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Speeding control and accidents in the Peruvian central road

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A B S T R A C T

The Central Road is the most connected road between the capital and cities of the jungle and the highlands in Peru. Nowadays, this road suffers from intense traffic jams that excessively delay time travel. Moreover, it is vulnerable to closures due to natural and human factors. Also, there is a proliferation of reckless drivers who do not care about speeding and cause terrible accidents. Hence, the current research explores whether the speeding record affected the occurrence of accidents on this road. After applying the Logit regression, it was possible to find that only recording speeding beyond 30 kilometers per hour over the limit was relevant to prevent accidents. It was also suggested that the speedometer should track 24 hours a day along with measures to improve the infrastructure of this road.

1. Introduction

Every day more than three thousand people worldwide die in car accidents (World Bank, 2017). It is widely known that these events destroy almost every life involved. It often requests innocent people's lives (Mincă et al., 2013). It can also be even deadlier than complex illnesses like cancer, aids, or covid (Kulkarni, 2020). Hence, it is a public health issue that must be examined for the wellness of society (Gopalakrishnan, 2012).

Driving requests, the best attention from drivers. Then, all senses must be put into this dangerous activity (Fisa et al., 2022). Since most car accidents are due to human failure, defensive driving is crucial to diminish the probability of a bad event (Ho & Gee, 2008). Car accidents can indeed be due to mechanical failure (Montero). However, reckless attitudes when driving still is a significant cause of road accidents (Topol & Drahotský, 2017). It was also stated that age was a possible factor in dangerous driving since drivers involved in this event were young (Ho & Gee, 2008). Among all the potential risk factors to determine a possible relationship with car accidents, like the research of Stanojević et al. (2013), there is only available data regarding one of the most dangerous attitudes while driving, i.e., speeding. The Peruvian security agency provides this data on the roads called SUTRAN.

Data about car accidents is necessary for a country where getting cancer might be safer than being involved in a car accident (Instituto Nacional de Estadística e Informática, 2016). This data is available in *Portal de Datos Abiertos* (Superintendencia de Transporte Terrestre de Personas, 2021a). Lima takes most of the car accidents in the Peruvian capital and biggest city; however, the deaths happen on Peruvian roads (Instituto Nacional de Estadística e Informática, 2016).

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Peru has been experimenting with economic growth never seen before since 1993. Hence, its road infrastructure cannot handle the demand of this emergent economy (Bonifaz et al., 2020). Additionally, the design of the road system does not follow the international norms about crossing or the number of lanes (Instituto Peruano de Economía, 2019). This lack of security measures might be an enabler of road accidents because the environment of the areas near the national road systems is dangerous (Commission for Latin America and the Caribbean, 2020). A road that combines outdated infrastructure along with a massive gap between the demand and offer is the Carretera Central [henceforth Central Road].

This road is classified as a national highway, although in practice, it is far from being a highway and is given the code PE-22 (Alarcón, 2016). It starts in Lima and continues its trace penetrating the Andean mountain range connecting the capital with the cities in the highlands and jungle. Besides, the Central Road is employed to transport minerals and workers since many essential mines are located near this road. This activity is responsible for more than 10% of the Peruvian GDP and one-quarter of all the national exports (Instituto Peruano de Economia, 2017).

Although there is a railway next to the road, it is mainly employed for freight transport. Hence, people should transit on this dangerous and congested road exposing their lives to an accident almost daily (Superintendencia de Transporte Terrestre de Personas, 2021b). Due to the characteristics of this road, there are locations where it is only possible to pass one truck. When accidents happen, the whole route is closed, generating travel hours of more than twelve hours for only 182 kilometers. Although the road is saturated and designed for the traffic of half of the past century, some reckless drivers speed over the limits to gain time on this challenging road.

Consequently, accidents are daily, and most of the time, mortals. Therefore, is there an actual link between the speeding record and accidents on Central Road? This research aims to analyze a possible link between speeding and road accidents on this vital road.

2. Literature review

Worldwide, speeding is an issue that is a reason for debate. Some specialists claim that low-speed limits can significantly reduce road accidents (Richards, 2010). In a country with few properly designed roads, speed limits are as follows: 80 kilometers per hour for trucks, 90 kilometers per hour for public transport, and 100 kilometers per hour for little cars. The fine for overspeeding is more than 250 dollars and can result in the driver's permission suspension. However, on Central Road is challenging to get to those speeds since the roads' design and the traffic permit only 20 kilometers per hour (Mendieta & Suito, 2017). However, accidents commonly happen when there are hurry drivers who Overspeed in areas where it converts into a high-risk activity to gain time.

In similar studies, Malyshkina & Mannering (2008) studied the relationship between speed limits and American road safety. They encountered no high effect on speed limit ranges and the severity of road accidents. Furthermore, even speed limits might have led to more accidents. A similar feeling was found by Alonso et al. (2013) since this study encountered that drivers felt that speed limits were too low, but the fines were too high to take the risk. However, they were not reluctant to take risks in places where vigilance was scarce.

The violation of the norms was not uncommon in the research of Goldenbeld et al. (2011). They stated that drivers who went beyond the speed limits had more probability of being involved in car accidents than those who were more responsible. The vigilance of roads seems to be a factor in preventing speeding, as Yannis et al. (2007) found that controlled roads had lower car accidents than non-supervised roads.

Speedometers are the most employed tool to control and fine overspeeding drivers. Although some are strategically placed on the South Pan American road outside Lima, they are pretty scarce on the Central route. Something constant is the vigilance of police to prevent surpassing continuous lines, which is prohibited. When there is speeding control, the crew of the Sutran is in charge.

The actual effect of this measure was studied around the world. Kloeden et al. (1997) encountered that on roads with limits of sixty kilometers per hour, drivers who surpassed this limit had more probability of suffering or causing a road accident than those who prefer to be within the limit. Therefore, it is widely believed that speeding control is the magic prescription for preventing road accidents, as the research of Gerald et al. (2022) stated. Nonetheless, Silvano (2016) encountered that the reduction of speed limits did not have the expected impact on the driver's head. Hence, Factor (2014) explained that speeding was not only a deliberate behavior but might be influenced by other determinants like biological needs, emergencies, or tiredness. In consequence, speed control can or not be determinant for explaining car accidents on roads like de Central Road, where drivers are pushed to take risky attitudes to get in time.

3. Methodology

This investigation harnessed the data set about road accidents and speed detection on Central Road during 2020-2021. This dataset was gathered from SUTRAN and is available on the web "Portal de Datos Abierto" (Superintendencia de Transporte Terrestre de Personas, 2021a). Hence the data was longitudinal and recorded each day from January 2020 to October 2021. Of course, there was a gap in data due to the national lockdown for Covid 19. The introduction explains that the Central road is Peru's most crucial penetration road. It connects the capital with the towns in the jungle and highlands. Although short, this road connects more than 50% of the national gross national product (Colegio de Ingenieros - Lima, 2019). Furthermore, its

closure affects many areas of the national economy, like mining, tourism, industry, and agriculture, and risks the food supply for the capital. Hence, it is clear that this road is vital for the national economy.

The database comprises 4 480 registers that combine speeding detection and accidents on this road from 2020 to 2021. Then, it can be stated that there is robust data to arrange a correct analysis.

3.1 Variables

The research employed two variables: the number of accidents and speeding records. The dependent variable will be the number of casualties, while speeding registration will be the independent one. The independent variable was classified into four categories: The first category was the number of speeding records surpassing the speed limit by 10 kilometers per hour. The second was the number of speeding records exceeding the speed limit by 20 kilometers per hour. Finally, the third category was the number of speeding, surpassing the limit by 30 kilometers per hour and beyond. It is necessary to clarify that on Central Road, the speed limit is 35 kilometers per hour when passing urban areas, while in some places it is 75 kilometers per hour. When specified, it is implied that the limit is 100 kilometers per hour for cars, 90 kilometers per hour for buses, and 80 kilometers per hour for trucks and other big vehicles. However, reaching those implied speed limits is difficult due to the design of the road and the usual traffic jam. The dependent variable was assigned the number zero when the records did not show any accident for the day and one if an accident or more happened. This method was taken from the study of Factor (2014). It is necessary to clarify that the technique employed in this research was logistic regression due to the nature of the dependent variable (Fox, 2013).

3.2 Logistic Regression

This regression states that *k* represents the group of observations named: *y1, ..., yk,* and its i-th component can be understood as the realization of the dependent variable,Y_i, with a binomial distribution (Rodriguez, 2007). Therefore, $Y_i \sim B(n_i, \pi_i)$. Where n_i is the binomial denominator, and π_i is the probabilistic denominator. Furthermore, the binomial denominator contains individual data for every *i,* which makes it possible to define the model's stochastic structure. The probability is assumed as a linear predictor function, or $logit(\pi_i) = x_i'\beta_j$. In this equation x_i' represents a covariance vector, while β stands for the logit regression coefficient vector. Additionally, this equation represents the model structure definition. In every logit regression, the logit values are represented by coefficients. Hence, β_j is the logit probability of change in the function of the j-th predictor, and other predictors are kept unchanged (Rodriguez, 2007). When the equation is taken into the exponential, the i-th units are provided by the following equation: $\frac{\pi_i}{1-\pi_i} = \exp\{x_i'\beta\}$. This mathematic representation defines a multiplicative probabilistic model. Hence, after the j-th is shifted, it is feasible to multiply its odds with $\exp\{\beta_j\}$. Hence, $e\exp\{x_i'\beta\}\ \exp\{\beta_j\}$. Consequently, the $\exp\{x_i'\beta\}$ stands for the variable odds ratios. Only after the odds of π_i is gotten, it is compulsory to harness derivates. In consequence, $\frac{d\pi_i}{dx_{ij}} = \beta_j\pi_i(1-\pi_i)$. This final mathematic representation means that the j-th predictor of π_i relies upon β_j and the probability value. Hence, it can finally deliver information about the predictors' odds (Rodriguez, 2007). We should also employ additional statistical tests like the goodness of fit, sensibility, and specificity to ensure we got a correct analysis (Rodriguez, 2007).

4. Results

Table 1
Descriptive statistics

Independent variable	Categories	Mean	Max	Std. Dev.	Dependent variables	Range
Speeding	Speed limit excess by 10 kilometers per hour	1.67	23.00	1.94	Central road accidents	0-1
	Speed limit excess by 20 kilometers per hour	3.19	50.00	1.85		
	Speed limit excess by more than 30 kilometers per hour	3.67	107.00	2.09		

Table 2
Logit regression for North Pan American highway

Regressors	Odds Ratio	Robust Standard Error	z	p>z	95% confidence interval		chi2	p>chi2
Speed limit excess by 10 kilometers per hour	1.08	0.05	1.64	0.10	0.98	1.19		
Speed limit excess by 20 kilometers per hour	1.05	0.04	1.24	0.22	0.97	1.13		
Speed limit excess by 30 kilometers per hour	0.96	0.02	-1.73	0.08*	0.93	1.00		
Constant	1.03	0.10	0.28	0.78	0.85	1.23		
Chi2							10.86	0.01
Pseudo R2	0.0169							
GOF							3.97	0.2649
Sensitivity	41.04%							
Specificity	74.06%							
Correctly	56.18%							

*significant at 10%,** significant at 5%, *significant at 10%

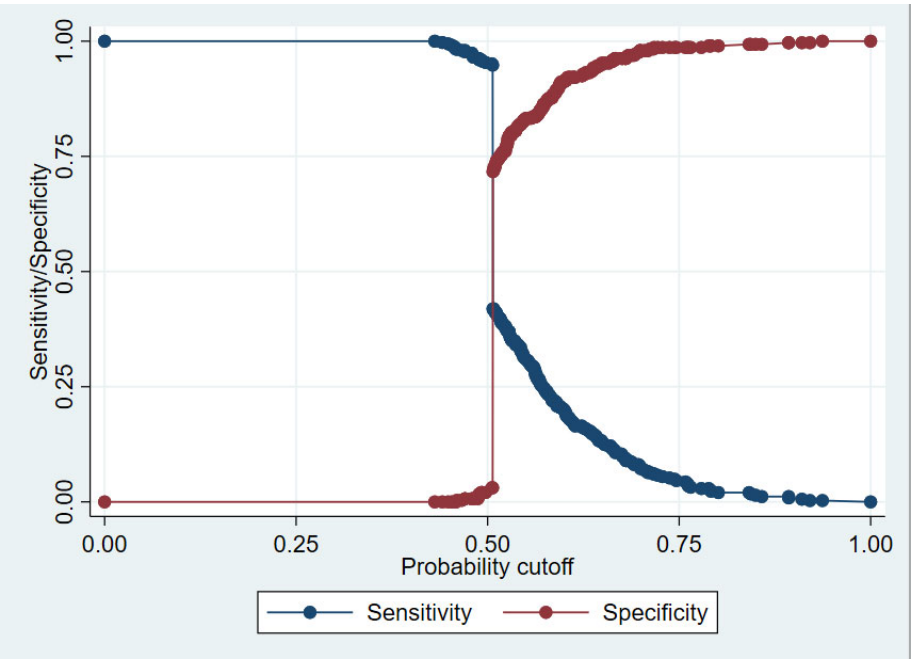

Fig. 1. Cut off value

Table 1 portrays the descriptive statistics for the variables employed in the current investigation. It can be observed that the majority of speeding detection was by more than 30 kilometers per hour, while the lowest was by 10 kilometers per hour. Astonishingly, most speeding cases violated the speed limit by more than 30 kilometers per hour. At the same time, only twenty-three cases surpassed the speed limit by 10 kilometers per hour, and fifty instances ran beyond 20 kilometers per hour over the speed limit. For the dependent variable, it was given a classification according to the happening of the event. In other words, on the days that there were no accidents, it was recorded as zero, while the days that recorded accidents were given a number one. The classification was according to the severity of the speeding according to the Sutran. Hence, the fine would be higher in a case where the speed limit violation was over 30 kilometers per hour than surpassing it by only 10 kilometers per hour (Superintendencia de Transporte Terrestre de Personas, 2022).

Table 2 provides the logit regression applied in the current research, its odds ratio, and its significance. It was seen that the detection of speed limits surpassing 10 kilometers per hour and 20 kilometers did not have any statistical significance. However, speeding detection by more than 30 kilometers per hour reduced the odds of an accident by 4%. This result was statistically significant.

Moreover, the chi2 test implied that in the model, at least one category affected the dependent variable. Furthermore, the goodness of fit test proved that there was not any difference between the expected and observed values. Hence, it was confirmed that the model had a specific predictive power. It is also necessary to state that those values come from a cut-off ratio of 0.53, as shown in Figure 1. Furthermore, this table showed that more than half of the data was correctly classified.

5. Discussion

This research studied the influence of speeding records and accidents on Central Road. Hence, the results showed that only detecting speed excess over 30 kilometers per hour had an inverse effect on accidents. In other words, only seeing relevant speeding helped prevent road accidents. This result is also in concordance with the finding of the descriptive statistics since it portrayed that most speeding car drivers had surpassed the speed limit by more than 30 kilometers per hour.

Additionally, the detection of minimum speeding did not significantly prevent or increase accidents on Central Road. It can indeed have an educational effect, but this research has not proved it. Therefore, the results in this research match with the findings of Malyshkina & Mannering (2008), Kloeden et al. (1997), and Goldenbeld et al. (2011) because those studies stated that only the speeding and detection of certain limits had real effects on the likelihood of having a road accident. Also, as stated before, the Peruvian authority increased the fines according to the grade the speed limit was broken. Hence, it seems that drivers might feel that surpassing the speed limit beyond 30 kilometers per hour or more does not offset the fine they will get, as Alonso et al. (2013) claimed.

Although the control of speeding is not a panacea for avoiding car accidents, it can still prevent some in specific ranges (Gerald et al., 2022). Therefore, only the control of this road's critical zones and heavier fines for drivers who surpass the speed limit by 30 kilometers per hour or more might reduce the high number of accidents on this road (Yannis et al., 2007).

Enforcing the punishment for excessing the velocity by more than 30 kilometers per hour may change the heads of the drivers following the finding (Silvano, 2016). It is also understandable that going 20 kilometers per hour or less due to the constant traffic jam on this road might be maddening (Factor, 2014). However, it is often preferable to lose minutes on the road than lose or making lose lives.

6. Conclusion

The current research aimed to analyze the effectiveness of speeding detection and road accidents on Central road. After applying the logit regression, it was possible to find that it had an effect only when detecting speed limit excess beyond 30 kilometers per hour. At the same time, it was not found to have any significance or impact on recording spending below 30 kilometers per hour. Moreover, the descriptive statistics showed that most speeding drivers surpassed this limit. Therefore, it is plausible to state that it is necessary to re-enforce the penalties for drivers who exceed the limits by more than 30 kilometers per hour. Also, the speeding control should work 24 hours a day and not sometimes, which is something that happens.

It is also understandable that this road has colossal traffic jams and areas where anybody can surpass 20 kilometers per hour due to the outdated design of the road. Therefore, it is also necessary to improve the conditions of this road to prevent desperate drivers. For further analysis, we would recommend using more variables to explain the occurrence of accidents on this road and others. However, it is also necessary to state that data might not be available. Consequently, authorities should focus on providing the required data to analyze this problem and save lives.

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