Statistical Analysis of the Virtual Safety Car in Formula One

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Abstract This paper reviews the potential statistical impacts that the Virtual Safety Car has on actual Safety Car Deployments in Formula One.

1 Introduction

In Formula One cars and drivers speed around a racetrack, occasionally creating accidents or situations that require caution. In 2015 Formula One introduced the Virtual Safety Car (VSC). Instead of deploying a physical safety car, a “virtual” safety car can be deployed to automatically slow down drivers when necessary. This paper analyzes the impact that the VSC may have had on actual safety car deployments.

2 Data

This paper analyzes data provided by Kaggle with supplementary stats compiled manually.

Year Year at which the race took place.

Race Name of the race.

Type Permanent (racing facility) or Street (street circuit).

Round The n-th round of the season (year).

TotalRounds Number of races for that season (year).

TotalLaps Total number of laps completed for that race.

Condition Dry (dry track), Mixed (mixed condition of dry and wet), or Wet (wet track)

Cause Cause of deploying the safety car.

Deployed The lap at which the safety car was deployed.

Retreated The lap at which the safety car returned to the pit lane. If empty, the race had a safety car finish.

FullLaps The number of laps led by the safety car.

3 Method

The data was analyzed using the R programming language to generate visual graphs and numerical comparisons. A histogram was generated for Formula One season 2010-2015 and 2015-2019 with a best-fit poisson line overlayed. Similarly, the interval between safety car deployments was graphed with a best-fit exponential line overlayed. Lastly, we conducted two-sample t-tests comparing both intervals, one with variance assumed equal and one without.

4 Results

Looking first at the means and standard deviations of the two samples, we see that the mean (# of safety car deployments) of the 2010-2015 sample is 0.7291667 and the standard deviation is 1.061074.

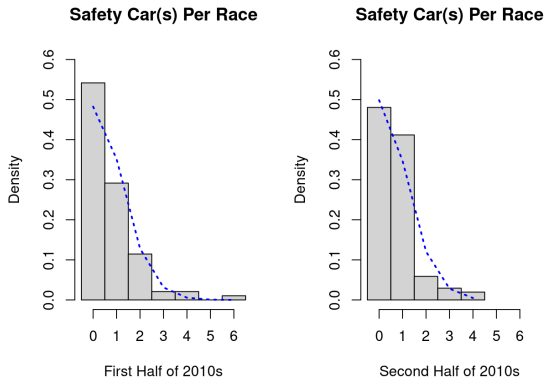

Figure 1: Histogram of Safety Car Deployments

The mean of the 2015-2019 sample is 0.6960784 and the standard deviation is 0.8650441. We can see the histogram of deployments in Figure 1.

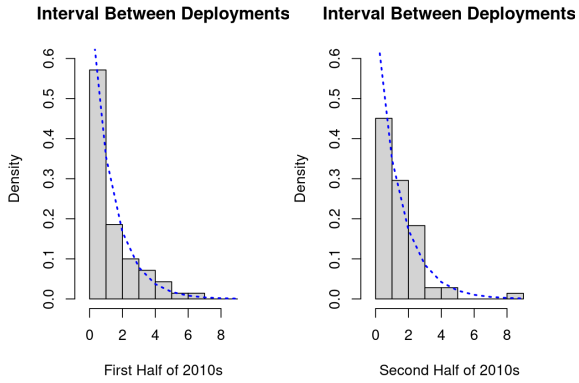

Figure 2: Histogram of Safety Car Intervals

Similarly, the mean of the intervals between deployments for 2010-2015 is 1.328827 vs 1.421543 for 2015-2019. We can see the histogram of intervals in Figure 2.

Finally, we conducted two-sample t-tests comparing both intervals, one with variance assumed equal and one without.

Assuming Equal Variance

$$t = -0.39129$$
$$df = 139$$
$$p\text{-}value = 0.6962$$

Which generated a p-value of 0.6962, indicating that the two samples are not significantly different. More specifically, the 95% confidence interval for the difference in means is [-0.5612108, 0.3757772].

Not Assuming Equal Variance

$$t = -0.39133$$
$$df = 139$$
$$p\text{-}value = 0.6962$$

Which generated a p-value of 0.6962, the same as the previous test. Lastly, the 95% confidence interval for the difference in means is [-0.5611611, 0.3757275].

Conclusion

Going by our t-tests and visually comparing histograms, we can conclude that there is not a significant impact on safety car deployments due to the introduction of the VSC. In other words, the null hypothesis that the mean number of safety car deployments is the same for both samples is not rejected. Additionally, our confidence interval covered zero, indicating that the two samples are not significantly different.

Though this study had a relatively small sample size (70 for 2010-2015, and 71 for 2015-2019), it is still a good indication that the VSC has not had a significant impact on safety car deployments. Additional analysis could be made by taking into account track type (Permanent vs. Street), weather conditions, and many other factors.

References

1. Trotman, James. *Formula 1 Race Events*
https://www.kaggle.com/datasets/jtrotman/formula-1-race-events