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Safety at the Racetrack: Results of Restrictor Plates in Superspeedway Competition

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In 1988, in an effort to reduce risks at auto races, the National Association for Stock Car Auto Racing (NASCAR) implemented a provision requiring the installation of carburetor restrictor plates at its higher speed events. Restrictor plates make a car's engine less effective, thereby slowing the field. Many NASCAR drivers and fans alike question whether the reduction in speed has led to increased safety. This article investigates the empirical determinants of racetrack safety, paying particular attention to the results of restrictor-plate racing on driver safety. We conclude that whereas restrictor-plate races are characterized by more cars being wrecked, there is no systematic evidence that they have led to more driver injuries.

JEL Classification: J28, L83

1. Introduction

In May of 1987, driver Bobby Allison's car became airborne after blowing a tire in the front stretch of the Talladega Superspeedway in Alabama. The car destroyed 100 feet of safety fencing and nearly entered the densely packed grandstands at 210 miles per hour. As it was, debris from the airborne car caused severe injuries, including the loss of an eye by a spectator. Allison was not seriously injured, but the National Association for Stock Car Auto Racing (NASCAR) saw the horrific possibilities and implemented a plan to slow down cars at its two fastest speedways: Talladega and the Daytona track in Florida (Duskey 2001).

NASCAR's solution was to mandate the use of restrictor plates at these tracks. This device limits the flow of air to the car's engine, thereby reducing the horsepower and, consequently, the speed the engine can generate. Since their introduction, restrictor plates have succeeded in reducing not only speeds reached during races, but also qualifying speeds. Prior to the implementation of the plates at Daytona and Talladega, qualifying speeds consistently exceeded 200 miles per hour (mph), reaching a high of 212.809 mph during the qualifying session in which Allison's infamous takeoff occurred. Since then, qualifying speeds have never reached 200 mph and have actually declined so that in 2000 and 2001, qualifying speeds averaged just under 187 mph. Despite achieving the objective of slowing down the cars, the use of restrictor plates has been controversial among drivers, many believing that their personal safety has been compromised. The refrain from many NASCAR drivers is that during a restrictor-plate race, "the big one" is inevitable, and hopefully no one will be seriously injured.

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Veteran Sterling Marlin voiced a common concern among NASCAR drivers after a last-lap crash at the Talladega race in October 2001 eliminated 16 of 43 cars: "They [restrictor plates] caused this and they'll continue to cause things like this until they [NASCAR officials] get them off the cars. It's not safe and they better do something" (Associated Press 2001).

This article investigates the empirical determinants of safety at NASCAR races, paying particular attention to the effects of restrictor plates. No one debates that spectator safety is now greater; however, if, as the drivers assert, their well-being is diminished, then NASCAR finds itself in the unenviable situation of placing its product in jeopardy for the safety of its fan base. What we seek to determine is whether, in fact, restrictor-plate racing is more hazardous than non-plate racing. We establish a model that evaluates not only the relationship between restrictor plates and driver injuries, but also between the plates and accidents on the track. It may be the case that what drivers are actually observing is more cars wrecking on the track and not necessarily an increased threat to their personal safety. If this is the case, then NASCAR may have happened upon a process for increasing fan interest in these races. When more cars wreck, viewership increases, while the drivers themselves are not harmed. NASCAR veteran driver Bobby Labonte sarcastically summed this up, saying, "The grandstands are full and everybody is OK, so I guess it's OK" (Associated Press 2001).

As we proceed with our analysis, section 2 examines the highway safety literature and makes a connection with our NASCAR data. Section 3 details the data, and section 4 sets up the model describing the number of wrecked cars. Section 5 expands the model to evaluate driver injuries. Finally, we summarize our findings in section 6.

2. Does Speed Kill or Does Variance Kill?

Research into NASCAR safety can be seen as an extension of highway safety studies, although in a highly controlled or even artificial setting. NASCAR races provide experiments in risk and safety in addition to entertainment. The data are cleaner than highway data, however, due to a number of differences. First, weather conditions are eliminated as a major influence on safety at NASCAR races, as races are postponed in rain and are never run in ice or snow. There are few threats of wildlife on the track, though deer have been known to wander onto the Pocono Speedway in Pennsylvania, and driver Dale Earnhardt once hit a seagull during a race. Furthermore, there are no drunk drivers at NASCAR races. Finally, and perhaps most importantly, the drivers are all professionals and acutely aware of the risks inherent in their profession.

The use of restrictor plates to slow the competitors naturally raises two questions, both having been extensively researched in the highway traffic safety literature. The first issue considers what Peltzman (1975) calls offsetting behavior. The second angle concerns the question of whether "speed kills," that is, whether accidents, injuries, and fatalities are more likely when speed is higher, other things equal.

Peltzman's seminal article shows that, as drivers feel safer in their cars, they tend to offset the reduction in potential injuries by driving more aggressively, thus inducing behavior that leads to more severe accidents for both the operator of the vehicle and pedestrians. In other words, regulations enacted to make drivers safer have been offset by increasingly reckless driving, thus shifting the accident affliction to pedestrians as shown using time series data. However, a cross-sectional model suggests that regulations precipitated an already developed downward trend in accidents. These regulations have resulted in fewer yet more severe accidents. Peltzman's main point is that the unintended consequences of the National Traffic and Motor Vehicle Safety Act of 1966 have been ignored, obviously, creating a good deal of consternation for those who advocate safer automobiles.

Robertson (1977) contradicts the offsetting behavior hypothesis by suggesting that Peltzman's model was not only incorrectly constructed, but also contained an omitted variable bias. Once the bias is corrected, Robertson finds no indication of increased risky behavior. Graham and Garber (1984) agree and show Peltzman's model to be fragile. Their version suggests that tens of thousands of lives were saved as a result of safety standards implemented by the National Traffic and Motor Vehicle Safety Act. Additionally, they show no increase in pedestrian deaths as predicted by Petlzman.

More recently, support for Peltzman has increased. Chirinko and Harper (1993) illustrate that offsetting behavior is indeed a concern in evaluating the severity and incidence of injuries in an increased safety-standards world. However, they concede that determining the cause of this offsetting behavior is difficult. Risa (1994) explores the presence of offsetting behavior in Norway. His conclusions indicate that the degree of risk that a driver is willing to undertake with the installation of a new technological innovation is instrumental in explaining the proportion of offsetting behavior. Sobel and Nesbit (2003) apply Peltzman's model to the NASCAR realm, concluding that using this micro-level data, offsetting behavior occurs due to increased safety features. In other words, as safety features have been added to cars, accidents have become more prevalent.

Though Peltzman's position focuses on offsetting behavior that results from the increased likelihood of a driver avoiding injury, the question that we are concerned with focuses on a safety feature that, as many of the NASCAR drivers contend, does not increase the safety of the driver. Instead, in Peltzman's terms, restrictor plates exist to prevent harm to bystanders, specifically fans. We therefore move to the second issue: the "speed kills" branch of the highway safety literature that provides additional background for our model.

During the debate over a national 55-mph speed limit, Lave (1985) proposed that it is not speed that kills, but rather variance of speeds that is more deadly. In his data analysis, there was no statistically significant relationship between speed and fatality rates. Though speed limits are often viewed as a constraint to behavior, in Lave's view, coordinating rather than limiting behavior may be more important. Thus, apart from speed considerations, if drivers are coordinated so that they all behave in a predictable, standardized fashion, the unexpected circumstances that lead to accidents will be less frequent. In other words, lower speed variance may create a safer environment even if it occurs at higher average speeds. Lave believes that not only do fast drivers impose externalities on others, but so do slow drivers. However, his research does not call for increasing speed limits indefinitely, as higher speeds may lead to more variation.

The position that can be simplified as "variance kills" is reinforced by Forester, McNown, and Singell (1984) in a cost-benefit analysis of the 55-mph speed limit. They conclude that though a reduced speed limit may have diminished the number of fatalities, the narrowing of speed variability contributed more to the decrease than the lower speed itself.

A number of critics have taken issue with the idea that "variance kills." Levy and Asch (1989) agree that variability is an issue, but maintain that it is inseparable from speed. Interacting a measure of speed with variability, they find that the coordination of drivers decreased at higher speeds, leading to more fatalities. Thus, in their analysis, speed is still the primary culprit in highway deaths.

Fowles and Loeb (1989) critique Lave's model by focusing on possible omitted variable bias. They add explanatory variables for motor-vehicle inspection and policy positions dealing with legalized drinking. Their results support the notion that in conjunction with variance, speed is an important variable in determining fatalities.

Snyder (1989) distinguishes between the variability of the fast driver and that of the slow driver in an attempt to discover whether faster speeds are more relevant. Whereas Lave (1985) measures the speed variation of drivers by subtracting the average speed of drivers from the speed of the 85th percentile of drivers, Snyder adds another category to control for the slow drivers. He subtracts the 15th percentile speed from the average speed, yielding a proxy for the interval 1 standard deviation above and below the mean. Snyder's conclusion indicates that speed is important in determining traffic fatalities and that speed variance is important only for the fast drivers. Snyder's estimations fail to provide evidence that the variance of the slow drivers is significant.

In a response to his critics, Lave (1989) retorts that the difference in results is not in the structure of the model, but in the data used. His studies relied on micro data, whereas the critical studies used aggregated data.

Years after the original "variance kills" debate was stalemated, Lave and Elias (1997) developed new channels to study how speed and variance affect fatalities system-wide. States that permanently increased their speed limits observed a decline in overall fatalities even as fatalities increased on the interstate highways where the speed limit changed. Lave and Elias show how drivers reallocate themselves from side roads to safer interstates as the incentives provided by faster speeds become more positive. They also show how reallocation of highway patrol resources away from speed enforcement toward higher value activities such as sobriety checks reduces system-wide fatalities. In the Lave–Elias model, the claim that "speed kills" is again an oversimplification and quite possibly incorrect.

NASCAR restrictor-plate races provide an unusually clean test of whether or not "variance kills," because the restrictor plates reduce variance in speeds. In the language of one race writer, "Restrictor plates allow turkeys to soar with eagles. What this means is that the restrictor plates have a tendency to even things out as far as speed goes. Cars that would normally be faster without these plates are slowed to the speeds of the slower cars" (Duskey 2001).

If the traditional arguments transfer directly from highway traffic safety to NASCAR, we should expect to see two distinct contributions to safety from restrictor plates. The first and most obvious contribution due to slowing the field would be a reduction of incidents on the track: the "speed kills" effect. A second contribution of reducing the variance between driver speeds would be that the number of accidents is curtailed: the "variance kills" effect. However, NASCAR drivers have long believed that higher variance is safer on the racetrack. There is one major difference with the variance examined here: In NASCAR races, variance may mean a foot or two between cars, whereas on the highway it means multiple yards. Thus, our analysis should not directly square with Lave's (1985) position. Instead, if variance matters, we expect to see the exact opposite result. When an "eagle" passes a "turkey," to use Duskey's metaphor, the pass is quickly accomplished when variance is high. With low variance, the cars bunch up, possibly heading into turns on the track side-by-side instead of in the safer nose-to-tail configuration.

Empirically, it is possible that the greater safety resulting from lower speeds in restrictor plate races is more than offset by the unsafe reduction in variance. If this is true, then an intended safety measure is actually adding to the risk faced by drivers.

3. Race and Safety Data

Our data set includes races from 1981 through 2001. Though much of our data was collected by culling newspapers for race results, we were greatly aided by Fielden (1990, 1994), whose books provide comprehensive race information for the earlier years of our sample. Race results as they appear in newspapers report the number of cars on the lead lap, average speed of the winner, number of laps completed, the number of cars that started the race, the number of lead changes, the number of cars on the lead lap, the number of caution flags (resulting from accidents or other unsafe track conditions), laps run under caution flags, and the cause of a driver exiting the race. This last item is particularly important because it notes whether the driver fails to complete a race for mechanical problems (such as an engine failure or brake problems) or due to being involved in an accident. Other characteristics such as the length of each track and the distance of the race are public knowledge. We verify the length of a race by multiplying the number of laps completed by the length of the track, as some races may end early due to perilous weather conditions or darkness.

Safety is affected by a number of contingencies. For example, on smaller tracks cars can bunch up more easily. Not only is there less track space to share, but also the faster cars can catch up to the slower ones. This lap traffic may interfere with the progress of faster cars, leading to more congestion on the track and an increased likelihood of an accident. To deal with this, we create a density variable equal to the number of cars per track mile.

Safety is additionally complicated by occasional year-to-year variations in factors affecting risk. For example, the occasional presence of competing tire suppliers resulted in "Tire wars" in 1988, part of 1989, and the entire 1994 season. These "wars" led to alterations in tire compounds, making the tires relatively softer or harder. The makeup of tires, therefore, differed between race teams. The safety issue surrounding the tire wars focuses on the consistency of tires. In order to take market share, tire companies made softer tires that gripped better in corners, but that did not wear as well. Though these softer tires helped a driver get around a track faster, they also broke apart more easily, thereby compromising driver safety. To account for year-to-year effects such as these, we included dummy variables for observations by year. Other sources of year-to-year variation include new safety measures, as noted in Sobel and Nesbit (2003), changes in manufacturers of cars, and changes in body types. Tracks themselves also differ greatly. Therefore, we also include track dummy variables to allow us to control for track-specific variation that may affect races such as the length of the track, the degree of banking in the turns, and the angles of the turns.

Because NASCAR does not provide data to the public on the severity of accidents that occur during races, injury and hospitalization information must be pulled from news stories and race summaries. All wrecks currently result in a physical exam of the driver by health professionals located at the racetrack. In most cases, the driver is examined and released on-site. On rarer occasions, drivers are hospitalized for more extensive care or observation. Consequently, we reviewed newspaper stories provided by the Associated Press, United Press International, and papers local to each track to determine whether drivers were hospitalized as a result of an accident. Fatalities were similarly determined. Our complete data set has 408 data points.

4. Results of Modeling Wrecks

The econometric model is OLS (ordinary least squares) and is designed based on the following equation:

$$\text{Wrecks} = \Phi X + \tau + \varepsilon. \tag{1}$$

Wrecks is the number of cars permanently eliminated from a race due to an accident. X is a vector of explanatory variables that controls for events that may raise or decrease driver safety, including a dummy for whether a race has restrictor plates equal to 1 if the plates are used and 0 otherwise; density of the cars on the track; the number of rookies in a race; laps run during the course of the race; and qualifying speed. Additionally, we run separate specifications using the starting position of the winner and the number of lead lap cars to measure the competitiveness of a race. These are detailed below.

If our theory is correct, namely, that restrictor-plate races experience more wrecked cars, the restrictor-plate dummy should be positive. We predict that the density variable will be positive. The more cars per track mile, the more likely it would be for them to wreck into each other. As Peltzman (1975) uses driver age to measure experience, we look at the number of rookie drivers in a race. We expect this variable to have a negative effect on safety. Though skilled, rookies still possess a lower level of experience in NASCAR races. Thus, more rookies should mean more wrecked cars and a positive sign for this variable. We also expect the laps variable to be positive. The more times the drivers circle the track, the more likely it becomes that either mechanical difficulties or driver fatigue may arise, causing cars to wreck. (Because laps and miles run during a race measure similar things, namely, the length of a race, we include only one of them at a time when we run versions of the model. Though we report only the laps variable, the regression results are similar if miles replaces laps). Finally, the qualifying speed variable should be positive. Taking a positive sign implies that on tracks with higher speed potential, wrecks that do occur put the driver out of the race. On slower tracks, a wreck may not necessarily end a driver's day, as hitting a wall at 90 mph may not damage a car as severely as hitting it at 190 mph. This could lead to validation of the "speed kills" position.

The effects of starting position and the number of lead lap cars are expected to be positive. If the race winner started back in the pack, he had to fight his way to the front, possibly taking more risks. Additionally, more lead lap cars at the end of a race indicates that there is a good deal of "trading paint" (contact between cars) going on. Thus, the more hotly a race is contested, the more wrecked cars we expect. These competitiveness variables will be run in separate versions of the model to avoid possible multicolinearity issues.

In testing our model, we inspect three different data groupings to verify the model's robustness: one using all races, a second with only tracks 2 miles and longer, and a third including only Daytona and Talladega. Each specification excludes the road courses at Sears Point, California, and Watkins Glen, New York, as they constitute a different genre of racing. Not only do road courses have far fewer laps in a race and much slower speeds than most tracks, they also include right- as well as left-hand turns. We also drop any data points where qualifying speed is missing, as would happen if the weather or darkness prevented the field from attempting to qualify for a race; including these zero values would contaminate the speed variable.

Between the three data groups we are required by data limitations to run two different time samples of the model. The first uses data for all races and those on tracks 2 miles or longer from 1992 through 2001. We also have a larger data set extending the sample period back to 1981 for the tracks 2 miles and longer, allowing us to compare the longer track samples, as well as Daytona and Talladega, specifically before and after the adoption of restrictor plates.

The results displayed in Tables 1–3 illustrate these various specifications. For the sake of brevity, all year and track dummies are excluded. Additionally, we ran each specification using different combinations of variables to test for robustness. Though not reported, the results are essentially the same in each circumstance. All results correct for heteroskedasticity using White (1980). The complete data set and copies of additional estimations are available from the authors upon request.

The first set of results includes all races from 1992 through 2001. As shown in Table 1, except for the first column, where we include no control variables, the restrictor-plate variable is always significant at the 1% level. This confirms our suspicion that restrictor plates lead to more wrecked cars. The data predict 3.5 more wrecks per race on average, reducing the normal 43 car starting

Table 1. Basic Regression Results on Number of Wrecks in a Race—All Races 1992–2001

	(1)	(2)	(3)	(4)	(5)	(6)
Restrictor plate	2.502**	3.149***	3.883***	3.906***	3.830***	3.856***
	(2.212)	(3.499)	(4.190)	(4.235)	(3.906)	(3.941)
Density		0.025	0.015	0.015	0.013	0.013
(cars per track mile)		(0.488)	(0.285)	(0.280)	(0.260)	(0.256)
Rookie		0.188	0.194	0.196*	0.195	0.197*
		(1.507)	(1.582)	(1.605)	(1.589)	(1.612)
Laps run during race		0.012***	0.011**	0.010**	0.011**	0.011**
		(3.011)	(2.287)	(2.248)	(2.313)	(2.262)
Qualifying speed			−0.026	−0.026	−0.025	−0.026
			(1.57)	(1.58)	(1.45)	(1.47)
Winner's starting position				0.013		0.012
				(0.734)		(0.711)
Cars on the lead lap					0.013	0.012
					(0.275)	(0.255)
Constant	0.867	−6.173**	−1.715	−1.741	−2.060	−2.060
	(1.244)	(1.96)	(0.37)	(0.38)	(0.41)	(0.41)
R^2	0.285	0.321	0.326	0.327	0.326	0.328
F-stat	3.359***	3.589***	3.552***	3.460***	3.445***	3.358***
Observations	293	293	293	293	293	293

T-stats in parentheses.
*** Significant at the 1% level.
** Significant at the 5% level.
* Significant at the 10% level.

field by 8%. Density, rookies, and laps all have the expected positive sign; however, only laps is consistently significant across the results presented in Table 1. The qualifying speed has a negative sign, suggesting that speed is not a cause of wrecks; however, it is not only insignificant, but also the coefficient is very small. Measuring –0.017 on average, the coefficient implies that a decrease in the qualifying speed of 1 mph increases wrecks by 0.017 per race. In order to actually increase the number of wrecks by 1, qualifying speed would have to decrease by nearly 60 mph. Therefore, despite the unusual sign on the variable, qualifying speed has virtually no effect on the number of wrecks.

Finally, the competition variables, the winner's starting position, or the number of lead lap cars, though assuming the expected positive sign, have no significance. We ran a number of different specifications for this version of the model with similar results: The restrictor-plate variable is always positive and significant, and all variables, except qualifying speed, have predictable signs. We report only a few of these outcomes in Table 1.

The second set of results covers only tracks greater than 2 miles in length for the years 1992 through 2001, eliminating smaller tracks where speeds are slower than on the superspeedways, and including the California, Daytona, Indianapolis, Michigan, Pocono, and Talladega raceways. These results are shown in Table 2. Because we are dealing with only 3 different-sized tracks (2, 2.5, and 2.66 miles) and 2 different mileages (400 and 500 miles), the miles and laps variables show little useful variation and are dropped. In columns 1–3, the sample covers the years 1992–2001. Here, the restrictor-plate variable continues to be positive and significant. Restrictor-plate races experience, on average, 2.8 more wrecked cars than non-plate races, taking out 7% of the drivers. We notice that all remaining variables, though taking on the expected signs, fail to display any significance. Of

Table 2. Basic Regression Results on Number of Wrecks in a Race—Tracks 2 Miles and Longer

	1992–2001			1981–2001		
	(1)	(2)	(3)	(4)	(5)	(6)
Restrictor plate	3.175***	3.374***	3.382***	1.700**	2.639***	2.633***
	(2.577)	(2.795)	(2.807)	(1.964)	(3.041)	(3.021)
Density (cars per track mile)		0.017	0.015		0.137*	0.133*
		(0.493)	(0.431)		(1.924)	(1.894)
Rookies		0.148	0.157		0.197	0.202
		(0.453)	(0.474)		(1.125)	(1.169)
Qualifying speed		0.003	0.003		0.038	0.038
		(0.346)	(0.300)		(1.335)	(1.325)
Winner's starting position			0.006			0.012
			(0.133)			(0.332)
Constant	0.753	−0.440	−0.426	3.769***	−12.900*	−12.836*
	(0.437)	(0.16)	(0.15)	(2.955)	(1.75)	(1.72)
R^2	0.226	0.229	0.229	0.340	0.351	0.352
F-stat	1.496	1.218	1.140	2.953***	2.727***	2.624***
Observations	93	93	93	176	176	176

T-stats in parentheses.
*** Significant at the 1% level.
** Significant at the 5% level.
* Significant at the 10% level.

particular note, the sign on the qualifying speed variable becomes positive. This means that perhaps speed does matter once the size of the tracks, and consequently, the attainable speeds increase. When we expand the sample to include races from 1981 to 2001 (columns 4–6), we find that the restrictor-plate variable continues to exhibit a positive and significant result, and density is marginally significant. The remaining variables, rookies, qualifying speed, and the winner's starting position, have the expected signs, but possess no explanatory power. (We ran the regressions using the other competitive measures noted earlier and reached almost identical conclusions).

The final sample looks only at Daytona and Talladega races. By using data that cover 1981 through 2001, we can explicitly focus on the effects of restrictor plates at these tracks pre- and post-adoption. Again, because we are dealing with only two tracks, the miles and laps variables show little useful variation and are dropped. Because density is calculated using track length, it is dropped as well. The restrictor-plate variable is still positive and significant, as observed in all columns of Table 3. Here, we observe an increase in wrecked cars of between 5.3 and 6.5 per race, taking out between 12% and 15% of drivers. Thus, other things being equal, there were more wrecked cars after restrictor plates were adopted than before. None of the other control variables are statistically significant.

These results lead us to two conclusions. First, it seems that as Lave (1985) observed, it is not speed that kills (cars in this case, not people). Qualifying speed as a proxy for speed varies in sign depending on the sample used and is never significant in determining wrecks. Second, variance is very important, especially at the high speeds attained by NASCAR drivers. In this controlled setting, it is variability that preserves cars. When the vehicles are bunched up during restrictor-plate racing, more cars are involved in accidents, as shown by the consistent positive sign on the density variable and by the positive and significant results for the restrictor-plate variable.

Table 3. Basic Regression Results on Number of Wrecks in a Race—Daytona and Talladega Tracks Only (1981–2001)

	(1)	(2)	(3)
Restrictor plate	6.500*** (3.355)	5.430** (2.091)	5.322** (1.993)
Rookies		−0.235 (0.76)	−0.265 (0.80)
Qualifying speed		−0.023 (0.30)	−0.014 (0.19)
Winner's starting position			0.032 (0.514)
Constant	3.907*** (3.118)	10.358 (0.698)	8.869 (0.599)
R^2	0.313	0.496	0.513
F-stat	1.346	2.418	2.442
N	84	84	84

T-stats in parentheses.
*** Significant at the 1% level.
** Significant at the 5% level.
* Significant at the 10% level.

5. Results of Modeling Injuries

We ran a separate version of the model to examine indirectly the "speed kills" argument. Driver fatalities are rare and tragic events not susceptible to statistical analysis due to small-numbers problems. (Three drivers were killed during Winston Cup races from 1981 through 2001). A much larger number, 68, suffered injuries, and this variable is more amenable to statistical analysis.

In our sample, at most two drivers were injured in a given race. Typically, a race with reported injuries involved only one driver being injured. Thus, we ran an ordered probit model based on the following form:

$$\text{Injury} = \Phi X + \tau + \varepsilon \ . \tag{2}$$

X is the same vector of control variables as in Equation 1 with one exception: We also include the number of wrecked cars in a race, as that may pick up the effects of the descriptive variables as they predict the number of accidents. We include both the year and track dummies in all specifications. The results are displayed in Table 4.

Columns 1 and 2 of Table 4 focus on the sample that comprises all tracks from 1992 to 2001. The reported results show that only wrecks is a significant predictor of injuries. No other variables possess predictive power.

Columns 3 and 4 of Table 4 examine the sample of races on tracks that are 2 miles and longer and that ran from 1992 to 2001. Here the same pattern persists. "Wrecks" is a strong predictor of injuries. However, in column 3, we see that, though not significant, the restrictor-plate variable is negative, indicating that restrictor-plate races actually have fewer injuries during this time span when compared to other tracks 2 miles or longer. Thus, it appears that whereas drivers are observing more wrecked cars at the restrictor-plate races, those wrecks are not as dangerous to the drivers. Additionally, the qualifying speed variable is negative, downplaying the "speed kills" argument.

Columns 5 and 6 expand the 2-mile-track sample to include races from 1981 through 2001. The results are again consistent with the other samples. In column 5, "Wrecks" is a significant and positive predictor of injuries. Additionally, qualifying speed is also negative and significant, diminishing yet again the "speed kills" position. As shown in column 6, once "Wrecks" is removed from the equation, density becomes significant and qualifying speed becomes less significant.

Table 4. Ordered Probit Results for Injuries

	All Races 1992–2001		2 Miles 1992–2001		2 Miles 1981–2001		Daytona and Talladega	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Restrictor	−0.518	0.053	−0.065	4.545	−1.405	−0.211	6.285	5.883
plate	(0.433)	(0.932)	(0.987)	(0.176)	(0.242)	(0.837)	(1.000)	(1.000)
Density	−0.017	−0.015	0.570	1.260	0.713	1.074**	1.393	1.986**
	(0.684)	(0.703)	(0.527)	(0.103)	(0.180)	(0.025)	(0.189)	(0.038)
Rookies	−0.024	−0.007	−0.033	−0.088	0.115	0.088	0.379	−0.064
	(0.820)	(0.946)	(0.890)	(0.668)	(0.426)	(0.495)	(0.327)	(0.844)
Qualifying	0.053	0.035	−0.045	−0.020	−0.076**	−0.053*	0.047	0.012
speed	(0.123)	(0.233)	(0.360)	(0.607)	(0.040)	(0.096)	(0.803)	(0.944)
Wrecks	0.191***		0.430***		0.319***		0.427***	
	(0.000)		(0.000)		(0.000)		(0.002)	
Constant	11.360	−7.568	−5.036	22.913	−11.252	−21.218	−46.961	−43.731
	(0.084)	(0.180)	(0.803)	(0.173)	(1.000)	(1.000)	(1.000)	(1.000)
Observations	293	293	92	92	175	175	83	83

Chi-squares in parentheses.
*** Significant at the 1% level.
** Significant at the 5% level.
* Significant at the 10% level.

Table 5. Summary Statistics

	Mean	Median	Maximum	Minimum	Observations
Density (cars per track mile)	31.44147	27.27273	81.74905	14	408
Injuries	0.167076	0	2	0	408
Laps run	286.3759	267	500	51	408
Number of cars on the lead lap	12.002	11.000	43	1	408
Qualifying speed	155.5503	165.217	212.809	0	408
Restrictor plate	0.135135	0	1	0	408
Rookies	3.39312	3	11	0	408
Winner's starting position	8.277641	5	39	1	408
Wrecks (i.e., cars wrecked)	3.488943	3	17	0	408

Finally, in columns 7 and 8 we observe the Daytona and Talladega tracks from only 1981 through 2001. Once again, in Column 7 "Wrecks" is a positive and significant predictor of injuries. Neither the restrictor plate nor the qualifying speed variables have an impact on injuries. When the "Wrecks" variable is removed from the model, the restrictor-plate variable again fails to have any significance, whereas density becomes significant. Table 5 provides sumary statistics of the data.

Throughout the results, the restrictor-plate variable is often negative but never possesses a significant sign. Thus, it would seem that the "speed kills" argument becomes more convincing. Relative to other races, restrictor-plate races have no measurable increase in driver injuries, despite the fears of drivers themselves; however, because the speed variable has no significance, the "speed kills" argument cannot be sustained. If, as the results of Equation 1 show, there are more wrecked cars at restrictor-plate races, at least the drivers are able to walk away from them.

6. Conclusions

NASCAR fans have become accustomed to the close fender-to-fender racing that accompanies short, bullring-type tracks. Short-track wrecks, though frequent, usually occur at speeds too slow to injure the drivers or to knock a car completely out of a race. However, at the larger superspeedway tracks, where drivers can reach speeds beyond 190 mph, a wreck could have serious consequences to both man and machine. The advent of restrictor plates to slow cars down has, in effect, moved the short-track bunching to the larger tracks, where a fender tap can leave 20 cars piled up in a twisted mess.

NASCAR's official position is that restrictor plates make the races safer for the fans. Drivers agree, but worry about their own safety as wrecked cars appear to proliferate during restrictor-plate racing. Our results confirm the drivers' concerns about collisions. Based on our model, wrecks that eliminate drivers from a race are more prevalent during a restrictor-plate event, indicating that the lower the variance in driver speeds on the track, the more unpleasant the consequences. This result seems to oppose the highway safety literature; however, it is important to remember that in NASCAR races, variance is often a miniscule distance between cars, whereas on the highway it means multiple yards. When viewed from this perspective, our results confirm the importance of variance between cars. Lave (1985) shows that variance on highways saves lives. In NASCAR, variance saves cars. However, as NASCAR advances safety features within the cars, the accompanying increase in accidents does not appear to lead to a significant increase in driver injuries. Overall, this yields a favorable outcome for NASCAR as fans enjoy the wrecks, and the drivers usually walk away.

References

Associated Press. 2001. Drivers vent anger toward NASCAR. News Release, 21 October.

Chirinko, Robert S., and Edward P. Harper, Jr. 1993. Buckle up or slow down? New estimates of offsetting behavior and their implications for automobile safety regulation. *Journal of Policy Analysis and Management* 12:270–96.

Duskey, Gaylen, for Turner Sports Interactive. 2001. Do restrictor plates harm or help? Accessed 5 May 2004. Available www.nascar.com/2001/NEWS/10/24/duskey_column/.

Fielden, Greg. 1990. *Forty years of stock car racing: The modern era 1972-1989.* Surfside Beach, SC: Garfield Press.

Fielden, Greg. 1994. *Forty years plus four 1990-1993: First supplement to the forty years of stock car racing series.* Surfside Beach, SC: Garfield Press.

Forester, Thomas H., Robert F. McNown, and Larry D. Singell. 1984. A cost-benefit analysis of the 55 mph speed limit. *Southern Economic Journal* 50:631–41.

Fowles, Richard, and Peter D. Loeb. 1989. Speeding, coordination, and the 55-mph limit: Comment. *American Economic Review* 79:916–21.

Graham, John D., and Steven Garber. 1984. Evaluating the effects of automobile safety regulation. *Journal of Policy Analysis and Management* 3:206–24.

Lave, Charles A. 1985. Speeding, coordination, and the 55 mph limit. *American Economic Review* 75:1159–64.

Lave, Charles A. 1989. Speeding, coordination, and the 55-mph limit: Reply. *American Economic Review* 79:926–31.

Lave, Charles A., and Patrick Elias. 1997. Resource allocation in public policy: The effects of the 65-MPH speed limit. *Economic Inquiry* 35:614–20.

Levy, David T., and Peter Asch. 1989. Speeding, coordination, and the 55-mph limit: Comment. *American Economic Review* 79:913–15.

Peltzman, Sam. 1975. The effects of automobile safety regulation. *Journal of Political Economy* 83:677–726.

Risa, Alf Erling. 1994. Adverse incentives from improved technology: Traffic safety regulation in Norway. *Southern Economic Journal* 60:844–57.

Robertson, Leon S. 1977. A critical analysis of Peltzman's 'The effects of automobile safety regulation.' *Journal of Economic Issues* 11:587–600.

Snyder, Donald. 1989. Speeding, coordination, and the 55-mph limit: Comment. *American Economic Review* 79:922–5.

Sobel, Russel S., and Todd M. Nesbit. 2003. Automobile safety and the incentive to drive recklessly: Evidence from NASCAR. West Virginia University Working Paper 03-01.

White, Halbert. 1980. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica* 48:817–38.