Development of CMFs for Traffic Signal Installation at High-Speed Intersections

Final Report
September 2025

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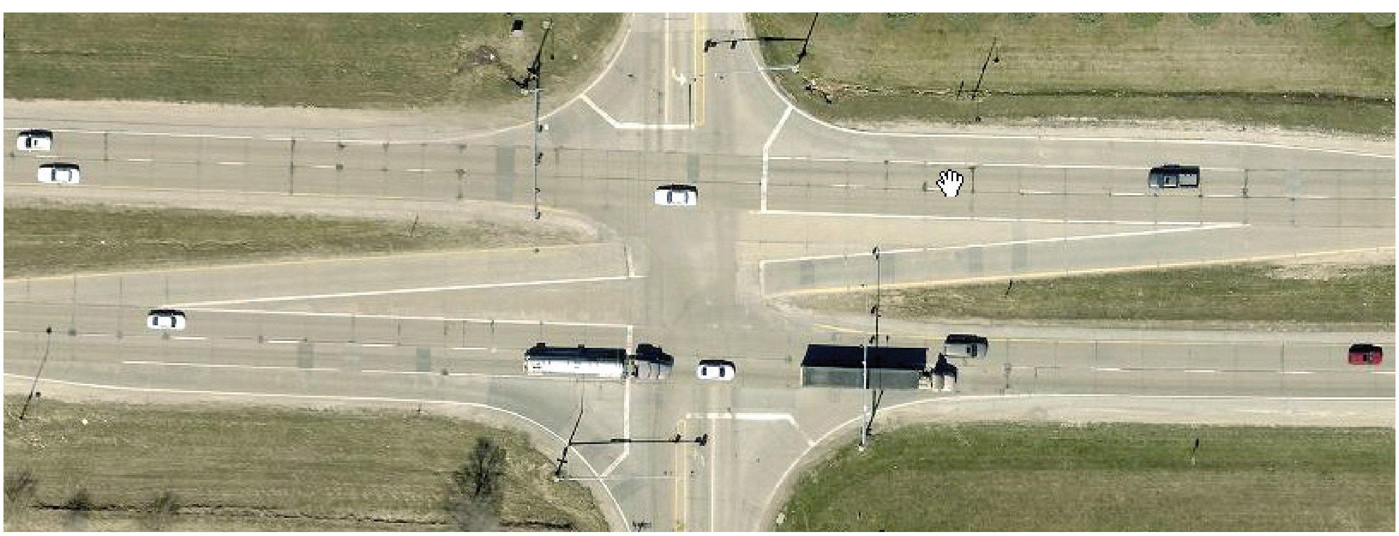
Center for Transportation Research and Education



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16. Abstract

Between 2016 and 2020, nearly 2,900 fatal, serious injury, and minor injury crashes occurred in Iowa at paved, all-way stop control and partial stop control intersections with at least one approach having a speed limit exceeding 45 mph, i.e., high-speed intersections. This increases to nearly 7,800 fatal, serious injury, and minor injury crashes when considering all paved, unsignalized intersections in the state. At the national level, 18% of all fatal crashes occurred at unsignalized intersections in 2018.

Several factors can contribute to crashes at unsignalized intersections, including drivers failing to recognize the intersection, not complying with the traffic control, or selecting inappropriate gaps. Additionally, reaction times are reduced as speeds increase, and the severity of crashes is greater. In fact, the safe system speed for "car/car (side impact, intersections)" crashes is only approximately 30 mph. Traffic signal installation is a countermeasure that may be considered at high-speed intersections; however, national research presents mixed findings on its effectiveness.

Since Iowa has a robust intersection database, high-quality crash data, and prior experience developing intersection safety performance functions (SPFs), this research focused on creating Iowa-specific crash modification factors (CMFs) for signalizing high-speed intersections. A five-step methodology was implemented.

This research revealed that signal installations at non-ramp high-speed locations increase all but broadside crashes on most facility types. The findings showed that signal installation at high-speed intersections reduced broadside crashes by less than 64%, while rear-end crashes increased by more than 70%, depending on intersection geometric characteristics. Additional CMF values were derived for subsets of high-speed intersection types, including divided, undivided, three-leg, and four-leg intersections. This report showcases a comparative analysis of the impact of signalization on different classes of high-speed intersections. The study's results were validated through hypothesis tests of proportions analysis and comparisons with existing literature.

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EXECUTIVE SUMMARY

Between 2016 and 2020, nearly 2,900 crashes involving fatalities or injuries occurred at high-speed, unsignalized intersections in Iowa with at least one approach exceeding 45 mph. This number rises to almost 7,800 crashes when considering all paved, unsignalized intersections statewide. Traffic signal installation is a countermeasure that may be considered at high-speed intersections; however, national research presents mixed findings on its effectiveness. This study aimed to develop Iowa-specific crash modification factors (CMFs) for signalizing high-speed intersections, leveraging the state's robust data systems and past work on intersection safety performance functions (SPFs).

A comprehensive literature review revealed that empirical Bayes (EB) and cross-sectional approaches are the most widely used methods to develop CMFs, each with strengths and limitations. Given limitations in before-and-after crash data for most Iowa intersections, this study used a cross-sectional analysis, comparing crash patterns at signalized and unsignalized intersections while controlling for traffic volumes and geometry.

Data were compiled from multiple sources, including the Iowa Department of Transportation's (DOT's) intersection inventory, crash database, and roadway asset management system (RAMS), along with supplemental tools like Google Street View and Pathways PathWeb. Seventy-three signalized non-ramp high-speed intersections were identified as treatment sites, and 813 non-ramp unsignalized intersections were retained as reference sites after rigorous screening for geometric and surface conditions.

A total of 252 SPFs were developed to model crashes by severity, manner of collision, vehicle action, and direction of travel. From these, 94 CMFs were found to be statistically significant at the 5% significance level. The results showed a consistent increase in total crashes following signal installation, driven largely by increases in rear-end, same-direction sideswipe, and stopped-vehicle crashes. However, broadside and perpendicular-direction crashes tended to decrease, consistent with expectations from signal installation. The CMFs for broadside crashes ranged from 0.383 to 0.639, indicating significant reductions. In contrast, rear-end crash CMFs exceeded 3.0.

Validation was conducted using comparisons with the CMFs in the Federal Highway Administration (FHWA) CMF Clearinghouse, hypothesis tests of crash type proportions, and local agency outreach regarding signal phasing. Results confirmed that permissive and protected-permissive left-turn phasing were associated with increased left-turn and angle crashes, suggesting that protected-only phasing may improve outcomes.

The study concluded that signal installation at high-speed intersections does not consistently reduce overall crashes or serious injuries and, in many cases, increases lower-severity crashes. Therefore, alternative intersection designs—such as roundabouts, reduced-conflict intersections, and median closures—should be considered prior to signal installation. Any signal installed should be accompanied by an access management strategy and include protected-only left-turn phasing where feasible.

INTRODUCTION

Between 2016 and 2020, nearly 2,900 fatal, serious injury, and minor injury crashes occurred in Iowa at paved, all-way stop control and partial stop control intersections with at least one approach having a speed limit exceeding 45 mph, i.e., high-speed intersections. This increases to nearly 7,800 fatal, serious injury, and minor injury crashes when considering all paved, unsignalized intersections in the state. At the national level, 18% of all fatal crashes occurred at unsignalized intersections in 2018. Several factors can contribute to crashes at unsignalized intersections, including drivers failing to recognize the intersection, not complying with traffic control, or selecting inappropriate gaps. Additionally, reaction times are reduced as speeds increase, and the severity of crashes is greater.

Traffic signal installation is a countermeasure that may be considered at high-speed intersections. The Federal Highway Administration (FHWA) Crash Modification Factors Clearinghouse (https://www.cmfclearinghouse.org) has several crash modification factors (CMFs) pertaining to traffic signal installation. However, the CMF values can vary widely, originate from studies of various quality levels and analysis periods, and employ data from single geographic regions or states.

A CMF is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. A CMF value below 1 indicates a reduction in crash count following countermeasure implementation. For example, if an intersection has 10 total crashes per year and a countermeasure with a CMF of 0.8 for all crashes is applied, it is expected that 8 crashes will occur annually following the implementation of the countermeasure.

The state of Iowa is well positioned to develop Iowa-specific CMFs for signalizing high-speed intersections, given the state's comprehensive intersection database, high-quality crash data, and past/ongoing efforts to develop intersection safety performance functions (SPFs). Therefore, the objective of this project was to develop Iowa-specific CMFs with respect to the installation of traffic signals at high-speed intersections. This report summarizes the work conducted as part of this project and consists of six main chapters:

- Introduction, discussing the value of this project
- Literature Review, summarizing the state of the practice
- Data Sources, providing a comprehensive overview of the data sources utilized in this project
- Methodology, detailing the step-by-step analysis conducted to develop the CMFs
- Findings and Discussion, highlighting the results of the analysis and the effectiveness of signalization at high-speed intersections in reducing crashes
- Conclusions, summarizing the key takeaways and recommendations for future implementation or research

LITERATURE REVIEW

A comprehensive review of the methodologies commonly used to develop CMFs was conducted, focusing on studies aimed at developing CMFs for signalizing intersections. This section summarizes the findings of the literature review.

CMF Development Methods

CMF development methods are generally classified into two categories: observational before-and-after studies and cross-sectional studies.

Observational Before-and-After Studies

Observational before-and-after studies are applied when the exact installation date of the treatment is known and when there is enough before and after crash data. Observational before-and-after studies are prevalent in the literature. The literature has five types of these studies.

Naïve Before-and-After Studies

This approach calculates the CMF of a treatment based only on sites where the treatment has been applied. It is considered the simplest approach to calculate a CMF. It calculates the CMF as the ratio of the after-treatment crashes to the before-treatment crashes. This method does not consider how the specific treatment sites compare to other similar sites or overall safety trends. It usually overestimates the treatment's impact due to the regression-to the mean problem, which happens when a specific location experiences an unusually high count of crashes in a given period followed by a low count of crashes in the following period due to natural fluctuations, meaning that the crash count tends to converge to a long-term mean.

Yoked Comparison and Comparison Group Approaches

These approaches account for the changes in external factors over time that the naïve approach does not. This is accomplished by pairing each treatment site with a comparison site (or group of sites) that did not receive the treatment and that has a similar crash history trend and comparable traffic, geometric, and geographic characteristics. Assuming that all factors have changed in the same manner at both the treatment and comparison sites, the ratio of the comparison sites' crashes in the after period to those in the before period is used to calculate the crashes in the after period at the treated sites if the countermeasure had not been implemented. The CMF is calculated as the ratio of the observed crashes at the treatment sites to the calculated crashes if no countermeasure had been implemented. The primary downside of this approach is that it does not account for the regression-to-the-mean problem.

Empirical Bayes Approach

In the empirical Bayes (EB) approach, the after-treatment crash frequency if the countermeasure had not been implemented is calculated more precisely using a large set of untreated sites that have similar characteristics to the treated sites. SPFs and their overdispersion factors, which are a key component in the EB approach, are used to estimate the expected count of crashes at the treatment sites if no treatment had been applied. This approach addresses the common regression-to-the-mean issue in before-and-after studies. It incorporates traffic volume changes, makes better use of limited data, and accounts for external factors that might influence crash frequency.

Full Bayes Approach

The full Bayes (FB) approach is similar to the EB approach in that both utilize a reference population. However, the FB approach substitutes the EB approach's point estimate with an expected crash frequency and its variance, generating a distribution of likely values. The FB approach allows for a multivariate analysis. It also treats each time period as an individual data point and integrates the estimation of the SPF and treatment effects within a single step, whereas these are two separate steps in the EB method. However, these advantages come at the expense of high complexity levels.

Cross-Sectional Studies

Cross-sectional studies are often employed when it is challenging to isolate the impact of a single treatment due to the presence of multiple treatments or when the exact installation date of a treatment is unknown. Two primary cross-sectional CMF development approaches are documented in the literature: the naïve and regression-based methods. Both approaches begin by identifying a set of similar sites based on predefined features such as number of legs, control type, whether the roadway is divided/undivided, number of lanes, area type, and traffic level.

In the naïve method, sites are divided into two groups based on the presence of the treatment. The CMF is calculated as the ratio of the average crash frequency at treatment sites to that at no-treatment sites.

In the regression-based method, regression analysis is utilized to fit an SPF that includes treatment presence as an independent variable. The regression model derives the CMF as the exponent of the treatment variable's coefficient.

CMFs for Signalizing Intersections

The FHWA CMF Clearinghouse was reviewed to identify research studies that developed CMFs for signalizing intersections. This research resulted in the following list:

1. *NCHRP Report 491: Crash Experience Warrant for Traffic Signals* (1)
2. *Accident Modification Factors for Traffic Engineering and ITS Improvements* (2)
3. *Validation and Application of Highway Safety Manual (Part D) in Florida* (3)
4. Comparison of safety evaluation approaches for intersection signalization in Florida (4)
5. *Safety Evaluation of Signal Installation with and without Left Turn Lanes on Two Lane Roads in Rural and Suburban Areas* (5)
6. A full Bayes before-after study accounting for temporal and spatial effects: Evaluating the safety impact of new signal installations (6)

These studies were reviewed with a focus on the analysis methods, factors considered for grouping intersections, types of crashes, number of treatment and reference sites, and resulting CMF values. The subsections below summarize the review findings.

Analysis Methods

Table 1 shows that in all research studies except for study number 6, the EB approach was used to develop the CMFs. Study number 6, on the other hand, utilized the FB approach. Study number 3, however, investigated all methods except FB and yoked comparison across a wide spectrum of crash types. Consequently, CMF values resulting from various methods were selected based on statistical significance.

Table 1. Summary of analysis methods

Research Study	Naïve Before-and-After	Comparison Group	EB	FB	Cross-Sectional
1			Y		
2			Y		
3	Y	Y	Y		Y
4			Y		
5			Y		
6				Y	

Crash Types

Figure 1(a) shows that the majority (nearly 60%) of the developed CMFs considered target crashes. Among these, rear-end collisions were the most frequently addressed, with 10 CMFs, followed by angle crashes and left-turn crashes with 6 CMFs. Other less common crash types, such as right turn same roadway, right turn different roadway, sideswipe, and head-on, each had fewer than 3 developed CMFs, totaling 6 CMFs. Notably, the relatively low frequency of target crashes led to the development of CMFs that do not consider crash severity. Figure 1(b) illustrates that 72% of the developed CMFs are applicable to all crashes.

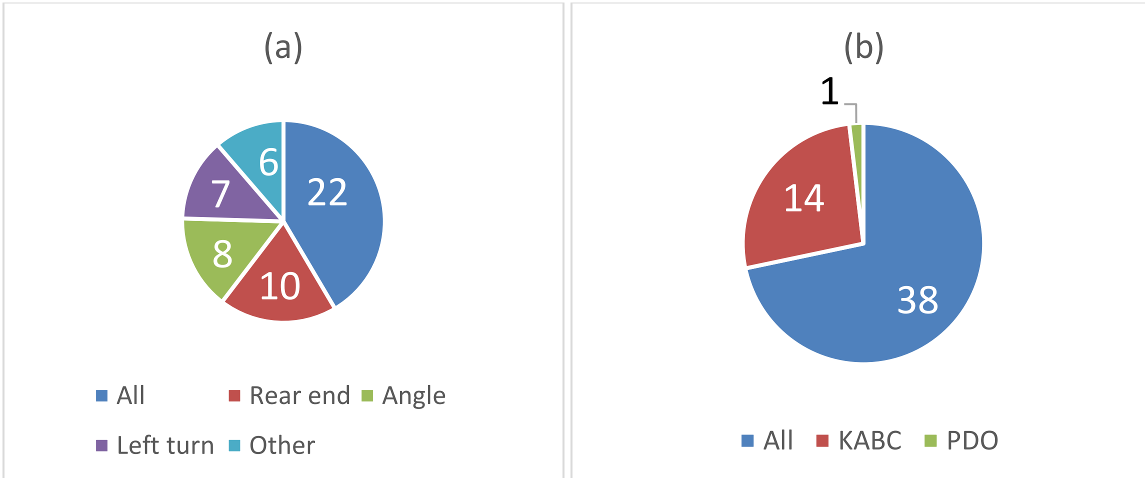

Figure 1. CMFs by (a) crash type and (b) crash severity

Sample Sizes

Table 2 demonstrates the extensive variation in sample sizes among the reviewed research studies. The sample sizes range from 2 to 100 treatment sites and from 19 to 1,405 reference sites. Notably, the sample size is significantly influenced by the factors used for selecting the treatment and reference sites, which are outlined in the subsequent section.

Table 2. Summary of sample sizes

Research Study	Sample Size
1	Intersections converted from stop to signal: • 3-leg: 22 • 4-leg: 100 A reference group of signalized intersections: • 3-leg: 19 • 4-leg: 96 A reference group of stop-controlled intersections: • 3-leg: 99 • 4-leg: 199
2	Different sample sizes were obtained from both California and Minnesota. Below is the breakdown of the sample sizes: California: • 3-leg/2 lanes on major road: treatment sites: 4, and reference sites: 1,405 • 4-leg/2 lanes on major road: treatment sites: 14, and reference sites: 742 • 4-leg/4 lanes on major road: treatment sites: 10, and reference sites: 183 Minnesota • 3-leg: treatment sites: 2, and reference sites: 522 • 4-leg: treatment sites: 15, and reference sites: 763
3	Treatment sites: 32 intersections • Rural areas: 8, and urban areas: 24 • 3-leg:15, and 4-leg: 9 Comparison sites: 202 sites with similar roadway characteristics and annual average daily traffic (AADT) values
4	This publication could not be accessed. The only information available is that the sample size is greater than 50 intersections.
5	Treatment sites (3-leg: 36, and 4-leg: 81) Reference sites (3-leg: 129, and 4-leg: 276)
6	Treatment sites: 19 intersections Reference sites: 107 intersections

Considered Factors

The factors utilized for grouping the treatment sites and selecting corresponding reference sites are summarized in Table 3. The number of legs is the most frequently used factor. Among the factors, AADT is noteworthy because it was used to conduct a disaggregate analysis to assess how the statistical significance of a CMF changes when grouping intersections based on AADT.

Table 3. Summary of considered factors

Research Study	Factors
1	AADT Speed Geometry: • Number of legs • Sight distance adequacy
2	AADT Geometry: • Number of legs • Number of lanes
3	Area type Number of legs
4	This publication could not be accessed. The only factor listed in the abstract is AADT.
5	Geometry: • Number of legs • Number of lanes • No left-turn lanes on the major road • Stop-controlled on the minor road Location: • No public street intersection within 100 ft • No rail grade crossing within 500 ft
6	Geometric design Traffic control characteristics

Resulting CMF Values

Figure 2 indicates that the majority of the developed CMFs are below 1 (86%), suggesting a reduction in crash frequencies following signal installation. Notably, all CMFs greater than one pertain to rear-end collisions occurring in both urban and rural areas, with the original intersection control type being all-way and partial stop control. Signals are well known for the dilemma zone, in which drivers must decide whether to stop or proceed before the signal turns red. The various decisions made by drivers result in a higher probability of rear-end crashes at signalized intersections (7).

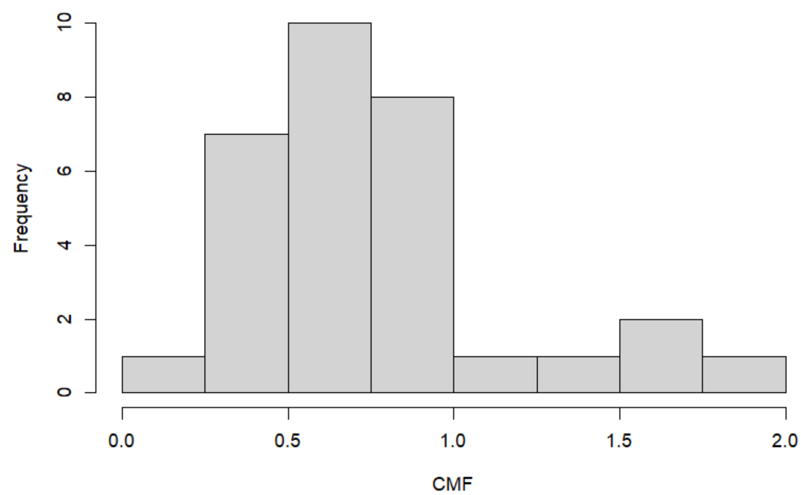

Figure 2. Distribution of CMF values

DATA SOURCES

For this study, a variety of data sources were utilized to collect information about the treatment sites (i.e., signalized intersections) and the reference sites (i.e., unsignalized intersections). The data sources used and their usage are shown in Table 4.

Table 4. Data sources and usage

Data Source	Usage
Intersection Inventory Database	Iowa DOT intersection database, developed in 2017 with targeted updates made in 2023. Used to identify the treatment and reference sites.
Crash Database	Iowa DOT reportable crash database. Used to obtain the count of crashes at each treatment and reference site.
Iowa DOT Roadway Asset Management System (RAMS)	Three RAMS layers—Iowa linear reference system (LRS) Network, Traffic Information, and Surface Type—were used to identify where ramps are located, obtain AADT values at each leg of the treatment sites, and exclude reference sites with at least one unpaved leg, respectively.
Google Street View	360-degree roadway images collected by Google. Used to assess road characteristics at treatment sites, including speed limits, control types, signal installation dates, lane configurations, and the presence of medians.
Pathways PathWeb	Panoramic, rear-facing, and roadway surface images, collected for the Iowa DOT by Pathways. Used as an alternative to Google Street View when more recent images were available.
Iowa Geographic Map Server	Statewide, multiyear aerial image dataset. Used to collect the geometric characteristics of signalized intersections when PathWeb and Google Street View were unable to provide the necessary information.

METHODOLOGY

A five-step methodology, presented in Figure 3, was followed to develop CMFs for signalizing high-speed intersections. The following subsections provide details about each step in the methodology.

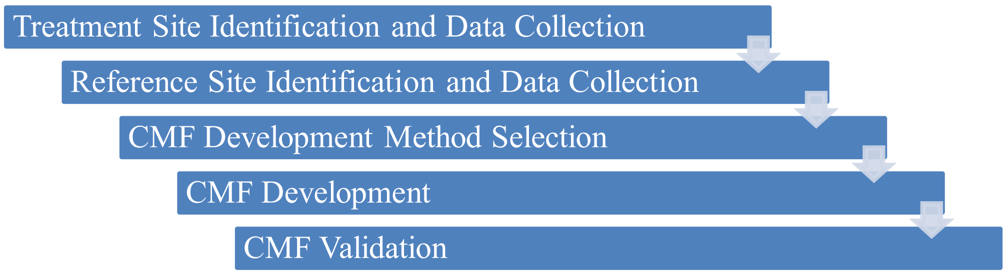

Figure 3. High-level project methodology

Treatment Site Identification and Data Collection

In this step, the intersection database was used to identify all treatment sites, with a focus on signalized intersections where at least one leg has a speed limit greater than 45 mph. Additional characteristics were manually collected using resources such as Google Street View, PathWeb, and the Iowa Geographic Map Server to establish a homogeneous set of treatment sites. Key intersection characteristics included the presence of medians, the number of legs with separate right- and left-turn lanes, the presence of ramps as intersection legs, the traffic control type prior to signal installation, and the dates of the first and last images showing the presence/absence of signalization.

The dates of the first and last images showing the presence/absence of signalization were critical in assessing the feasibility of conducting an EB before-and-after analysis for CMF development, depending on the availability of pre- and post-installation crash data. These image dates were also used to verify the accuracy of the control type reported in the intersection database. Additionally, the speed limit was validated for all legs of each intersection. As a result of this manual data collection, the high-speed signalized intersection database was refined, as shown in Figure 4. Figure 5 and Figure 6 highlight the major characteristics of the non-ramp-related high-speed signalized intersections and show their spatial distribution.

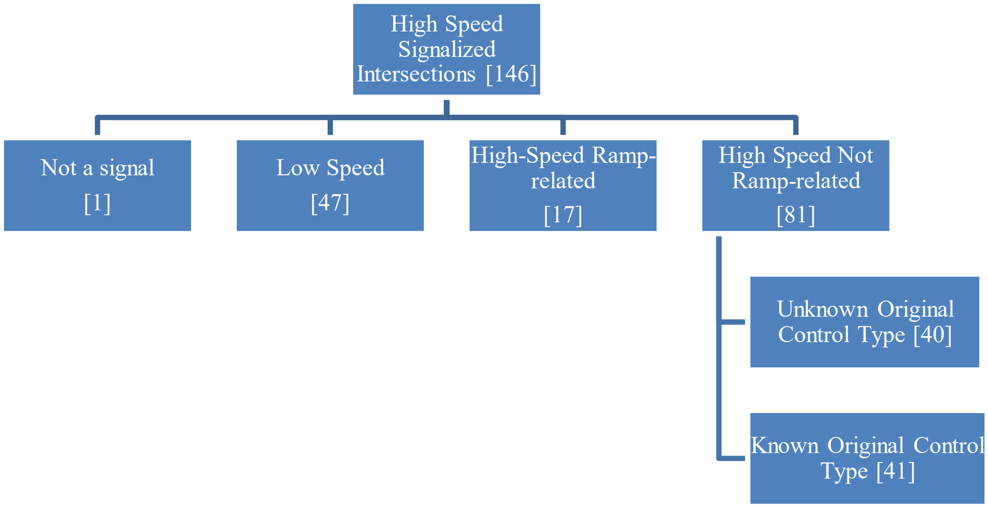

Figure 4. Breakdown of high-speed signalized intersections in the intersection database

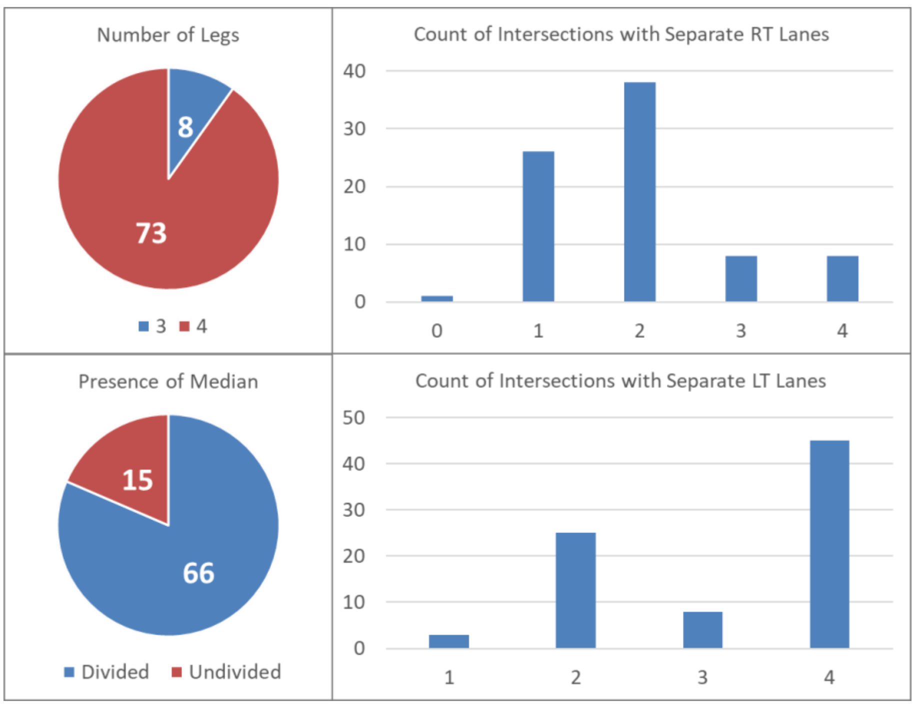

Figure 5. Geometric characteristics of non-ramp-related high-speed signalized intersections

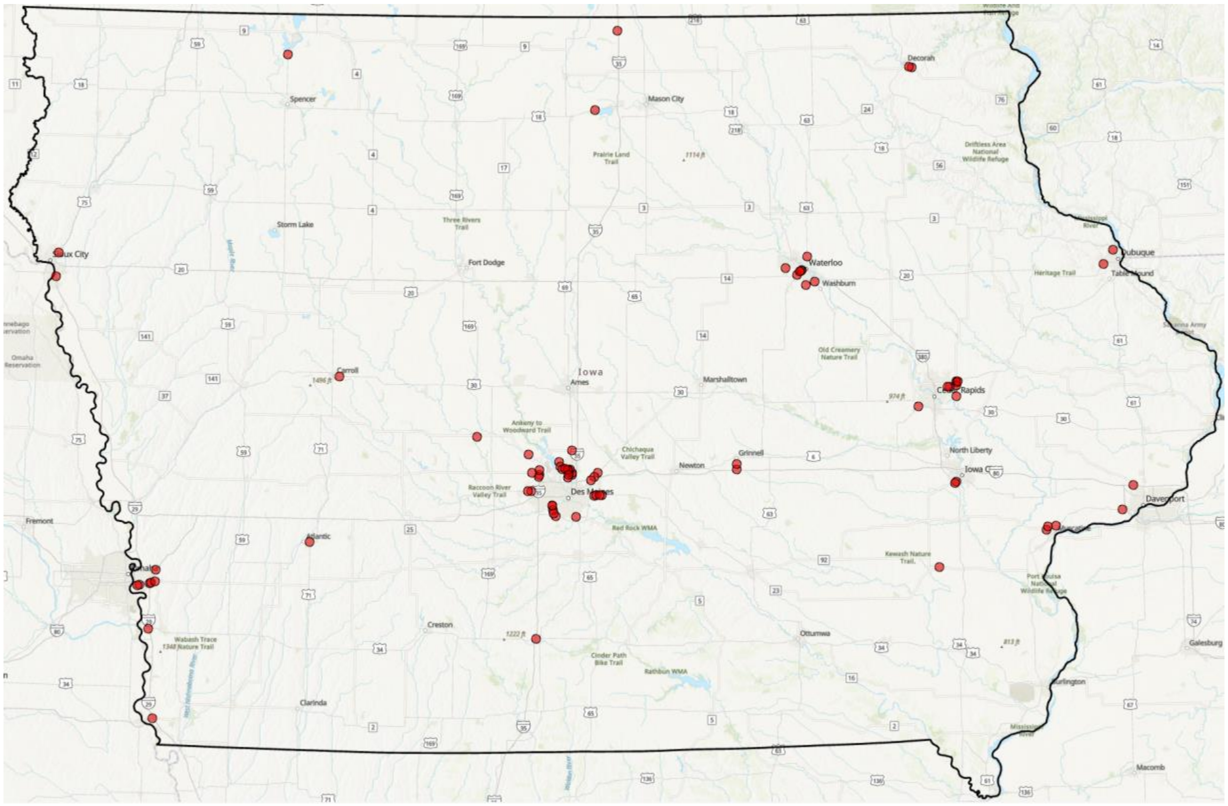

Figure 6. Map of non-ramp-related high-speed signalized intersections

In addition to manual data collection, the RAMS Traffic Information layer was used to obtain both major and minor AADT values for each intersection, with a focus on the middle year of the five-year period following signal installation. Furthermore, the five-year crash count was calculated for each intersection, covering the five years after signal installation at the intersections. To expand the list of treatment sites with sufficient after-installation crash data, a second set of CMFs was also developed using three years of crash data.

Reference Site Identification and Data Collection

Regardless of the CMF development methodology, reference sites must be identified to develop SPFs for an EB before-and-after analysis, establish a comparison group for estimating no-treatment crashes at treatment sites, or represent the population of intersections needed to develop cross-sectional models.

The first step in reference site selection was to identify all unsignalized intersections in the intersection database, which resulted in 28,190 potential reference sites. Because the intersection database had not been comprehensively updated since its initial development, the traffic control at each intersection was validated using the following three-step process, which reduced the number of potential reference sites to 28,049 intersections:

1. Spatially join crashes to reference sites. The same methodology used to identify intersection crashes during SPF development, which had been approved by the Iowa Department of Transportation (DOT), was utilized.
2. Create a summary of traffic control at the vehicle level by reference site.
3. Manually review reference sites where at least one crash was reported as having a traffic signal control type, which could suggest that the traffic control changed during the five-year period.

Since ramp-related intersections are inherently different from traditional intersections—in that ramps feature one-way entry and departure—the potential reference sites were separated into ramp-related and non-ramp-related intersections using the following methodology:

1. Spatially join ramps to reference sites using a 250 ft buffer.
2. Identify potential ramp-related reference sites.
3. Manually review the reference sites identified in the previous step.

As expected, the majority of the unsignalized intersections were found to be non-ramp related (27,506). Ramp-related intersections were excluded from the analysis because of the complexity of traffic movements and the challenges in accurately assigning crashes to intersections, especially at the reference sites. To ensure that both the treatment and reference sites have similar traffic conditions, the retained non-ramp-related reference sites were limited to intersections with major and minor AADT values within 10% of those of the non-ramp-related treatment sites. This step reduced the number of non-ramp-related reference sites to 1,019.

The last intersection refinement step involved excluding intersections with at least one unpaved leg. The following methodology was used:

1. Identify unpaved roads using the surface type from the RAMS Surface Type layer.
2. Spatially join unpaved roads to reference sites using a 250 ft buffer.
3. Exclude intersections with at least one unpaved segment within 250 ft.

This reduced the reference sites to 813.

After identifying the reference sites, the number of legs, the presence of a median, and major and minor AADT values were obtained from the intersection database. The team also obtained the number of legs with separate right-turn (RT) and left-turn (LT) lanes from the approach layer of the intersection database. The team was unable to identify 37 reference sites from the approach layer of the intersection database. Therefore, corresponding data were collected manually using Google Street View for these sites. Crashes between 2019 and 2023 were joined to the reference sites and summarized by type and severity. Figure 7 highlights the major characteristics of the non-ramp-related unsignalized intersections. Figure 8 shows the locations of the reference sites.

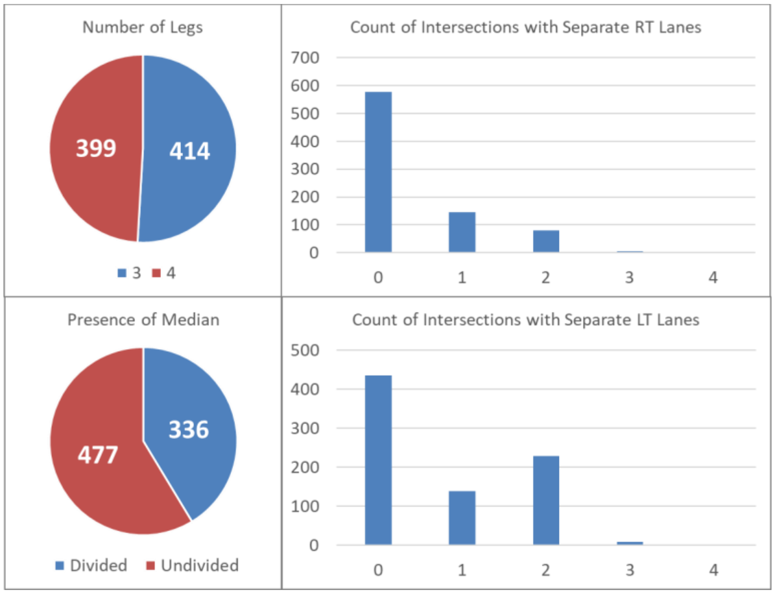

Figure 7. Geometric characteristics of non-ramp-related high-speed unsignalized intersections

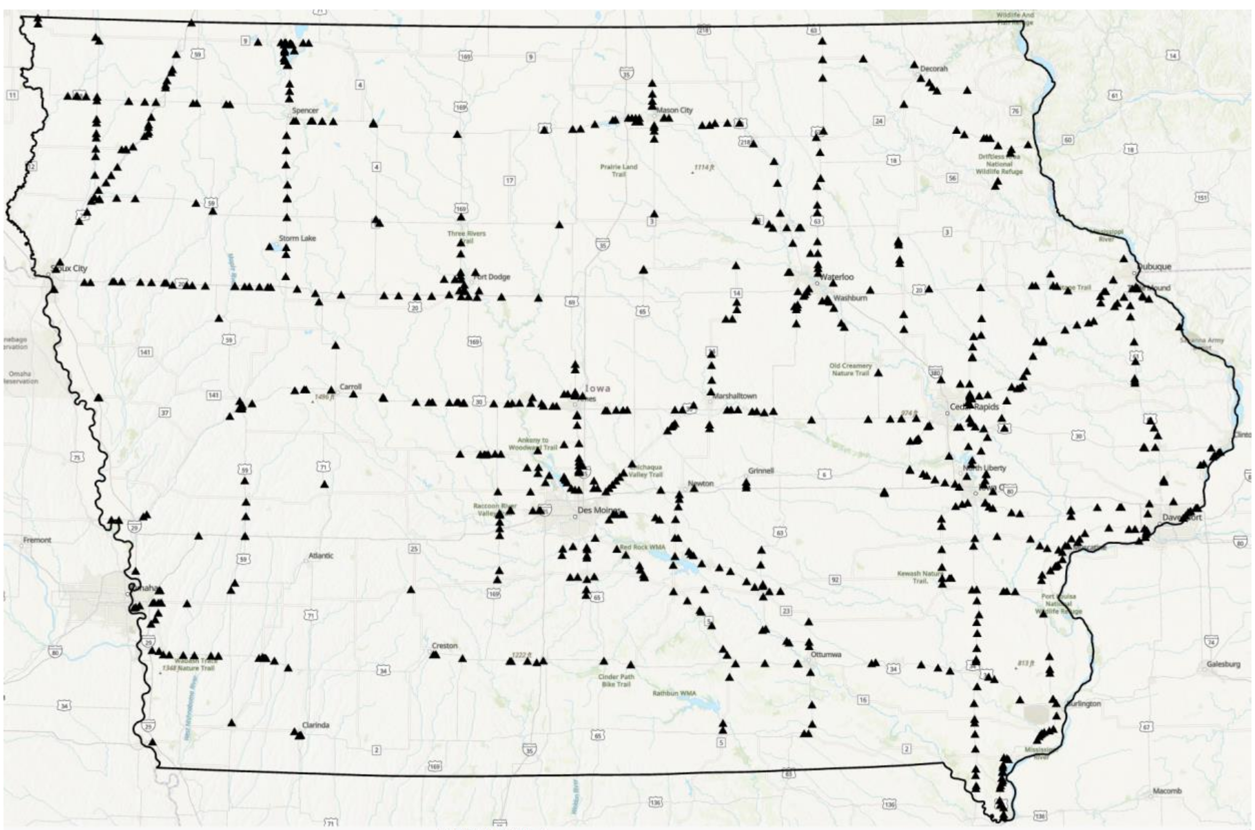

Figure 8. Map of non-ramp-related high-speed unsignalized intersections

Selection of CMF Development Method

After collecting the characteristics of the treatment and reference sites, the most appropriate method for developing CMFs was selected. Two key factors influenced the selection: the availability of signal installation dates and the availability of crash data from before and after the installations. As shown in Figure 9, most signals were installed before 2014, which limits access to before-installation crash data due to the Iowa DOT's 10-year crash data retention policies. Additionally, only a few signals (eight) were installed after 2019, limiting the availability of sufficient after-installation crash data. Therefore, cross-sectional analysis was selected as the method for developing CMFs in this project.

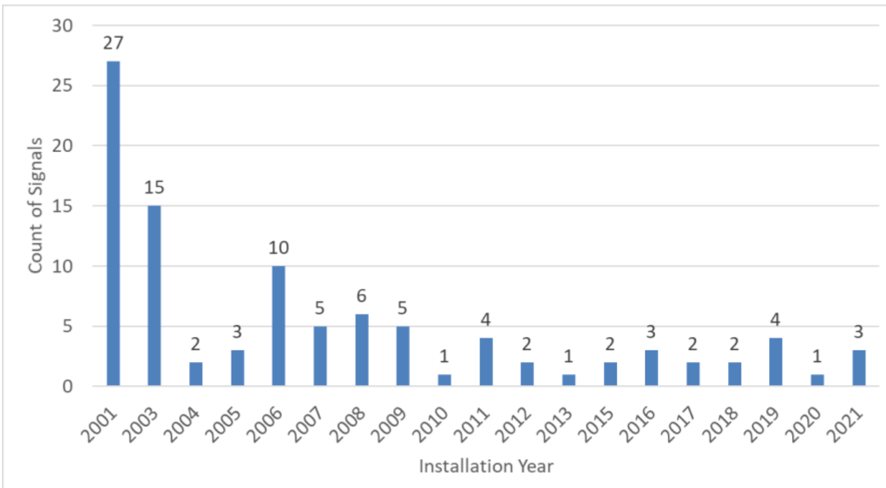

Figure 9. Count of signals by installation year

CMF Development

To develop CMFs using cross-sectional analysis, SPFs must be fitted with a binary independent variable indicating the presence or absence of a signal at the intersection. The format of the SPFs is shown below:

$$\text{Predicted Crashes} = \exp(\alpha + \beta_1 Ln(MINORAADT) + \beta_2 Ln(MAJORAADT) + \beta_3 SIGNAL)$$

The CMF value can be obtained as the exponent of β_3. The statistical significance of the CMF can be assessed by conducting hypothesis testing on the value of β_3, specifically, by testing the presence of strong evidence to prove that the value of β_3 is not zero, which thus indicates that the value of the CMF is different than one. The hypothesis testing formulation is shown in the following:

- Ho: $\beta_3 = 0 \rightarrow CMF = 1$
- Ha: $\beta_3 \neq 0 \rightarrow CMF \neq 1$

- If the p-value of this hypothesis testing is less than a predefined significance level (e.g., α = 0.05), there is enough evidence to prove that the CMF value is not 1.

A total of 252 SPFs were developed covering the following: two model types (Poisson and negative binomial), the six homogeneous intersection groups shown in Table 5, in addition to the group of all intersections, and the 18 crash severities and types shown in Table 6.

Table 5. Homogeneous grouping logic for intersections

Factor	Groups
Median presence	Divided – Undivided
Number of legs	3-Leg – 4-Leg
Number of legs with separate LT lanes	Min. one leg with a separate LT lane
Number of legs with separate RT lanes	Min. one leg with a separate RT lane

Table 6. Crash severities and types for CMF development

Crash Severities	Crash Types (Manner of Collision)	Crash Types (Vehicle Action)	Crash Types (Vehicle Direction of Travel)
Total (KABCO) Fatal through possible injury (KABC) Fatal, serious, and minor injury (KAB) Possible injury and property damage only (CO) Property damage-only (PDO)	Angle Broadside Rear end Sideswipe same direction Sideswipe opposite direction Head-on	Crash involving a right-turning vehicle Crash involving a left-turning vehicle Crash involving a vehicle changing lanes Crash involving a stopped vehicle	Crash involving vehicles moving in opposite directions Crash involving vehicles moving in perpendicular directions Crash involving vehicles moving in the same direction

After identifying the CMFs that were statistically significant at the 5% significance level, additional refinement was performed based on sample size and the goodness of fit of the SPFs. The sample size criteria included crash counts greater than 300 and a reference-to-treatment site ratio exceeding 4:1, which were identified from the literature review. The goodness of fit was evaluated using the cumulative residuals (CURE) deviation percentage (CDP), with a threshold of less than 5%. Some of these assumptions were also relaxed, and the impact on the resulting CMFs was analyzed, as detailed in the Findings and Discussion chapter.

CMF Validation

To ensure the robustness and reliability of the developed CMFs, three primary validation methods were employed: literature validation, hypothesis tests of proportions, and local agency outreach. Each method provided a unique perspective on the credibility and applicability of the obtained CMFs.

1. Literature Validation

A comparative analysis was conducted between the obtained CMFs and those available in the literature. This validation step ensured that the estimated CMFs fell within a reasonable range based on previous studies.

2. Hypothesis Tests of Proportions

Two hypothesis tests of proportions were conducted to evaluate differences in crash proportions between signalized and unsignalized intersections and assess whether the proportions of different crash types follow a similar trend to the developed CMFs. The null hypothesis for both tests stated that the proportion of a specific crash type at signalized intersections is equal to that at unsignalized intersections. Two alternative hypotheses were tested:

- The proportion of a specific crash type at signalized intersections is lower than that at unsignalized intersections.
- The proportion of a specific crash type at signalized intersections is higher than that at unsignalized intersections.

3. Local Agency Outreach

To enhance the contextual understanding of the obtained CMFs, 34 local agencies (counties and cities) were contacted to gather information on signal phasing. This outreach was particularly valuable in explaining unexpected CMF values, especially for angle crashes, by considering the impact of traffic signal operations.

FINDINGS AND DISCUSSION

This research study resulted in 252 SPFs, from which 252 CMFs were derived for various high-speed intersection characteristics and crash types. Ninety-four CMFs were statistically significant at the 5% significance level. The following subsections provide a detailed discussion of these SPFs and CMFs and the findings of the validation efforts.

Sample SPF

A sample SPF model summary and CURE plot are shown in Figure 10. This model represents broadside crashes at undivided intersections. The CURE plot shows that cumulative residuals fluctuate around zero without exhibiting specific trends, indicating a good model fit. The model parameters (β_1, β_2, and β_3) demonstrate reasonable relationships between predicted crashes, traffic volume, and traffic control. Specifically, β_1 and β_2 indicate that broadside crash frequency increases with higher major and minor AADT values. Conversely, β_3 shows that intersections with traffic signals experience lower broadside crash frequencies compared to those with other traffic control types. The resulting CMF for this model is 0.436, with a p-value of 0.029, indicating high statistical significance. The model's CDP is 0.2%, which is well below the recommended 5% threshold. Appendix A provides a complete table of the 94 SPFs that yielded statistically significant CMFs at the 5% significance level.

Parameter	Value
Sample	489
Crashes	578
R2	0.311553171
CDP	0.204498978
MACD	16.90502085
MAD	1.103798204
Theta	1.253660577
Alpha	-8.51872222
Beta1	0.473561358
Beta2	0.735883772
Beta3	-0.81945172
p_value	0.029098902
CMF	0.4361752
StdErr	0.206249806
AIC	1369.300733

CURE Plot

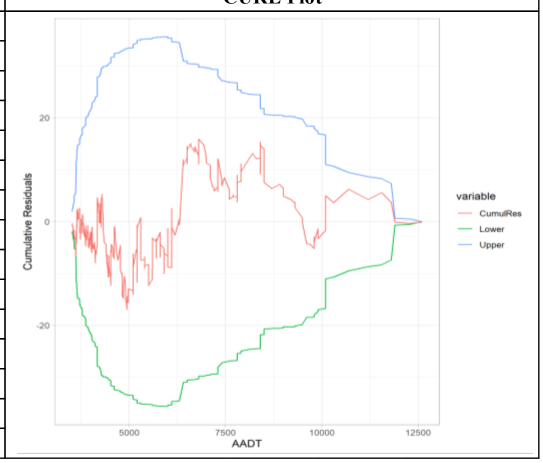

Figure 10. Sample SPF model parameters and CURE plot

Discussion of CMF Values

The crash types for which CMF values were calculated can be grouped into four categories: severity, manner of collision, vehicle action, and colliding vehicles' directions of travel. Table 7 presents all of the statistically significant CMF values. The bolded CMFs are those meeting three literature-based criteria listed in the methodology section. Furthermore, the underlined CMFs are those obtained using three years of crash data instead of five years. The following subsections provide detailed observations for each crash type group and the results of consistency and reasonableness checks for the CMF values.

Table 7. Summary of CMF values

Crash Type		Intersection Category						
		All	3-Leg	4-Leg	Divided	Undivided	Separate RT	Separate LT
Severity	KABCO	**1.795**	**1.504**	**1.730**	**2.023**	**0.798**	1.453	**1.722**
	KABC	**1.440**		**1.398**	**1.614**	0.590	1.202	**1.323**
	KAB					0.282		
	CO	**2.004**	**1.664**	**1.930**	**2.278**		1.586	**1.961**
	PDO	**2.033**	**1.652**	**1.958**	**2.328**		1.629	**2.024**
Manner of Collision	Rear end	3.690	**3.408**	3.520	**4.405**	**1.761**	3.311	**3.865**
	Sideswipe same-direction	2.969	2.224	3.141	2.936	2.812	2.815	2.814
	Angle	**2.436**		**2.631**	3.229		1.820	**2.390**
	Broadside	0.561	**0.383**	**0.565**	0.639	**0.436**	0.452	0.563
	Head on	2.276		2.084	4.221			
Vehicle Action	Crash involving a stopped vehicle	3.764	2.835	3.733	**4.752**	**1.788**	3.142	4.112
	Crash involving a left-turning vehicle	**1.730**		**1.773**	**1.987**	**0.624**	1.311	**1.620**
	Crash involving a right-turning vehicle	**1.680**		**1.632**	**1.925**		1.536	1.515
Direction of Travel	Crash involving vehicles moving in opposite directions	**2.545**		**2.296**	**3.089**		1.627	**2.289**
	Crash involving vehicles moving in perpendicular directions	0.577	**0.361**	**0.590**	0.660	**0.449**	0.476	0.573
	Crash involving vehicles moving in the same direction	**3.595**	**2.959**	3.515	**4.142**	**1.763**	3.129	3.651
Count of Signalized Intersections		73	6	67	61	12	72	73
Count of Unsignalized Intersections		813	414	399	336	477	246	389

Green cells represent CMFs less than one (improvement in safety condition).

Red cells represent CMFs greater than one (worsening safety condition).

Blank cells correspond to statistically insignificant CMFs.

Bolded CMFs are those meeting three literature-based criteria (crash frequency > 300, reference-to-treatment sites ratio > 4:1, CDP < 5%).

Underlined CMFs are obtained using three years of crash data instead of five years.

Severity Analysis

The CMFs for KABCO (total) crashes range from approximately 1.5 to 2.5, generally increasing for more complex intersection types like divided intersections (CMF = 2.02). These values that exceed 2 may suggest potential overestimation or unique local conditions. For KAB (fatal, serious, and minor injury) crashes, only one CMF was statistically significant. The value of that CMF is 0.282. However, the sample size for signalized intersections is only 12, which is low. Furthermore, the 71.8% reduction in injury crashes may be an overestimate. The CMFs for CO (possible injury and property damage) crashes and PDO (property damage-only) crashes show a similar pattern, with higher values for more complex intersection types. These values are consistent with an increase in low-severity crashes.

Manner of Collision Analysis

Rear-end crashes have the highest CMFs, exceeding 3.5 across all intersection types except undivided intersections and intersections with a maximum of one leg with a separate right turn. The large CMFs for rear-end crashes are consistent with the literature, where studies have found that signalization tends to increase rear-end collisions due to abrupt stopping behavior. On the other hand, broadside crashes have CMFs less than 1, indicating a reduction in crashes involving vehicles entering the intersection from approaches at a perpendicular angle, which aligns with the expected results from a reduction in crossing conflicts.

Same-direction sideswipe crashes have higher CMFs, generally between 2 and 3. This crash increase may be associated with the stop-and-go traffic pattern at signalized intersections, which leads to lane-changing behavior to avoid stopping. It may also be associated with lanes merging or dropping near signalized intersections. Furthermore, angle crashes have CMFs greater than 1, indicating increased crashes at signalized intersections. Although a reduction in crossing conflicts is expected, this increase in angle crashes may be associated with permissive turn phasing, which will be discussed later.

Vehicle Action Analysis

The CMFs for crashes involving stopped vehicles are consistently high (e.g., 2.835 for three-leg intersections), which aligns with the increase in sudden stops and rear-end collisions due to signalization. However, these values are somewhat larger than expected, especially for undivided intersections and intersections with separate left-turn lanes. Regarding turn-related crashes, left-turn crashes have moderate CMFs, mostly ranging from 1.5 to 2, suggesting partial mitigation of conflicts but an increase in crashes due to the potential presence of permissive turning phases. Right-turn crashes show similar CMFs to left-turn crashes.

Direction of Travel Analysis

The CMFs for crashes involving perpendicular directions of travel are consistently below 1, reflecting the effectiveness of signalization. This is consistent with expectations and with the

CMF values for broadside crashes, as signalization eliminates many crossing conflicts. For crashes involving vehicles moving in opposite directions, the CMFs range from 1.6 to 3. The higher CMFs for opposite-direction crashes (e.g., 3.1 for divided intersections) may indicate unique issues like insufficient signal timing or poor visibility, which merit further investigation. The CMFs for same-direction crashes are the highest in this category, with values exceeding 4 at divided intersections. This aligns with the increase in rear-end and sideswipe same-direction collisions noted above.

Validation

The following subsections highlight the findings of the three validation methodologies conducted in this research project.

Literature-Based Validation

The calculated CMFs were validated by comparing them with values from the literature, specifically from studies summarized in the FHWA CMF Clearinghouse. The maximum and minimum CMF values for each crash type from these studies are presented in Table 8. A calculated CMF was considered to be validated if it fell within the range of CMFs reported in the literature. The CMFs for both rear-end and KABC (fatal through possible injury) crashes for undivided high-speed intersections fall within the range of values from the literature, confirming their validity.

Table 8. CMF ranges in the signal installation literature

Crash Type	Minimum CMF	Maximum CMF
Angle	0.230	0.700
Left turn	0.400	0.500
Rear End	1.427	1.950
KABCO	0.560	0.840
KABC	0.465	0.860
PDO	0.898	0.898

Supplemental CMFs were developed using three years of crash data. This analysis resulted in two additional CMFs that did not exist in the five-year analysis. These two CMFs are for undivided intersections and for KABCO (total) crashes and crashes involving a vehicle turning left. The CMF for KABCO crashes is 0.798, which falls within the range of minimum and maximum values reported in the literature, validating its reliability. Similarly, the CMF for crashes involving left-turning vehicles is 0.624. While this value does not fall strictly within the range of values reported in the literature, it can be considered reasonable and effectively validated, providing additional insights into crash mitigation at these types of intersections.

Hypothesis Tests of Proportions

Table 9 functions as a validation tool for comparing and checking the alignment of the obtained CMF values with the results of hypothesis tests of proportions. The colors shown in the table mean the following:

- **Green**: Both the proportions test and the CMF indicate a reduction in the analyzed crash type after signal installation.
- **Red**: Both the proportions test and the CMF indicate an increase in the analyzed crash type after signal installation.
- **Black**: The proportions test and the CMF do not align, showing a mismatch.
- **Blue**: Insufficient evidence exists to reject the null hypothesis in the proportions test.
- **White**: No statistically significant CMF was identified.

Table 9. Alignment check between CMFs and hypothesis tests of proportions

		Intersection Category						
	Crash Type	**All**	**3-Leg**	**4-Leg**	**Divided**	**Undivided**	**Separate RT**	**Separate LT**
Severity	KABC							
	KAB							
	CO							
	O							
Manner of Collision	Rear end							
	Sideswipe same-direction							
	Angle							
	Broadside							
	Head On							
Vehicle Action	Crash involving a stopped vehicle							
	Crash involving a left-turning vehicle							
	Crash involving a right-turning vehicle							
Direction of Travel	Crash involving vehicles moving in opposite directions							
	Crash involving vehicles moving in perpendicular directions							
	Crash involving vehicles moving in the same direction							

The analysis revealed several key findings regarding the relationship between the hypothesis test of proportions results and the CMF values for various crash types. Both methods consistently indicate a reduction in broadside crashes and crashes involving vehicles moving in perpendicular directions following signal installation. Conversely, both approaches show an increase in six crash types: CO crashes, PDO crashes, rear-end crashes, angle crashes, crashes involving stopped vehicles, and crashes involving vehicles heading in the same direction.

For several crash types, the hypothesis test of proportions results show no significant difference in proportions between signalized and unsignalized intersections for the majority of the high-speed intersection subsets. These crash types include sideswipe same-direction crashes, head-on crashes, crashes involving right-turning vehicles, and crashes involving vehicles moving in opposite directions. As a result, the CMFs associated with these crash types were excluded from the final recommendations due to a lack of statistical significance.

Additionally, a discrepancy was observed for two crash types: KABC crashes and crashes involving left-turning vehicles. While the CMFs suggest an increase in these crash types after signal installation, the hypothesis test of proportions results indicate the opposite.

Local Agency Outreach

Useful phasing information was obtained from 18 out of the 34 local agencies contacted, covering 53 signalized intersections. The collected data included details on left-turn and right-turn phasing for each intersection leg, with classifications of protected, permitted, or protected-permitted.

Since the primary focus of this validation effort was on angle and left-turn crashes, the reported phasing information was aggregated into broader categories, as presented in Table 10. The analysis revealed that 64% of the signalized intersections include a permitted phase or a combination of permitted and protected phasing. Permitted phasing requires drivers to make gap acceptance decisions, which can introduce variability in driver behavior and lead to an increased likelihood of conflict, particularly for left-turning vehicles interacting with opposing through traffic. This characteristic of permitted phasing helps explain the high CMF values obtained for angle and left-turn crashes. This conclusion was supported by comparing the average angle and left-turn crash rates at all-protected signals and signals with a permitted phase. Table 11 shows that signals that have only protected left-turn phasing have lower average angles and left-turn crash rates.

Table 10. Signal phasing summary

Left-Turn Phasing Type	Count of Intersections
All Protected	19
All Protected-Permitted	7
50/50 Protected/Permitted	12
50/50 Protected-Permitted/Permitted	5
50/50 Protected-Permitted/Protected	3
75/25 Protected-Permitted/Protected	1
25/50/25 Protected-Permitted/Protected/Permitted	3
25/75 Protected-Permitted/Protected	2
50/25/25 Protected-Permitted/Protected/Permitted	1

Table 11. Average crash rate comparison by signal phasing

Signal Phasing Type	Average Angle Crash Rate	Average LT Crash Rate
Signals with a Permitted Phase	0.408	0.983
All-Protected Signals	0.293	0.828

This conclusion was also supported by comparing the major cause distribution of angle crashes at all-protected signals and signals with a permitted phase, as shown in Table 12. The top major cause of angle crashes at intersections with a permitted phase is failure to yield the right of way (FTYROW) while making a left turn, which may be associated with permitted phasing. On the other hand, angle crashes at all-protected signals are mainly associated with running a traffic signal.

Table 12. Major cause comparison of angle crashes by signal phasing

Major Cause	Signals with a Permitted Phase	All-Protected Signals
FTYROW: Making a Left Turn	62%	31%
Ran Traffic Signal	14%	40%
Made Improper Turn	9%	7%
Unknown	3%	8%
Other (Explain in Narrative): Other	4%	4%
FTYROW: Making A Right Turn On Red Signal	1%	4%

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This research project used cross-sectional analysis to develop a comprehensive list of Iowa-specific CMFs for signalizing high-speed intersections. Multiple validation steps were performed to ensure the robustness of these CMFs, including examining various aspects of the data and comparing the results with values reported in the literature. The finalized list of CMFs is presented in Table 13, representing the culmination of rigorous analysis and verification efforts. The key takeaways from this research are as follows:

1. Traffic signal installation is a countermeasure that may be considered at high-speed intersections. This research reveals that such installations increase all but broadside crashes on most facility types.
   a. Overall intersection crashes are predicted to increase.
   b. The intersection will not experience a significant reduction in overall serious injury crashes.
   c. The intersection may experience a reduction in broadside/right-angle ("T-bone") collisions, although the intersection will still experience some broadside crashes from red light running and permissive left-turn collisions.
   d. The intersection will also experience an increase in mainline rear-end collisions. Due to higher speeds, these rear-end crashes will be more severe.
2. KABCO crash reductions were only observed on undivided intersections. This may be because these intersections generally occur in more suburban/urban transition zones, where driver expectancy of encountering traffic signals is increased.

Recommendations and Considerations

When selecting the right countermeasure at high-speed intersections, the research recommends taking into consideration the following points:

1. Alternatives to high-speed traffic signals should be evaluated before high-speed traffic signals are proposed. Alternative intersections should be considered, such as the following:
   a. Roundabout
   b. Reduced-conflict intersection
   c. Right-in/right-out
   d. Median closure
2. The trade-offs of high-speed traffic signals should be communicated to the traveling public and local officials during intersection evaluation.
3. Any potential traffic signal at a high-speed location should be part of a corridor access management agreement.
   a. This agreement should consider other existing intersections that may already be signalized or other intersections that may also be signalized in the near term.
   b. The impact of the first signal can set a precedent for future intersections.

c. This agreement should note “major intersections” instead of “pre-determined signal locations.”

4. Protected-only left-turn phasing is strongly recommended over permissive or protected-permissive phasing. This could mean all-day protected left-turn movements or left-turn phasing that varies based on time-of-day peak traffic and/or left-turn queue detection.

Table 13. Final CMF recommendations

Crash Type		Intersection Category: All	3-Leg	4-Leg	Divided	Undivided	Separate RT	Separate LT
Severity	KABCO	**1.795**	**1.504**	**1.730**	**2.023**	<u>**0.798**</u>	1.453	**1.722**
	KABC	**1.440**		**1.398**	**1.614**	0.590	1.202	**1.323**
	KAB					0.282		
	CO	**2.004**	**1.664**	**1.93**	**2.278**		1.586	**1.961**
	O	**2.033**	**1.652**	**1.958**	**2.328**		1.629	**2.024**
Manner of Collision	Rear end	3.690	**3.408**	3.520	**4.405**	**1.761**	3.311	**3.865**
	Sideswipe same-direction	2.969	2.224	3.141	2.936	2.812	2.815	2.814
	Angle	**2.436**		**2.631**	3.229		1.820	**2.390**
	Broadside	0.561	**0.383**	**0.565**	0.639	**0.436**	0.452	0.563
	Head on	2.276		2.084	4.221			
Vehicle Action	Crash involving a stopped vehicle	3.764	2.835	3.733	**4.752**	**1.788**	3.142	4.112
	Crash involving a left-turning vehicle	**1.730**		**1.773**	**1.987**	<u>**0.624**</u>	1.311	**1.620**
	Crash involving a right-turning vehicle	**1.680**		**1.632**	**1.925**		1.536	1.515
Direction of Travel	Crash involving vehicles moving in opposite directions	**2.545**		**2.296**	**3.089**		1.627	**2.289**
	Crash involving vehicles moving in perpendicular directions	0.577	**0.361**	**0.590**	0.660	**0.449**	0.476	0.573
	Crash involving vehicles moving in the same direction	**3.595**	**2.959**	3.515	**4.142**	**1.763**	3.129	3.651
Literature validation only								
Proportions test validation only								
Both validation tests								
Not statistically significant – Value not reported								
Bolded CMFs are those meeting three literature-based criteria (crash frequency > 300, reference-to-treatment sites ratio > 4:1, CDP < 5%).								

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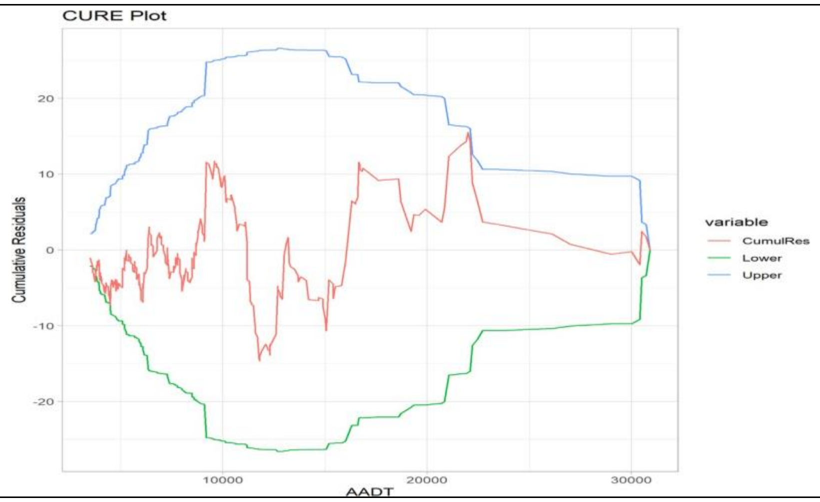
APPENDIX A. SPFS DETAILED MODELS AND CURE PLOTS

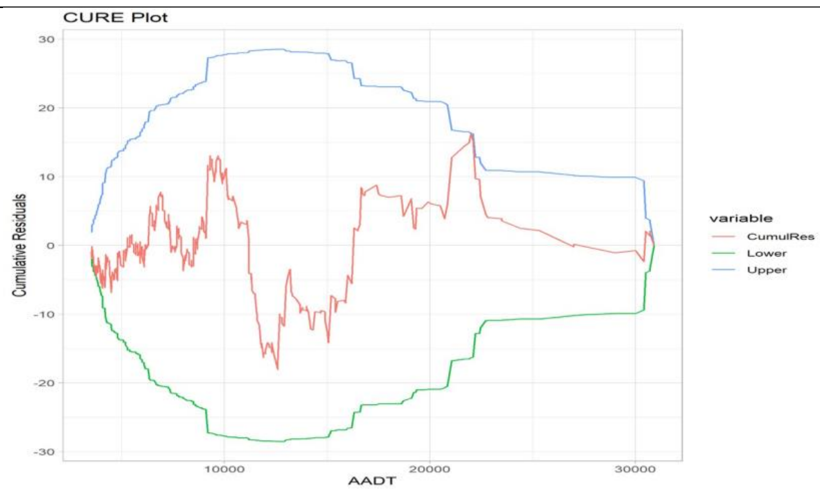
Parameter	Value
Intersection Type	4 Leg Intersection
Crash Type	angle
Sample	466
Crashes	301
R2	0.5592531
CDP	3.648069
MACD	15.51221
MAD	0.654735
Alpha	-8.502465
Beta1	0.2890754
Beta2	0.7082957
Beta3	0.9671822
p value	2.055257e-08
CMF	2.630522
AIC	814.9659

CURE Plot



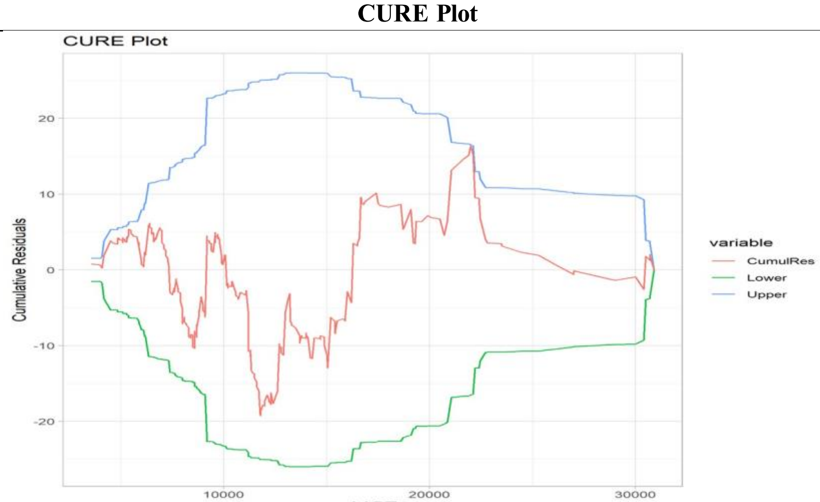
Parameter	Value
Intersection Type	All
Crash Type	angle
Sample	886
Crashes	384
R2	0.5650594
CDP	0.3386005
MACD	18.05508
MAD	0.4851122
Alpha	-9.060243
Beta1	0.3223255
Beta2	0.7409329
Beta3	0.890366
p value	8.196501e-09
CMF	2.436021
AIC	1226.491

CURE Plot



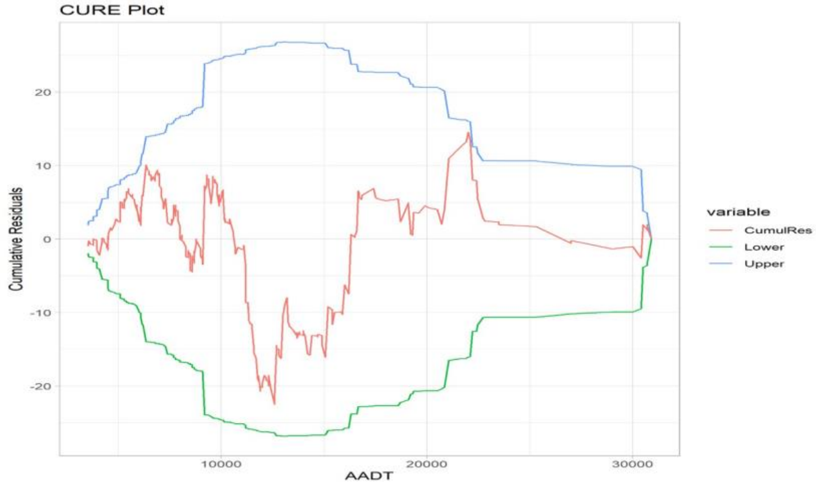
Parameter	Value
Intersection Type	Divided
Crash Type	angle
Sample	397
Crashes	269
R2	0.5639024
CDP	0.2518892
MACD	19.29377
MAD	0.6633547
Alpha	-8.399344
Beta1	0.2416787
Beta2	0.7292256
Beta3	1.172187
p value	1.726051e-10
CMF	3.229046
AIC	684.4217

CURE Plot



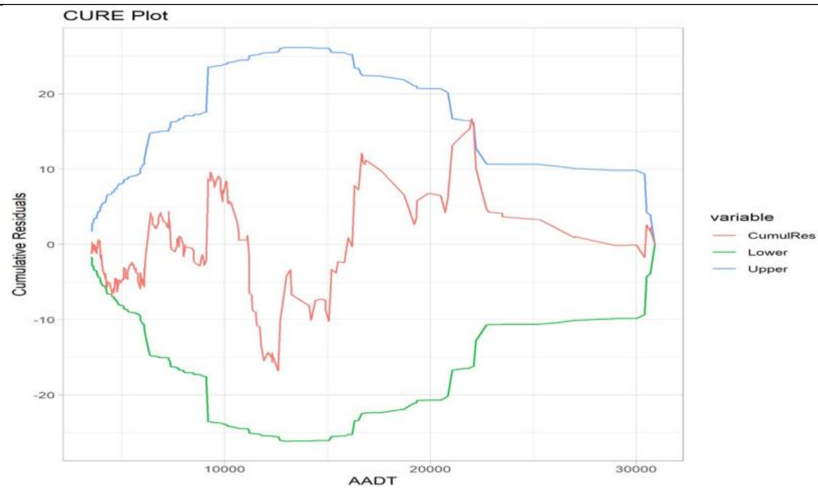
Parameter	Value
Intersection Type	Separate LT
Crash Type	angle
Sample	462
Crashes	304
R2	0.5508112
CDP	0.2164502
MACD	22.49944
MAD	0.6557891
Alpha	-8.916647
Beta1	0.296216
Beta2	0.7559031
Beta3	0.8712069
p value	3.583482e-07
CMF	2.389793
AIC	813.5517

CURE Plot



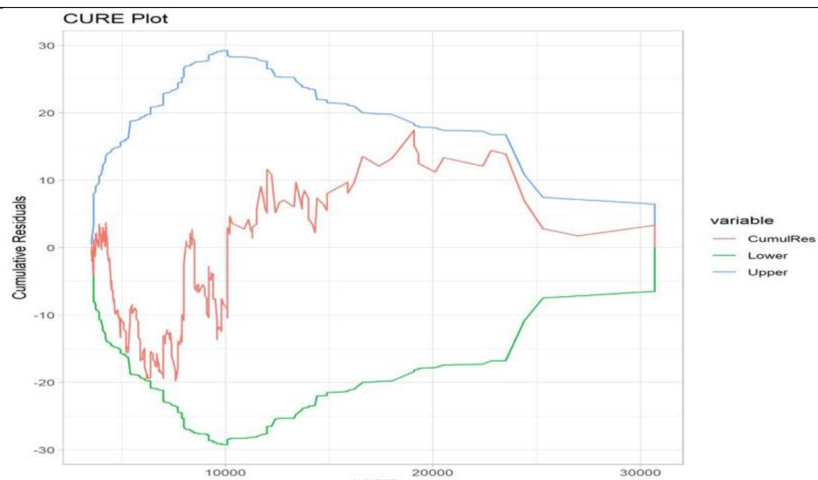
Parameter	Value
Intersection Type	Separate RT
Crash Type	angle
Sample	318
Crashes	273
R2	0.5286874
CDP	1.257862
MACD	16.79626
MAD	0.8084937
Alpha	-9.45768
Beta1	0.3704989
Beta2	0.766091
Beta3	0.59869
p value	0.002256928
CMF	1.819733
AIC	663.9594

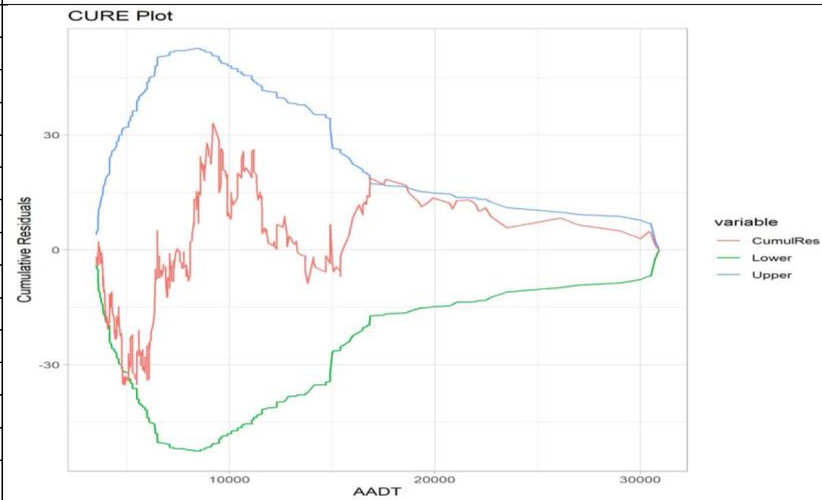
CURE Plot

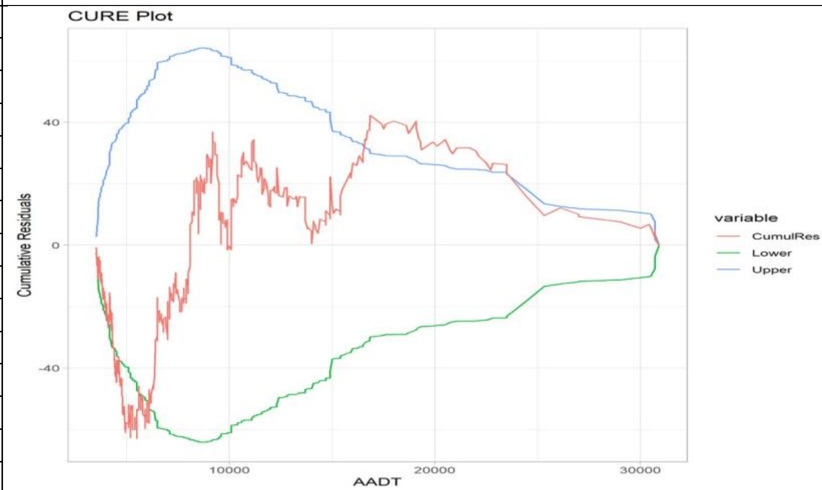


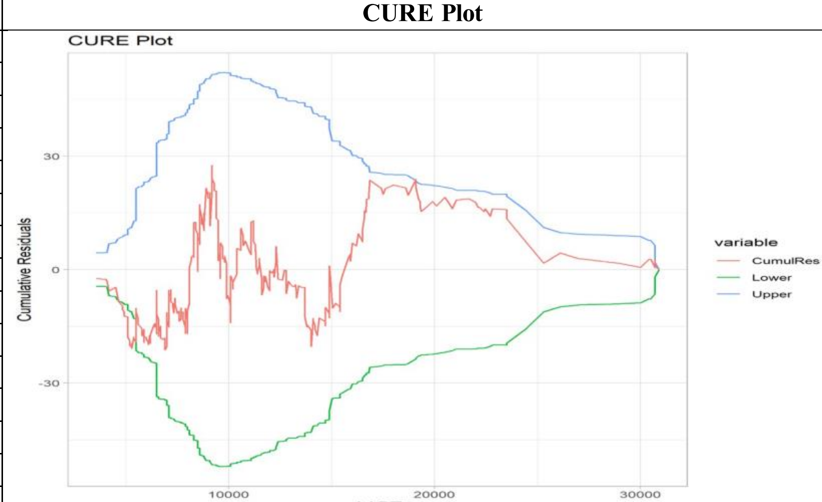
Parameter	Value
Intersection Type	3 Leg Intersection
Crash Type	broadside
Sample	420
Crashes	332
R2	0.1268298
CDP	1.904762
MACD	19.75721
MAD	0.879481
Alpha	-12.42044
Beta1	0.9711531
Beta2	0.5759846
Beta3	-0.9590143
p value	0.003539788
CMF	0.3832705
AIC	1029.009

CURE Plot



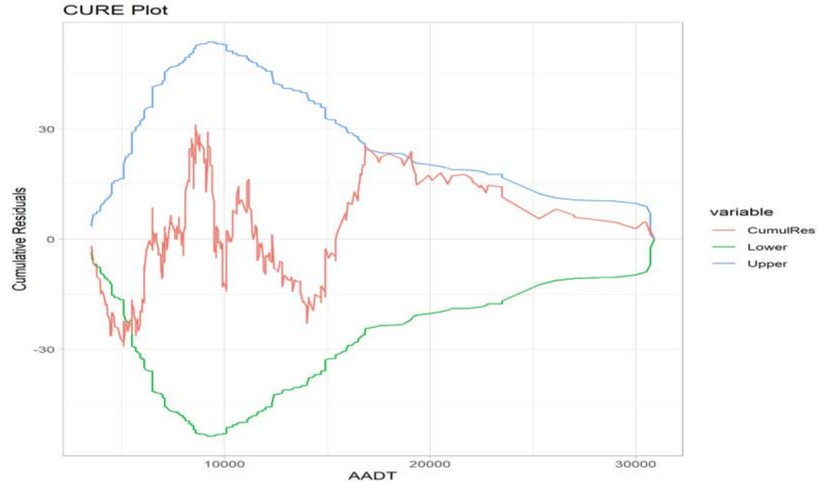
Parameter	Value	CURE Plot
Intersection Type	4 Leg Intersection	
Crash Type	broadside	
Sample	466	
Crashes	1242	
R2	0.4334838	
CDP	4.506438	
MACD	35.31956	
MAD	1.719504	
Alpha	-4.757085	
Beta1	0.2174903	
Beta2	0.5715014	
Beta3	-0.5702985	
p value	1.740435e-10	
CMF	0.5653566	
AIC	1998.192	

Parameter	Value	CURE Plot
Intersection Type	All	
Crash Type	broadside	
Sample	886	
Crashes	1574	
R2	0.3746391	
CDP	30.69977	
MACD	62.91562	
MAD	1.445064	
Alpha	-7.368868	
Beta1	0.4171751	
Beta2	0.6507186	
Beta3	-0.5783039	
p value	8.737009e-12	
CMF	0.5608488	
AIC	3270.593	

Parameter	Value	CURE Plot
Intersection Type	Divided	
Crash Type	broadside	
Sample	397	
Crashes	996	
R2	0.3609495	
CDP	6.549118	
MACD	27.60467	
MAD	1.81834	
Alpha	-4.40299	
Beta1	0.1404552	
Beta2	0.6032084	
Beta3	-0.4472614	
p value	1.839907e-06	
CMF	0.6393767	
AIC	1753.372	

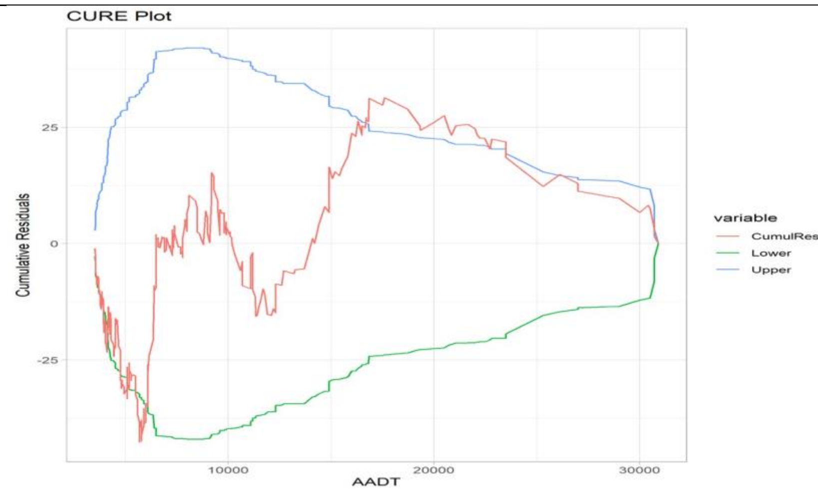
Parameter	Value
Intersection Type	Separate LT
Crash Type	broadside
Sample	462
Crashes	1136
R2	0.3720616
CDP	12.98701
MACD	31.11505
MAD	1.788844
Alpha	-5.457821
Beta1	0.2542099
Beta2	0.6090384
Beta3	-0.574121
p value	2.530219e-10
CMF	0.5631997
AIC	2011.749

CURE Plot



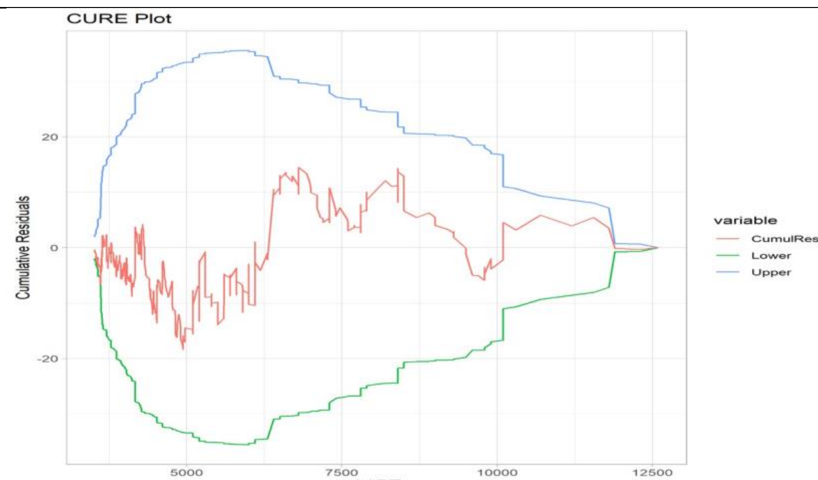
Parameter	Value
Intersection Type	Separate RT
Crash Type	broadside
Sample	318
Crashes	841
R2	0.5175879
CDP	27.04403
MACD	42.66188
MAD	1.743359
Alpha	-6.703511
Beta1	0.3678674
Beta2	0.6524686
Beta3	-0.7935324
p value	7.012919e-14
CMF	0.4522445
AIC	1352.329

CURE Plot



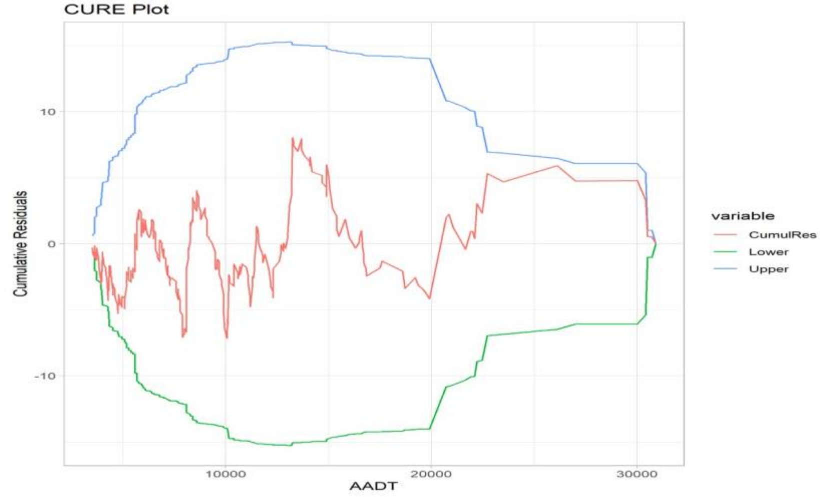
Parameter	Value
Intersection Type	Undivided
Crash Type	broadside
Sample	489
Crashes	578
R2	0.3129055
CDP	0.204499
MACD	18.3814
MAD	1.104865
Alpha	-8.343099
Beta1	0.4588795
Beta2	0.728508
Beta3	-0.8290974
p value	0.0002498093
CMF	0.4364431
AIC	1491.636

CURE Plot



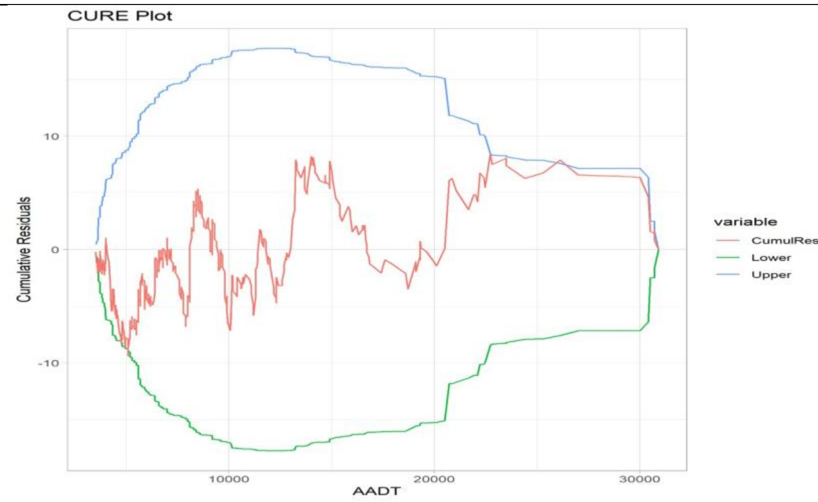
Parameter	Value
Intersection Type	4 Leg Intersection
Crash Type	Vehicle changing lanes
Sample	466
Crashes	176
R2	0.6193117
CDP	1.502146
MACD	8.03283
MAD	0.4430716
Alpha	-11.15059
Beta1	0.8608396
Beta2	0.3138449
Beta3	0.5785548
p value	0.009275035
CMF	1.783459
AIC	659.9516

CURE Plot



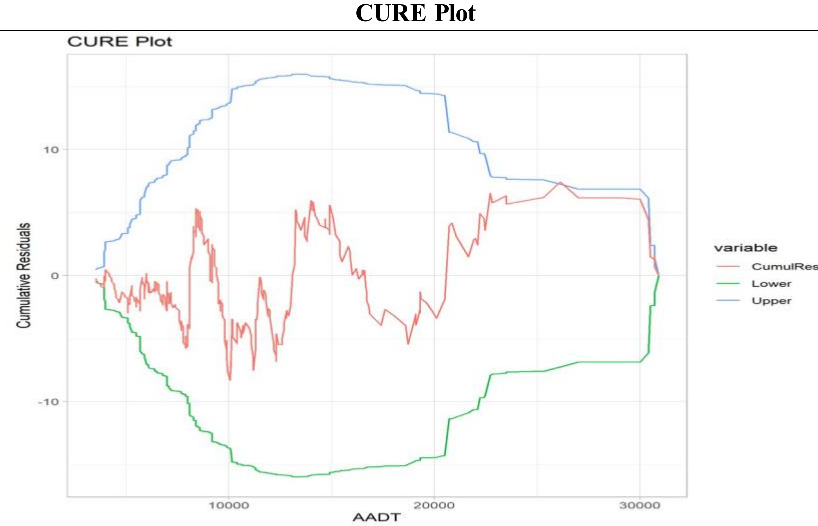
Parameter	Value
Intersection Type	All
Crash Type	Vehicle changing lanes
Sample	886
Crashes	242
R2	0.6090127
CDP	3.273138
MACD	9.378979
MAD	0.3505452
Alpha	-13.0028
Beta1	1.041975
Beta2	0.3267315
Beta3	0.5502926
p value	0.005633589
CMF	1.73376
AIC	1015.689

CURE Plot



Parameter	Value
Intersection Type	Separate LT
Crash Type	Vehicle changing lanes
Sample	462
Crashes	195
R2	0.6152568
CDP	1.515152
MACD	8.317003
MAD	0.4881691
Alpha	-12.5988
Beta1	0.971644
Beta2	0.3756818
Beta3	0.4246057
p value	0.04627968
CMF	1.528987
AIC	707.4984

CURE Plot

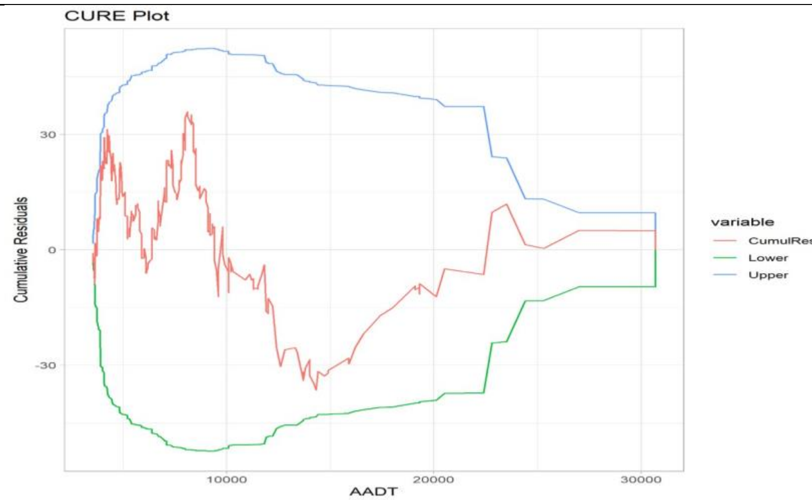


Parameter	Value
Intersection Type	Undivided
Crash Type	Vehicle changing lanes
Sample	489
Crashes	56
R2	0.2540474
CDP	3.680982
MACD	5.359162
MAD	0.1976302
Alpha	-10.37524
Beta1	1.008215
Beta2	-0.08864716
Beta3	1.268939
p value	0.02031495
CMF	3.557077
AIC	360.4192

CURE Plot

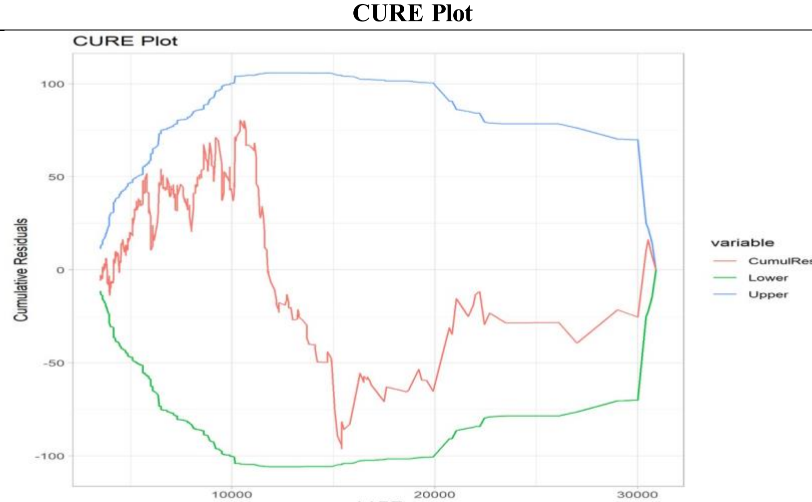
Parameter	Value
Intersection Type	3 Leg Intersection
Crash Type	CO
Sample	420
Crashes	1007
R2	0.4723153
CDP	0.7142857
MACD	36.4575
MAD	1.701866
Alpha	-7.316378
Beta1	0.5578911
Beta2	0.5218577
Beta3	0.5090343
p value	0.0001292149
CMF	1.663684
AIC	1736.633

CURE Plot



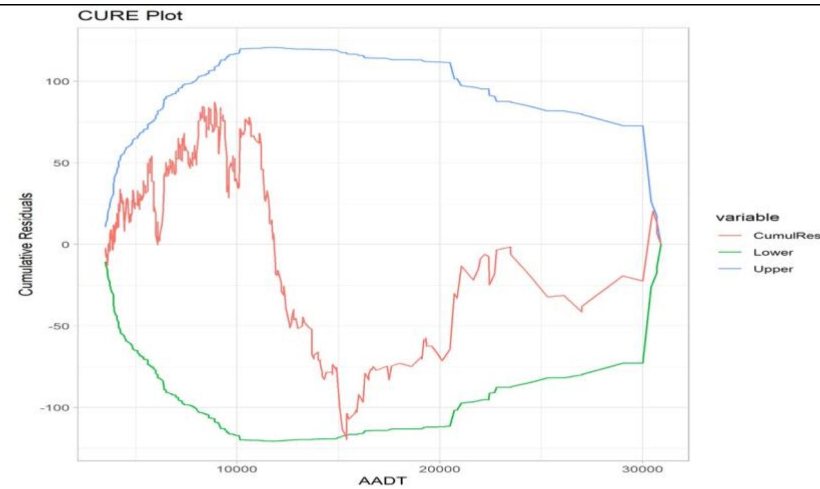
Parameter	Value
Intersection Type	**4 Leg Intersection**
Crash Type	CO
Sample	466
Crashes	3060
R2	0.8370551
CDP	0.2145923
MACD	96.10932
MAD	3.012321
Alpha	-6.874475
Beta1	0.5168632
Beta2	0.546507
Beta3	0.6574929
p value	4.895234e-35
CMF	1.929948
AIC	2593.446

CURE Plot



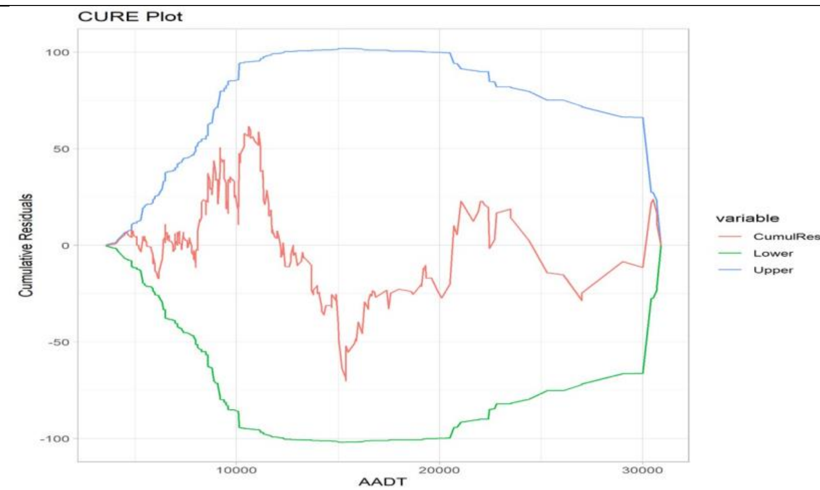
Parameter	Value
Intersection Type	All
Crash Type	CO
Sample	886
Crashes	4067
R2	0.8152474
CDP	0.3386005
MACD	119.8283
MAD	2.426215
Alpha	-7.157277
Beta1	0.5261108
Beta2	0.5621462
Beta3	0.6951644
p value	1.141433e-47
CMF	2.004038
AIC	4367.357

CURE Plot



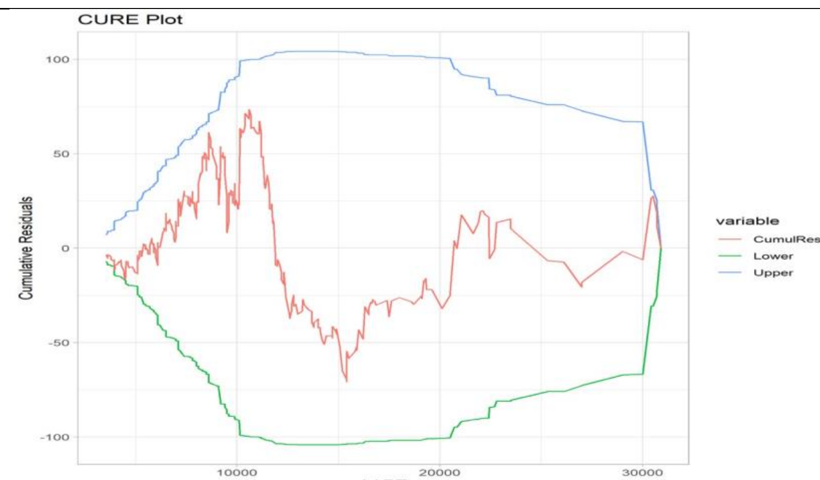
Parameter	Value
Intersection Type	Divided
Crash Type	CO
Sample	397
Crashes	2720
R2	0.8456465
CDP	0.2518892
MACD	70.19007
MAD	3.130714
Alpha	-7.994475
Beta1	0.6082816
Beta2	0.556656
Beta3	0.8232637
p value	8.538416e-49
CMF	2.277922
AIC	2189.732

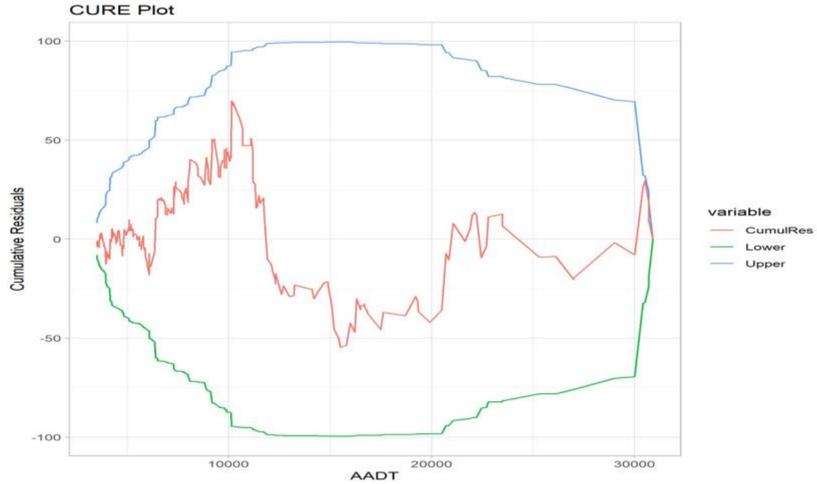
CURE Plot

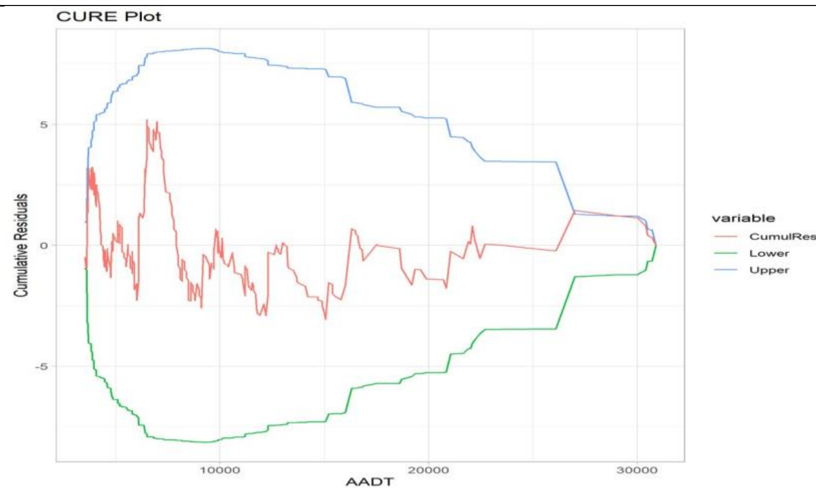


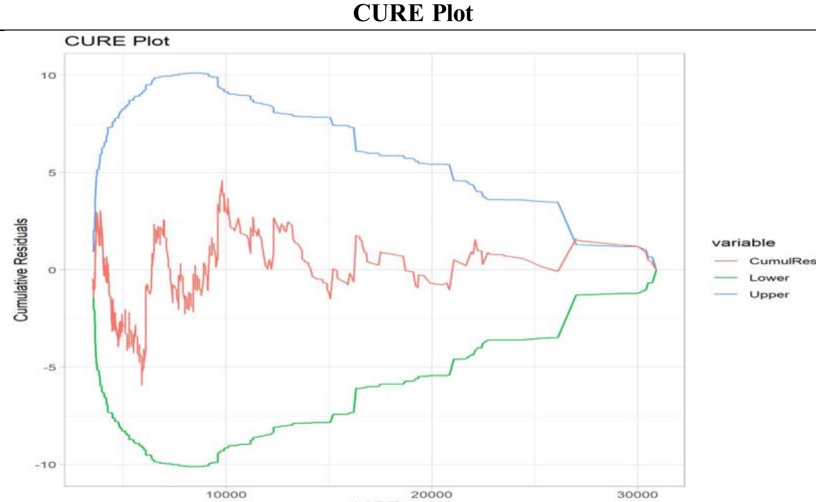
Parameter	Value
Intersection Type	Separate LT
Crash Type	CO
Sample	462
Crashes	2986
R2	0.8459044
CDP	0.2164502
MACD	73.31703
MAD	2.926532
Alpha	-8.848283
Beta1	0.6890195
Beta2	0.5788012
Beta3	0.6734252
p value	4.991897e-35
CMF	1.960943
AIC	2464.213

CURE Plot



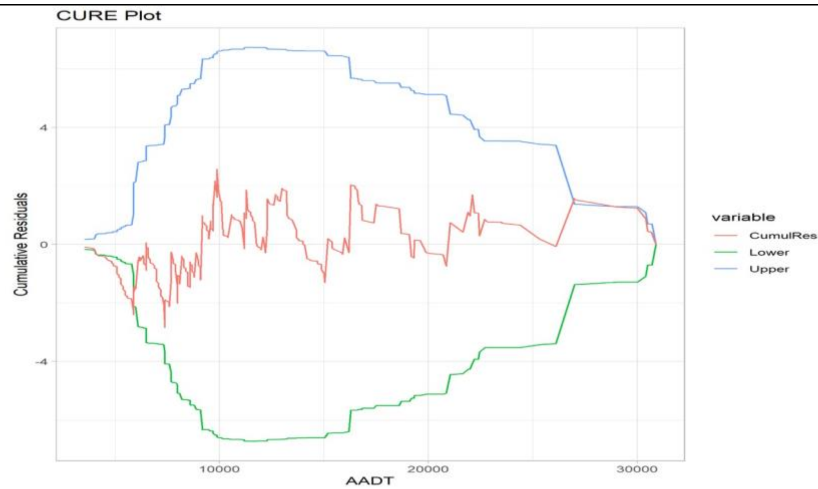
Parameter	Value	CURE Plot
Intersection Type	Separate RT	
Crash Type	CO	
Sample	318	
Crashes	2589	
R2	0.845499	
CDP	0.3144654	
MACD	69.73279	
MAD	3.413479	
Alpha	-8.20424	
Beta1	0.628048	
Beta2	0.5971663	
Beta3	0.4610768	
p value	1.059852e-13	
CMF	1.585781	
AIC	1845.442	

Parameter	Value	CURE Plot
Intersection Type	4 Leg Intersection	
Crash Type	Head On	
Sample	466	
Crashes	69	
R2	0.972003	
CDP	0.6437768	
MACD	5.198628	
MAD	0.2248556	
Alpha	-2.693152	
Beta1	-0.4283051	
Beta2	0.636719	
Beta3	0.734404	
p value	0.03418698	
CMF	2.084239	
AIC	369.6523	

Parameter	Value	CURE Plot
Intersection Type	All	
Crash Type	Head On	
Sample	886	
Crashes	100	
R2	0.6509797	
CDP	1.128668	
MACD	5.913246	
MAD	0.1846577	
Alpha	-2.617392	
Beta1	-0.3913883	
Beta2	0.5701961	
Beta3	0.8224172	
p value	0.009007205	
CMF	2.275995	
AIC	596.2094	

Parameter	Value
Intersection Type	Divided
Crash Type	Head On
Sample	397
Crashes	45
R2	0.85794
CDP	9.823678
MACD	2.843918
MAD	0.1628514
Alpha	-2.946017
Beta1	-0.424781
Beta2	0.5870103
Beta3	1.440131
p value	0.0010496
CMF	4.22125
AIC	239.4059

CURE Plot

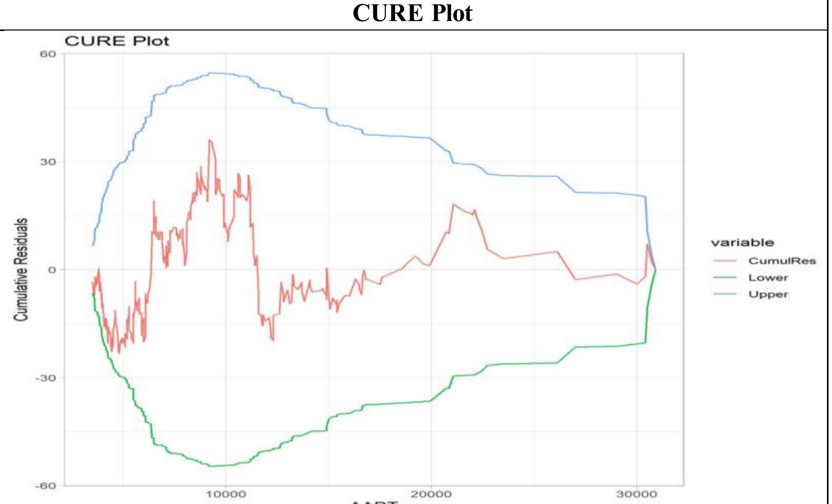


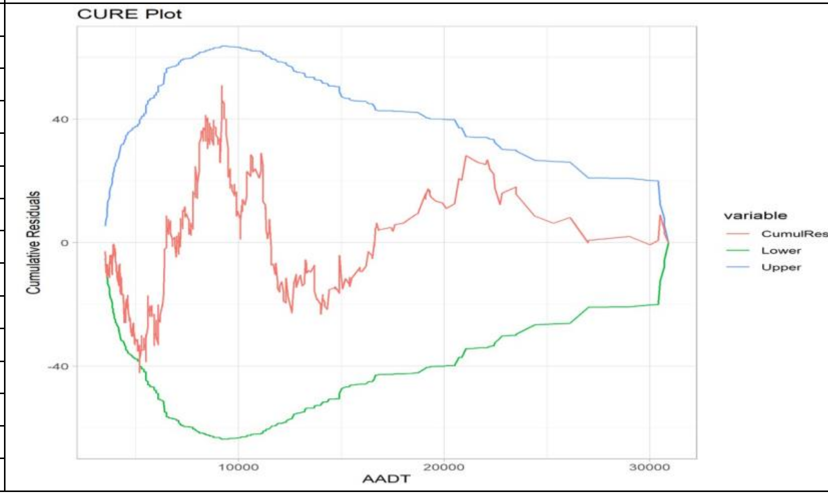
Parameter	Value
Intersection Type	Undivided
Crash Type	KAB
Sample	489
Crashes	364
R2	0.23206
CDP	8.997955
MACD	19.17867
MAD	0.7652326
Alpha	-8.92632
Beta1	0.7233999
Beta2	0.3963001
Beta3	-1.265155
p value	0.001668797
CMF	0.2821956
AIC	1148.792

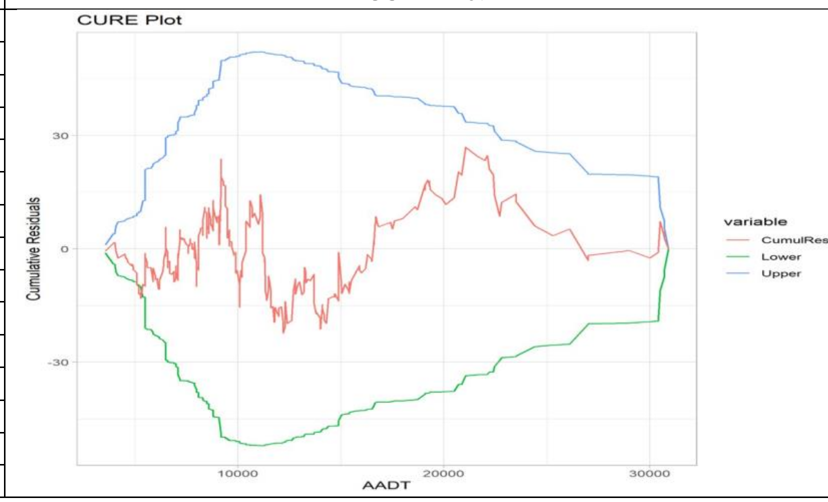
CURE Plot

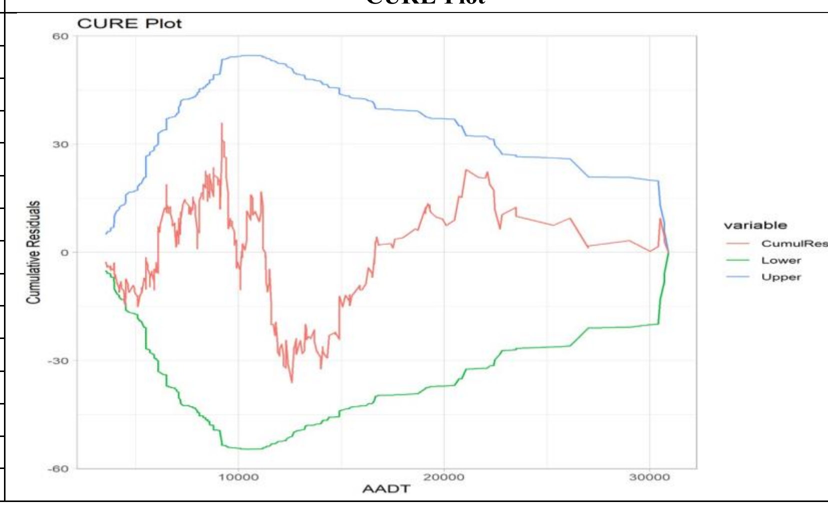
Parameter	Value
Intersection Type	4 Leg Intersection
Crash Type	KABC
Sample	466
Crashes	1426
R2	0.7246037
CDP	0.2145923
MACD	36.03626
MAD	1.78468
Alpha	-6.170738
Beta1	0.4511568
Beta2	0.4522157
Beta3	0.3347594
p value	1.747507e-05
CMF	1.397604
AIC	1980.992

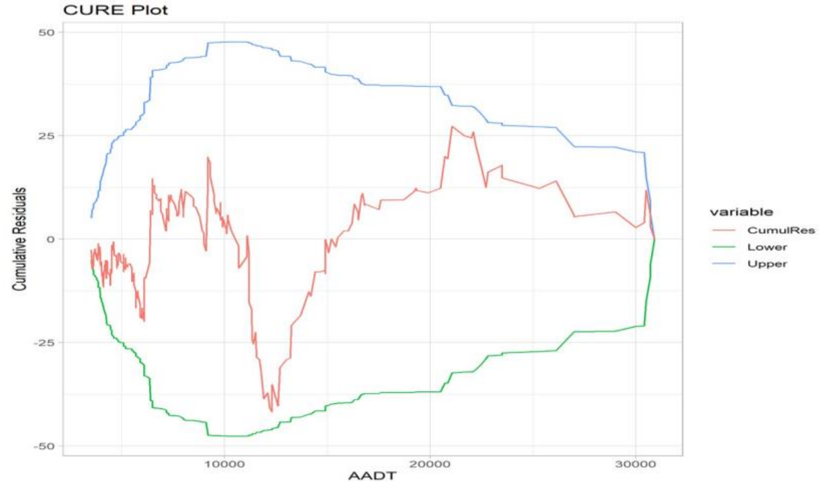
CURE Plot

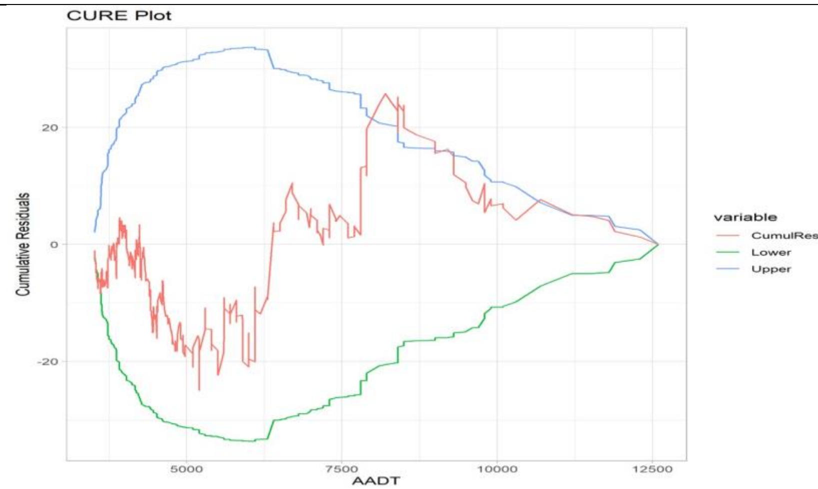


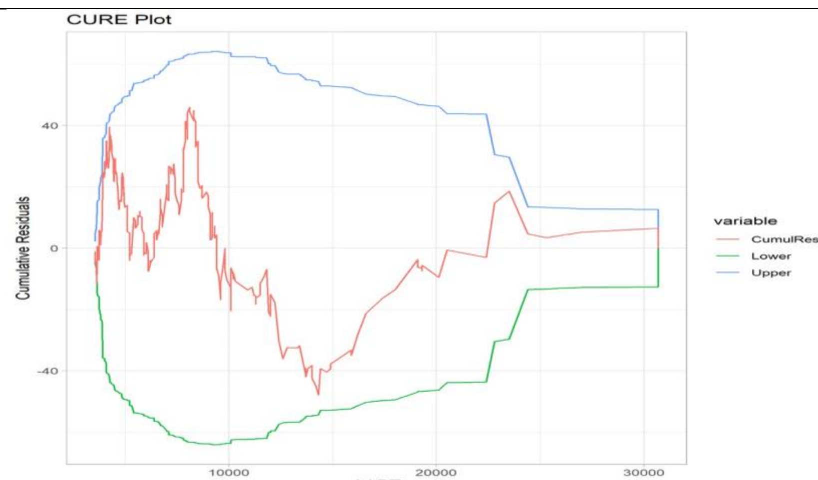
Parameter	Value	CURE Plot
Intersection Type	All	
Crash Type	KABC	
Sample	886	
Crashes	1937	
R2	0.7042783	
CDP	1.918736	
MACD	50.82389	
MAD	1.476437	
Alpha	-7.409569	
Beta1	0.5507548	
Beta2	0.4798549	
Beta3	0.364526	
p value	2.938221e-07	
CMF	1.439831	
AIC	3295.748	

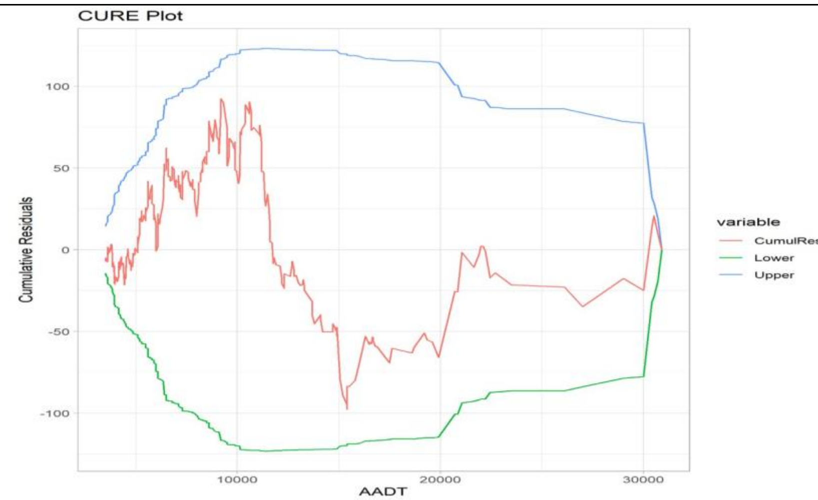
Parameter	Value	CURE Plot
Intersection Type	Divided	
Crash Type	KABC	
Sample	397	
Crashes	1273	
R2	0.7510573	
CDP	2.267003	
MACD	26.92031	
MAD	1.821808	
Alpha	-6.492912	
Beta1	0.4427719	
Beta2	0.4896535	
Beta3	0.4789578	
p value	2.543462e-09	
CMF	1.614391	
AIC	1704.591	

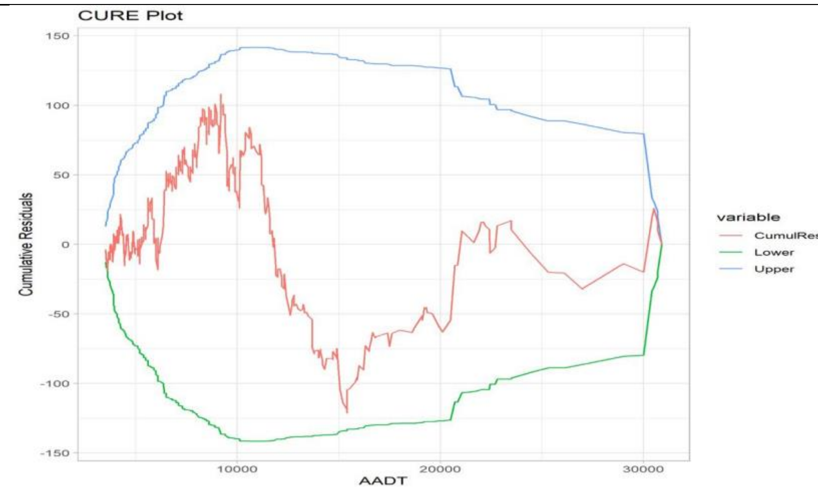
Parameter	Value	CURE Plot
Intersection Type	Separate LT	
Crash Type	KABC	
Sample	462	
Crashes	1395	
R2	0.7351175	
CDP	0.8658009	
MACD	36.19865	
MAD	1.799033	
Alpha	-7.77971	
Beta1	0.5649478	
Beta2	0.5179528	
Beta3	0.2800996	
p value	0.0003653559	
CMF	1.323262	
AIC	1960.232	

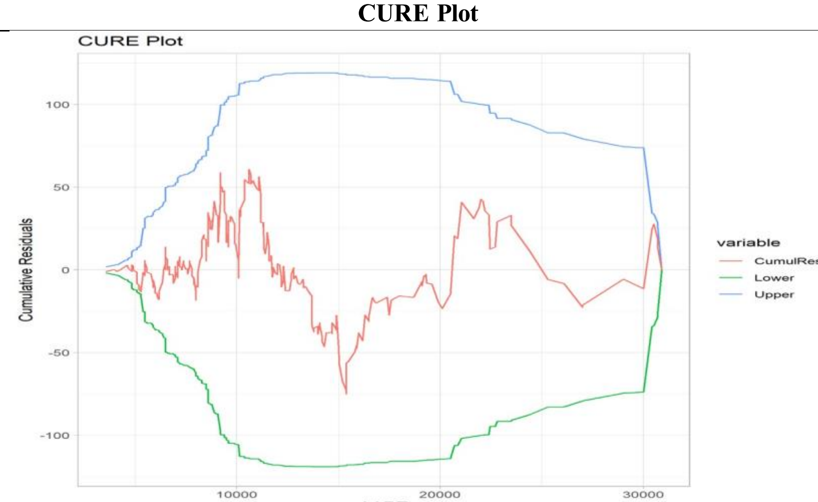
Parameter	Value	CURE Plot
Intersection Type	Separate RT	
Crash Type	KABC	
Sample	318	
Crashes	1114	
R2	0.7754094	
CDP	0.6289308	
MACD	41.76175	
MAD	1.848535	
Alpha	-7.647638	
Beta1	0.5848235	
Beta2	0.4900525	
Beta3	0.1842731	
p value	0.04391513	
CMF	1.202344	
AIC	1368.569	

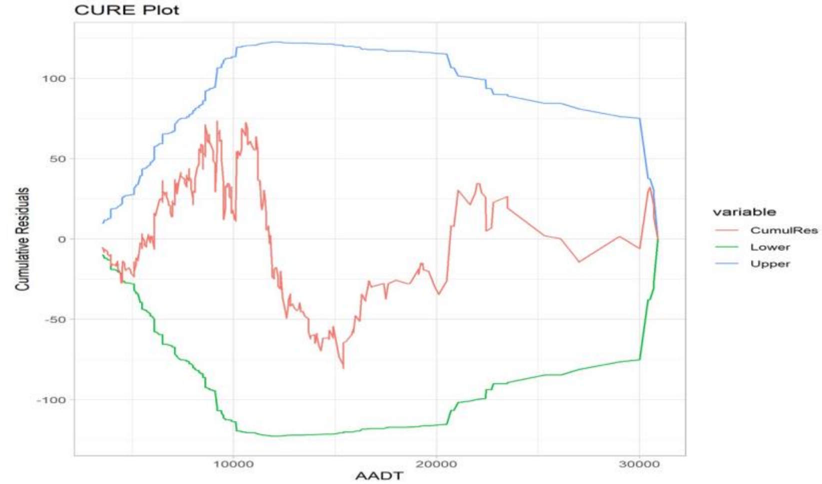
Parameter	Value	CURE Plot
Intersection Type	Undivided	
Crash Type	KABC	
Sample	489	
Crashes	664	
R2	0.2831507	
CDP	7.566462	
MACD	25.76449	
MAD	1.149935	
Alpha	-8.493676	
Beta1	0.7053834	
Beta2	0.4438241	
Beta3	-0.5273489	
p value	0.01404338	
CMF	0.5901675	
AIC	1564.134	

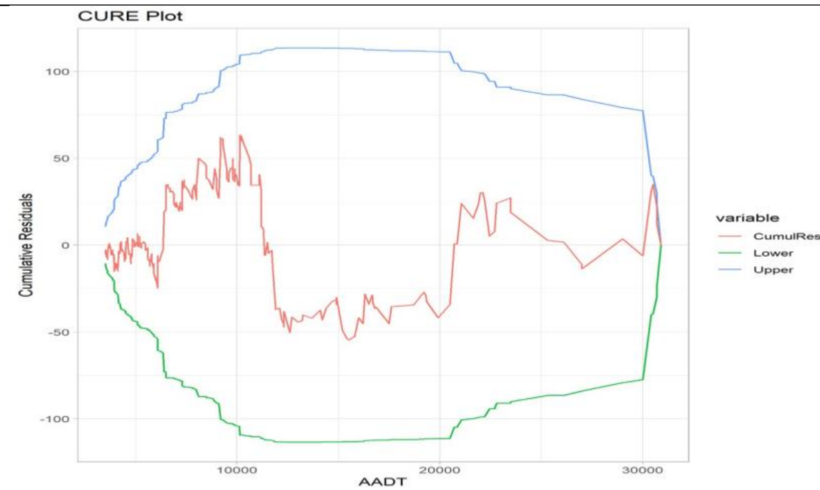
Parameter	Value	CURE Plot
Intersection Type	3 Leg Intersection	
Crash Type	KABCO	
Sample	420	
Crashes	1281	
R2	0.435175	
CDP	1.428571	
MACD	47.87507	
MAD	2.111777	
Alpha	-7.329554	
Beta1	0.6082555	
Beta2	0.4923325	
Beta3	0.4083551	
p value	0.0008125562	
CMF	1.504341	
AIC	1997.634	

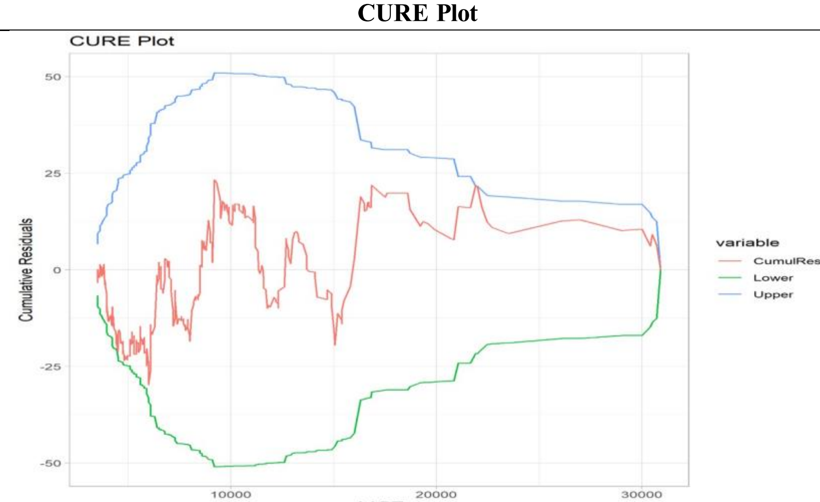
Parameter	Value	CURE Plot
Intersection Type	4 Leg Intersection	
Crash Type	KABCO	
Sample	466	
Crashes	3749	
R2	0.8137904	
CDP	0.2145923	
MACD	97.69698	
MAD	3.596586	
Alpha	-6.189488	
Beta1	0.4984976	
Beta2	0.5129052	
Beta3	0.5481026	
p value	2.591413e-30	
CMF	1.729967	
AIC	2910.147	

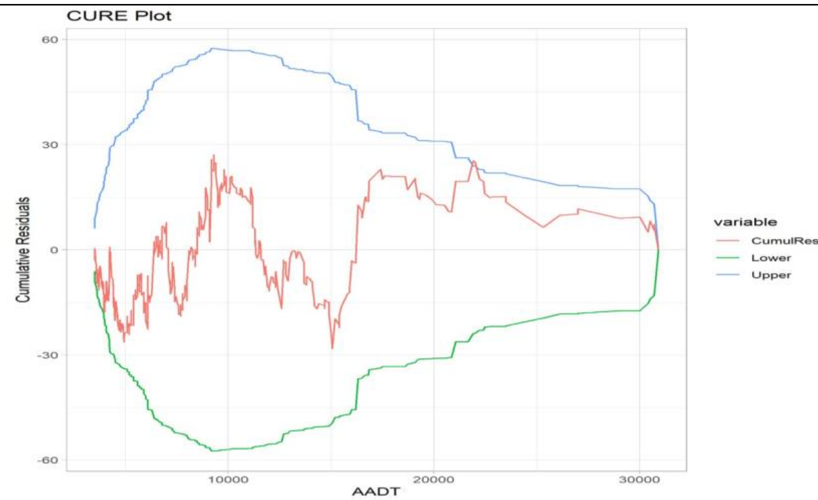
Parameter	Value	CURE Plot
Intersection Type	All	
Crash Type	KABCO	
Sample	886	
Crashes	5030	
R2	0.7903851	
CDP	0.1128668	
MACD	121.2016	
MAD	2.93202	
Alpha	-6.720194	
Beta1	0.5287463	
Beta2	0.5341773	
Beta3	0.5849732	
p value	1.438999e-41	
CMF	1.794943	
AIC	4979.341	

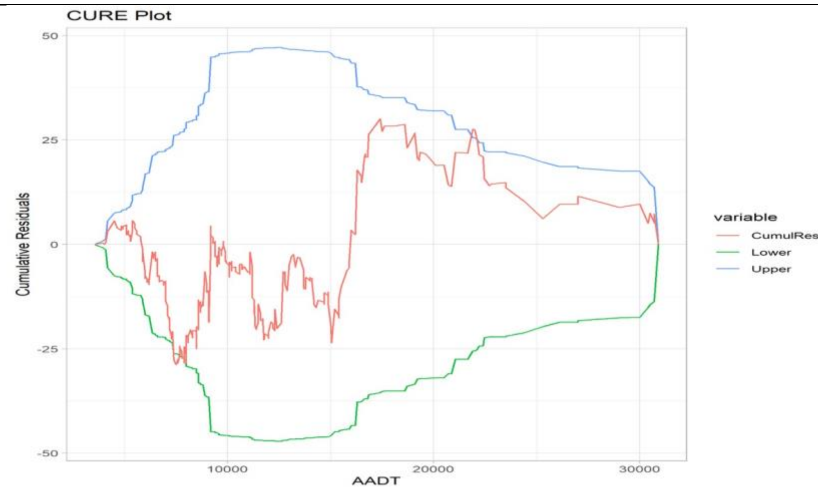
Parameter	Value	CURE Plot
Intersection Type	Divided	
Crash Type	KABCO	
Sample	397	
Crashes	3319	
R2	0.8236788	
CDP	0.2518892	
MACD	75.0948	
MAD	3.775658	
Alpha	-7.147002	
Beta1	0.5674694	
Beta2	0.531642	
Beta3	0.7047971	
p value	1.026694e-44	
CMF	2.023436	
AIC	2523.406	

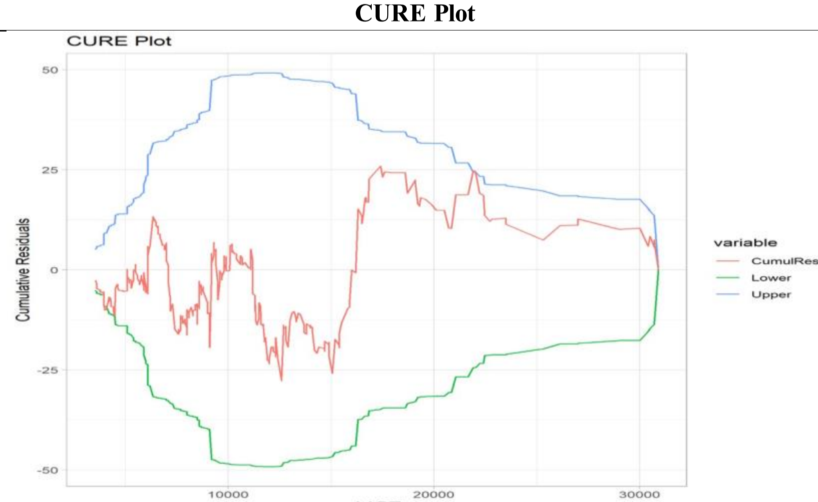
Parameter	Value	CURE Plot
Intersection Type	Separate LT	
Crash Type	KABCO	
Sample	462	
Crashes	3662	
R2	0.8195958	
CDP	1.731602	
MACD	80.49314	
MAD	3.608261	
Alpha	-7.981126	
Beta1	0.6470201	
Beta2	0.5534484	
Beta3	0.5432221	
p value	8.429719e-29	
CMF	1.721545	
AIC	2867.63	

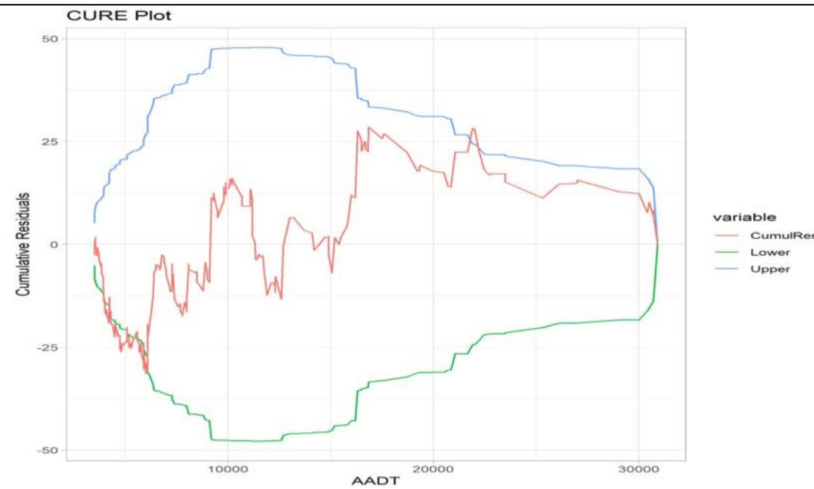
Parameter	Value	CURE Plot
Intersection Type	Separate RT	
Crash Type	KABCO	
Sample	318	
Crashes	3088	
R2	0.829971	
CDP	0.3144654	
MACD	63.41351	
MAD	3.996197	
Alpha	-7.459669	
Beta1	0.6043139	
Beta2	0.5601594	
Beta3	0.3739333	
p value	2.434201e-11	
CMF	1.45344	
AIC	2049.668	

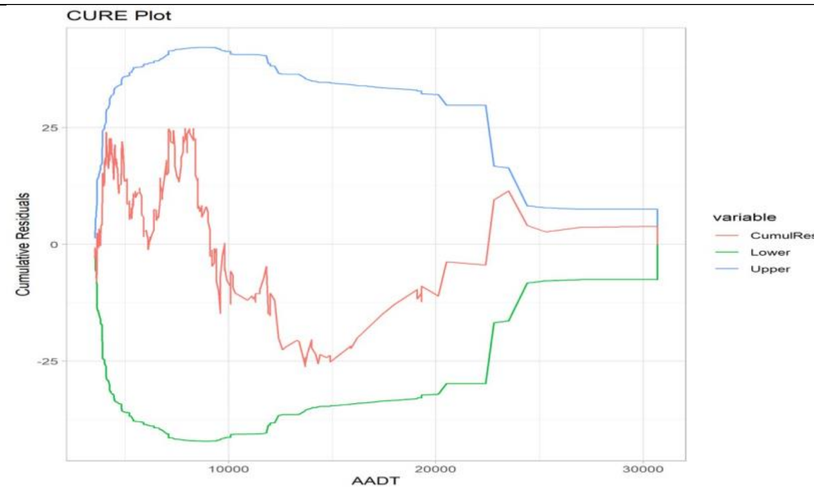
Parameter	Value	CURE Plot
Intersection Type	4 Leg Intersection	
Crash Type	Left-turning vehicle	
Sample	466	
Crashes	976	
R2	0.6181445	
CDP	0.4291845	
MACD	29.74512	
MAD	1.471226	
Alpha	-5.106055	
Beta1	0.1947824	
Beta2	0.5618591	
Beta3	0.572902	
p value	8.312323e-10	
CMF	1.773406	
AIC	1717.934	

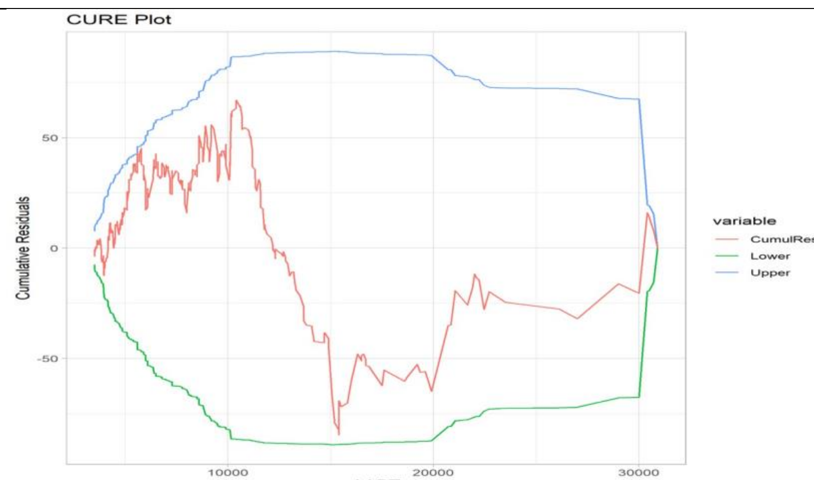
Parameter	Value	CURE Plot
Intersection Type	All	
Crash Type	Left-turning vehicle	
Sample	886	
Crashes	1389	
R2	0.6011156	
CDP	0.3386005	
MACD	28.17483	
MAD	1.215943	
Alpha	-5.436683	
Beta1	0.2293188	
Beta2	0.5601478	
Beta3	0.5481948	
p value	4.619536e-11	
CMF	1.730127	
AIC	2857.439	

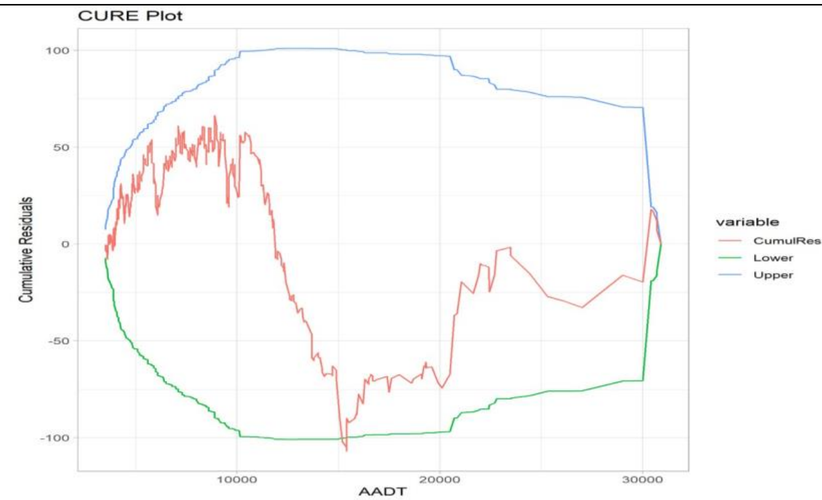
Parameter	Value	CURE Plot
Intersection Type	Divided	
Crash Type	Left-turning vehicle	
Sample	397	
Crashes	804	
R2	0.6526228	
CDP	4.534005	
MACD	30.05387	
MAD	1.427039	
Alpha	-6.02743	
Beta1	0.2202535	
Beta2	0.6312276	
Beta3	0.6864394	
p value	8.838671e-12	
CMF	1.986629	
AIC	1344.734	

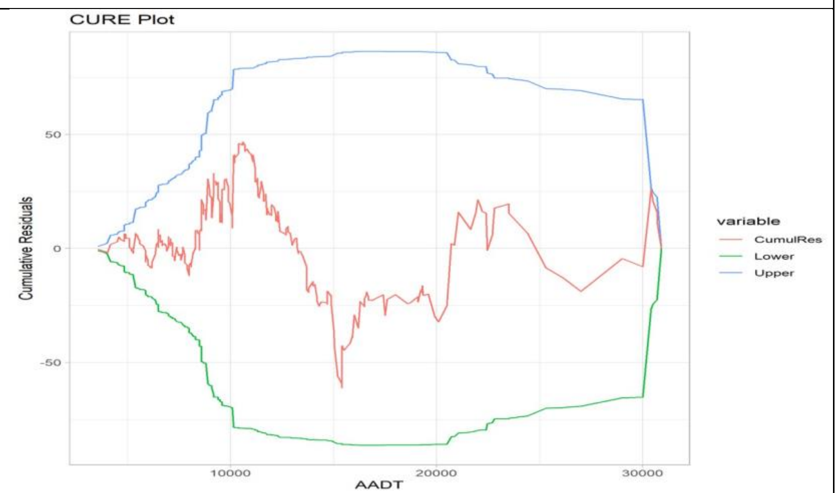
Parameter	Value	CURE Plot
Intersection Type	Separate LT	
Crash Type	Left-turning vehicle	
Sample	462	
Crashes	925	
R2	0.6389518	
CDP	1.298701	
MACD	27.73004	
MAD	1.386782	
Alpha	-6.604932	
Beta1	0.2870691	
Beta2	0.6414038	
Beta3	0.4825608	
p value	4.069462e-07	
CMF	1.620218	
AIC	1589.895	

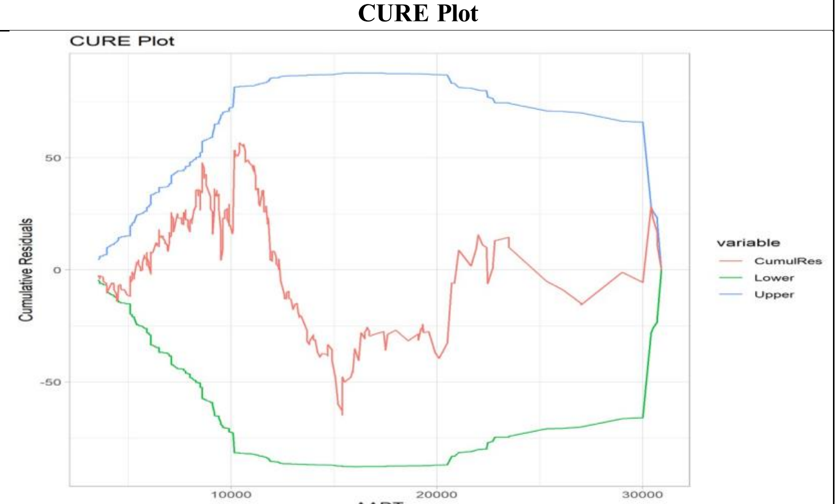
Parameter	Value	CURE Plot
Intersection Type	Separate RT	
Crash Type	Left-turning vehicle	
Sample	318	
Crashes	818	
R2	0.6092136	
CDP	27.04403	
MACD	31.46255	
MAD	1.635662	
Alpha	-6.323006	
Beta1	0.3082671	
Beta2	0.6075211	
Beta3	0.2706933	
p value	0.01191808	
CMF	1.310873	
AIC	1261.876	

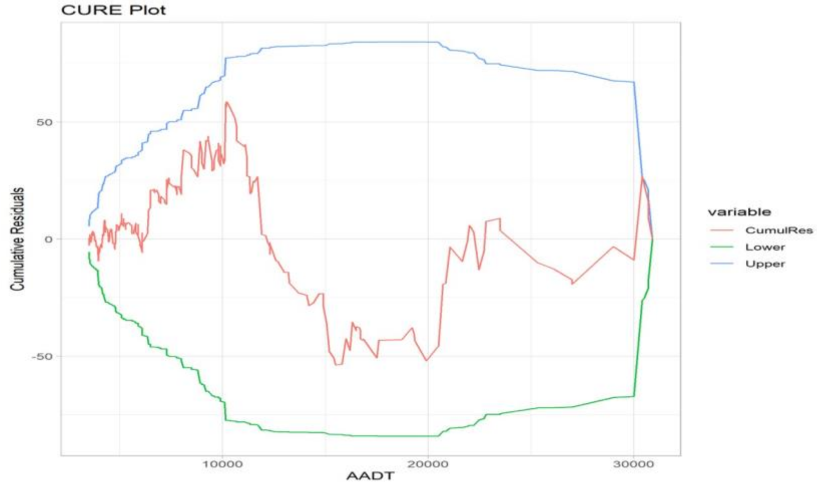
Parameter	Value	CURE Plot
Intersection Type	3 Leg Intersection	
Crash Type	PDO	
Sample	420	
Crashes	770	
R2	0.439437	
CDP	0.7142857	
MACD	26.22203	
MAD	1.380706	
Alpha	-7.097906	
Beta1	0.4910492	
Beta2	0.5395054	
Beta3	0.502276	
p value	0.001053433	
CMF	1.652478	
AIC	1513.183	

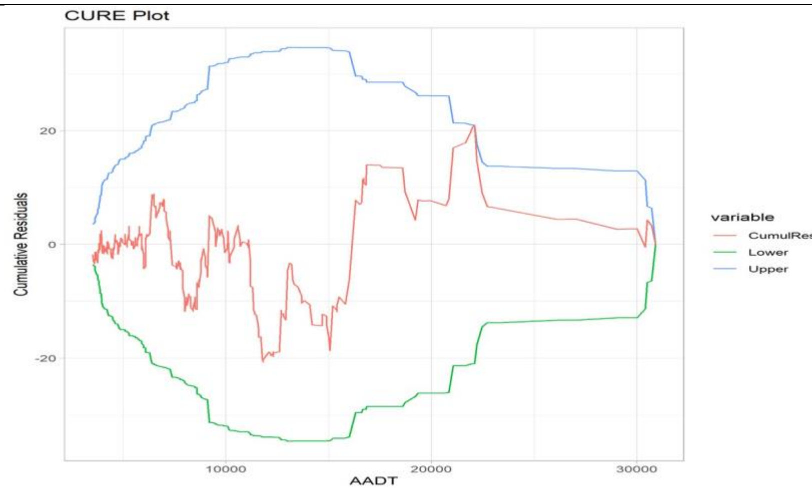
Parameter	Value	CURE Plot
Intersection Type	4 Leg Intersection	
Crash Type	PDO	
Sample	466	
Crashes	2323	
R2	0.8182602	
CDP	0.2145923	
MACD	84.61416	
MAD	2.441668	
Alpha	-7.312426	
Beta1	0.5277619	
Beta2	0.5534172	
Beta3	0.6721738	
p value	4.413069e-28	
CMF	1.95849	
AIC	2297	

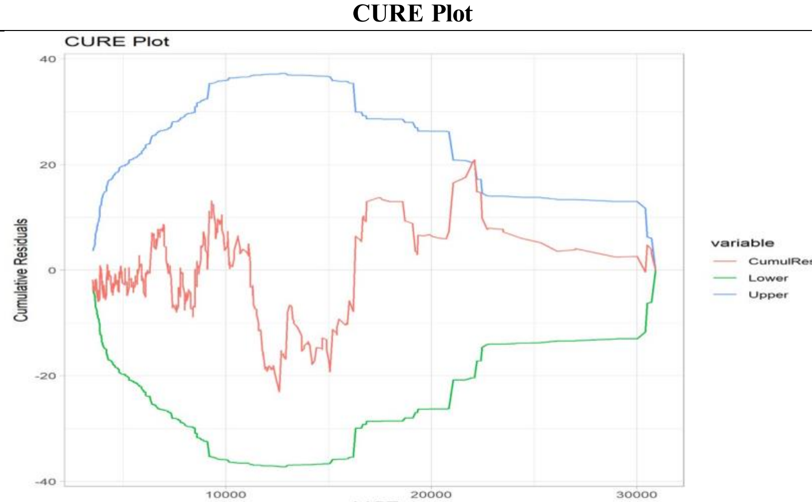
Parameter	Value	CURE Plot
Intersection Type	All	
Crash Type	PDO	
Sample	886	
Crashes	3093	
R2	0.7958636	
CDP	0.4514673	
MACD	106.9516	
MAD	1.95556	
Alpha	-7.386168	
Beta1	0.5141502	
Beta2	0.5702367	
Beta3	0.709643	
p value	3.441719e-38	
CMF	2.033265	
AIC	3832.387	

Parameter	Value	CURE Plot
Intersection Type	Divided	
Crash Type	PDO	
Sample	397	
Crashes	2046	
R2	0.8232955	
CDP	0.2518892	
MACD	61.15888	
MAD	2.521816	
Alpha	-8.681197	
Beta1	0.6455421	
Beta2	0.560972	
Beta3	0.8451692	
p value	9.189239e-39	
CMF	2.328372	
AIC	1918.933	

Parameter	Value	CURE Plot
Intersection Type	Separate LT	
Crash Type	PDO	
Sample	462	
Crashes	2267	
R2	0.8258535	
CDP	1.298701	
MACD	64.72035	
MAD	2.370138	
Alpha	-9.204568	
Beta1	0.6970458	
Beta2	0.5770123	
Beta3	0.7051161	
p value	2.633058e-29	
CMF	2.024082	
AIC	2170.894	

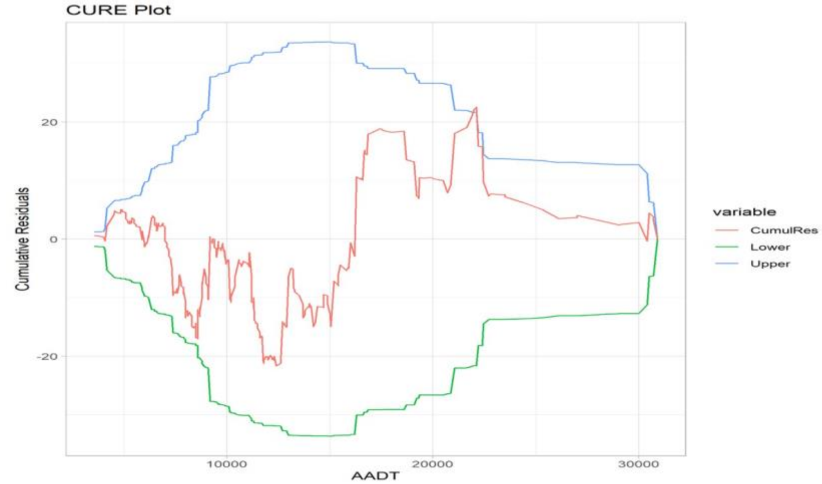
Parameter	**Value**	**CURE Plot**
Intersection Type	Separate RT	
Crash Type	PDO	
Sample	318	
Crashes	1974	
R2	0.8237668	
CDP	0.6289308	
MACD	58.74437	
MAD	2.757734	
Alpha	-8.416577	
Beta1	0.6159242	
Beta2	0.601987	
Beta3	0.487835	
p value	7.474777e-12	
CMF	1.628786	
AIC	1641.009	

Parameter	**Value**	**CURE Plot**
Intersection Type	4 Leg Intersection	
Crash Type	Opposite-direction vehicles	
Sample	466	
Crashes	438	
R2	0.5062189	
CDP	0.2145923	
MACD	20.95113	
MAD	0.8937784	
Alpha	-6.20323	
Beta1	0.1375939	
Beta2	0.6528557	
Beta3	0.8311014	
p value	2.831973e-09	
CMF	2.295846	
AIC	1088.616	

Parameter	**Value**	**CURE Plot**
Intersection Type	All	
Crash Type	Opposite-direction vehicles	
Sample	886	
Crashes	572	
R2	0.5103842	
CDP	0.3386005	
MACD	23.06672	
MAD	0.6910696	
Alpha	-5.86913	
Beta1	0.1046501	
Beta2	0.6335445	
Beta3	0.934013	
p value	2.408699e-13	
CMF	2.544701	
AIC	1696.368	

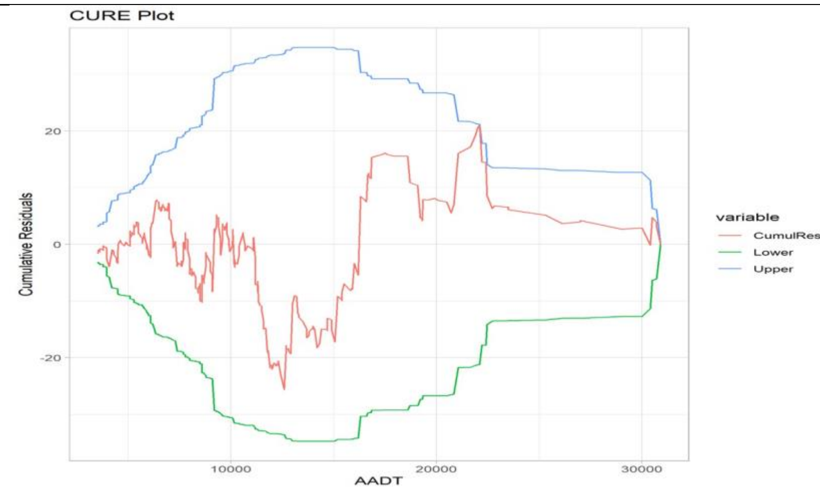
Parameter	Value
Intersection Type	Divided
Crash Type	opposite
Sample	397
Crashes	351
R2	0.5060383
CDP	0.7556675
MACD	22.55174
MAD	0.8550022
Alpha	-6.568603
Beta1	0.08606028
Beta2	0.7223497
Beta3	1.127685
p value	9.238054e-13
CMF	3.0885
AIC	841.6628

CURE Plot



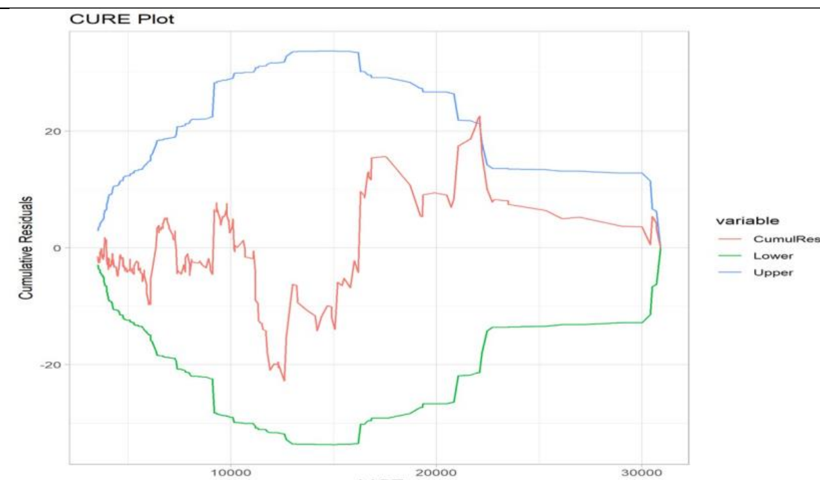
Parameter	Value
Intersection Type	Separate LT
Crash Type	Opposite-direction vehicles
Sample	462
Crashes	408
R2	0.4951071
CDP	0.2164502
MACD	25.64119
MAD	0.8551405
Alpha	-7.020661
Beta1	0.1395935
Beta2	0.7434134
Beta3	0.8279786
p value	1.210947e-08
CMF	2.288688
AIC	1010.626

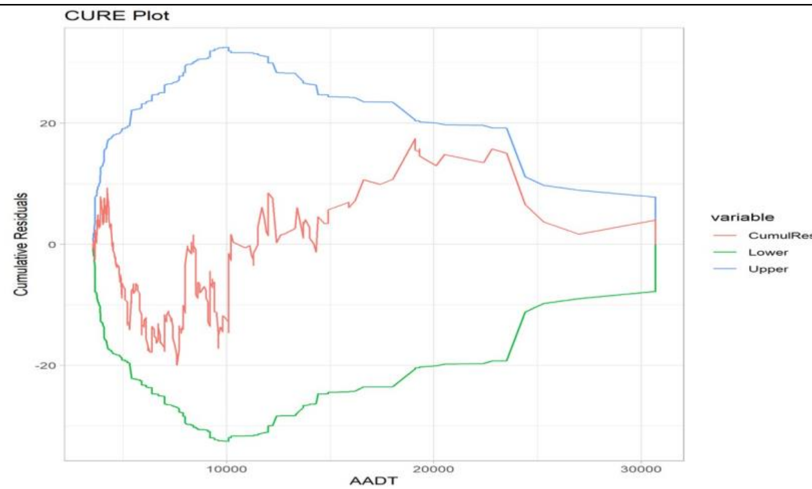
CURE Plot

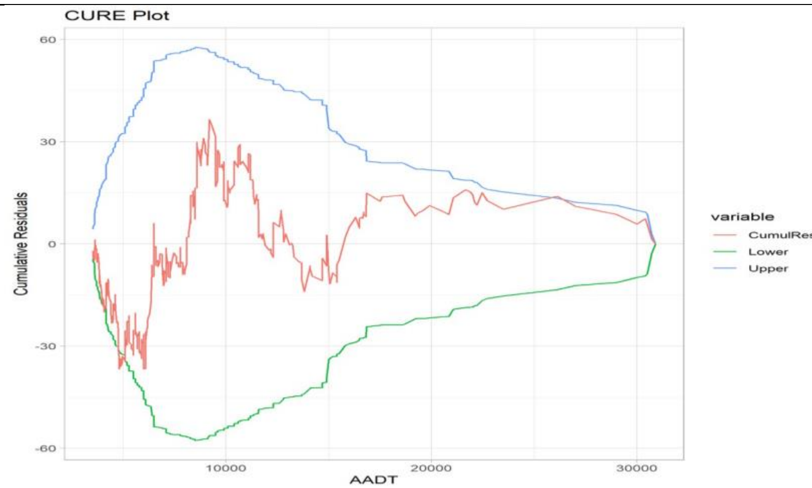


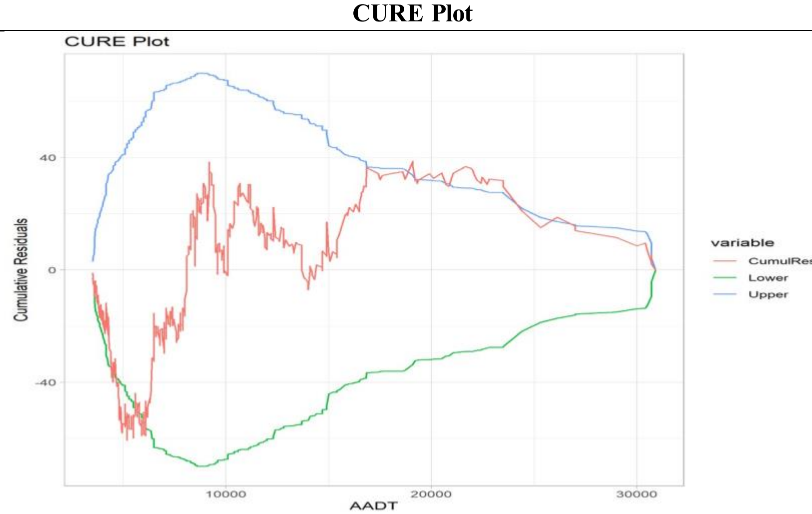
Parameter	Value
Intersection Type	Separate RT
Crash Type	Opposite-direction vehicles
Sample	318
Crashes	380
R2	0.479091
CDP	0.9433962
MACD	22.75459
MAD	1.066092
Alpha	-7.051989
Beta1	0.1639705
Beta2	0.758461
Beta3	0.4869575
p value	0.002585842
CMF	1.627357
AIC	844.9332

CURE Plot

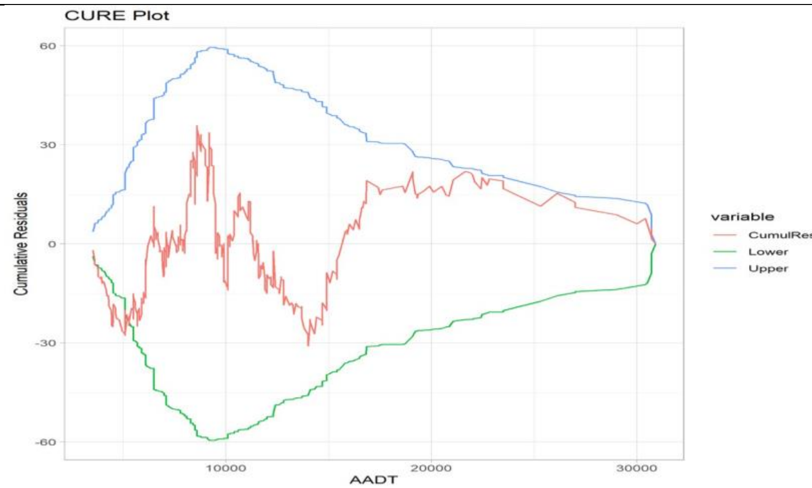


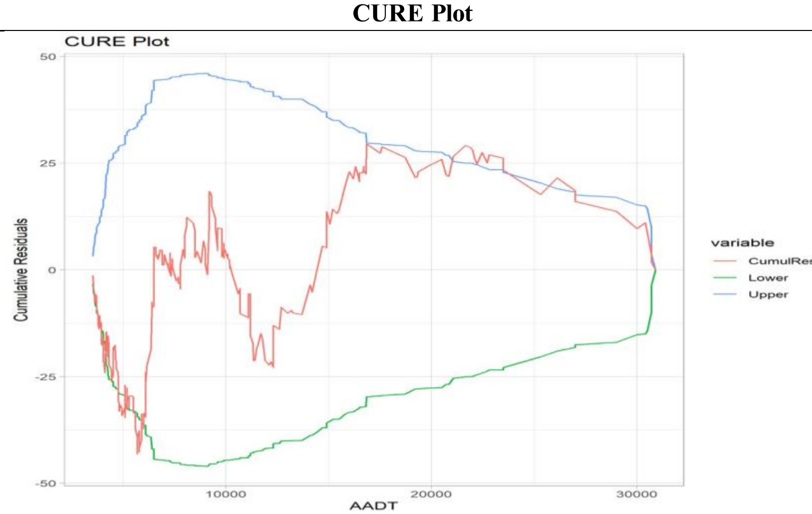
Parameter	Value	CURE Plot
Intersection Type	3 Leg Intersection	
Crash Type	Perpendicular-direction vehicles	
Sample	420	
Crashes	399	
R2	0.1518867	
CDP	0.2380952	
MACD	19.93052	
MAD	0.9756512	
Alpha	-12.13743	
Beta1	0.932546	
Beta2	0.6151063	
Beta3	-1.019801	
p value	0.0007246535	
CMF	0.3606668	
AIC	1120.972	

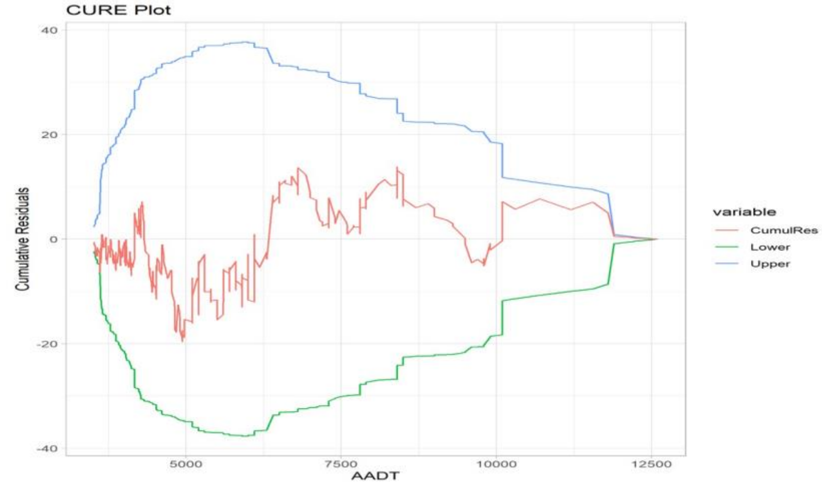
Parameter	Value	CURE Plot
Intersection Type	4 Leg Intersection	
Crash Type	Perpendicular-direction vehicles	
Sample	466	
Crashes	1391	
R2	0.4632412	
CDP	3.433476	
MACD	36.7347	
MAD	1.878693	
Alpha	-5.132371	
Beta1	0.2601625	
Beta2	0.5843354	
Beta3	-0.5270353	
p value	2.418897e-10	
CMF	0.5903526	
AIC	2092.417	

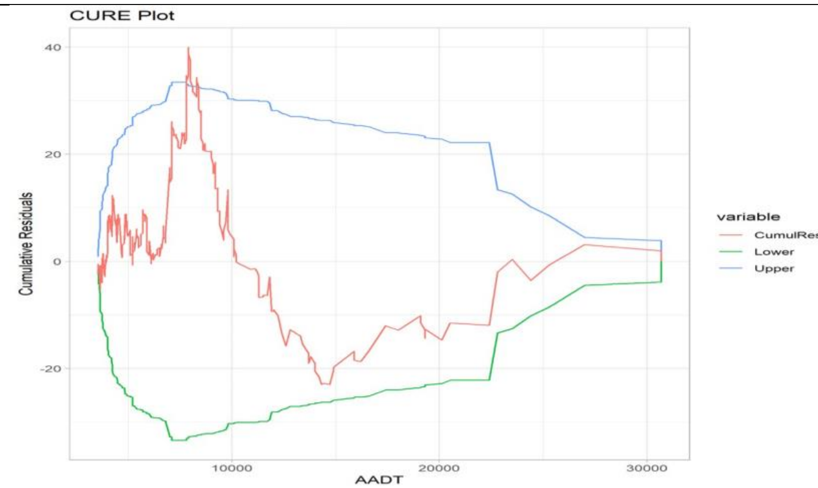
Parameter	Value	CURE Plot
Intersection Type	All	
Crash Type	Perpendicular-direction vehicles	
Sample	886	
Crashes	1790	
R2	0.4117321	
CDP	21.7833	
MACD	60.71556	
MAD	1.567791	
Alpha	-7.583294	
Beta1	0.4456375	
Beta2	0.662112	
Beta3	-0.5502757	
p value	2.219824e-12	
CMF	0.5767908	
AIC	3435.973	

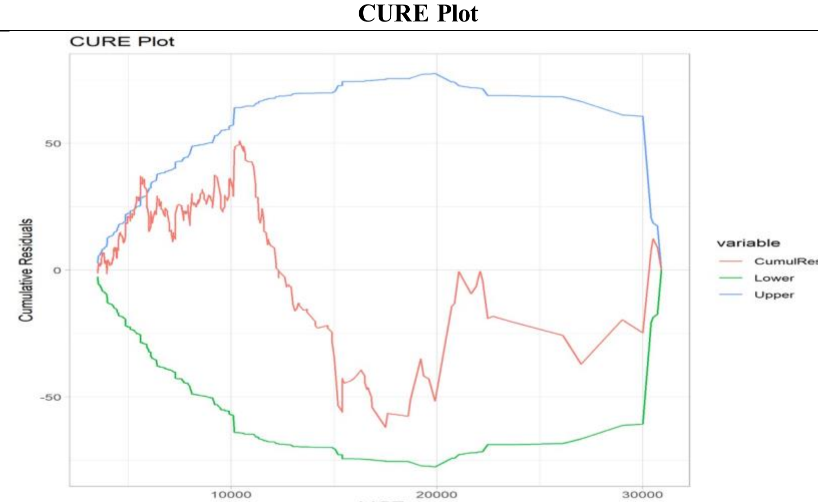
Parameter	Value	CURE Plot
Intersection Type	Divided	
Crash Type	Perpendicular-direction vehicles	
Sample	397	
Crashes	1142	
R2	0.3908663	
CDP	5.289673	
MACD	29.8562	
MAD	2.009379	
Alpha	-4.918581	
Beta1	0.2084988	
Beta2	0.6045337	
Beta3	-0.4150838	
p value	1.803472e-06	
CMF	0.6602849	
AIC	1849.83	

Parameter	Value	CURE Plot
Intersection Type	Separate LT	
Crash Type	Perpendicular-direction vehicles	
Sample	462	
Crashes	1298	
R2	0.4054522	
CDP	10.17316	
MACD	35.85328	
MAD	1.972972	
Alpha	-5.959606	
Beta1	0.3112799	
Beta2	0.6233133	
Beta3	-0.5560226	
p value	4.014875e-11	
CMF	0.5734855	
AIC	2120.72	

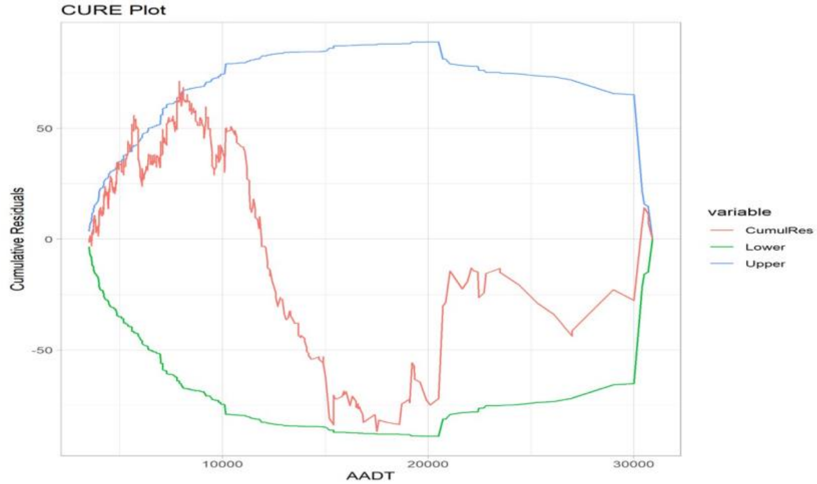
Parameter	Value	CURE Plot
Intersection Type	Separate RT	
Crash Type	Perpendicular-direction vehicles	
Sample	318	
Crashes	964	
R2	0.5478117	
CDP	22.95597	
MACD	43.13354	
MAD	1.922802	
Alpha	-6.84441	
Beta1	0.3919949	
Beta2	0.6577133	
Beta3	-0.7424541	
p value	4.777618e-14	
CMF	0.4759445	
AIC	1414.821	

Parameter	Value	CURE Plot
Intersection Type	Undivided	
Crash Type	Perpendicular-direction vehicles	
Sample	489	
Crashes	648	
R2	0.3577583	
CDP	0.204499	
MACD	19.62609	
MAD	1.169607	
Alpha	-8.26693	
Beta1	0.4355097	
Beta2	0.7645405	
Beta3	-0.8003616	
p value	0.0001199673	
CMF	0.4491665	
AIC	1559.182	

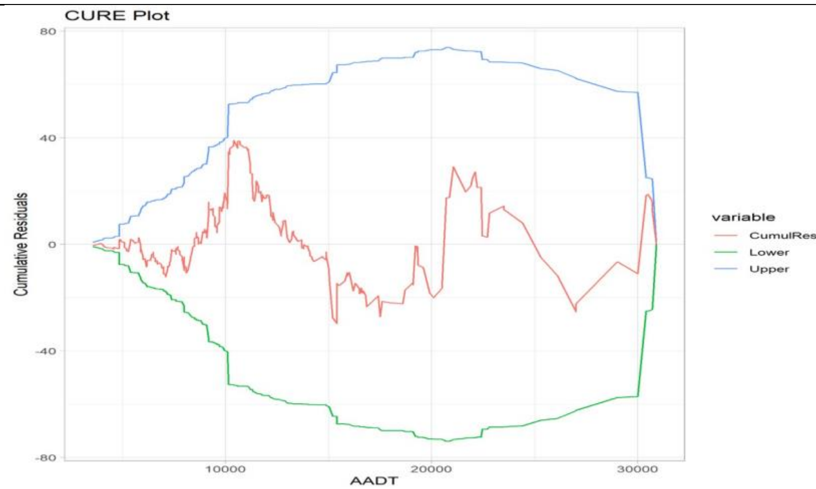
Parameter	Value	CURE Plot
Intersection Type	3 Leg Intersection	
Crash Type	Rear end	
Sample	420	
Crashes	468	
R2	0.486842	
CDP	3.809524	
MACD	39.94773	
MAD	1.096481	
Alpha	-7.270829	
Beta1	0.593499	
Beta2	0.333679	
Beta3	1.226204	
p value	9.877664e-12	
CMF	3.408268	
AIC	1286.544	

Parameter	Value	CURE Plot
Intersection Type	4 Leg Intersection	
Crash Type	Rear end	
Sample	466	
Crashes	1500	
R2	0.8169537	
CDP	6.652361	
MACD	61.98546	
MAD	1.7643	
Alpha	-10.47746	
Beta1	0.8410931	
Beta2	0.4777355	
Beta3	1.258479	
p value	2.545545e-54	
CMF	3.520063	
AIC	1770.027	

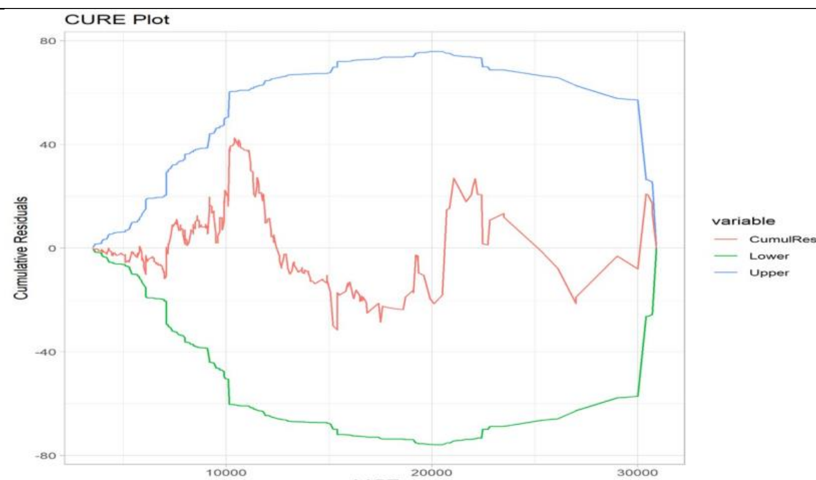
Parameter	Value	CURE Plot
Intersection Type	All	
Crash Type	Rear end	
Sample	886	
Crashes	1968	
R2	0.7832564	
CDP	8.126411	
MACD	86.75861	
MAD	1.477442	
Alpha	-9.555021	
Beta1	0.7706119	
Beta2	0.4402168	
Beta3	1.305724	
p value	1.014899e-76	
CMF	3.690362	
AIC	3072.401	

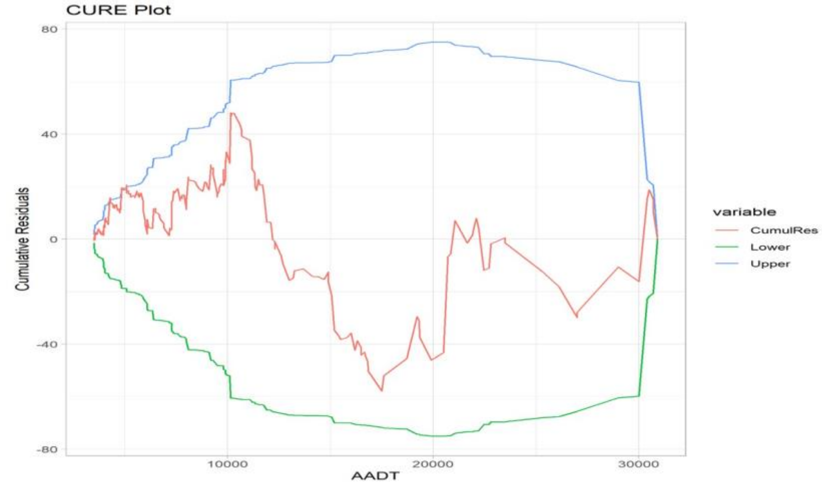


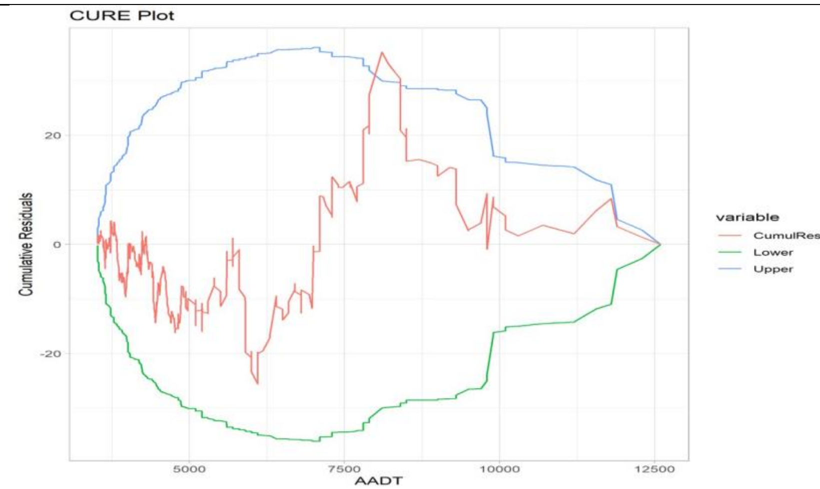
Parameter	Value	CURE Plot
Intersection Type	Divided	
Crash Type	Rear end	
Sample	397	
Crashes	1385	
R2	0.8312533	
CDP	0.2518892	
MACD	38.99267	
MAD	1.797033	
Alpha	-12.55276	
Beta1	1.012265	
Beta2	0.5003274	
Beta3	1.482627	
p value	1.097076e-65	
CMF	4.404502	
AIC	1414.785	

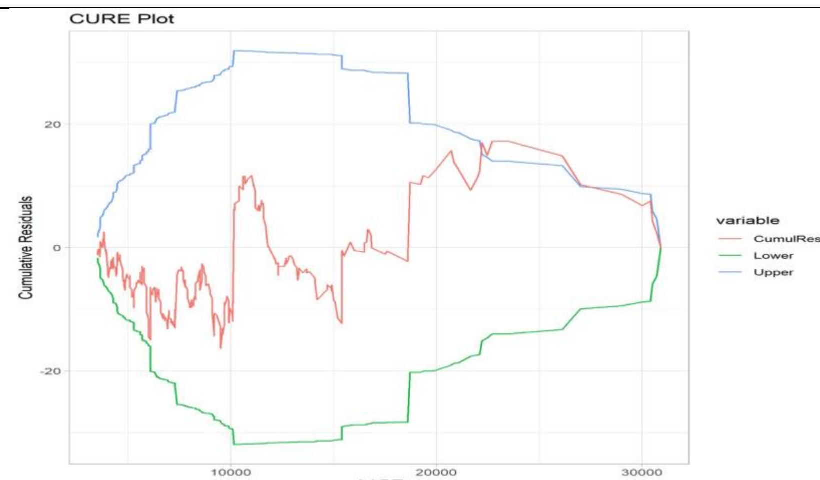


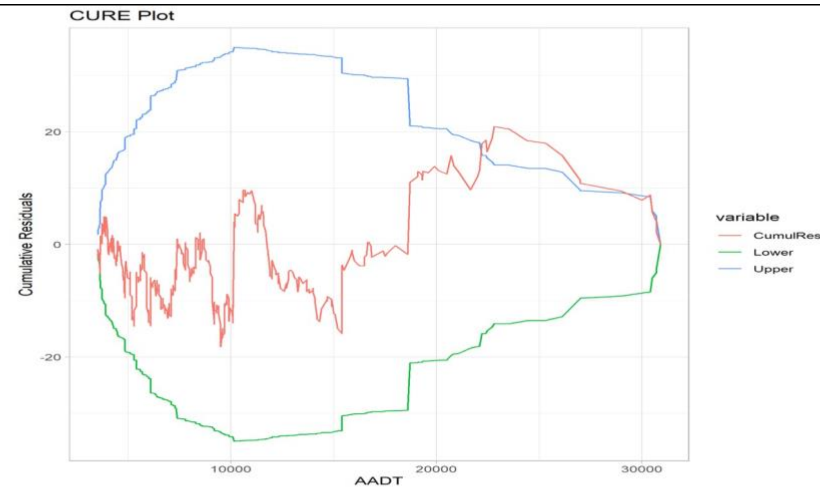
Parameter	Value	CURE Plot
Intersection Type	Separate LT	
Crash Type	Rear end	
Sample	462	
Crashes	1485	
R2	0.8295411	
CDP	0.2164502	
MACD	42.53488	
MAD	1.698121	
Alpha	-13.33191	
Beta1	1.082813	
Beta2	0.5238594	
Beta3	1.351841	
p value	2.429132e-57	
CMF	3.864534	
AIC	1611.112	

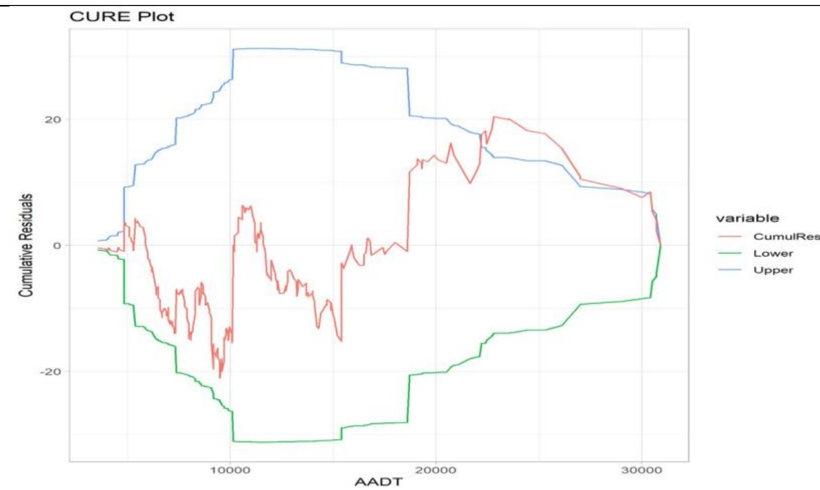


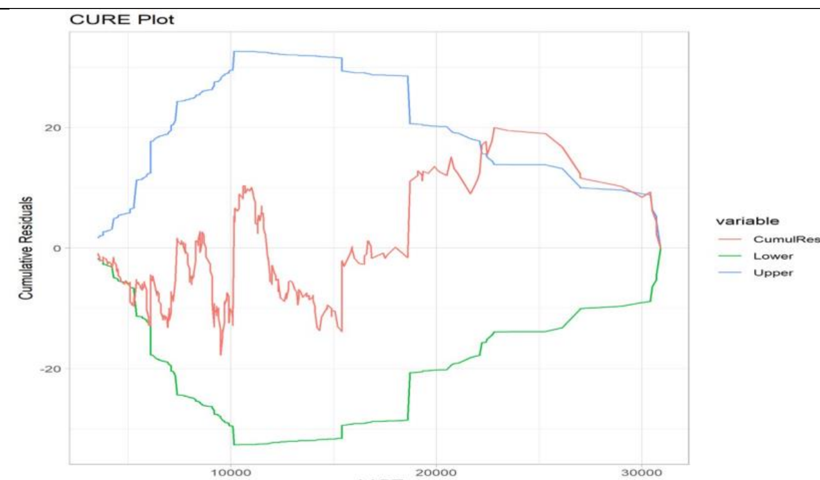
Parameter	Value	CURE Plot
Intersection Type	Separate RT	
Crash Type	Rear end	
Sample	318	
Crashes	1367	
R2	0.8143508	
CDP	2.830189	
MACD	57.82324	
MAD	2.170259	
Alpha	-11.45672	
Beta1	0.9312322	
Beta2	0.494558	
Beta3	1.197169	
p value	3.857827e-37	
CMF	3.310731	
AIC	1322.682	

Parameter	Value	CURE Plot
Intersection Type	Undivided	
Crash Type	Rear end	
Sample	489	
Crashes	583	
R2	0.3618477	
CDP	1.226994	
MACD	35.28208	
MAD	1.09511	
Alpha	-10.57182	
Beta1	1.008224	
Beta2	0.3263512	
Beta3	0.5658176	
p value	0.0006805581	
CMF	1.760887	
AIC	1526.753	

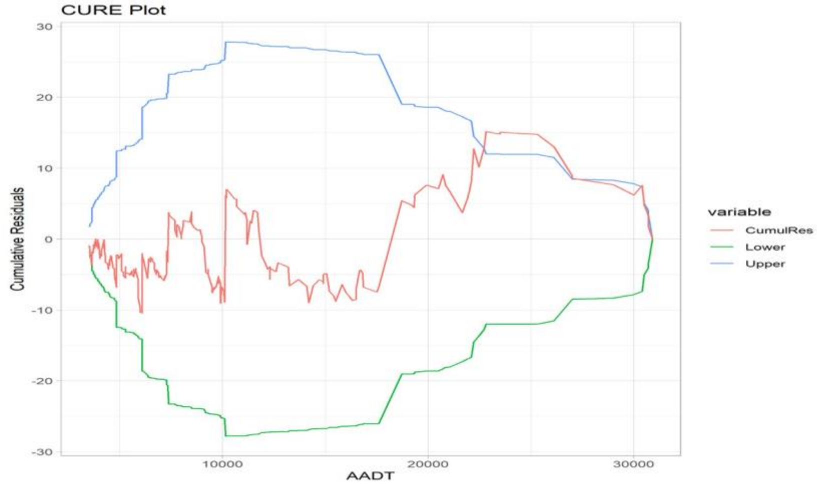
Parameter	Value	CURE Plot
Intersection Type	4 Leg Intersection	
Crash Type	Right-turning vehicle	
Sample	466	
Crashes	415	
R2	0.5505551	
CDP	1.502146	
MACD	17.25886	
MAD	0.8237181	
Alpha	-9.746382	
Beta1	0.6169862	
Beta2	0.5501562	
Beta3	0.4898175	
p value	0.0006747362	
CMF	1.632018	
AIC	1095.418	

Parameter	Value	CURE Plot
Intersection Type	All	
Crash Type	Right-turning vehicle	
Sample	886	
Crashes	569	
R2	0.5531593	
CDP	2.708804	
MACD	20.9439	
MAD	0.6639344	
Alpha	-9.640847	
Beta1	0.577748	
Beta2	0.5774466	
Beta3	0.5188801	
p value	5.002316e-05	
CMF	1.680145	
AIC	1727.532	

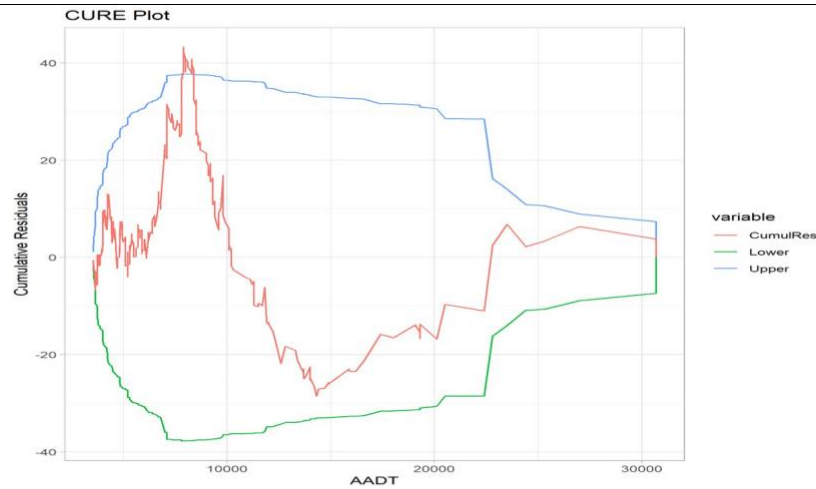
Parameter	Value	CURE Plot
Intersection Type	Divided	
Crash Type	Right-turning vehicle	
Sample	397	
Crashes	391	
R2	0.5580783	
CDP	3.778338	
MACD	21.08231	
MAD	0.8846841	
Alpha	-8.983916	
Beta1	0.5169558	
Beta2	0.5584995	
Beta3	0.6550376	
p value	6.932444e-06	
CMF	1.925215	
AIC	978.896	

Parameter	Value	CURE Plot
Intersection Type	Separate LT	
Crash Type	Right-turning vehicle	
Sample	462	
Crashes	445	
R2	0.5469559	
CDP	8.441558	
MACD	20.0046	
MAD	0.868247	
Alpha	-9.819175	
Beta1	0.5977888	
Beta2	0.5879891	
Beta3	0.4153288	
p value	0.002815406	
CMF	1.514869	
AIC	1145.08	

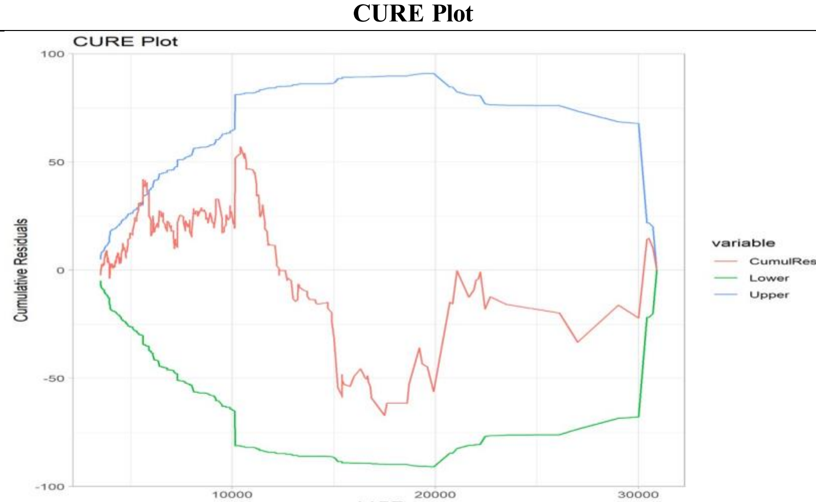
Parameter	Value	CURE Plot
Intersection Type	Separate RT	
Crash Type	Right-turning vehicle	
Sample	318	
Crashes	331	
R2	0.6216651	
CDP	5.031447	
MACD	15.16226	
MAD	0.84517	
Alpha	-9.781111	
Beta1	0.5010318	
Beta2	0.6909788	
Beta3	0.4295042	
p value	0.0137	
CMF	1.536496	
AIC	767.7197	

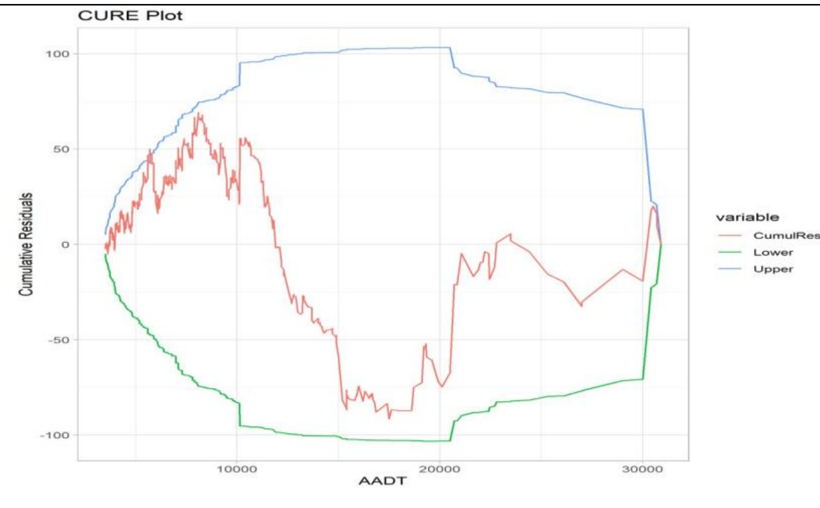


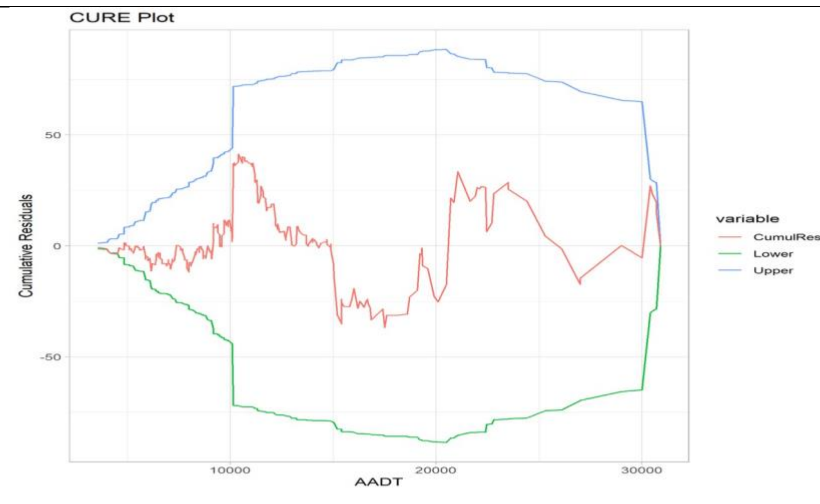
Parameter	Value	CURE Plot
Intersection Type	3 Leg Intersection	
Crash Type	Same-direction vehicles	
Sample	420	
Crashes	601	
R2	0.51898	
CDP	4.285714	
MACD	43.23868	
MAD	1.233105	
Alpha	-8.206416	
Beta1	0.7627224	
Beta2	0.2825385	
Beta3	1.084979	
p value	2.042927e-11	
CMF	2.959379	
AIC	1414.606	

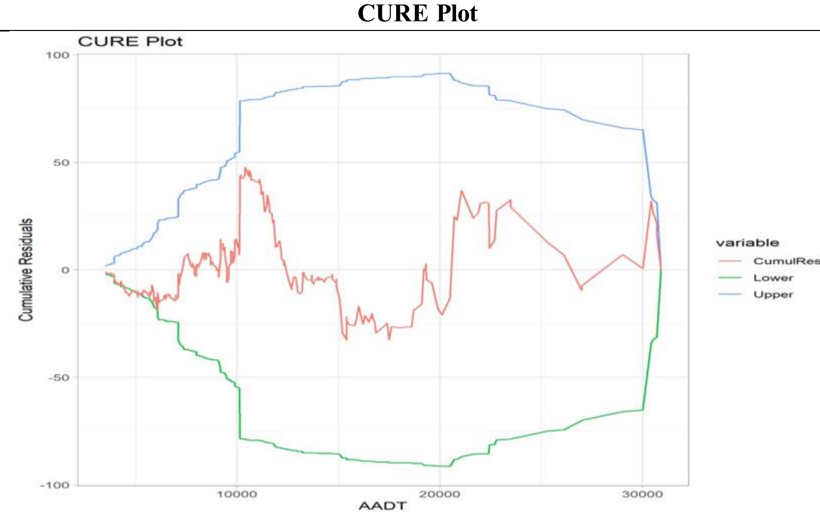


Parameter	Value	CURE Plot
Intersection Type	4 Leg Intersection	
Crash Type	Same-direction vehicles	
Sample	466	
Crashes	1843	
R2	0.8145533	
CDP	6.223176	
MACD	67.15558	
MAD	2.017391	
Alpha	-9.421767	
Beta1	0.7635405	
Beta2	0.4632938	
Beta3	1.257094	
p value	2.035281e-67	
CMF	3.515191	
AIC	1965.611	

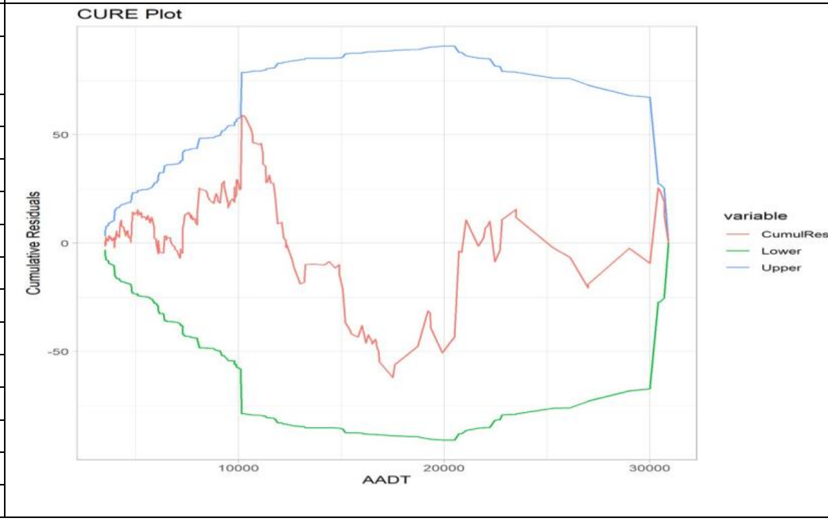


Parameter	Value	CURE Plot
Intersection Type	All	
Crash Type	Same-direction vehicles	
Sample	886	
Crashes	2444	
R2	0.782484	
CDP	0.6772009	
MACD	91.46165	
MAD	1.686438	
Alpha	-9.063701	
Beta1	0.7646421	
Beta2	0.4129685	
Beta3	1.27965	
p value	1.218473e-91	
CMF	3.595383	
AIC	3398.784	

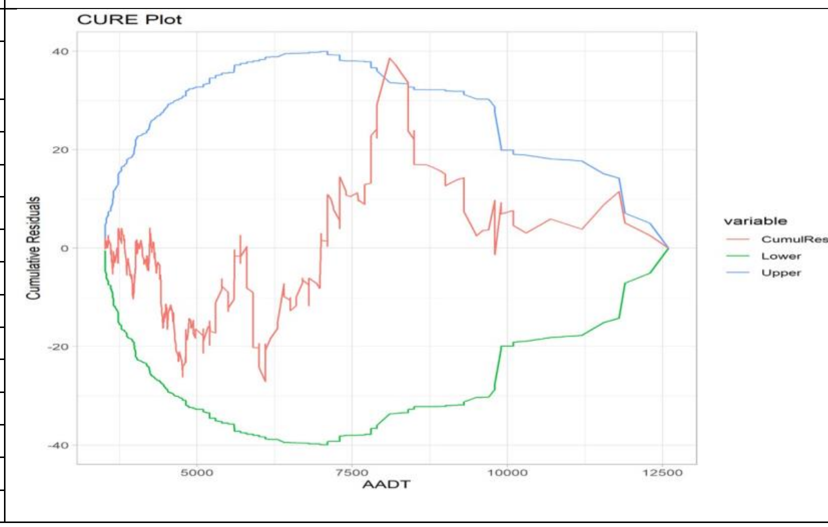
Parameter	Value	CURE Plot
Intersection Type	Divided	
Crash Type	Same-direction vehicles	
Sample	397	
Crashes	1738	
R2	0.8194867	
CDP	0.7556675	
MACD	41.33811	
MAD	2.102129	
Alpha	-11.02965	
Beta1	0.9124832	
Beta2	0.4641464	
Beta3	1.421059	
p value	3.304377e-79	
CMF	4.141503	
AIC	1621.972	

Parameter	Value	CURE Plot
Intersection Type	Separate LT	
Crash Type	Same-direction vehicles	
Sample	462	
Crashes	1852	
R2	0.8165594	
CDP	6.926407	
MACD	47.68245	
MAD	1.991794	
Alpha	-12.20671	
Beta1	1.024341	
Beta2	0.485871	
Beta3	1.294945	
p value	3.55042e-68	
CMF	3.650796	
AIC	1832.263	

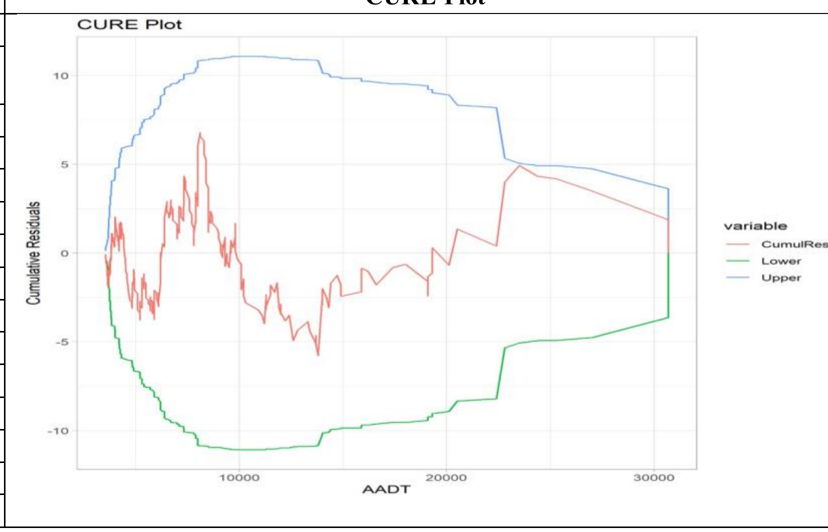
Parameter	Value	CURE Plot
Intersection Type	Separate RT	
Crash Type	Same-direction vehicles	
Sample	318	
Crashes	1669	
R2	0.8030976	
CDP	0.3144654	
MACD	62.0909	
MAD	2.57625	
Alpha	-10.65093	
Beta1	0.8794026	
Beta2	0.4865418	
Beta3	1.140805	
p value	2.249552e-42	
CMF	3.129287	
AIC	1501.21	



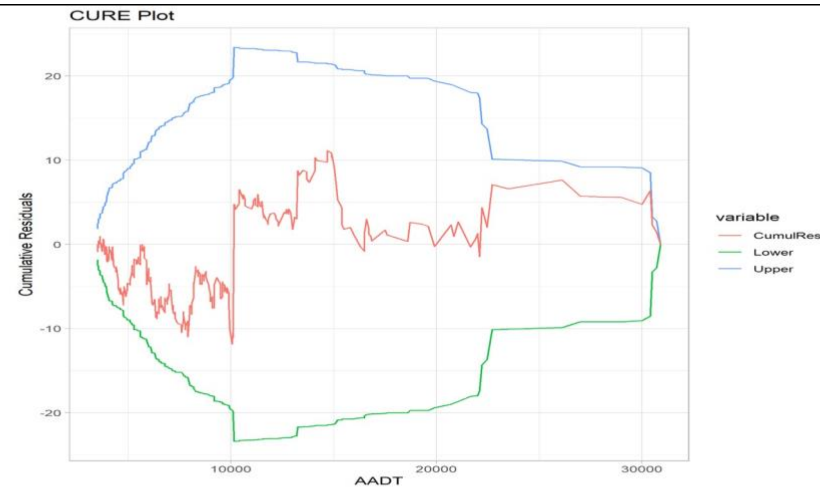
Parameter	Value	CURE Plot
Intersection Type	Undivided	
Crash Type	Same-direction vehicles	
Sample	489	
Crashes	706	
R2	0.3767018	
CDP	1.022495	
MACD	38.60877	
MAD	1.229588	
Alpha	-10.13166	
Beta1	1.001509	
Beta2	0.2967433	
Beta3	0.5670266	
p value	0.0002213428	
CMF	1.763017	
AIC	1667.384	



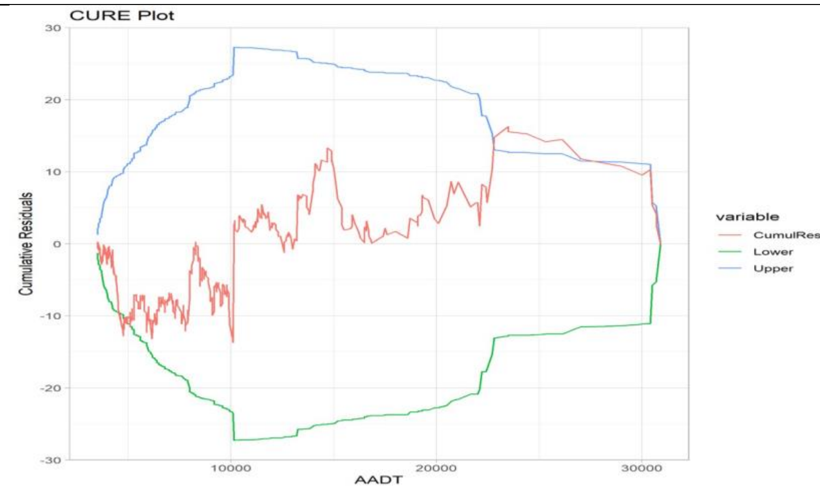
Parameter	Value	CURE Plot
Intersection Type	3 Leg Intersection	
Crash Type	Sideswipe same direction	
Sample	420	
Crashes	112	
R2	0.7450394	
CDP	4.761905	
MACD	6.79575	
MAD	0.3540116	
Alpha	-14.8123	
Beta1	1.405057	
Beta2	0.1383672	
Beta3	0.799501	
p value	0.0312998	
CMF	2.224431	
AIC	487.7339	



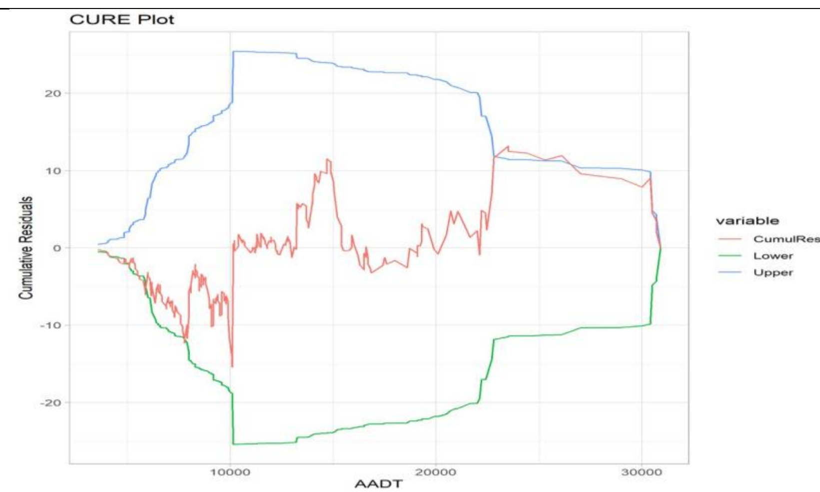
Parameter	Value	CURE Plot
Intersection Type	4 Leg Intersection	
Crash Type	Sideswipe same direction	
Sample	466	
Crashes	294	
R2	0.6439019	
CDP	0.2145923	
MACD	11.8313	
MAD	0.5791161	
Alpha	-9.117709	
Beta1	0.5296032	
Beta2	0.4811889	
Beta3	1.144523	
p value	9.245059e-11	
CMF	3.140942	
AIC	812.1837	

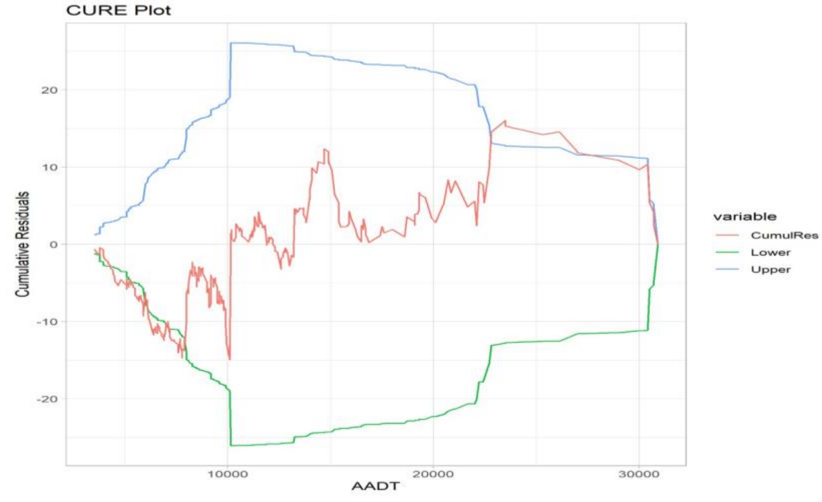


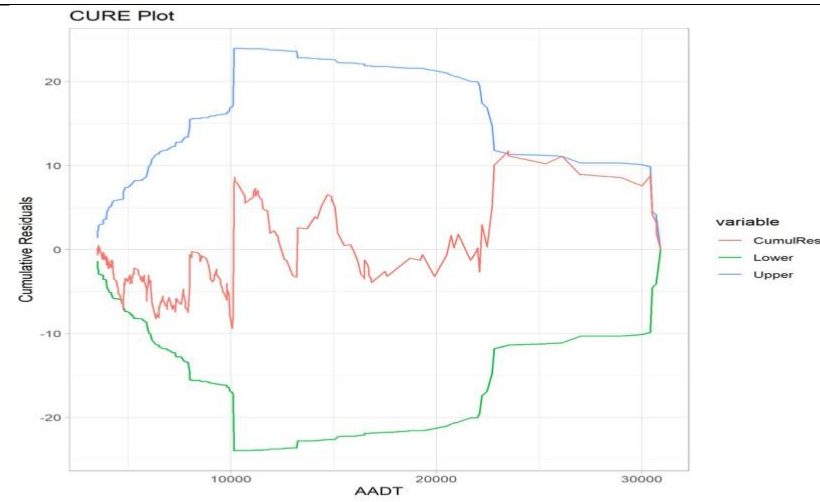
Parameter	Value	CURE Plot
Intersection Type	All	
Crash Type	Sideswipe same direction	
Sample	886	
Crashes	406	
R2	0.6012859	
CDP	5.643341	
MACD	16.31415	
MAD	0.4850674	
Alpha	-11.0807	
Beta1	0.8396572	
Beta2	0.361485	
Beta3	1.088122	
p value	1.386154e-12	
CMF	2.968692	
AIC	1313.364	

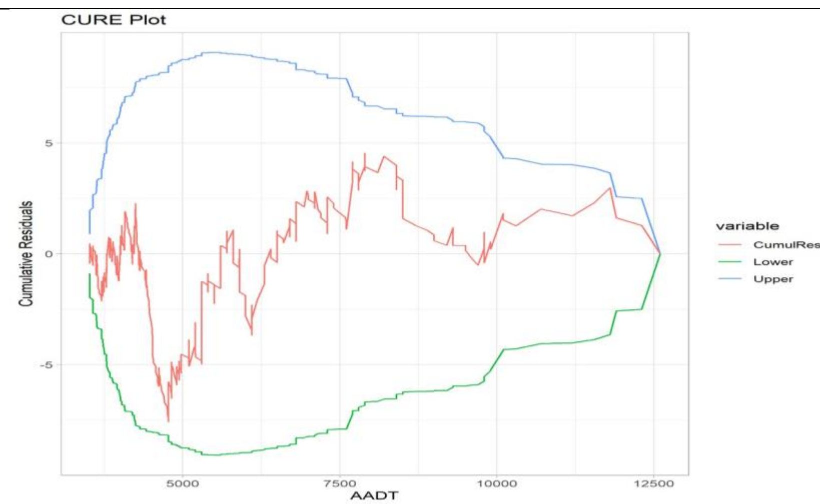


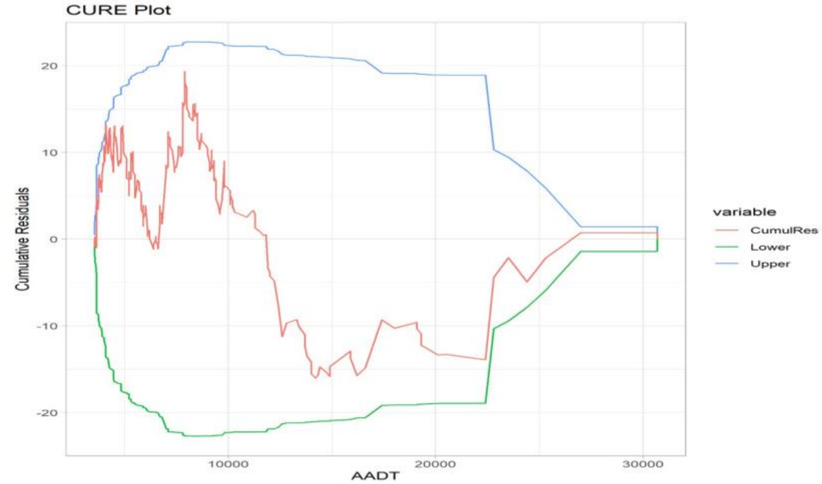
Parameter	Value	CURE Plot
Intersection Type	Divided	
Crash Type	Sideswipe same direction	
Sample	397	
Crashes	317	
R2	0.5925014	
CDP	6.801008	
MACD	15.44047	
MAD	0.7172726	
Alpha	-9.146776	
Beta1	0.6220295	
Beta2	0.3899617	
Beta3	1.077073	
p value	8.254742e-11	
CMF	2.936073	
AIC	833.0827	

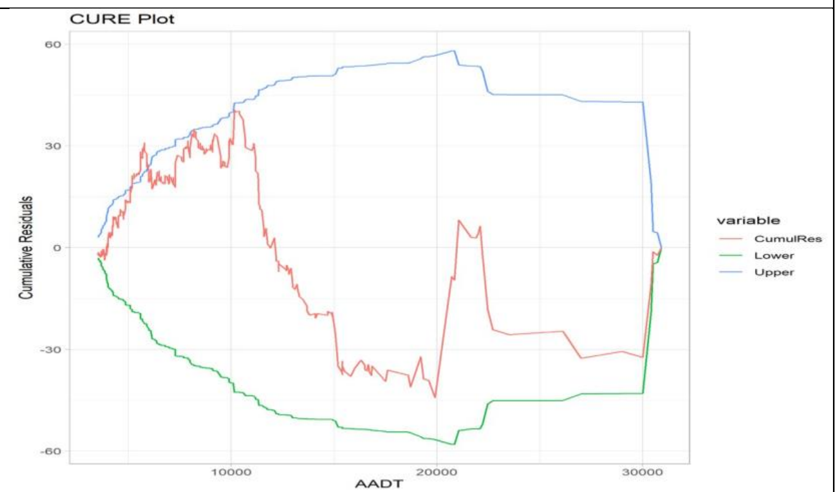


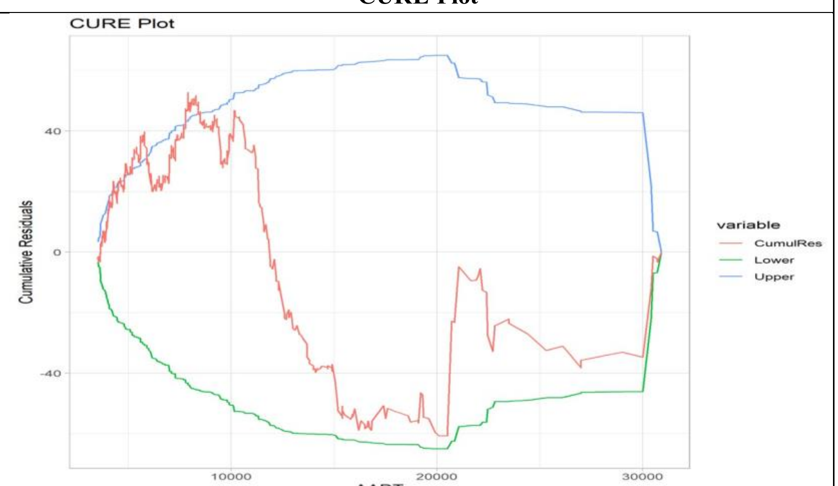
Parameter	Value	CURE Plot
Intersection Type	Separate LT	
Crash Type	Sideswipe same direction	
Sample	462	
Crashes	326	
R2	0.5784393	
CDP	30.30303	
MACD	16.04685	
MAD	0.6505516	
Alpha	-11.28453	
Beta1	0.8408024	
Beta2	0.3912079	
Beta3	1.034546	
p value	6.567203e-10	
CMF	2.813829	
AIC	888.5873	

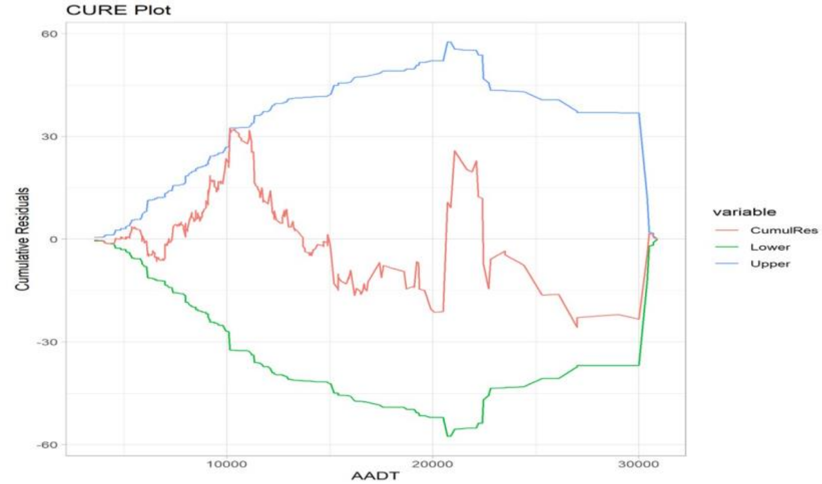
Parameter	Value	CURE Plot
Intersection Type	Separate RT	
Crash Type	Sideswipe same direction	
Sample	318	
Crashes	260	
R2	0.6044633	
CDP	2.830189	
MACD	11.73491	
MAD	0.6799114	
Alpha	-10.67665	
Beta1	0.6957758	
Beta2	0.4865738	
Beta3	1.034788	
p value	4.563555e-07	
CMF	2.81451	
AIC	632.0872	

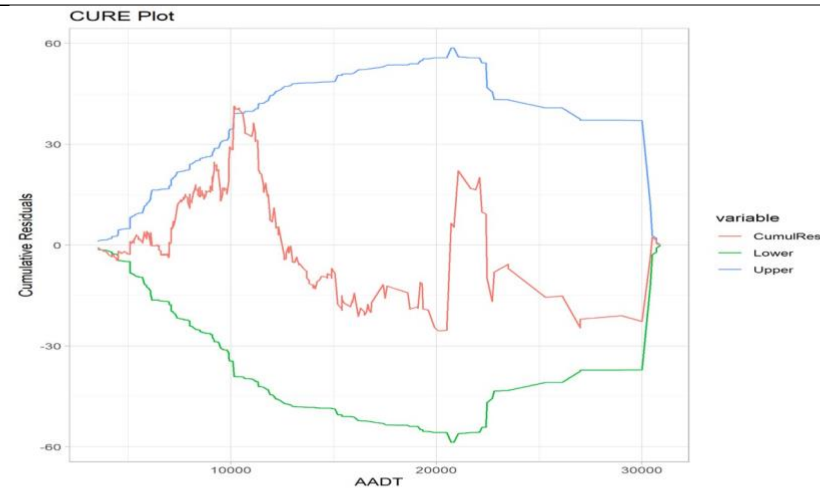
Parameter	Value	CURE Plot
Intersection Type	Undivided	
Crash Type	Sideswipe same direction	
Sample	489	
Crashes	89	
R2	1.540938	
CDP	0.204499	
MACD	7.571692	
MAD	0.2870617	
Alpha	-9.300197	
Beta1	0.7273213	
Beta2	0.2066314	
Beta3	1.033947	
p value	0.01245417	
CMF	2.812144	
AIC	476.7495	

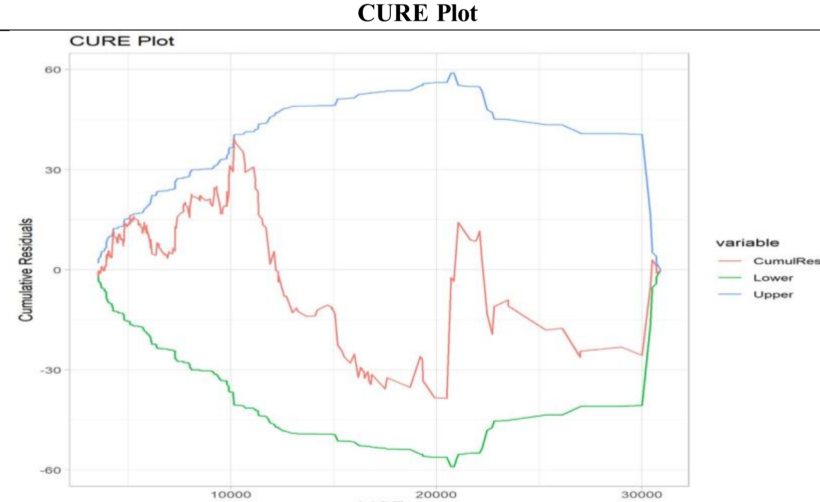
Parameter	Value	CURE Plot
Intersection Type	3 Leg Intersection	
Crash Type	Stopped vehicle	
Sample	420	
Crashes	264	
R2	0.4869071	
CDP	0.2380952	
MACD	19.32353	
MAD	0.7139916	
Alpha	-8.616334	
Beta1	0.5630851	
Beta2	0.4993839	
Beta3	1.04187	
p value	6.611163e-06	
CMF	2.834513	
AIC	883.0388	

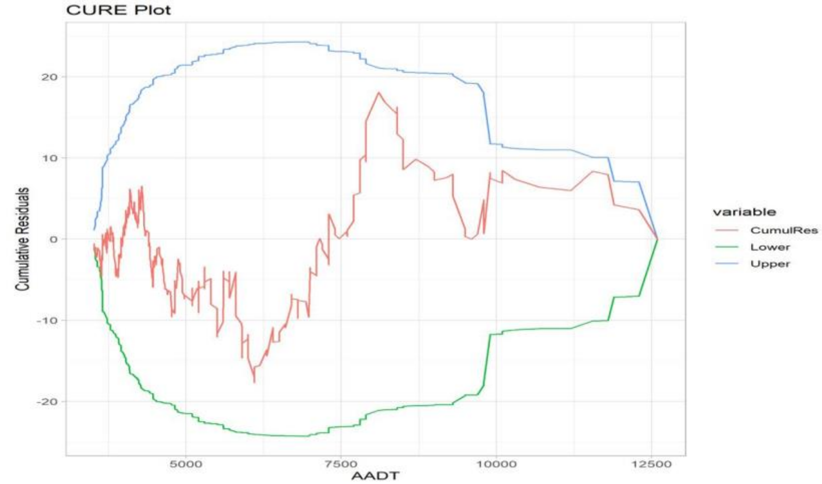
Parameter	Value	CURE Plot
Intersection Type	4 Leg Intersection	
Crash Type	Stopped vehicle	
Sample	466	
Crashes	1019	
R2	0.7994874	
CDP	11.37339	
MACD	44.23575	
MAD	1.285381	
Alpha	-10.46486	
Beta1	0.7040786	
Beta2	0.5861308	
Beta3	1.317217	
p value	8.989139e-40	
CMF	3.733019	
AIC	1360.523	

Parameter	Value	CURE Plot
Intersection Type	All	
Crash Type	Stopped vehicle	
Sample	886	
Crashes	1283	
R2	0.7751563	
CDP	23.36343	
MACD	60.74597	
MAD	1.029861	
Alpha	-9.989584	
Beta1	0.6653816	
Beta2	0.5694711	
Beta3	1.325446	
p value	1.376184e-51	
CMF	3.763865	
AIC	2248.771	

Parameter	Value	CURE Plot
Intersection Type	Divided	
Crash Type	Stopped vehicle	
Sample	397	
Crashes	920	
R2	0.8168858	
CDP	0.7556675	
MACD	32.17701	
MAD	1.268114	
Alpha	-13.1274	
Beta1	0.9201271	
Beta2	0.6242469	
Beta3	1.558609	
p value	1.879196e-45	
CMF	4.752204	
AIC	1043.391	

Parameter	Value	CURE Plot
Intersection Type	Separate LT	
Crash Type	Stopped vehicle	
Sample	462	
Crashes	996	
R2	0.8122085	
CDP	7.792208	
MACD	41.42009	
MAD	1.239163	
Alpha	-13.51138	
Beta1	0.961944	
Beta2	0.6357231	
Beta3	1.414019	
p value	1.824583e-40	
CMF	4.112452	
AIC	1218.441	

Parameter	Value	CURE Plot
Intersection Type	Separate RT	
Crash Type	Stopped vehicle	
Sample	318	
Crashes	953	
R2	0.7838929	
CDP	0.6289308	
MACD	39.26939	
MAD	1.628574	
Alpha	-11.60075	
Beta1	0.8455965	
Beta2	0.5747264	
Beta3	1.144812	
p value	7.172781e-24	
CMF	3.14185	
AIC	1075.906	

Parameter	Value	CURE Plot
Intersection Type	Undivided	
Crash Type	Stopped vehicle	
Sample	489	
Crashes	363	
R2	0.4560897	
CDP	0.204499	
MACD	18.09283	
MAD	0.774496	
Alpha	-10.19907	
Beta1	0.794586	
Beta2	0.4812154	
Beta3	0.5808848	
p value	0.003866492	
CMF	1.787619	
AIC	1118.317	