The Impact of Formula 1 Tire Compounds

An analysis of F1 Tire Compound Impact at the 2024 Hungarian Grand Prix

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Introduction and Race Context

Tire compound selection plays a crucial role in Formula 1 race strategy, directly affecting lap time, tire degradation, and overall race performance. However, the effectiveness of each compound can vary significantly depending on track characteristics and race conditions.

This analysis investigates which tire compound performed best at the 2024 Hungarian Grand Prix. Using lap time and stint data, we examine how tire performance changes with tire age, lap time, and compound by comparing lap times achieved by each driver on different compounds.

The results show that the medium compound consistently outperformed the soft and hard compounds at this race, while the soft compound performed poorly overall.

To understand tire performance at the Hungarian Grand Prix, we first examine how lap times evolve as tires age. We then compare each driver's fastest laps across compounds and finally discuss strategic insights for optimizing tire choice during the race.

Tire Performance Overview

How Tire Age Affects Lap Time

Tire age strongly influences lap time, as tires degrade and lose grip over more laps completed. Examining this relationship helps identify which compound maintains optimal performance and for how long.

Figure 1: Average Lap Time vs. Tire Age By Compound Line Chart

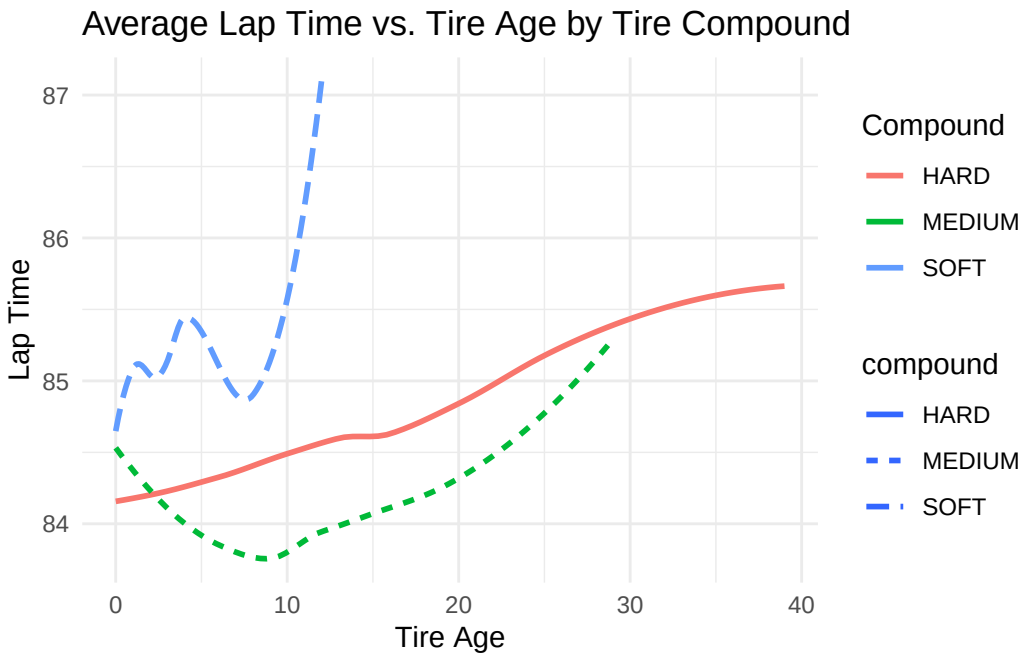

Figure 1 displays the relationship between average lap time and tire age for each tire compound (soft, medium, hard). Tire age is measured as the number of laps completed on a specific set of tires. The values were calculated by averaging lap times at each tire age across all stints using that compound. The figure illustrates distinct length patterns for each compound. Soft tires last about 10 laps, medium about 30 laps, and hard up to 40 laps. Lower points on the line represent faster lap times, while spikes and upward trends represent slower times and drop in tire performance. Softer tires are expected to be the fastest compound, however, at this race, it was the slowest on average. Medium tires performed the best overall, reaching its peak at 10 laps. Hard tires were moderate, remaining consistent between soft and medium. Overall, we learn that at the Hungarian Grand Prix, the soft compound was relatively ineffective, making it a less desirable option for race performance. In contrast, the medium compound provided the best balance of speed and durability, emerging as the optimal tire choice for this race.

While Figure 1 shows general trends by compound, the next section explores individual driver performance to see how these trends relate to fastest laps on each tire.

Comparing Drivers' Fastest Laps by Compound

Different drivers may show different performance from the same tire compound due to driving style and stint strategy. Comparing their fastest laps highlights both individual differences and the overall effectiveness of each compound.

Table 1: Driver's Fastest Lap on each Compound

Driver	Soft	Medium	Hard
Alexander Albon	85.933	83.930	NA
Carlos Sainz	NA	82.908	81.441
Charles Leclerc	NA	82.182	82.299
Daniel Ricciardo	NA	82.640	85.717
Esteban Ocon	81.610	84.057	86.158
Fernando Alonso	85.854	83.063	83.792
George Russell	NA	80.305	82.211
Guanyu Zhou	NA	83.487	85.991
Kevin Magnussen	85.911	83.553	NA
Lance Stroll	84.400	82.338	84.176
Lando Norris	NA	82.820	81.712
Lewis Hamilton	NA	82.153	84.001
Logan Sargeant	80.561	84.090	85.070
Max Verstappen	NA	82.655	80.908
Nico Hulkenberg	NA	83.461	88.821
Oscar Piastri	NA	82.654	81.716
Pierre Gasly	NA	85.164	83.340
Sergio Perez	NA	84.197	81.096
Valtteri Bottas	NA	82.792	84.876
Yuki Tsunoda	NA	83.533	84.541

Table 1 displays the fastest lap for each driver on each compound they competed with. All drivers completed at least one stint on the medium compound, and the majority also used the hard compound. Furthermore, only 6 drivers recorded laps on the soft compound. Across nearly all drivers, the medium compound produced the fastest lap times compared to the other compounds. For drivers who used multiple compounds, their quickest lap was typically set on medium tires. In contrast, the soft compound generally resulted in slower fastest lap times when compared to medium and even hard tires. This further supports the earlier findings as seen in Figure 1, that the soft compound underperformed at the 2024 Hungarian Grand Prix, despite its reputation as the fastest tire. Overall, the table strengthens the conclusion that the medium compound was the most effective tire choice for achieving peak lap performance, while the soft compound was the least competitive option in this race.

Fig 2

Fig 3

Table 2

Table 3

Race Strategy Insights and Conclusions

Combining insights from tire age trends and driver lap times, we can conclude implications for race strategy. The data suggest which compounds offered the best balance of speed and durability, and how teams could optimize their tire choices during the race.

Medium Compound Dominance: The medium tire compound provided the best overall lap times and consistent performance across stints.

Soft Compound Underperformance: Contrary to expectations, soft tires did not yield the fastest laps due to rapid degradation at the Hungarian track. They led the slowest.

Hard Compound Consistency: Hard tires were slower than medium tires but provided longer stints, highlighting their preferred role in longer runs.

Race Strategy Implications: Optimal race strategy at the Hungarian Grand Prix involved prioritizing medium tires for key performance windows, while using hard tires for longevity and soft tires sparingly.

Overall, the data creates a clear narrative: medium tires were the optimal choice at this race, balancing speed and durability, while the other compounds were either too fragile (soft) or too slow (hard) for maximum performance.

Code Appendix

```
source("Data/DataFiles.R")
# Lap Time vs. Tire Age Visualization
# Author: Elisabeth Hadzic

# 1: Load needed packages
library(tidyverse)
library(ggplot2)

# 2:Create the line plot
laps_stints_data %>%
  group_by(driver_number, stint_number) %>% # group by driver and stint
  arrange(lap_number) %>%
  mutate(
    stint_lap = row_number() - 1, # resets the stint lap number to 1 for each new stint
```

```
  ) %>%
  ggplot(aes(x=stint_lap, y=lap_duration, color = compound, linetype = compound)) + # map the a
  geom_smooth(se = FALSE) + # smooths the line
  theme_minimal() +
  labs( # Adds labels to the plot
    title = "Average Lap Time vs. Tire Age by Tire Compound",
    x = "Tire Age",
    y = "Lap Time",
    color = "Compound"
  )
# Driver's fastest lap per compound table
# Author: Elisabeth Hadzic

# 1: Load needed packages
library(tidyverse)
library(kableExtra)
library(knitr)

# 2: Filter for medium tires and find fastest laps
compound_fastest <- laps_stints_data %>%
  filter(compound %in% c("SOFT", "MEDIUM", "HARD")) %>%  # filter 3 compounds
  mutate(compound = factor(compound, levels = c("SOFT", "MEDIUM", "HARD"))) %>% # to stay in or
  group_by(driver, compound) %>% # group by driver and compound
  summarise(
    fastest_lap = min(lap_duration, na.rm = TRUE), # take min lap time for fastest
    #.groups = "drop"
  ) %>%
  pivot_wider(
    names_from = compound,
    values_from = fastest_lap
  )

# 3: Create the table with kableExtra
compound_fastest %>%
  kable(
    caption = "Driver's Fastest Lap on each Compound", # add title
    col.names = c("Driver", "Soft", "Medium", "Hard"), # apply column names
    align = c("l", "c", "c", "c"),
    booktabs = TRUE,
  ) %>%
  kableExtra::kable_classic(
    font_size = 15,
    lightable_options = "striped" # style type
  )
```