Quantifying Uncertainty with ciTools

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Use ciTools to answer important questions about your data quickly and easily

Compare results against thresholds

Quantify uncertainty

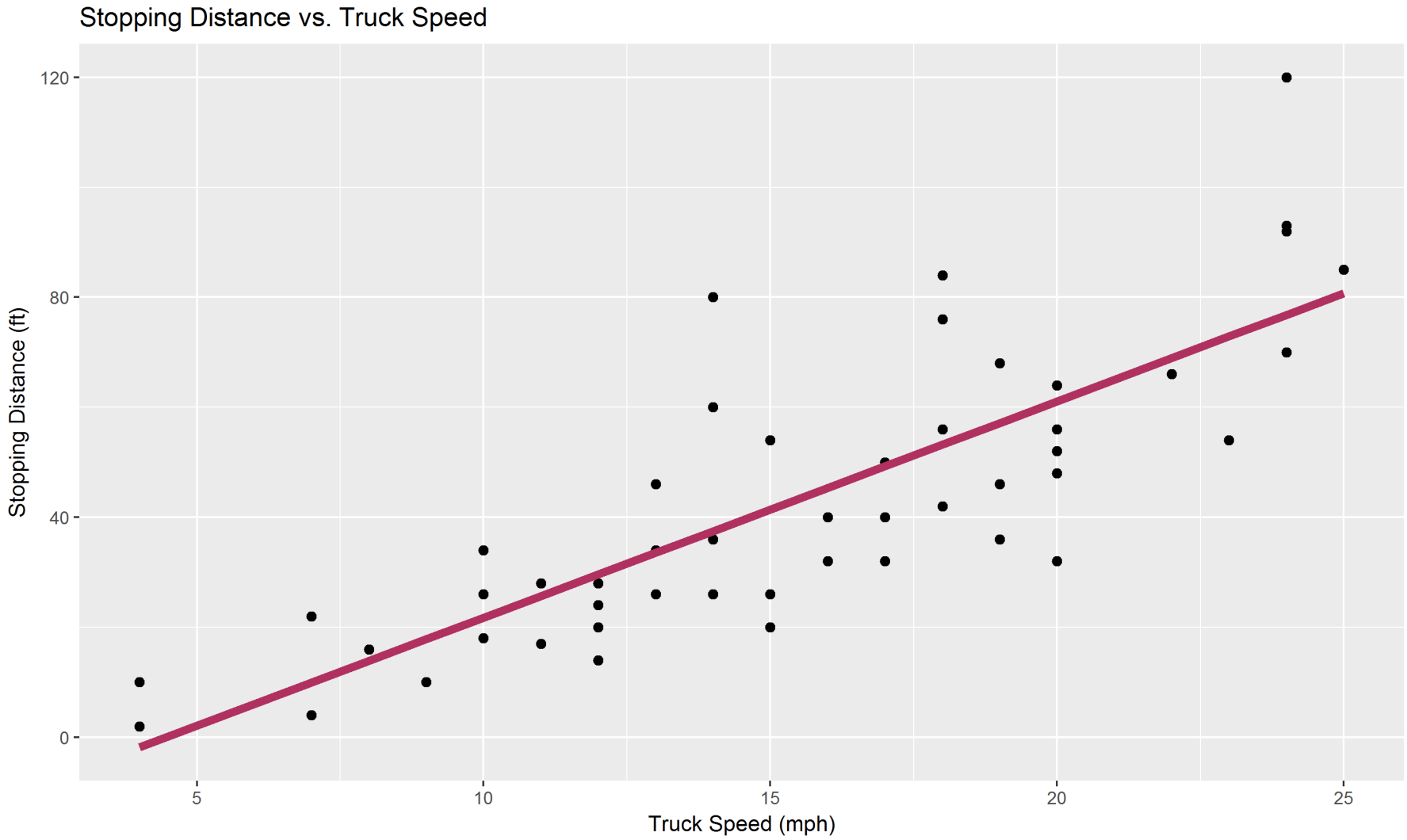
Estimate mission-critical statistics

The New Heavy Truck (NHT) has a requirement to be able to stop quickly from a speed of 20 mph.

What do the data look like?

```
# A tibble: 50 x 2
   speed  dist
   <db1> <db1>
 1  4.00  2.00
 2  4.00 10.0
 3  7.00  4.00
 4  7.00 22.0
 5  8.00 16.0
 6  9.00 10.0
 7 10.0  18.0
 8 10.0  26.0
 9 10.0  34.0
10 11.0  17.0
# ... with 40 more rows
```

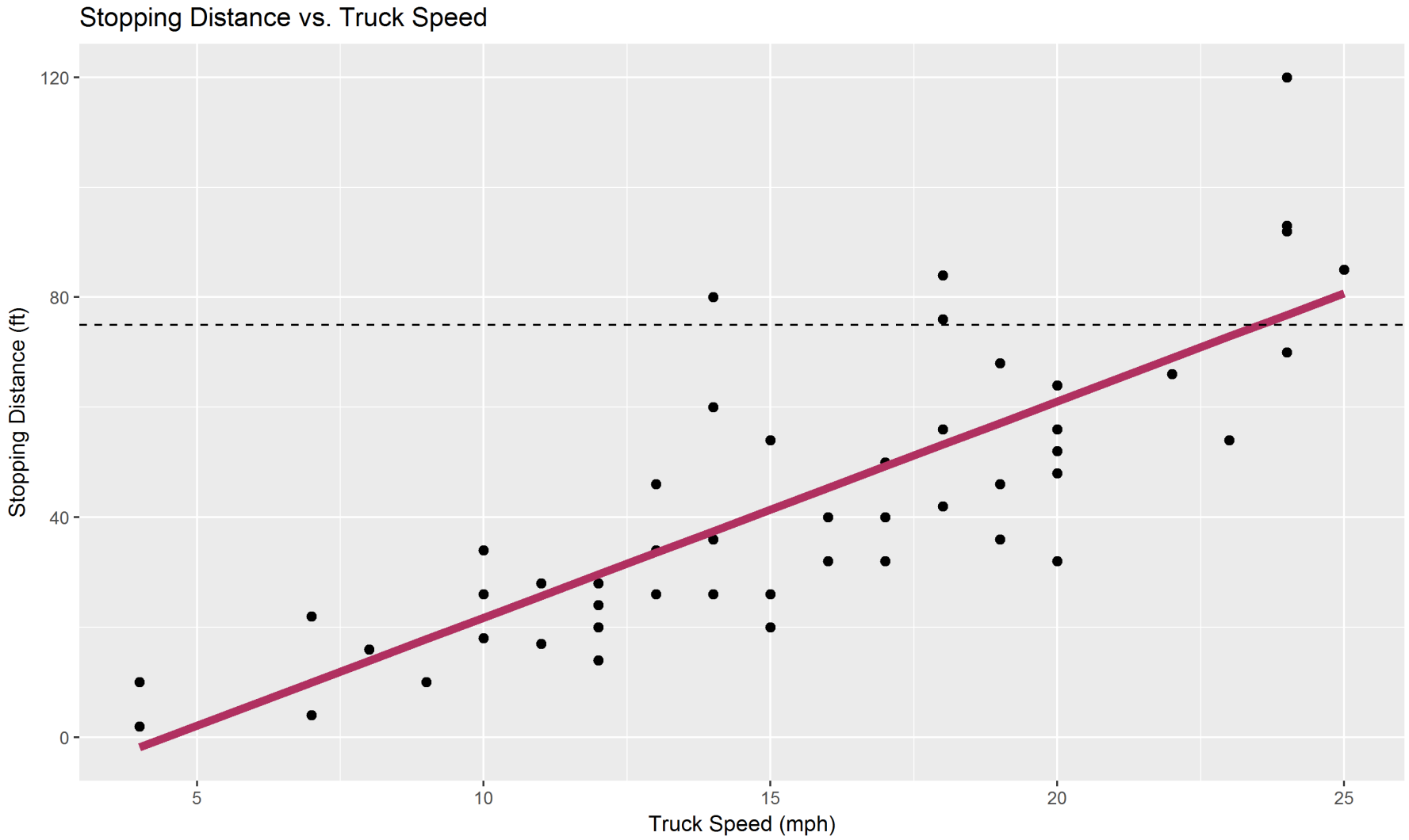
Plotting the data



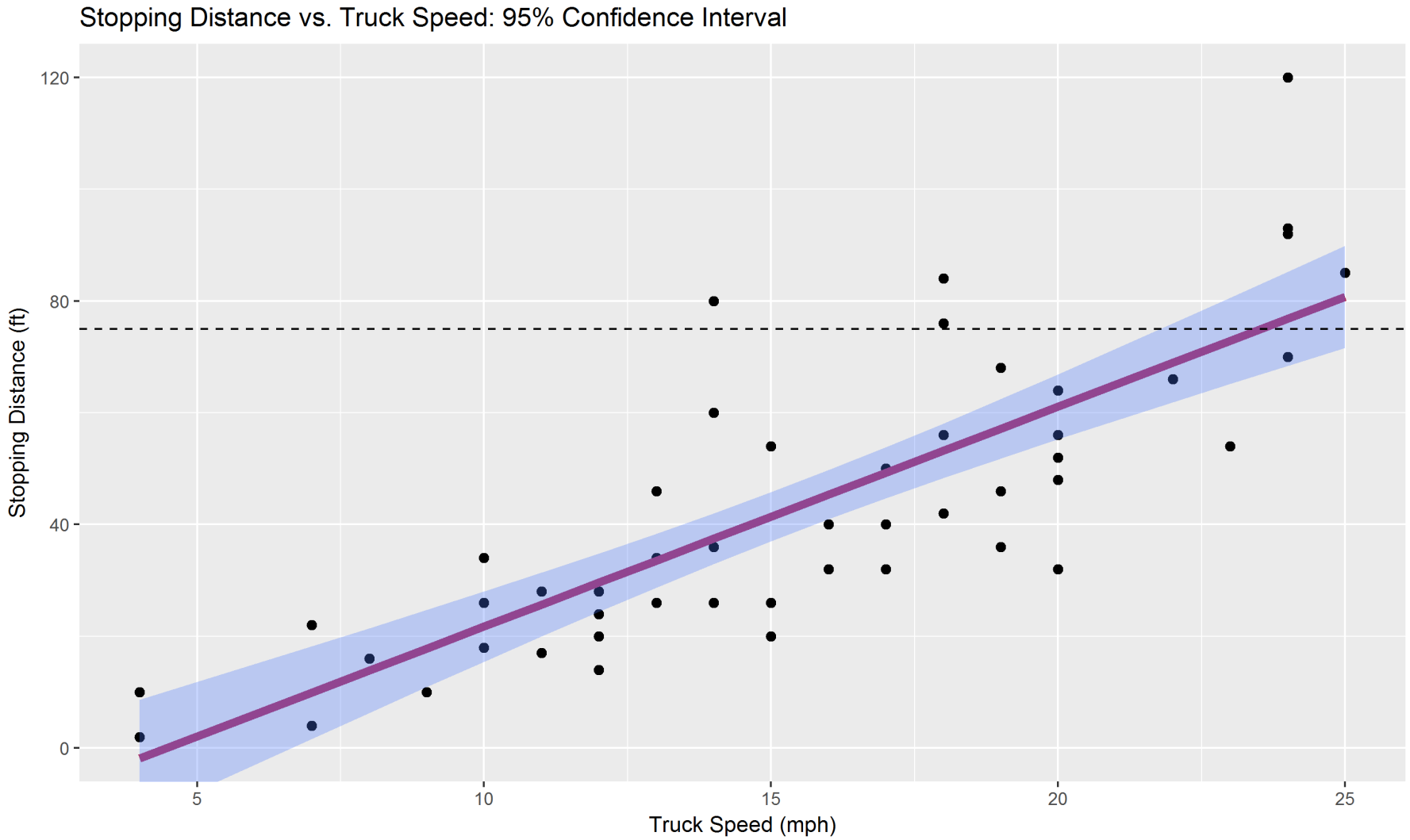
Requirement:

"NHT must have a stopping distance of less than 75 feet"

Plotting the requirement shows that we're doing pretty well, but…



We should use a confidence interval for that comparison!



"At 20 MPH, the NHT's average stopping distance is less than 75 feet, meeting the requirement with statistical confidence."

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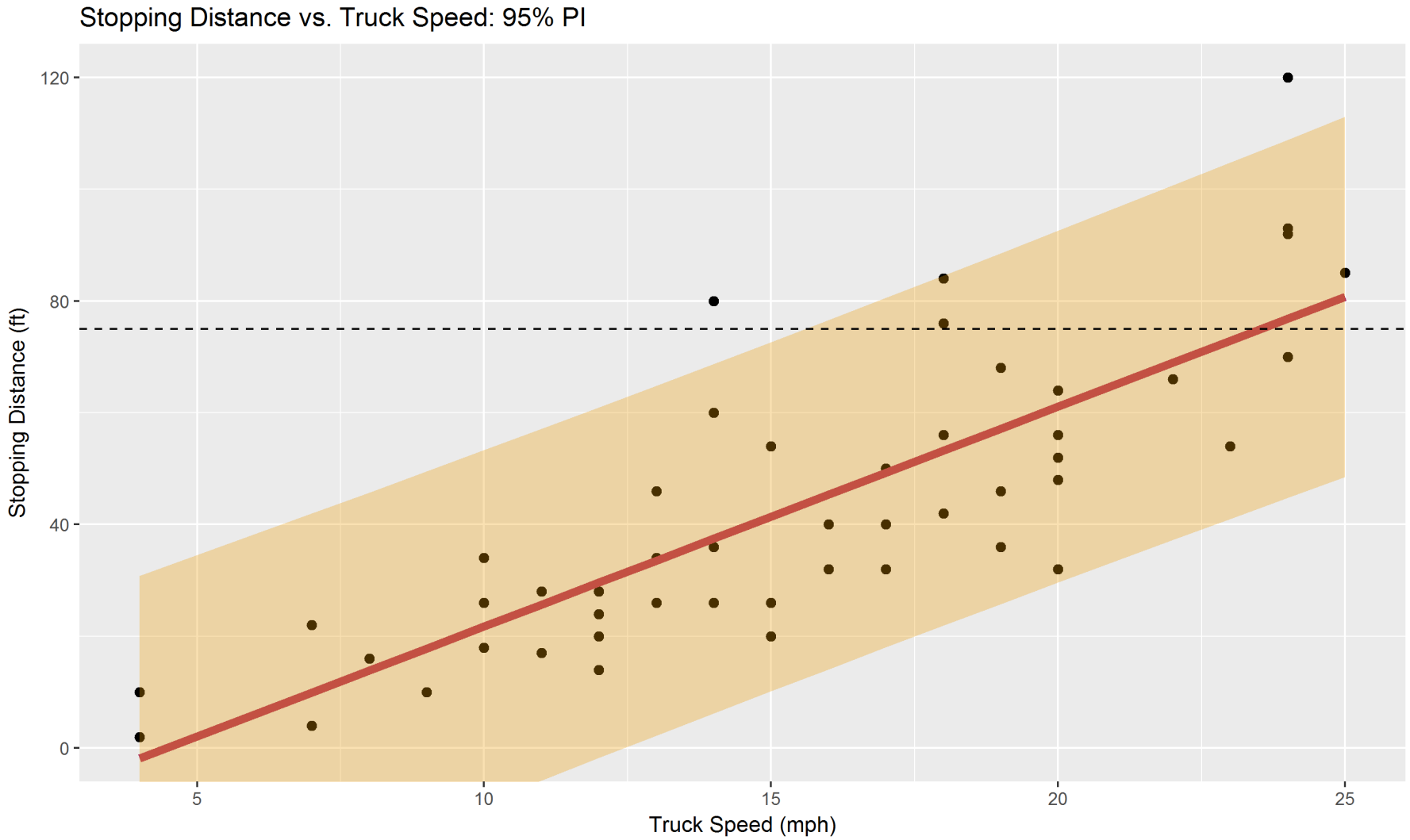
But what if we want to say more?

It may be more interesting to know about the population rather than the average



"At 20 MPH, the NHT's average stopping distance is less than 75 feet, and an NHT traveling 20 MPH will be able to stop within 75 feet most of the time."

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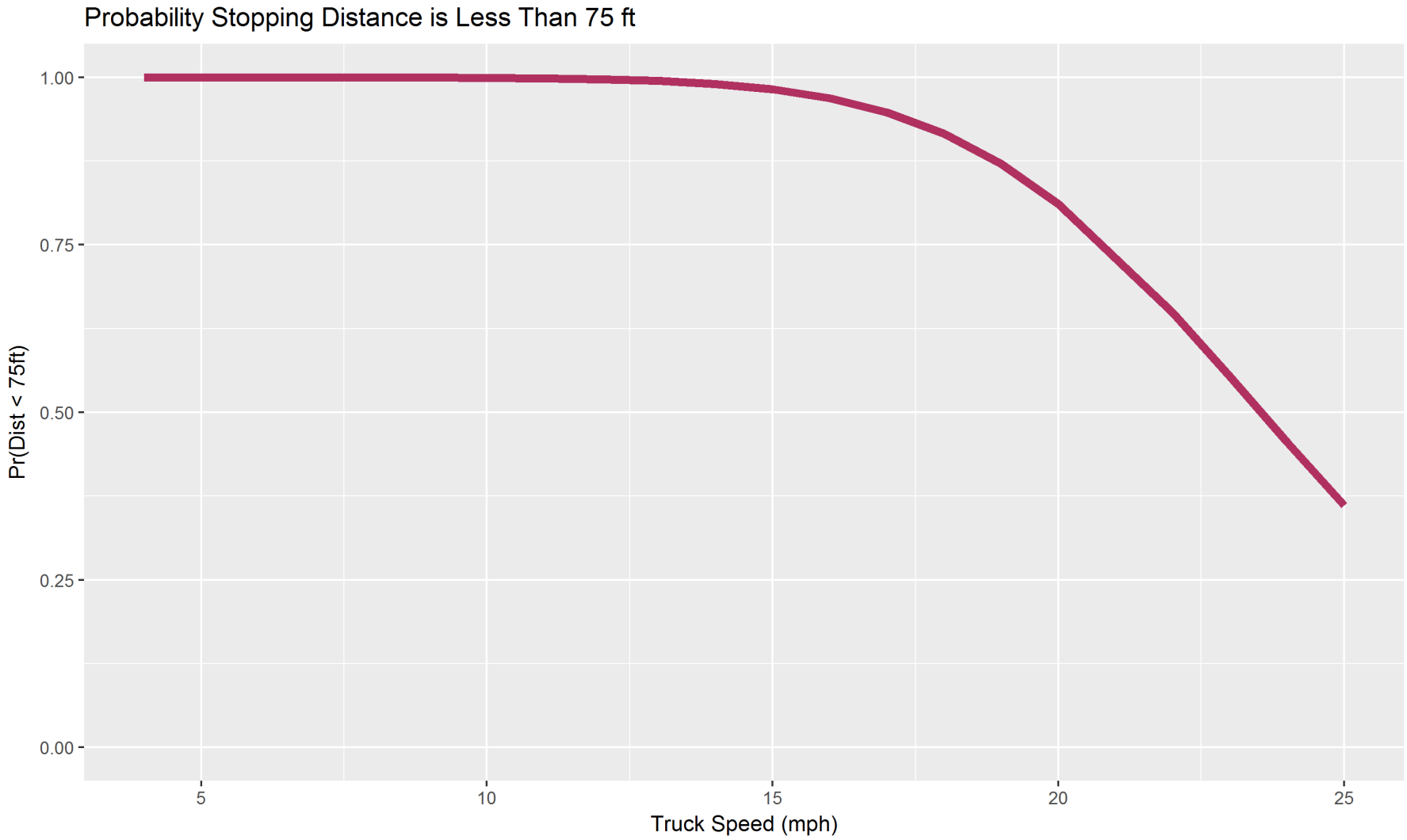
What if we want to be more specific?

We can compute the probability of stopping within the required distance!



“At 20 MPH, the NHT will stop in less than the required 75 feet 81 percent of the time”

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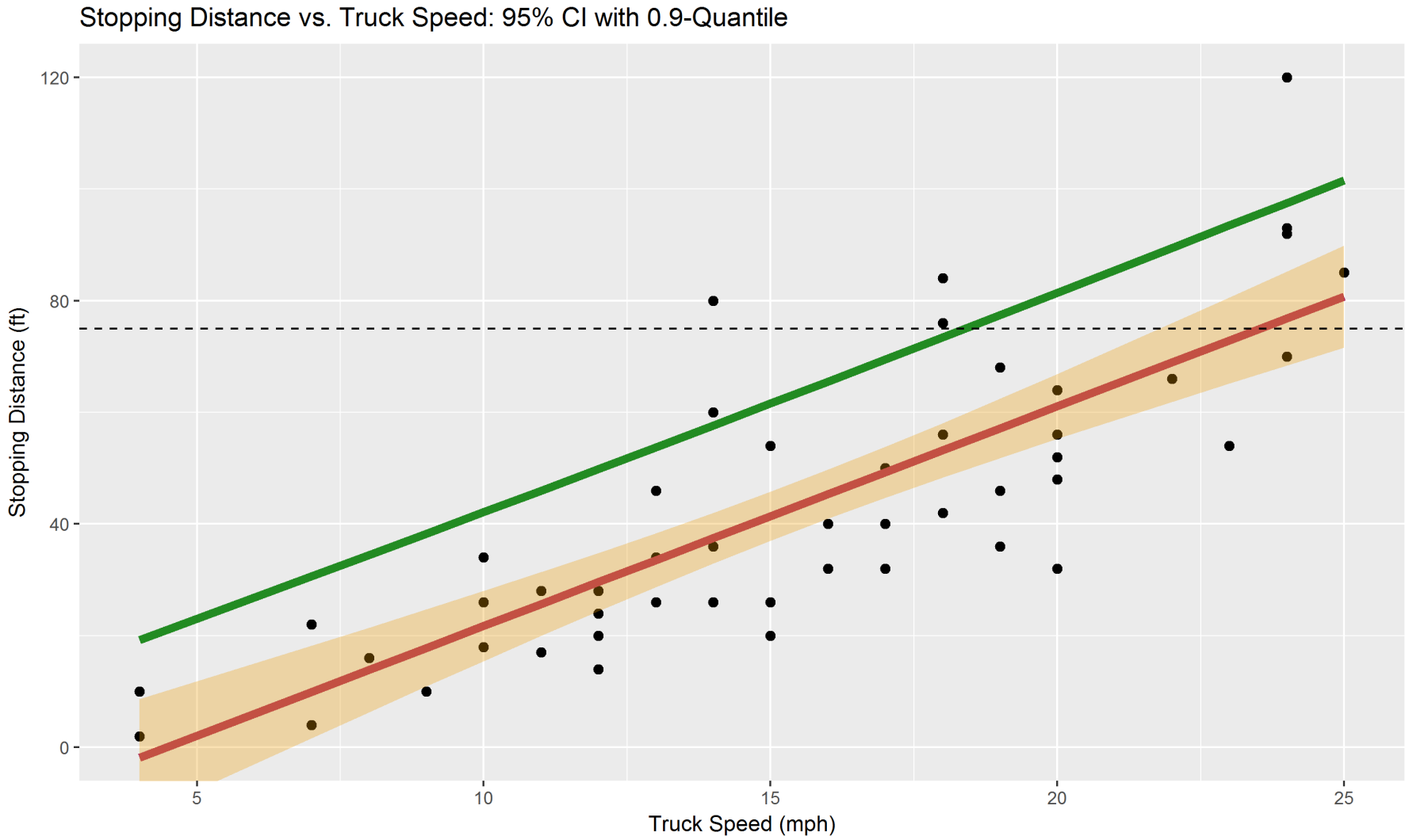
What if the requirement is written differently?

Alternative Requirement:

"NHT must be able to stop within 75 feet 90 percent of the time."

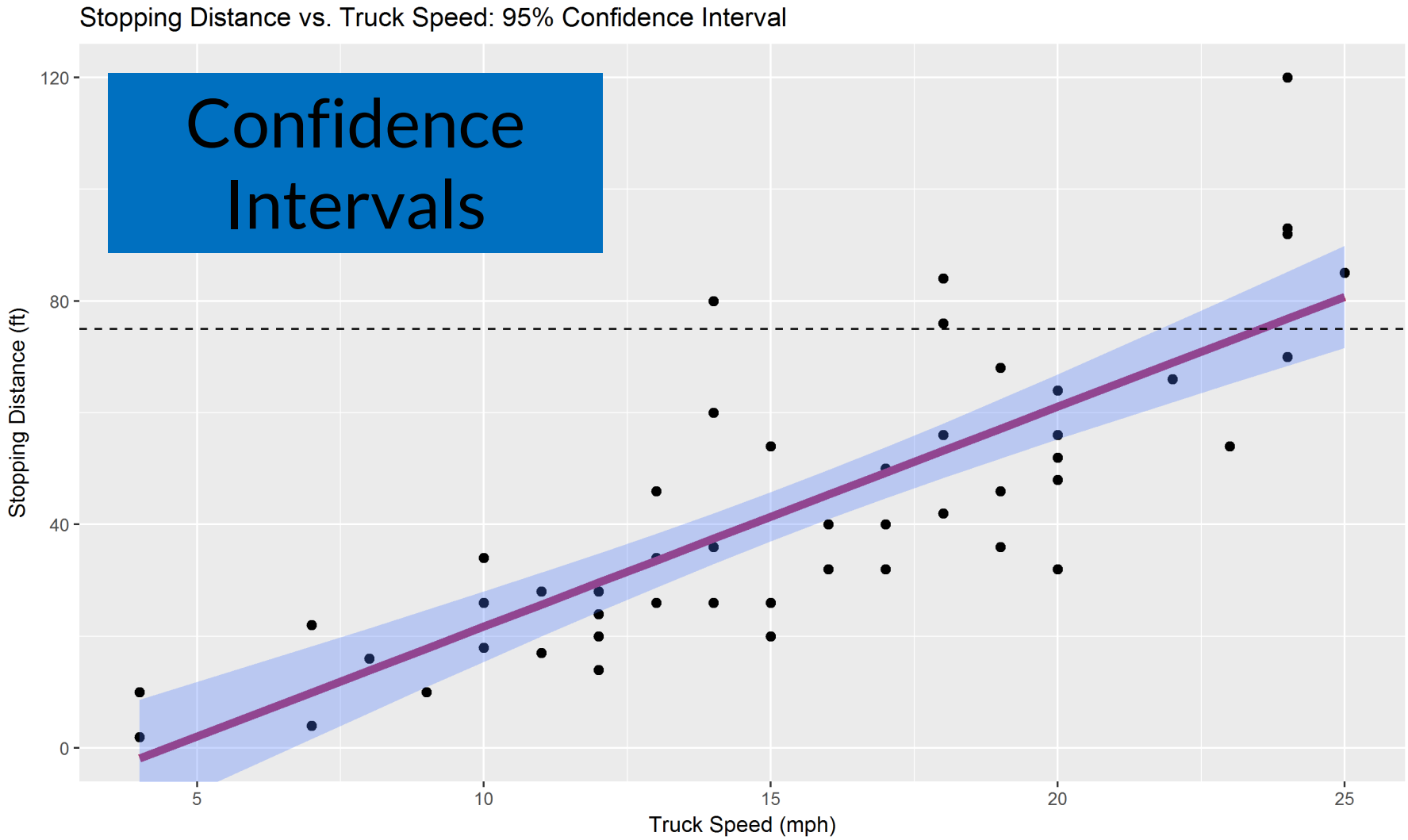
We can estimate the 90th percentile and compare it to the requirement



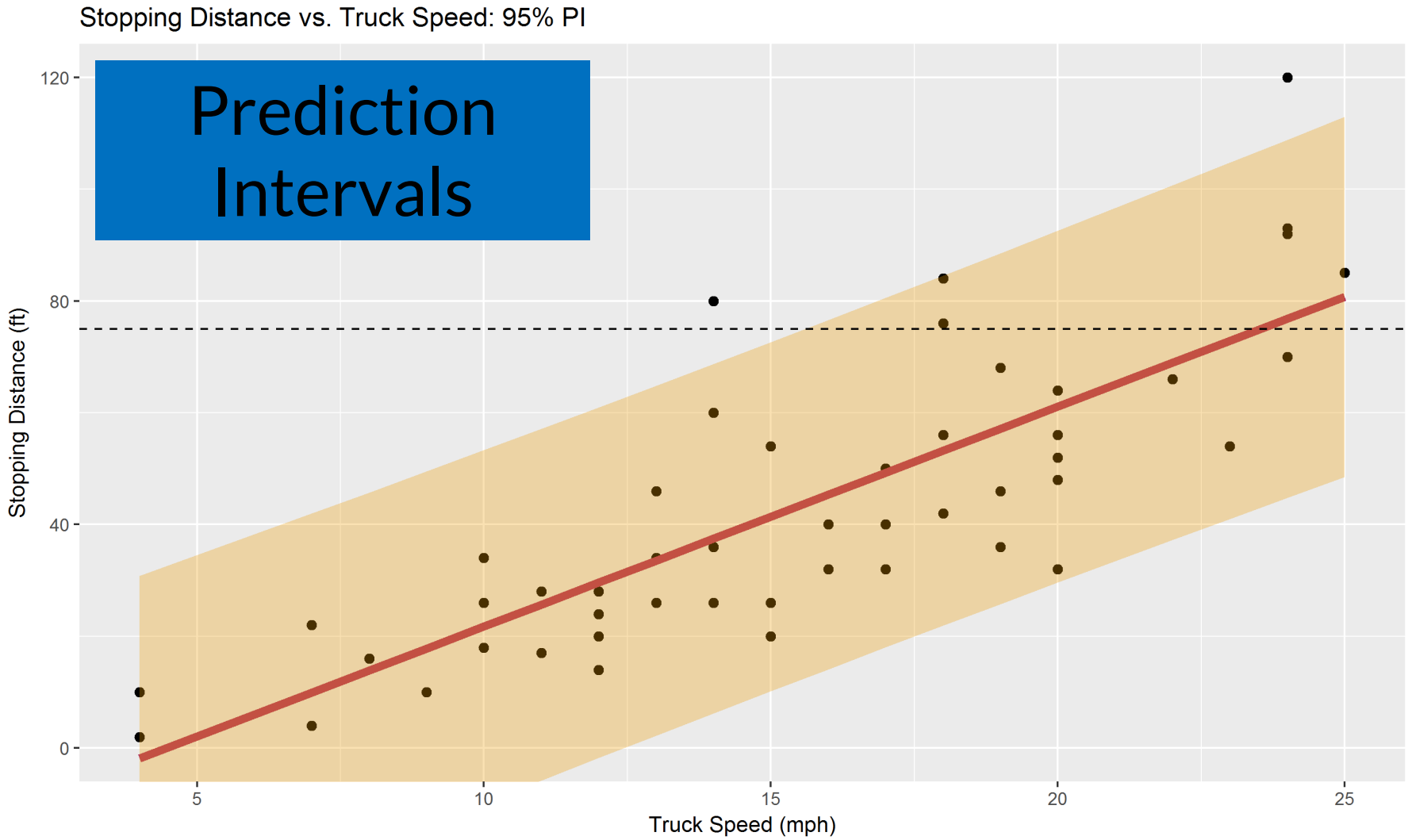
"NHT will have a stopping distance less than 75 feet 90 percent of the time if it's speed is less than 18.5 mph."

We can make all of these plots quickly and easily in R using the ciTools package

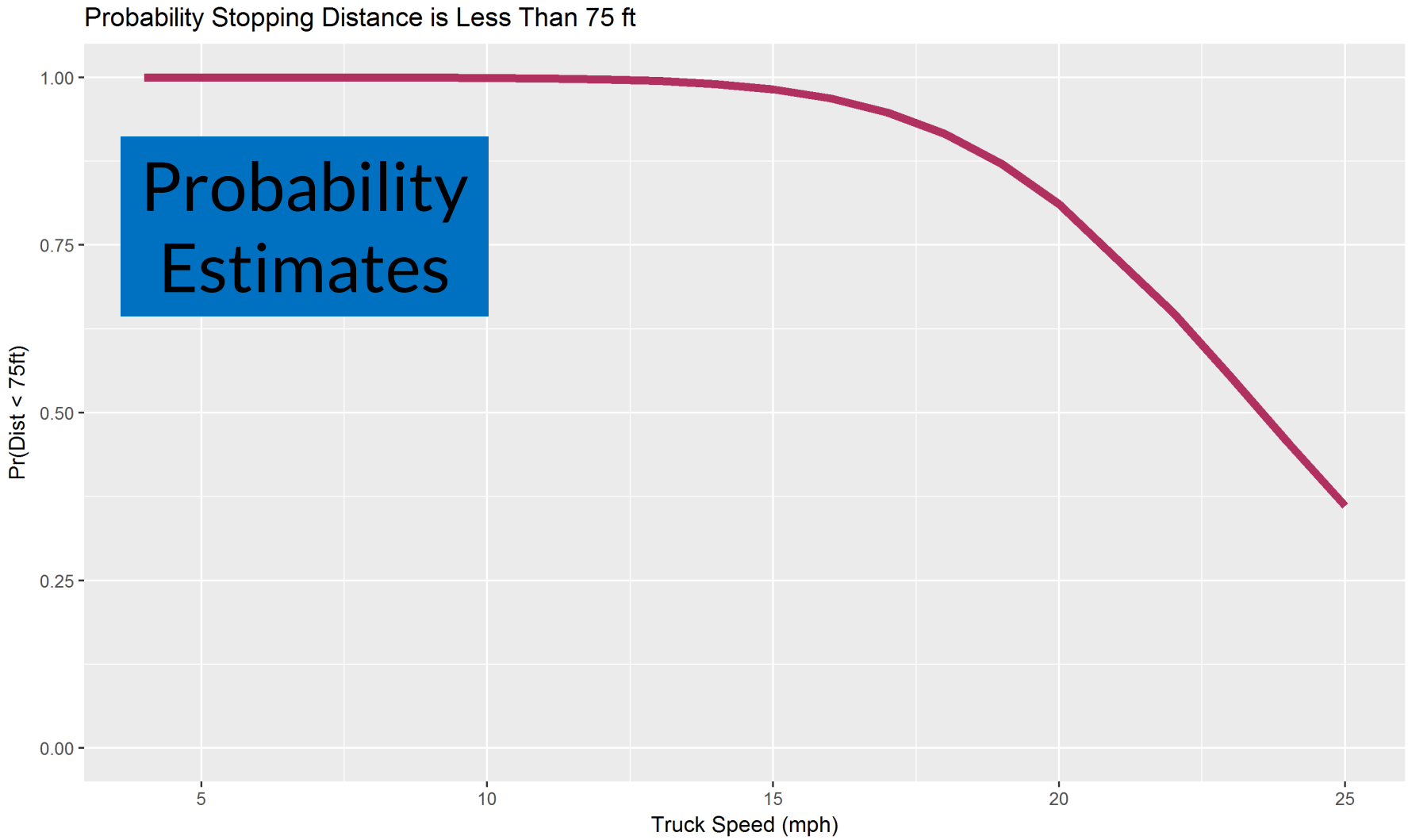
`ciTools::add_ci(tb, fit)`



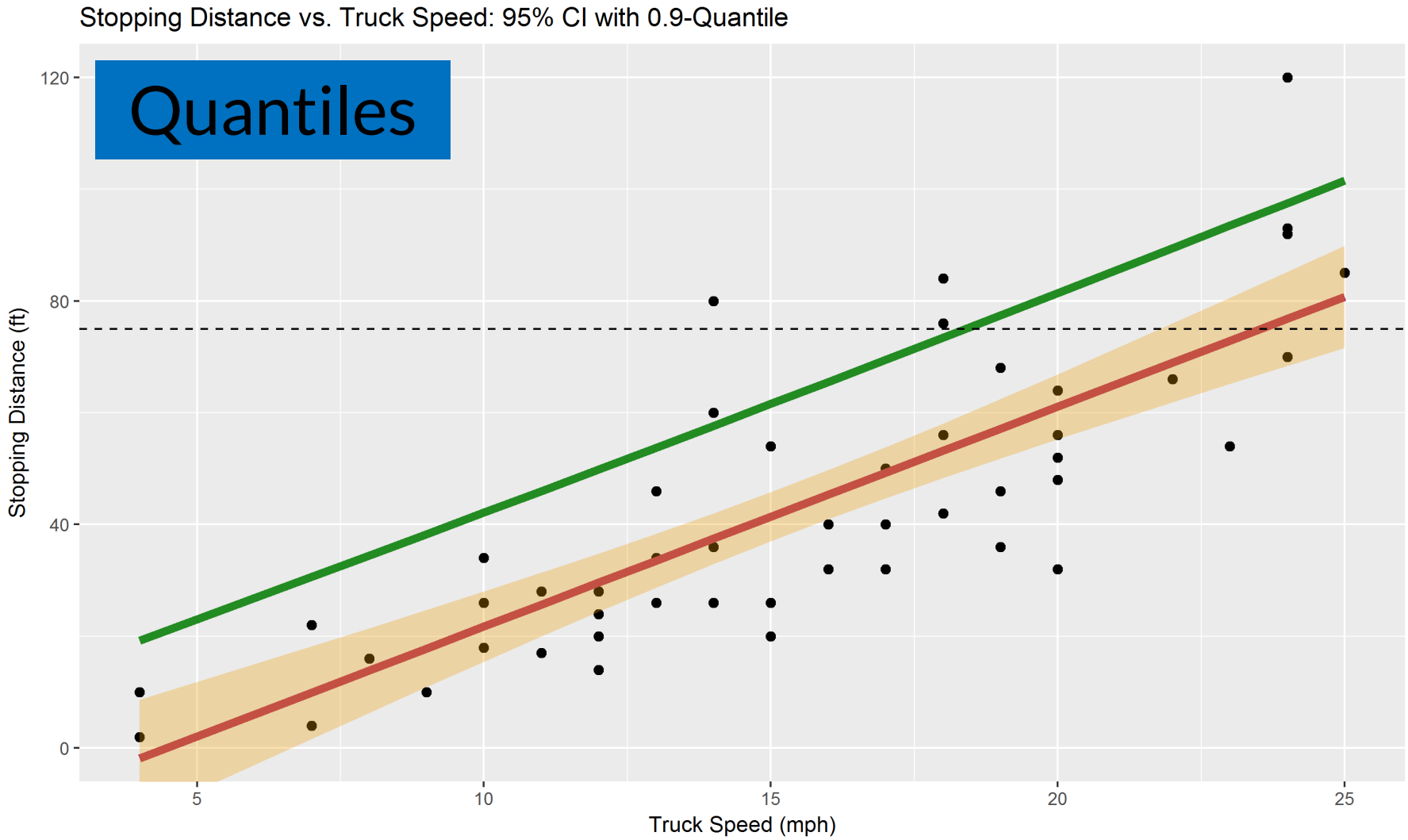
`ciTools::add_pi(tb, fit)`



`ciTools::add_probs(tb, fit, p)`



`ciTools::add_quantile(tb, fit, q)`



Uniformity in `ciTools`

`ciTools` works for many types of models, but the syntax doesn't change

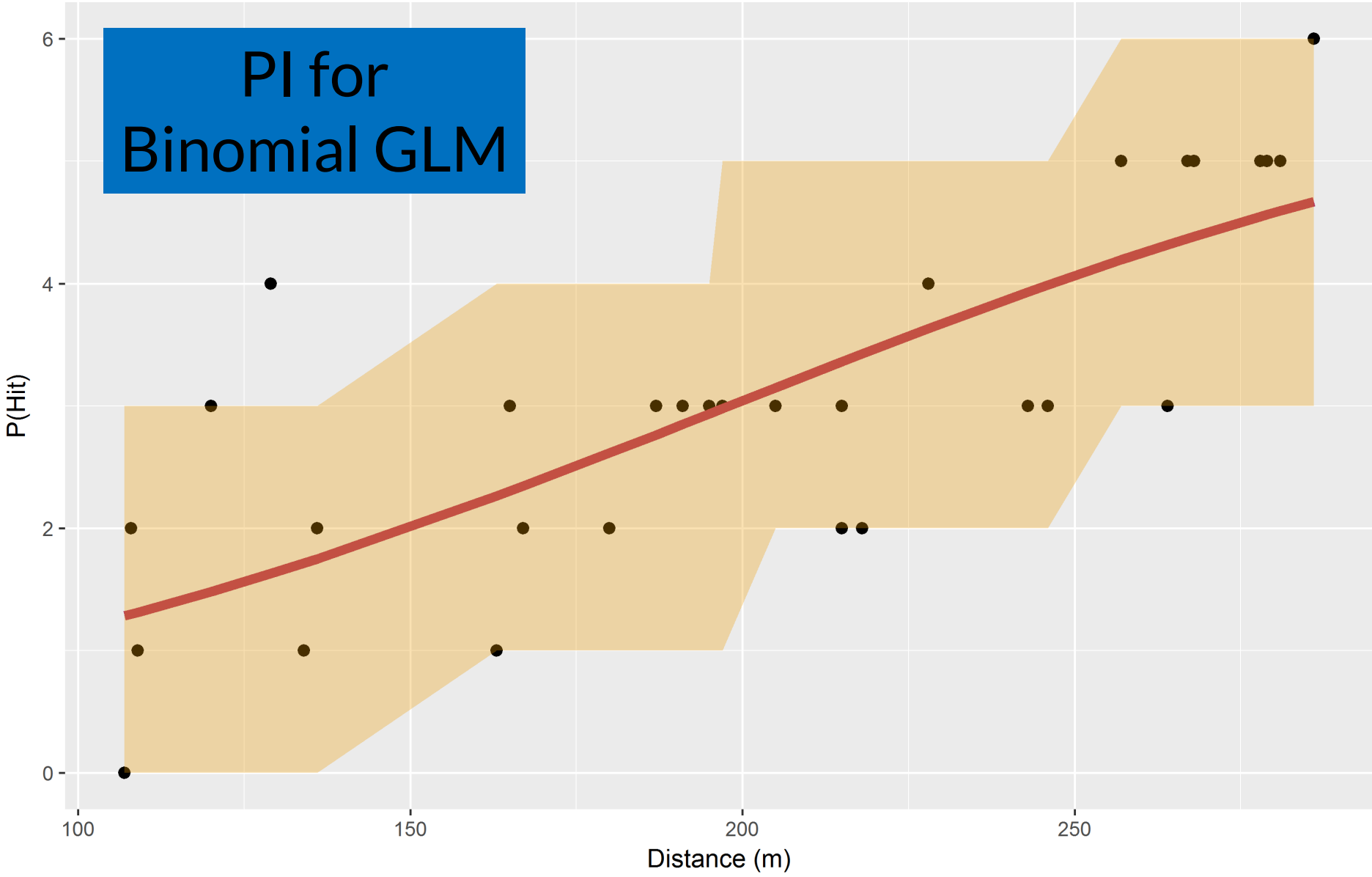
Confidence Intervals	**Prediction Intervals**
`add_ci(data, model, …)`	`add_pi(data, model, …)`
Probabilities	**Quantiles**
`add_probs(data, model, quantile, …)`	`add_quantile(data, model, probability, …)`

Automatically chooses the right method based on your model

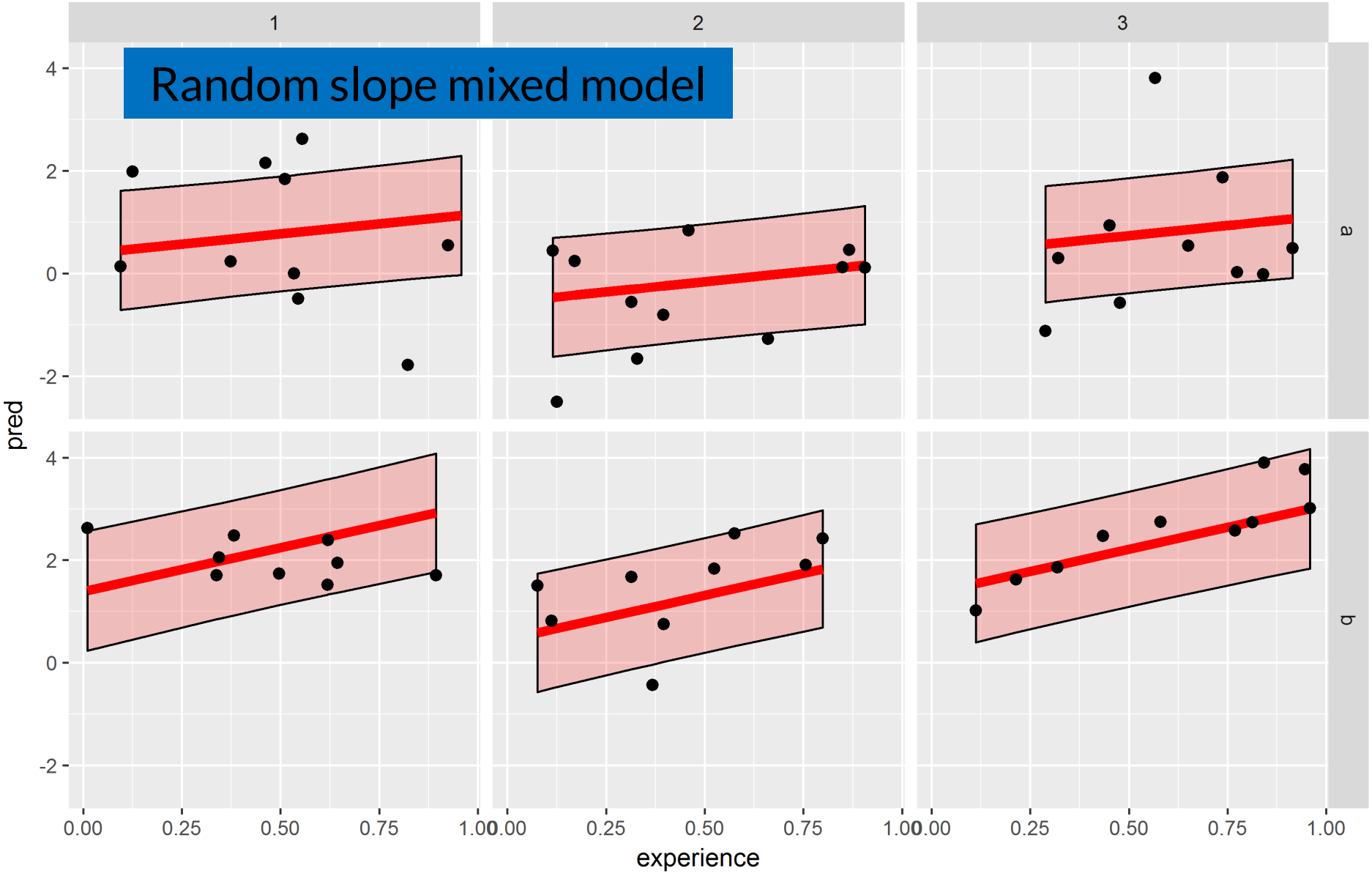
Scope of `ciTools`

R object	Confidence Intervals	Prediction Intervals	Probabilities	Quantiles
Linear Models	✓	✓	✓	✓
Skewed Data (Lognormal)	✓	✓	✓	✓
Count/Binary Data (GLMs)	✓	✓	✓	✓
Random Group Data (Mixed Models)	✓	✓	✓	✓
Skewed Random Group Data	In Progress…	✓	✓	✓
Survival/Censored Data Models	Future Work	Future Work	Future Work	Future Work
…	…	…	…	…

```
add_pi(tb, fit, type = "boot")
```



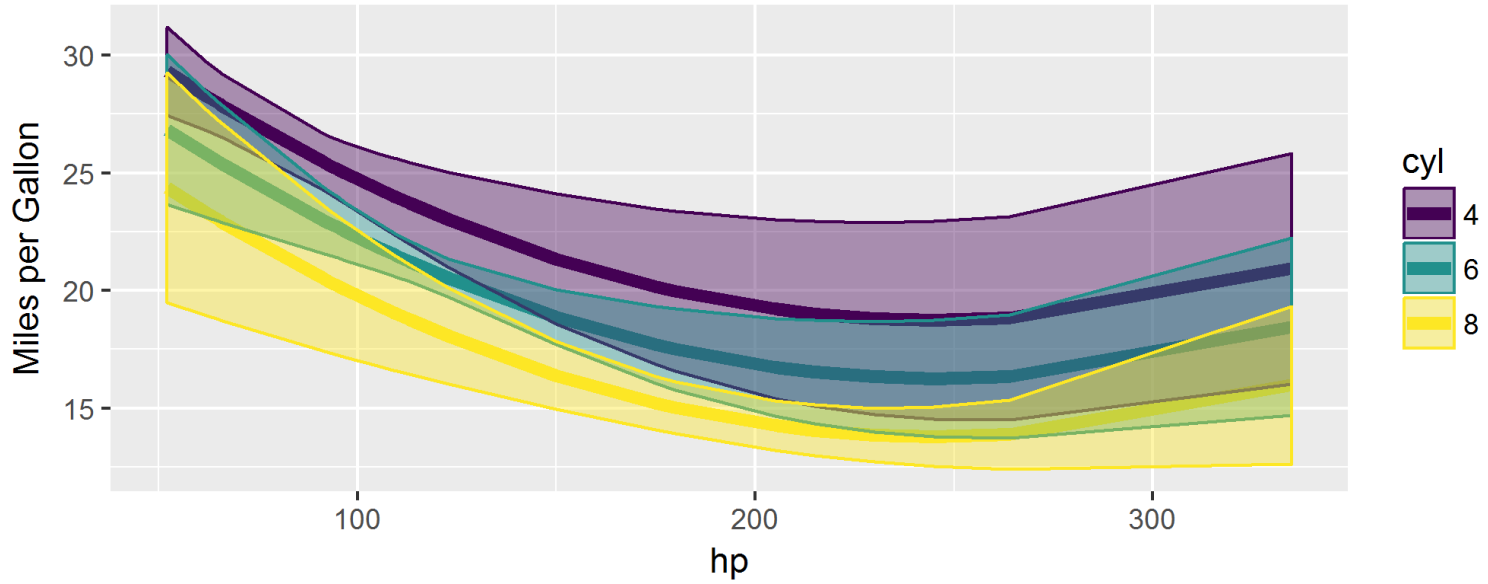
```
add_ci(tb, fit, includeRanef = T)
```



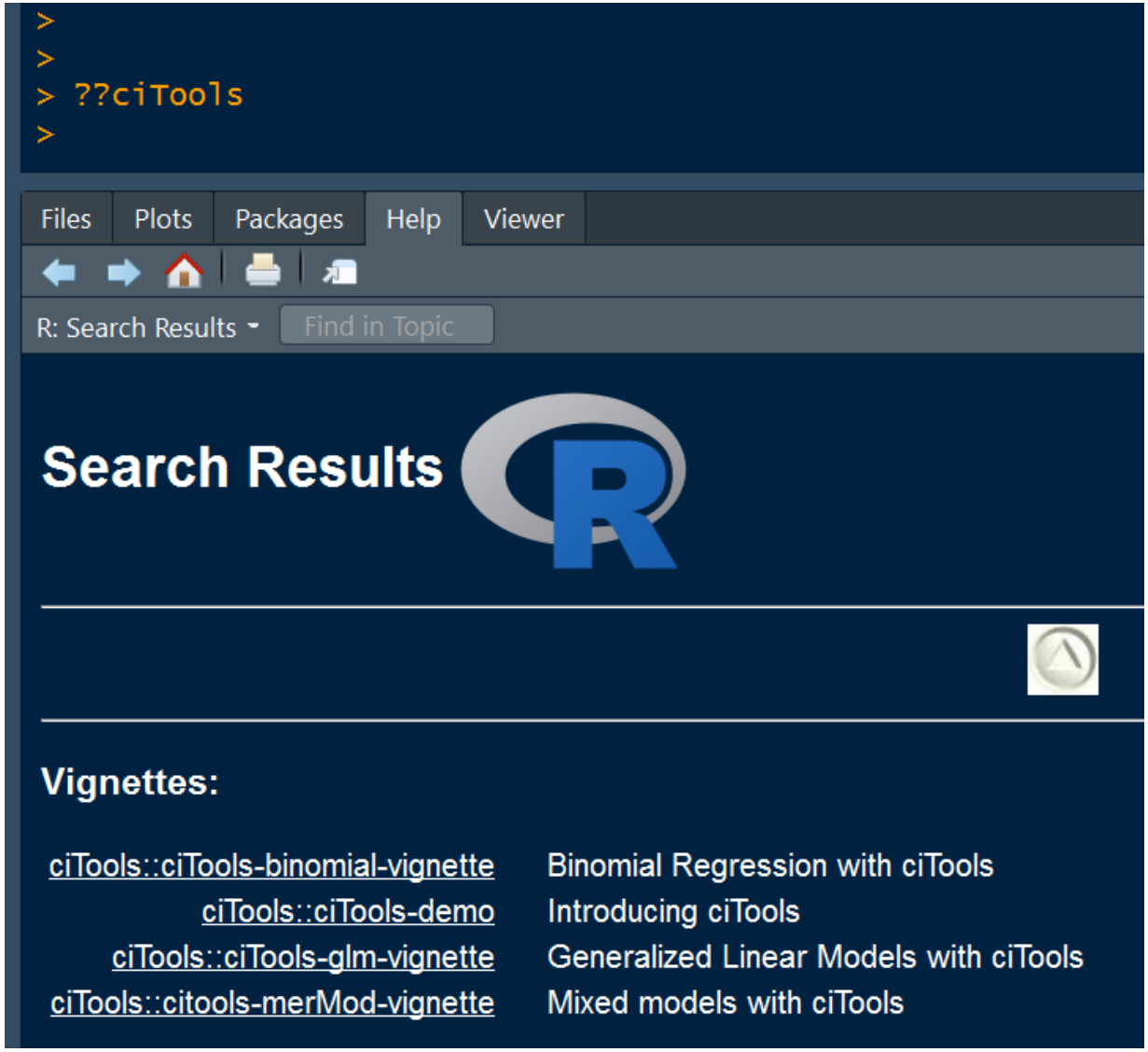
ciTools fits in with your existing workflow!

```
library(tidyverse)
library(ciTools)
library(viridis)

fit <- lm(mpg ~ cyl + hp + I(hp^2) , data = mtcars)
mtcars %>%
  expand(cyl, hp) %>%
  add_ci(fit, alpha = .2, names = c("lower", "upper"), yhatName = "Miles per Gallon") %>%
  mutate(cyl = as.factor(cyl)) %>%
  ggplot(aes(x = hp, y = `Miles per Gallon`, colour = cyl, fill = cyl)) +
  geom_line(size = 2) +
  geom_ribbon(aes(ymin = lower, ymax= upper), alpha = .4) +
  scale_colour_viridis(discrete = T) +
  scale_fill_viridis(discrete = T)
```



Learn how to use ciTools



Tutorials available for free via R or on GitHub!

Get ciTools where R packages are found!

```
install.packages("ciTools")
```

```
install_github("jthaman/ciTools")
```