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Truck drivers and drugs: impact of mandatory drug testing on safety on Brazilian highways

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Abstract

This study evaluates the impact of the mandatory drug test requirement for truck and bus drivers on traffic accidents on Brazilian highways from 2010 to 2020. Employing the difference-in-differences approach, the results reveal a significant reduction of 12.9% in accidents involving heavy vehicles on Brazilian highways. Although no statistically significant relationship was found with the mortality rate, the decline in accident rates underscores the significance of public policies aimed at enhancing traffic safety.

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1. Introduction

There are more than 5,000 deaths on Brazilian federal roads each year. Traffic accidents also can result in permanent disability, serious injuries to people, material damage to infrastructure, loss of cargo, hospital costs and congestion. Given this reality, this study evaluates the impact of a new law in Brazil (Law 13,103 of March 2nd, 2015) regarding the requirement for drug tests for truck and bus drivers on the rates of accidents and mortality on Brazilian highways.

To investigate the causal impact of the requirement for drug tests on traffic safety, the Difference-in-Differences (DiD) approach was used to compare data (from 2010 to 2020) on accidents involving heavy vehicles, before and after the test requirement.

This article is structured as follows: section 2 presents the context. Section 3 presents the empirical strategy used and the data. Section 4 presents the results, and section 5 the conclusion.

2. Contextualization

Among the causes of traffic accidents, those resulting from human behavior stand out, such as fatigue, drowsiness, and drug use (Drummer et al, 2004; Ogden and Moskowitz, 2004; Singh, 2018; Useche et al, 2022). In 2015, a study was released in Brazil (CNT, 2016) indicating that drugs were being widely used by drivers, especially among professionals. Bombana et al (2017) evaluated 762 randomly selected drug tests carried out on Brazilian truck drivers and identified that, of the total sample, 5.2% tested positive for drugs, mainly cocaine (2.8%) and amphetamines (2.1%).

In a systematic literature review, Girotto et al (2014) summarize the scientific evidence on the prevalence of psychoactive substance use and the factors associated with their intake among truck drivers in many countries. They find that the most frequent factors associated with the use of alcohol, amphetamines, marijuana, and cocaine are younger age, higher income, longer trips, driving in the night shift and fewer hours of rest. In a study of drivers in Norway, Gjerde et al (2012) identified the presence of alcohol or drugs in 1.9% and 6.6% of the samples from truck drivers and car/van drivers, respectively. In a study in Spain (Alcañiz, Guillen and Montserrat, 2021), marijuana (5.6%) and cocaine (3.5%) were the most detected drugs.

Regarding the literature on the effects of drug testing in the workplace on accident and death rates, Pidd and Roche (2014) performed a systematic review of studies carried out between 1990 and 2013. Of the 23 studies found, only one used a rigorous and robust methodology. That study (Brady et al, 2009) found that implementation of the mandatory alcohol testing programs was associated with a 23% reduced risk of alcohol involvement in fatal crashes by motor carrier drivers.

Most studies, however, evaluate the results of exams required by the employing company, and for few toxic substances (mostly for the alcohol exam). Differently, the Brazilian exam is required for all those who wish to drive heavy vehicles (buses and trucks), from 2015 onwards, regardless of their affiliation to any company. It is worth mentioning that, in 2019, self-employed drivers represented 67% of professional drivers in Brazil.

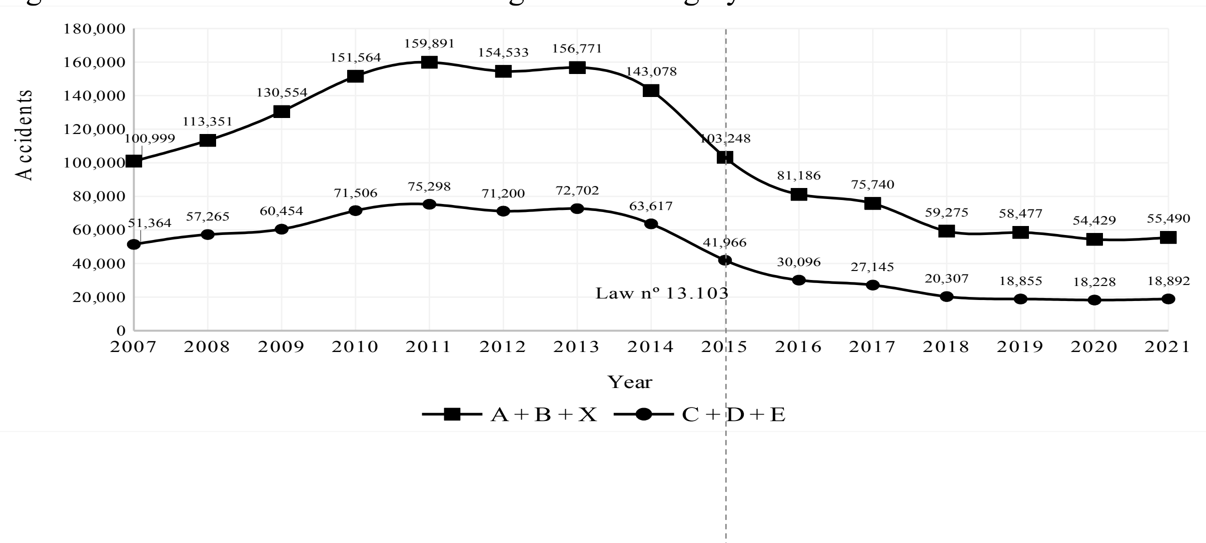
In addition, as commented in Jacobson (2003), in USA the exam is taken in many situations: preemployment, reasonable-cause, random, periodic, and postaccident. On the other hand, in Brazil, it is the driver himself who schedules his test, providing time to get clean from drugs. The treatment event (Law of drug testing) is our strategy for identifying effects, unlike other methods based on the requirement of a random sample of drug testing.

According to Brazilian regulations, there are 5 categories of driver's licenses: A, B, C, D, and E. Drug tests were only instituted for the driving of heavy vehicles, corresponding to categories C, D, and E, which should be carried out when obtaining and renewing the National Driver's License – NDL. The law requiring drug testing was published in March 2015, and was expected to come into force in 90 days. However, due to various operational reasons, the tests started to be carried out at the beginning of 2016, for drivers and applicants whose licensing processes had not yet begun. A dissuasive effect was expected since the publication of the law, therefore the date of 2015 as the year of occurrence of the treatment in this paper.

Based on data from traffic accidents on federal highways, which are annually published by the Federal Highway Police, *Polícia Rodoviária Federal* (2022), it is possible to observe similar trends in the quantities referring to the two groups of vehicles (whose drivers were affected or not by the requirement of drug testing) in recent years.

Figure 1 below shows the number of traffic accidents for each year between 2007 and 2021. They were grouped according to the driver's required NDL category for the involved vehicle in the accident.

Figure 1: Number of accidents according to each category of driver´s license



Note: category X refers to the authorization to drive a moped. C, D or E are categories of heavy vehicles (trucks, buses and other vehicles exceeding 3,500 kg).

Based on the data obtained from the National Traffic Department - *Secretaria Nacional de Trânsito* - we show the number of drug tests already performed (table 1). During the evaluated period, 162,790 drivers tested positive for toxic substances, which prevented them from obtaining or renewing their driver's licenses. It is reasonable to assume that if some of these disqualified drivers continue to drive, they could contribute to an increase in the number of traffic accidents.

Regarding the percentage of positive test results, we understand that the variation in the percentage is not relevant, except for the year 2020. In this year, after the beginning of the Covid pandemic, there was a determination by the National Traffic Council (Resolution n. 782, of June 18, 2020) to suspend the carrying out of exams and extending the validity of driver's licenses that are expiring. This led to a reduction in the number of exams and in the proportion of positive tests, which can be explained by drivers who use drugs opting not to undergo these tests.

Table 1: Drug tests carried out after Law 13,103 of 2015.

Year	Negatives	Positives	Quantity of drivers	% of Positives
2016	1,061,188	20,361	1,081,549	1.88%
2017	1,931,024	43,470	1,974,494	2.20%
2018	1,815,472	42,016	1,857,488	2.26%
2019	2,089,789	44,216	2,134,005	2.07%
2020	1,701,239	27,955	1,729,194	1.62%
Total	**8,598,712**	**162,790**	**8.776.730**	

As mentioned, drug tests were only instituted for the driving of heavy vehicles, which should be carried out when obtaining and renewing the National Driver's License – NDL. The regulation from the traffic council authority requires that this examination has a minimum detection window of ninety days. If there is drug consumption within 90 days prior to the examination, it will be detected in the test. The substances to be tested are amphetamines, mazindol, cannabinoids, cocaine, and opioids.

Requiring 90 days without drug use already imposes an effort to reduce consumption, so at least during this period, drivers will be driving without drug use if they want to obtain a driver's license renewal. There is also the potential effect of excluding drivers who undergo the test and test positive for the substances from the market. These drivers will no longer be operating on the roads for at least the next 3 months (when it will be possible to take a new test and try again for renewal).

3. Methodology

3.1. Empirical strategy

To achieve the proposed objective, we will adopt the quasi-experimental difference-in-differences approach. Some recent studies highlight that the commonly used two-way fixed effects (TWFE) DiD estimates are inconsistent in specifications with multiple periods, especially when there is heterogeneity in treatment effects and variation in treatment timing (Roth et al., 2023). According to these studies, the presence of heterogeneity in the treatment effect and variation in treatment timing can violate the assumption of strict exogeneity and lead to estimates with the opposite sign of the expected effect. In addition, the static DiD specification with TWFE can generate inadequate comparisons between treated units and units that become control units again. Similarly, the dynamic DiD with TWFE, which uses leads and lags of the treatment, can generate biased coefficients due to contamination from other leads and lags and inadequate comparisons.

To address these limitations, recent studies propose alternative estimators that are robust to heterogeneity in treatment effects and variation in treatment timing. Therefore, we will use the estimator proposed by Callaway and Sant'Anna (2021), which allows for estimating the average treatment effect in the treated group at the time $(ATT(g,t))$ and considers heterogeneity in treatment effects and variation in timing.

Finally, a test for pre-treatment parallel trends is performed, which considers more information than simply checking whether $ATT(g,t)$ is statistically significant for the pre-treatment period. The test is based on a regression that includes the variable of interest, time, and a dummy variable indicating whether the unit is in the treatment or control group. If the coefficient of the interaction between the treatment variable and time is not significant, we can have more confidence in the results of the DiD estimator. Otherwise, we would be dealing with a selection bias that needs to be appropriately addressed.

3.2. Data

The period in this study covers the years 2010 to 2020. In order to evaluate the impact of the law that requires drug tests for heavy vehicle drivers, data were collected for sections of federal highways granted to nine concessionaires. The choice of granted sections was based on the availability of accident and traffic volume data provided by the National Land Transport Agency (Antt, 2022). The database used was the entire database available for federal highways. On non-concession highways, traffic volume data are not available, which made it impossible to incorporate them into the study. We understand that there is no prejudice to the study carried out because we do not see any explanation for the effect of the toxicological examination being different for highways not granted to the private initiative, in relation to those granted.

To define the individuals (for the data panel) who are subject to the law's intervention, data on accidents, traffic volume, and deaths involving heavy and light vehicles were separated for each section of highway. Consequently, the treatment group is composed of the interaction between heavy vehicles and highway sections, while the control group is formed by the interaction between light vehicles and highway sections.

In addition, the dependent variable used was the accident (or death) rate, which neutralizes the influence of traffic volume. This indicator is calculated by dividing the number of accidents (or deaths) by the traffic volume. No enforcement actions or educational campaigns focused on a specific group of vehicles were identified during the analyzed period. Table 2 presents the descriptive statistics of the data set. Figures 2 and 3 show the graph of parallel trends (in logarithms) for the death and accident rates. We counted accidents and deaths that involved both a light and heavy vehicle in the two groups (control and treatment).

Table 2: Descriptive statistics of the data

Variáveis	**n.**	**Mean**	**S.d.**	**Min**	**Max**
		Treatment group			
Accidents	99	1441.14	1089.45	198	4399
Deaths	99	44.94	27.79	8	111
Traffic volume	99	12.889.748	10.356.795	2.733.662	32.481.870
		Control group			
Accidents	198	2282.89	2535.53	117	9265
Deaths	198	38.31	33.63	1	150

Traffic volume	198	12.307.878	17.337.765	147.118	62.205.599

Figure 2: Parallel trends (in logarithms) for accident rates.

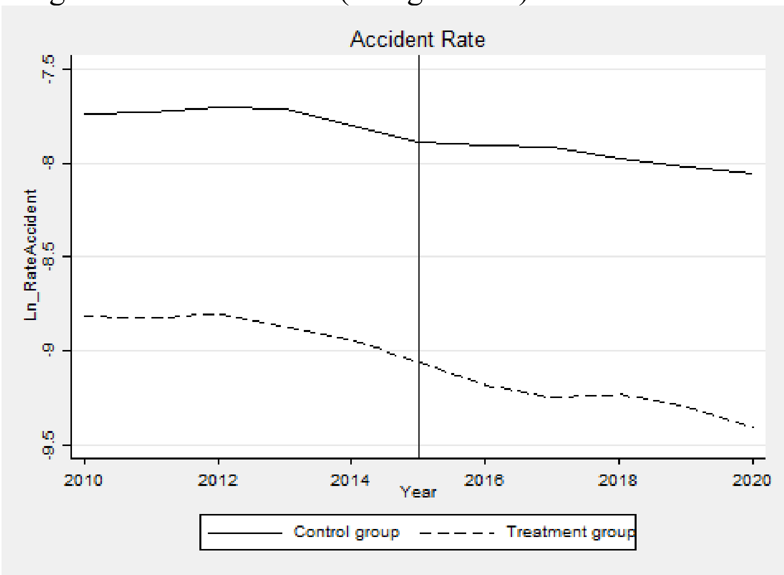
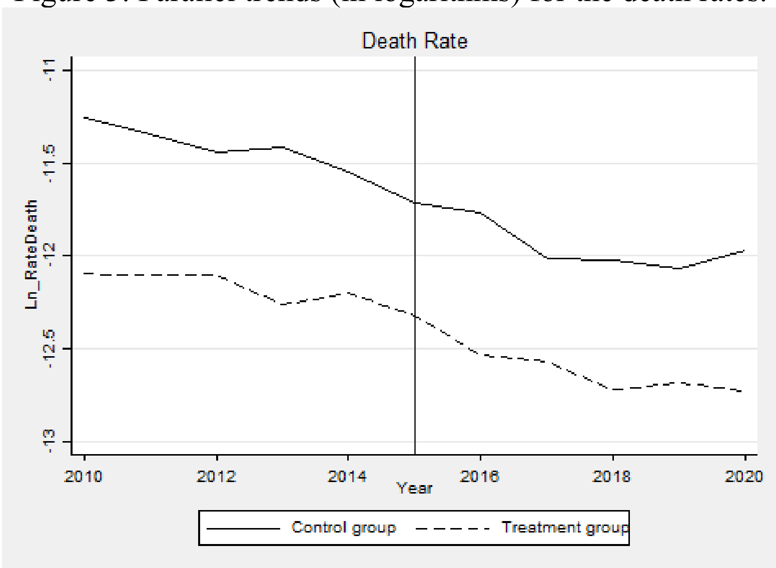


Figure 3: Parallel trends (in logarithms) for the death rates.



4. Results

The results are presented in table 3. Models (1) and (4) show the results for the Callaway and Sant'Anna (2021) estimator using linear regression, while models (2) and (5) show the results using the doubly robust method. Models 3 and 6 show the results for the conventional TWFE estimator.

According to the results, there was a 12.9% decrease in the incidence of accidents involving heavy vehicles on Brazilian highways, using Callaway and Sant'Anna (2021) estimator. With the TWFE estimator, the impact is a 19.1% reduction in accidents. The impact estimates were adjusted by the equation 100*[exp(β)-1], as it is a log-lin model with a dummy variable, as proposed by Giles (2011).

However, no statistically significant relationship was observed with the mortality rate in all models. Furthermore, the pre-parallel trends test showed that there were no divergences between the treatment and control groups, allowing for the establishment of a causal relationship between the implementation of the drug test provided by the law and the reduction in the incidence of accidents.

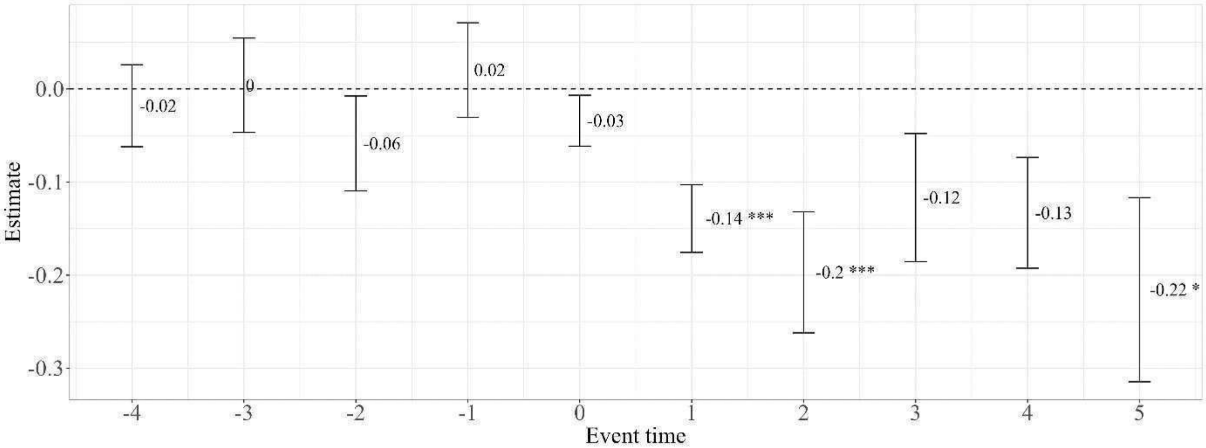
Table 3: Impact of Law 13.103/2015 (drug examination).

	Accidents (1)	Accidents (2)	Accidents (3)	Deaths (4)	Deaths (5)	Deaths (6)
Law 13.103/2015	**-0.138*****	**-0.138*****	**-0.212*****	-0.014	-0.014	0.024
	(0.05)	(0.08)	(0.05)	(0.09)	(0.11)	(0.08)
Specification	REG	DR	TWFE	REG	DR	TWFE
Pre-test (P-value)	0.80	0.80	-	0.32	0.32	-
N	297	297	297	297	297	297

Note: Significance levels are represented by *** p<0.01; ** p<0.05, * p<0.1; the value in parentheses represents the robust standard error. Models 1, 2, 4 and 5 were estimated with Callaway and Sant'Anna (2021) estimator. The dependent variable is calculated by dividing the number of accidents (or deaths) by the traffic volume. Dependent variable is in logarithm.

Figure 4 illustrates the findings of the study on the impact of Law 13,103/2015 on the accident rate, employing the event studies approach to visualize the law's effects on pre- and post-intervention periods. The results reveal that the effects were only observed in the years 2016, 2017, and 2020.

Figure 4: Impact of Law 13,103/2015 (drug examination) on the accident rate



Note: Significance levels are represented by *** p<0.01; ** p<0.05, * p<0.1.

Regarding the effects in the years 2018 and 2019, in Figure 2, the coefficient resulted in a negative effect of -0.12 and -0.13 (reduction in accidents), but without statistical significance. The event study for the effect of each year can normally generate greater variations, given the individualization of the effects, however we understand that the results do not contradict the evaluation obtained: there is a causal effect of reduction in accidents after the Law after the requirement of toxicological examination.

5. Conclusion

The analysis of the results presented in table 3 and figure 4 reveals that the requirement for drug testing for heavy vehicles drivers had a significant impact on reducing the accident rate involving these vehicles on Brazilian highways. Although no statistically significant relationship was observed with the death rate, the result highlights the importance of public policies aimed at improving road safety. It is not unlikely that many drivers will refrain from using inappropriate substances for several months prior to license renewal or may even decide not to renew their licenses altogether.

Using an estimate of cost per accident (without death) from a study by the Institute of Applied Economic Research – IPEA (Carvalho, 2014), a Brazilian government agency, it is possible to calculate the avoided cost due to the reduction in accidents. With the cost of US$ 43,190 (US dollars) per accident, and the 12.9% reduction in road accidents in Brazil, we calculated the annual avoided cost of 105 million US dollars per year. It should be noted that, as the IPEA calculation is an average of the cost per accident involving light or heavy vehicles, it is an underestimated calculation when applied to accident involving heavy vehicles.

It would be interesting, additionally, to deepen the study to identify the reasons why a significant result in the number of deaths was not observed.

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