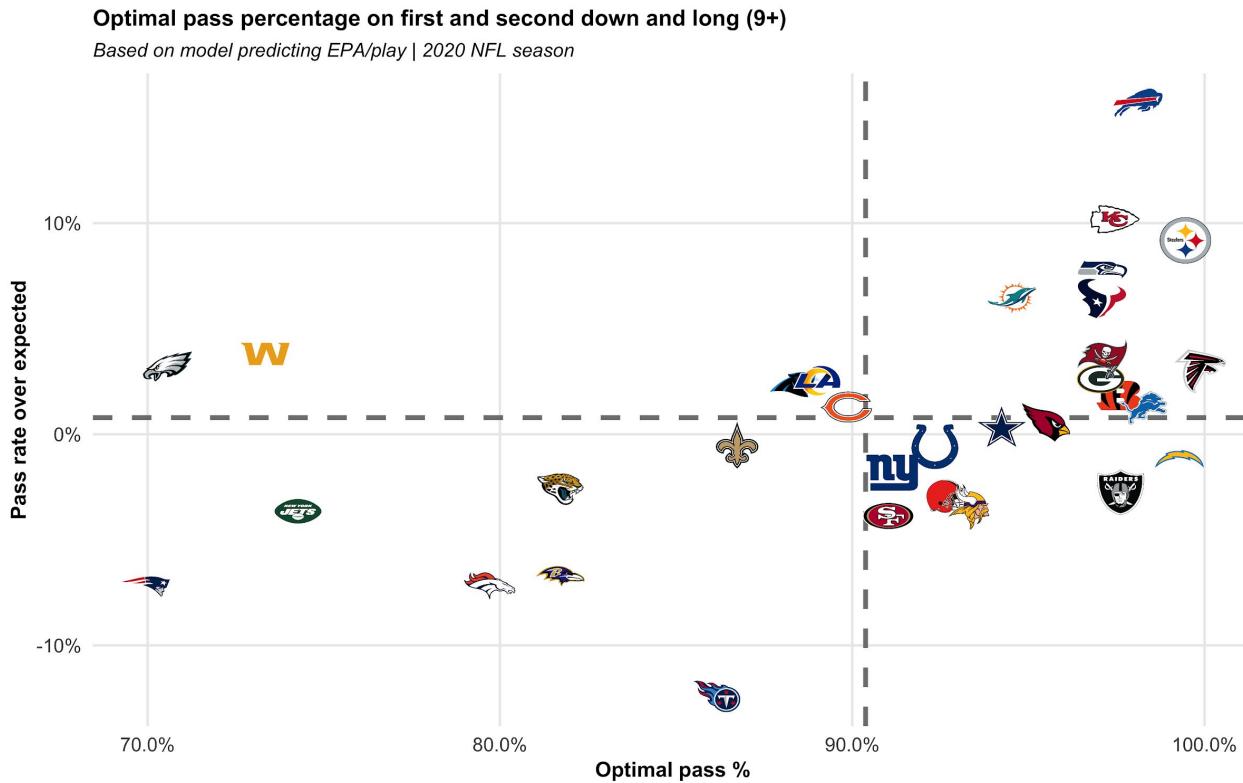
Our model suggests they should have been the **4th most pass heavy** of any team on early downs and 9+ yards to go



The Bills took advantage of their strong passing game

The Bills ranked **1st** in
pass rate over
expectation on long
early downs
according to @nflfastR

→ Ranked **5th** in
EPA/play in these
situations



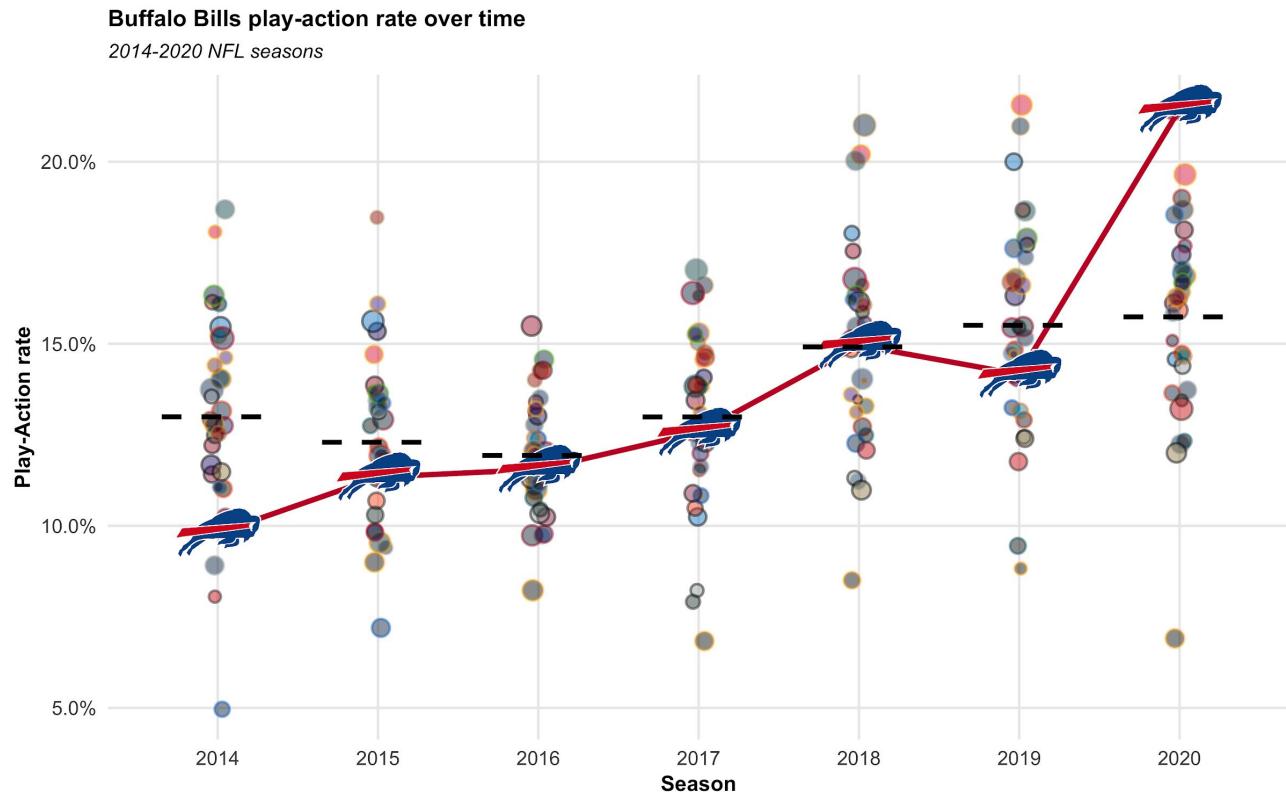
Data: @nflfastR + PFF

The Bills play-action rate spiked in 2020

Bills ranked **1st** in
play-action rate
according to PFF

→ Ranked **22nd** in
play-action rate in
2019

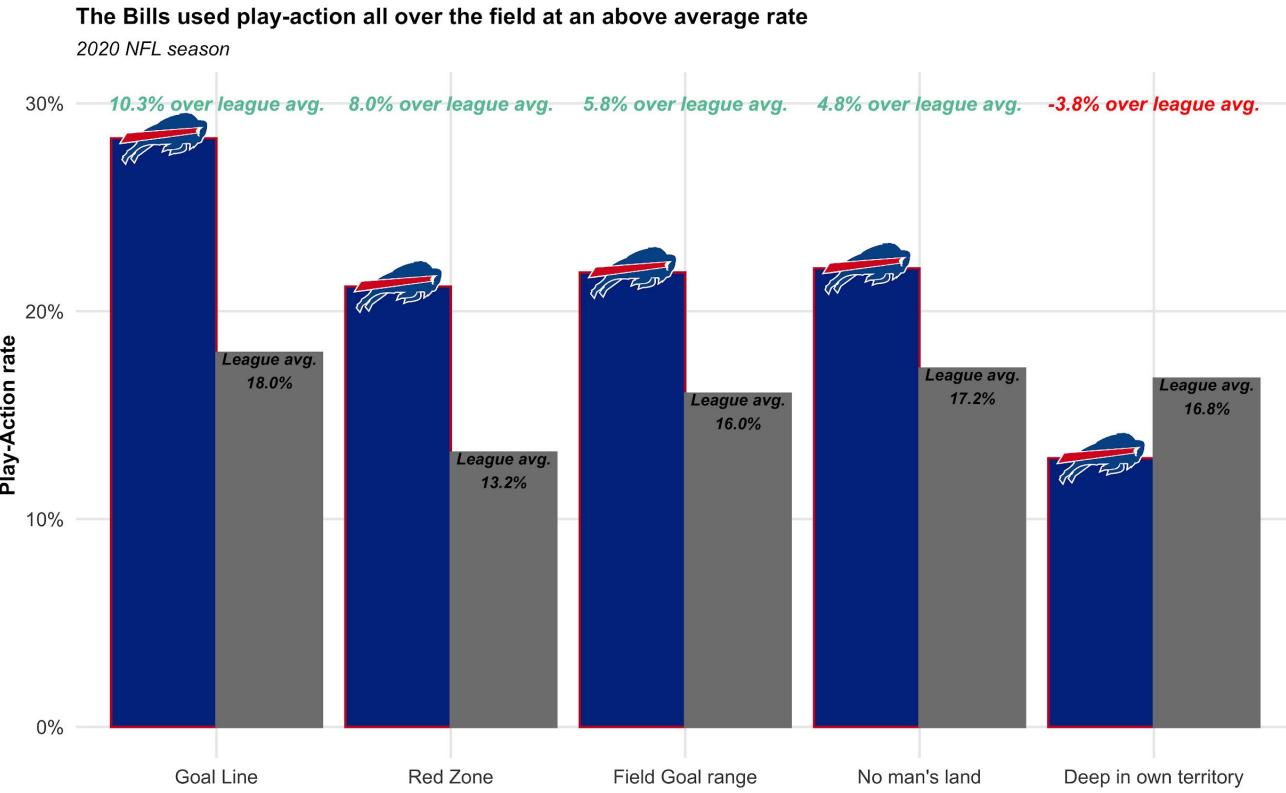
Jumped in EPA/play
from 22nd in 2019 to
5th in 2020



The Bills understand that play-action works

Bills used **play-action** on all parts of the field

Ranked 1st in passing over expectation, yet still ranked **8th in EPA/play on play-action**



Case study:

Tampa Bay Buccaneers



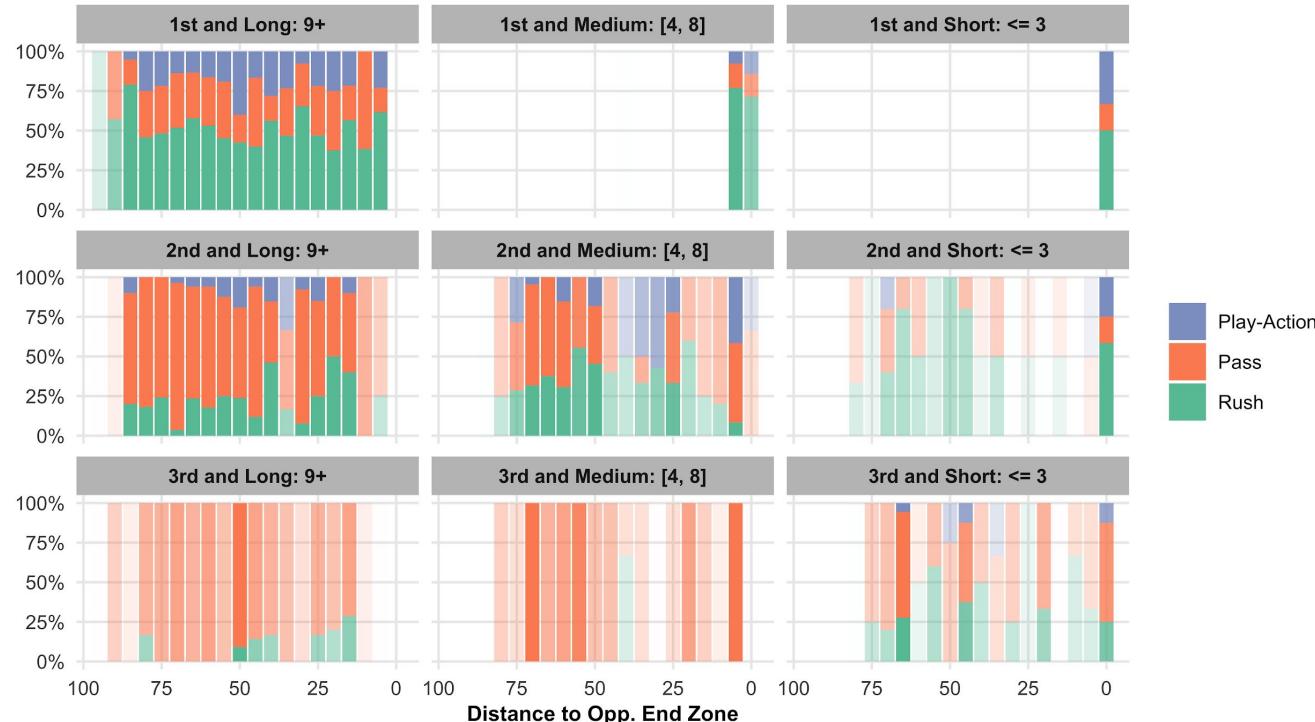
Tampa Bay Buccaneers actual run/pass ratio

Finished **11-5** and won
the Super Bowl

The Bucs **ran** the ball
a lot on 1st & 10 given
their QB and receiving
options

TB's actual run/pass ratios based on down and distance

Transparency scaled by number of plays | 2020 NFL season

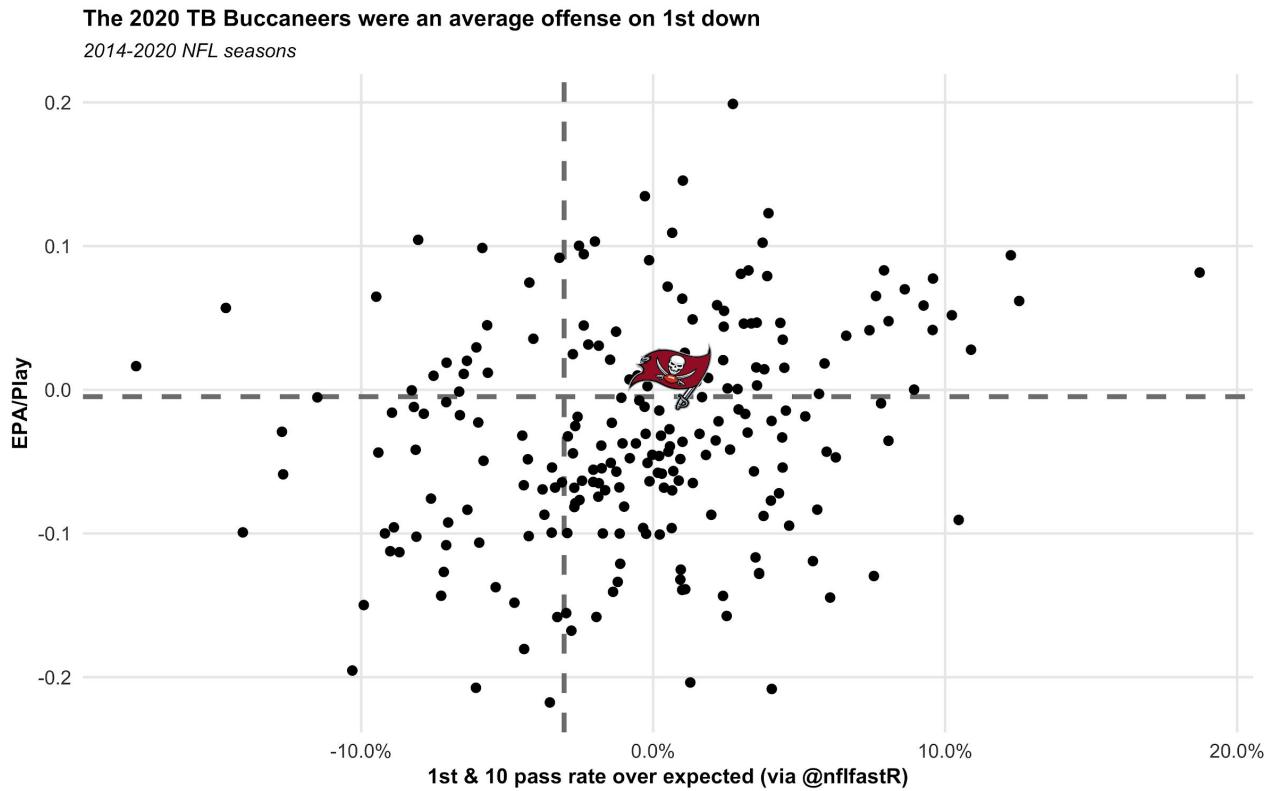


Data: @nflfastR + PFF

The Bucs hindered themselves by running on 1st down

The Bucs **ranked 4th**
in overall PFF
EPA/play

→ They ranked just
13th in EPA/play
on **first downs**



Tampa Bay Buccaneers optimal run/pass ratio

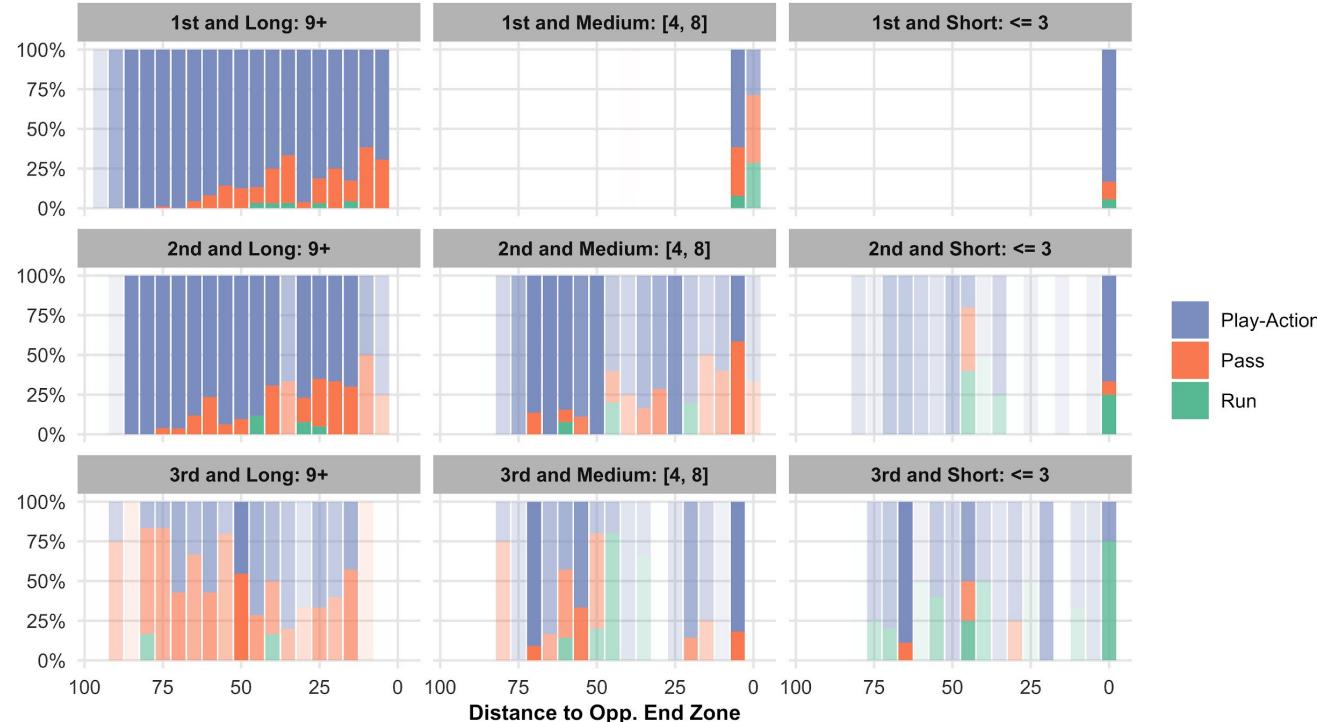
Our model suggests the Bucs should have been the **7th most pass heavy** of any team

Ranked **2nd** in PFF **passing** grade

Ranked **7th** in PFF **receiving** grade

TB's theoretical run/pass ratios based on down and distance

Transparency scaled by number of plays | 2020 NFL season

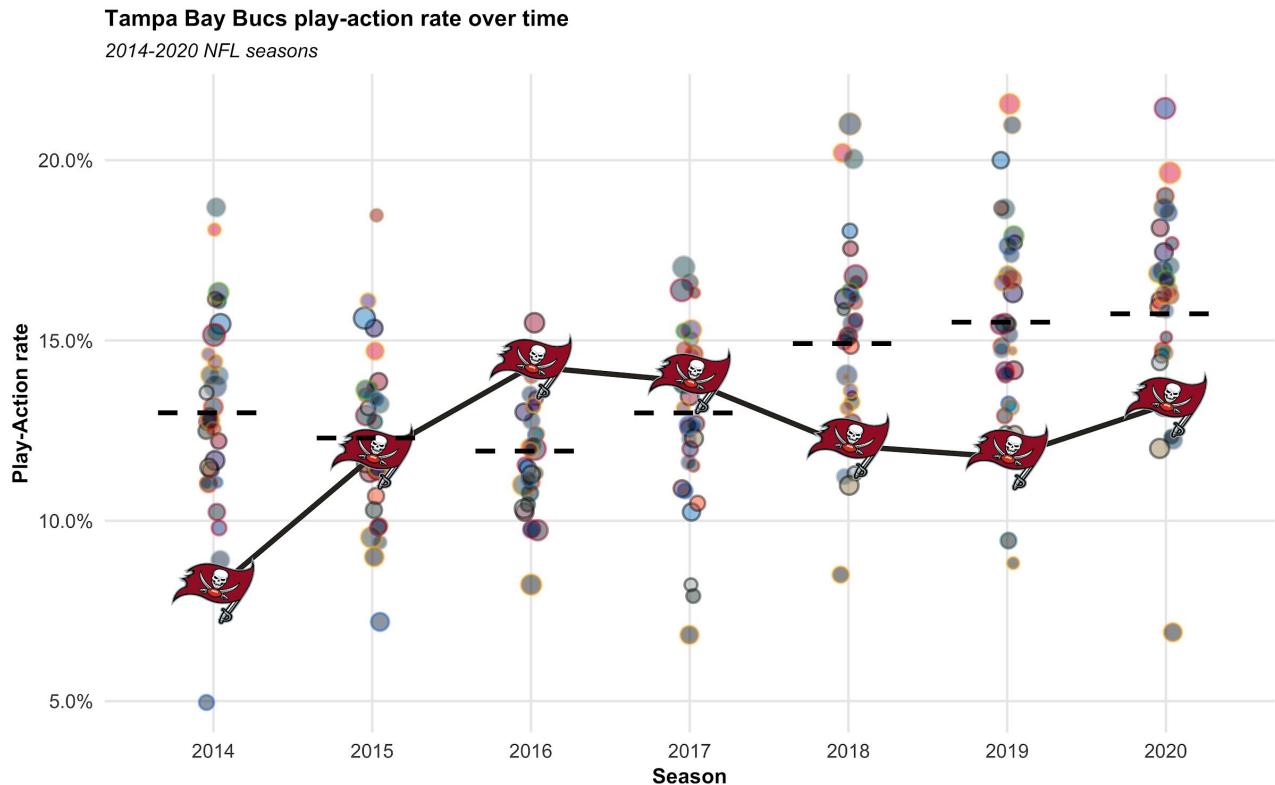


Data: @nflfastR + PFF

The Bucs do not run play-action enough

The Bucs had a
bottom 5 play-action
rate this season

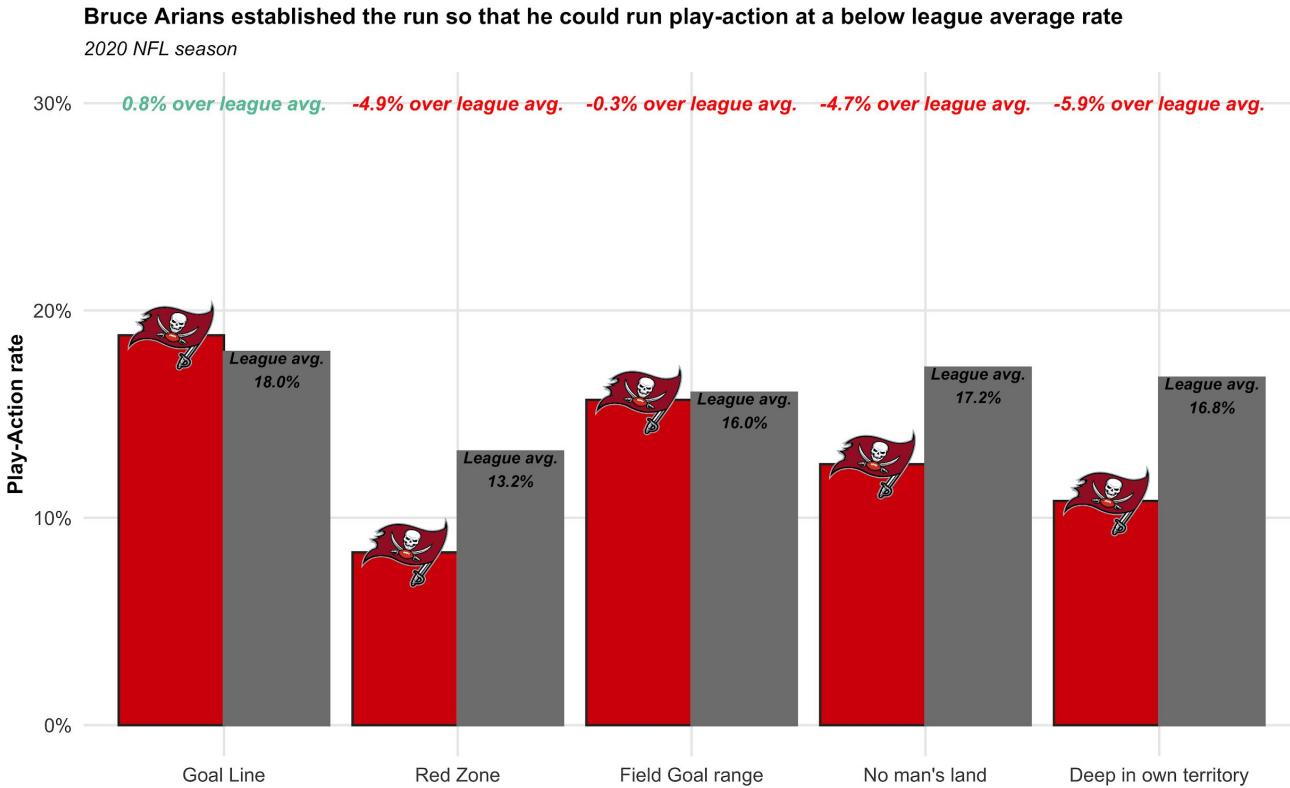
- Although they ranked 5th in EPA/Play, their offense could have been even better



The Bucs established the run for nothing

The Bucs used
play-action at below
league average rate
at most areas of the
field

→ Ranked 2nd in
EPA/play on
play-action



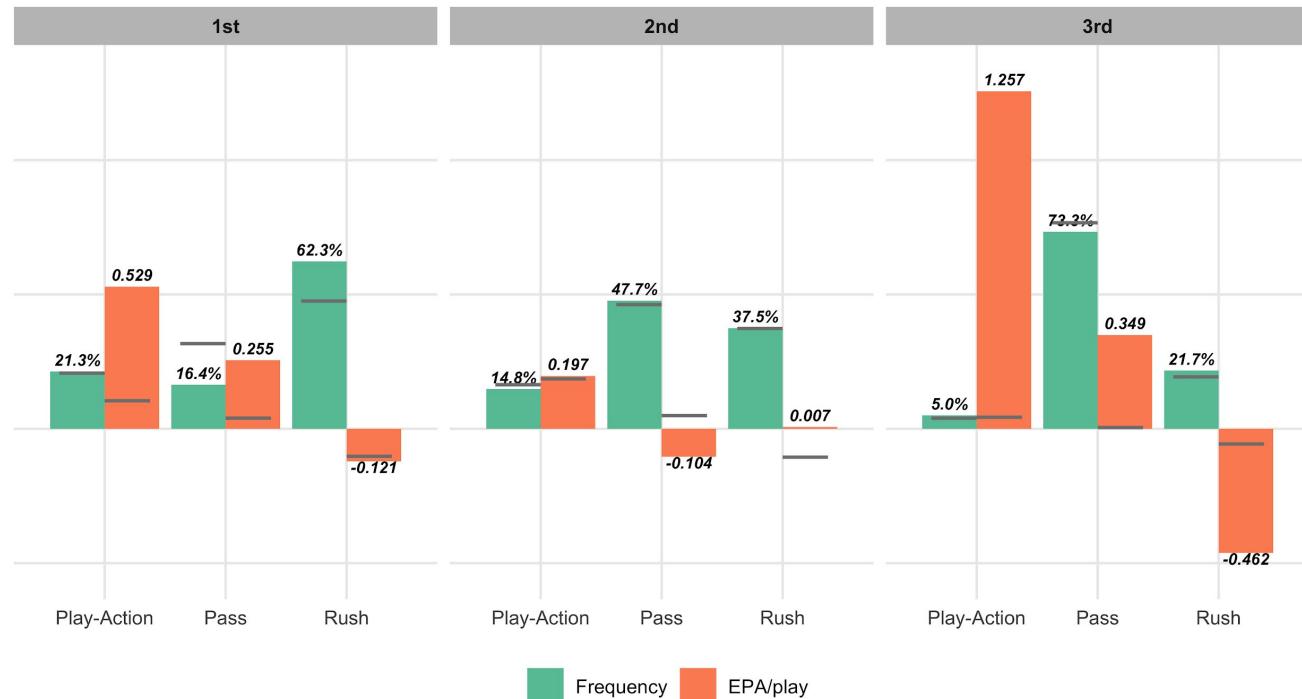
What about the playoffs?

Despite success throwing, the **Bucs** continued to run on early downs at an **above average rate**

→ The Bucs relied on **late down Tom Brady** heroics

The Buccaneers relied on late down passing to win in the playoffs

Dotted line indicates 2020 league averages | 2020 NFL playoffs



So... should teams just pass almost every play?

No. Teams should not just pass every play

Just like basketball team's cannot simply shoot only layups and threes

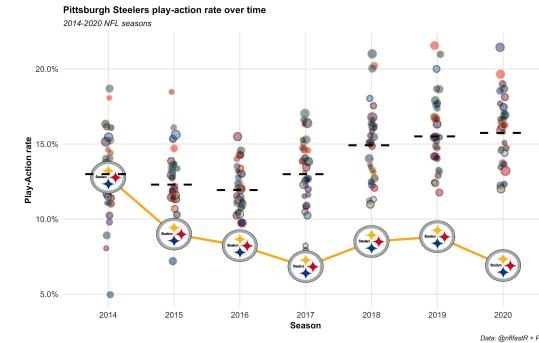
- Defenses can adjust by putting fewer men in the box
- Dropbacks may increase a QB's chance of injury more than handing the ball off

The **optimal** run/pass ratio is **likely quite far away** from **current run/pass ratios**

Teams will reach a point of diminishing returns with passing, but it is clear teams are not yet at that point

What about play-action?

- It is possible that certain QB's **really dislike** play-action
 - ◆ Play-action is mostly run from under center
 - ◆ Requires a QB to turn their back to the defense
- Model is **extrapolating** play-action efficacy to incredibly high play action frequency
 - ◆ Unclear how effective play-action would be if used at the rates the model recommends



However, **play-action should be incorporated far more** into gameplans across the league

Limitations to our approach

Should teams be optimizing **EPA** or **win probability**?

→ Metrics are aligned until end of game situations

Trained using **season** grades, so **injuries** affect the model's ability to correctly determine optimal play types in individual games, especially QB injuries

Missing potential model features:

- Defenders in the box
- QB run
- Outside/inside run
- Offensive personnel
- Shotgun/under center

Model is maximizing the **expectation** of EPA

Thank you, we appreciate your time!
