- γ_t is the temporal fixed-effect term.
- ϵ_{it} is the noise term, which is assumed to follow a Normal distribution with mean 0 and standard deviation 1, i.e., $\epsilon_{it} \sim N(0, 1)$.

Regarding calculating the aggregate SSM in our experiment, we have selected Time-to-collision(TTC) and Deceleration-rate-to-avoid-crash(DRAC) as our primary SSM metrics. To illustrate, if we establish a threshold of 3 seconds for TTC, we can define $X^{it}_{0<SSM<3}$ as the total count of instances in which a vehicle experiences a TTC of less than 3 seconds. As for the DRAC metric, where a higher value indicates a more perilous situation, we define the SSM threshold as a, and use ∞ to represent b.

3 Experiments and Results

As shown in Table 1, our primary model indicates that for the subject SSMs, there is a significant positive correlation with the number of crashes, demonstrating that SSMs can serve as strong indicators of roadway safety. However, although we expected the correlation to decrease with less strict thresholds for SSMs, this was not observed in our numerical results.

Table 1: Results for our proposed model

Time to Collision			DRAC		
Threshold	Coef	P-value	Threshold	Coef	P-value
1	0.000054	1.59E-13	5	6.77E-05	3.45E-10
1.5	0.000033	4.62E-14	4.5	5.75E-05	2.69E-10
2	0.000025	4.25E-14	4	4.907E-05	2.04E-10
2.5	0.000021	5.40E-14	3.5	4.23E-05	2.04E-10
3	0.000017	4.87E-14	3	3.62E-05	2.07E-10

4 Significance and Impact

In this study, we delve into a longstanding oversight in research: the suitability of simulated environments for deriving Safety Surrogate Measures (SSM) and informing roadway safety analyses using publicly available data. With meticulous efforts to utilize diverse data sources and construct models with precision, we uncover a significant correlation between SSM counts and crash numbers. However, altering SSM thresholds does not reveal statistically significant trends. The absence of this analysis in prior studies suggests that existing simulated roadway safety assessments might inadequately equip us to evaluate the safety impacts of emerging mobility technologies accurately. Our investigation exposes several challenging limitations regarding open-access data, notably limited access to detailed driving data, potentially resulting in a disparity between actual and simulated driver behavior. Our reliance on public data from the Performance Measurement System (PEMS), the largest global open dataset for highway driving, reveals a lack of detailed crash data, hindering the identification of crashes directly linked to SSM metrics. Moreover, the absence of fine-grained driving trajectories poses integration challenges. An alternative approach using naturalistic driving data, such as the Second Strategic Highway Research Program (SHRP2), promises more accurate SSMs with precise vehicle trajectories. Although accessing such data is difficult, its limited applicability to macro-level traffic scenarios underscores the importance of developing robust methodologies to advance safety analysis.