Analysis of Field Effects Associated with the GM Super Cruise System

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16. Abstract

This effort examined the field impact of the Super Cruise system on lane departure crashes and “quasi” system-relevant rear-end striking crashes. Two statistical approaches, binomial exact tests and a quasi-induced exposure logistic regression, were used to explore the limited data available more thoroughly. The Super Cruise-equipped vehicles used in this analysis were Model Year 2018-2020 Cadillac CT6 sedans and Model Year 2021 Cadillac CT4, CT5, and Escalade vehicles. Matched Model Year 2016- 2021 vehicles were used as comparison fleets. These fleets were matched to police-reported crashes from 12 states. In light of the widespread lack of statistical significance across the variety of analysis approaches employed and the large number of statistical tests conducted, there is currently no evidence for a difference in system-relevant crash risk for Super Cruise-equipped vehicles compared to matched highly-ADAS equipped vehicles without Super Cruise. Continuing to revisit this Super Cruise field analysis with additional crash data and miles driven should continue to improve our ability to evaluate the effect of Super Cruise on system-relevant crashes in the future.

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Table of Contents

Executive Summary

The General Motors (GM) Super Cruise system was introduced on the 2018 Cadillac CT6. This system combines Adaptive Cruise Control (ACC) and automatic lane-centering control and allows hands-free driving on GPS-defined system compatible roads, which include certain limited-access highways and trunk roads. Super Cruise uses a series of escalating alerts (including a steering wheel light bar) to prompt the driver to pay close attention to the road ahead (monitored by a face camera) and take steering control whenever take over requests are issued. As advised in the Owner's Manual, and consistent with SAE Level 2 automation terminology, when using Super Cruise, the driver is responsible for operating the vehicle in a safe manner and must remain attentive to traffic, surroundings, and road conditions at all times.

This effort examines the potential impact of the Super Cruise system on "system-relevant" lane departure crashes on Super Cruise compatible roads. Additional analyses examined the impact Super Cruise may have on rear-end striking crashes (considered "quasi" system-relevant). Although such crashes are not directly related to the added automatic lane-centering control offered by Super Cruise, any changes in the prevalence of such crashes are of interest to evaluate potential unintended consequences associated with this system.

Model Year 2018-2020 Cadillac CT6 vehicles were included in this analysis, as well as several other models that introduced Super Cruise in Model Year 2021, namely the Cadillac CT4, CT5, and Escalade models. Vehicles ranging from Model Years 2016 through 2021 were used to develop the Super Cruise and non-Super Cruise comparison fleets. Since Super Cruise-equipped vehicles are also highly equipped with ADAS features that have been shown to reduce rear-end striking, lane departure, and lane change crashes, in an attempt to isolate Super Cruise field effects, the non-Super Cruise comparison fleet was required to be highly ADAS-equipped. More precisely, the set of required matching ADAS features included fusion-based Automatic Emergency Braking with Forward Collision Alert, Lane Keep Assist with Lane Departure, and Rear Camera Mirror with Lane Change Alert and Side Blind Zone Alert.

Matching these vehicles to Vehicle Identification Numbers (VINs) from 12 police-report state databases available to the University of Michigan Transportation Research Institute (UMTRI) resulted in 276 matched, analysis-relevant (i.e., either system-relevant or control) crash cases on Super Cruise compatible roads, including 18 such matches for Super Cruise-equipped vehicles and 258 such matches for the highly ADAS-equipped comparison vehicles. These 276 matched cases were then further filtered (e.g., by crash type or due to missing police report variables) based on the statistical analysis approach used.

The analysis strategy taken here was to employ a variety of statistical approaches, each with complementary strengths and weaknesses, to explore the limited data available more thoroughly. Each of the three approaches used here examined the impact of Super Cruise on system-relevant crash types on Super Cruise compatible roads, including same-direction sideswipe, single-vehicle road departures, and rear-end striking crashes.

The Binomial Exact "Engaged Crash Rate" analysis addressed *whether the proportion (or rate) of system-relevant crashes involving Super Cruise engagement is more extreme (higher or lower)* *than expected based on the proportion of Super Cruise engaged driving.* Of the eight system-relevant crashes identified by GM to have occurred with Super Cruise-equipped vehicles on system compatible highways, only one involved engagement based on the crash time and location information available in the police accident report. For this crash, Super Cruise engaged driving ended after a system degraded state occurring in rough proximity to the reported rear-end striking crash event (Note the actual role Super Cruise played in this crash, if any, cannot be determined with high confidence based on the information available.)

This ratio of 0.125 (1/8) is less than the estimated 18% (0.18) Super Cruise engagement rate on system compatible highways (based on an OnStar telematics study of Super Cruise owner usage reported by LeBlanc et al. (2022)). This Binomial Exact Test was not significant (p=1.00), meaning that, based on this limited sample size, there is no support for the hypothesis that Super Cruise either increases or decreases crash rate when engaged. Unlike this analysis, the remaining two analyses do not account for Super Cruise engagement surrounding the crash, but instead use general estimates of driving exposure.

The Binomial Exact "Equipped Crash Rate" analysis addressed *whether the proportion (or rate) of Super Cruise-equipped vehicles in system-relevant crashes on system-compatible roads is more extreme (higher or lower) than expected based on the proportion of equipped vehicle years in the entire analysis fleet.* The six tests conducted were formed by crossing three system-relevant crash types on Super Cruise compatible roads (same-direction sideswipe, single-vehicle road departure, and rear-end striking) with two vehicle models (CT6 and Escalade). Results from five of these six tests failed to approach significance (p>0.43). For the CT6, the estimated rate of same-direction sideswipe crashes on Super Cruise compatible roads trends higher than expected (p=0.12).

The Quasi-Induced Exposure regression analysis addressed *whether system-relevant (relative to control) crash rates on Super Cruise compatible roads were impacted by the presence of the Super Cruise system.* The six regression analyses conducted were formed by crossing two system-relevant crash types (same-direction sideswipe and rear-end striking crashes) by three control crash types. These control crash types included rear-end struck crashes on Super Cruise compatible roads, all rear-end struck crashes (regardless of whether the crash occurred on a Super Cruise compatible roads), and system-relevant crashes (either same-direction sideswipe or rear-end striking) that were not on a Super Cruise compatible road. Once again, none of the results from this regression analysis approached significance (p>0.26). Hence, consistent with the previous two analyses, these induced exposure logistic regressions results do not provide evidence of a significant effect of Super Cruise on system-relevant crashes.

In summary, in light of the widespread lack of statistical significance across the variety of analysis approaches employed and the large number of statistical tests conducted, there is no evidence for a difference in system-relevant crash risk for Super Cruise-equipped vehicles compared to matched highly-ADAS equipped vehicles without Super Cruise. Taken together, the three distinct statistical analyses employed formed a more cohesive view of potential Super Cruise field effects on crashes than could be obtained in any single analysis, which is of particular importance given the existing data limitations. Unlike various ADAS features that are specifically aimed at reducing system-relevant crashes, Super Cruise, similar to Adaptive Cruise control (ACC), is a driver convenience system and is engaged (i.e., used) for a considerably lower proportion of driving. This relatively low Super Cruise system usage on system compatible roads, when considered together with the low initial Super Cruise volumes and current system compatible road restrictions, as well as the fact that compatible road crash rates are generally low, creates data limitation challenges for detecting any existing Super Cruise field effects if such a difference actually exists (referred to as "statistical power"). Hence, the lack of statistical significance observed here is not a definitive conclusion of "no effect." Continuing to revisit this Super Cruise field analysis with additional crash data and miles driven should continue to improve our ability to evaluate the effect of Super Cruise on system-relevant crashes in the future.

Introduction

This report describes a field effect analysis of the General Motors (GM) Super Cruise system. This system, introduced on the 2018 Cadillac CT6, combines Adaptive Cruise Control (ACC) and automatic lane-centering control and allows hands-free driving on GPS-defined system compatible roads, which include certain limited-access highways and trunk roads. Super Cruise uses a series of escalating alerts (including a steering wheel light bar) to prompt the driver to pay close attention to the road ahead (monitored by a face camera) and take steering control whenever take over requests are issued. As advised in the Owner's Manual, and consistent with SAE Level 2 automation terminology, when using Super Cruise, the driver is responsible for operating the vehicle in a safe manner and must remain attentive to traffic, surroundings, and road conditions, at all times.

This analysis was conducted as part of the fourth study in a series of field effectiveness studies that have examined and quantified system-relevant crash reduction benefits associated with a wide range of GM Advanced Driver Assistance Systems (ADAS) features (Flannagan & Leslie; 2020; Leslie et al. 2019[1], 2021, 2022). Although safety systems can be motivated by harm reduction opportunities apparent in the field (Najm, Smith, and Yanagisawa, 2007; Swanson et al., 2019), and tested in simulation, on test tracks, and on public, real-world crash data remains fundamental for understanding *achieved* ADAS safety effects in the field. Achieved safety benefits incorporate important real-world factors such as the extent to which drivers leave these systems on, the demographics of drivers of ADAS-equipped vehicles, and the wide range of driving conditions experienced by drivers with these systems.

The current effort examines the potential impact of the Super Cruise system on "system-relevant" lane departure crashes on Super Cruise compatible roads. Additional analyses examined the impact Super Cruise on rear-end striking crashes (considered "quasi" system-relevant). Although such crashes are not directly related to the added automatic lane-centering control offered by Super Cruise, any changes in the prevalence of such crashes are of interest to evaluate potential unintended consequences associated with this system. Unlike previous ADAS features examined, Super Cruise is a driver convenience system, the fleet penetration is limited in size (with the initial launch being restricted to a few Cadillac models), the system is only available on certain limited-access highways and trunk roads, and system usage by customers on Super Cruise compatible roads is somewhat limited. As such, the three distinct statistical analyses employed in the current effort formed a more cohesive view of potential Super Cruise field effects on crashes than could be obtained in any single analysis, which is of particular importance given the existing data limitations.

[1] Accessible through University of Michigan Deep Blue: https://deepblue.lib.umich.edu/handle/2027.42/150660

Methods

Data

In this analysis, police-reported crashes were matched with VIN-linked system content data provided by GM for models offering the Super Cruise system.

Safety Content Data

The safety content dataset provided by GM for this analysis contained VIN-linked data for Cadillac CT4, CT5, CT6, and Escalade vehicles sold as of June 2021. This dataset provided the presence or absence of a variety of ADAS features, including Super Cruise. In order to better isolate Super Cruise field effects, it was necessary to identify a population of matched comparison vehicles without Super Cruise that were also similarly highly equipped with ADAS features which have been shown to reduce rear-end striking, lane departure, and lane change crashes (Flannagan & Leslie; 2020; Leslie et al, 2019[2], 2021, 2022). Consequently, both the Super Cruise-equipped and the matched comparison fleets were equipped with the following ADAS features:

- Fusion-based (radar and camera) Automatic Emergency Braking with Forward Collision Alert (Fusion AEB with FCA); offered with Full-speed range Adaptive Cruise Control (Fusion AEB with FSACC)
- Lane Keep Assist with Lane Departure Warning (LKA with LDW)
- Lane Change Alert with Side Blind Zone Alert (LCA with SBZA)
- Rear Camera Mirror (RCM)

Police Crash Report Data

UMTRI obtained police-reported crash data from 12 states that were able to provide full 17-character VINs for the vehicles involved in these crashes, as well as crash location data that could be used to classifying crashes occurring on Super Cruise compatible roads. Table 1 shows a calendar year summary of the crash data used in the analysis.

[2] Accessible through University of Michigan Deep Blue: https://deepblue.lib.umich.edu/handle/2027.42/150660

Table 1. States and calendar years of police crash report data used in the analysis

State	Calendar Years
Connecticut	2015 – 2020
Florida	2015 – March 2021
Kansas	2015 – June 2021
Maryland	2015 – June 2021
Michigan	2015 – 2020
Missouri	2015 – 2019
Ohio	2015 – June 2021
Nebraska	2015 – 2020
South Dakota	2015 – 2020
Tennessee	2015 – June 2021
Texas	2015 – June 2021
Utah	2015 – 2020

Matched Subset Data

The police-reported crash data was aligned (as discussed further below) across the 12 states and merged with the safety content dataset. This process resulted in identifying a matched dataset consisting of 2,351 crashes that involved either a Super Cruise-equipped or Highly ADAS-equipped (without Super Cruise) vehicles and had a police-reported crash location GPS (latitude and longitude) coordinates that could be used to determine whether or not the crash occurred on a Super Cruise compatible roads. As shown in Table 2, the largest group of vehicles were “Highly ADAS-Equipped” Escalades without Super Cruise at 1,981 (84.2% of the matches), with only a total of 141 Super Cruise-equipped vehicles identified (of which all but 3 were CT6s). These matching results were largely driven by the higher volumes of Escalade sales compared to CT6s, coupled with the limited opportunity to observe crashes in Model Year 2021 Escalades, CT4, and CT5 vehicles. Indeed, for these latter two models no Super Cruise equipped vehicles were present in the matched dataset, and hence were excluded from any further analysis (a total of 32 CT5s and no CT4s were identified). More generally, the volume of vehicles shown in Table 2 illustrates challenging data limitations even before further filtering these crashes to meet analysis requirements (crash type and location) described below.

Table 2. Breakdown of matched vehicles by Equipment Level and Model Year. Cells with "—" indicate Model Years where the Super Cruise system was not offered.

Cadillac Model	Model Year	2016	2017	2018	2019	2020	2021	Total
CT6	Super Cruise	—	—	78	32	28	—	138
	Highly ADAS-Equipped (without Super Cruise)	96	97	26	4	6	—	229
Escalade	Super Cruise	—	—	—	—	—	3	3
	Highly ADAS-Equipped (without Super Cruise)	—	844	623	337	122	55	1,981

Analysis Structure

This analysis used three different statistical approaches to determine the effect of Super Cruise on system-relevant crashes observed on GPS-defined Super Cruise compatible roads. The crash definitions, data handling, and statistical approaches required for each of these methods are described below.

Crash Definitions and Variable Creation

Although police reports have a core set of available fields present in most states, the coding of the variables associated with those fields is not uniform. For example, initial impact location is coded in various states with either an 8-, 12- or 16-point grid, with additional variability coming from the orientation of the reference grid around the vehicle. Consequently, before pooling the crash data across states, each state dataset was separately reduced to a standard set of crash definitions and potential covariates to ensure comparable, consistent data fields across states. The difficulty in aligning state crash field levels also leads to the need for binary coding for many covariates in order to maximize consistency of variable definitions across states, including definitions of weather and road surface conditions.

The assumed system-relevant and corresponding control crash definitions used in this Super Cruise-focused analysis, developed in consultation with GM, are shown in Table 3. Note that, in addition to the crash type definitions provided in Table 3, some states had additional special variables that we used in the analysis, when available, which more directly indicated the crash types of particular interest for this analysis. Consistent with the GM Model Year 2013-2020 ADAS effectiveness effort (Leslie et al., 2022), as shown in Table 3, lane departure crashes were further broken down into same-direction sideswipe and road departure crash types.

It should be noted that we could not determine - based on the police-report data - whether or not Super Cruise (or any ADAS feature with ON/OFF capabilities) was turned on or off at the time of the crash, or whether the driver used the safety system properly (i.e., as characterized in the Owner's Manual system descriptions). For the Super Cruise system, an effort was made to determine whether the system was engaged (and hence, in use) surrounding the crash time (described further below), but no comparable data were available for other ADAS features, including those used here for matching fleets which address lane departure and rear-end striking crashes. If use of those systems was different between the two analysis groups (i.e., Super Cruise-equipped versus Highly ADAS-Equipped (but without Super Cruise)), the different use of those systems on crash outcomes would affect the estimated Super Cruise effect.

Table 3. Crash types and definitions for system-relevant (blue) and control (yellow) crashes, (SCCR=Super Cruise Compatible Road.)

Crash Type	Use in Analysis	Definition
Lane Departure - Same-Direction Sideswipe on SCCR	System-relevant	Manner of Crash = Same-direction Sideswipe AND On a SCCR
Lane Departure - Single Vehicle Road Departure on SCCR	System-relevant	Single Vehicle AND Harmful Event IN {Run off road, Cross centerline, Cross median, Fixed object} AND On a SCCR
Rear-end Striking on SCCR	"Quasi" System-relevant[3]	Manner of Crash = Rear-end AND Initial Contact Point on Vehicle = Front AND On a SCCR
Rear-end Struck	Control	Manner of Crash = Rear-end AND Initial Contact Point on Vehicle = Rear
Rear-end Struck on SCCR	Control	Manner of Crash = Rear-end AND Initial Contact Point on Vehicle = Rear AND On a SCCR
"Non-SCCR" System-Relevant Crash	Control	Any of the system-relevant crash types shown in blue above AND not on a SCCR

Super Cruise Compatible Road Identification

Five of the six crash type definitions shown in Table 3 required determining whether or not the crash occurred on a Super Cruise compatible road, which involved a three-stage review process:

1. GM located a set of anonymized crash cases with crash location GPS (latitude and longitude) coordinates provided by UMTRI to determine whether these crashes were within 100 feet of a Super Cruise compatible road.

[3] The Super Cruise system is primarily a lane-keeping system that works with Adaptive Cruise Control, so longitudinal crashes, like rear-end striking, may not be strongly associated with the system (and instead associated with the AEB with FCA feature which was equipped on all vehicles used in the analyses). Nevertheless, this crash type was treated as a "quasi" system-relevant crash type primarily for the purpose of exploring any possible effects Super Cruise may have on rear-end striking crashes.

2. GM performed a review of specific cases flagged as within that radius and marked them as "on a compatible road," "not on a compatible road", or "in need of further review".
3. UMTRI reviewed police reports associated with cases marked as "in need of further review" for evidence of ramp use, overpasses, and/or frontage roads, and provided a final characterization of the location.

As shown in Table 4, a total of 276 crashes (of these four analysis-relevant types) on Super Cruise compatible roads were identified via the process outlined above that were suitable for further analysis.[4] This represents a substantial reduction in crash sample size from the full set of matched crashes (shown in Table 2), in part due to the relatively low occurrence of crashes on Super Cruise compatible roads. Consistent with the full matched crash dataset, the majority of crashes identified were for "Highly ADAS-Equipped" Escalades without Super Cruise, and the vast majority of Super Cruise-equipped vehicles were CT6s.

Table 4. Breakdown of matched vehicles located to Super Cruise compatible roads by Equipment Level and Model Year. Cells with "—" indicate Model Years where the equipage was unavailable.

Cadillac Model	Model Year	2016	2017	2018	2019	2020	2021	Total
CT6	Super Cruise	--	--	11	5	1	--	17
	Highly ADAS-Equipped (without Super Cruise)	10	10	5	0	0	--	25
Escalade	Super Cruise	--	--	--	--	--	1	1
	Highly ADAS-Equipped (without Super Cruise)	--	99	74	39	15	6	233

Binomial Exact Test

The binomial exact test is a small sample analysis approach that uses the binomial distribution to test for the likelihood that the observed data arises from a specified population rate. The test assumes that the data follows the binomial distribution (Equation 1) and calculates the likelihood of observing a result as or more extreme than the one observed (either higher or lower), given the population rate assumed under the null hypothesis.

Equation 1: The binomial distribution (n=trials, x=successes, p=success rate)

$$P(x) = \binom{n}{x} p^x (1-p)^{n-x}$$

[4] An additional 4 cases CT5 cases were matched, but since none were Super Cruise vehicles, CT5 were not used in the analysis.

While n and x are generally conceptualized as "trials" and "successes," in this analysis they are instead "vehicles involved in a crash type" and "Super Cruise-equipped vehicles involved in that crash type." By testing the proportion of vehicles in a crash type equipped with Super Cruise against the population Super Cruise equipped rate, it is possible to determine if the system is over-, under- or neutrally-represented in crashes of that type. The layout of a binomial exact test is shown in Table 5, where the ratio $\frac{A}{A+B}$ is compared to the population Super Cruise equipped rate. The specific null hypothesis targets selected for the analyses using this method will be discussed with the matching results.

Table 5. The layout for a binomial exact test

	Super Cruise	
	Equipped	Not Equipped
Lane Departure Crash Count on Super Cruise compatible roads	A	B

Induced Exposure Logistic Regression

In the Induced Exposure Logistic Regression approach, both system-relevant and control crashes were identified so that they could be compared to determine the effect of the presence of Super Cruise on system-relevant crashes. This method, called quasi-induced exposure (Keall & Newstead, 2009), was intended to control for the lack of traditional exposure data (e.g., miles traveled on Super Cruise compatible roads). The control crash needs to be a crash type that should not be impacted by the system (in this case Super Cruise) and would, therefore, occur at a similar rate in both equipped and unequipped populations since these control crashes are assumed to occur randomly as exposure (i.e., vehicle miles traveled on Super Cruise compatible roads) increases, rather than due to particular driver actions. Conversely, the system-relevant crash is expected to be influenced by the vehicle equipment and thus may occur in a different proportion relative to the control crash for the equipped and unequipped vehicle groups. The prevalence of these system-relevant and control crash types was then evaluated using odds ratios. To illustrate, when evaluating ADAS backing systems (e.g., Rear Vision Camera), backing crashes are assumed to be the system-relevant crash type and rear-end struck crashes are assumed to be the control crash type. Backing ADAS features should not influence the occurrence of rear-end struck crashes, but are designed to affect (i.e., reduce) backing crashes.

Similarly, for the Super Cruise system, we use lane-departure crashes as the system-relevant crash type and rear-end struck crashes as the control crash type. These assumptions are shown in Table 6, which illustrates the concept underlying the quasi-induced exposure technique, where A, B, C, D represent observed crash counts. The odds of an equipped vehicle being involved in a lane departure crash relative to a rear-end struck control crash is represented by A/C while the odds of an unequipped vehicle (without Super Cruise) being involved in a lane departure crash relative to the control crash is represented by B/D. The odds ratio for the effect of the Super Cruise system on lane departure crashes is then defined as $\left(\frac{A}{C}\right) / \left(\frac{B}{D}\right)$. Crashes are sufficiently rare that this ratio represents an estimate of the risk ratio for lane departure crashes (i.e., the relative risk of experiencing such a crash in a Super Cruise-equipped vehicle versus an unequipped (but matched) vehicle). Ratios less than 1 indicate safety benefits, and conversely ratios greater than 1 indicate safety disbenefits. In the full analysis, we used a logistic regression approach to adjust for various covariates (described below).

Table 6. The layout for quasi-induced exposure logistic regression

		Super Cruise	
		Equipped	Not Equipped
Crash Configuration	Lane Departure	A	B
	Rear-end Struck	C	D

The final odds ratios were estimated using a logistic regression model. For each model, the full set of matched vehicles was limited to cases of the system-relevant and associated control type crashes, and then a model predicting the probability of the system-relevant crash was constructed.

As in the Model Year 2013-2020 GM ADAS effectiveness analysis (Leslie et al., 2022), a variety of predictors were available for inclusion in the induced exposure logistic regressions. The starting model included effects for Super Cruise presence and the various covariates listed below. (Note that two other covariate variables considered, fatigue and alcohol use, did not have sufficient data for inclusion in the Model).

- Driver age: <25, 25-64, 65+ (required)
- Driver gender: Male, Female (required)
- Speed Limit (miles per hour): Continuous
- Distracted Driver: No, Cell phone distraction, Other distraction
- Weather: Clear/Cloudy, Not Clear/ Cloudy (rain, snow, etc.)
- Road Surface Condition: Dry, Not Dry (wet, icy, etc.)
- Light Condition: daylight, dawn/dusk, dark – lit, dark – unlit
- Model Year: 2017 – 2021
- Crash Year: 2016 – 2021
- Vehicle Model: CT6, Escalade

Backward selection using a likelihood ratio test was then performed until all non-significant effects were removed, except driver age and gender. These driver demographic characteristics were included in all models because they have been previously shown to affect crash outcomes and they provide a means for attempting to control for demographic patterns.

Advantages and Disadvantages of Analysis Approaches

The analysis strategy taken here was to employ a variety of statistical approaches to explore the limited data available more thoroughly. As summarized in Table 7, each approach had distinct advantages and disadvantages, as discussed below.

The three analyses accounted for exposure in very different fashions. The engaged crash rate analysis did not involve the unequipped fleet, so it simply required that the driving in the Super Cruise equipped fleet be consistent with that observed in other studies. The equipped crash rate analysis did use the non-Super Cruise equipped vehicles, but captured exposure through the target rates. Rather than using the rate of equipped vehicles directly, the use of "vehicle years" reflected the greater exposure opportunity for crashes among older vehicles. Note, however, that this is a rough estimate of exposure and does not directly account for driving on Super Cruise compatible roads (SSCRs), vehicles leaving the fleet, or vehicles seeing more or less use on an individual level. These factors are assumed to influence approximately equally the Super Cruise and matched fleets. That is, Super Cruise-equipped and "Highly Equipped" vehicles without Super Cruise are assumed to have similar distributions of driving. Unlike the binomial exact test methods, induced exposure logistic regression is designed to account for differences in exposure (see previous section). Two control crash types were used to account for differences in overall driving (rear-end struck, whether or not crash occurred on a SCCR) and driving on SCCR (rear-end struck on SCCR). A third control crash, non-SCCR system-relevant, does not directly control for exposure, but instead for differences in the prevalence of system-relevant crashes between the two groups.

The method of evaluating Super Cruise also differs across these analyses. The engaged crash rate test compares the observed rate of system-relevant crashes during Super Cruise engagement (or use) to the estimated overall rate of Super Cruise engagement. So this test does not evaluate the rate of the crashes compared to an unequipped fleet, but rather to the overall expected engagement rate of the system. To complement this engaged crash rate test, the equipped crash rate test examines the prevalence of Super Cruise-equipped vehicles in system-relevant crashes compared to the expected rate of these crashes in the more general driving population (in this case, the combination of the Super Cruise and matched vehicle fleets). Since this test does not account for Super Cruise engagement, if equipped vehicles experienced more system-relevant crashes, the test would reflect that even if the rate of engaged crashes was lower than expected. This equipped crash rate approach behaves generally like the third induced exposure approach used here, which also considers the presence/absence of the Super Cruise system, but ties it more tightly to observed exposure by relating it to the control crash rate. Taken together, these three distinct analyses formed a more cohesive view of potential Super Cruise field effects on crashes that could be obtained in any single analysis, which is of particular importance given the data limitations characteristic of this analysis.

The firm distinction between analysis of the engaged crash rate and the equipped crash rate is due to the complexity of incorporating Super Cruise engagement (i.e., system use) into the equipped crash rate analysis. This is because the matched highly ADAS-equipped vehicles without Super Cruise do not have information available on system engagement state surrounding the crash, and thus, cannot be handled the same way as the equipped vehicles.

The binomial exact test examining engaged crash rate sidesteps this issue by excluding the unequipped portion of the fleet, but to incorporate engagement into the equipped crash rate test, one would need to establish the appropriate target rate. Rather than the Super Cruise engagement rate or the probability of being equipped, this hypothetical analysis would require that those metrics be combined, which is a nontrivial task since the engagement rate value is based only on travel on Super Cruise compatible roads, and such values are not available for ADAS features across both fleets. Consequently, divorcing these engaged versus equipped crash rate analyses facilitated more precise and better justified target rates.

This issue is further exacerbated in the induced exposure analysis, where the exposure is evaluated through the rate of control crashes. Since it is impossible to have engaged system-relevant crashes in the unequipped (but also highly ADAS-equipped) comparison fleet, the numerators must be different ("engaged system-relevant" for equipped vehicles and "engaged or non-engage system-relevant" for unequipped vehicles), but there are two ways to handle the control crashes. If one were to not adjust the control crashes, and hence, use "all control crashes" for both equipped and unequipped vehicles, this would systemically overestimate exposure for the equipped vehicles. That is, the system-relevant count is reduced to account for the engagement rate, but the control count is not correspondingly adjusted. If, instead, the control count is also modified, using "engaged control" for equipped and "all control" for unequipped vehicles, this implies that the ratio of system-relevant to control crashes is the same during engaged driving relative to all driving on Super Cruise compatible roads. Given that drivers have been shown to engage Super Cruise strategically (similar to ACC) based on OnStar data, such as using it in lower traffic environments, this assumption may not be valid. Furthermore, if that ratio was, indeed, the same for engaged versus all driving, then necessarily, it would also be the same for engaged system and unengaged system driving. That being the case, reducing to engaged only driving in the equipped population would effectively reducing the sample size while providing little benefit in the analysis.

Table 7. Brief comparison of analytical methods employed in the analysis

Comparison Factor	Statistical Approach		
	Binomial Exact Test (Engaged Crash Rate)	Binomial Exact Test * (Equipped Crash Rate)	Quasi-Induced Exposure Logistic Regression
Data source(s) used in analysis	- State Police Report data available to UMTRI - GM Super Cruise transition state data	- State Police Report data available to UMTRI	- State Police Report data available to UMTRI
Approach used to control for driving exposure between Super Cruise versus matched fleet	Matched fleet not used	Uses vehicle years in the null hypothesis to establish assumed system-relevant crash rate	Control crash types (akin to approach used in GM ADAS feature effectiveness research)
Comparison approach used to assess Super Cruise field effect	Compares the proportion (or rate) of system-relevant crashes involving Super Cruise engagement to the proportion of Super Cruise engaged driving (based on OnStar telematics data)	Compares the proportion (or rate) of Super Cruise vehicles in system-relevant crashes on compatible roads to the proportion of equipped vehicles in the entire fleet	Compares the ratio of system-relevant crashes on Super Cruise compatible roads to control crashes for Super Cruise-equipped versus non-equipped (but also highly-ADAS equipped) vehicles
Accounts for Super Cruise being "in use" (engaged) surrounding the crash	Yes	No	No
Designed for small samples characteristic of the current study	Yes	Yes	No
Controls for driver age and gender	No	No	Yes
Level of statistical assumptions required	Low	Low	Moderate

* The GM OnStar driving mileage and state sales data was only used for target setting in the Binomial Exact Test (Equipped Tests).

Returning to the comparison factors discussed in Table *7*, the majority of the comparison factors shown in the bottom rows focus on the simplicity of the binomial exact test approach relative to the induced exposure approach. Unlike the latter approach, the former approach is tailored to analyze small sample datasets with simple yes/no outcomes (as shown in Table 5). However, unlike the binomial exact test approach, the induced exposure logistic regression can control for confounding variables, though the ability to do so in the current effort is effectively restricted due to sample size limitations.

As this difference in the statistical testing approaches would imply, the binomial exact test requires fewer assumptions about the underlying data. It essentially only requires that the target rate be an appropriate estimate (e.g., here, either of the population equipment rate or the Super Cruise engagement rate). The induced exposure approach, conversely, requires several assumptions, the most notable of which is that the control crash is an appropriate estimate of driving exposure and that it is not impacted by the system under study.

Results

The results of the three analyses are presented below. The analyses are presented in sequence, with further discussion of the results provided in a latter section.

Rate of Super Cruise Engaged System-relevant Crashes

This Binomial Exact "Engaged Crash Rate" analysis addressed *whether the proportion (or rate) of system-relevant crashes involving Super Cruise engagement is more extreme (higher or lower) than expected based on the proportion of Super Cruise engaged driving*. As shown in Table 8 (which also can be seen in Table 4), a total of 276 vehicles were identified from the police-report data to have been involved in crashes on Super Cruise compatible roads. Of these crashes, 18 involved Super Cruise-equipped vehicles and 11 involved either a system-relevant or quasi-system relevant crash type (as defined in Table 3). For these latter 11 crashes, GM used telematics-based GPS Super Cruise state transition (OnStar) data to determine system engaged state at the time of the crash.[5] Three of these 11 crash cases were excluded from further analysis, since the available GM data did not show a trip at the time indicated on the police crash report, which left 8 of these crashes cases with a known Super Cruise engagement status. Of these 8 crashes, only one crash appeared to occur near or during a period of Super Cruise engagement, which did not trigger an Advanced Automatic Crash Notification (AACN) event. Prior to this crash, the driver appeared to have experienced a long period of Super Cruise engagement during highway driving in which they alternated between engaged and override (manual steering) Super Cruise states for several miles. The Super Cruise engaged driving ended after a degraded state occurring in rough proximity to the rear-end striking crash location, based on the location information available in the police accident report. It should be noted that the actual role Super Cruise played in this crash, if any, cannot be determined with high confidence based on the information available.

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[5] This Super Cruise state determination using GPS data was conducted within the limits of the privacy agreement requirements in place between UMTRI and the 12 states providing UMTRI police-report data used in this analysis.

Based on these eight crashes available for analysis, the estimated rate of Super Cruise engaged crashes out of a combined set of system-relevant and quasi system-relevant crashes on compatible roads is 0.125 (1/8). A recent OnStar telematics-based evaluation of the 2018-2019 Cadillac Super Cruise system reported by LeBlanc et al. (2022) estimated that Super Cruise was engaged for approximately 18% of driving on compatible motorways[6]. Performing a binomial exact test using this 0.18 value as the target rate (which assumes a random distribution of crashes), produced a p-value of 1.00, suggesting that these data do not indicate a significant difference between observed rate (or proportion) of engagement in system-relevant crashes and the overall rate of Super Cruise engagement.

Table 8. Breakdown of the crashes observed on Super Cruise compatible roads

Type of Crash	Count
Identified crashes on Super Cruise compatible roads	276
… for Super Cruise-equipped vehicles	18
… of a system-relevant or quasi system-relevant crash type	11
… with a known system status	8
… where Super Cruise was engaged (at or around the time of the crash)	1

Rate of Super Cruise Equipped System-relevant Crashes

This Binomial Exact "Equipped Crash Rate" analysis addressed *whether the proportion (or rate) of Super Cruise-equipped vehicles in system-relevant crashes on system compatible roads is more extreme (higher or lower) than expected based on the proportion of equipped vehicle years in the entire analysis fleet.* As previously discussed, the binomial exact tests for the rate of Super Cruise-equipped vehicles in system-relevant (or quasi system-relevant) crashes uses the proportion of equipped vehicle years to reflect the greater exposure of older vehicles for crashes. These values were calculated with Model Year 2021 vehicles being weighted at 0.5 years, Model Year 2020 at 1 year, and so on, to Model Year 2016 being weighted at 5 years. The total vehicle years for Super Cruise-equipped vehicles was then divided by the sum total of vehicle years observed for both Super Cruise-equipped and the comparison set of "Highly ADAS-Equipped" (without Super Cruise) vehicles. Using the vehicle counts provided by GM, this produces an estimated Super Cruise equipment target rate of 0.3379 for CT6s and 0.0167 for Escalades. The two Cadillac models were calculated separately since the rollout was very different and the binomial exact test does not have a mechanism for testing the significance of a model effect.

[6] The NHTSA sponsored study did not include trunk roads in this metric, but it represents the current "best knowledge" of the rate of Super Cruise engagement out of all driving on compatible roads.

As shown in Table 9, all six binomial exact tests, formed by crossing three system-relevant crash types crossed with two vehicle models were found to be non-significant. However, keeping in mind the limited amount of data available, directional trends are noted as follows. For the CT6 (which used a 0.3379 target rate) model, the Super Cruise-equipped vehicles were overrepresented in both same-direction sideswipe (observed rate= 0.5833) and rear-end striking (observed rate=0.5000) crashes, but underrepresented in single- vehicle road departures (observed rate=0.1429), but again, none of these results were statistically significant. The Escalade model provides no meaningful data for even noting trends, since only a single Super Cruise-equipped crash was observed on system compatible roads, which produced very low rates of Super Cruise-equipped vehicles in system-relevant same-direction sideswipe, using this 0.18 value as the target rate (which assumes a random distribution of crashes), produced a p-value of 1.00, suggesting that these data do not indicate a significant difference between observed rate (or proportion) of engagement in system-relevant crashes and the overall rate of Super Cruise engagement.

Table 9. Binomial exact tests for system-relevant crash types, split by vehicle model; tests are two-tailed with a targeted rate as listed in the first column. (SCCR=Super Cruise Compatible Road.)

Cadillac Model (Target Rate)	Value	Same-direction Sideswipe on SCCR	Single -Vehicle Road Departure on SCCR	Rear-end Striking on SCCR
CT6	Highly ADAS-equipped	5	6	2
	Super Cruise-equipped	7	1	2
(Target Rate =	Observed Rate	0.5833	0.1429	0.5000
0.3379)	p-value	0.1217	0.4354	0.6077
Escalade	Highly ADAS-equipped	72	16	49
	Super Cruise-equipped	1	0	0
(Target Rate =	Observed Rate	0.0137	0.0000	0.0000
0.0167)	p-value	1.0000	1.0000	1.0000

Overall, given that there are no significant differences for any of these crash types across the two Cadillac models, these results do not provide significant evidence that Super Cruise-equipped vehicles are engaged in system-relevant crashes at a different rate than their rate in the population overall.

Induced Exposure Logistic Regression

This analysis addressed *whether system-relevant crash rates (relative to control crash rates) on Super Cruise compatible roads were impacted by the presence of the Super Cruise system*. Note that there were are two important differences between this analysis and the preceding equipped crash rate analysis. First, unlike the latter analysis, the induced exposure analysis pooled the CT6 and Escalade model crashes and included a term in the model to account for any differences due to model. This term was not significant in any of the regressions conducted, indicating that that vehicle model did not significantly impact the ratio of system-relevant to control crashes. Second, the presence of only one instance of a Super Cruise equipped vehicle in the single vehicle road departure crash type (as shown in Table 11) caused the logistic regression to be unstable. (A single data point is easily divided from the rest of the data by particular variables leading to "perfect separation" in the model.) Consequently, no results for the system-relevant single vehicle road departure crash type are presented here.

Likely due to the sample size, while a variety of covariates were available during model fitting (see *Induced Exposure Logistic Regression* above), only the required terms, driver age and gender, and the distraction variable were significant in the final regressions. However, this should not be interpreted to mean that none of the other factors would have an impact if more data were available. Since these factors were not of primary interest to this analysis and were included only to account for unexplained variability, their effects are not discussed further here.

Results are shown in Table 10, for all six induced exposure logistic regressions, formed by crossing two system-relevant crash types (same-direction sideswipe and rear-end striking crashes) by three control crash types. These control crash types included all rear-end struck crashes (regardless of whether the crash occurred on a Super Cruise compatible road), rear-end struck crashes on Super Cruise compatible roads, and system-relevant crashes (either same-direction sideswipe or rear-end striking) that were not on a Super Cruise compatible road.

Table 10. Odds ratios, confidence intervals and p-values for Super Cruise from the induced exposure logistic regression. (SCCR=Super Cruise Compatible Road.)

	Same-direction Sideswipe on SCCR			Rear-end Striking on SCCR		
Control Crash Type	Odds Ratio	Confidence Interval	p-value	Odds Ratio	Confidence Interval	p-value
Rear-end Struck	1.58	(0.69, 3.61)	0.282	0.59	(0.13, 2.60)	0.481
Rear-end Struck on SCCR	1.85	(0.63, 5.44)	0.265	0.60	(0.11, 3.21)	0.553
System-Relevant Crash off SCCR	1.07	(0.45, 2.58)	0.872	0.57	(0.12, 2.74)	0.481

For the system-relevant same direction sideswipe crash, all three models showed an increased rate of these sideswipe crashes, but the increase was not significant in any of the models. When using either the control crash types (all) rear-end struck or rear-end struck on SCCRs , the data suggest an increase in the odds of same direction sideswipe crashes (odds ratios of 1.58 and 1.85, respectively). However, when using these sideswipe crashes off of SCCRs as the control crash type, the odds ratio falls to 1.07. Overall, this pattern of results (albeit non-significant) may suggest that equipped vehicles are encountering more same direction sideswipe crashes, but this occurs both on and off of system compatible roads, indicating that the result is unlikely to be related to the Super Cruise system.

For all three models looking at the (quasi) system-relevant rear-end striking crash, the estimated odds of being in this type of crash, relative to a control crash type, is about 40% lower for the Super Cruise-equipped vehicles, though none of the models indicate that the result is significant. The consistency of the results suggests that this pattern is present on SCCR specifically, but there is not sufficient evidence to conclude that this pattern is related to the Super Cruise system.

Overall, keeping in mind that all six combinations of system-relevant and control crash types have very wide confidence intervals (as shown in Table 10) due to the limited data available, consistent with the previous two analyses, these induced exposure logistic regressions results do not provide evidence of a significant effect of Super Cruise on system-relevant crashes.

Use Rate, Sample Size and Power

Unlike various ADAS features that are specifically aimed at reducing system-relevant crashes, Super Cruise, similar to Adaptive Cruise control (ACC), is a driver convenience system and is engaged (i.e., used) for a considerably lower proportion of driving. This relatively low system usage, when considered together with the low initial Super Cruise volumes and current compatible road restrictions, as well as the fact that compatible road crash rates are generally low, creates data limitation challenges for detecting any existing Super Cruise field effects. For example, even if the Super Cruise system were 100% effective at avoiding system-relevant crashes on compatible roads (where as discussed earlier, system use is estimated at 18% based findings reported by LeBlanc et al. (2022)), then assuming that crashes and use were independent, the maximum observable difference in effectiveness analyses would be 18% (the achieved effect in the field). If Super Cruise expanded to other (e.g., lower-speed) road types where system usage may be lower, than the maximum possible system effect for these road types would be further reduced on these road types. Conversely, the opposite would be true if Super Cruise use increased beyond 18% usage for these road types.

Table 11 shows the required crash sample sizes for 80% power (where "power" refers to the likelihood of detecting a difference when in fact a difference actually exists) on a binomial exact test across three scenarios explored which assume (1) Super Cruise reduces system-relevant crashes by 20%; (2) Super Cruise use rates on compatible roads are either 20%, 40%, or 100%, where system use is generally believed to increase with further system refinement; (3) Super Cruise-equipped rate is either 25% or 50%. In the 20% use categories, which approximates the best available estimate of use on motorways, the (maximum) observable reduction in system-relevant crashes is only 4%. Referring to Table 11, this produces very large required sample sizes at 14,542 for a 0.25 population equipment rate and 4,951 for the 0.50 equipment rate. The much lower required sample size for the latter category reflects the fact that the observable reduction does not change, since the estimated system effectiveness and use proportions remain constant, and it is easier to detect a 4% reduction in a proportion of 0.50

than 0.25 (i.e., a change of 0.02 vs. 0.01). If the usage doubled to 40%, the required sample sizes drop by approximately a factor of four, dropping to 3,584 and 1,251 for equipment rates of 0.25 and 0.50, respectively. Even when the expected use rate increases to 100%, allowing the full system effect to be observable, achieving 80% power still requires hundreds of cases (526 for a 0.25 equipment rate and 201 for a 0.50 equipment rate). Note that the lowest of these required sample sizes, 201 in the bottom row of Table 11, is still well over twice the sample size of the largest binomial exact test in this report (73 Escalades in the same direction lane departure Equipped Crash Rate analysis). Additionally, achieving that scenario would require a substantial increase in the number of Super Cruise equipped vehicles to bring the equipment rate up to 0.50 since the equipped rate for CT6s (in vehicle years) for this study was 0.3379.

Table 11. Estimated sample sizes required for 80% power for a binomial exact test given select estimated benefits of Super Cruise for system-relevant crashes and use rates on compatible roads

Equipment Rate in the Population (vehicle years)	Estimated Reduction in System-relevant Crashes	Estimated System Use on Compatible Roads	Observable Reduction in System-relevant Crashes	Required Sample Size for 80% Power
0.25	20%	20%	4%	14,542
0.25	20%	40%	8%	3,584
0.25	20%	100%	20%	562
0.50	20%	20%	4%	4,951
0.50	20%	40%	8%	1,251
0.50	20%	100%	20%	201

It should be further noted that crashes on Super Cruise compatible roads are currently quite rare. Of the 2,351 matched crashes identified at the start of this analysis (refer to Table 2), only 276 (or 11.7%) of these crashes occurred on a Super Cruise compatible road. As the compatible road network increases, this percentage should increase. While this does not change the required sample sizes shown in Table 11 (under a given level of use), it does make it easier to reach the required sample sizes. For example, assuming that an expanded Super Cruise system doubled the number of compatible roads, and assuming an even distribution of crashes over all compatible roads, the proportion of crashes on compatible roads could conceivably also double. This would make it substantially easier to accumulate the requisite amount of data but does come with a substantial limitation: backwards compatibility. If the expanded road network is only available on newer vehicles, and not backfilled onto the existing fleet, it would not be appropriate to combine them for purposes of analysis and the set of roads considered would need to be tailored to the most limited set included to avoid overestimating exposure for the engaged crash rate analysis and reducing the effective usage rate for the other analyses.

Discussion

This effort examines the potential impact of the Super Cruise system on "system-relevant" lane departure crashes on Super Cruise compatible roads. Additional analyses examined the impact Super Cruise on rear-end striking crashes (considered "quasi" system-relevant). Although such crashes are not directly related to the added automatic lane-centering control offered by Super Cruise, any changes in the prevalence of such crashes are of interest to evaluate potential unintended consequences associated with this system.

Model Year 2018-2020 Cadillac CT6 vehicles were included in this analysis, as well as several other models that introduced Super Cruise in Model Year 2021, namely the Cadillac CT4, CT5, and Escalade. Vehicles ranging from Model Years 2016 through 2021 were used to develop the Super Cruise and non-Super Cruise comparison fleets. Since Super Cruise-equipped vehicles are also highly equipped with ADAS features that have been shown to reduce rear-end striking, lane departure, and lane change crashes, in an attempt to isolate Super Cruise field effects, the non-Super Cruise comparison fleet was required to be highly ADAS-equipped. More precisely, the set of required matching ADAS features included fusion-based Automatic Emergency Braking with Forward Collision Alert, Lane Keep Assist with Lane Departure, and Rear Camera Mirror with Lane Change Alert and Side Blind Zone Alert.

Matching these vehicles to Vehicle Identification Numbers (VINs) from 12 police-report state databases available to the University of Michigan Transportation Research Institute (UMTRI) resulted in 276 matched, analysis-relevant (i.e., either system-relevant or control) crash cases on Super Cruise compatible roads, including 18 such matches for Super Cruise-equipped vehicles and 258 such matches for the highly ADAS-equipped comparison vehicles. These 276 matched cases were then further filtered (e.g., by crash type or due to missing police report variables) based on which of the three statistical analysis approaches were used, each of which has unique complementary strengths and weaknesses for this analysis, as characterized in Table 7.

The analysis strategy taken here was to employ a variety of statistical approaches to explore the limited data available more thoroughly. Three statistical analysis approaches were used to examine the impact of Super Cruise on system-relevant crash types on Super Cruise compatible roads, including lane departure crashes (same-direction sideswipes and single-vehicle road departures) and rear-end striking crashes.

The Binomial Exact "Engaged Crash Rate" analysis addressed *whether the proportion (or rate) of system-relevant crashes involving Super Cruise engagement is more extreme (higher or lower) than expected based on the proportion of Super Cruise engaged driving.* Of the eight system-relevant crashes identified by GM to have occurred with Super Cruise-equipped vehicles on system compatible roads, only one involved engagement based on the crash time and location information available in the police accident report. For this crash, Super Cruise engaged driving ended after a system degraded state occurring in rough proximity to the reported rear-end striking crash event. (Note the actual role Super Cruise played in this crash, if any, cannot be determined with high confidence based on the information available.) This ratio of 0.125 (1/8) is less than the estimated 18% (0.18) Super Cruise engagement rate on system compatible roads (based on an OnStar telematics study of Super Cruise owner usage reported by LeBlanc et al. (2022)). This Binomial Exact Test was not significant (p=1.00), meaning that, based on this limited sample size, there is no support for the hypothesis that Super Cruise either increases or decreases crash rate when engaged. Unlike this analysis, the remaining two analyses do not attempt to account for Super Cruise engagement associated with the crash, but instead use general estimates of driving exposure.

The Binomial Exact "Equipped Crash Rate" analysis addressed *whether the proportion (or rate) of Super Cruise-equipped vehicles in system-relevant crashes on system-compatible roads is more extreme (higher or lower) than expected based on the proportion of equipped vehicle years in the entire analysis fleet.* The six tests conducted were formed by crossing three system-relevant crash types on Super Cruise compatible roads (same-direction sideswipe, single-vehicle road departure, and rear-end striking) with two vehicle models (CT6 and Escalade). Results from five of these six tests failed to approach significance (p>0.43). For the CT6, the estimated rate of same-direction sideswipe crashes on Super Cruise compatible roads trends higher than expected (p=0.12).

The Quasi-Induced Exposure regression analysis *addressed whether system-relevant (relative to control) crash rates on Super Cruise compatible roads were impacted by the presence of the Super Cruise system.* The six regression analyses conducted were formed by crossing two system-relevant crash types (same-direction sideswipe and rear-end striking crashes) by three control crash types. These control crash types included rear-end struck crashes on Super Cruise compatible roads, all rear-end struck crashes (regardless of whether the crash occurred on a Super Cruise compatible road), and system-relevant crashes (either same-direction sideswipe or rear-end striking) that were not on a Super Cruise compatible road. Once again, none of the results from this regression analysis approached significance (p>0.26). Hence, consistent with the previous two analyses, these induced exposure logistic regressions results do not provide evidence of a significant effect of Super Cruise on system-relevant crashes.

In summary, in light of the widespread lack of statistical significance across the variety of analysis approaches employed and the large number of statistical tests conducted, there is no evidence for a difference in system-relevant crash risk for Super Cruise-equipped vehicles compared to matched highly-ADAS equipped vehicles without Super Cruise. Taken together, the three distinct statistical analyses employed formed a more cohesive view of potential Super Cruise field effects on crashes than could be obtained in any single analysis, which is of particular importance given the existing data limitations. Unlike various ADAS features that are specifically aimed at reducing system-relevant crashes, Super Cruise, similar to Adaptive Cruise control (ACC), is marketed as a driver convenience system and is engaged (i.e., used) for a considerably lower proportion of driving. This relatively low Super Cruise system usage on system compatible roads, when considered together with the low initial Super Cruise volumes and current system-compatible road restrictions, as well as the fact that compatible road crash rates are generally low, creates data limitation challenges for detecting any existing Super Cruise field effects when in fact a difference actually exists (referred to as "statistical power").

Hence, the lack of statistical significance observed here is not a definitive conclusion of “no effect.” Continuing to revisit this Super Cruise field analysis with additional crash data and miles driven should continue to improve our ability to evaluate the effect of Super Cruise on system-relevant crashes.

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