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For the student

The Value of Pole Position in Formula 1 History

Dennis Wesselbaum and P. Dorian Owen*

Abstract

In this article, we study the effect of the Pole Position in Formula 1 history on the outcome of the race. Using data for every race between 1950 and 2013, we use two approaches to quantify the effect of being on Pole. First, we estimate the effect on the probability of winning the race using a logit model. Second, we estimate a Poisson model to express the effect in terms of finishing positions. We find that the Pole sitter does have a significant advantage over the other drivers on the grid: two positions at the finish line or about a 10 percentage point higher probability of winning the race. These estimates capture the effect controlling for various confounding factors and a rich set of fixed effects, including driver ability, track characteristics and constructor performance. We also document that the effect varies over seasons.

JEL CLASSIFICATION

C2; L58; Z20

* Wesselbaum and Owen, Department of Economics, University of Otago, P.O. Box 56, Dunedin 9054, New Zealand. Corresponding author: Wesselbaum, email <dennis.wesselbaum@otago.ac.nz>.

1. Introduction

It used to be that the man who scored pole position was almost certain to win the race. But as the series prepares for the Chinese Grand Prix outside Shanghai this weekend, the value of the pole and qualifying in general seem to have diminished as the fastest drivers on Saturday have rarely been those who finish the race in the top spots. (New York Times 2012).

The FIA Formula One (F1) World Championship is the most prestigious motor racing series in the world. Its began in 1950 with the first Grand Prix held in Silverstone (Great Britain). Since then, more than 900 Grands Prix have been held all around the world. Apart from the racing on the track, F1 is a billion dollar industry viewed by millions of supporters around the world with 405.5 million unique viewers and a total audience of 1.92 billion viewers in 2019 (Formula 1 2020). According to financial data from the Formula 1 Group, the value of F1 is around US$3 billion (including debt). Further, in 2018, F1 constructors had a combined spending budget of about US$2.6 billion (*Forbes* 2018).

Intuitively, all drivers want to have the best starting position possible, the so-called Pole Position. A front position in the grid can be very important for subsequent race performance. It puts the driver in a good position for the (standing) start to gain an advantage at the first corner, avoid collisions in the packed midfield, and, for the race leader, to drive in 'clean air', which increases the aerodynamic efficiency of the car, helps manage tyre degradation and allows the most flexible pit stop strategy.

In line with our opening quotation, at the end of every qualifying session and before the green lights flash on race day, journalists, supporters and officials ask themselves how the grid position will affect the outcome of the race. Will the Pole sitter be able to use their advantage and dominate the race from the start to the finish line? Can a driver further back in the grid improve their position, or even win the race?

In this article, we approach this question by relying on econometric methods and data from each Formula 1 race between 1950 and 2013. Answering the question of how the Pole Position affects the race outcome involves selecting an appropriate estimation strategy. The outcome variable, the finishing position, is a so-called limited dependent variable, as it varies between 1 and 24 (the worst position in our dataset). This outcome variable is discrete and takes on only a limited (finite) number of integer values. Therefore, it cannot be treated as a continuous variable and using a standard estimation method, for example Ordinary Least Squares (OLS) is not appropriate.

We choose two different approaches to answer the question and deal with the idiosyncrasies of the data. First, we define a dummy variable, which equals one if a driver wins the race and zero otherwise. Then, a binary response model can be estimated. We choose the logit model but also examine robustness using the other common choice, the probit model. In this approach, we can determine the effect of the Pole Position on the probability of winning the race. Second, we estimate a Poisson model, which can deal with the nature of the finishing position as a limited dependent variable. Here, we also examine robustness using other commonly used estimators.

In order to isolate the effect of the Pole Position, we control for various potentially confounding variables. These include the ability of the driver, the performance of the constructor, differences in race track characteristics and the effect of rain.

Our results suggest that being on Pole Position significantly increases the probability of winning the race by about 10 percentage points. Put differently, the advantage is about two positions at the finish line. The effect is time-varying over the different Formula 1 seasons and appears to be affected by various factors, such as rules and regulations, technological development, professionalisation and unobserved factors.

2. A Preliminary View of the Data

2.1 Background Information

A Formula 1 weekend proceeds as follows: there are two practice sessions on Friday and one practice session on Saturday morning.[1] Then, the starting order for the race on Sunday is determined in a qualifying session on Saturday afternoon.[2]

The design of the qualifying process has changed quite substantially over time. Until 1996 two 1-hour qualifying sessions were held on Friday and Saturday afternoons, while the Friday session was skipped from 1996 to 2003. For each session, drivers were only allowed to complete 12 laps. Then, from 2003 on, two sessions on Friday and Saturday determined the grid. In 2004, Friday sessions moved to Saturday morning; from the start of the 2005 season sessions were held on Saturday and Sunday, and from mid-2005 on there was just one session on Saturday. In contrast to previous designs, times set in both sessions determined the grid. From the 2006 season on, qualifying is organised into three knock-out sessions. The slowest six drivers are eliminated in the first round. In the second round, from the remaining drivers, the slowest six are again eliminated. In the final round, the 10 fastest drivers have the opportunity to put themselves on Pole Position.

Over most of the history of qualifying, the fastest driver/constructor-pair would be on Pole Position. This is because cars were only taking on fuel for a handful of laps: typically a driver would make an out lap (out of the box/pit lane), a so-called flying lap and an in lap (return to box). However, between 2003 and 2009, the rules were changed and a driver had to start the race with the amount of fuel left in the car after qualifying. This opens up considerations about the race strategy even during qualifying. A driver might choose to use a low amount of fuel in qualifying to gain starting positions. However, this comes at the cost of having to make a pit stop earlier in the race. This, in turn, affects the tyre strategy, as the driver will have to either make an additional pit stop for new tyres or manage the set of tyres (meaning, generally, being slower) during the race. This practice was abandoned when refuelling during the race was banned from the 2010 season.

Races are held on Sunday afternoons. There are two ways a Grand Prix can end.[3] Either the standardised race distance (305 km) is reached or the 2-hour time limit is reached.[4] Only Grands Prix on street circuits, for example the Grand Prix of Monte Carlo, are shorter, because otherwise the time limit would be reached.

2.2 Data

At this point, it is useful to have a preliminary look at the dataset. The data covers the period from 1950 to 2013 (64 seasons) with a total of 901 races. For every race, we observe the starting position of each driver (Start) and where the driver finishes the race (Finish). In total, this gives us 20,327 observations of which 8,528 are retired drivers (11,799 classified drivers). Retired drivers are not classified and we therefore assign them the last possible finishing position (25). We distinguish between retirements due to technical problems (6,845), accidents (1,638), withdrawn drivers (36), disqualifications (DSQ) (123) and not classified (NC) drivers (182).[5] The dataset also includes information on the season (Year), the constructor whose team the driver is part of (Constructor) and the race track (Track).[6] Table 1 presents the descriptive statistics of the key variables.

The results show that 34 per cent of drivers retired and 8 per cent had an accident. Of the 901 races, 117 (13 per cent) were rain races. Further, 363 (40 per cent) were won from Pole Position. There is a positive correlation between being in Pole Position and winning the race (0.38).

Table 1 also presents descriptive statistics for the respective decades. We find that means for most variables are stable over time. Interestingly, technical retirements vary between 21 and 43 per cent over time. The low number of technical

Table 1 Descriptive Statistics

	Full sample	*1950s*	*1960s*	*1970s*	*1980s*	*1990s*	*2000s*
Variables							
Finish	14.97	15.61	14.81	15.53	16.34	15.50	13.18
	(9.30)	(9.68)	(9.79)	(9.37)	(9.49)	(9.41)	(8.70)
Dummy win	0.04	0.05	0.05	0.04	0.04	0.04	0.05
	(0.21)	(0.21)	(0.22)	(0.20)	(0.20)	(0.20)	(0.21)
Technical ret	0.34	0.41	0.39	0.35	0.43	0.39	0.21
	(0.47)	(0.49)	(0.49)	(0.48)	(0.50)	(0.49)	(0.41)
Accident	0.08	0.07	0.06	0.11	0.08	0.07	0.08
	(0.27)	(0.25)	(0.24)	(0.31)	(0.27)	(0.26)	(0.28)
DSQ	0.006	0.003	0.004	0.007	0.01	0.004	0.006
	(0.08)	(0.05)	(0.06)	(0.08)	(0.11)	(0.06)	(0.07)
NC	0.009	0.005	0.02	0.02	0.01	0.001	0.001
	(0.09)	(0.07)	(0.13)	(0.15)	(0.11)	(0.04)	(0.03)
Withdrawn	0.002	0.001	0.001	0.003	0.001	0.001	0.004
	(0.04)	(0.03)	(0.03)	(0.06)	(0.03)	(0.03)	(0.06)
Rain	0.13	0.14	0.14	0.12	0.10	0.15	0.13
	(0.34)	(0.34)	(0.35)	(0.32)	(0.31)	(0.35)	(0.34)
Wins from Pole (in %)	40.3	40.2	36.6	36.6	28.4	42.6	50.6
Correlation (Pole, win)	0.38	0.38	0.33	0.34	0.25	0.40	0.48
Observations	20,327	1,796	1,894	3,440	3,915	3,858	3,625

Note: Standard deviation in parentheses.

retirements in the 2000s compared to earlier decades is most likely due to limitations on technical innovations and budget ceilings. Accidents peaked at 11 per cent during the 1970s, but then decreased back to the 6–8 per cent range. This could be due to an increase in Grands Prix and (young) drivers.

Figure 1 shows the number of races, the number of rain races and wins from Pole Position for each season in absolute (upper panel) and relative (lower panel) terms.

We observe that the number of races has steadily increased over time (from seven in 1950 to 20 in 2012). Further, the number of races driven in the rain is fairly low across seasons. In 1981 and 2008, of the 15 and 18 Grands Prix, respectively, six were rain affected, while in 2013, for example, no race was driven in wet conditions.

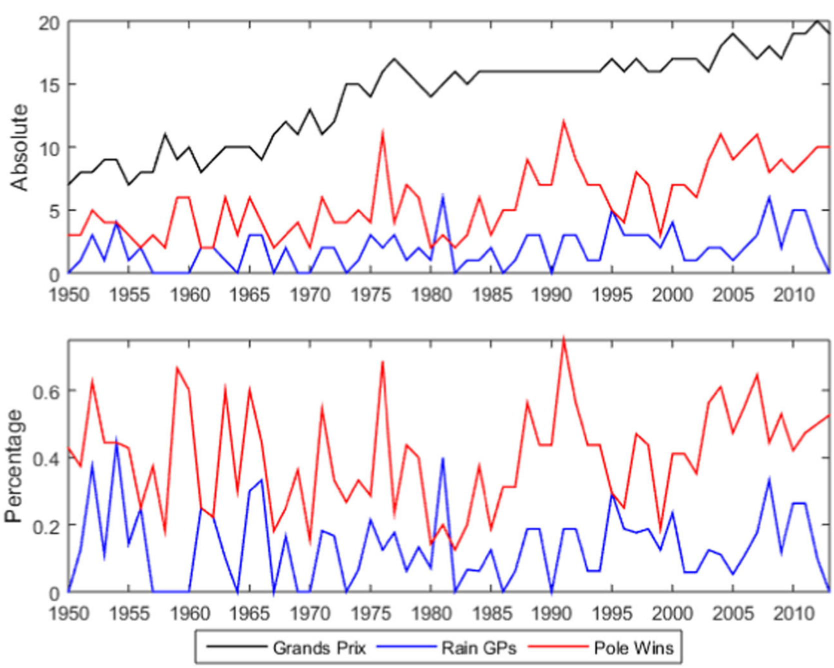
Most interesting for our question is the number of wins from Pole Position. Here, we observe quite large differences across seasons. For example, in 1991, 75 per cent of the races were won from Pole Position (mainly by Pole sitters Ayrton Senna and Nigel Mansell). In contrast, in 1982, only roughly 13 per cent (two races) were won from Pole Position (Alain Prost and Rene Arnoux). Overall, 40 per cent of the races were won from Pole Position. Put differently, more races were won from further down the grid than from Pole Position. Table 1 also shows the wins from Pole Position per decade. This number varies quite sizeably over time, ranging from 28.4 to 50.6 per cent. The high number in the 2000s is mainly due to the successful Michael Schumacher–Ferrari connection, winning 46 per cent of races he started during this time period.

3. Results

3.1 Econometric Methodology

In this section, we want to estimate the 'value' of the Pole Position. We do so by estimating the single equation:

Figure 1 Number of Grands Prix (black line), Number of Grands Prix in Rain Conditions (blue line), and Number of Grand Prix Wins from Pole Position (red line) for Each of the Seasons from 1950 to 2013



Note: Absolute numbers in upper panel and relative number in lower panel.

Table 2 Win Probability

	(1) Full sample	(2) Full sample	(1a) Full sample	(3) 1950s	(4) 1960s	(5) 1970s	(6) 1980s	(7) 1990s	(8) 2000s
Variables									
Dummy Pole	0.218***	0.100***	0.246***	0.017	0.085	0.054**	0.032	0.118	0.147***
	(0.02)	(0.027)	(0.032)	(0.064)	(0.069)	(0.022)	(0.053)	(0.086)	(0.041)
Start	−0.003***	−0.033***	−0.017***	−0.088***	−0.026**	−0.034***	−0.034***	−0.037***	−0.023***
	(0.000)	(0.004)	(0.002)	(0.012)	(0.010)	(0.006)	(0.007)	(0.014)	(0.007)
Rain	−0.001	0.002	−0.003	−0.092**	0.010	0.011	−0.017	0.037	0.001
	(0.006)	(0.028)	(0.030)	(0.041)	(0.094)	(0.052)	(0.082)	(0.081)	(0.049)
Drivers									
Schumacher	0.089	0.019	−0.022					1.588***	0.206***
	(0.095)	(0.207)	(0.124)					(0.148)	(0.015)
Senna	0.030	0.398	0.235**				−1.257***	1.694***	
	(0.094)	(0.256)	(0.118)				(0.208)	(0.194)	
Prost	0.07	0.353	0.171				−1.347***	0.502***	
	(0.092)	(0.265)	(0.116)				(0.214)	(0.041)	
Hamilton	−0.058	0.031	−0.149						−0.623***
	(0.093)	(0.207)	(0.122)						(0.139)
Vettel	−0.089	0.456**	−0.121						−0.582***
	(0.097)	(0.228)	(0.186)						(0.127)
Estimator	OLS	Logit	OLS	Logit	Logit	Logit	Logit	Logit	Logit
Fixed effects									
Year×Constructor	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Track	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Driver	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	20,324	4,188	4,188	217	414	755	687	636	866
R^2	0.29	0.29	0.36	0.39	0.35	0.31	0.20	0.26	0.33

Notes: Dependent variable: win dummy. Clustered standard errors at the driver level in parentheses. For logit estimation, the average marginal effect is presented and the R^2 is pseudo R^2. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

$$Finish_{i,j,k,t} = \beta_0 + \beta_1 Pole_{i,j,t} + \gamma X_{i,j,t} + \delta_i + \delta_j + \delta_{k,t} + \varepsilon_{i,j,t}, \quad (1)$$

where we explain the result for each driver i in Grand Prix j, driving for constructor k in year t, by a Pole Position dummy (Pole) and a set of control variables $X_{i,j,t}$. The set of controls includes the starting position, a rain dummy, and controls for technical retirements, accidents, withdrawals and non-classifications.

Further, we include the following set of fixed effects. We use driver fixed effects, δ_i, track fixed effects, δ_j and year-constructor fixed effects, $\delta_{k,t}$. Standard errors for all regression are clustered at the driver level.

3.2 Estimation Results

This section presents our estimation results using a win dummy (logit) and the finishing position (Poisson) as dependent variables, respectively.[7]

3.2.1 Winning Probability

We investigate whether the Pole Position significantly affects the probability of winning the race. In Table 2, we present the estimation results as average marginal effects.[8]

We begin by presenting the OLS estimates in column (1).[9] We find that the effect of the Pole Position is statistically significant at the 1 per cent level ($p < 0.01$) and positive. As expected, we find that a larger value for Start (that is a starting position further back in the grid) reduces the probability of winning the race ($p < 0.01$). Rain has no statistically significant effect on the probability of winning the race.

In column (2), we present the results from using the logit estimator.[10] We find that being on Pole Position increases the probability of winning the race by 10 percentage points ($p < 0.01$). This estimate captures the effect excluding the starting position, rain and a rich set of fixed effects, including driver ability, track characteristics and constructor performance.

The model explains 29 per cent of the variation in the winning dummy. A higher starting position, as before, has a negative, significant effect on the winning probability ($p < 0.01$) of 3.3 percentage points, while rain has no statistically significant effect.

The table also presents the effects for the five most successful drivers in Formula 1 history. We selected these drivers because they are in the top five of drivers according to wins or Pole Positions. However, there appears to be no statistically significant effect on the winning probability for any of these drivers.[11]

The only related work to put these numbers into perspective is due to Depken (2006). He finds that, for example, being on Pole Position in the US NASCAR series in 2006 resulted in an 8 percentage point higher probability of winning a race. This is consistent with our estimate. He also documents that the value of the Pole Position is decreasing over time.

So far, we have used the full sample, that is all observations, in our analysis. Columns (3)–(8) present the estimated average marginal effects for the respective decades from the 1950s to the 2000s. One caveat of splitting our observations into decades is the reduction in the number of observations.

We find some interesting time-variability in the effect of the Pole Position. Overall, it appears that the effect of Pole Position is increasing over time. In the 1950s the effect is insignificant and in the 1960s we only imprecisely estimate the effect. The average marginal effect is 8.5 percentage points when on Pole Position but with a large standard error. This is due to the low number of observations and the clustering of standard errors, which increases the standard errors by design. In the 1970s, the effect is statistically significant ($p < 0.05$) and being on Pole increase the probability of winning by 5.4 percentage points. Then, in the 1980s, the effect is only 3.2 percentage points and statistically insignificant. Again, for the 1990s, we find a large effect of 11.8 percentage points of being on Pole Position, but with a large standard error. The effect of being on Pole is largest during the 2000s, with 14.7 percentage points ($p < 0.01$).

Overall, we conclude that the effect of being on Pole Position does vary over time. This is most likely due to changes in regulations, for example, changes to qualifying rules or the ban on refuelling, and technical regulations. It is likely no coincidence that the effect of Pole Position is smallest during the 1980s, where retirements due to technical reasons are highest. The 1980s and the 1990s saw large investments in new technologies (for example, active suspensions, traction control, launch control, electronics, sequential gearbox, etc.). This 'pushing the boundary' might have led to excessive risk taking and more technical breakdowns. This might be particularly relevant for the fastest teams (with drivers on Pole Position) as they face the highest level of competition. With limitations on development and team's budgets during the 2000s and onwards, we see that the technical retirements more than halve.[12]

The effect of the staring position is always highly significant and varies between 2.3 percentage points and 10 percentage points. In contrast to the full sample, we find that the five drivers presented have a significant effect on the win probability. During the 1990s Michael Schumacher had a higher probability of winning a race compared to the other drivers. Based on point estimates, his effect was slightly smaller compared to Ayrton Senna's but larger than that of Alain Prost's. We find evidence suggesting that the effect of a driver on the winning probability goes through a life-cycle, as the driver effects vary over decades. This life-cycle is largely affected by learning, changes in reaction times, driving for different constructors and unobservable factors (such as investment in testing).

Table 3 Finishing Position

	(1) Full sample	*(2) Full sample*	*(3) 1950s*	*(4) 1960s*	*(5) 1970s*	*(6) 1980s*	*(7) 1990s*	*(8) 2000s*
Variables								
Dummy Pole	−0.666***	−1.809***	−1.628**	−1.049**	−2.053***	−0.542	−0.750*	−2.751*
	(0.131)	(0.341)	(0.785)	(0.444)	(0.674)	(0.701)	(0.386)	(1.445)
Start	0.139***	0.161***	0.157***	0.180***	0.167***	0.125***	0.112***	0.221***
	(0.006)	(0.007)	(0.018)	(0.016)	(0.012)	(0.013)	(0.013)	(0.017)
Rain	0.105	0.101	−0.290	0.000	0.288	0.329	0.165	0.040
	(0.075)	(0.096)	(0.285)	(0.219)	(0.225)	(0.224)	(0.156)	(0.212)
Drivers								
Schumacher	−0.629	−1.74***					−2.250***	−3.293***
	(1.757)	(0.41)					(0.195)	(0.222)
Senna	0.223	−0.203				−0.269	−1.337***	
	(1.759)	(0.394)				(0.758)	(0.340)	
Prost	−1.064	−2.447***				−2.489***	−2.942***	
	(1.743)	(0.243)				(0.312)	(0.445)	
Hamilton	−0.906	−0.337						−0.709
	(1.764)	(0.343)						(0.508)
Vettel	−1.030	−2.401***						−0.774
	(1.786)	(0.385)						(0.689)
Estimator	OLS	Poisson	Poisson	Poisson	Poisson	Poisson	Poisson	Poisson
Fixed effects								
Year×Constructor	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Track	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Driver	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	20,324	20,324	1,793	1,894	3,440	3,915	3,858	3,625
R^2	0.92	0.49	0.53	0.55	0.49	0.51	0.51	0.47

Notes: Dependent variable: Finish. Clustered standard errors at the driver level in parentheses. For Poisson estimation, the average marginal effect is presented. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

3.2.2 Finish Position

We also analyse the value of the Pole Position when we use Finish, the position the driver finishes the race, as the dependent variable. As explained earlier, we use a Poisson regression to obtain our results. Table 3 presents the average marginal effects.[13]

As before, column (1) presents OLS estimates. We find that being on Pole Position statistically significantly ($p < 0.01$) improves the finish position and that a higher starting position has a significantly negative effect on the finish position ($p < 0.01$). Again, rain does not have a statistically significant effect. In column (2), we present the results for the Poisson regression. We find that being on Pole Position significantly reduces the race result of a driver by 1.8 positions. Every starting position further down the grid will incur a penalty of 0.16 finishing positions ($p < 0.01$).

When we turn to the top five drivers, we find that Schumacher, Prost and Vettel are statistically better compared to the average driver by about two finish positions in the full sample. The model explains about half of the observed variation in the race outcome.

As in the previous section, we also consider regressions for the individual decades. Columns (3)–(8) present the regression results for the 1950–2000s. We find that, again, the value of Pole Position varies over time quite sizeably. Its effect is not statistically significant during the 1980s and, based on point estimates, largest during the 2000s. Being on Pole is advantageous in the 1950s (1.6 positions), 1960s (1 position), 1970s (2 positions), 1990s (0.8 positions) and the 2000s (2.8 positions).

Again, this finding is in line with our results for the effect of the Pole Position on the probability of winning the race. The value is lowest during the innovative 1980s and 1990s and largest in the years of limited regulations and budgets (2000s and onwards).

We also find more support for the life-cycle effects for drivers. The effects of the top five drivers vary sizeably over time. Schumacher has a positional advantage of 3.3 positions relative to the average; the largest advantage among the top drivers. Second in line is Alain Prost in the 1990s (2.9 positions) and Senna in the 1990s (1.3 positions). Vettel's advantage of 2.4 positions derives from his World Championship run from 2010 to 2013.

In conclusion, starting from Pole Position significantly improves the chances of winning the race and, relatedly, of achieving a better race finish (lower finishing position). However, this effect does vary over time and is likely affected by other factors such as rule changes and changes to technical regulations as discussed earlier. In addition, we have not taken into consideration changes to the point system. For the 1960 season, the sixth placed driver also received one championship point. In 1991–2002, the winner received 10 instead of nine championship points. From 2003 to 2009 the first eight placed drivers obtained points and since 2010 the first 10 placed drivers receive points with the winner taking 25 points instead of 10. This will change the incentives to overtake (and defend) on the track, which also might be affected by the increased media attention in the sport over time.

Further, penalties during the race (for breaking rules or technical regulations) have changed over time. Drivers have also become more professional with respect to physical and mental training, practising on and off (in simulators) the track and the help teams can give the driver during the race (radio communication and telemetry data). In addition, teams became more professional, with strategy being added by GPS tracking of cars on the race track and real-time computer simulations of strategies. While our fixed effects strategy should take into account some of these factors, part of the unexplained variation is due to these and additional factors.

3.2.3 Robustness

We also consider several robustness checks. For the regression using the win dummy, we estimate a probit model and find a coefficient of 0.107 ($p < 0.01$) for the effect of the Pole Position, which is slightly larger compared to the logit estimate of 0.088 ($p < 0.01$). Further, we choose a different set of fixed effects using year and constructor fixed effects independently.

In this specification, the coefficient is 0.072 ($p < 0.01$), again of similar size compared to our preferred specification (0.088).

Robustness checks for the finishing position regressions also support our results. When we use the different set of fixed effects mentioned earlier, we find a stronger effect of 2.6 positions rather than 1.8 positions (both $p < 0.01$). We then select the negative binomial regression to account for potential overdispersion in the data (this, most likely, is a result of assigning the position 25 to retired drivers).[14] We find an identical effect of 1.8 positions ($p < 0.01$). Finally, estimating a Tobit model, letting the algorithm pick the upper and lower bound, we find a slightly smaller effect of 1.4 positions ($p < 0.01$).

Overall, we find that the effect of the Pole Position on the winning probability and the finishing position remain statistically significant and of similar magnitude across various specifications.

4. Conclusion

Does Pole Position afford a driver in F1 a significant advantage compared to their rivals? How large is this advantage? This article tries to answer these two questions and quantifies the value of the Pole Position in the history of F1 racing.

We find that being in Pole Position does provide a significant advantage over the other drivers in the grid. This advantage is about two positions at the finish line or about a 10 percentage point higher probability of winning the race. These estimates capture the effect controlling for starting position, rain and a rich set of fixed effects, including driver ability, track characteristics and constructor performance. The effect is time-varying and appears to be affected by various factors, such as rules and regulations, technological development, professionalisation and unobserved factors.

Endnotes

1. Free practice sessions for the Grand Prix de Monaco are held on Thursday.
2. From 1996 to 2002 and since 2011 drivers need to be within 107 per cent of the fastest time set (since 2011 this applies to the time set in the first of three qualifying sessions). If a driver fails to meet this cut-off, his start in the race is at the discretion of the stewards.

3. Note that in exceptional circumstances, a race can be stopped ('red flagged'). Examples involve the 2014 Japanese Grand Prix after the fatal accident of Jules Bianchi, the 1997 Canadian Grand Prix after an accident involving Oliver Panis, or the 1991 Australian Grand Prix due to rain. Half points can be awarded if less than 75 per cent of the race distance and more than two laps have been completed (as, for example, for the 1991 Australian Grand Prix).

4. Until 1966, the race distance varied between 300 and 600 km. In 1966, the race distance was limited to 400 km and it was further reduced to 325 km in 1971.

5. Note that drivers can be counted as retired and withdrawn as well as retired and disqualified at the same time.

6. Note that while we have information on the race track, we do not control for layout changes. For example, the German Hockenheimring race track was redesigned in 2002, shortening the race track from 6.8 to 4.6 km while dramatically changing the design of the track.

7. Notice that computing time can vary sizeably across computers and Stata versions (our results are obtained using Stata 15 MP). Running the entire corresponding do-file can take hours.

8. Notice that the associated Stata code does not compute the Wald statistic, due to our choice of clustering standard errors, because the number of parameters is larger than the number of clusters.

9. We also estimate the model using OLS on the sample used by the logit estimator. This leaves our main findings unaffected.

10. The logit sample is smaller compared to the OLS sample, because the logit estimator drops observations that perfectly predict 0 or 1 outcomes. Here, it drops drivers who never win a race (the majority of drivers).

11. Only for Sebastian Vettel did we find a statistically significant positive effect. However, it is only marginally significant at the 10 per cent level.

12. For example, since 2004, engines had to last an entire race weekend and were not allowed to be changed without taking a 10 grid position penalty. In 2008, traction control was banned and limits were imposed on wind tunnel usage and the use of Computational Fluid Dynamics (CFD).

13. Notice that different versions of Stata can lead to slightly different parameter estimates for the Poisson model (results presented use Stata MP 15.1). This is because we are estimating a large set of parameters using a maximum likelihood estimator, which encounters a flat likelihood region. This leaves our main results unaffected.

14. Excluding retired drivers from the analysis does not change our main findings.

References

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.