U.S. Department
of Transportation
National Highway
Traffic Safety
Administration

NHTSA

DOT HS 812 444 August 2017

Trends and Rollover-Reduction Effectiveness of Static Stability Factor in Passenger Vehicles

Suggested APA Format Reference:

Pai, J. (2017, August). *Trends and Rollover-Reduction Effectiveness of Static Stability Factor in Passenger Vehicles*. (Report No. DOT HS 812 444). Washington, DC: National Highway Traffic Safety Administration.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT HS 182 444		

4. Title and Subtitle	5. Report Date
Trends and Rollover-Reduction Effectiveness of Static Stability Factor in Passenger Vehicles	August 2017
	6. Performing Organization Code
7. Author(s) Jia-Ern Pai	8. Performing Organization Report No.
9. Performing Organization Name and Address Evaluation Division; National Center for Statistics and Analysis National Highway Traffic Safety Administration Washington, DC 20590	10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address National Highway Traffic Safety Administration 1200 New Jersey Avenue SE. Washington, DC 20590	13. Type of Report and Period Covered NHTSA Technical Report 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The Static Stability Factor (SSF) and the NCAP dynamic rollover test provide NHTSA the information to assess rollover resistance of new vehicles. From model year (MY) 2004-2013, the weighted average of SSF in SUVs improved from 1.17 to 1.21 while the weighted average of SSF in pickup trucks worsened from 1.21 to 1.18. Other types of passenger vehicles did not have significant trends in the weighted average of SSF during those MYs. Some light trucks and vans (LTVs) failed the dynamic rollover test, but none of the passenger vehicles failed the test since MY 2008.

Based on the State Data System 2004-2011 with MY 2004-2010, this report evaluates the effects of SSF on rollovers in single-vehicle crashes and rollovers in multi-vehicle crashes when SSF increases by 0.01. SSF has statistically significant effects on reducing rollovers, except rollovers by passenger cars in multi-vehicle crashes with wet roadways:

	Reduced-odds of Rollovers in Single-Vehicle Crashes	Confidence Interval
All passenger cars	3.39 %	0.94 % to 6.33 %
Passenger cars without ESC	4.69 %	4.34 % to 5.05 %
Passenger cars with ESC	1.96 %	0 % to 3.87 %
All LTVs	5.75 %	5.38 % to 6.11 %
LTVs without ESC	5.41 %	4.21 % to 6.51 %
LTVs with ESC	4.89 %	3.88 % to 5.90 %
	Reduced-odds of Rollovers in Multi-Vehicle Crashes	**Confidence Interval**
Passenger cars on wet roadways	0.14 %	-3.36 % to 3.68 %
Passenger cars on dry roadways	9.26 %	5.95 % to 12.36 %
All LTVs	7.57 %	6.71 % to 8.42 %

17. Key Words	18. Distribution Statement
Static Stability Factor, SSF, dynamic rollover test, tip up, rollovers, ESC	Document is available to the public from the National Technical Information Service www.ntis.gov.

19. Security Classif. (Of this report)	20. Security Classif. (Of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	141	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Table of Contents

1 Introduction 1

1.1 Background 1

1.2 Purpose of Evaluation 2

2 Static Stability Factor and NCAP Dynamic Rollover Test 2

2.1 Assessment of Static Stability Factor 2

2.1.1 Measurement of Track Width 3

2.1.2 Measurement of Center of Gravity Height 3

2.1.3 Static Stability Factor Variation Due to Optional Equipment 4

2.2 NCAP Dynamic Rollover Test 5

3 Weighted Average of Static Stability Factor and NCAP Tip-up Rate 6

3.1 Weight Assignment 6

3.2 Coverage of NCAP Rollover Resistance Program 6

3.3 Weighted Average of Static Stability Factor 7

3.4 Weighted Tip-up Rate in the Dynamic Rollover Test 9

4 Setting of Analysis 11

4.1 Rollover Associated Covariates 12

4.2 Analysis Methodology 14

4.3 Analysis Limitations 16

5 First-Event Rollovers in Single-Vehicle Crashes 16

5.1 Single-Vehicle Crashes 17

5.2 First-Event Rollovers 17

5.3 State Data Sets of First-Event Rollovers 17

5.4 Vehicle Categorization of First-Event Rollovers 18

5.5 First-Event Rollovers in Single-Vehicle Crashes by Passenger Cars 20

5.5.1 Effect of SSF on First-Event Rollovers by Passenger Cars 21

5.5.2 Effect of ESC on First-Event Rollovers by Passenger Cars 24

5.6 First-Event Rollovers in Single-Vehicle Crashes by Passenger Cars without ESC 27

5.7 First-Event Rollovers in Single-Vehicle Crashes by Passenger Cars with ESC 29

5.8 First-Event Rollovers in Single-Vehicle Crashes by LTVs 33

5.8.1 Effect of SSF on First-Event Rollovers by LTVs 34

5.8.2 Effect of ESC on First-Event Rollovers by LTVs 36

5.9 First-Event Rollovers in Single-Vehicle Crashes by LTVs without ESC 38

5.10 First-Event Rollovers in Single-Vehicle Crashes by LTVs with ESC 41
5.11 Summary for Statistical Inference of First-Event Rollovers 44
6 Subsequent Rollovers in Multi-Vehicle Crashes 45
6.1 Multi-Vehicle Crashes 45
6.2 Subsequent Rollovers after Side-Impact Multiple-Vehicle Crashes 46
6.3 State Data Sets of Subsequent Rollovers 46
6.4 Vehicle Separation of Subsequent Rollovers 47
6.5 Subsequent Rollovers in Side-Impact Multi-Vehicle Crashes by Passenger Cars 47
6.5.1 Effect of SSF on Subsequent Rollovers by Passenger Cars 49
6.5.2 Effect of ESC on Subsequent Rollovers by Passenger Cars 52
6.6 Subsequent Rollovers in Side-Impact Multi-Vehicle Crashes by LTVs 53
6.6.1 Effect of SSF on Subsequent Rollovers by LTVs 55
6.6.2 Effect of ESC on Subsequent Rollovers by LTVs 56
6.7 Summary for Statistical Inference of Subsequent Rollovers 58
7 Conclusion 59
Appendix A A1
A.1 SSF of Passenger Cars MY 2004 to 2013 .... A1
A.2 SSF of SUVs MY 2004 to 2013 .... A21
A.3 SSF of Pickup Trucks MY 2004 to 2013 .... A48
A.4 SSF of Minivans MY 2004 to 2013 .... A54
A.5 SSF of Full-size passenger vans MY 2004 to 2013 .... A56
Appendix B B1
B.1 Trend of the Estimated Effect of SSF on First-event Rollovers by Passenger Cars B1
B.2 Trend of the Estimated Effect of ESC on First-event Rollovers by Passenger Cars B2
B.3 Trend of the Estimated Effect of ESC on First-event Rollovers by LTVs B5
B.4 Trend of the Estimated Effect of SSF on First-event Rollovers by LTVs without ESC B7
B.5 Trend of the Estimated Effect of SSF on Subsequent Rollovers by Passenger Cars with Wet Roadway Surfaces B8
B.6 Trend of the Estimated Effect of SSF on Subsequent Rollovers by Passenger Cars with Dry Roadway Surfaces B9
B.7 Trend of the Estimated Effect of ESC on Subsequent Rollovers by LTVs B11

LIST OF ABBREVIATIONS

2DR	2-door
4DR	4-door
2WD	2-wheel drive
4WD	4-wheel drive
AIC	Akaike information criterion
CUV	crossover utility vehicle
CY	calendar year
ESC	Electronic Stability Control
FARS	Fatality Analysis Reporting System
FMVSS	Federal Motor Vehicle Safety Standard
GVWR	gross vehicle weight rating
LTV	light trucks and vans (includes pickup trucks, SUVs, minivans, and full-size passenger vans)
MLE	Maximum likelihood estimation
MY	model year
NCAP	New Car Assessment Program

NHTSA	National Highway Traffic Safety Administration
NVPP	National Vehicle Population Profile
PDO	property damage only
SDS	State Data System
SSF	Static Stability Factor
SUV	sport utility vehicle
VIMF	Vehicle Inertia Measurement Facility
VIN	vehicle identification number

Executive Summary

The New Car Assessment Program (NCAP) rollover resistance program includes at-rest measurements, known as the Static Stability Factor (SSF[1]) and a dynamic rollover test starting MY 2004. The National Highway Traffic Safety Administration (NHTSA) began reporting SSF measurements as part of NCAP in 2001, and the dynamic rollover test was added to NCAP starting with model year (MY) 2004. These assessments provide NHTSA the information to assign star safety-ratings for rollover resistance of new vehicles. This evaluation report estimates the effects of SSF and Electronic Stability Control (ESC) installation rate on rollovers in single-vehicle crashes and certain types of multi-vehicle crashes from MY 2004 to 2010.

This evaluation report groups the test vehicles into passenger cars, sport utility vehicles (SUVs), pickup trucks, minivans and full-size passenger vans, and the collection of pickup trucks, SUVs, minivans and full-size passenger vans is called light trucks and vans (LTVs). The NCAP rollover resistance program attempts to cover at least 80 percent of passenger vehicles in the market from MY 2004 to 2013, and the coverage is more than 85 percent in passenger cars. The coverages in SUVs, pickup trucks and minivans are less than 80 percent in each MY from MY 2004 to 2006 while the coverage in full-size passenger vans is less than 80 percent until MY 2010. The weighted average of SSF in passenger cars remained close to 1.41 in each MY from MY 2004 to 2013 while the weighted average values of SSF have improved over this timespan from 1.17 to 1.21 in SUVs. However, the weighted average of SSF may have deteriorated in pickup trucks during those years: the weighted average of SSF was 1.21 from MY 2004 to 2006 but only 1.18 from MY 2009 to 2013. SSF showed little trend in either direction for minivans or full-size passenger vans, with SSF for the individual years varying between 1.25 and 1.29 in minivans and between 1.07 and 1.11 in full-size passenger vans. Not all passenger vehicles with measured SSF values had the NCAP dynamic rollover test, and NCAP assumed that all passenger cars can pass the test in all MYs. None of the minivans failed the NCAP dynamic rollover test in any MY from 2004 to 2013 while some SUVs, pickup trucks and full-size passenger vans failed the test as recently as 2007. None of the LTVs failed the test in any MY from 2008 to 2013.

A first-event rollover is a rollover that occurred as the first event in a crash, and the first-event rollovers include both tripped and untripped rollovers. The average estimated effect of SSF on reducing the odds of first-event rollovers in single-vehicle crashes is 3.39 percent[2] in all passenger cars, 4.69 percent in passenger cars without ESC, and 1.96 percent in passenger cars with ESC, respectively, when the SSF increases by 0.01. The effect of SSF on first-event rollovers is statistically greater in passenger cars without ESC than in passenger cars with ESC. The average estimated effect of SSF on reducing the odds of first-event rollovers in single-

[1] The static stability factor is a value used to represent the vehicle geometric properties associated with single-vehicle rollover events, in particular, track width and center of gravity height. The test determines whether a vehicle is vulnerable to tipping up on the road in a severe maneuver.

[2] All estimated effects of SSF and ESC installation shown in the executive summary are statistically significant at 0.05 level of significance.

vehicle crashes is 5.75 percent in all LTVs, 5.41 percent in LTVs without ESC, and 4.89 percent in LTVs with ESC, respectively, when the SSF increases by 0.01. There is no statistically significant difference among the effects of SSF on first-event rollovers in all LTVs, LTVs without ESC and LTVs with ESC. Based on the observed single-vehicle crashes[3] in the State Data System (SDS), the average estimated effect of ESC installation rate on reducing the odds of first-event rollovers in single-vehicle crashes is 58.97 percent in passenger cars and 68.96 percent in LTVs, respectively, when the ESC installation rate increases from 0 to 100 percent.

A subsequent rollover is defined for this report as a rollover that occurred as the second sequential event in a crash. In this evaluation report, the analysis of subsequent rollovers is limited to those in which the first sequential event is a side impact in a multi-vehicle crash[4]. The estimated effect of SSF on reducing subsequent rollovers in passenger cars depends on the condition of roadway surface, and SSF was not found to be statistically significant when the roadway surface is wet; but for dry roadway surfaces, the average estimated effect of SSF on reducing the odds of subsequent rollovers in side-impact multi-vehicle crashes is 9.26 percent in passenger cars and 7.57 percent in LTVs, respectively, when the SSF increases by 0.01. The average estimated effect of ESC installation on reducing the odds of subsequent rollovers in multi-vehicle crashes is 40.20 percent and 23.70 percent in all passenger cars and all LTVs, respectively, when the ESC installation rate increases from 0 to 100 percent.

The rollover analysis published in Federal Register Volume 66, No. 9, January 12, 2001 analyzed the SSF as a measure of rollover risk with regard to all rollover types in single vehicle crashes. That analysis or its future update remains the official NCAP rollover analysis and is not superseded by this evaluation report. This evaluation report analyzes first-event single-vehicle rollovers and subsequent rollovers in multi-vehicle crashes, as defined in this report, as an added exploration of the SSF in specific rollover types.

[3] ESC has statistically significant effects on both first-event rollovers and single-vehicle crashes. Some first-event rollovers did not occur, since ESC prevented the single-vehicle crashes in advance. This evaluation report is not intended to estimate the absolute effect of ESC on reducing first-event rollovers.

[4] This evaluation report only considers two-vehicle crashes.

1 Introduction

1.1 Background

Every year, thousands of motor vehicle crashes result in a vehicle rollover, often after a vehicle ran off the road. Among run-off-road crashes, the rollover event is one of the significant safety problems in roadway departure incidents. The term "rollover" describes the condition of at least a 90-degree rotation about the longitudinal axis of a vehicle, regardless of whether the vehicle ends up laying on its side, roof, or even returning upright on all four wheels[5]. NHTSA analysis shows that 18.9 percent fatal crashes in 2014 (7,592 of 40,164) involved rollovers[6].

NHTSA describes rollovers as "tripped" or "untripped." A tripped rollover event occurs when a vehicle runs off the road and is tripped by a ditch, soft soil, a curb or other object causing a vehicle to roll over. An untripped rollover event happens when the tire/road interface friction is the only external force acting on a vehicle, thereby inducing it to roll over. NHTSA analysis[7] indicated that approximately 95 percent of rollovers in single-vehicle crashes are tripped, and only 5 percent of rollover crashes are untripped. NHTSA noted that the tire traction is not a significant factor to a tripped rollover when a vehicle is in a tripping situation. NHTSA further pointed out that certain vehicle geometric properties would be the most relevant vehicle influences on the likelihood of rollover events. Thus, NHTSA[8] believed that the center of gravity height and the track width of a vehicle are highly correlated with rollovers. In 2004, NCAP began conducting dynamic rollover tests to collect more information on untripped rollovers.

The Static Stability Factor (SSF) was introduced to NHTSA in 1973 by vehicle manufacturers as a scientifically potential substitute for dynamic rollover tests, and NCAP began reporting SSF in 2001. NHTSA considers the SSF as a significant factor of rollover resistance, since the SSF represents the vehicle geometric properties that are associated with rollover events, i.e., the center of gravity height and the track width. SSF indicates rollover risk in a single-vehicle crash and the NCAP rollover resistance rating quantifies the risk of a rollover if a single-vehicle crash occurs. The NCAP rollover ratings are produced exclusively for consumer information only, and no regulatory requirements specifically related to rollover mitigation are placed on vehicle manufacturers. The NCAP rating does not predict the likelihood of a rollover crash occurring, only the likelihood of a rollover occurring given that a single vehicle crash occurs.

Starting with MY 2004, NHTSA combines a vehicle's SSF measurement with its performance in a dynamic "fishhook" test maneuver and presents a single safety rating for rollover resistance by

[5] "Rating System for Rollover Resistance, An Assessment," Transportation Research Board Special Report 265, National Research Council.

[6] Traffic Safety Facts 2014: A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System. (Report No. DOT HS 812 261). Washington, DC: National Highway Traffic Safety Administration.

[7,5] 66 FR 3388, January 12, 2001. Response to Comments, Notice of Final Decision. (Docket No. NHTSA-2000-8298-0001).

make-model. In the NCAP rating system, the lowest rated vehicles (1-star) are at least 4 times more likely to rollover than the highest rated vehicles (5-star). NCAP publishes all SSF measurements and the NCAP dynamic rollover test results in Docket No. NHTSA-2001-9663. NCAP star-ratings for rollover resistance of individual vehicles can be viewed by visiting **www.safercar.gov**.

1.2 Purpose of Evaluation

NHTSA believes that improving the SSF can reduce both tripped and untripped rollovers. If a vehicle is assigned an NCAP rollover rating, NHTSA reports the dynamic test tip result and the projected rollover rate. Manufacturers are encouraged to improve the SSF when designing new vehicles.

The first part of this evaluation report presents the weighted average of SSF starting from MY 2004 to 2013, in which the weight parameter is the sales volume of each make-model tested. This evaluation report also focuses on examining the trend of SSF. Vehicles were separated into passenger cars, SUVs, pickup trucks, minivans and full-size passenger vans to calculate the weighted average of SSF, since the vehicle geometric properties (i.e., the center of gravity height and the track width) differ among vehicle groups.

The second part of the evaluation is to estimate the effect of SSF on reducing certain types of rollovers. The effect of SSF will be estimated based on available State crash data in NHTSA's State Data System (SDS) from MY 2004 to 2010 and calendar year (CY) 2004 to 2011. The analysis focuses on rollovers as a first event in single-vehicle crashes and in certain types of multi-vehicle crashes. Based on the vehicle group and the ESC installation rate, the effect of SSF is estimated for different scenarios.

The rollover analysis published in Federal Register Volume 66, No. 9, January 12, 2001 analyzed the SSF as a measure of rollover risk with regard to all rollover types in single vehicle crashes. That analysis or its future update remains the official NCAP rollover analysis and is not superseded by this evaluation report. This evaluation report analyzes first-event single-vehicle rollovers and subsequent rollovers in multi-vehicle crashes, as defined in this report, as an added exploration of the SSF in specific rollover types.

2 Static Stability Factor and NCAP Dynamic Rollover Test

Laboratory test procedures for measuring the SSF and evaluating light vehicle dynamic rollover propensity are available at **https://www.safercar.gov/NCAP_Test_Procedures**.

2.1 Assessment of Static Stability Factor

The SSF of a vehicle is expressed by the following formula:

$$\text{SSF} = \frac{\text{Track Width}}{2 \cdot (\text{Center of Gravity Height})}$$

A value of SSF suggests the vehicle would be more likely to experience a rollover. A vehicle with a higher SSF value is considered to be more geometrically stable and less top-heavy. NCAP records the values of SSF by rounding the test values to the nearest hundredth; therefore all analyses in this evaluation report are based on the SSF recorded by NCAP. The NCAP records reveal a minimum SSF of 0.92 and a maximum SSF of 1.59. Across all passenger cars and LTVs, the SSF typically ranges from 1.00 to 1.50.

NCAP tests make-models with high-volume-sales whose gross vehicle weight rating (GVWR) is less than or equal to 10,000 lb. Corporate twinned vehicles (e.g., the 2007 Chevrolet Cobalt and the 2007 Pontiac G5) are considered to have the same value of SSF, since they are built with the same wheelbase, under-hood and interior components. The compiled list of make-models tested and their SSF values from MY 2004 to 2013 are listed in Appendix I by vehicle type.

The formula of the SSF is a function of the track width and the center of gravity height of a vehicle. Before measuring these two geometric properties of the test vehicles, the tester prepares and verifies that the fuel tank is full, and the tires are inflated to the manufacturer's recommended pressure. The size of tires also needs to fit the manufacturer's requirements. The following sections describe the measurement processes of the track width and the center of gravity height of a test vehicle.

2.1.1 Measurement of Track Width

The steering wheels and steered road wheels of a test vehicle are set straight ahead with zero steer angles when measuring the track width. To minimize measurement errors caused by small steer angles, the track width of each test vehicle is recorded by taking the average of eight independent measurements (i.e., four front track measurements and four rear track measurements). Each independent measurement is required to be made to the nearest 0.05 inches.

2.1.2 Measurement of Center of Gravity Height

Each test vehicle is loaded with an anthropomorphic dummy on the driver's seat before measuring the center of gravity height. The anthropomorphic dummy represents the 50th percentile of the body size and weight of human males.

NCAP uses the Vehicle Inertia Measurement Facility (VIMF)[9] to measure the center of gravity height of each test vehicle. The vehicle and axle weights need to be calibrated when measuring the center of gravity height. Measurement errors of each axle weight and wheel weight are kept

[9] **http://www.sealimited.com/vehicle-inertia-measurement-facility-vimf.html**.

within ± 2 lb. and ± 1 lb., respectively. NCAP records the center of gravity height of each test vehicle by taking the average of four independent measurements. Each independent measurement is rounded to the nearest 0.01 inches to provide a 0.5 percent accuracy. For example, the measurement is at least accurate to 0.1 inches for a 20-inche center of gravity height.

2.1.3 Static Stability Factor Variation Due to Optional Equipment

Optional body styles in the same make-model could cause a different value of SSF, since the center of gravity height could vary. Based on prior research comparing vehicle inertial parameters, the number of doors is the main optional equipment affecting the SSF in passenger cars. For example, the SSF of the 2005 Honda Accord 2-door coupe is 1.44 while the SSF of the 4-door Sedan of the same make-model is 1.42. Based on the body styles, NHTSA separates passenger cars into 2-door (2DR) and 4-door (4DR) as the following table shows.

Passenger Cars	
Description	Body Style
2DR	2-Door Coupe, 3-Door Hatchback, 2-Door Convertible
4DR	4-Door Sedan, 5-Door Hatchback, Station Wagon

NHTSA distinguishes the different values of SSF in the same make-model, but there are some exceptions. For example, the SSF of the 2004 Chrysler Sebring 2-door coupe is 1.44 while the SSF of the 2004 Chrysler Sebring 2-door convertible is 1.51. If a passenger car has more than one body style, NCAP will measure the SSF for each body style.

NHTSA noted that the drive system is the main optional equipment affecting the values of SSF in SUVs, pickup trucks, mini-vans and full-size passenger vans. For example, the SSF of the 2007 Honda CR-V front-wheel drive is 1.22 while the SSF of the 2007 Honda CR-V 4x4 is 1.26. Based on the drive systems, NHTSA separates LTVs into 2-wheel drive (2WD) and 4-wheel drive (4WD) as the following table shows.

LTVs	
Description	Drive System
2WD	Front-wheel Drive, Rear-wheel Drive, 4x2
4WD	All-wheel Drive, 4x4

If an LTV has more than one body style, NCAP will test each body style.

The engine and transmission are grouped into gasoline, hybrid and electric. Besides the body style and the drive system, the different type of engine and transmission could affect the SSF in the same make-model. For examples, the SSF of the 2008 Toyota Camry hybrid 4-door Sedan is 1.41 while the SSF of the 2008 Toyota Camry 4-door Sedan (gasoline) is 1.42; the SSF of the 2008 Ford Escape hybrid front-wheel drive is 1.14 while the SSF of the 2008 Ford Escape front-wheel drive (gasoline) is 1.13. If a passenger vehicle has more than one type of engine and transmission, NCAP will test each powertrain style.

2.2 NCAP Dynamic Rollover Test

NHTSA's star safety-rating for rollover resistance were only based on the SSF before MY 2004. NHTSA analysis indicates that an untripped rollover in a single-vehicle crash is likely to occur when a driver tries to regain the lane position after dropping two wheels off the roadway onto the shoulder. Starting with MY 2004, NCAP began the dynamic rollover test to assess the likelihood of untripped rollovers in single-vehicle crashes. Not all new passenger vehicles with measured SSF values had the NCAP dynamic rollover test, and passenger vehicles with major feature changes that may affect their SSF values are given priority.

The procedure is comprised of one characterization maneuver and one rollover resistance maneuver (i.e., the fishhook test). The Slowly Increasing Steer maneuver is used to characterize the lateral dynamics of each vehicle and the steering that produces a lateral acceleration of 0.3 g. The Fishhook maneuver is designed to maximize the roll motion of the test vehicle. The NCAP dynamic rollover test does not represent tripped rollovers.

To simulate the five-occupant loading scenario, NCAP requires loading three water dummies on all test vehicles that are able to carry at least five occupants. Some test vehicles are only loaded with two water dummies, since they are designed for four occupants.

The NCAP dynamic rollover test is performed on a smooth pavement road to simulate the maneuver of a sharp position switching on a roadway right after a rapid steering input. During the NCAP dynamic rollover test, the test vehicle is driven in a straight line at the beginning. The driver is required to maintain the speed between 35 to 50 mph briefly after the steering is input. After the required speed is achieved, the driver then triggers the commanded handwheel input. The handwheel position is linearly increased from zero to 270 degrees at the rate of 13.5 degrees per second. The handwheel position is held at 270 degrees for two seconds, and then the driver harshly turns the handwheel back to zero degrees. When a robotic steering controller is employed, it will reverse steer at a handwheel angle at 0.3 g for left to right and right to left for 5.5 and 6.5 scalars, respectively.

If the inside wheels simultaneously lift more than two inches off the pavement road during the maneuver of vehicle turning left/right, then NCAP considers the test vehicle to tip up. Test vehicles with tip-up are projected to have higher risk of experiencing untripped rollovers than test vehicles without tip-up. Appendix I lists the NCAP dynamic rollover test results from MY 2004 to 2013.

3 Weighted Average of Static Stability Factor and NCAP Tip-up Rate

3.1 Weight Assignment

Walz[10] reported the weighted average of SSF for the years MY 1975 to 2003. This evaluation will extend Walz's investigations from MY 2004 to 2013. The sales volume of each new vehicle tested in the NCAP rollover resistance program is used to calculate the weighted average of SSF in each MY. The National Vehicle Population Profile (NVPP) database compiled by IHS, Inc. (formerly R.L. Polk) provides the registration counts of each make-model in every CY in the U.S. nationwide. However, the registration counts may not precisely represent the sales of a vehicle, since a vehicle could have already been traded and registered multiple times. Directly using the registration counts would over-count the sales of vehicles, especially when the difference between CY and MY is significant.

Walz indicated that the number of new vehicles in a given MY that were registered in the following CY is a reasonable estimate of the sales volume, since almost all new vehicles are sold before the end of the following CY and an extremely small proportion of new vehicles is traded or retired within one year of sales. Based on Walz's recommendation, $CY = MY + 1$ will be applied as a constraint when using the NVPP database to calculate the sales volume of new vehicles in every MY. For example, the sales volume of the 2004 Honda Civics are calculated by the registration counts of the 2004 Honda Civics in CY 2005.

Based on the NVPP database with $CY = MY + 1$, the following sections show the coverage of NCAP rollover resistance program, the weighted average of SSF and the weighted NCAP tip-up rate.

3.2 Coverage of NCAP Rollover Resistance Program

NHTSA's star safety-rating for rollover resistance is based on the SSF and the NCAP dynamic rollover test. Not all new vehicles in the market are rated for rollover resistance; the SSF values and the NCAP dynamic rollover test results are generated each year for a limited number of make-models. The list of make-models tested are chosen based on sales volume, with higher sales volume make-models given priority. The NCAP rollover resistance program attempts to represent at least 80 percent of new vehicles in the market in each MY.

Based on the NVPP database with $CY = MY + 1$, coverage of the NCAP rollover resistance program is represented by the ratio of the total sales volume of the test make-models to the overall sales volume of new vehicles in the market. The following table shows the coverage of the NCAP rollover resistance program in each MY with passenger cars, SUVs, pickup trucks, minivans and full-size passenger vans.

[10] Walz, M. (2005, June). Trends in the Static Stability Factor of Passenger Cars, Light Trucks, and Vans. (Report No. DOT HS 809 868). Washington, DC: National Highway Traffic Safety Administration.

Table 1: Coverage of NCAP Rollover Resistance Program MY 2004 to 2013

MY	Passenger Cars	SUVs	Pickup Trucks	Minivans	Full-size Passenger Vans
2004	89%	39%	45%	43%	< 1%
2005	90%	69%	65%	72%	14%
2006	87%	79%	78%	90%	53%
2007	86%	88%	82%	94%	51%
2008	90%	91%	80%	79%	56%
2009	92%	95%	95%	100%	74%
2010	93%	91%	95%	100%	96%
2011	86%	84%	90%	97%	98%
2012	86%	90%	89%	96%	96 %
2013	86%	90%	93%	98%	98%

The coverage of the NCAP rollover resistance program in passenger cars appears to be steady in every MY while the coverages in LTVs appear to significantly increase in the early MYs. The coverage is at least 85 percent in passenger cars in each MY while the coverages in LTVs are less than 80 percent in the early MYs. The coverages in SUVs, pickup trucks and minivans are lower than 80 percent up to MY 2006, and the coverage of full-size passenger vans is below 80 percent up to MY 2009.

A low coverage of the NCAP rollover resistance program suggests that the NCAP test results (i.e., the values of SSF and the NCAP dynamic rollover test results) would only be applied to a small proportion of new vehicles. The NCAP test results would represent the majority of new passenger cars, since the coverage of the NCAP rollover resistance program in passenger cars is above 85 percent in each MY. The NCAP test results of SUVs, pickup trucks and minivans should not be applied to the majority of new vehicles until MY 2007, since their coverages of the NCAP rollover resistance program from MY 2004 to 2006 are lower than 80 percent. The NCAP test results in full-size passenger vans should not be applied to the majority of new vehicles until MY 2010, since the coverage of the NCAP rollover resistance program in full-size passenger vans is significantly lower than 80 percent until MY 2010.

3.3 Weighted Average of Static Stability Factor

Based on the NCAP rollover resistance program and the NVPP database with $CY = MY + 1$, the weighted average of SSF is calculated by dividing the sum of each multiplication of the SSF and sales volume of the test make-model by the total sales volume of test vehicles. The following table shows the weighted average of SSF in each vehicle group from MY 2004 to 2013.

Table 2: Weighted Average of SSF MY 2004 to 2013

MY	Passenger Cars	SUVs	Pickup Trucks	Minivans	Full-size Passenger Vans
2004	1.41	1.17	1.21	1.28	1.09
2005	1.41	1.19	1.20	1.25	1.11
2006	1.41	1.19	1.21	1.25	1.08
2007	1.40	1.19	1.20	1.26	1.08
2008	1.41	1.20	1.20	1.26	1.08
2009	1.40	1.21	1.18	1.26	1.08
2010	1.41	1.21	1.18	1.26	1.08
2011	1.42	1.21	1.18	1.29	1.07
2012	1.41	1.20	1.18	1.28	1.07
2013	1.41	1.21	1.18	1.27	1.07

The weighted average of SSF in passenger cars accounts for the majority of passenger cars in the market, since the coverages of the NCAP rollover resistance program in passenger cars are greater than 85 percent in all MYs as shown in Table 1. The weighted average values of SSF in SUVs, pickup trucks and minivans in MY 2004 and MY 2005 does not account for the majority of SUVs, pickup trucks and minivans in the market, since the coverages of the NCAP rollover resistance program are not close to 80 percent in MY 2004 and MY 2005. The weighted average of SSF in full-size passenger vans does not account for the majority of full-size passenger vans in the market until MY 2010, since the coverage of the NCAP rollover resistance program in full-size passenger vans is less than 80 percent until MY 2010.

The weighted average of SSF in passenger cars remains steady up to MY 2013 while the weighted average values of SSF in SUVs and minivans increase from MY 2005 to 2013. The weighted average of SSF in pickup trucks remains steady up to MY 2008 and then decreases in MY 2009 while the weighted average of SSF in full-size passenger vans remains constant starting MY 2006 to 2010 and then drops in MY 2011.

Based on the NCAP test results from MY 2004 to 2013, passenger cars have the highest weighted average of SSF in all MYs while full-size passenger vans have the lowest weighted average of SSF in all MYs. Passenger cars appear to be the most stable passenger vehicles, and full-size passenger vans appear to be the most top-heavy passenger vehicles, but any passenger vehicles could still experience rollover events. Walz[11] stated, "In MY 2003, the sales-weighted average SSF was 1.41 for passenger cars, 1.17 for SUV's, 1.18 for pickup trucks, 1.24 for minivans and 1.12 for full-size passenger vans." and "Most passenger cars have values of SSF in the 1.30 to 1.50 range. Higher-riding SUVs, pickup trucks and vans usually have values of SSF in the 1.00 to 1.30 range." The weighted averages of SSF in passenger cars and SUVs in MY 2004 as shown in Table 2 are consistent with Walz's report, while the weighted averages of SSF in pickup trucks, minivans and full-size passenger vans in MY 2004 do not appear to be consistent with Walz's report. The low coverages of NCAP rollover resistance program for

[11] Walz, M. (2005, June). Trends in the Static Stability Factor of Passenger Cars, Light Trucks, and Vans. (Report No. DOT HS 809 868). Washington, DC: National Highway Traffic Safety Administration.

pickup trucks, minivans and full-size passenger vans in MY 2004 as shown in Table 1 might be a reason.

The increasing weighted average of SSF in SUVs as shown in Table 2 suggest that manufacturers already redesigned most of the new SUVs. Based on the Ward's Automotive Yearbook[12], the entire SUVs in Table 2 are grouped into car-based SUVs (i.e., crossover utility vehicle (CUV)) and truck-based SUVs. The following table shows the weighted averages of SSF in CUVs and truck-based SUVs from MY 2004 to 2013.

MY	CUVs	Truck-based SUVs
2004	1.25	1.14
2005	1.23	1.15
2006	1.23	1.16
2007	1.24	1.15
2008	1.22	1.16
2009	1.22	1.17
2010	1.22	1.16
2011	1.22	1.17
2012	1.22	1.18
2013	1.22	1.19

The weighted average of SSF is greater in CUVs than in truck-based SUVs in each MY. CUVs are becoming prevalent in recent MYs, since the weighted average of SSF in CUVs is close to the weighted average of SSF in the entire SUVs as shown in Table 2 starting with MY 2008. Manufacturers improved the SSF of SUVs by redesigning truck-based SUVs into CUVs. However, the weighted average of SSF in pickup trucks decreases starting with MY 2009 and in full-size passenger vans starting with MY 2011. The growing popularity of heavy duty pickup trucks (e.g., GMC Sierra and Dodge Ram) and high-roof walk-in full-size passenger vans with GVWR less than 10,000 lb. might be a reason.

3.4 Weighted Tip-up Rate in the Dynamic Rollover Test

With testing one or two passenger cars with low SSF values (e.g., the 2004 Ford Focus 4-door wagon and the 2004 Toyota Echo sedan) in each MY, NCAP noticed that none of the test passenger cars experienced tip up from MY 2004 to 2016. NCAP assumes that all passenger cars will pass the NCAP dynamic rollover test, and NHTSA believes that passenger cars are unlikely to tip up in the test. NHTSA focuses on the test results in LTVs, and this evaluation report only estimates the weighted tip-up rate in LTVs.

Test vehicles with higher SSF values have reduced rates of tip up in the NCAP dynamic rollover test. NHTSA considers any test vehicle that tips up in the NCAP dynamic rollover test a test failure and is applied to the whole vehicle fleet of the make-model. The following indicator variable is used to represent the result of the NCAP dynamic rollover test.

[12] Ward's Automotive Yearbook is annually published by Ward's Automotive Group.

$$I_{TIP-UP} = \begin{cases} 1, \text{if tip} - \text{up} \\ 0, \text{otherwise} \end{cases}$$

Based on the results of NCAP dynamic rollover test and the NVPP database with $CY = MY + 1$, the weighted tip-up rate of NCAP dynamic rollover test is calculated by dividing the sum of each multiplication of I_{Tip-up} and sales volume of the test make-model by the total sales volume of test vehicles. The following table shows the weighted tip-up rate in each vehicle group from MY 2004 to 2013.

Table 3: Weighted Tip-up Rate of NCAP Dynamic Rollover Test in LTVs MY 2004 to 2013

MY	SUVs	Pickup Trucks	Minivans	Full-size Passenger Vans
2004	32%	9%	0%	0%
2005	33%	0%	0%	97%
2006	16%	0%	0%	34%
2007	5%	0%	0%	1%
2008	0%	0%	0%	0%
2009	0%	0%	0%	0%
2010	0%	0%	0%	0%
2011	0%	0%	0%	0%
2012	0%	0%	0%	0%
2013	0%	0%	0%	0%

None of the minivans tipped up in all MYs while some SUVs, pickup trucks and full-size passenger vans failed the test. None of the LTVs tested resulted in a tip-up starting with MY 2008. The weighted tip-up rates in SUVs, pickup trucks and full-size passenger vans appear to have decreased. The weighted tip-up rate in full-size passenger vans from MY 2004 to 2009 does not account for the majority of full-size passenger vans in the market, since the coverage of the NCAP rollover resistance program in full-size passenger vans is less than 80 percent until MY 2010.

NHTSA recognizes that the SSF may not be the only factor affecting the NCAP dynamic rollover test results, and that other safety equipment could also have an effect on reducing the occurrence of rollover events. NHTSA analysis[13,14] found that ESC has a statistically significant effect on reducing rollover events. Comments[15] submitted in response to a 2001 NHTSA Request for Comment suggested that ESC may reduce the risk of untripped rollover and help drivers regain control after leaving the roadway. When ESC predicts a loss of lateral or roll stability, ESC automatically applies one or more brakes and reduces engine output to keep the yaw rate of the vehicle proportional to the speed and lateral acceleration. Thus, ESC is designed to maintain

[13] Sivinski R. (2011, June) Crash Prevention Effectiveness of Light-Vehicle Electronic Stability Control: An Update of the 2007 NHTSA Evaluation (Report No. DOT HS 811 486). Washington, DC: National Highway Traffic Safety Administration.
[14] Kahane, C. J. (2014, May). Updated Estimates of Fatality Reduction by Electronic Stability Control. (Report No. DOT HS 812 020). Washington, DC: National Highway Traffic Safety Administration.
[15] 6 FR 3388, January 12, 2001, Request for Comment; Notice of Final Decision.

the driver's directional control, help the driver keep the vehicle on the road, and prevent vehicle tip-up.

Federal Motor Vehicle Safety Standard (FMVSS) No. 126[16] specifies performance and equipment requirements for ESC systems. FMVSS No. 126 applies to passenger cars, multipurpose passenger vehicles, trucks and buses with GVWR of 4,536 kg (10,000 lb.) or less. FMVSS No. 126 specified a phase-in schedule for Manufacturers with benchmark compliance rates of ESC installation starting with MY 2009. The following table shows NHTSA's phase-in schedule of the compliance rate of ESC installation.

MY	Compliance Rate of ESC
2009	55%
2010	75%
2011	95%
2012	100%

Only luxury vehicles were equipped with ESC in early MYs, although ESC has been prevalent in recent MYs and has been required since MY 2012. Once ESC became required equipment on all new vehicles, NHTSA anticipated reduced tip-up rates in the NCAP dynamic rollover test as shown in Table 3.

4 Setting of Analysis

This evaluation report uses the SDS to estimate the effect of SSF on certain types of rollover events. Participating States provide NHTSA data files that contain the information of motor vehicle crashes occurred in the States, and each State data file is a census of crash events with all types of severity (i.e., fatal, injury and property damage only (PDO)) in a given year of the State. Thirty-four States have participated in the SDS up to CY 2016, and each participating State provides police crash report data annually, for use in NHTSA internal research.

The target vehicles include the passenger cars and LTVs in SDS with GVWR less than 10,000 lb. that were tested for NHTSA's star safety-rating for rollover resistance from MY 2004 to 2010. Based on the target vehicles, the first part of the analysis estimates the effects of SSF and ESC installation rate on first-event rollovers in single-vehicle crashes, and the second part of the analysis evaluates the effect of SSF on rollovers in a certain type of multiple-vehicle crash. The target vehicles will be filtered by different criteria (e.g., the crash mode, the vehicle group and the ESC installation rate), but the same analysis methodology will be used in each section. The following sections will show the potential rollover-associated covariates and the analysis methodology.

[16] 49 CFR Parts 571.126 and 585 Subpart I (585.81 - 585.88).

4.1 Rollover Associated Covariates

Besides the SSF and the NCAP dynamic rollover test results, other covariates might also have effects on rollover events, and some of the rollover-associated covariates might have statistically significant interactions with the SSF. The estimated effect of SSF would be biased if the statistically significant rollover-associated covariates are missing. Based on the safety equipment present on a vehicle, the driver's contributions and the circumstance contributions, the following factors are potentially rollover-associated covariates.

- ESC

Rollover events in single-vehicle crashes often occur when a vehicle runs off the road and then contact an off-road tripping object (e.g., a ditch or a curb). ESC may reduce the likelihood of rollovers by maintaining the driver's directional control and helping the driver keep the vehicle on the road. ESC is an important rollover-associated covariate when assessing the effect of SSF on rollovers, and Kahane[17] indicated, "With FARS data through 2011, there are statistically significant estimates of fatal-crash reduction by ESC."

Based on the SDS, the ESC installation status of an individual vehicle cannot be identified unless the ESC installation rate of the entire vehicle fleet of the make-model is 0 or 100 percent. For example, the ESC installation rate of the 2005 Honda Pilots is 71 percent, but the ESC installation status of an individual 2005 Honda Pilot would not be identified in the data. It is not practical to set the ESC installation status of an individual vehicle to be a binary variable in this evaluation report. The Ward's Automotive Yearbook provides the ESC installation rate of new vehicles in each MY, and this ESC installation rate is used to represent the whole vehicle fleet of the make-model. The statistical inference related to the ESC installation will represent the overall vehicle fleet of the make-model instead of an individual vehicle. The ESC installation rate ranges from 0 to 100 percent.

- Curb Weight

The curb weight is the weight of a vehicle excluding the weights of passengers, trailers and attachments. The curb weight of a vehicle is considered to be a potential rollover-associated covariate, and Kahane[18] reported that the curb weight has a statistically significant effect on the fatality rate in passenger cars with curb weight less than 3,106 lb. when the vehicle footprint[19] is held constant. The curb weight of passenger vehicles ranges from 1,787 lb. to 6,653 lb.

---

[17] Kahane, C. J. (2014, May). Updated Estimates of Fatality Reduction by Electronic Stability Control. (Report No. DOT HS 812 020). Washington, DC: National Highway Traffic Safety Administration.

[18] Kahane, C. J. (2012, August). Relationships Between Fatality Risk, Mass, and Footprint in Model Year 2000-2007 Passenger Cars and LTVs. (Report No. DOT HS 811 665). Washington, DC: National Highway Traffic Safety Administration.

[19] Footprint is a measure of a vehicle's size, it is roughly equal to the wheelbase times the average of the front and rear track widths.

- Age of Vehicle

Besides the SSF, the NCAP dynamic rollover test results, ESC, and the curb weight, other safety equipment might also have effects on rollovers. The age of vehicle represents the effects of safety equipment that is not included in the statistical model. The age of a vehicle is expressed by $(CY - MY + 1)$ where CY is from 2004 to 2011 and MY is from 2004 to 2010 in this evaluation report. For example, the age of a 2005 Honda Pilot in CY 2007 is 3.

- Driver's Contributions

NHTSA[20] believes that the driver's behaviors and characteristics have effects on rollover events, since the driver's response is critical when the vehicle drops two wheels off the roadway. The SDS cannot describe the driver's response when the driver lost control of a vehicle, but the driver's age and gender (i.e., male/female) might represent some of the driver's behaviors. The driver's age implies the driving experience, and male drivers usually pose a greater risk than female drivers in traffic incidents. The following indicator variable is used to represent the driver's gender.

$$I_{MALE} = \begin{cases} 1, \text{if a male driver} \\ 0, \text{otherwise} \end{cases}$$

- Circumstance Contributions

Manufacturers[21] commented that NHTSA over-estimated the SSF on rollovers, since the road characteristics and the roadway surface would have effects on the crash outcome. Based on the variables in the SDS, the road characteristics are categorized by the curve and the hill, and the roadway surface is presented by the wet. The following indicator variables represent the road characteristics and the roadway surface.

$$I_{CURVE} = \begin{cases} 1, \text{if a curved road} \\ 0, \text{otherwise} \end{cases}$$

$$I_{HILL} = \begin{cases} 1, \text{if a hill road} \\ 0, \text{otherwise} \end{cases}$$

$$I_{WET} = \begin{cases} 1, \text{if wet surface} \\ 0, \text{otherwise} \end{cases}$$

[20] 66 FR 3388, January 12, 2001, Request for Comment; Notice of Final Decision. (Docket No. NHTSA-2000-8298-0001). Washington, DC: National Highway Traffic Safety Administration.

[21] See 66 FR 3388, January 12, 2001, Request for Comment; Notice of Final Decision. Also available at **www.regulations.gov** in Docket No. NHTSA-2000-8298-0001. Washington, DC: National Highway Traffic Safety Administration.

Besides the road condition and the roadway surface, the light condition might have an effect on the crash outcome, since driving in the dark appears to be riskier then driving in the daylight. The following indicator variable represents the light condition.

$$I_{DARK} = \begin{cases} 1\text{ , if driving in the dark} \\ 0\text{, otherwise} \end{cases}$$

- State Index

Besides the road characteristics, the roadway surface and the light condition, other circumstance conditions in the State could also affect the rollovers. The State index represents the effects of circumstance covariates in the State (e.g., regional weather, local roadway conditions and State traffic laws) that are not included in the statistical model. The State index is an indicator variable that represents the State. For example, the following is the State index of Florida.

$$I_{FL} = \begin{cases} 1\text{, if the crash is in Florida} \\ 0\text{, otherwise} \end{cases}$$

Anti-lock braking system (ABS) is not considered as a rollover-associated covariate. Although ABS can reduce the potential loss of vehicle control, NHTSA[22] noticed that the expectation of ABS on rollover events has not been proved based on years of crash statistics.

4.2 Analysis Methodology

The following binary variable denotes the crash outcome of each crash event.

$$Y_i = \begin{cases} 1\text{, if a rollover} \\ 0\text{, otherwise} \end{cases}$$

Based on the statistical properties of the crash event, the effect of SSF is estimated by logistic regression. Denoting P_i as the probability of experiencing a rollover in the i^{th} crash, each Y_i is an independent Bernoulli random variable with P_i as the expected value.

Assuming there are *p* covariates in the logistic regression model, the following notations are set for the analysis.

$$\boldsymbol{X}^T = \left[1, X_1, X_2, \dots, X_p\right]^T$$

$$\boldsymbol{X}_i^T = \left[1, X_{i,1}, X_{i,2}, \dots, X_{i,p}\right]^T$$

$$\boldsymbol{B}^T = \left[B_0, B_1, B_2, \dots, B_p\right]^T$$

[22] See 66 FR 3388, January 12, 2001, Request for Comment; Notice of Final Decision. Also available at **www.regulations.gov** in Docket No. NHTSA-2000-8298-0001. Washington, DC: National Highway Traffic Safety Administration.

$\boldsymbol{X}^T$ is the random vector with covariates X_1 to X_p. $\boldsymbol{X}_i^T$ is the constant vector which provides the observed values for the covariates based on the i^{th} crash event. $\boldsymbol{B}^T$ is the vector with the parameters in the logistic regression model.

Based on the logistic response function, the following equation represents the relationship among P_i, $\boldsymbol{X}_i^T$ and $\boldsymbol{B}$.

$$P_i = \frac{\exp\,(\boldsymbol{X}_i^T \boldsymbol{B})}{1 + \exp\,(\boldsymbol{X}_i^T \boldsymbol{B})}$$

Applying the logit transformation to P_i, the following equation is the logistic regression model.

$$log\left(\frac{P_i}{1 - P_i}\right) = \boldsymbol{X}_i^T \boldsymbol{B}$$

The value $\left(\frac{P_i}{1-P_i}\right)$ is the odds of experiencing a rollover in the i^{th} crash, and the probability of experiencing a rollover decreases when the value of odds decreases. The parameters in the logistic regression model will be estimated by the maximum likelihood estimation (MLE) in this evaluation report.

Holding covariates, (X_1, X_2,..,X_p), constant except X_q where q is a number between 1 and p, the covariate, X_q, increases by one then the corresponding parameter, B_q, can be expressed as the following equation.

$$\frac{log(\text{Odds}|X_q = x_q + 1)}{log(\text{Odds}|X_q = x_q)} = log\left(\frac{\text{Odds}|X_q = x_q + 1}{\text{Odds}|X_q = x_q}\right) = log(\text{Odds Ratio}) = B_q$$

Taking the exponential function on both sides, the following equation represents the above odds ratio.

$$\left(\frac{\text{Odds}|X_q = x_q + 1}{\text{Odds}|X_q = x_q}\right) = \text{Odds Ratio} = \exp\,(B_q)$$

Equation 1

If the odds ratio is less than 1, increasing the value of X_q will decrease the likelihood of experiencing a rollover. If $(odds|X_q = x_q)$ in Equation 1 is known, the effect of increasing X_q by one can be expressed by the fitted probability as the following.

$$P(\text{rollover}|X_q = x_q + 1) = \frac{\exp(B_q) \cdot (\text{Odds}|X_q = x_q)}{1 + \exp(B_q) \cdot (\text{Odds}|X_q = x_q)}$$

Equation 2

The analysis of the effect of SSF on rollover events will be expressed by the odds ratio in Equation 1 and the probability in Equation 2.

A.3 Analysis Limitations

NHTSA[23] has estimated the effect of SSF on reducing rollovers in single vehicle crashes since 1990, and it should be noticed that some rollovers might be prevented by an object (e.g., tree, pole, or wall) instead of SSF improvement or ESC installation. For example, a vehicle might strike an object (e.g., tree, pole, or wall) after running off the road, so a rollover did not occur. Such crash events will end up as non-rollover single-vehicle collision crashes, and they will change the exact probability of rollovers in single-vehicle crashes. With non-rollover single-vehicle collision crashes, rollover events and non-rollover events in single-vehicle crashes are not treatment and control groups in statistical analysis, and the estimated effect of SSF on reducing rollovers will be biased. However, it is reasonable to assume that the frequency of such rollover-prevented single-vehicle collision crashes is small in SDS, since rollovers in single-vehicle crashes are rare events in SDS. The bias of the estimated effect of SSF should be trivial in this evaluation report.

Sivinski[24] reported that ESC has a statistically significant effect on reducing single-vehicle crashes, so the true probability of rollovers in single-vehicle crashes might be different with the observed probability of rollovers in single-vehicle crashes in SDS. The estimated effect of ESC on reducing rollovers in single-vehicle crashes might be biased, since some single-vehicle crashes were already prevented by ESC.

ESC is considered in this evaluation report, since ESC is a crucial covariate when estimating the effect of SSF on rollovers. Estimating the exact effect of ESC on reducing rollovers in single-vehicle crashes is not the primary topic in this evaluation report. Without further assumptions, the effect of ESC on reducing rollovers will be estimated based on the observed single-vehicle crashes in SDS in later sections.

5 First-Event Rollovers in Single-Vehicle Crashes

The conditions of first-event rollovers and single-vehicle crashes, the setting of the SDS and the analysis of first-event rollovers in single-vehicle crashes will be expressed in the following sections.

[23] Harwin, E. A. & Brewer, H. K. (1990). Analysis of the relationship between vehicle rollover stability and rollover risk using the NHTSA CARDFILE accident database. Journal of Traffic Medicine, Vol. 18, No. 3, pp. 109-112.

[24] Sivinski R. (2011, June) Crash Prevention Effectiveness of Light-Vehicle Electronic Stability Control: An Update of the 2007 NHTSA Evaluation (Report No. DOT HS 811 486). Washington, DC: National Highway Traffic Safety Administration.

5.1 Single-Vehicle Crashes

Single-vehicle crashes are events where only one vehicle is involved and do not involve any collisions with pedestrians, pedal cycles, animals or trains. Based on NCAP rollover resistance test results and the SDS, the target population is those vehicles with measured values of SSF that experienced single-vehicle crashes. Vehicles with trailers or attachments are not included in the target population, since trailers and attachments change the center of gravity height and the value of SSF. Ambulances, police cars, fire trucks and rescue vehicles on emergency calls are also not included in the target population, since traveling at high speeds has higher likelihood of causing rollovers than traveling at regular speeds. Parked and stopped vehicles on a roadway are not included in the target population, since this evaluation report excludes vehicles that were not in transport at the time of the crash.

5.2 First-Event Rollovers

Rollovers could occur after the vehicle runs into an object, such as a mail box, a pole or guardrail, and also could happen after the wheels contact a tripping object, such as a ditch, soft soil or a curb. Although the NCAP dynamic rollover test simulates the untripped rollover on a paved road, only 5 percent[25] of rollover crashes are untripped. Tripped and untripped rollovers may not be distinguished by the crash report in the SDS. For example, if a rollover occurred on a roadway with a pothole, the crash report may not be able to indicate whether the rollover is caused by the pothole.

A first-event rollover is the incident where the rollover is the first event in the crash that causes personal injuries or vehicle damages. A first-event rollover includes both tripped and untripped rollovers in this evaluation report.

5.3 State Data Sets of First-Event Rollovers

The SDS from CY 2004 to 2011 was used to identify single-vehicle crashes and first-event rollovers. This evaluation report includes only those State data sets that provide vehicle identification number (VIN), since important vehicle information such as the MY, body style, drive system and fuel type can be identified based on VIN. The data sets of 17 States[26] are used to estimate the effect of the SSF on first-event rollovers in single-vehicle crashes. The following table expresses the 17 States and the year range of each State data set.

---

[25] Consumer Information Regulations; Federal Motor Vehicle Safety Standards; Rollover Resistance. (Docket No. NHTSA-2000-8298). Washington, DC: National Highway Traffic Safety Administration.

[26] The 17 states include Alabama (AL), Florida (FL), Illinois (IL), Kansas (KS), Kentucky (KY), Maryland (MD), Missouri (MO), North Carolina (NC), North Dakota (ND), Nebraska (NE), New Jersey (NJ), New Mexico (NM), New York (NY), Pennsylvania (PA), Washington (WA), Wisconsin (WI) and Wyoming (WY)

Table 4: State Data Sets of Single-Vehicle Crashes

	AL	FL	IL	KS	KY	MD	MO	NC	ND
First CY	2004	2004	2004	2004	2004	2004	2004	2004	2004
Last CY	2011	2011	2011	2011	2011	2011	2011	2011	2011

	NE	NJ	NM	NY	PA	WA	WI	WY
First CY	2004	2004	2006	2004	2006	2004	2004	2004
Last CY	2011	2011	2011	2011	2011	2011	2011	2011

The crash data reporting system of a State may not be the same in each CY. The State data sets of New Mexico and Pennsylvania in CY 2004 and 2005 are truncated as shown in Table 4, since the variables in their crash data reporting system prior to CY 2006 did not identify first-event rollovers. To apply the statistical inference to New Mexico and Pennsylvania in CY 2004 and 2005, this evaluation report assumes that their first-event rollovers in single-vehicle crashes in CY 2004 and 2005 follow their probability distributions of first-event rollovers from CY 2006 to 2011.

The thresholds of the reported PDO incidents in Illinois and New York have been revised. The dollar-amount threshold of a reported PDO crash in Illinois increased from $500 to $1,500 in CY 2009 while the threshold was adjusted in CY 2006 and 2007 in New York. If there is a change in the threshold of reported PDO crashes, the probability distribution of first-event rollovers in single-vehicle crashes could be affected. Therefore, the State data sets of Illinois and New York will be divided based on the thresholds of PDO crash reports. For example, the State data of Illinois will be divided into CY 2004 to 2008 and CY 2009 to 2011 in this evaluation report.

5.4 Vehicle Categorization of First-Event Rollovers

If the first-event rollover rate is not the same in each vehicle group, then each vehicle group would have a different probability distribution of first-event rollovers. To estimate the effect of SSF, vehicles should be separated based on the probability distribution of first-event rollovers.

Kahane[27] reported that ESC is statistically significant in reducing first-event rollovers based on Fatality Analysis Reporting System (FARS) data up to 2011. The effect of ESC could reduce the effect of SSF on first-event rollovers, so vehicles should be divided based on the ESC installation rate. Based on the probability distribution of first-event rollovers and the ESC installation rate, this section shows the vehicle separation in this evaluation report.

- Vehicle Group

Limiting the State data sets in Table 4 to MY 2004 to 2010, the following table shows the first-event rollover rate and the average ESC installation rate in passenger cars and LTVs that experienced single-vehicle crashes in each MY.

[27] Kahane, C. J. (2014, May). Updated Estimates of Fatality Reduction by Electronic Stability Control. (Report No. DOT HS 812 020). Washington, DC: National Highway Traffic Safety Administration.

Table 5: First-Event Rollover Rate in 17 States MY 2004 to 2010

Passenger Cars							
MY	2004	2005	2006	2007	2008	2009	2010
First-Event Rollover	3971	3727	3195	2782	1772	872	345
Single-Vehicle Crash	92575	86791	77081	66678	43951	23164	13242
First-Event Rollover Rate	4.29%	4.29%	4.14%	4.17%	4.03%	3.76%	2.61%
Average ESC Rate	10.19%	9.48%	15.95%	15.29%	24.18%	28.78%	66.40%
LTVs							
MY	2004	2005	2006	2007	2008	2009	2010
First-Event Rollover	9421	6830	4255	2461	1602	365	214
Single-Vehicle Crash	86013	70524	51038	34779	24492	8057	6116
First-Event Rollover Rate	10.95%	9.68%	8.34%	7.08%	6.54%	4.53%	3.50%
Average ESC Rate	7.79%	12.70%	25.65%	45.12%	54.17%	78.88%	87.24%

Passenger cars and LTVs have different probability distributions of first-event rollovers, since the first-event rollover rate is lower in passenger cars than in LTVs in each MY. Vehicles with single-vehicle crashes will be separated into the passenger vehicle group and the LTV group in this evaluation report.

- ESC Installation Rate

Table 5 shows that the average ESC installation rate in LTVs appears to be higher than the average ESC installation rate in passenger cars. Based on the State data sets in Table 4 and the Ward's Automotive Yearbook up to 2011, the following table shows the ESC installation rates of passenger cars and LTVs from MY 2004 to 2010 that experienced single-vehicle crashes.

Table 6: ESC Installation Rate in Single-Vehicle Crashes MY 2004 to 2010

Passenger Cars		
ESC Installation Rate	Frequency	Percentage
0 %	287753	71.32%
0% < ESC Rate < 100%	68848	17.06%
100 %	46881	11.62%
LTVs		
ESC Installation Rate	Frequency	Percentage
0 %	179252	64.99%
0% < ESC Rate < 100%	35964	13.04%
100 %	60583	21.97%

Starting MY 2004 to 2010, more than 60 percent of passenger cars and LTVs that experienced single-vehicle crashes were not equipped with ESC while 12.57 percent of passenger cars and 22.76 percent of LTVs in single-vehicle crashes were equipped with ESC. Based on the ESC installation rate, vehicles will be divided into the following groups to evaluate the effect of SSF in this evaluation report.

- Vehicles without any restriction on ESC installation rate
- Vehicles with 0 percent ESC installation rate

- Vehicles with 100 percent ESC installation rate

Based on the vehicle groups (i.e., the passenger vehicle group and the LTV group) and the ESC installation rate (i.e., no restriction, 0 percent and 100 percent), the effect of SSF on first-event rollovers will be analyzed in six sections in this evaluation report.

5.5 First-Event Rollovers in Single-Vehicle Crashes by Passenger Cars

Limiting the State data sets in Table 4 to MY 2004 to 2010, the target population includes passenger cars with measured SSF values that experienced single-vehicle crashes. The research interests in this section include the effects of SSF and ESC installation rate on first-event rollovers by passenger cars. The following table shows the first-event rollover rate, the average SSF and the average ESC installation rate in the target population.

Table 7: First-Event Rollovers by Passenger Cars in 17 States MY 2004 to 2010

MY	2004	2005	2006	2007	2008	2009	2010
First-Event Rollover	3636	3202	2756	2504	1599	812	298
Single-Vehicle Crash	83271	75458	66837	59696	39842	21461	12006
First-Event Rollover Rate	4.37%	4.24%	4.12%	4.19%	4.01%	3.78%	2.48%
Average SSF	1.41	1.41	1.41	1.40	1.40	1.40	1.40
Average ESC Rate	7.02%	6.81%	12.75%	12.55%	22.12%	25.39%	66.05%

The first-event rollover rate appears to decrease while the average SSF remains steady. The average ESC installation rate appears to increase starting MY 2005 to 2010. The first-event rollover rate appears to decrease with the average SSF remaining constant while the ESC installation rate increases.

The following binary variable represents the outcome of a single-vehicle crash.

$$Y_i = \begin{cases} 1, \text{if first} - \text{event rollover} \\ 0, \text{otherwise} \end{cases}$$

Applying the logistic regression model in Section 4.2 with potential rollover-associated covariates in Section 4.1, the effects of SSF and ESC installation rate on first-event rollovers by passenger cars are estimated. Two-way interactions between two covariates are also included in the logistic regression model denoted by covariate A*covariate B in the analysis results. The final model is chosen by using the forward selection with the Akaike information criterion (AIC) as the model comparison criterion. Setting the level of significance at 0.05, the following table shows the statistically significant covariates, the estimates, the standard errors, the test statistics and the p-values in the final logistic regression model where the curb weight is scaled in 100 lb. per increment.

Table 8: Logistic Regression of First-Event Rollovers by Passenger Cars

Parameter Global Test					
	Chi-Square		DF	P-value	
Likelihood Ratio Test	3448.1322		23	< 0.0001	
Score Test	3292.7524		23	< 0.0001	
Wald Test	3046.6769		23	< 0.0001	
Parameter Estimation					
	DF	Estimate	Std. Error	Chi-Square	P-value
Intercept	1	-6.3168	1.9853	10.1240	0.0015
SSF	1	2.9699	1.4269	4.3319	0.0374
ESC	1	-4.8501	1.1287	18.4637	< 0.0001
CURB WEIGHT	1	0.3102	0.0652	22.6283	< 0.0001
I_{WET}	1	-0.3418	0.0242	199.7107	< 0.0001
I_{HILL}	1	0.0116	0.0138	0.7086	0.3999
I_{CURVE}	1	0.0211	0.0767	0.0760	0.7827
Driver Age	1	-0.0122	0.00143	73.0954	< 0.0001
I_{MALE}	1	0.1666	0.0750	4.9344	0.0263
Vehicle Age	1	0.0140	0.0107	1.7191	0.1898
SSF*ESC	1	3.6477	0.8108	20.2409	< 0.0001
SSF*CURB WEIGHT	1	-0.2304	0.0468	24.2471	< 0.0001
ESC*CURB WEIGHT	1	-0.0530	0.0123	18.4295	< 0.0001
ESC *I_{WET}	1	0.2979	0.0937	10.0959	0.0015
ESC *I_{HILL}	1	0.2609	0.0935	7.7943	0.0052
ESC *I_{CURVE}	1	0.2807	0.0920	9.3201	0.0023
ESC *I_{MALE}	1	0.4068	0.0932	19.0581	< 0.0001
CURB WEIGHT*I_{CURVE}	1	0.0102	0.00506	4.0404	0.0444
CURB WEIGHT*I_{MALE}	1	-0.0190	0.00499	14.4263	0.0001
I_{WET}*I_{CURVE}	1	-0.2472	0.0390	40.2131	< 0.0001
I_{HILL}*I_{CURVE}	1	-0.1721	0.0395	18.9807	< 0.0001
Driver Age*I_{WET}	1	0.00943	0.00127	54.7846	< 0.0001
Driver Age*I_{MALE}	1	0.00414	0.00118	12.2141	0.0005
Driver Age*Vehicle Age	1	-0.00132	0.000310	18.2036	< 0.0001

The logistic regression model in Table 8 is statistically significant, since the p-values of the parameter global tests are less than the level of significance. A covariate or a two-way interaction is statistically significant if its p-value is less than the level of significance. Based on Equation 1 and Equation 2 in Section 4.2, if the estimate of a covariate is negative with other covariates being held constant, the odds ratio and the probability of experiencing first-event rollovers will decrease when that covariate increases by one unit. The effect of SSF in Table 8 depends on the curb weight and the ESC installation rate, since the SSF has the statistically significant interactions with the curb weight and the ESC installation rate. The effect of ESC installation rate depends on the SSF, the curb weight, the driver's gender and the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}). The effects of SSF and ESC installation rate on first-event rollovers will be expressed in the following sections.

5.5.1 Effect of SSF on First-Event Rollovers by Passenger Cars

The SSF has a statistically significant main effect and the statistically significant interactions with the curb weight and the ESC installation rate, since their p-values in Table 8 are less than the level of significance. The effect of SSF varies among make-models, since different make-models have distinct curb weights and ESC installation rates.

With the ESC installation rate being held constant, the effect of SSF is greater on first-event rollovers with the heavier curb weight of a passenger car. With the curb weight being held constant, the effect of SSF is lower with the increasing ESC installation rate. NHTSA[28,29] reported that the effect of ESC is statistically significant in first-event rollovers. The effect of SSF is lower in passenger cars with ESC than in passenger cars without ESC, since the effect of SSF on first-event rollovers is reduced by ESC.

NCAP records the value of SSF by rounding the actual value to the nearest hundredth, so this evaluation report uses 0.01 as one increment unit in the SSF when representing the effect of SSF. Based on Equation 1 and the estimates in Table 8, the following equation represents the estimated odds ratio of first-event rollovers in single-vehicle crashes when the SSF increases by 0.01.

$$\widehat{\text{Odds Ratio}} = \exp(2.9699 \cdot 0.01 + 3.6477 \cdot 0.01 \cdot ESC - 0.2304 \cdot 0.01 \cdot CURB\ WEIGHT)$$

Equation 3

The estimate, $(1 - \widehat{\text{Odds Ratio}}) \cdot 100\%$, is used to represent the estimated effect of SSF on the odds of experiencing first-event rollovers. The ESC installation rate and the curb weight in Equation 3 vary among make-models, and the trend of the estimated effect of SSF based on Equation 3 will be evaluated in Appendix II. With other covariates being held constant, the estimated odds ratio in Equation 3 is an exponential function of the SSF increment. For example, when the SSF of the 2008 Honda Accord 4DR sedan increases from 1.48 to 1.49 (SSF increment is 0.01), the estimated odds ratio is 0.9879[30], and the estimated effect of SSF is 1.21 percent ($(1 - 0.9879) \cdot 100\%$). If the SSF increases from 1.48 to 1.51 (SSF increment is 0.03), the estimated odds ratio decreases to 0.9642 ($(0.9879)^3$), and the estimated effect of SSF increases to 3.58 percent ($1 - (0.9879)^3 \cdot 100\%$).

The ESC installation rates among make-models in a certain MY should be similar, and the curb weights among make-models in a certain MY should also be similar. This evaluation report uses the average ESC installation rate and the average curb weight in a given MY to represent the

---

[28] Sivinski R. (2011, June) Crash Prevention Effectiveness of Light-Vehicle Electronic Stability Control: An Update of the 2007 NHTSA Evaluation (Report No. DOT HS 811 486). Washington, DC: National Highway Traffic Safety Administration.

[29] Kahane, C. J. (2014, May). Updated Estimates of Fatality Reduction by Electronic Stability Control. (Report No. DOT HS 812 020). Washington, DC: National Highway Traffic Safety Administration.

[30] The ESC installation rate and the curb weight of the 2008 Honda Accord 4DR sedan is 100 % and 3,400 lb., respectively. Applying Equation 3 with the curb weight in 100 lb. per unit, the odds ratio is estimated by ($\exp(2.9699 \cdot 0.01 + 3.6477 \cdot 0.01 \cdot 1 - 0.2304 \cdot 0.01 \cdot 34)$) which yields 0.9879.

ESC installation rate and the curb weight over the entire target population in that MY. When the SSF increases by 0.01 and other covariates are held constant, the estimated odds ratio in each MY is calculated by substituting the average ESC installation rate and the average curb weight into Equation 3. The estimated effect of SSF is then represented based on the estimated odds ratio. The following table shows the estimated odds ratio, the estimated effect of SSF, the average ESC installation rate and the average curb weight in each MY.

Table 9: Estimated Effect of SSF on First-Event Rollovers by Passenger Cars

MY	2004	2005	2006	2007	2008	2009	2010
Average Curb Weight	31.08	31.08	31.69	31.41	31.48	30.85	31.63
Average ESC Rate	7.02%	6.81%	12.75%	12.55%	22.12%	25.39%	66.05%
Estimated Odds Ratio	0.9614	0.9613	0.9621	0.9626	0.9658	0.9684	0.9811
Estimated Effect of SSF	3.86%	3.87%	3.79%	3.74%	3.42%	3.16%	1.89%

With other covariates being held constant, Table 9 shows that the estimated odds of experiencing first-event rollovers in MY 2004 and MY 2010 decrease by 3.86 percent $((1-0.9614)\cdot 100\%)$ and by 1.89 percent $((1-0.9811)\cdot 100\%)$, respectively, and the average estimated effect of SSF from MY 2004 to 2010 is 3.39 percent when the SSF increases by 0.01. The estimated effect of SSF appears to decrease with the average curb weight remaining steady while the average ESC installation rate appears to increase. The SSF has a statistically significant effect on first-event rollovers by passenger cars, but the increasing average ESC installation rate appears to reduce the estimated effect of SSF in each MY.

This evaluation report also provides the estimated 95 percent confident interval of the effect of SSF based on the t-distribution. A covariate is statistically significant at 0.05 level of significance if its estimated 95 percent confidence interval does not include 0. Two parameters are not statistically different at 0.05 level of significance if their estimated 95 percent confidence intervals are overlapping. Based on Table 8, the estimated 95 percent confidence interval of the effect of SSF on first-event rollovers by passenger cars is between 0.94 to 6.33 percent when the SSF increases by 0.01. The estimated confidence interval shows that the SSF has a statistically significant effect on first-event rollovers by passenger cars, since the confidence interval does not include 0. With a statistically significant interaction between the SSF and ESC installation rate in Table 8, the estimated confidence interval of the effect of SSF is wide-ranging, since the average ESC installation rate in Table 9 changes in each MY.

Although a first-event rollover may be prevented by improving the SSF, the single-vehicle crash could occur in a different crash mode (e.g., single-vehicle collision crashes). This evaluation report assumes the total number of single-vehicle crashes in each MY to be constant. The effect of SSF on first-event rollovers can be expressed in probability by the following equation.

$$\text{Percentage of Rate Reduction} = -\frac{(\text{Fitted Rollover Rate} - \text{Observed Rollover Rate})}{\text{Observed Rollover Rate}} \cdot 100\%$$

Equation 4

Equation 3 expresses the estimated effect of SSF in odds ratio while Equation 4 expresses the estimated effect of SSF in percentage reduction of rollover rate in single-vehicle crashes when SSF increases by 0.01. Analysis results from Equation 3 and Equation 4 are equivalent. Based on Equation 2 in Section 4.2, the estimated fitted rollover rate is calculated by the first-event rollover rate in Table 7 and the estimated odds ratio in Table 9. The observed rollover rate in Equation 4 is the first-event rollover rate in Table 7. The following table shows the estimated fitted rollover rate and the estimated percentage of reduction in each MY.

Table 10: Estimated Percentage of Rate Reduction of SSF on First-Event Rollovers by Passenger Cars

MY	2004	2005	2006	2007	2008	2009	2010
Observed Rollover Rate	4.37%	4.24%	4.12%	4.19%	4.01%	3.78%	2.48%
Estimated Fitted Rollover Rate	4.21%	4.08%	3.97%	4.04%	3.88%	3.66%	2.43%
Estimated Percentage of Rate Reduction	3.66%	3.77%	3.64%	3.58%	3.24%	3.17%	2.02%

With other covariates being held constant, the estimated probabilities of first-event rollovers decrease by 3.66 percent ($-\frac{(4.21\%-4.37\%)}{4.37\%} \cdot 100\%$) and by 2.02 percent ($-\frac{(2.43\%-2.48\%)}{2.48\%} \cdot 100\%$) in MY 2004 and MY 2010, respectively, and the average estimated percentage of rate reduction from MY 2004 to 2010 is 3.3 percent when the SSF increases by 0.01. NHTSA required ESC installation in MY 2009 vehicles, so the estimated percentage of reduction starting with MY 2009 is lower than the estimated percentage of reduction from MY 2004 to 2008.

5.5.2 Effect of ESC on First-Event Rollovers by Passenger Cars

The ESC installation rate has a statistically significant main effect and the statistically significant interactions with the SSF, the curb weight, the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and the driver's gender (i.e., I_{MALE}), since their p-values in Table 8 are less than the level of significance. The effect of ESC installation rate on first-event rollovers varies among make-models and single-vehicle crashes, since the SSF and the curb weight differ among make-models, and the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and the driver's gender (i.e., I_{MALE}) are not the same in each single-vehicle crash.

With the curb weight, the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and the driver's gender (i.e., I_{MALE}) being held constant, the effect of ESC installation rate is lower with the increasing SSF. The effect of ESC installation rate is statistically significant in first-event rollovers, but the effect of ESC installation rate is reduced by the SSF.

With the SSF, the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and driver's gender (i.e., I_{MALE}) being held constant, the effect of ESC installation rate is greater with the heavier curb weight of a passenger car. With the SSF, the curb weight and the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}) being held constant, the effect of ESC installation rate is higher with female drivers than with male drivers. Distinct driving behaviors between males and females might be a reason.

The statistically significant interactions between the ESC installation rate and the circumstance covariates (i.e. I_{WET}, I_{HILL} and I_{CURVE}) shows that the effect of ESC installation rate depends on the road characteristics and the roadway surface. The effect of ESC installation rate is greater with a dry, level and straight roadway than the effect of ESC installation rate with a wet, up/down grade and curve road.

Less than 25 percent of passenger cars in the target population were equipped with ESC before MY 2009 as shown in Table 7. This evaluation report estimates the effect of ESC installation rate on first-event rollovers when the ESC installation rate increases from 0 to 100 percent. Based on Equation 1 and the estimates in Table 8, the following equation shows the estimated odds ratio of experiencing first-event rollovers in single-vehicle crashes when the ESC installation rate increases from 0 to 100 percent.

$$\widehat{\text{Odds Ratio}} = \exp\left(-4.8501 + 3.6477 \cdot SSF - 0.0530 \cdot CURB\ WEIGHT + 0.2979 \cdot I_{WET} + 0.2609 \cdot I_{HILL} + 0.2807 \cdot I_{CURVE} + 0.4068 \cdot I_{MALE}\right)$$

Equation 5

Equation 5 cannot be applied to make-models that were already equipped with ESC, since increasing the ESC installation rate on make-models with ESC will not reduce the first-event rollover rate. For example, the ESC installation rate of the 2004 Mercedes C is 100 percent so that the 2004 Mercedes C cannot reduce the first-event rollover rate by increasing the ESC installation rate. The estimate, $(1 - \widehat{\text{Odds Ratio}}) \cdot 100\%$, is used to represent the estimated effect of ESC installation rate on the odds of experiencing first-event rollovers. The trend of the estimated effect of ESC installation rate based on Equation 5 will be evaluated in Appendix II.

Although the SSF and the curb weights vary among make-models, the SSF and the curb weights among make-models in a certain MY should be similar. This evaluation report uses the average SSF and the average curb weight in a given MY to represent the SSF and the curb weight over the entire target population in that MY. The circumstance covariates (i.e. I_{WET}, I_{HILL} and I_{CURVE}) and the driver's gender (i.e., I_{MALE}) are binary variables, and they are represented by their rates in the target population in each MY.

When the ESC installation rate increases from 0 to 100 percent and other covariates are held constant, the estimated odds ratio in each MY is calculated by substituting the average SSF, the average curb weights, the rate of wet, the rate of hill, the rate of curve, and the rate of male drivers into Equation 5. The estimated effect of ESC installation rate is then represented based on the estimated odds ratio. The following table shows the estimated odds ratio and the estimated effect of ESC installation rate in each MY.

Table 12: Estimated Effect of ESC on First-Event Rollovers by Passenger Cars

MY	2004	2005	2006	2007	2008	2009	2010
Average SSF	1.41	1.41	1.41	1.40	1.40	1.40	1.40
Average Curb Weight	31.08	31.08	31.69	31.41	31.48	30.85	31.63
Rate of Wet	41%	40%	40%	41%	39%	37%	28%
Rate of Hill	31%	31%	30%	30%	29%	29%	26%
Rate of Curve	34%	34%	33%	33%	32%	31%	27%
Rate of Male Driver	52%	52%	53%	52%	53%	53%	57%
Estimated Odds Ratio	0.4299	0.4287	0.4145	0.4052	0.4007	0.4107	0.3826
Estimated Effect of ESC	57.01%	57.13%	58.55%	59.48%	59.93%	58.93%	61.74%

With other covariates being held constant, Table 12 shows that the estimated odds of experiencing first-event rollovers in MY 2004 and MY 2005 decrease by 57.01 percent $((1-0.4299)\cdot 100\%)$ and by 57.13 percent $((1-0.4287)\cdot 100\%)$, respectively, and the average estimated effect of ESC installation rate from MY 2004 to 2010 is 58.97 percent when the ESC installation rate increases from 0 to 100 percent. The estimated effect of ESC installation rate appears to increase, since the rate of wet, the rate of hill and the rate of curve appear to decrease. The roadway conditions appear to be improved in each MY. There is a statistically significant interaction between the ESC installation rate and the SSF as shown in Table 8. However, the average SSF in passenger cars appears to be constant in each MY and does not affect the estimated effect of ESC installation rate in passenger cars.

Based on FARS, Kahane[31] selected passenger cars with 0 or 100 percent ESC installation rate to estimate the effect of ESC on first-event rollovers in fatal single-vehicle crashes, while the estimated effect of ESC installation rate in Table 12 is based on all passenger cars with SSF values that experienced single-vehicle crashes in 17 States of SDS. With the different data base and restrictions on ESC installation rate, the analysis results in Kahane's report and Table 12 are not comparable. However, Kahane reported that the estimated 95 percent confidence interval of the effect of ESC on first-event rollovers by passenger cars is between 48.7 to 68.1 percent, and Table 12 shows that the estimated effect of ESC installation rate in each MY is included in the estimated 95 percent confidence interval reported by Kahane. The estimated effect of ESC installation rate on first-event rollovers by passenger cars in this evaluation report is consistent with Kahane's report.

The percentage of rate reduction in Equation 4 expresses the effect of ESC installation rate in probability. Based on Equation 4, the following table shows the estimated percentage of rate reduction in each MY.

[31] Kahane, C. J. (2014, May). Updated Estimates of Fatality Reduction by Electronic Stability Control. (Report No. DOT HS 812 020). Washington, DC: National Highway Traffic Safety Administration.

Table 13: Estimated Percentage of Rate Reduction of ESC on First-Event Rollovers by Passenger Cars

MY	2004	2005	2006	2007	2008	2009	2010
Observed Rollover Rate	4.37%	4.24%	4.12%	4.19%	4.01%	3.78%	2.48%
Estimated Fitted Rollover Rate	1.93%	1.86%	1.75%	1.74%	1.65%	1.59%	0.96%
Estimated Percentage of Rate Reduction	55.84%	56.13%	57.52%	58.47%	58.85%	57.94%	61.29%

The observed rollover rate is the first-event rollover rate in Table 7. The estimated fitted rollover rate is calculated by the first-event rollover rate in Table 7 and the estimated odds ratio in Table 12. With other covariates being held constant, the estimated probabilities of first-event rollovers decrease by 55.84 percent ($-\frac{(1.93\%-4.37\%)}{4.37\%} \cdot 100\%$) and by 56.13 percent ($-\frac{(1.86\%-4.24\%)}{4.24\%} \cdot 100\%$) in MY 2004 and MY 2005, respectively, and the average estimated percentage of rate reduction from MY 2004 to 2010 is 58 percent when the ESC installation rate increases from 0 to 100 percent. The estimated percentage of rate reduction appears to increase, since the estimated effect of ESC installation rate in Table 12 appears to increase in each MY.

5.6 First-Event Rollovers in Single-Vehicle Crashes by Passenger Cars without ESC

Limiting the State data sets in Table 4 to MY 2004 to 2010, the target population includes the passenger cars without ESC that had measured SSF values and experienced single-vehicle crashes. The following table shows the average SSF and the first-event rollover rate in each MY.

Table 14: First-Event Rollovers by Passenger Cars without ESC in 17 States MY 2004 to 2010

MY	2004	2005	2006	2007	2008	2009	2010
First-Event Rollover	3250	2816	2416	1939	1052	548	138
Single-Vehicle Crash	69131	62193	52798	41706	21919	11760	3147
First-Event Rollover Rate	4.70%	4.53%	4.58%	4.65%	4.80%	4.66%	4.39%
Average SSF	1.41	1.41	1.41	1.40	1.40	1.39	1.39

The frequency of single-vehicle crashes appears to decrease in each MY. The first-event rollover rate appears to fluctuate without a trend while the average SSF appears to remain steady in each MY. Most of the vehicles in the target population were manufactured before MY 2009, since NHTSA required the ESC installation in MY 2009.

The following binary variable represents the crash outcome of a single-vehicle crash.

$$Y_i = \begin{cases} 1, \text{if first} - \text{event rollover} \\ 0, \text{otherwise} \end{cases}$$

The effect of SSF on first-event rollovers by passenger cars without ESC is estimated by the logistic regression model in Section 4.2 with potential rollover-associated covariates in Section 4.1. The logistic regression model includes two-way interactions between two covariates which are denoted by covariate A*covariate B in the analysis results. The final model is selected by using the forward selection with the AIC as the model comparison criterion. Setting the level of significance at 0.05, the following table shows the statistically significant covariates, the estimates, the standard errors, the test statistics and the p-values in the final logistic regression model.

Table 15: Logistic Regression of First-Event Rollovers by Passenger Cars without ESC

Parameter Global Test					
	Chi-Square		DF	P-value	
Likelihood Ratio Test	1820.5316		7	< 0.0001	
Score Test	1786.4094		7	< 0.0001	
Wald Test	1756.5302		7	< 0.0001	
Parameter Estimation					
	DF	Estimate	Std. Error	Chi-Square	P-value
Intercept	1	4.1959	0.2649	250.8701	< 0.0001
SSF	1	-4.8066	0.1889	647.3052	< 0.0001
Driver Age	1	-0.0132	0.000665	393.6314	< 0.0001
I_{WET}	1	-0.1975	0.0135	213.8383	< 0.0001
I_{HILL}	1	0.0167	0.0147	1.2952	0.2551
I_{CURVE}	1	0.1687	0.0142	140.3176	< 0.0001
$I_{WET}*I_{CURVE}$	1	-0.2679	0.0428	39.0866	< 0.0001
$I_{HILL}*I_{CURVE}$	1	-0.1856	0.0435	18.2265	< 0.0001

The logistic regression model in Table 15 is statistically significant, since the p-values of the parameter global tests are less than the level of significance. The SSF has a statistically significant main effect on first-event rollovers by passenger cars without ESC, since its p-value is less than the level of significance. There are not statistically significant interactions between the SSF and other covariates in the logistic regression model. Based on Equation 1 and the estimate in Table 15, the following equation represents the estimated odds ratio when the SSF increases by 0.01.

$$\widehat{\text{Odds Ratio}} = \exp(-4.8066 \cdot 0.01) = 0.9531$$

Equation 6

The estimate, $(1 - \widehat{\text{Odds Ratio}}) \cdot 100\%$, is used to represent the estimated effect of SSF on the odds of experiencing first-event rollovers. The estimated effect of SSF in Equation 6 is a constant value, since there are not statistically significant interactions between the SSF and other covariates in Table 15. With other covariates being held constant, the estimated odds of experiencing first-event rollovers decreases by 4.69 percent ($(1 - 0.9531) \cdot 100\%$) when the SSF increases by 0.01. Starting MY 2004 to 2010, the estimated effect of SSF on first-event rollovers is smaller in passenger cars (3.39 %, see Section 5.5.1) than in passenger cars without ESC (4.69 %). The SSF appears to have less effect on first-event rollovers with an increasing ESC installation rate.

Based on Table 15, the estimated 95 percent confidence interval of the effect of SSF on first-event rollovers by passenger cars without ESC is between 4.34 to 5.05 percent when the SSF increases by 0.01. The estimated confidence interval shows that the SSF has a statistically significant effect on first-event rollovers by passenger cars without ESC, since the estimated confidence interval does not include 0. The range of the estimated confidence interval in passenger cars without ESC is narrower than the range of the estimated confidence interval in all passenger cars (0.94 % to 6.33 %, see Section 5.5.1), since there are not statistically significant interactions between the SSF and other covariates in Table 15.

The percentage of rate reduction in Equation 4 expresses the effect of SSF in probability. The following table shows the estimated percentage of rate reduction in each MY.

Table 16: Estimated Percentage of Rate Reduction of SSF on First-Event Rollovers by Passenger Cars without ESC

MY	2004	2005	2006	2007	2008	2009	2010
Observed Rollover Rate	4.70%	4.53%	4.58%	4.65%	4.80%	4.66%	4.39%
Estimated Fitted Rollover Rate	4.49%	4.33%	4.37%	4.44%	4.59%	4.45%	4.19%
Estimated Percentage of Rate Reduction	4.47%	4.42%	4.59%	4.52%	4.38%	4.51%	4.56%

The observed rollover rate is the first-event rollover rate in Table 14. The estimated fitted rollover rate is calculated by the first-event rollover rate in Table 14 and the estimated odds ratio in Equation 6. With other covariates being held constant, the estimated probabilities of first-event rollovers by passenger cars without ESC decrease by 4.47 percent ($-\frac{(4.49\%-4.70\%)}{4.70\%} \cdot 100\%$) and by 4.42 percent ($-\frac{(4.33\%-4.53\%)}{4.53\%} \cdot 100\%$) in MY 2004 and MY 2005, respectively, and the average estimated percentage of rate reduction from MY 2004 to 2010 is 4.49 percent when the SSF increases by 0.01. With the estimated odds ratio in Equation 6 being a constant value, the estimated percentage of rate reduction in Table 16 appears to vary in each MY since the first-event rollover rate in Table 14 appears to fluctuate without a trend. The estimated effect of SSF and the estimated percentage of rate reduction in this section does not account for the majority of passenger cars in the current MY, since NHTSA required ESC installation in MY 2009 vehicles.

5.7 First-Event Rollovers in Single-Vehicle Crashes by Passenger Cars with ESC

Limiting the State data sets in Table 4 to MY 2004 to 2010, the target population includes the passenger cars with ESC that had measured SSF values and experienced single-vehicle crashes. The following table shows the average SSF and the first-event rollover rate in each MY.

Table 17: First-Event Rollovers by Passenger Cars with ESC in 17 States MY 2004 to 2010

MY	2004	2005	2006	2007	2008	2009	2010
First-Event Rollover	31	35	53	77	110	54	108
Single-Vehicle Crash	2200	2100	4099	4705	6098	4522	7301
First-Event Rollover Rate	1.41%	1.67%	1.29%	1.64%	1.80%	1.19%	1.48%
Average SSF	1.42	1.42	1.43	1.42	1.43	1.43	1.41

The frequencies of first-event rollovers and the single-vehicle crashes appear to increase in each MY. Most of the vehicles in the target population were manufactured closed to MY 2009, since NHTSA required the ESC installation in MY 2009. There are significant decreases in the frequency of first-event rollovers, the frequency of single-vehicle crashes and the first-event rollover rate in MY 2009, in which the change of the economics climates might be a reason. Based on Table 14 and 17, the first-event rollover rate is lower in passenger cars with ESC than in passenger cars without ESC since ESC has a statistically significant effect on first-event rollovers as shown in Table 8.

The following binary variable represents the outcome of a single-vehicle crash.

$$Y_i = \begin{cases} 1, \text{if first} - \text{event rollover} \\ 0, \text{otherwise} \end{cases}$$

The effect of SSF on first-event rollovers by passenger cars with ESC is estimated by the logistic regression model in Section 4.2 with potential rollover-associated covariates in Section 4.1. The logistic regression model includes two-way interactions between two covariates which are denoted by covariate A*covariate B in the analysis results. The final model is chosen based on the forward selection and the AIC model comparison criterion. Setting the level of significance at 0.05, the following table shows the statistically significant covariates, the estimates, the standard errors, the test statistics and the p-values in the final logistic regression model.

Table 18: Logistic Regression of First-Event Rollovers by Passenger Cars with ESC

Parameter Global Test					
	Chi-Square		DF	P-value	
Likelihood Ratio Test	241.1797		15	< 0.0001	
Score Test	271.1904		15	< 0.0001	
Wald Test	243.7144		15	< 0.0001	
Parameter Estimation					
	DF	Estimate	Std. Error	Chi-Square	P-value
Intercept	1	1.3406	1.2654	1.1223	0.2894
SSF	1	-1.9765	1.0050	3.8682	0.0492
CURB WEIGHT	1	-0.00072	0.000157	20.7043	< 0.0001
I_{HILL}	1	0.1445	0.0554	6.8063	0.0091
I_{CURVE}	1	0.0412	0.0991	0.1731	0.6774
Driver Age	1	-0.00855	0.00308	7.6955	0.0055
I_{MALE}	1	0.1035	0.0654	2.5055	0.1134
$I_{CURVE}*I_{MALE}$	1	0.4672	0.2303	4.1154	0.0425
I_{FL}	1	0.7652	0.1531	24.9757	< 0.0001
I_{NE}	1	1.2278	0.3384	13.1637	0.0003
I_{NJ}	1	-0.4895	0.1660	8.6992	0.0032
I_{NM}	1	1.2177	0.2708	20.2257	< 0.0001
$I_{NY\ and\ CY>2006}$	1	-0.9598	0.1925	24.8580	< 0.0001
I_{PA}	1	-0.7450	0.2293	10.5591	0.0012
I_{WA}	1	0.6100	0.2035	8.9850	0.0027
I_{WI}	1	0.7265	0.1865	15.1772	< 0.0001

The logistic regression model in Table 18 is statistically significant, since the p-values of the parameter global tests are less than the level of significance. The SSF has a statistically significant main effect on first-event rollovers by passenger cars with ESC, but there are not statistically significant interactions between the SSF and other covariates in the logistic regression model. Some State indices (i.e., I_{FL}, I_{NE}, I_{NJ}, I_{NM}, $I_{NY\ and\ CY>2006}$, I_{PA}, I_{WA} and I_{WI}) have statistically significant main effects on first-event rollovers as shown in Table 18. A statistically significant State index represents the effects of rollover-associated covariates in that State (e.g., regional weather, local roadway conditions and State traffic laws), although these covariates are not included in the logistic regression model. Based on Equation 1 and the estimate in Table 18, the following equation shows the estimated odds ratio when the SSF increases by 0.01.

$$\widehat{\text{Odds Ratio}} = \exp(-1.9765 \cdot 0.01) = 0.9804$$

Equation 7

The estimate, $(1 - \widehat{\text{Odds Ratio}}) \cdot 100\%$, is used to represent the effect of SSF on the odds of experiencing first-event rollovers. Equation 7 shows that the estimated effect of SSF is a constant value, since there are not statistically significant interactions between the SSF and other covariates in Table 18. With other covariates being held constant, the estimated odds of experiencing first-event rollovers decreases by 1.96 percent ($(1 - 0.9804) \cdot 100\%$) when the SSF increases by 0.01. With other covariates being held constant, the estimated effect of SSF is lower in passenger cars with ESC (1.96 %) than in passenger cars without ESC (4.69 %, see Section 5.6) when the SSF increases by 0.01. The ESC installation rate also reduces the effect of SSF on first-event rollovers by passenger cars.

Based on Table 18, the estimated 95 percent confidence interval of the effect of SSF on first-event rollovers by passenger cars with ESC is between 0.0067 to 3.87 percent when the SSF increases by 0.01. Although the lower bound of the estimated confidence interval is close to 0, the SSF still has a statistically significant effect on first-event rollovers by passenger cars with ESC as shown in Table 18. The estimated effect of SSF on first-event rollovers is statistically greater in passenger cars without ESC than in passenger cars with ESC, since the lower bound of the confidence interval in passenger cars without ESC (4.34 %, see Section 5.6) is greater than the upper bound of the confidence interval in passenger cars with ESC (3.87 %).

The percentage of rate reduction in Equation 4 expresses the effect of SSF in probability. Based on Equation 4, the following table shows the estimated percentage of rate reduction in each MY.

Table 19: Estimated Percentage of Rate Reduction of SSF on First-Event Rollovers by Passenger Cars with ESC

MY	2004	2005	2006	2007	2008	2009	2010
Observed Rollover Rate	1.41%	1.67%	1.29%	1.64%	1.80%	1.19%	1.48%
Estimated Fitted Rollover Rate	1.38%	1.64%	1.27%	1.61%	1.77%	1.17%	1.45%
Estimated Percentage of Rate Reduction	2.13%	1.80%	1.55%	1.83%	1.67%	1.68%	2.03%

The observed rollover rate is the first-event rollover rate in Table 17. The estimated fitted rollover rate is calculated by the first-event rollover rate in Table 17 and the estimated odds ratio in Equation 7. With other covariates being held constant, the estimated probabilities of first-event rollovers by passenger cars with ESC decrease by 2.13 percent ($-\frac{(1.38\%-1.41\%)}{1.41\%} \cdot 100\%$) and by 1.80 percent ($-\frac{(1.64\%-1.67\%)}{1.67\%} \cdot 100\%$) in MY 2004 and MY 2005, respectively, and the average estimated percentage of rate reduction from MY 2004 to 2010 is 1.81 percent when the SSF increases by 0.01. The estimated percentage of rate reduction appears to fluctuate without a trend, since the first-event rollover rate in Table 17 varies in each MY. The estimated effect of SSF and the estimated percentage of rate reduction in this section accounts for the majority of passenger cars in the current MY, since NHTSA required the ESC installation in MY 2009.

5.8 First-Event Rollovers in Single-Vehicle Crashes by LTVs

Limiting the State data sets in Table 4 to MY 2004 to 2010, the target population includes LTVs with measured SSF values that experienced single-vehicle crashes. The research interests in this section include the effects of SSF and ESC installation rate on first-event rollovers by LTVs. The following table shows the first-event rollover rate, the average SSF and the average ESC installation rate in the target population.

Table 20: First-Event Rollovers by LTVs in 17 States MY 2004 to 2010

MY	2004	2005	2006	2007	2008	2009	2010
First-Event Rollover	3676	4294	2982	1752	1060	282	180
Single-Vehicle Crash	33263	45596	38580	27034	19237	6947	5340
First-Event Rollover Rate	11.05%	9.42%	7.73%	6.48%	5.51%	4.06%	3.37%
Average SSF	1.19	1.20	1.21	1.20	1.20	1.20	1.20
Average ESC Rate	5.78%	10.50%	27.89%	48.27%	60.71%	82.86%	89.21%

The first-event rollover rate appears to decrease while the average SSF remains steady. The average ESC installation rate appears to increase up to MY 2010. The opposite trends of the first-event rollover rate and the average ESC installation rate from MY 2004 to 2010 imply that the ESC installation rate should be a significant factor in first-event rollovers by LTVs.

The following binary variable represents the outcome of a single-vehicle crash.

$$Y_i = \begin{cases} 1, \text{if first} - \text{event rollover} \\ 0, \text{otherwise} \end{cases}$$

Applying the logistic regression model in Section 4.2 with potential rollover-associated covariates in Section 4.1, the effects of SSF and ESC installation rate on first-event rollovers by LTVs are estimated. Two-way interactions between two covariates are also included in the logistic regression model denoted by covariate A*covariate B in the analysis results. The final model is selected by using the forward selection with the AIC model comparison criterion. Setting the level of significance at 0.05, the following table shows the statistically significant covariates, the estimates, the standard errors, the test statistics and the p-values in the final logistic regression model where the curb weight is scaled in 100 lb. per increment.

Table 21: Logistic Regression of First-Event Rollovers by LTVs

Parameter Global Test					
	Chi-Square		DF	P-value	
Likelihood Ratio Test	3700.3511		17	< 0.0001	
Score Test	3207.1480		17	< 0.0001	
Wald Test	2990.1077		17	< 0.0001	
Parameter Estimation					
	DF	Estimate	Std. Error	Chi-Square	P-value
Intercept	1	5.8176	0.2541	524.0316	< 0.0001
SSF	1	-5.9195	0.1977	896.3003	< 0.0001
ESC	1	-1.5236	0.0527	835.3536	< 0.0001
CURB WEIGHT	1	-0.0175	0.00189	86.0735	< 0.0001
DRIVER AGE	1	-0.0122	0.000982	153.2392	< 0.0001
I_{DARK}	1	0.0532	0.0257	4.2812	0.0385
ESC*I_{DARK}	1	0.1388	0.0580	5.7259	0.0167
I_{WET}	1	-0.3944	0.0642	37.7383	< 0.0001
I_{HILL}	1	0.00356	0.0138	0.0664	0.7967
I_{CURVE}	1	0.1663	0.0167	99.0650	< 0.0001
ESC*I_{WET}	1	0.3353	0.0581	33.2792	< 0.0001
ESC*I_{HILL}	1	0.2449	0.0621	15.5405	< 0.0001
ESC*I_{CURVE}	1	0.2914	0.0616	22.3716	< 0.0001
CURB WEIGHT*I_{WET}	1	0.0108	0.00269	16.1717	< 0.0001
DRIVER AGE*I_{DARK}	1	-0.00387	0.00134	8.3660	0.0038
DRIVER AGE*I_{WET}	1	0.0127	0.00125	103.0426	< 0.0001
I_{WET}*I_{CURVE}	1	-0.4357	0.0403	116.6731	< 0.0001
I_{HILL}*I_{CURVE}	1	-0.0940	0.0421	4.9855	0.0256

The logistic regression model in Table 21 is statistically significant, since the p-values of the parameter global tests are less than the level of significance. The effect of SSF on first-event rollover by LTVs is statistically significant and does not depend on other covariates in the logistic regression model, since there are not statistically significant interactions between the SSF and other covariates. The effect of ESC installation rate is statistically significant in first-event rollover by LTVs and depends on the light condition (i.e., I_{DARK}) and the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}). The effects of SSF and ESC installation rate on first-event rollovers will be expressed in the following sections.

5.8.1 Effect of SSF on First-Event Rollovers by LTVs

Based on Equation 1 and the estimate in Table 21, the following equation shows the estimated odds ratio when the SSF increases by 0.01.

$$\widehat{\text{Odds Ratio}} = \exp(-5.9195 \cdot 0.01) = 0.9425$$

Equation 8

The estimate, $(1 - \widehat{\text{Odds Ratio}}) \cdot 100\%$, is used to represent the effect of SSF on the odds of experiencing first-event rollovers. The estimated effect of SSF in Equation 8 is a constant value, since there are not statistically significant interactions between the SSF and other covariates in Table 21. The estimated effect of SSF in LTVs remains constant while the estimated effect of SSF in passenger cars in Equation 3 depends on the ESC installation rate and the curb weight. With other covariates being held constant, the estimated odds of experiencing first-event rollovers decreases by 5.75 percent ($(1 - 0.9425) \cdot 100\%$) when the SSF increases by 0.01. Starting MY 2004 to 2010, the average estimated effect of SSF on first-event rollovers is lower in passenger cars (3.39 %, see Section 5.5.1) than in LTVs (5.75 %). The SSF appears to have a greater effect on first-event rollovers by LTVs.

Based on Table 21, the estimated 95 percent confidence interval of the effect of SSF on first-event rollovers by LTVs is between 5.38 to 6.11 percent when the SSF increases by 0.01. The estimated confidence interval shows that the SSF has a statistically significant effect on first-event rollovers by LTVs, since the estimated confidence interval does not include 0. The range of the estimated confidence interval of the effect of SSF is narrower in LTVs than in passenger cars (0.94 % to 6.33 %, see Section 5.5.1), since there are not statistically significant interactions between the SSF and other covariates in LTVs as shown in Table 21.

The percentage of rate reduction in Equation 4 expresses the effect of SSF in probability. The following table shows the estimated percentage of rate reduction in each MY.

Table 22: Estimated Percentage of Rate Reduction of SSF on First-Event Rollovers by LTVs

MY	2004	2005	2006	2007	2008	2009	2010
Observed Rollover Rate	11.05%	9.42%	7.73%	6.48%	5.51%	4.06%	3.37%
Estimated Fitted Rollover Rate	10.48%	8.93%	7.32%	6.13%	5.21%	3.84%	3.18%
Estimated Percentage of Rate Reduction	5.16%	5.20%	5.30%	5.40%	5.44%	5.42%	5.64%

The observed rollover rate is the first-event rollover rate in Table 20. The estimated fitted rollover rate is calculated by the first-event rollover rate in Table 20 and the estimated odds ratio in Equation 8. With other covariates being held constant, the estimated probabilities of first-event rollovers by LTVs decrease by 5.16 percent ($-\frac{(10.48\% - 11.05\%)}{11.05\%} \cdot 100\%$) and by 5.20 percent ($-\frac{(8.93\% - 9.42\%)}{9.42\%} \cdot 100\%$) in MY 2004 and MY 2005, respectively, and the average estimated percentage of rate reduction from MY 2004 to 2010 is 5.37 percent when the SSF increases by 0.01. With the estimated odds ratio in Equation 8 being a constant value, the estimated percentage of rate reduction in Table 22 appears to increase since the first-event rollover rate in Table 20 appears to decrease in each MY. The average estimated percentage of rate reduction is greater in LTVs (5.37 %) than in passenger cars (3.3 %, see Section 5.5.1) when the SSF increases by 0.01.

5.8.2 Effect of ESC on First-Event Rollovers by LTVs

The ESC installation rate has a statistically significant main effect and the statistically significant interactions with the light condition (i.e. I_{DARK}) and the circumstance covariates (i.e. I_{WET}, I_{HILL} and I_{CURVE}), since their p-values in Table 21 are less than the level of significance. The effect of ESC installation rate on first-event rollovers varies, since the light condition (i.e. I_{DARK}) and the circumstance covariates (i.e. I_{WET}, I_{HILL} and I_{CURVE}) are not the same in each single-vehicle crash.

With the circumstance covariates (i.e. I_{WET}, I_{HILL} and I_{CURVE}) being held constant, the estimated effect of ESC installation rate is higher in the daylight than in the dark. With a positive estimate of interaction between the ESC installation rate and the light condition (i.e. I_{DARK}) in Table 21, the first-event rollover rate appears to be higher in the dark than in the daylight. Poor driver's visibility in the dark might be a reason for the higher first-event rollover rate.

The statistically significant interactions between the ESC installation rate and the circumstance covariates (i.e. I_{WET}, I_{HILL} and I_{CURVE}) shows that the effect of ESC installation rate depends on the road characteristics and the roadway surface. With the light condition (i.e. I_{DARK}) being held constant, the effect of ESC installation rate is greater with a dry, level and straight roadway than with a wet, up/down grade and curve road.

Based on Equation 1 and the estimates in Table 21, the following equation shows the estimated odds ratio of experiencing first-event rollovers in single-vehicle crashes when the ESC installation rate increases from 0 to 100 percent.

$$\widehat{\text{Odds Ratio}} = \exp\left(-1.5236 + 0.1388 \cdot I_{DARK} + 0.3353 \cdot I_{WET} + 0.2449 \cdot I_{HILL} + 0.2914 \cdot I_{CURVE}\right)$$

Equation 9

The estimate, $(1 - \widehat{\text{Odds Ratio}}) \cdot 100\%$, is used to represent the estimated effect of ESC installation rate on the odds of experiencing first-event rollovers. The trend of the estimated effect of ESC installation rate based on Equation 9 will be evaluated in Appendix II. Based on Equation 5 and Equation 9, the effects of ESC installation rate on first-event rollovers by passenger cars and by LTVs depend on the circumstance covariates (i.e. I_{WET}, I_{HILL} and I_{CURVE}). In all, a dry, level and straight roadway increases the effect of ESC installation rate on first-event rollovers by passenger cars and LTVs.

Based on Equation 9, the effect of ESC installation rate on first-event rollovers varies among single-vehicle crashes. The light condition (i.e. I_{DARK}) and the circumstance covariates (i.e. I_{WET}, I_{HILL} and I_{CURVE}) are binary variables, and they are represented by their rates in the target population in each MY. When the ESC installation rate increases from 0 to 100 percent and other covariates are held constant, the estimated odds ratio in each MY is calculated by substituting the rate of dark, the rate of wet, the rate of hill and the rate of curve into Equation 9. The estimated effect of ESC installation rate is then represented based on the estimated odds ratio. The following table shows the estimated odds ratio and the estimated effect of ESC installation rate in each MY.

Table 23: Estimated Effect of ESC on First-Event Rollovers by LTVs

MY	2004	2005	2006	2007	2008	2009	2010
Rate of Dark	41%	41%	41%	40%	40%	37%	37%
Rate of Wet	51%	49%	45%	42%	41%	34%	30%
Rate of Hill	33%	32%	31%	30%	30%	28%	27%
Rate of Curve	31%	31%	30%	28%	28%	28%	27%
Estimated Odds Ratio	0.3248	0.3218	0.3159	0.3097	0.3087	0.2988	0.2932
Estimated Effect of ESC	67.52%	67.82%	68.41%	69.03%	69.13%	70.12%	70.68%

With other covariates being held constant, Table 23 shows that the estimated odds of experiencing first-event rollovers in MY 2004 and MY 2010 decrease by 67.52 percent ($(1 - 0.3248) \cdot 100\%$) and by 70.68 percent ($(1 - 0.2932) \cdot 100\%$), respectively, and the average estimated effect of ESC installation rate from MY 2004 to 2010 is 68.96 percent when the ESC installation rate increases from 0 to 100 percent. The estimated effect of ESC installation rate appears to increase, since the rate of dark, the rate of wet, the rate of hill and the rate of curve appear to decrease in each MY. The roadway conditions appear to be improved in each MY.

Based on FARS, Kahane[32] selected LTVs with 0 or 100 percent ESC installation rate to estimate the effect of ESC on first-event rollovers in fatal single-vehicle crashes, while the estimated effect of ESC installation rate in Table 23 is based on all LTVs with SSF values that experienced single-vehicle crashes in 17 States of SDS. The analysis results in Kahane's report and Table 23 are not comparable, since the analyzed data base and the restrictions on ESC installation rate are different. However, Kahane reported that the estimated 95 percent confidence interval of the effect of ESC on first-event rollovers by LTVs is between 67.7 to 79.1 percent, and Table 23 shows that the estimated effect of ESC installation rate starting MY 2005 to 2010 are included in the estimated 95 percent confidence interval reported by Kahane. The estimated effect of ESC installation rate on first-event rollovers by LTVs in this evaluation report is consistent with Kahane's report.

The percentage of rate reduction in Equation 4 expresses the effect of ESC installation rate in probability. Based on Equation 4, the following table shows the estimated percentage of rate reduction in each MY.

[32] Kahane, C. J. (2014, May). Updated Estimates of Fatality Reduction by Electronic Stability Control. (Report No. DOT HS 812 020). Washington, DC: National Highway Traffic Safety Administration.

Table 24: Estimated Percentage of Rate Reduction of ESC on First-Event Rollovers by LTVs

MY	2004	2005	2006	2007	2008	2009	2010
Observed Rollover Rate	11.05%	9.42%	7.73%	6.48%	5.51%	4.06%	3.37%
Estimated Fitted Rollover Rate	3.88%	3.24%	2.58%	2.10%	1.77%	1.25%	1.01%
Estimated Percentage of Rate Reduction	64.89%	65.61%	66.62%	67.59%	67.88%	69.21%	70.03%

The observed rollover rate is the first-event rollover rate in Table 20. The estimated fitted rollover rate is calculated by the first-event rollover rate in Table 20 and the estimated odds ratio in Table 23. With other covariates being held constant, the estimated probabilities of first-event rollovers decrease by 64.89 percent ($-\frac{(3.88\%-11.05\%)}{11.05\%}\cdot 100\%$) and by 70.03 percent ($-\frac{(1.01\%-3.37\%)}{3.37\%}\cdot 100\%$) in MY 2004 and MY 2010, respectively, and the average estimated percentage of rate reduction from MY 2004 to 2010 is 67.40 percent when the ESC installation rate increases from 0 to 100 percent. With the increasing estimated effect of ESC installation rate as shown in Table 23, the estimated percentage of rate reduction in Table 24 appears to increase since the first-event rollover rate in Table 20 appears to decrease in each MY. The average estimated percentage of rate reduction is greater in LTVs (67.40 %) than in passenger cars (58 %, see Section 5.5.2) when the ESC installation rate increases from 0 to 100 percent.

5.9 First-Event Rollovers in Single-Vehicle Crashes by LTVs without ESC

Limiting the State data sets in Table 4 to MY 2004 to 2010, the target population includes the LTVs without ESC that had measured SSF values and experienced single-vehicle crashes. The following table shows the average SSF and the first-event rollover rate in each MY.

Table 25: First-Event Rollovers by LTVs without ESC in 17 States MY 2004 to 2010

MY	2004	2005	2006	2007	2008	2009	2010
First-Event Rollover	2838	3898	2098	1026	446	75	34
Single-Vehicle Crash	25358	38432	22606	10754	4901	671	338
First-Event Rollover Rate	11.19%	10.14%	9.28%	9.54%	9.10%	11.18%	10.06%
Average SSF	1.19	1.20	1.21	1.22	1.20	1.17	1.16

The frequencies of first-event rollovers and the single-vehicle crashes appear to decrease in each MY. Most of the vehicles in the target population in this section are manufactured before MY 2009, since NHTSA required the ESC installation in MY 2009. Some pickup trucks (e.g., the 2010 Chevrolet Colorado, the 2010 Dodge Dakota, the 2010 Dodge Ram and the 2010 Ford Ranger) are the LTVs without ESC after MY 2009. The first-event rollover rate appears to decrease up to MY 2008 and then increases in MY 2009 while the average SSF appears to increase up to MY 2007 and then decreases. The opposite trends of the first-event rollover rate and the average SSF from MY 2004 to 2007 imply that the SSF should be a significant factor in first-event rollovers by LTVs without ESC.

The following binary variable represents the crash outcome of a single-vehicle crash.

$$Y_i = \begin{cases} 1, \text{if first} - \text{event rollover} \\ 0, \text{otherwise} \end{cases}$$

The effect of SSF on first-event rollovers by LTVs without ESC is estimated by the logistic regression model in Section 4.2 with potential rollover-associated covariates in Section 4.1. The logistic regression model includes two-way interactions between two covariates which are denoted by covariate A*covariate B in the analysis results. The final model is chosen by using the forward selection with the AIC model comparison criterion. Setting the level of significance at 0.05, the following table shows the statistically significant covariates, the estimates, the standard errors, the test statistics and the p-values in the final logistic regression model.

Table 26: Logistic Regression of First-Event Rollovers by LTVs without ESC

Parameter Global Test					
	Chi-Square		DF	P-value	
Likelihood Ratio Test	708.2990		7	< 0.0001	
Score Test	713.3083		7	< 0.0001	
Wald Test	704.2798		7	< 0.0001	
Parameter Estimation					
	DF	Estimate	Std. Error	Chi-Square	P-value
Intercept	1	3.8791	0.7482	26.8775	< 0.0001
SSF	1	-4.3011	0.6222	47.7875	< 0.0001
CURB WEIGHT	1	-0.0145	0.00154	88.2953	< 0.0001
DRIVER AGE	1	0.0310	0.0186	2.7836	0.0952
I_{HILL}	1	0.0151	0.0152	0.9921	0.3192
I_{CURVE}	1	0.0620	0.0155	15.9884	< 0.0001
I_{HILL}*I_{CURVE}	1	-0.1361	0.0490	7.7137	0.0055
SSF*DRIVER AGE	1	-0.0320	0.0156	4.2426	0.0394

The logistic regression model in Table 26 is statistically significant, since the p-values of the parameter global tests are less than the level of significance. The SSF has a statistically significant main effect and a statistically significant interaction with the driver's age, since their p-values are less than the level of significance. With other covariates being held constant, the effect of SSF on first-event rollovers is greater with older drivers than with younger drivers. Based on Equation 1 and the estimates in Table 26, the following equation shows the estimated odds ratio of experiencing first-event rollovers when the SSF increases by 0.01.

$$\widehat{\text{Odds Ratio}} = \exp(-4.3011 \cdot 0.01 - 0.0320 \cdot 0.01 \cdot DRIVER\ AGE)$$

Equation 10

The estimate, $(1 - \widehat{\text{Odds Ratio}}) \cdot 100\%$, is used to represent the estimated effect of SSF on the odds of experiencing first-event rollovers. The trend of the estimated effect of SSF based on Equation 10 will be evaluated in Appendix II. Although the driver's age is different in each single-vehicle crash, the distribution of driver's age among different MYs should be similar. This evaluation report uses the average driver's age in each MY to estimate the effect of SSF. When the SSF increases by 0.01 and other covariates are held constant, the estimated odds ratio in each MY is calculated by substituting the average driver's age into Equation 10. The estimated effect of SSF is then represented based on the estimated odds ratio. The following table shows the estimated odds ratio and the estimated effect of SSF in each MY.

Table 27: Estimated Effect of SSF on First-Event Rollovers by LTVs without ESC

MY	2004	2005	2006	2007	2008	2009	2010
Average Driver Age	37.20	37.44	38.32	39.66	40.04	40.51	41.85
Estimated Odds Ratio	0.9466	0.9465	0.9462	0.9458	0.9457	0.9456	0.9452
Estimated Effect of SSF	5.34%	5.35%	5.38%	5.42%	5.43%	5.44%	5.48%

With other covariates being held constant, Table 27 shows that the estimated odds of experiencing first-event rollovers in MY 2004 and MY 2010 decrease by 5.34 percent ($(1-0.9466)\cdot 100\%$) and by 5.48 percent ($(1-0.9452)\cdot 100\%$), respectively, and the average estimated effect of SSF from MY 2004 to 2010 is 5.41 percent when the SSF increases by 0.01. The estimated effect of SSF appears to increase, since the average driver's age appears to increase in each MY. The average estimated effect of SSF on first-event rollovers is greater in LTVs without ESC (5.41 %) than in passenger cars without ESC (4.69 %, see Section 5.6) when the SSF increases by 0.01. The average values of the estimated effect of SSF in LTVs (5.75 %, see Section 5.8.1) and in LTVs without ESC (5.41 %) are close, since there is not a statistically significant interaction between the SSF and the ESC installation rate in the logistic regression model as shown in Table 21.

Based on Table 26, the estimated 95 percent confidence interval of the effect of SSF on first-event rollovers by LTVs without ESC is between 4.21 to 6.51 percent when the SSF increases by 0.01. The estimated confidence interval shows that the SSF has a statistically significant effect on first-event rollovers by LTVs without ESC, since the estimated confidence interval does not include 0. The effects of SSF in all LTVs and LTVs without ESC are not statistically different, since their estimated confidence interval are overlapping (5.38 % to 6.11 % in all LTVs, see Section 5.8.1).

The percentage of rate reduction in Equation 4 expresses the effect of SSF in probability. Based on Equation 4, the following table shows the estimated percentage of rate reduction in each MY.

Table 28: Estimated Percentage of Rate Reduction of SSF on First-Event Rollovers by LTVs without ESC

MY	2004	2005	2006	2007	2008	2009	2010
Observed Rollover Rate	11.19%	10.14%	9.28%	9.54%	9.10%	11.18%	10.06%
Estimated Fitted Rollover Rate	10.66%	9.65%	8.83%	9.07%	8.65%	10.64%	9.56%
Estimated Percentage of Rate Reduction	4.74%	4.83%	4.85%	4.93%	4.95%	4.83%	4.97%

The observed rollover rate is the first-event rollover rate in Table 25. The estimated fitted rollover rate is calculated by the first-event rollover rate in Table 25 and the estimated odds ratio in Table 27. With other covariates being held constant, the estimated probabilities of first-event rollovers decrease by 4.74 percent ($-\frac{(10.66\%-11.19\%)}{11.19\%}\cdot 100\%$) and by 4.83 percent ($-\frac{(9.65\%-10.14\%)}{10.14\%}\cdot 100\%$) in MY 2004 and MY 2005, respectively, and the average estimated percentage of rate reduction from MY 2004 to 2010 is 4.87 percent when the SSF increases by 0.01. The estimated percentage of rate reduction appears to increase since the estimated effect of SSF increases in each MY as shown in Table 27. The estimated effect of SSF and the estimated percentage of rate reduction in this section does not account for the majority of LTVs in the current MY, since NHTSA required the ESC installation in MY 2009.

5.10 First-Event Rollovers in Single-Vehicle Crashes by LTVs with ESC

Limiting the State data sets in Table 4 to MY 2004 to 2010, the target population includes the LTVs with ESC that had measured SSF values and experienced single-vehicle crashes. The following table shows the average SSF and the first-event rollover rate in each MY.

Table 29: First-Event Rollovers by LTVs with ESC in 17 States MY 2004 to 2010

MY	2004	2005	2006	2007	2008	2009	2010
First-Event Rollover	45	86	387	449	339	142	119
Single-Vehicle Crash	733	2925	9678	12604	11148	5261	4548
First-Event Rollover Rate	6.14%	2.94%	4.00%	3.56%	3.04%	2.70%	2.62%
Average SSF	1.17	1.19	1.18	1.19	1.20	1.20	1.21

The frequencies of first-event rollovers and the single-vehicle crashes appear to increase up to MY 2008 and then decrease in MY 2009. Most of the vehicles in the target population were manufactured close to MY 2009, since NHTSA required the ESC installation in MY 2009. The first-event rollover rates in MY 2004 and MY 2005 do not appear to follow the probability distribution of the first-event rollover rate from MY 2006 to 2010, since the coverages of NCAP rollover resistance program in LTVs are less than 80 percent in MY 2004 and MY 2005 as shown in Table 1. Starting MY 2006 to 2010, the first-event rollover rate appears to decrease while the average SSF appears to increase in each MY. The opposite trends of the first-event rollover rate and the average SSF from MY 2006 to 2010 imply that the SSF should be a significant factor in first-event rollovers by LTVs with ESC.

The following binary variable represents the outcome of a single-vehicle crash.

$$Y_i = \begin{cases} 1, \text{if first} - \text{event rollover} \\ 0, \text{otherwise} \end{cases}$$

The effect of SSF on first-event rollovers by LTVs with ESC is estimated by the logistic regression model in Section 4.2 with potential rollover-associated covariates in Section 4.1. The logistic regression model includes two-way interactions between two covariates which are denoted by covariate A*covariate B in the analysis results. The final model is selected by using the forward selection with the AIC model comparison criterion. Setting the level of significance at 0.05, the following table shows the statistically significant covariates, the estimates, the standard errors, the test statistics and the p-values in the final logistic regression model.

Table 30: Logistic Regression of First-Event Rollovers by LTVs with ESC

Parameter Global Test					
	Chi-Square		DF	P-value	
Likelihood Ratio Test	722.6580		14	< 0.0001	
Score Test	743.4358		14	< 0.0001	
Wald Test	666.8124		14	< 0.0001	
Parameter Estimation					
	DF	Estimate	Std. Error	Chi-Square	P-value
Intercept	1	3.1487	0.6416	24.0840	< 0.0001
SSF	1	-5.0179	0.5430	85.4108	< 0.0001
DRIVER AGE	1	-0.0137	0.00238	33.0160	< 0.0001
I_{WET}	1	0.1349	0.0797	2.8685	0.0903
I_{HILL}	1	0.1558	0.0305	26.0766	< 0.0001
I_{CURVE}	1	0.3256	0.0389	70.0340	< 0.0001
I_{FL}	1	0.7078	0.1012	48.9424	< 0.0001
I_{IL}	1	0.5339	0.0941	32.1818	< 0.0001
I_{MD}	1	-0.7488	0.2022	13.7101	0.0002
I_{NE}	1	1.1162	0.1536	52.8138	< 0.0001
I_{NM}	1	1.5348	0.1273	145.3947	< 0.0001
$I_{NY\ and\ CY>2006}$	1	-1.0512	0.1144	84.4001	< 0.0001
I_{NC}	1	0.3227	0.0812	15.7759	< 0.0001
$I_{WET}*I_{CURVE}$	1	-0.4283	0.1164	13.5503	0.0002
DRIVER AGE*I_{WET}	1	0.00932	0.00374	6.2153	0.0127

The logistic regression model in Table 30 is statistically significant, since the p-values of the parameter global tests are less than the level of significance. The SSF has a statistically significant main effect on first-event rollovers by LTVs with ESC, and there are not statistically significant interactions between the SSF and other covariates in the logistic regression model. Some State indices (i.e., I_{FL}, I_{IL}, I_{MD}, I_{NE}, I_{NM} and $I_{NY\ and\ CY>2006}$) are statistically significant in first-event rollovers as shown in Table 30, and these State indices represent the effects of rollover-associated covariates that are not included in the logistic regression model. Based on Equation 1 and the estimate in Table 30, the following equation shows the estimated odds ratio when the SSF increases by 0.01.

$$\widehat{Odds\ Ratio} = \exp(-5.0179 \cdot 0.01) = 0.9511$$

Equation 11

The estimate, $(1 - \widehat{\text{Odds Ratio}}) \cdot 100\%$, is used to represent the estimated effect of SSF on the odds of experiencing first-event rollovers. The estimated effect of SSF in Equation 11 is a constant value, since there are not statistically significant interactions between the SSF and other covariates in Table 30. With other covariates being held constant, the estimated odds of experiencing first-event rollovers decreases by 4.89 percent ($(1 - 0.9511) \cdot 100\%$) when the SSF increases by 0.01. The estimated effect of SSF on first-event rollovers is smaller in passenger cars with ESC (1.96 %, see Section 5.7) than in LTVs with ESC (4.89 %) when the SSF increases by 0.01. The average values of the estimated effect of SSF in LTVs (5.75 %, see Section 5.8.1), LTVs without ESC (5.41 %, see Section 5.9) and LTVs with ESC (4.89 %) are close, since there is not a statistically significant interaction between the SSF and the ESC installation rate in the logistic regression model as shown in Table 21.

Based on Table 30, the estimated 95 percent confidence interval of the effect of SSF on first-event rollovers by LTVs with ESC is between 3.88 to 5.9 percent when the SSF increases by 0.01. The estimated confidence interval shows that the SSF has a statistically significant effect on first-event rollovers by LTVs with ESC, since the estimated confidence interval does not include 0. Each pairwise comparison[33] among the effects of SSF in all LTVs, LTVs without ESC, and LTVs with ESC is not statistically different, since their estimated confidence interval are overlapping (5.38 % to 6.11 % in all LTVs, see Section 5.8.1 and 4.21 % to 6.51 % in LTVs without ESC, see Section 5.9).

The percentage of rate reduction in Equation 4 expresses the effect of SSF in probability. Based on Equation 4, the following table shows the estimated percentage of rate reduction in each MY.

Table 31: Estimated Percentage of Rate Reduction of SSF on First-Event Rollovers by LTVs with ESC

MY	2004	2005	2006	2007	2008	2009	2010
Observed Rollover Rate	6.14%	2.94%	4.00%	3.56%	3.04%	2.70%	2.62%
Estimated Fitted Rollover Rate	5.86%	2.80%	3.81%	3.39%	2.90%	2.57%	2.49%
Estimated Percentage of Rate Reduction	4.56%	4.76%	4.75%	4.78%	4.61%	4.81%	4.96%

The observed rollover rate is the first-event rollover rate in Table 29. The estimated fitted rollover rate is calculated by the first-event rollover rate in Table 29 and the estimated odds ratio in Equation 11. With other covariates being held constant, the estimated probabilities of first-event rollovers by LTVs with ESC decrease by 4.75 percent ($-\frac{(3.81\%-4.00\%)}{4.00\%} \cdot 100\%$) and by 4.78 percent ($-\frac{(3.39\%-3.56\%)}{3.56\%} \cdot 100\%$) in MY 2006 and MY 2007, respectively, and the average estimated percentage of rate reduction from MY 2004 to 2010 is 4.75 percent when the SSF increases by 0.01. With the estimated odds ratio in Equation 11 being a constant value, the estimated percentage of rate reduction appears to increase since the first-event rollover rate in Table 29 decreases starting MY 2006 to 2010. The estimated effect of SSF and the estimated percentage of rate reduction in this section accounts for the majority of LTVs in the current MY, since NHTSA required the ESC installation in MY 2009.

[33] The estimated confidence intervals are based on the t-distribution, and the t-distribution can only compare two parameters at one time. The pairwise comparisons in this section include the effects of SSF in all LTVs and LTVs without ESC, the effects of SSF in all LTVs and LTVs with ESC, and the effects of SSF in LTVs without ESC and LTVs with ESC.

A.11 Summary for Statistical Inference of First-Event Rollovers

Vehicles with measured SSF values from the 17 State data sets starting with MY 2004 to 2010 are used to evaluate the effect of SSF on first-event rollovers in single-vehicle crashes. The target vehicles are separated by the vehicle group (i.e., the passenger vehicle group and the LTV group) and the ESC installation rate (i.e., no restriction, 0 percent and 100 percent). Based on the statistical inference from Section 5.5 to 5.10, the following table shows the average estimated effect of SSF, the estimated 95 percent confidence interval of the effect of SSF, and the average estimated percentage of rate reduction when the SSF increases by 0.01.

Table 32: Statistical Inference of SSF on First-Event Rollovers MY 2004 to 2010

Passenger Car Group			
	Passenger Cars	Passenger Cars without ESC	Passenger Cars with ESC
Average Estimated Effect of SSF	3.39%	4.69%	1.96%
Estimated 95% Confidence Interval of SSF Effect	0.94% to 6.33%	4.34% to 5.05%	0.0067% to 3.87%
Average Estimated Percentage of Rate Reduction	3.30%	4.49%	1.81%
LTV Group			
	LTVs	LTVs without ESC	LTVs with ESC
Average Estimated Effect of SSF	5.75%	5.41%	4.89%
Estimated 95% Confidence Interval of SSF Effect	5.38% to 6.11%	4.21% to 6.51%	3.88% to 5.9%
Average Estimated Percentage of Rate Reduction	5.37%	4.87%	4.75%

The average estimated effect of SSF shows the average reduced-odds of first-event rollovers while the average estimated percentage of rate reduction shows the percentage reduction of first-event rollovers when the SSF increases by 0.01. The average estimated effect and the average estimated percentage of rate reduction are mathematically identical. The average estimated effect of SSF and the average estimated percentage of rate reduction are smaller in the passenger vehicle group than in the LTV group. The effects of SSF in passenger cars without ESC and LTVs without ESC are not statistically different, since their estimated confidence intervals are overlapping. However, the effect of SSF is statistically greater in LTVs with ESC than in passenger cars with ESC, since the lower bound of the estimated confidence interval in LTVs with ESC (3.88%) is greater than the upper bound of the estimated confidence interval in passenger cars with ESC (3.87%).

The average estimated effect of SSF in the passenger car group decreases when the ESC installation rate increases, since there is a statistically significant interaction between the SSF and the ESC installation rate as shown in Table 8. The effect of SSF is statistically greater in passenger cars without ESC than in passenger cars with ESC, since the lower bound of the estimated confidence interval in passenger cars without ESC (4.34%) is greater than the upper bound of the estimated confidence interval in passenger cars with ESC (3.87%).

The average estimated effect of SSF in the LTV group remains steady, since there is not a statistically significant interaction between the SSF and the ESC installation rate as shown in

Table 21. Each pairwise comparison among the effects of SSF in all LTVs, LTVs without ESC, and LTVs with ESC is not statistically different, since their estimated confidence intervals are overlapping.

Based on Sections 5.5.2 and 5.8.2, the following table shows the average estimated effect of ESC installation rate and the average estimated percentage of rate reduction on first-event rollovers when the ESC installation rate increases from 0 to 100 percent.

Table 33: Statistical Inference of ESC on First-Event Rollovers MY 2004 to 2010

	Passenger Cars	LTVs
Average Estimated Effect of ESC	58.97%	68.96%
Average Estimated Percentage of Rate Reduction	58%	67.40%

The average estimated effect of ESC and the average percentage of rate reduction are greater in LTVs than in passenger cars. The ESC installation rate is more effective in reducing first-event rollovers by LTVs than by passenger cars. The ESC installation rate has a greater effect on first-event rollovers than the SSF as shown in Table 32 and Table 33.

6 Subsequent Rollovers in Multi-Vehicle Crashes

Since 1996, NCAP[34] has conducted a dynamic side-impact test to simulate a 90-degree side-impact vehicle-to-vehicle collision by striking a stationary vehicle with a moving deformable barrier at 61.9 km/h (38.5 mph). NHTSA found that some LTVs, such as the 2011 Nissan Rogue, 2011 Ford Escape, 2012 Chevrolet Suburban 1500, 2012 Dodge Durango, and 2014 Chevrolet Silverado Extended Cab rolled over ¼ or ½ turns during the NCAP dynamic side-impact test. The NCAP dynamic side-impact test shows that a side impact could cause vehicles to be lifted up and then lead to rollovers. Therefore, this evaluation report extends single-vehicle crashes to vehicle-to-vehicle side-impact crashes and estimates the effect of SSF on rollovers after a side-impact collision involving multiple vehicles.

6.1 Multi-Vehicle Crashes

Based on the NCAP dynamic side-impact test, the target population includes passenger vehicles with measured SSF values that involved a side-impact collision in two-vehicle crashes. The target population excludes passenger vehicles that involved collisions with pedestrians, pedal cycles, animals or trains. The vehicles in the target population could either be struck or be striking. For examples, the vehicle could be struck on the side by the front of the other vehicle when passing a crossroads, or the vehicle could strike the other vehicle by the side of the vehicle when making a U-turn. Furthermore, the side impact needs to be the first event that caused personal injury, vehicular or property damage. The applicable SDS cases can be identified by

[34] Hershman, L. L. (2001, June). The U.S. New Car Assessment Program (NCAP): Past, Present and Future. Washington, DC: National Highway Traffic Safety Administration.

investigating the number of vehicles in the crash, the sequence of events and the first point of vehicle damage sustained in the crash.

The SSF of a crashed vehicle would be affected because of the severe deformation caused by a collision, and a vehicle tends to be seriously deformed in a crash with another vehicle traveling at high speed. As in the preceding analyses, ambulances, police cars, fire trucks and rescue vehicles that were on high-speed emergency calls are removed from the target population. Vehicles with trailers and attachments are excluded from the target population, since trailers and attachments would change the center of gravity height of vehicles. Parked and stopped vehicles are not included in the target population, since this study does not include vehicles that were not in transport at the time of the crash.

6.2 Subsequent Rollovers after Side-Impact Multiple-Vehicle Crashes

In this evaluation report, a subsequent rollover is defined to be a rollover that occurred in a two-vehicle crash, in which the side impact is the first impact point of the rolled vehicle with damage at right/left front, right/left side or right/left rear in the crash. Recognizing that a vehicle could have experienced other crash events before a rollover in a side-impact multi-vehicle crash, this evaluation report further restricts a subsequent rollover to be the second sequential event in the crash where a side impact is the first sequential event.

6.3 State Data Sets of Subsequent Rollovers

Starting with CY 2004 to 2011, the SDS with VIN is used to identify subsequent rollovers and side-impact multi-vehicle crashes. Most of the States provide variables that describe the sequential events in crashes, but only a few States have variables that indicate the first impact point of vehicle in the crash. The data sets of 8 States[35] are chosen to estimate the effect of the SSF on subsequent rollovers in side-impact multi-vehicle crashes. The following table expresses the 8 States and the CY range of each State data set.

Table 34: State Data Sets of Side-Impact Multi-Vehicle Crashes

	FL	IL	KY	MD	MO	NE	NJ	PA
First CY	2004	2004	2004	2004	2004	2004	2004	2004
Last CY	2011	2011	2011	2008	2011	2011	2011	2011

The State data set of Maryland from CY 2009 to 2011 is truncated as shown in Table 34, since the new crash data reporting system does not indicate the first impact point of vehicle in the crash. To apply the statistical inference to Maryland from CY 2009 to 2011, this evaluation report assumes that subsequent rollovers in Maryland from CY 2009 to 2011 follow the probability distribution of subsequent rollovers in Maryland from CY 2004 to 2008.

[35] Florida (FL), Illinois (IL), Kentucky (KY), Maryland (MD), Missouri (MO), Nebraska (NE), New Jersey (NJ) and Pennsylvania (PA)

6.4 Vehicle Separation of Subsequent Rollovers

If each vehicle group has distinct probability distributions of subsequent rollovers, vehicles should be separated based on the vehicle group to estimate the effect of SSF. Limiting the State data sets in Table 34 to MY 2004 to 2010, the following table shows the subsequent rollover rate in passenger cars and LTV that experienced side-impact multi-vehicle crashes in each MY.

Table 35: Subsequent Rollover Rate in 8 States MY 2004 to 2010

Passenger Cars							
MY	2004	2005	2006	2007	2008	2009	2010
Subsequent Rollover	169	193	157	147	73	45	27
Side-Impact Multi-Vehicle Crash	123076	111935	94058	82870	55947	31396	21012
Subsequent Rollover Rate	0.14 %	0.17 %	0.17 %	0.18 %	0.13 %	0.14 %	0.13 %
LTVs							
MY	2004	2005	2006	2007	2008	2009	2010
Subsequent Rollover	833	664	464	349	259	79	76
Side-Impact Multi-Vehicle Crash	97697	88878	71034	55588	39891	15796	12871
Subsequent Rollover Rate	0.85 %	0.75 %	0.65 %	0.63 %	0.65 %	0.50 %	0.59 %

The probability distributions of subsequent rollovers in passenger cars and LTVs are different, since the subsequent rollover rate is lower in passenger cars than in LTVs in each MY. Vehicles with side-impact multi-vehicle crashes will be separated into the passenger vehicle group and the LTV group in the following sections.

6.5 Subsequent Rollovers in Side-Impact Multi-Vehicle Crashes by Passenger Cars

Limiting the State data sets in Table 34 to MY 2004 to 2010, the target population includes the passenger cars with measured SSF values that experienced side-impact multi-vehicle crashes. This evaluation report includes the effects of SSF and ESC installation rate on subsequent rollovers by passenger cars. The following table shows the subsequent rollover rate, the average SSF and the average ESC installation rate in the target population.

Table 36: Subsequent Rollovers by Passenger Cars in 8 States MY 2004 to 2010

MY	2004	2005	2006	2007	2008	2009	2010
Subsequent Rollover	154	157	125	131	62	42	24
Side-Impact Multi-Vehicle Crash	111871	100430	82614	74758	51446	29299	19499
Subsequent Rollover Rate	0.14%	0.16%	0.15%	0.18%	0.12%	0.14%	0.12%
Average SSF	1.41	1.41	1.40	1.40	1.40	1.40	1.40
Average ESC Rate	8.48%	9.50%	20.35%	18.22%	29.90%	35.49%	77.44%

The frequencies of subsequent rollovers and side-impact multi-vehicle crashes appear to decrease in each MY. The subsequent rollover rate fluctuates without a trend while the average SSF remains steady. The average ESC installation rate appears to increase in each MY. Apart from the SSF and ESC installation rate, other potential rollover-associated covariates in Section 4.1 might have statistically significant effects on subsequent rollovers by passenger cars.

The following binary variable represents the outcome of a side-impact multi-vehicle crash.

$$Y_i = \begin{cases} 1, \text{if subsequent rollover} \\ 0, \text{otherwise} \end{cases}$$

Applying the logistic regression model in Section 4.2 with potential rollover-associated covariates in Section 4.1, the effects of SSF and ESC installation rate on subsequent rollovers in side-impact multi-vehicle crashes are estimated. Two-way interactions between two covariates are also included in the logistic regression model denoted by covariate A*covariate B in the analysis results. The final model is chosen by using the forward selection with the AIC model comparison criterion. Setting the level of significance at 0.05, the following table shows the statistically significant covariates, the estimates, the standard errors, the test statistics and the p-values in the final logistic regression.

Table 37: Logistic Regression of Subsequent Rollovers by Passenger Cars

Parameter Global Test					
	Chi-Square		DF	P-value	
Likelihood Ratio Test	680.1098		16	< 0.0001	
Score Test	803.2103		16	< 0.0001	
Wald Test	673.1468		16	< 0.0001	
Parameter Estimation					
	DF	Estimate	Std. Error	Chi-Square	P-value
Intercept	1	-5.3237	2.8217	3.5595	0.0592
SSF	1	-6.0408	1.8005	11.2564	0.0008
ESC	1	-0.5141	0.1407	13.3433	0.0003
I_{WET}	1	-7.2215	1.6348	19.5141	< 0.0001
I_{CURVE}	1	0.2494	0.0730	11.6801	0.0006
I_{DARK}	1	0.0633	0.0514	1.5145	0.2185
I_{MALE}	1	0.0877	0.0397	4.8764	0.0272
Driver Age	1	0.1142	0.0562	4.1314	0.0421
SSF*I_{WET}	1	9.4391	2.3118	16.6718	< 0.0001
SSF*DRIVER AGE	1	-0.0879	0.0407	4.6596	0.0309
DRIVER AGE*I_{WET}	1	0.0152	0.00673	5.0613	0.0245
I_{DARK}*I_{CURVE}	1	0.6777	0.2522	7.2210	0.0072
I_{FL}	1	1.7276	0.1111	241.8670	< 0.0001
I_{KY}	1	1.0011	0.1230	66.2797	< 0.0001
I_{MD}	1	2.3018	0.1502	234.8383	< 0.0001
I_{MO}	1	0.5898	0.1721	11.7502	0.0006
I_{PA}	1	1.7244	0.1391	153.6665	< 0.0001

The logistic regression model in Table 37 is statistically significant, since the p-values of parameter global tests are less than the level of significance. The SSF has a statistically significant main effect and statistically significant interactions with the circumstance covariate (i.e., I_{WET}) and the driver's age, since their p-values are less than the level of significance. The effect of ESC installation rate is constant, since there are not statistically significant interactions between the ESC installation rate and other covariates. Some State indices (i.e., I_{FL}, I_{KY}, I_{MD}, I_{MO}

and I_{PA}) are statistically significant in subsequent rollovers as shown in Table 37, and these State indices represent the effects of rollover-associated covariates that are not included in the logistic regression model.

6.5.1 Effect of SSF on Subsequent Rollovers by Passenger Cars

The effect of SSF on subsequent rollovers by passenger cars depends on the circumstance covariate (i.e., I_{WET}) and the driver's age. The estimate of the interaction between the SSF and the circumstance covariate (i.e., I_{WET}) is positive as shown in Table 37, so the effect of SSF is greater with dry roadway surfaces than with wet roadway surfaces when the driver's age is held constant. The SSF appears to be more effective in subsequent rollovers by passenger cars with a better roadway condition. The estimate of the interaction between the SSF and the driver's age is negative as shown in Table 37, so the effect of SSF is greater with older drivers than with younger drivers when the circumstance covariate (i.e., I_{WET}) is held constant. The SSF appears to be more effective in subsequent rollovers by passenger cars with more experienced drivers.

Based on Equation 1 and the estimate in Table 37, the following equation shows the estimated odds ratio when the SSF increases by 0.01.

$$\widehat{\text{Odds Ratio}} = \exp(-6.0408 \cdot 0.01 + 9.4391 \cdot 0.01 \cdot I_{WET} - 0.0879 \cdot 0.01 \cdot DRIVER\ AGE)$$

Equation 12

With a great-positive estimated parameter of the interaction between the SSF and the circumstance covariate (i.e., I_{WET}) as shown in Equation 12, the estimated effect of SSF on subsequent rollovers by passenger cars should be significantly greater with dry roadway surfaces than with wet roadway surfaces. This evaluation report will then group the target population and present the estimated effect of SSF based on the condition of roadway surfaces. The following tables show the frequencies and the rates of subsequent rollovers, the averages of SSF and the averages of ESC installation rate with wet and dry roadway surfaces, respectively.

Table 38: Subsequent Rollovers by Passenger Cars with Wet Roadway Surfaces in 8 States MY 2004 to 2010

MY	2004	2005	2006	2007	2008	2009	2010
Subsequent Rollover	22	18	21	12	10	2	2
Side-Impact Multi-Vehicle Crash	23479	21021	17296	16064	10572	5710	3622
Subsequent Rollover Rate	0.09%	0.09%	0.12%	0.07%	0.09%	0.04%	0.06%
Average SSF	1.41	1.41	1.41	1.40	1.40	1.40	1.40
Average ESC	7.87%	8.80%	18.85%	17.55%	28.58%	34.10%	76.91%

Table 39: Subsequent Rollovers by Passenger Cars with Dry Roadway Surfaces in 8 States
MY 2004 to 2010

MY	2004	2005	2006	2007	2008	2009	2010
Subsequent Rollover	132	139	104	118	52	40	22
Side-Impact Multi-Vehicle Crash	87689	78896	64884	58345	40638	23448	15799
Subsequent Rollover Rate	0.15%	0.18%	0.16%	0.20%	0.13%	0.17%	0.14%
Average SSF	1.41	1.41	1.41	1.40	1.41	1.40	1.40
Average ESC	8.66%	9.70%	20.73%	18.40%	30.26%	35.83%	77.55%

The frequencies of subsequent rollovers and side-impact multi-vehicle crashes are greater with dry roadway surfaces than with wet roadway surfaces, while the averages of SSF and ESC installation rate with dry and wet roadway surfaces appear to be close in each MY. The probability distributions of subsequent rollovers with dry and wet roadway surfaces are different, since the subsequent rollover rate is greater with dry roadway surfaces than with wet roadway surfaces in each MY.

Based on Equation 12, the following equations show the estimated odds ratios of experiencing subsequent rollovers by passenger cars with wet and dry roadway surfaces, respectively, when the SSF increases by 0.01.

$$\widehat{\text{Odds Ratio}} = \exp(-6.0408 \cdot 0.01 + 9.4391 \cdot 0.01 \cdot 1 - 0.0879 \cdot 0.01 \cdot DRIVER\ AGE)$$

Equation 13

$$\widehat{\text{Odds Ratio}} = \exp(-6.0408 \cdot 0.01 - 0.0879 \cdot 0.01 \cdot DRIVER\ AGE)$$

Equation 14

The estimate, $(1 - \widehat{\text{Odds Ratio}}) \cdot 100\%$, is used to represent the estimated effect of SSF on the odds of experiencing subsequent rollovers. The estimated odds ratios in Equation 13 and Equation 14 vary among side-impact multi-vehicle crashes, since the driver's age is different in each side-impact multi-vehicle crash. The trends of the estimated effect of SSF based on Equation 13 and 14 will be evaluated in Appendix II.

Although the driver's age is different in each side-impact multi-vehicle crash, the distribution of driver's age among different MYs should be similar. Based on the target population grouped by the condition of roadway surfaces, this evaluation report uses the average driver's age in each MY. The estimated odds ratios with wet and dry roadway surfaces in each MY are calculated by substituting the average driver's age with wet and dry roadway surfaces into Equation 13 and Equation 14, respectively. The estimated effects of SSF with wet and dry roadway surfaces are then represented based on their estimated odds ratios. The following tables show the estimated odds ratios and the estimated effects of SSF with wet and dry roadway surfaces, respectively, in each MY.

Table 40: Estimated Effect of SSF on Subsequent Rollovers
by Passenger Cars with Wet Roadway Surfaces

MY	2004	2005	2006	2007	2008	2009	2010
Average Driver Age	39.50	40.09	39.43	39.85	39.91	41.75	41.57
Estimated Odds Ratio	0.9993	0.9987	0.9993	0.9990	0.9989	0.9973	0.9974
Estimated Effect of SSF	0.07%	0.13%	0.07%	0.10%	0.11%	0.27%	0.26%

Table 41: Estimated Effect of SSF on Subsequent Rollovers
by Passenger Cars with Dry Roadway Surfaces

MY	2004	2005	2006	2007	2008	2009	2010
Average Driver Age	41.15	41.63	41.15	41.47	41.52	42.88	42.62
Estimated Odds Ratio	0.9079	0.9076	0.9079	0.9077	0.9076	0.9066	0.9068
Estimated Effect of SSF	9.21%	9.24%	9.21%	9.23%	9.24%	9.34%	9.32%

With other covariates being held constant, Table 40 and Table 41 show that the estimated odds of experiencing subsequence rollovers with wet and dry roadway surfaces in MY 2004 decrease by 0.07 percent ($(1 - 0.9993) \cdot 100\%$) and by 9.21 percent ($(1 - 0.9079) \cdot 100\%$), respectively. The average estimated effect of SSF from MY 2004 to 2010 with wet roadway surfaces is 0.14 percent, while the average estimated effect of SSF with dry roadway surfaces is 9.26 percent when the SSF increases by 0.01. The estimated effect of SSF is significantly greater with dry roadway surfaces than with wet roadway surfaces in each MY, and the estimated effect of SSF with wet roadway surfaces appears to be close to 0 in each MY.

Based on Table 37, the estimated 95 percent confidence interval of the effect of SSF with wet roadway surfaces is between -3.36 to 3.68 percent, while the estimated confidence interval with dry roadway surfaces is between 5.95 to 12.36 percent when the SSF increases 0.01. The SSF was not found to have a statistically significant effect on subsequent rollovers by passenger cars with wet roadway surfaces, since its confidence interval includes 0. However, the SSF is statistically significant with dry roadway surfaces, since its confidence interval does not include 0. Although Table 37 shows that the SSF has a statistically significant effect on the overall subsequent rollovers by passenger cars, it is noted that the SSF was only found to be statistically significant with dry roadway surfaces.

The subsequent rollovers in this evaluation report are the rollovers that occurred as the second sequential event in the side-impact multi-vehicle crashes where the first sequential event is a side impact. Although a subsequent rollover may be prevented by improving the SSF, a side impact has already occurred as the first sequential event in a side-impact multi-vehicle crash. Thus, the total number of side-impact multi-vehicle crashes in each MY is constant, and the percentage of rate reduction in Equation 4 can be used to express the effect of SSF in probability. Based on Equation 4, the following tables show the estimated percentages of rate reduction with wet and dry roadway surfaces, respectively, in each MY.

Table 42: Estimated Percentage of Rate Reduction of SSF on Subsequent Rollovers by Passenger Cars with Wet Roadway Surfaces

MY	2004	2005	2006	2007	2008	2009	2010
Observed Rollover Rate	0.09%	0.09%	0.12%	0.07%	0.09%	0.04%	0.06%
Estimated Fitted Rollover Rate	0.089%	0.089%	0.119%	0.069%	0.089%	0.039%	0.059%
Estimated Percentage of Rate Reduction	1.11%	1.11%	0.83%	1.43%	1.11%	2.50%	1.67%

Table 43: Estimated Percentage of Rate Reduction of SSF on Subsequent Rollovers by Passenger Cars with Dry Roadway Surfaces

MY	2004	2005	2006	2007	2008	2009	2010
Observed Rollover Rate	0.15%	0.18%	0.16%	0.20%	0.13%	0.17%	0.14%
Estimated Fitted Rollover Rate	0.138%	0.166%	0.147%	0.185%	0.119%	0.157%	0.129%
Estimated Percentage of Rate Reduction	8.00%	7.78%	8.13%	7.50%	8.46%	7.65%	7.86%

The observed rollover rates in Table 42 and Table 43 are the subsequent rollover rates in Table 38 and Table 39, respectively. The estimated fitted rollover rates with wet and dry roadway surfaces are calculated by the subsequent rollover rates in Table 38 and Table 39 and the estimated odds ratios in Table 40 and Table 41, respectively. With other covariates being held constant, the estimated probabilities of subsequent rollovers with wet and dry roadway surfaces in MY 2004 decrease by 1.11 percent ($-\frac{(0.089\%-0.09\%)}{0.09\%}\cdot 100\%$) and by 8.00 percent ($-\frac{(0.138\%-0.15\%)}{0.15\%}\cdot 100\%$), respectively. The average estimated percentage of rate reduction with wet roadway surfaces is 1.39 percent, while the average estimated percentage of rate reduction with dry roadway surfaces is 7.91 percent when the SSF increases by 0.01. The average estimated percentage of rate reduction is significantly greater with dry roadway surfaces than with wet roadway surfaces in each MY. The average estimated percentage of rate reduction with wet roadway surfaces appears to be close to 0 in each MY as shown in Table 42, since the SSF does not have a statistically significant effect on subsequent rollovers by passenger cars with wet roadway surfaces.

6.5.2 Effect of ESC on Subsequent Rollovers by Passenger Cars

The ESC installation rate has a statistically significant main effect, but there are not statistically significant interactions between the ESC installation rate and other covariates in Table 37. The estimated effect of ESC installation rate on subsequent rollovers does not depend on other covariates. Based on Equation 1 and the estimate in Table 37, the following equation shows the estimated odds ratio of experiencing subsequent rollovers in side-impact multi-vehicle crashes when the ESC installation rate increases from 0 to 100 percent.

$$\widehat{\text{Odds Ratio}} = \exp(-0.5141) = 0.5980$$

Equation 15

The estimate, $(1 - \widehat{\text{Odds Ratio}}) \cdot 100\%$, is used to represent the estimated effect of ESC installation rate on the odds of experiencing subsequent rollovers. The estimated effect of ESC installation rate in Equation 13 is a constant value, since there are not statistically significant interactions between the ESC installation rate and other covariates in Table 37. With other covariates being held constant, the estimated odds of subsequent rollovers by passenger cars decreases by 40.20 percent ($(1 - 0.5980) \cdot 100\%$) when the ESC installation rate increases from 0 to 100 percent.

The percentage of rate reduction in Equation 4 expresses the effect of ESC installation rate in probability. Based on Equation 4, the following table shows the estimated percentage of rate reduction in each MY.

Table 44: Estimated Percentage of Rate Reduction of ESC on Subsequent Rollovers by Passenger Cars

MY	2004	2005	2006	2007	2008	2009	2010
Observed Rollover Rate	0.14%	0.16%	0.15%	0.18%	0.12%	0.14%	0.12%
Estimated Fitted Rollover Rate	0.08%	0.10%	0.09%	0.11%	0.07%	0.08%	0.07%
Estimated Percentage of Rate Reduction	42.86%	37.5%	40%	38.89%	41.67%	42.86%	41.67%

The observed rollover rate is the subsequent rollover rate in Table 36. The estimated fitted rollover rate is calculated by the subsequent rollover rate in Table 36 and the estimated odds ratio in Equation 15. With other covariates being held constant, the estimated probabilities of subsequent rollovers by passenger cars decrease by 38.89 percent ($-\frac{(0.11\%-0.18\%)}{0.18\%} \cdot 100\%$) and by 41.67 percent ($-\frac{(0.07\%-0.12\%)}{0.12\%} \cdot 100\%$) in MY 2007 and MY 2008, respectively, and the average estimated percentage of rate reduction from MY 2004 to 2010 is 40.78 percent when the ESC installation rate increases from 0 to 100 percent. With the estimated effect of ESC installation rate based on Equation 13 being a constant value, the estimated percentage of rate reduction appears to decrease starting MY 2007, since the subsequent rollover rate appears to decrease since MY 2007.

6.6 Subsequent Rollovers in Side-Impact Multi-Vehicle Crashes by LTVs

Limiting the State data sets in Table 34 to MY 2004 to 2010, the target population includes the LTVs with NHTSA's star-ratings of rollover resistance that experienced side-impact multi-vehicle crashes. This evaluation report includes the effects of SSF and ESC installation rate on subsequent rollovers by LTVs. The following table shows the subsequent rollover rate, the average SSF and the average ESC installation rate in the target population.

Table 45: Subsequent Rollovers by LTVs in 8 States MY 2004 to 2010

MY	2004	2005	2006	2007	2008	2009	2010
Subsequent Rollover	289	416	370	290	222	65	64
Side-Impact Multi-Vehicle Crash	34096	54902	53863	43807	32285	13556	11022
Subsequent Rollover Rate	0.85%	0.76%	0.69%	0.66%	0.69%	0.48%	0.58%
Average SSF	1.20	1.21	1.21	1.21	1.21	1.21	1.21
Average ESC Rate	10.74%	20.77%	42.58%	64.12%	78.38%	90.64%	92.72%

The frequencies of subsequent rollovers and side-impact multi-vehicle crashes are lower in MY 2004 than in MY 2005, since the coverage of NCAP rollover test is smaller in MY 2004 than in MY 2005 as shown in Table 1. Starting MY 2005 to 2010, the frequencies of subsequent rollovers and side-impact multi-vehicle crashes appear to decrease in each MY. The frequency of subsequent rollovers, the frequency of side-impact multi-vehicle crashes and the subsequent rollover rate significantly decrease in MY 2009, in which the change of the economics climates might be a reason. With the average of SSF in Table 45 being constant, the subsequent rollover rate appears to decrease while the average ESC installation rate increases in each MY. The opposite trends of the subsequent rollover rate and the average ESC installation rate imply that the ESC installation rate should be a significant factor in subsequent rollovers by LTVs.

The following binary variable represents the outcome of a side-impact multi-vehicle crash.

$$Y_i = \begin{cases} 1, \text{if subsequent rollover} \\ 0, \text{otherwise} \end{cases}$$

Applying the logistic regression model in Section 4.2 with potential rollover-associated covariates in Section 4.1, the effects of SSF and ESC installation rate on subsequent rollovers in side-impact multi-vehicle crashes are estimated. Two-way interactions between two covariates are also included in the logistic regression model denoted by covariate A*covariate B in the analysis results. The final model is selected by using the forward selection with the AIC model comparison criterion. Setting the level of significance at 0.05, the following table shows the statistically significant covariates, the estimates, the standard errors, the test statistics and the p-values in the final logistic regression model where the curb weight is scaled in 100 lb. per increment.

Table 46: Logistic Regression of Subsequent Rollovers by LTVs

Parameter Global Test					
	Chi-Square		DF	P-value	
Likelihood Ratio Test	1045.6514		14	< 0.0001	
Score Test	1204.9856		14	< 0.0001	
Wald Test	1086.4688		14	< 0.0001	
Parameter Estimation					
	DF	Estimate	Std. Error	Chi-Square	P-value
Intercept	1	5.9550	0.6546	82.7678	< 0.0001
SSF	1	-7.8675	0.4722	277.6021	< 0.0001
ESC	1	-0.1717	0.0551	9.7149	0.0018
CURB WEIGHT	1	-0.0521	0.00388	179.5904	< 0.0001
DRIVER AGE	1	-0.00322	0.00160	4.0679	0.0437
I_{WET}	1	-1.0717	0.2553	17.6219	< 0.0001
I_{CURVE}	1	0.0618	0.0540	1.3075	0.2529
I_{DARK}	1	0.0770	0.0341	5.1018	0.0239
ESC*I_{WET}	1	-0.4644	0.1805	6.6184	0.0101
CURB WEIGHT*I_{WET}	1	0.0285	0.0115	6.1679	0.0130
I_{DARK}*I_{WET}	1	0.3136	0.1800	3.0369	0.0814
I_{DARK}*I_{CURVE}	1	-0.4991	0.2415	4.2704	0.0388
I_{WET}*I_{CURVE}	1	1.0741	0.2083	26.5895	< 0.0001
I_{FL}	1	1.1699	0.0557	441.0480	< 0.0001
I_{MD}	1	0.9870	0.1337	54.4688	< 0.0001

The logistic regression model in Table 46 is statistically significant, since the p-values of parameter global tests are less than the level of significance. The SSF has a statistically significant main effect, but there are not statistically significant interactions between the SSF and other covariates. The effect of ESC installation rate on subsequent rollovers by LTVs depends on the circumstance covariate (i.e., I_{WET}), since there is a statistically significant interaction between the ESC installation rate and the circumstance covariate (i.e., I_{WET}). Two State indices (i.e., I_{FL} and I_{MD}) are statistically significant in subsequent rollovers by LTVs, and these State indices represent the effects of rollover-associated covariates which are not included in the logistic regression model.

The effects of SSF and ESC installation rate on subsequent rollovers will be expressed in the following sections.

6.6.1 Effect of SSF on Subsequent Rollovers by LTVs

The effect of SSF on subsequent rollovers by LTVs is a constant value, since there are not statistically significant interactions between the SSF and other covariates in Table 46. Based on Equation 1 and the estimate in Table 46, the following equation shows the estimated odds ratio when the SSF increases by 0.01.

$$\widehat{\text{Odds Ratio}} = \exp(-7.8675 \cdot 0.01) = 0.9243$$

Equation 16

The estimate, $(1 - \widehat{\text{Odds Ratio}}) \cdot 100\%$, is used to represent the estimated effect of SSF on the odds of experiencing subsequent rollovers. With other covariates being held constant, the estimated odds of subsequent rollovers by LTVs decreases by 7.57 percent ($(1 - 0.9243) \cdot 100\%$) when the SSF increases by 0.01.

Based on Table 46, the estimated 95 percent confidence interval of the effect of SSF on subsequent rollovers by LTVs is between 6.71 to 8.42 percent when the SSF increases by 0.01. The estimated confidence interval shows that the SSF has a statistically significant effect on subsequent rollovers by LTVs, since the confidence interval does not include 0.

The percentage of rate reduction in Equation 4 expresses the effect of SSF in probability. Based on Equation 4, the following table shows the estimated percentage of rate reduction in each MY.

Table 47: Estimated Percentage of Rate Reduction of SSF on Subsequent Rollovers by LTVs

MY	2004	2005	2006	2007	2008	2009	2010
Observed Rollover Rate	0.85%	0.76%	0.69%	0.66%	0.69%	0.48%	0.58%
Estimated Fitted Rollover Rate	0.79%	0.70%	0.64%	0.61%	0.64%	0.44%	0.54%
Estimated Percentage of Rate Reduction	7.06%	7.89%	7.25%	7.58%	7.25%	8.33%	6.90%

The observed rollover rate is the subsequent rollover rate in Table 45. The estimated fitted rollover rate is calculated by the subsequent rollover rate in Table 45 and the estimated odds ratio in Equation 16. With other covariates being held constant, the estimated probabilities of subsequent rollovers by LTVs decrease by 7.58 percent ($-\frac{(0.61\%-0.66\%)}{0.66\%} \cdot 100\%$) and by 7.25 percent ($-\frac{(0.64\%-0.69\%)}{0.69\%} \cdot 100\%$) in MY 2007 and MY 2008, respectively, and the average estimated percentage of rate reduction from MY 2004 to 2010 is 7.47 percent when the SSF increases by 0.01. The estimated percentages of rate reduction from MY 2004 to 2006 do not appear to follow the probability distribution of the estimated percentage of rate reduction from MY 2007 to 2010, since the coverage of NCAP rollover resistance program in LTVs is less than 80 percent until MY 2006 as shown in Table 1. With the estimated effect of SSF being a constant value, the estimated percentage of rate reduction appears to decrease starting MY 2007 to 2010. However, there is a significant increase in the estimated percentage of rate reduction in MY 2009, in which the change of the economics climates might be a reason.

6.6.2 Effect of ESC on Subsequent Rollovers by LTVs

The ESC installation rate has a statistically significant main effect and a statistically significant interaction with the circumstance covariate (i.e. I_{WET}), since their p-values in Table 46 are less than the level of significance. The effect of ESC installation rate on subsequent rollovers by

LTVs varies among side-impact multi-vehicle crashes, since the circumstance covariate (i.e. I_{WET}) is not the same in each side-impact multi-vehicle crash. With other covariates being held constant, the estimated effect of ESC installation rate on subsequent rollovers by LTVs is greater on a wet roadway surface than on a dry roadway surface, since the estimate of the interaction between the SSF and the circumstance covariate (i.e. I_{WET}) in Table 46 is negative. The estimated main effect of the circumstance covariate (i.e. I_{WET}) is also negative as shown in Table 46. With a wet roadway surface, some subsequent rollovers by LTVs might turn into another crash mode (e.g., collision crashes) after a side impact as the first sequential event in a side-impact multi-vehicle crash.

Based on Equation 1 and the estimates in Table 46, the following equation shows the estimated odds ratio of experiencing subsequent rollovers by LTVs in side-impact multi-vehicle crashes when the ESC installation rate increases from 0 to 100 percent.

$$\widehat{\text{Odds Ratio}} = \exp\left(-0.1717 - 0.4644 \cdot I_{WET}\right)$$

Equation 17

The estimate, $(1 - \widehat{\text{Odds Ratio}}) \cdot 100\%$, is used to represent the estimated effect of ESC installation rate on the odds of experiencing subsequent rollovers by LTVs. The trend of the estimated effect of SSF based on Equation 17 will be evaluated in Appendix II.

The circumstance covariates (i.e. I_{WET}) in Equation 17 is a binary variable, and it is represented by its rate in the target population in each MY. When the ESC installation rate increases from 0 to 100 percent and other covariates are held constant, the estimated odds ratio in each MY is calculated by substituting the rate of wet into Equation 17. The estimated effect of ESC installation rate is then represented based on the estimated odds ratio. The following table shows the estimated odds ratio and the estimated effect of ESC installation rate in each MY.

Table 48: Estimated Effect of ESC on Subsequent Rollovers by LTVs

MY	2004	2005	2006	2007	2008	2009	2010
Rate of Wet	22%	21%	22%	21%	22%	22%	19%
Estimated Odds Ratio	0.7604	0.7640	0.7604	0.7640	0.7604	0.7604	0.7711
Estimated Effect of ESC	23.96%	23.60%	23.96%	23.60%	23.96%	23.96%	23.89%

With other covariates being held constant, Table 48 shows that the estimated odds of experiencing subsequent rollovers in MY 2004 and MY 2005 decrease by 23.96 percent ($(1 - 0.7604) \cdot 100\%$) and by 23.60 percent ($(1 - 0.7640) \cdot 100\%$), respectively, and the average estimated effect of ESC installation rate from MY 2004 to 2010 is 23.70 percent when the ESC installation rate increases from 0 to 100 percent. The estimated effect of ESC installation rate remains steady up to MY 2010, since the rate of wet appears to be constant.

The percentage of rate reduction in Equation 4 expresses the effect of ESC installation rate in probability. Based on Equation 4, the following table shows the estimated percentage of rate reduction in each MY

Table 49: Estimated Percentage of Rate Reduction of ESC on Subsequent Rollovers by LTVs

MY	2004	2005	2006	2007	2008	2009	2010
Observed Rollover Rate	0.85%	0.76%	0.69%	0.66%	0.69%	0.48%	0.58%
Estimated Fitted Rollover Rate	0.65%	0.58%	0.53%	0.51%	0.53%	0.37%	0.45%
Estimated Percentage of Rate Reduction	23.53%	23.68%	23.19%	22.73%	23.19%	22.92%	22.41%

The observed rollover rate is the subsequent rollover rate in Table 45. The estimated fitted rollover rate is calculated by the subsequent rollover rate in Table 45 and the estimated odds ratio in Table 48. With other covariates being held constant, the estimated probabilities of first-event rollovers decrease by 23.68 percent ($-\frac{(0.58\%-0.76\%)}{0.76\%} \cdot 100\%$) and by 23.19 percent ($-\frac{(0.53\%-0.69\%)}{0.69\%} \cdot 100\%$) in MY 2005 and MY 2006, respectively, and the average estimated percentage of rate reduction from MY 2004 to 2010 is 23.09 percent when the ESC installation rate increases from 0 to 100 percent. With the estimated effect of ESC installation rate remaining steady, the estimated percentage of rate reduction appears to decrease starting MY 2005 to 2010 since the subsequent rollover rate appears to decrease.

6.7 Summary for Statistical Inference of Subsequent Rollovers

Passenger vehicles with measured SSF values from 8 State crash data sets starting with MY 2004 to 2010 are used to evaluate the effect of SSF on subsequent rollovers in side-impact multi-vehicle crashes, and the target vehicles are separated by the vehicle group (i.e., passenger car group and the LTV group). With a statistically significant interaction between the SSF and the condition of roadway surfaces (i.e., wet roadway surfaces and dry roadway surfaces), the passenger cars are separated by the condition of roadway surfaces. Based on the statistical inference in Sections 6.5.1 and 6.6.1, the following table shows the average estimated effect of SSF and the average estimated percentage of rate reduction when the SSF increases by 0.01.

Table 50: Statistical Inference of SSF on Subsequent Rollovers MY 2004 to 2010

Passenger Car Group		
	Wet Roadway Surfaces	Dry Roadway Surfaces
Average Estimated Effect of SSF	0.14%	9.26%
Estimated 95% Confidence Interval of SSF Effect	-3.36% to 3.68%	5.95% to 12.36%
Average Estimated Percentage of Rate Reduction	1.39%	7.91%
LTV Group		
Average Estimated Effect of SSF	7.57%	
Estimated 95% Confidence Interval of SSF Effect	6.71% to 8.42%	
Average Estimated Percentage of Rate Reduction	7.47%	

The average estimated effect of SSF shows the average reduced-odds of subsequent rollovers while the average estimated percentage of rate reduction shows the percentage reduction of subsequent rollovers when the SSF increases by 0.01. The average estimated effect and the average estimated percentage of rate reduction are mathematically identical. The effect of SSF on subsequent rollovers by passenger cars is greater with dry roadway surfaces than with wet roadway surfaces, while the effect of SSF on subsequent rollovers by LTVs does not depend on the condition of roadway surfaces. The effect of SSF on subsequent rollovers by passenger cars with wet roadway surfaces was not found to be statistically significant at 0.05 level of significance, since its estimated 95 percent confidence interval includes 0. The average estimated effects of SSF on subsequent rollovers by passenger cars with dry roadway surfaces and by LTVs are not statistically different, since their estimated confidence intervals are overlapping. With a statistically significant interaction between the SSF and the driver's age in passenger cars as shown in Table 37, the range of the estimated confidence interval of the effect of SSF on subsequent rollovers is wider by passenger cars with dry roadway surfaces than by LTVs.

Based on Sections 6.5.2 and 6.6.2, the following table shows the average estimated effect of ESC installation rate and the average estimated percentage of rate reduction on subsequent rollovers when the ESC installation rate increases from 0 to 100 percent.

Table 51: Statistical Inference of ESC on Subsequent Rollovers MY 2004 to 2010

	Passenger Cars	LTVs
Average Estimated Effect of ESC	40.20%	23.70%
Average Estimated Percentage of Rate Reduction	40.78%	23.09%

The average estimated effect of ESC installation rate and the average percentage of rate reduction are greater in passenger cars than in LTVs. The ESC installation rate is more effective in reducing subsequent rollovers by passenger cars than by LTVs. The ESC installation rate has a greater effect on subsequent rollovers than the SSF as shown in Table 50 and Table 51.

7 Conclusion

The NCAP SSF measurement starting with MY 2004 to 2011 shows a minimum SSF of 0.92 and a maximum SSF of 1.59. Across all passenger cars and LTVs, the SSF typically ranges from 1.00 to 1.50. This evaluation report shows that the SSF has statistically significant effects on both first-event rollovers and subsequent rollovers (as defined for this evaluation report) by passenger vehicles except subsequent rollovers by passenger cars with wet roadway surfaces. The SSF should be considered when investigating rollover events.

When the SSF increases by 0.01 and other covariates are held constant, the average estimated effects of SSF on reducing first-event rollovers are 3.39 percent and 5.75 percent in passenger cars and LTVs, respectively. When the ESC installation rate increases from 0 to 100 percent and other covariates are held constant, the average estimated effects of ESC installation rate on reducing first-event rollovers that occurred in observed single-vehicle crashes are 58.97 percent and 68.96 percent in passenger cars and LTVs, respectively. Thus, the average estimated effect of ESC installation rate increasing from 0 to 100 percent is significantly greater than the average estimated effect of SSF increasing by 0.01. The average estimated effect of ESC installation rate increasing from 0 to 100 percent on reducing first-event rollovers by passenger cars is equivalent to the average estimated effect of SSF increasing by 0.26[36]. The average estimated effect of ESC installation rate increasing from 0 to 100 percent on reducing first-event rollovers by LTVs is equivalent to the average estimated effect of SSF increasing by 0.2[37]. Although the effect of ESC installation rate on first-event rollovers depends on the roadway conditions (i.e., wet, curve and up/down grade), the effect of SSF is not affected by the roadway conditions. Since the effect of SSF on first-event rollovers is not as affected by roadway conditions as the effect of ESC installation rate is, the effect of SSF on first-event rollovers is more predictable than the effect of ESC installation rate.

The effect of SSF on reducing subsequent rollovers by passenger cars depends on the condition of roadway surfaces, and the SSF was not found to have a statistically significant effect on subsequent rollovers by passenger cars with wet roadway surfaces. When the SSF increases by 0.01 and other covariates are held constant, the average values of the estimated effect of SSF on reducing subsequent rollovers are 9.26 percent and 7.57 percent in passenger cars with dry roadway surfaces and in LTVs, respectively. When the ESC installation rate increases from 0 to 100 percent and other covariates are held constant, the average values of the estimated effect of ESC installation rate on reducing subsequent rollovers are 40.20 percent and 23.70 percent in passenger cars and LTVs, respectively. Thus, the average estimated effect of ESC installation rate increasing from 0 to 100 percent is significantly greater than the average estimated effect of SSF increasing by 0.01. The average estimated effect of ESC installation rate increasing from 0 to 100 percent on reducing subsequent rollovers by passenger cars with dry roadway surfaces is equivalent to the average estimated effect of SSF increasing by 0.05[38]. The average estimated effect of ESC installation rate increasing from 0 to 100 percent on reducing subsequent rollovers by LTVs is equivalent to the average estimated effect of SSF increasing by 0.03[39]. Although the

---

[36] The average estimated effects of ESC installation rate and SSF are 58.97% and 3.39%, respectively, in passenger cars. The equation, $58.97\% = 1 - (1 - 3.39\%)^n$, yields a rounded value of *n* as 26. Since one unit increment of SSF is 0.01 in this evaluation report, the SSF needs to increase by 0.26 (26·0.01) to obtain the same effectiveness of ESC installation rate.

[37] The average estimated effects of ESC installation rate and SSF are 68.96% and 5.75%, respectively, in LTVs. The equation, $68.96\% = 1 - (1 - 5.75\%)^n$, yields a rounded value of *n* as 20. Since one unit increment of SSF is 0.01 in this evaluation report, the SSF needs to increase by 0.2 (20·0.01) to obtain the same effectiveness of ESC installation rate.

[38] The average estimated effects of ESC installation rate and SSF are 40.20% and 9.26%, respectively, in passenger cars. The equation, $40.20\% = 1 - (1 - 9.26\%)^n$, yields a rounded value of *n* as 5. Since one unit increment of SSF is 0.01 in this evaluation report, the SSF needs to increase by 0.5 (5·0.01) to obtain the same effectiveness of ESC installation rate.

[39] The average estimated effects of ESC installation rate and SSF are 23.70% and 7.57%, respectively, in LTVs. The equation, $23.70\% = 1 - (1 - 7.57\%)^n$, yields a rounded value of *n* as 3. Since one unit increment of SSF is 0.01 in this evaluation report, the SSF needs to increase by 0.03 (3·0.01) to obtain the same effectiveness of ESC installation rate.

SSF needs to be improved in both passenger cars with dry roadway surfaces and LTVs to achieve equivalent effects of ESC installation on reducing subsequent rollovers, the SSF is easier to achieve equivalent effects of ESC installation on reducing subsequent rollovers than on reducing first-event rollovers.

There is not a statistical difference between the effects of SSF on first-event rollovers by passenger cars and on subsequent rollovers by passenger cars with dry roadway surfaces, since their estimated confidence intervals of the effect of SSF are overlapping (0.94% to 6.33% on first-event rollovers, see Section 5.5.1 and 5.95% to 12.36% on subsequent rollovers, see Section 6.5.1). However, there is a statistical difference between the effects of SSF on first-event rollovers and on subsequent rollovers by LTVs, since their estimated confidence intervals of the effect of SSF are not overlapping (5.38% to 6.11% on first-event rollovers, see Section 5.8.1 and 6.71% to 8.42% on subsequent rollovers, see Section 6.6.1). The effect of SSF is statistically significant greater on subsequent rollovers than on first-event rollovers by LTVs. The effects of ESC installation rate appear to be greater on first-event rollovers than on subsequent rollovers by both passenger cars and LTVs, since the estimated effects on first-event rollovers (58.97% on passenger cars, see Section 5.5.2 and 68.96% on LTVs, see Section 5.8.2) are greater than on subsequent rollovers (40.20% on passenger cars, see Section 6.5.2 and 23.70% on LTVs, see Section 6.6.2).

Appendix A

A.1 SSF of Passenger Cars MY 2004 to 2013

Description	Body Style
2DR	2-Door Coupe, 3-Door Hatchback, 2-Door Convertible
4DR	4-Door Sedan, 5-Door Hatchback, Station Wagon

Employing the convention of the table in Section 2.1.3, the following table shows the make name, the model name, MY, the body style description, the SSF, and the NCAP dynamic rollover test result of the test passenger cars from MY 2004 to 2013.

Make	Model	MY	Body Style Description	SSF	TIP-UP
ACURA	ILX	2013	4DR	1.42	N
ACURA	RL	2004	4DR	1.43	N
ACURA	RL	2005	4DR	1.47	N
ACURA	RL	2006	4DR	1.47	N
ACURA	RL	2007	4DR	1.47	N
ACURA	RL	2008	4DR	1.47	N
ACURA	RL	2009	4DR	1.47	N
ACURA	RL	2010	4DR	1.47	N
ACURA	RL	2011	4DR	1.47	N
ACURA	RL	2012	4DR	1.47	N
ACURA	RSX	2004	2DR	1.39	N
ACURA	RSX	2005	2DR	1.39	N
ACURA	RSX	2006	2DR	1.39	N
ACURA	TL	2004	4DR	1.44	N
ACURA	TL	2005	4DR	1.44	N
ACURA	TL	2006	4DR	1.44	N
ACURA	TL	2007	4DR	1.44	N
ACURA	TL	2008	4DR	1.44	N
ACURA	TL	2009	4DR	1.49	N
ACURA	TL	2010	4DR	1.49	N
ACURA	TL	2011	4DR	1.49	N
ACURA	TL	2012	4DR	1.49	N
ACURA	TL	2013	4DR	1.49	N
ACURA	TSX	2004	4DR	1.37	N
ACURA	TSX	2005	4DR	1.37	N
ACURA	TSX	2006	4DR	1.37	N
ACURA	TSX	2007	4DR	1.37	N
ACURA	TSX	2008	4DR	1.37	N
ACURA	TSX	2009	4DR	1.46	N
ACURA	TSX	2010	4DR	1.46	N
ACURA	TSX	2011	4DR	1.46	N
ACURA	TSX	2012	4DR	1.46	N
ACURA	TSX	2013	4DR	1.46	N
AUDI	A4	2004	4DR	1.42	N
AUDI	A4	2005	4DR	1.42	N
AUDI	A4	2006	4DR	1.42	N
AUDI	A4	2007	4DR	1.42	N
AUDI	A4	2008	4DR	1.42	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
AUDI	A4	2009	4DR	1.46	N
AUDI	A4	2010	4DR	1.46	N
AUDI	A4	2011	4DR	1.46	N
AUDI	A4	2012	4DR	1.46	N
AUDI	A4	2013	4DR	1.46	N
AUDI	ALLROAD	2013	4DR	1.46	N
AUDI	RS4	2008	4DR	1.42	N
AUDI	S4	2004	4DR	1.42	N
AUDI	S4	2005	4DR	1.42	N
AUDI	S4	2006	4DR	1.42	N
AUDI	S4	2008	4DR	1.42	N
AUDI	S4	2010	4DR	1.46	N
AUDI	S4	2011	4DR	1.46	N
AUDI	S4	2012	4DR	1.46	N
AUDI	S4	2013	4DR	1.46	N
AUDI	TT	2004	2DR	1.51	N
AUDI	TT	2005	2DR	1.51	N
AUDI	TT	2006	2DR	1.51	N
BMW	3 SERIES	2004	4DR	1.41	N
BMW	3 SERIES	2005	4DR	1.41	N
BMW	3 SERIES	2006	4DR	1.44	N
BMW	3 SERIES	2007	4DR	1.44	N
BMW	3 SERIES	2008	4DR	1.44	N
BMW	3 SERIES	2009	4DR	1.44	N
BMW	3 SERIES	2010	2DR	1.49	N
BMW	3 SERIES	2010	4DR	1.44	N
BMW	3 SERIES	2011	2DR	1.49	N
BMW	3 SERIES	2011	4DR	1.44	N
BMW	3 SERIES	2012	2DR	1.49	N
BMW	3 SERIES	2012	4DR	1.48	N
BMW	3 SERIES	2013	2DR	1.49	N
BMW	3 SERIES	2013	4DR	1.48	N
BMW	5 SERIES	2008	4DR	1.43	N
BMW	5 SERIES	2009	4DR	1.43	N
BMW	5 SERIES	2010	4DR	1.43	N
BMW	5 SERIES	2011	4DR	1.49	N
BMW	5 SERIES	2012	4DR	1.49	N
BMW	5 SERIES	2013	4DR	1.49	N
BMW	Z4	2004	2DR	1.57	N
BMW	Z4	2005	2DR	1.57	N
BMW	Z4	2006	2DR	1.57	N
BMW	Z4	2007	2DR	1.57	N
BMW	Z4	2008	2DR	1.57	N
BUICK	CENTURY	2004	4DR	1.41	N
BUICK	CENTURY	2005	4DR	1.41	N
BUICK	LACROSSE	2005	4DR	1.39	N
BUICK	LACROSSE	2006	4DR	1.39	N
BUICK	LACROSSE	2007	4DR	1.39	N
BUICK	LACROSSE	2008	4DR	1.39	N
BUICK	LACROSSE	2009	4DR	1.39	N
BUICK	LACROSSE	2010	4DR	1.37	N
BUICK	LACROSSE	2011	4DR	1.37	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
BUICK	LACROSSE	2012	4DR	1.37	N
BUICK	LACROSSE	2013	4DR	1.37	N
BUICK	LESABRE	2004	4DR	1.45	N
BUICK	LESABRE	2005	4DR	1.45	N
BUICK	LUCERNE	2006	4DR	1.45	N
BUICK	LUCERNE	2007	4DR	1.45	N
BUICK	LUCERNE	2008	4DR	1.45	N
BUICK	LUCERNE	2009	4DR	1.45	N
BUICK	LUCERNE	2010	4DR	1.45	N
BUICK	LUCERNE	2011	4DR	1.45	N
BUICK	PARK AVENUE	2004	4DR	1.43	N
BUICK	PARK AVENUE	2005	4DR	1.43	N
BUICK	REGAL	2004	4DR	1.41	N
BUICK	REGAL	2012	4DR	1.41	N
BUICK	REGAL	2013	4DR	1.41	N
BUICK	VERANO	2013	4DR	1.39	N
CADILLAC	ATS	2013	4DR	1.45	N
CADILLAC	CTS	2004	4DR	1.40	N
CADILLAC	CTS	2005	4DR	1.40	N
CADILLAC	CTS	2006	4DR	1.40	N
CADILLAC	CTS	2007	4DR	1.40	N
CADILLAC	CTS	2008	4DR	1.44	N
CADILLAC	CTS	2009	4DR	1.44	N
CADILLAC	CTS	2010	4DR	1.44	N
CADILLAC	CTS	2011	4DR	1.44	N
CADILLAC	CTS	2012	4DR	1.44	N
CADILLAC	CTS	2013	4DR	1.44	N
CADILLAC	DEVILLE	2004	4DR	1.48	N
CADILLAC	DEVILLE	2005	4DR	1.48	N
CADILLAC	DTS	2006	4DR	1.40	N
CADILLAC	DTS	2007	4DR	1.40	N
CADILLAC	DTS	2008	4DR	1.40	N
CADILLAC	DTS	2009	4DR	1.40	N
CADILLAC	DTS	2010	4DR	1.40	N
CADILLAC	DTS	2011	4DR	1.40	N
CADILLAC	STS	2007	4DR	1.45	N
CADILLAC	STS	2008	4DR	1.45	N
CADILLAC	STS	2009	4DR	1.45	N
CADILLAC	STS	2010	4DR	1.45	N
CADILLAC	STS	2011	4DR	1.45	N
CADILLAC	XTS	2013	4DR	1.37	N
CHEVROLET	AVEO	2004	4DR	1.32	N
CHEVROLET	AVEO	2005	4DR	1.32	N
CHEVROLET	AVEO	2006	4DR	1.32	N
CHEVROLET	AVEO	2007	4DR	1.32	N
CHEVROLET	AVEO	2008	4DR	1.32	N
CHEVROLET	AVEO	2009	4DR	1.32	N
CHEVROLET	AVEO	2010	4DR	1.32	N
CHEVROLET	AVEO	2011	4DR	1.32	N
CHEVROLET	CAMARO	2010	2DR	1.53	N
CHEVROLET	CAMARO	2011	2DR	1.53	N
CHEVROLET	CAMARO	2012	2DR	1.53	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
CHEVROLET	CAMARO	2013	2DR	1.53	N
CHEVROLET	CAVALIER	2004	2DR	1.39	N
CHEVROLET	CAVALIER	2004	4DR	1.35	N
CHEVROLET	CAVALIER	2005	2DR	1.39	N
CHEVROLET	CAVALIER	2005	4DR	1.35	N
CHEVROLET	COBALT	2005	4DR	1.40	N
CHEVROLET	COBALT	2006	2DR	1.41	N
CHEVROLET	COBALT	2006	4DR	1.40	N
CHEVROLET	COBALT	2007	2DR	1.41	N
CHEVROLET	COBALT	2007	4DR	1.40	N
CHEVROLET	COBALT	2008	2DR	1.41	N
CHEVROLET	COBALT	2008	4DR	1.40	N
CHEVROLET	COBALT	2009	2DR	1.41	N
CHEVROLET	COBALT	2009	4DR	1.40	N
CHEVROLET	COBALT	2010	2DR	1.41	N
CHEVROLET	COBALT	2010	4DR	1.40	N
CHEVROLET	CRUZE	2011	4DR	1.41	N
CHEVROLET	CRUZE	2012	4DR	1.41	N
CHEVROLET	CRUZE	2013	4DR	1.41	N
CHEVROLET	IMPALA	2004	4DR	1.36	N
CHEVROLET	IMPALA	2005	4DR	1.36	N
CHEVROLET	IMPALA	2006	4DR	1.39	N
CHEVROLET	IMPALA	2007	4DR	1.39	N
CHEVROLET	IMPALA	2008	4DR	1.39	N
CHEVROLET	IMPALA	2009	4DR	1.39	N
CHEVROLET	IMPALA	2010	4DR	1.39	N
CHEVROLET	IMPALA	2011	4DR	1.39	N
CHEVROLET	IMPALA	2012	4DR	1.39	N
CHEVROLET	IMPALA	2013	4DR	1.39	N
CHEVROLET	MALIBU	2004	4DR	1.40	N
CHEVROLET	MALIBU	2005	4DR	1.40	N
CHEVROLET	MALIBU	2006	4DR	1.40	N
CHEVROLET	MALIBU	2007	4DR	1.40	N
CHEVROLET	MALIBU	2008	4DR	1.41	N
CHEVROLET	MALIBU	2009	4DR	1.41	N
CHEVROLET	MALIBU	2010	4DR	1.41	N
CHEVROLET	MALIBU	2011	4DR	1.41	N
CHEVROLET	MALIBU	2012	4DR	1.41	N
CHEVROLET	MALIBU	2013	4DR	1.40	N
CHEVROLET	MALIBU CLASSIC	2004	4DR	1.40	N
CHEVROLET	MALIBU CLASSIC	2005	4DR	1.40	N
CHEVROLET	MALIBU CLASSIC	2008	4DR	1.40	N
CHEVROLET	MONTE CARLO	2004	2DR	1.42	N
CHEVROLET	MONTE CARLO	2005	2DR	1.42	N
CHEVROLET	MONTE CARLO	2006	2DR	1.44	N
CHEVROLET	MONTE CARLO	2007	2DR	1.44	N
CHEVROLET	SONIC	2012	4DR	1.34	N
CHEVROLET	SONIC	2013	4DR	1.34	N
CHEVROLET	VOLT	2011	4DR	1.49	N
CHEVROLET	VOLT	2012	4DR	1.49	N
CHEVROLET	VOLT	2013	4DR	1.49	N
CHRYSLER	200	2012	4DR	1.40	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
CHRYSLER	200	2013	4DR	1.40	N
CHRYSLER	300	2004	4DR	1.43	N
CHRYSLER	300	2005	4DR	1.41	N
CHRYSLER	300	2006	4DR	1.41	N
CHRYSLER	300	2007	4DR	1.41	N
CHRYSLER	300	2008	4DR	1.41	N
CHRYSLER	300	2009	4DR	1.41	N
CHRYSLER	300	2010	4DR	1.41	N
CHRYSLER	300	2012	4DR	1.39	N
CHRYSLER	300	2013	4DR	1.39	N
CHRYSLER	CONCORDE	2004	4DR	1.45	N
CHRYSLER	CROSSFIRE	2005	2DR	1.48	N
CHRYSLER	CROSSFIRE	2006	2DR	1.48	N
CHRYSLER	CROSSFIRE	2007	2DR	1.48	N
CHRYSLER	CROSSFIRE	2008	2DR	1.48	N
CHRYSLER	SEBRING	2004	2DR	1.44	N
CHRYSLER	SEBRING	2004	4DR	1.49	N
CHRYSLER	SEBRING	2005	2DR	1.44	N
CHRYSLER	SEBRING	2005	4DR	1.49	N
CHRYSLER	SEBRING	2006	4DR	1.49	N
CHRYSLER	SEBRING	2007	4DR	1.39	N
CHRYSLER	SEBRING	2008	4DR	1.39	N
CHRYSLER	SEBRING	2009	4DR	1.39	N
CHRYSLER	SEBRING	2010	4DR	1.39	N
CHRYSLER	SEBRING CONVERTIBLE	2004	2DR	1.51	N
CHRYSLER	SEBRING CONVERTIBLE	2005	2DR	1.51	N
CHRYSLER	SEBRING CONVERTIBLE	2006	2DR	1.51	N
CHRYSLER	SEBRING CONVERTIBLE	2008	2DR	1.38	N
CHRYSLER	SEBRING CONVERTIBLE	2009	2DR	1.38	N
CHRYSLER	SEBRING CONVERTIBLE	2010	2DR	1.38	N
DODGE	AVENGER	2008	4DR	1.37	N
DODGE	AVENGER	2009	4DR	1.37	N
DODGE	AVENGER	2010	4DR	1.37	N
DODGE	AVENGER	2011	4DR	1.37	N
DODGE	AVENGER	2012	4DR	1.37	N
DODGE	AVENGER	2013	4DR	1.37	N
DODGE	CALIBER	2007	4DR	1.26	N
DODGE	CALIBER	2008	4DR	1.26	N
DODGE	CALIBER	2009	4DR	1.26	N
DODGE	CALIBER	2010	4DR	1.26	N
DODGE	CALIBER	2011	4DR	1.26	N
DODGE	CALIBER	2012	4DR	1.26	N
DODGE	CHALLENGER	2009	2DR	1.40	N
DODGE	CHALLENGER	2010	2DR	1.40	N
DODGE	CHALLENGER	2011	2DR	1.40	N
DODGE	CHALLENGER	2012	2DR	1.40	N
DODGE	CHALLENGER	2013	2DR	1.40	N
DODGE	CHARGER	2006	4DR	1.41	N
DODGE	CHARGER	2007	4DR	1.41	N
DODGE	CHARGER	2008	4DR	1.41	N
DODGE	CHARGER	2009	4DR	1.41	N
DODGE	CHARGER	2010	4DR	1.41	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
DODGE	CHARGER	2012	4DR	1.45	N
DODGE	CHARGER	2013	4DR	1.45	N
DODGE	DART	2013	4DR	1.42	N
DODGE	INTREPID	2004	4DR	1.45	N
DODGE	NEON	2004	4DR	1.41	N
DODGE	NEON	2005	4DR	1.41	N
DODGE	STRATUS	2004	2DR	1.44	N
DODGE	STRATUS	2004	4DR	1.49	N
DODGE	STRATUS	2005	2DR	1.44	N
DODGE	STRATUS	2005	4DR	1.49	N
DODGE	STRATUS	2006	4DR	1.49	N
FIAT	500	2012	2DR	1.28	N
FIAT	500	2013	2DR	1.28	N
FORD	500	2005	4DR	1.43	N
FORD	500	2006	4DR	1.43	N
FORD	500	2007	4DR	1.43	N
FORD	C-MAX	2013	4DR	1.28	N
FORD	CROWN VICTORIA	2004	4DR	1.51	N
FORD	CROWN VICTORIA	2005	4DR	1.51	N
FORD	CROWN VICTORIA	2006	4DR	1.51	N
FORD	CROWN VICTORIA	2007	4DR	1.51	N
FORD	CROWN VICTORIA	2008	4DR	1.51	N
FORD	CROWN VICTORIA	2009	4DR	1.51	N
FORD	CROWN VICTORIA	2010	4DR	1.51	N
FORD	CROWN VICTORIA	2011	4DR	1.51	N
FORD	FIESTA	2011	4DR	1.29	N
FORD	FIESTA	2012	4DR	1.29	N
FORD	FIESTA	2013	4DR	1.29	N
FORD	FOCUS	2004	4DR	1.33	N
FORD	FOCUS	2005	4DR	1.33	N
FORD	FOCUS	2006	4DR	1.33	N
FORD	FOCUS	2007	4DR	1.33	N
FORD	FOCUS	2008	4DR	1.33	N
FORD	FOCUS	2009	4DR	1.33	N
FORD	FOCUS	2010	4DR	1.33	N
FORD	FOCUS	2011	2DR	1.30	N
FORD	FOCUS	2011	4DR	1.33	N
FORD	FOCUS	2012	4DR	1.38	N
FORD	FOCUS	2013	4DR	1.38	N
FORD	FOCUS ELECTRIC DRIVE	2013	4DR	1.45	N
FORD	FOCUS HATCHBACK	2004	2DR	1.30	N
FORD	FOCUS HATCHBACK	2005	2DR	1.30	N
FORD	FOCUS HATCHBACK	2006	2DR	1.30	N
FORD	FOCUS HATCHBACK	2007	2DR	1.30	N
FORD	FOCUS HATCHBACK	2008	2DR	1.30	N
FORD	FOCUS HATCHBACK	2009	2DR	1.30	N
FORD	FOCUS HATCHBACK	2010	2DR	1.30	N
FORD	FOCUS WAGON	2004	4DR	1.30	N
FORD	FOCUS WAGON	2012	4DR	1.38	N
FORD	FOCUS WAGON	2013	4DR	1.38	N
FORD	FUSION	2006	4DR	1.43	N
FORD	FUSION	2007	4DR	1.43	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
FORD	FUSION	2008	4DR	1.43	N
FORD	FUSION	2009	4DR	1.43	N
FORD	FUSION	2010	4DR	1.43	N
FORD	FUSION	2011	4DR	1.43	N
FORD	FUSION	2012	4DR	1.43	N
FORD	FUSION	2013	4DR	1.41	N
FORD	MUSTANG	2004	2DR	1.45	N
FORD	MUSTANG	2005	2DR	1.53	N
FORD	MUSTANG	2006	2DR	1.53	N
FORD	MUSTANG	2007	2DR	1.53	N
FORD	MUSTANG	2008	2DR	1.53	N
FORD	MUSTANG	2009	2DR	1.53	N
FORD	MUSTANG	2010	2DR	1.53	N
FORD	MUSTANG	2011	2DR	1.53	N
FORD	MUSTANG	2012	2DR	1.53	N
FORD	MUSTANG	2013	2DR	1.53	N
FORD	TAURUS	2004	4DR	1.43	N
FORD	TAURUS	2005	4DR	1.43	N
FORD	TAURUS	2006	4DR	1.43	N
FORD	TAURUS	2007	4DR	1.43	N
FORD	TAURUS	2008	4DR	1.43	N
FORD	TAURUS	2009	4DR	1.43	N
FORD	TAURUS	2010	4DR	1.39	N
FORD	TAURUS	2011	4DR	1.39	N
FORD	TAURUS	2012	4DR	1.39	N
FORD	TAURUS	2013	4DR	1.39	N
FORD	TAURUS WAGON	2004	4DR	1.38	N
FORD	THUNDERBIRD	2004	2DR	1.51	N
FORD	THUNDERBIRD	2005	2DR	1.51	N
HONDA	ACCORD	2004	2DR	1.44	N
HONDA	ACCORD	2004	4DR	1.42	N
HONDA	ACCORD	2005	2DR	1.44	N
HONDA	ACCORD	2005	4DR	1.42	N
HONDA	ACCORD	2006	2DR	1.44	N
HONDA	ACCORD	2006	4DR	1.42	N
HONDA	ACCORD	2007	2DR	1.44	N
HONDA	ACCORD	2007	4DR	1.42	N
HONDA	ACCORD	2008	2DR	1.47	N
HONDA	ACCORD	2008	4DR	1.48	N
HONDA	ACCORD	2009	2DR	1.47	N
HONDA	ACCORD	2009	4DR	1.48	N
HONDA	ACCORD	2010	2DR	1.47	N
HONDA	ACCORD	2010	4DR	1.48	N
HONDA	ACCORD	2011	2DR	1.47	N
HONDA	ACCORD	2011	4DR	1.48	N
HONDA	ACCORD	2012	2DR	1.47	N
HONDA	ACCORD	2012	4DR	1.48	N
HONDA	ACCORD	2013	2DR	1.46	N
HONDA	ACCORD	2013	4DR	1.46	N
HONDA	CIVIC	2004	2DR	1.38	N
HONDA	CIVIC	2004	4DR	1.40	N
HONDA	CIVIC	2005	2DR	1.38	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
HONDA	CIVIC	2005	4DR	1.40	N
HONDA	CIVIC	2006	2DR	1.44	N
HONDA	CIVIC	2006	4DR	1.43	N
HONDA	CIVIC	2007	2DR	1.44	N
HONDA	CIVIC	2007	4DR	1.43	N
HONDA	CIVIC	2008	2DR	1.44	N
HONDA	CIVIC	2008	4DR	1.43	N
HONDA	CIVIC	2009	2DR	1.44	N
HONDA	CIVIC	2009	4DR	1.43	N
HONDA	CIVIC	2010	2DR	1.44	N
HONDA	CIVIC	2010	4DR	1.43	N
HONDA	CIVIC	2011	2DR	1.44	N
HONDA	CIVIC	2011	4DR	1.43	N
HONDA	CIVIC	2012	2DR	1.37	N
HONDA	CIVIC	2012	4DR	1.41	N
HONDA	CIVIC	2013	2DR	1.37	N
HONDA	CIVIC	2013	4DR	1.43	N
HONDA	CIVIC HATCHBACK	2004	2DR	1.35	N
HONDA	CIVIC HATCHBACK	2005	2DR	1.35	N
HONDA	CR-Z	2011	2DR	1.48	N
HONDA	CR-Z	2012	2DR	1.48	N
HONDA	CR-Z	2013	2DR	1.48	N
HONDA	FIT	2007	4DR	1.32	N
HONDA	FIT	2008	4DR	1.32	N
HONDA	FIT	2009	4DR	1.35	N
HONDA	FIT	2010	4DR	1.35	N
HONDA	FIT	2011	4DR	1.35	N
HONDA	FIT	2012	4DR	1.35	N
HONDA	FIT	2013	4DR	1.35	N
HONDA	INSIGHT	2004	2DR	1.38	N
HONDA	INSIGHT	2005	2DR	1.38	N
HONDA	INSIGHT	2006	2DR	1.38	N
HONDA	INSIGHT	2010	4DR	1.39	N
HONDA	INSIGHT	2011	4DR	1.39	N
HONDA	INSIGHT	2012	4DR	1.39	N
HONDA	INSIGHT	2013	4DR	1.39	N
HONDA	S2000	2004	2DR	1.57	N
HONDA	S2000	2005	2DR	1.57	N
HONDA	S2000	2006	2DR	1.57	N
HONDA	S2000	2007	2DR	1.57	N
HONDA	S2000	2008	2DR	1.57	N
HONDA	S2000	2009	2DR	1.57	N
HYUNDAI	ACCENT	2004	4DR	1.42	N
HYUNDAI	ACCENT	2005	2DR	1.41	N
HYUNDAI	ACCENT	2005	4DR	1.42	N
HYUNDAI	ACCENT	2006	4DR	1.35	N
HYUNDAI	ACCENT	2007	4DR	1.35	N
HYUNDAI	ACCENT	2008	4DR	1.35	N
HYUNDAI	ACCENT	2009	4DR	1.35	N
HYUNDAI	ACCENT	2010	2DR	1.34	N
HYUNDAI	ACCENT	2010	4DR	1.35	N
HYUNDAI	ACCENT	2011	2DR	1.34	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
HYUNDAI	ACCENT	2011	4DR	1.35	N
HYUNDAI	ACCENT	2012	4DR	1.35	N
HYUNDAI	ACCENT	2013	4DR	1.35	N
HYUNDAI	AZERA	2006	4DR	1.42	N
HYUNDAI	AZERA	2007	4DR	1.42	N
HYUNDAI	AZERA	2008	4DR	1.42	N
HYUNDAI	AZERA	2009	4DR	1.42	N
HYUNDAI	AZERA	2010	4DR	1.42	N
HYUNDAI	AZERA	2011	4DR	1.42	N
HYUNDAI	ELANTRA	2004	4DR	1.40	N
HYUNDAI	ELANTRA	2005	4DR	1.40	N
HYUNDAI	ELANTRA	2006	4DR	1.40	N
HYUNDAI	ELANTRA	2007	4DR	1.42	N
HYUNDAI	ELANTRA	2008	4DR	1.42	N
HYUNDAI	ELANTRA	2009	4DR	1.42	N
HYUNDAI	ELANTRA	2010	4DR	1.42	N
HYUNDAI	ELANTRA	2011	4DR	1.42	N
HYUNDAI	ELANTRA	2012	4DR	1.41	N
HYUNDAI	ELANTRA	2013	4DR	1.41	N
HYUNDAI	GENESIS	2009	4DR	1.48	N
HYUNDAI	GENESIS	2010	2DR	1.57	N
HYUNDAI	GENESIS	2010	4DR	1.48	N
HYUNDAI	GENESIS	2011	2DR	1.57	N
HYUNDAI	GENESIS	2011	4DR	1.48	N
HYUNDAI	GENESIS	2012	2DR	1.57	N
HYUNDAI	GENESIS	2012	4DR	1.48	N
HYUNDAI	GENESIS	2013	2DR	1.57	N
HYUNDAI	GENESIS	2013	4DR	1.48	N
HYUNDAI	SONATA	2004	4DR	1.45	N
HYUNDAI	SONATA	2005	4DR	1.45	N
HYUNDAI	SONATA	2006	4DR	1.44	N
HYUNDAI	SONATA	2007	4DR	1.44	N
HYUNDAI	SONATA	2008	4DR	1.44	N
HYUNDAI	SONATA	2009	4DR	1.44	N
HYUNDAI	SONATA	2010	4DR	1.44	N
HYUNDAI	SONATA	2011	4DR	1.47	N
HYUNDAI	SONATA	2012	4DR	1.47	N
HYUNDAI	SONATA	2013	4DR	1.47	N
HYUNDAI	TIBURON	2004	2DR	1.41	N
HYUNDAI	TIBURON	2005	2DR	1.41	N
HYUNDAI	TIBURON	2006	2DR	1.41	N
HYUNDAI	TIBURON	2007	2DR	1.41	N
HYUNDAI	TIBURON	2008	2DR	1.41	N
HYUNDAI	XG 350	2004	4DR	1.40	N
HYUNDAI	XG 350	2005	4DR	1.40	N
INFINITI	EX35	2008	4DR	1.33	N
INFINITI	EX35	2009	4DR	1.33	N
INFINITI	EX35	2010	4DR	1.33	N
INFINITI	EX35	2011	4DR	1.33	N
INFINITI	EX35	2012	4DR	1.33	N
INFINITI	EX35	2013	4DR	1.33	N
INFINITI	G25	2012	4DR	1.45	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
INFINITI	G35	2008	4DR	1.45	N
INFINITI	G37	2009	4DR	1.45	N
INFINITI	G37	2010	4DR	1.45	N
INFINITI	G37	2011	4DR	1.45	N
INFINITI	G37	2012	4DR	1.45	N
INFINITI	G37	2013	4DR	1.45	N
INFINITI	I35	2004	4DR	1.38	N
INFINITI	M35	2011	4DR	1.39	N
INFINITI	M35	2012	4DR	1.39	N
INFINITI	M35	2013	4DR	1.39	N
JAGUAR	S-TYPE	2004	4DR	1.51	N
JAGUAR	S-TYPE	2005	4DR	1.51	N
JAGUAR	S-TYPE	2006	4DR	1.51	N
JAGUAR	S-TYPE	2007	4DR	1.51	N
JAGUAR	S-TYPE	2008	4DR	1.51	N
JAGUAR	X-TYPE	2004	4DR	1.43	N
JAGUAR	X-TYPE	2005	4DR	1.43	N
JAGUAR	X-TYPE	2006	4DR	1.43	N
JAGUAR	X-TYPE	2007	4DR	1.43	N
JAGUAR	X-TYPE	2008	4DR	1.43	N
KIA	AMANTI	2004	4DR	1.40	N
KIA	AMANTI	2005	4DR	1.40	N
KIA	AMANTI	2006	4DR	1.40	N
KIA	FORTE	2010	4DR	1.44	N
KIA	FORTE	2011	4DR	1.44	N
KIA	FORTE	2012	4DR	1.44	N
KIA	FORTE	2013	4DR	1.44	N
KIA	OPTIMA	2004	4DR	1.45	N
KIA	OPTIMA	2005	4DR	1.45	N
KIA	OPTIMA	2006	4DR	1.45	N
KIA	OPTIMA	2007	4DR	1.40	N
KIA	OPTIMA	2008	4DR	1.40	N
KIA	OPTIMA	2009	4DR	1.40	N
KIA	OPTIMA	2010	4DR	1.40	N
KIA	OPTIMA	2011	4DR	1.48	N
KIA	OPTIMA	2012	4DR	1.48	N
KIA	OPTIMA	2013	4DR	1.48	N
KIA	RIO	2004	4DR	1.36	N
KIA	RIO	2005	4DR	1.36	N
KIA	RIO	2006	4DR	1.37	N
KIA	RIO	2007	4DR	1.37	N
KIA	RIO	2008	4DR	1.37	N
KIA	RIO	2009	4DR	1.37	N
KIA	RIO	2010	4DR	1.37	N
KIA	RIO	2011	4DR	1.37	N
KIA	RIO	2012	4DR	1.38	N
KIA	RIO	2013	4DR	1.38	N
KIA	RONDO	2007	4DR	1.32	N
KIA	RONDO	2008	4DR	1.32	N
KIA	RONDO	2009	4DR	1.32	N
KIA	RONDO	2010	4DR	1.32	N
KIA	RONDO	2011	4DR	1.32	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
KIA	SPECTRA	2005	4DR	1.32	N
KIA	SPECTRA	2006	4DR	1.32	N
KIA	SPECTRA	2007	4DR	1.32	N
KIA	SPECTRA	2008	4DR	1.32	N
KIA	SPECTRA	2009	4DR	1.32	N
LEXUS	ES300H	2013	4DR	1.40	N
LEXUS	ES330	2004	4DR	1.37	N
LEXUS	ES330	2005	4DR	1.37	N
LEXUS	ES330	2006	4DR	1.37	N
LEXUS	ES350	2007	4DR	1.41	N
LEXUS	ES350	2008	4DR	1.41	N
LEXUS	ES350	2009	4DR	1.41	N
LEXUS	ES350	2010	4DR	1.41	N
LEXUS	ES350	2011	4DR	1.41	N
LEXUS	ES350	2012	4DR	1.41	N
LEXUS	ES350	2013	4DR	1.40	N
LEXUS	HS250H	2010	4DR	1.33	N
LEXUS	HS250H	2011	4DR	1.33	N
LEXUS	IS250	2008	4DR	1.45	N
LEXUS	IS250	2009	4DR	1.45	N
LEXUS	IS250	2010	4DR	1.45	N
LEXUS	IS250	2011	4DR	1.45	N
LEXUS	IS250	2012	4DR	1.45	N
LEXUS	IS250	2013	4DR	1.45	N
LEXUS	IS300	2004	4DR	1.47	N
LEXUS	IS300	2005	4DR	1.47	N
LINCOLN	LS	2004	4DR	1.51	N
LINCOLN	LS	2005	4DR	1.51	N
LINCOLN	LS	2006	4DR	1.51	N
LINCOLN	MKS	2009	4DR	1.37	N
LINCOLN	MKS	2010	4DR	1.37	N
LINCOLN	MKS	2011	4DR	1.37	N
LINCOLN	MKS	2012	4DR	1.37	N
LINCOLN	MKS	2013	4DR	1.39	N
LINCOLN	MKZ	2007	4DR	1.43	N
LINCOLN	MKZ	2008	4DR	1.43	N
LINCOLN	MKZ	2009	4DR	1.43	N
LINCOLN	MKZ	2010	4DR	1.43	N
LINCOLN	MKZ	2011	4DR	1.43	N
LINCOLN	MKZ	2012	4DR	1.43	N
LINCOLN	MKZ	2013	4DR	1.41	N
LINCOLN	TOWN CAR	2004	4DR	1.48	N
LINCOLN	TOWN CAR	2005	4DR	1.48	N
LINCOLN	TOWN CAR	2006	4DR	1.48	N
LINCOLN	TOWN CAR	2007	4DR	1.48	N
LINCOLN	TOWN CAR	2008	4DR	1.48	N
LINCOLN	TOWN CAR	2009	4DR	1.48	N
LINCOLN	TOWN CAR	2010	4DR	1.48	N
LINCOLN	TOWN CAR	2011	4DR	1.48	N
LINCOLN	ZEPHYR	2006	4DR	1.43	N
MAZDA	MAZDA3	2004	4DR	1.43	N
MAZDA	MAZDA3	2005	4DR	1.43	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
MAZDA	MAZDA3	2006	4DR	1.43	N
MAZDA	MAZDA3	2007	4DR	1.43	N
MAZDA	MAZDA3	2008	4DR	1.43	N
MAZDA	MAZDA3	2009	4DR	1.43	N
MAZDA	MAZDA3	2010	4DR	1.41	N
MAZDA	MAZDA3	2011	4DR	1.41	N
MAZDA	MAZDA3	2012	4DR	1.41	N
MAZDA	MAZDA3	2013	4DR	1.41	N
MAZDA	MAZDA5	2008	4DR	1.30	N
MAZDA	MAZDA5	2009	4DR	1.30	N
MAZDA	MAZDA5	2010	4DR	1.30	N
MAZDA	MAZDA6	2004	4DR	1.46	N
MAZDA	MAZDA6	2005	4DR	1.46	N
MAZDA	MAZDA6	2006	4DR	1.46	N
MAZDA	MAZDA6	2007	4DR	1.46	N
MAZDA	MAZDA6	2008	4DR	1.46	N
MAZDA	MAZDA6	2009	4DR	1.49	N
MAZDA	MAZDA6	2010	4DR	1.49	N
MAZDA	MAZDA6	2011	4DR	1.49	N
MAZDA	MAZDA6	2012	4DR	1.49	N
MAZDA	MAZDA6	2013	4DR	1.49	N
MAZDA	MAZDA6 WAGON	2005	4DR	1.41	N
MAZDA	MAZDA6 WAGON	2006	4DR	1.41	N
MAZDA	MAZDA6 WAGON	2007	4DR	1.41	N
MAZDA	MX-5	2004	2DR	1.59	N
MAZDA	MX-5	2005	2DR	1.59	N
MAZDA	RX8	2004	4DR	1.59	N
MAZDA	RX8	2005	4DR	1.59	N
MAZDA	RX8	2006	4DR	1.59	N
MAZDA	RX8	2007	4DR	1.59	N
MAZDA	RX8	2008	4DR	1.59	N
MAZDA	RX8	2009	4DR	1.59	N
MAZDA	RX8	2010	4DR	1.59	N
MAZDA	RX8	2011	4DR	1.59	N
MERCEDES-BENZ	C	2004	4DR	1.35	N
MERCEDES-BENZ	C	2005	4DR	1.35	N
MERCEDES-BENZ	C	2006	4DR	1.35	N
MERCEDES-BENZ	C	2007	4DR	1.35	N
MERCEDES-BENZ	C	2008	4DR	1.43	N
MERCEDES-BENZ	C	2009	4DR	1.43	N
MERCEDES-BENZ	C	2010	4DR	1.43	N
MERCEDES-BENZ	C	2011	4DR	1.43	N
MERCEDES-BENZ	C	2012	4DR	1.43	N
MERCEDES-BENZ	C	2013	4DR	1.43	N
MERCEDES-BENZ	E	2004	4DR	1.45	N
MERCEDES-BENZ	E	2005	4DR	1.45	N
MERCEDES-BENZ	E	2006	4DR	1.45	N
MERCEDES-BENZ	E	2007	4DR	1.45	N
MERCEDES-BENZ	E	2008	4DR	1.45	N
MERCEDES-BENZ	E	2009	4DR	1.45	N
MERCEDES-BENZ	E	2010	4DR	1.46	N
MERCEDES-BENZ	E	2011	4DR	1.46	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
MERCEDES-BENZ	E	2012	4DR	1.46	N
MERCEDES-BENZ	E	2013	4DR	1.46	N
MERCURY	GRAND MARQUIS	2004	4DR	1.51	N
MERCURY	GRAND MARQUIS	2005	4DR	1.51	N
MERCURY	GRAND MARQUIS	2006	4DR	1.51	N
MERCURY	GRAND MARQUIS	2007	4DR	1.51	N
MERCURY	GRAND MARQUIS	2008	4DR	1.51	N
MERCURY	GRAND MARQUIS	2009	4DR	1.51	N
MERCURY	GRAND MARQUIS	2010	4DR	1.51	N
MERCURY	GRAND MARQUIS	2011	4DR	1.51	N
MERCURY	MARAUDER	2004	4DR	1.51	N
MERCURY	MILAN	2006	4DR	1.43	N
MERCURY	MILAN	2007	4DR	1.43	N
MERCURY	MILAN	2008	4DR	1.43	N
MERCURY	MILAN	2009	4DR	1.43	N
MERCURY	MILAN	2010	4DR	1.43	N
MERCURY	MILAN	2011	4DR	1.43	N
MERCURY	MONTEGO	2005	4DR	1.43	N
MERCURY	MONTEGO	2006	4DR	1.43	N
MERCURY	MONTEGO	2007	4DR	1.43	N
MERCURY	SABLE	2004	4DR	1.43	N
MERCURY	SABLE	2005	4DR	1.43	N
MERCURY	SABLE	2008	4DR	1.43	N
MERCURY	SABLE	2009	4DR	1.43	N
MERCURY	SABLE WAGON	2004	4DR	1.38	N
MINI	COOPER	2004	2DR	1.44	N
MINI	COOPER	2005	2DR	1.44	N
MINI	COOPER	2006	2DR	1.44	N
MINI	COOPER	2008	2DR	1.45	N
MINI	COOPER	2009	2DR	1.45	N
MINI	COOPER	2010	2DR	1.45	N
MINI	COOPER	2011	2DR	1.45	N
MINI	COOPER	2012	2DR	1.45	N
MINI	COOPER	2013	2DR	1.45	N
MITSUBISHI	GALANT	2005	4DR	1.42	N
MITSUBISHI	GALANT	2006	4DR	1.42	N
MITSUBISHI	GALANT	2007	4DR	1.42	N
MITSUBISHI	GALANT	2008	4DR	1.42	N
MITSUBISHI	GALANT	2009	4DR	1.42	N
MITSUBISHI	GALANT	2010	4DR	1.42	N
MITSUBISHI	GALANT	2011	4DR	1.42	N
MITSUBISHI	GALANT	2012	4DR	1.42	N
MITSUBISHI	LANCER	2004	4DR	1.42	N
MITSUBISHI	LANCER	2005	4DR	1.42	N
MITSUBISHI	LANCER	2006	4DR	1.42	N
MITSUBISHI	LANCER	2007	4DR	1.42	N
MITSUBISHI	LANCER	2008	4DR	1.36	N
MITSUBISHI	LANCER	2009	4DR	1.36	N
MITSUBISHI	LANCER	2010	4DR	1.36	N
MITSUBISHI	LANCER	2011	4DR	1.36	N
MITSUBISHI	LANCER	2012	4DR	1.36	N
MITSUBISHI	LANCER	2013	4DR	1.36	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
MITSUBISHI	i-MiEV	2012	4DR	1.28	N
MITSUBISHI	i-MiEV	2013	4DR	1.28	N
NISSAN	350Z	2004	2DR	1.57	N
NISSAN	350Z	2005	2DR	1.57	N
NISSAN	350Z	2006	2DR	1.57	N
NISSAN	350Z	2007	2DR	1.57	N
NISSAN	350Z	2008	2DR	1.57	N
NISSAN	350Z	2009	2DR	1.57	N
NISSAN	ALTIMA	2004	4DR	1.44	N
NISSAN	ALTIMA	2005	4DR	1.44	N
NISSAN	ALTIMA	2006	4DR	1.44	N
NISSAN	ALTIMA	2007	4DR	1.43	N
NISSAN	ALTIMA	2008	2DR	1.49	N
NISSAN	ALTIMA	2008	4DR	1.43	N
NISSAN	ALTIMA	2009	2DR	1.49	N
NISSAN	ALTIMA	2009	4DR	1.43	N
NISSAN	ALTIMA	2010	2DR	1.49	N
NISSAN	ALTIMA	2010	4DR	1.43	N
NISSAN	ALTIMA	2011	2DR	1.49	N
NISSAN	ALTIMA	2011	4DR	1.43	N
NISSAN	ALTIMA	2012	2DR	1.49	N
NISSAN	ALTIMA	2012	4DR	1.43	N
NISSAN	ALTIMA	2013	2DR	1.49	N
NISSAN	ALTIMA	2013	4DR	1.44	N
NISSAN	ALTIMA HYBRID	2008	4DR	1.42	N
NISSAN	ALTIMA HYBRID	2009	4DR	1.42	N
NISSAN	ALTIMA HYBRID	2010	4DR	1.42	N
NISSAN	ALTIMA HYBRID	2011	4DR	1.43	N
NISSAN	LEAF	2011	4DR	1.41	N
NISSAN	LEAF	2012	4DR	1.41	N
NISSAN	LEAF	2013	4DR	1.41	N
NISSAN	MAXIMA	2004	4DR	1.42	N
NISSAN	MAXIMA	2005	4DR	1.42	N
NISSAN	MAXIMA	2006	4DR	1.42	N
NISSAN	MAXIMA	2007	4DR	1.42	N
NISSAN	MAXIMA	2008	4DR	1.42	N
NISSAN	MAXIMA	2009	4DR	1.45	N
NISSAN	MAXIMA	2010	4DR	1.45	N
NISSAN	MAXIMA	2011	4DR	1.45	N
NISSAN	MAXIMA	2012	4DR	1.45	N
NISSAN	MAXIMA	2013	4DR	1.45	N
NISSAN	SENTRA	2004	4DR	1.38	N
NISSAN	SENTRA	2005	4DR	1.38	N
NISSAN	SENTRA	2006	4DR	1.38	N
NISSAN	SENTRA	2007	4DR	1.38	N
NISSAN	SENTRA	2008	4DR	1.38	N
NISSAN	SENTRA	2009	4DR	1.38	N
NISSAN	SENTRA	2010	4DR	1.38	N
NISSAN	SENTRA	2011	4DR	1.38	N
NISSAN	SENTRA	2012	4DR	1.38	N
NISSAN	SENTRA	2013	4DR	1.36	N
NISSAN	VERSA	2007	4DR	1.30	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
NISSAN	VERSA	2008	4DR	1.30	N
NISSAN	VERSA	2009	4DR	1.30	N
NISSAN	VERSA	2010	4DR	1.30	N
NISSAN	VERSA	2011	4DR	1.30	N
NISSAN	VERSA	2012	4DR	1.28	N
NISSAN	VERSA	2013	4DR	1.28	N
NISSAN	VERSA HATCHBACK	2008	4DR	1.30	N
NISSAN	VERSA HATCHBACK	2009	4DR	1.30	N
NISSAN	VERSA HATCHBACK	2010	4DR	1.30	N
NISSAN	VERSA HATCHBACK	2011	4DR	1.30	N
NISSAN	VERSA HATCHBACK	2012	4DR	1.30	N
OLDSMOBILE	ALERO	2004	2DR	1.41	N
OLDSMOBILE	ALERO	2004	4DR	1.41	N
PONTIAC	BONNEVILLE	2004	4DR	1.45	N
PONTIAC	BONNEVILLE	2005	4DR	1.45	N
PONTIAC	G3	2009	4DR	1.32	N
PONTIAC	G5	2007	2DR	1.41	N
PONTIAC	G5	2008	2DR	1.41	N
PONTIAC	G5	2009	2DR	1.41	N
PONTIAC	G6	2005	4DR	1.43	N
PONTIAC	G6	2006	2DR	1.46	N
PONTIAC	G6	2006	4DR	1.43	N
PONTIAC	G6	2007	2DR	1.46	N
PONTIAC	G6	2007	4DR	1.43	N
PONTIAC	G6	2008	2DR	1.46	N
PONTIAC	G6	2008	4DR	1.43	N
PONTIAC	G6	2009	2DR	1.46	N
PONTIAC	G6	2009	4DR	1.43	N
PONTIAC	G6	2010	4DR	1.43	N
PONTIAC	GRAND AM	2004	2DR	1.41	N
PONTIAC	GRAND AM	2004	4DR	1.41	N
PONTIAC	GRAND AM	2005	2DR	1.41	N
PONTIAC	GRAND AM	2005	4DR	1.41	N
PONTIAC	GRAND PRIX	2004	4DR	1.41	N
PONTIAC	GRAND PRIX	2005	4DR	1.41	N
PONTIAC	GRAND PRIX	2006	4DR	1.41	N
PONTIAC	GRAND PRIX	2007	4DR	1.41	N
PONTIAC	GRAND PRIX	2008	4DR	1.41	N
PONTIAC	SOLSTICE	2007	2DR	1.65	N
PONTIAC	SOLSTICE	2008	2DR	1.65	N
PONTIAC	SOLSTICE	2009	2DR	1.65	N
PONTIAC	SUNFIRE	2004	2DR	1.40	N
PONTIAC	SUNFIRE	2005	2DR	1.40	N
PONTIAC	VIBE	2004	4DR	1.27	N
PONTIAC	VIBE	2005	4DR	1.27	N
PONTIAC	VIBE	2006	4DR	1.27	N
PONTIAC	VIBE	2007	4DR	1.27	N
PONTIAC	VIBE	2008	4DR	1.27	N
PONTIAC	VIBE	2009	4DR	1.31	N
PONTIAC	VIBE	2010	4DR	1.31	N
SAAB	9-2X	2005	4DR	1.37	N
SAAB	9-2X	2006	4DR	1.37	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
SAAB	9-3	2007	4DR	1.36	N
SAAB	9-3	2008	4DR	1.36	N
SAAB	9-3	2009	4DR	1.36	N
SAAB	9-3	2010	4DR	1.36	N
SAAB	9-3	2011	4DR	1.36	N
SAAB	9-3	2012	4DR	1.36	N
SAAB	9-3 WAGON	2007	4DR	1.34	N
SAAB	9-3 WAGON	2008	4DR	1.34	N
SAAB	9-3 WAGON	2009	4DR	1.34	N
SAAB	9-3 WAGON	2010	4DR	1.34	N
SAAB	9-3 WAGON	2011	4DR	1.34	N
SAAB	9-3 WAGON	2012	4DR	1.36	N
SAAB	9-5	2004	4DR	1.37	N
SAAB	9-5	2005	4DR	1.37	N
SAAB	9-5	2006	4DR	1.37	N
SAAB	9-5	2007	4DR	1.37	N
SAAB	9-5	2008	4DR	1.37	N
SAAB	9-5	2009	4DR	1.37	N
SAAB	9-5 WAGON	2007	4DR	1.33	N
SAAB	9-5 WAGON	2008	4DR	1.33	N
SAAB	9-5 WAGON	2009	4DR	1.33	N
SATURN	AURA	2007	4DR	1.38	N
SATURN	AURA	2008	4DR	1.38	N
SATURN	AURA	2009	4DR	1.38	N
SATURN	AURA	2010	4DR	1.38	N
SATURN	ION	2004	4DR	1.38	N
SATURN	ION	2005	2DR	1.38	N
SATURN	ION	2005	4DR	1.38	N
SATURN	ION	2006	2DR	1.38	N
SATURN	ION	2006	4DR	1.38	N
SATURN	ION	2007	2DR	1.38	N
SATURN	ION	2007	4DR	1.38	N
SATURN	L	2004	4DR	1.42	N
SATURN	L	2005	4DR	1.42	N
SATURN	SKY	2007	2DR	1.65	N
SATURN	SKY	2008	2DR	1.65	N
SATURN	SKY	2009	2DR	1.65	N
SMART	FORTWO	2008	2DR	1.16	N
SMART	FORTWO	2009	2DR	1.16	N
SMART	FORTWO	2010	2DR	1.16	N
SMART	FORTWO	2011	2DR	1.16	N
SMART	FORTWO	2012	2DR	1.16	N
SMART	FORTWO	2013	2DR	1.16	N
SMART	FORTWO ELECTRIC DRIVE	2013	2DR	1.26	N
SUBARU	IMPREZA	2004	4DR	1.37	N
SUBARU	IMPREZA	2005	4DR	1.37	N
SUBARU	IMPREZA	2006	4DR	1.37	N
SUBARU	IMPREZA	2007	4DR	1.37	N
SUBARU	IMPREZA	2008	4DR	1.44	N
SUBARU	IMPREZA	2009	4DR	1.44	N
SUBARU	IMPREZA	2010	4DR	1.44	N
SUBARU	IMPREZA	2011	4DR	1.44	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
SUBARU	IMPREZA	2012	4DR	1.46	N
SUBARU	IMPREZA	2012	4DR	1.44	N
SUBARU	IMPREZA	2013	4DR	1.46	N
SUBARU	IMPREZA	2013	4DR	1.44	N
SUBARU	LEGACY	2004	4DR	1.42	N
SUBARU	LEGACY	2007	4DR	1.42	N
SUBARU	LEGACY	2008	4DR	1.42	N
SUBARU	LEGACY	2009	4DR	1.42	N
SUBARU	LEGACY	2010	4DR	1.45	N
SUBARU	LEGACY	2011	4DR	1.45	N
SUBARU	LEGACY	2012	4DR	1.45	N
SUBARU	LEGACY	2013	4DR	1.45	N
SUBARU	LEGACY WAGON	2004	4DR	1.37	N
SUBARU	OUTBACK	2004	4DR	1.26	N
SUZUKI	FORENZA	2004	4DR	1.38	N
SUZUKI	FORENZA	2005	4DR	1.38	N
SUZUKI	FORENZA	2006	4DR	1.38	N
SUZUKI	FORENZA	2007	4DR	1.38	N
SUZUKI	FORENZA	2008	4DR	1.38	N
SUZUKI	KIZASHI	2010	4DR	1.41	N
SUZUKI	KIZASHI	2011	4DR	1.41	N
SUZUKI	KIZASHI	2012	4DR	1.41	N
SUZUKI	KIZASHI	2013	4DR	1.41	N
SUZUKI	RENO	2008	4DR	1.38	N
SUZUKI	SX4	2008	4DR	1.32	N
SUZUKI	SX4	2009	4DR	1.32	N
SUZUKI	SX4	2010	4DR	1.32	N
SUZUKI	SX4	2011	4DR	1.32	N
SUZUKI	SX4	2012	4DR	1.32	N
SUZUKI	SX4	2013	4DR	1.32	N
SUZUKI	VERONA	2005	4DR	1.41	N
SUZUKI	VERONA	2006	4DR	1.41	N
TESLA	MODEL S	2013	4DR	1.83	N
TOYOTA	AVALON	2004	4DR	1.42	N
TOYOTA	AVALON	2005	4DR	1.40	N
TOYOTA	AVALON	2006	4DR	1.40	N
TOYOTA	AVALON	2007	4DR	1.40	N
TOYOTA	AVALON	2008	4DR	1.40	N
TOYOTA	AVALON	2009	4DR	1.40	N
TOYOTA	AVALON	2010	4DR	1.40	N
TOYOTA	AVALON	2011	4DR	1.40	N
TOYOTA	AVALON	2012	4DR	1.40	N
TOYOTA	AVALON	2013	4DR	1.42	N
TOYOTA	CAMRY	2004	4DR	1.40	N
TOYOTA	CAMRY	2005	4DR	1.40	N
TOYOTA	CAMRY	2006	4DR	1.40	N
TOYOTA	CAMRY	2007	4DR	1.42	N
TOYOTA	CAMRY	2008	4DR	1.42	N
TOYOTA	CAMRY	2009	4DR	1.42	N
TOYOTA	CAMRY	2010	4DR	1.42	N
TOYOTA	CAMRY	2011	4DR	1.42	N
TOYOTA	CAMRY	2012	4DR	1.40	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
TOYOTA	CAMRY	2013	4DR	1.40	N
TOYOTA	CAMRY HYBRID	2008	4DR	1.41	N
TOYOTA	CAMRY HYBRID	2009	4DR	1.42	N
TOYOTA	CAMRY HYBRID	2010	4DR	1.42	N
TOYOTA	CAMRY HYBRID	2011	4DR	1.42	N
TOYOTA	CAMRY HYBRID	2012	4DR	1.40	N
TOYOTA	CAMRY HYBRID	2013	4DR	1.40	N
TOYOTA	CAMRY SOLARA	2004	2DR	1.38	N
TOYOTA	CAMRY SOLARA	2005	2DR	1.38	N
TOYOTA	CAMRY SOLARA	2006	2DR	1.38	N
TOYOTA	CAMRY SOLARA	2007	2DR	1.38	N
TOYOTA	CAMRY SOLARA	2008	2DR	1.38	N
TOYOTA	CELICA	2004	2DR	1.47	N
TOYOTA	CELICA	2005	2DR	1.47	N
TOYOTA	COROLLA	2004	4DR	1.34	N
TOYOTA	COROLLA	2005	4DR	1.34	N
TOYOTA	COROLLA	2006	4DR	1.34	N
TOYOTA	COROLLA	2007	4DR	1.34	N
TOYOTA	COROLLA	2008	4DR	1.34	N
TOYOTA	COROLLA	2009	4DR	1.36	N
TOYOTA	COROLLA	2010	4DR	1.36	N
TOYOTA	COROLLA	2011	4DR	1.36	N
TOYOTA	COROLLA	2012	4DR	1.36	N
TOYOTA	COROLLA	2013	4DR	1.36	N
TOYOTA	ECHO	2004	4DR	1.28	N
TOYOTA	ECHO	2005	4DR	1.28	N
TOYOTA	MATRIX	2004	4DR	1.27	N
TOYOTA	MATRIX	2005	4DR	1.27	N
TOYOTA	MATRIX	2006	4DR	1.27	N
TOYOTA	MATRIX	2007	4DR	1.27	N
TOYOTA	MATRIX	2008	4DR	1.27	N
TOYOTA	MATRIX	2009	4DR	1.31	N
TOYOTA	MATRIX	2010	4DR	1.31	N
TOYOTA	MATRIX	2011	4DR	1.31	N
TOYOTA	MATRIX	2012	4DR	1.31	N
TOYOTA	MATRIX	2013	4DR	1.31	N
TOYOTA	PRIUS	2004	4DR	1.33	N
TOYOTA	PRIUS	2005	4DR	1.33	N
TOYOTA	PRIUS	2006	4DR	1.33	N
TOYOTA	PRIUS	2007	4DR	1.33	N
TOYOTA	PRIUS	2008	4DR	1.33	N
TOYOTA	PRIUS	2009	4DR	1.33	N
TOYOTA	PRIUS	2010	4DR	1.36	N
TOYOTA	PRIUS	2011	4DR	1.36	N
TOYOTA	PRIUS	2012	4DR	1.36	N
TOYOTA	PRIUS	2013	4DR	1.36	N
TOYOTA	PRIUS C	2013	4DR	1.37	N
TOYOTA	PRIUS ELECTRIC DRIVE	2012	4DR	1.35	N
TOYOTA	PRIUS ELECTRIC DRIVE	2013	4DR	1.35	N
TOYOTA	PRIUS V	2013	4DR	1.31	N
TOYOTA	SCION IQ	2012	2DR	1.28	N
TOYOTA	SCION IQ	2013	2DR	1.28	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
TOYOTA	SCION TC	2005	2DR	1.38	N
TOYOTA	SCION TC	2006	2DR	1.38	N
TOYOTA	SCION TC	2007	2DR	1.38	N
TOYOTA	SCION TC	2008	2DR	1.38	N
TOYOTA	SCION TC	2009	2DR	1.38	N
TOYOTA	SCION TC	2010	2DR	1.38	N
TOYOTA	SCION TC	2011	2DR	1.41	N
TOYOTA	SCION TC	2012	2DR	1.41	N
TOYOTA	SCION TC	2013	2DR	1.41	N
TOYOTA	SCION XA	2004	4DR	1.26	N
TOYOTA	SCION XA	2005	4DR	1.26	N
TOYOTA	SCION XA	2006	4DR	1.26	N
TOYOTA	SCION XB	2006	4DR	1.20	N
TOYOTA	SCION XD	2008	4DR	1.27	N
TOYOTA	SCION XD	2009	4DR	1.27	N
TOYOTA	SCION XD	2010	4DR	1.27	N
TOYOTA	YARIS	2007	4DR	1.33	N
TOYOTA	YARIS	2008	4DR	1.33	N
TOYOTA	YARIS	2009	4DR	1.33	N
TOYOTA	YARIS	2010	4DR	1.33	N
TOYOTA	YARIS	2011	4DR	1.33	N
TOYOTA	YARIS	2012	4DR	1.22	N
TOYOTA	YARIS LIFTBACK	2008	2DR	1.30	N
TOYOTA	YARIS LIFTBACK	2009	2DR	1.30	N
TOYOTA	YARIS LIFTBACK	2009	4DR	1.30	N
TOYOTA	YARIS LIFTBACK	2010	2DR	1.30	N
TOYOTA	YARIS LIFTBACK	2010	4DR	1.30	N
TOYOTA	YARIS LIFTBACK	2011	2DR	1.30	N
TOYOTA	YARIS LIFTBACK	2011	4DR	1.30	N
TOYOTA	YARIS LIFTBACK	2012	4DR	1.31	N
TOYOTA	YARIS LIFTBACK	2013	4DR	1.31	N
VOLKSWAGEN	BEETLE	2012	2DR	1.43	N
VOLKSWAGEN	BEETLE	2013	2DR	1.43	N
VOLKSWAGEN	CC	2009	4DR	1.37	N
VOLKSWAGEN	CC	2010	4DR	1.37	N
VOLKSWAGEN	CC	2011	4DR	1.37	N
VOLKSWAGEN	CC	2012	4DR	1.37	N
VOLKSWAGEN	CC	2013	4DR	1.37	N
VOLKSWAGEN	GLI	2008	4DR	1.36	N
VOLKSWAGEN	GLI	2009	4DR	1.36	N
VOLKSWAGEN	GOLF	2010	4DR	1.36	N
VOLKSWAGEN	GOLF	2011	4DR	1.36	N
VOLKSWAGEN	GOLF	2012	4DR	1.36	N
VOLKSWAGEN	GOLF	2013	4DR	1.36	N
VOLKSWAGEN	GTI	2007	4DR	1.36	N
VOLKSWAGEN	GTI	2008	4DR	1.36	N
VOLKSWAGEN	GTI	2009	4DR	1.36	N
VOLKSWAGEN	GTI	2010	4DR	1.36	N
VOLKSWAGEN	JETTA	2004	4DR	1.37	N
VOLKSWAGEN	JETTA	2005	4DR	1.36	N
VOLKSWAGEN	JETTA	2006	4DR	1.36	N
VOLKSWAGEN	JETTA	2007	4DR	1.36	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
VOLKSWAGEN	JETTA	2008	4DR	1.36	N
VOLKSWAGEN	JETTA	2009	4DR	1.36	N
VOLKSWAGEN	JETTA	2010	4DR	1.36	N
VOLKSWAGEN	JETTA	2011	4DR	1.36	N
VOLKSWAGEN	JETTA	2012	4DR	1.36	N
VOLKSWAGEN	JETTA	2013	4DR	1.36	N
VOLKSWAGEN	JETTA WAGON	2004	4DR	1.34	N
VOLKSWAGEN	JETTA WAGON	2008	4DR	1.36	N
VOLKSWAGEN	JETTA WAGON	2009	4DR	1.36	N
VOLKSWAGEN	JETTA WAGON	2010	4DR	1.36	N
VOLKSWAGEN	JETTA WAGON	2011	4DR	1.36	N
VOLKSWAGEN	JETTA WAGON	2012	4DR	1.36	N
VOLKSWAGEN	JETTA WAGON	2013	4DR	1.36	N
VOLKSWAGEN	NEW BEETLE	2004	2DR	1.39	N
VOLKSWAGEN	NEW BEETLE	2005	2DR	1.39	N
VOLKSWAGEN	NEW BEETLE	2006	2DR	1.39	N
VOLKSWAGEN	NEW BEETLE	2007	2DR	1.39	N
VOLKSWAGEN	NEW BEETLE	2008	2DR	1.39	N
VOLKSWAGEN	NEW BEETLE	2009	2DR	1.39	N
VOLKSWAGEN	NEW BEETLE	2010	2DR	1.39	N
VOLKSWAGEN	NEW BEETLE CONVERTIBLE	2004	2DR	1.43	N
VOLKSWAGEN	NEW BEETLE CONVERTIBLE	2007	2DR	1.39	N
VOLKSWAGEN	NEW BEETLE CONVERTIBLE	2008	2DR	1.39	N
VOLKSWAGEN	NEW BEETLE CONVERTIBLE	2009	2DR	1.39	N
VOLKSWAGEN	NEW BEETLE CONVERTIBLE	2010	2DR	1.39	N
VOLKSWAGEN	PASSAT	2004	4DR	1.41	N
VOLKSWAGEN	PASSAT	2005	4DR	1.41	N
VOLKSWAGEN	PASSAT	2006	4DR	1.37	N
VOLKSWAGEN	PASSAT	2007	4DR	1.37	N
VOLKSWAGEN	PASSAT	2008	4DR	1.37	N
VOLKSWAGEN	PASSAT	2009	4DR	1.37	N
VOLKSWAGEN	PASSAT	2010	4DR	1.37	N
VOLKSWAGEN	PASSAT	2012	4DR	1.42	N
VOLKSWAGEN	PASSAT	2013	4DR	1.42	N
VOLKSWAGEN	RABBIT	2007	4DR	1.36	N
VOLKSWAGEN	RABBIT	2008	4DR	1.36	N
VOLKSWAGEN	RABBIT	2009	4DR	1.36	N
VOLVO	S40	2005	4DR	1.40	N
VOLVO	S40	2006	4DR	1.40	N
VOLVO	S40	2007	4DR	1.40	N
VOLVO	S40	2008	4DR	1.40	N
VOLVO	S40	2009	4DR	1.40	N
VOLVO	S40	2010	4DR	1.40	N
VOLVO	S40	2011	4DR	1.40	N
VOLVO	S60	2004	4DR	1.49	N
VOLVO	S60	2005	4DR	1.49	N
VOLVO	S60	2006	4DR	1.49	N
VOLVO	S60	2007	4DR	1.49	N
VOLVO	S60	2008	4DR	1.49	N
VOLVO	S60	2009	4DR	1.49	N
VOLVO	S60	2012	4DR	1.45	N
VOLVO	S60	2013	4DR	1.45	N

Make	Model	MY	Body Style Description	SSF	TIP-UP
VOLVO	S80	2004	4DR	1.47	N
VOLVO	S80	2005	4DR	1.47	N
VOLVO	S80	2006	4DR	1.47	N
VOLVO	V70	2005	4DR	1.43	N
VOLVO	V70	2006	4DR	1.43	N
VOLVO	V70	2007	4DR	1.43	N
VOLVO	XC70	2005	4DR	1.33	N
VOLVO	XC70	2006	4DR	1.33	N
VOLVO	XC70	2007	4DR	1.33	N

A.2 SSF of SUVs MY 2004 to 2013

Description	Drive System
2WD	Front-wheel Drive, Rear-wheel Drive, 4x2
4WD	All-wheel Drive, 4x4

Employing the convention of the table in Section 2.1.3, the following table shows the make name, the model name, MY, the drive system description, and the NCAP dynamic rollover test result of the test SUVs from MY 2004 to 2013.

Make	Model	MY	Drive System Description	SSF	TIP-UP
ACURA	MDX	2005	4WD	1.27	N
ACURA	MDX	2006	4WD	1.27	N
ACURA	MDX	2007	4WD	1.30	N
ACURA	MDX	2008	4WD	1.30	N
ACURA	MDX	2009	4WD	1.30	N
ACURA	MDX	2010	4WD	1.30	N
ACURA	MDX	2011	4WD	1.30	N
ACURA	MDX	2012	4WD	1.30	N
ACURA	MDX	2013	4WD	1.30	N
ACURA	RDX	2007	4WD	1.26	N
ACURA	RDX	2008	4WD	1.26	N
ACURA	RDX	2009	4WD	1.26	N
ACURA	RDX	2010	4WD	1.26	N
ACURA	RDX	2011	4WD	1.26	N
ACURA	RDX	2012	4WD	1.26	N
ACURA	ZDX	2010	4WD	1.33	N
ACURA	ZDX	2011	4WD	1.33	N
ACURA	ZDX	2012	4WD	1.33	N
ACURA	ZDX	2013	4WD	1.33	N
AUDI	Q5	2009	4WD	1.27	N
AUDI	Q5	2010	4WD	1.27	N
AUDI	Q5	2011	4WD	1.27	N
AUDI	Q5	2012	4WD	1.27	N
AUDI	Q5	2013	4WD	1.27	N
AUDI	Q5 HEV	2013	4WD	1.27	N
AUDI	Q7	2007	4WD	1.20	N
AUDI	Q7	2008	4WD	1.20	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
AUDI	Q7	2009	4WD	1.20	N
AUDI	Q7	2010	4WD	1.20	N
AUDI	Q7	2011	4WD	1.20	N
AUDI	Q7	2012	4WD	1.20	N
AUDI	Q7	2013	4WD	1.20	N
BMW	X5	2008	4WD	1.22	N
BMW	X5	2009	4WD	1.22	N
BMW	X5	2010	4WD	1.22	N
BMW	X5	2011	4WD	1.22	N
BMW	X5	2012	4WD	1.22	N
BMW	X5	2013	4WD	1.22	N
BUICK	ENCLAVE	2008	2WD	1.23	N
BUICK	ENCLAVE	2008	4WD	1.26	N
BUICK	ENCLAVE	2009	2WD	1.23	N
BUICK	ENCLAVE	2009	4WD	1.26	N
BUICK	ENCLAVE	2010	2WD	1.23	N
BUICK	ENCLAVE	2010	4WD	1.26	N
BUICK	ENCLAVE	2011	2WD	1.23	N
BUICK	ENCLAVE	2011	4WD	1.26	N
BUICK	ENCLAVE	2012	2WD	1.23	N
BUICK	ENCLAVE	2012	4WD	1.26	N
BUICK	ENCLAVE	2013	2WD	1.23	N
BUICK	ENCLAVE	2013	4WD	1.26	N
BUICK	ENCORE	2013	2WD	1.18	N
BUICK	ENCORE	2013	4WD	1.21	N
BUICK	RAINIER	2004	2WD	1.17	N
BUICK	RAINIER	2004	4WD	1.19	N
BUICK	RAINIER	2005	2WD	1.17	N
BUICK	RAINIER	2005	4WD	1.19	N
BUICK	RAINIER	2006	2WD	1.17	N
BUICK	RAINIER	2006	4WD	1.19	N
BUICK	RAINIER	2007	2WD	1.17	N
BUICK	RAINIER	2007	4WD	1.19	N
CADILLAC	ESCALADE	2005	2WD	1.12	N
CADILLAC	ESCALADE	2005	4WD	1.14	N
CADILLAC	ESCALADE	2006	2WD	1.12	N
CADILLAC	ESCALADE	2006	4WD	1.14	N
CADILLAC	ESCALADE	2007	2WD	1.12	N
CADILLAC	ESCALADE	2007	4WD	1.14	N
CADILLAC	ESCALADE	2008	2WD	1.12	N
CADILLAC	ESCALADE	2008	4WD	1.14	N
CADILLAC	ESCALADE	2009	2WD	1.12	N
CADILLAC	ESCALADE	2009	4WD	1.14	N
CADILLAC	ESCALADE	2010	2WD	1.12	N
CADILLAC	ESCALADE	2010	4WD	1.14	N
CADILLAC	ESCALADE	2011	2WD	1.12	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
CADILLAC	ESCALADE	2011	4WD	1.14	N
CADILLAC	ESCALADE	2012	2WD	1.12	N
CADILLAC	ESCALADE	2012	4WD	1.14	N
CADILLAC	ESCALADE	2013	2WD	1.12	N
CADILLAC	ESCALADE	2013	4WD	1.14	N
CADILLAC	ESCALADE ESV	2005	4WD	1.15	N
CADILLAC	ESCALADE ESV	2006	4WD	1.15	N
CADILLAC	ESCALADE ESV	2007	2WD	1.13	N
CADILLAC	ESCALADE ESV	2007	4WD	1.13	N
CADILLAC	ESCALADE ESV	2008	2WD	1.13	N
CADILLAC	ESCALADE ESV	2008	4WD	1.13	N
CADILLAC	ESCALADE ESV	2009	2WD	1.13	N
CADILLAC	ESCALADE ESV	2009	4WD	1.13	N
CADILLAC	ESCALADE ESV	2010	2WD	1.13	N
CADILLAC	ESCALADE ESV	2010	4WD	1.13	N
CADILLAC	ESCALADE ESV	2011	4WD	1.13	N
CADILLAC	ESCALADE ESV	2012	2WD	1.13	N
CADILLAC	ESCALADE ESV	2012	4WD	1.13	N
CADILLAC	ESCALADE ESV	2013	2WD	1.13	N
CADILLAC	ESCALADE ESV	2013	4WD	1.13	N
CADILLAC	ESCALADE EXT	2005	4WD	1.15	N
CADILLAC	ESCALADE EXT	2006	4WD	1.15	N
CADILLAC	ESCALADE EXT	2007	2WD	1.14	N
CADILLAC	ESCALADE EXT	2007	4WD	1.16	N
CADILLAC	ESCALADE EXT	2008	4WD	1.16	N
CADILLAC	ESCALADE EXT	2009	4WD	1.16	N
CADILLAC	ESCALADE EXT	2010	4WD	1.16	N
CADILLAC	ESCALADE EXT	2011	4WD	1.16	N
CADILLAC	ESCALADE EXT	2012	4WD	1.16	N
CADILLAC	ESCALADE EXT	2013	4WD	1.16	N
CADILLAC	ESCALADE HEV	2009	2WD	1.12	N
CADILLAC	ESCALADE HEV	2009	4WD	1.14	N
CADILLAC	ESCALADE HEV	2010	2WD	1.12	N
CADILLAC	ESCALADE HEV	2010	4WD	1.14	N
CADILLAC	ESCALADE HEV	2011	2WD	1.12	N
CADILLAC	ESCALADE HEV	2011	4WD	1.14	N
CADILLAC	ESCALADE HEV	2012	2WD	1.12	N
CADILLAC	ESCALADE HEV	2012	4WD	1.14	N
CADILLAC	ESCALADE HEV	2013	2WD	1.12	N
CADILLAC	ESCALADE HEV	2013	4WD	1.14	N
CADILLAC	SRX	2008	2WD	1.21	Y
CADILLAC	SRX	2008	4WD	1.21	N
CADILLAC	SRX	2009	2WD	1.21	Y
CADILLAC	SRX	2009	4WD	1.21	N
CADILLAC	SRX	2010	2WD	1.21	N
CADILLAC	SRX	2010	4WD	1.24	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
CADILLAC	SRX	2011	2WD	1.21	N
CADILLAC	SRX	2011	4WD	1.24	N
CADILLAC	SRX	2012	2WD	1.21	N
CADILLAC	SRX	2012	4WD	1.24	N
CADILLAC	SRX	2013	2WD	1.21	N
CADILLAC	SRX	2013	4WD	1.24	N
CHEVROLET	AVALANCHE	2005	2WD	1.11	N
CHEVROLET	AVALANCHE	2005	4WD	1.15	N
CHEVROLET	AVALANCHE	2006	2WD	1.11	N
CHEVROLET	AVALANCHE	2006	4WD	1.15	N
CHEVROLET	AVALANCHE	2007	2WD	1.14	N
CHEVROLET	AVALANCHE	2007	4WD	1.16	N
CHEVROLET	AVALANCHE	2008	2WD	1.14	N
CHEVROLET	AVALANCHE	2008	4WD	1.16	N
CHEVROLET	AVALANCHE	2009	2WD	1.14	N
CHEVROLET	AVALANCHE	2009	4WD	1.16	N
CHEVROLET	AVALANCHE	2010	2WD	1.14	N
CHEVROLET	AVALANCHE	2010	4WD	1.16	N
CHEVROLET	AVALANCHE	2011	2WD	1.14	N
CHEVROLET	AVALANCHE	2011	4WD	1.16	N
CHEVROLET	AVALANCHE	2012	2WD	1.14	N
CHEVROLET	AVALANCHE	2012	4WD	1.16	N
CHEVROLET	AVALANCHE	2013	2WD	1.14	N
CHEVROLET	AVALANCHE	2013	4WD	1.16	N
CHEVROLET	CAPTIVA	2011	2WD	1.20	N
CHEVROLET	CAPTIVA	2011	4WD	1.25	N
CHEVROLET	CAPTIVA	2012	2WD	1.20	N
CHEVROLET	CAPTIVA	2012	4WD	1.25	N
CHEVROLET	CAPTIVA	2013	2WD	1.20	N
CHEVROLET	CAPTIVA	2013	4WD	1.25	N
CHEVROLET	EQUINOX	2005	2WD	1.23	Y
CHEVROLET	EQUINOX	2005	4WD	1.25	Y
CHEVROLET	EQUINOX	2006	2WD	1.23	Y
CHEVROLET	EQUINOX	2006	4WD	1.25	Y
CHEVROLET	EQUINOX	2007	2WD	1.20	N
CHEVROLET	EQUINOX	2007	4WD	1.24	N
CHEVROLET	EQUINOX	2008	2WD	1.20	N
CHEVROLET	EQUINOX	2008	4WD	1.24	N
CHEVROLET	EQUINOX	2009	2WD	1.20	N
CHEVROLET	EQUINOX	2009	4WD	1.24	N
CHEVROLET	EQUINOX	2010	2WD	1.19	N
CHEVROLET	EQUINOX	2010	4WD	1.22	N
CHEVROLET	EQUINOX	2011	2WD	1.19	N
CHEVROLET	EQUINOX	2011	4WD	1.22	N
CHEVROLET	EQUINOX	2012	2WD	1.19	N
CHEVROLET	EQUINOX	2012	4WD	1.22	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
CHEVROLET	EQUINOX	2013	2WD	1.19	N
CHEVROLET	EQUINOX	2013	4WD	1.22	N
CHEVROLET	HHR	2006	2WD	1.29	N
CHEVROLET	HHR	2007	2WD	1.29	N
CHEVROLET	HHR	2008	2WD	1.29	N
CHEVROLET	HHR	2009	2WD	1.29	N
CHEVROLET	HHR	2010	2WD	1.29	N
CHEVROLET	HHR	2011	2WD	1.29	N
CHEVROLET	SUBURBAN 1500	2005	2WD	1.13	N
CHEVROLET	SUBURBAN 1500	2005	4WD	1.15	N
CHEVROLET	SUBURBAN 1500	2006	2WD	1.13	N
CHEVROLET	SUBURBAN 1500	2006	4WD	1.15	N
CHEVROLET	SUBURBAN 1500	2007	2WD	1.13	N
CHEVROLET	SUBURBAN 1500	2007	4WD	1.13	N
CHEVROLET	SUBURBAN 1500	2008	2WD	1.13	N
CHEVROLET	SUBURBAN 1500	2008	4WD	1.13	N
CHEVROLET	SUBURBAN 1500	2009	2WD	1.13	N
CHEVROLET	SUBURBAN 1500	2009	4WD	1.13	N
CHEVROLET	SUBURBAN 1500	2010	2WD	1.13	N
CHEVROLET	SUBURBAN 1500	2010	4WD	1.13	N
CHEVROLET	SUBURBAN 1500	2011	2WD	1.13	N
CHEVROLET	SUBURBAN 1500	2011	4WD	1.13	N
CHEVROLET	SUBURBAN 1500	2012	2WD	1.13	N
CHEVROLET	SUBURBAN 1500	2012	4WD	1.13	N
CHEVROLET	SUBURBAN 1500	2013	2WD	1.13	N
CHEVROLET	SUBURBAN 1500	2013	4WD	1.13	N
CHEVROLET	TAHOE	2004	2WD	1.12	Y
CHEVROLET	TAHOE	2004	4WD	1.14	Y
CHEVROLET	TAHOE	2005	2WD	1.12	Y
CHEVROLET	TAHOE	2005	4WD	1.14	Y
CHEVROLET	TAHOE	2006	2WD	1.12	N
CHEVROLET	TAHOE	2006	4WD	1.14	N
CHEVROLET	TAHOE	2007	2WD	1.12	N
CHEVROLET	TAHOE	2007	4WD	1.14	N
CHEVROLET	TAHOE	2008	2WD	1.12	N
CHEVROLET	TAHOE	2008	4WD	1.14	N
CHEVROLET	TAHOE	2009	2WD	1.12	N
CHEVROLET	TAHOE	2009	4WD	1.14	N
CHEVROLET	TAHOE	2010	2WD	1.12	N
CHEVROLET	TAHOE	2010	4WD	1.14	N
CHEVROLET	TAHOE	2011	2WD	1.12	N
CHEVROLET	TAHOE	2011	4WD	1.14	N
CHEVROLET	TAHOE	2012	2WD	1.12	N
CHEVROLET	TAHOE	2012	4WD	1.14	N
CHEVROLET	TAHOE	2013	2WD	1.12	N
CHEVROLET	TAHOE	2013	4WD	1.14	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
CHEVROLET	TAHOE HEV	2008	2WD	1.12	N
CHEVROLET	TAHOE HEV	2008	4WD	1.14	N
CHEVROLET	TAHOE HEV	2009	2WD	1.12	N
CHEVROLET	TAHOE HEV	2009	4WD	1.14	N
CHEVROLET	TAHOE HEV	2010	2WD	1.12	N
CHEVROLET	TAHOE HEV	2010	4WD	1.14	N
CHEVROLET	TAHOE HEV	2011	2WD	1.12	N
CHEVROLET	TAHOE HEV	2011	4WD	1.14	N
CHEVROLET	TAHOE HEV	2012	2WD	1.12	N
CHEVROLET	TAHOE HEV	2012	4WD	1.14	N
CHEVROLET	TAHOE HEV	2013	2WD	1.12	N
CHEVROLET	TAHOE HEV	2013	4WD	1.14	N
CHEVROLET	TRAILBLAZER	2004	2WD	1.17	N
CHEVROLET	TRAILBLAZER	2004	4WD	1.19	N
CHEVROLET	TRAILBLAZER	2005	2WD	1.17	N
CHEVROLET	TRAILBLAZER	2005	4WD	1.19	N
CHEVROLET	TRAILBLAZER	2006	2WD	1.17	N
CHEVROLET	TRAILBLAZER	2006	4WD	1.19	N
CHEVROLET	TRAILBLAZER	2007	2WD	1.17	N
CHEVROLET	TRAILBLAZER	2007	4WD	1.19	N
CHEVROLET	TRAILBLAZER	2008	2WD	1.17	N
CHEVROLET	TRAILBLAZER	2008	4WD	1.19	N
CHEVROLET	TRAILBLAZER	2009	2WD	1.17	N
CHEVROLET	TRAILBLAZER	2009	4WD	1.19	N
CHEVROLET	TRAILBLAZER EXT	2006	2WD	1.14	N
CHEVROLET	TRAILBLAZER EXT	2006	4WD	1.18	N
CHEVROLET	TRAVERSE	2009	2WD	1.23	N
CHEVROLET	TRAVERSE	2009	4WD	1.26	N
CHEVROLET	TRAVERSE	2010	2WD	1.23	N
CHEVROLET	TRAVERSE	2010	4WD	1.26	N
CHEVROLET	TRAVERSE	2011	2WD	1.23	N
CHEVROLET	TRAVERSE	2011	4WD	1.26	N
CHEVROLET	TRAVERSE	2012	2WD	1.23	N
CHEVROLET	TRAVERSE	2012	4WD	1.26	N
CHEVROLET	TRAVERSE	2013	2WD	1.23	N
CHEVROLET	TRAVERSE	2013	4WD	1.26	N
CHRYSLER	ASPEN	2007	2WD	1.16	N
CHRYSLER	ASPEN	2007	4WD	1.19	N
CHRYSLER	ASPEN	2008	2WD	1.16	N
CHRYSLER	ASPEN	2008	4WD	1.19	N
CHRYSLER	ASPEN	2009	2WD	1.16	N
CHRYSLER	ASPEN	2009	4WD	1.19	N
CHRYSLER	PACIFICA	2004	2WD	1.30	N
CHRYSLER	PACIFICA	2004	4WD	1.33	N
CHRYSLER	PACIFICA	2005	2WD	1.30	N
CHRYSLER	PACIFICA	2005	4WD	1.33	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
CHRYSLER	PACIFICA	2006	2WD	1.30	N
CHRYSLER	PACIFICA	2006	4WD	1.33	N
CHRYSLER	PACIFICA	2007	2WD	1.30	N
CHRYSLER	PACIFICA	2007	4WD	1.33	N
CHRYSLER	PACIFICA	2008	2WD	1.30	N
CHRYSLER	PACIFICA	2008	4WD	1.33	N
CHRYSLER	PT CRUISER	2005	2WD	1.31	N
CHRYSLER	PT CRUISER	2006	2WD	1.31	N
CHRYSLER	PT CRUISER	2007	2WD	1.31	N
CHRYSLER	PT CRUISER	2008	2WD	1.31	N
CHRYSLER	PT CRUISER	2009	2WD	1.31	N
CHRYSLER	PT CRUISER	2010	2WD	1.31	N
DODGE	DURANGO	2006	4WD	1.19	N
DODGE	DURANGO	2007	2WD	1.16	N
DODGE	DURANGO	2007	4WD	1.19	N
DODGE	DURANGO	2008	2WD	1.16	N
DODGE	DURANGO	2008	4WD	1.19	N
DODGE	DURANGO	2009	2WD	1.16	N
DODGE	DURANGO	2009	4WD	1.19	N
DODGE	DURANGO	2012	2WD	1.14	N
DODGE	DURANGO	2012	4WD	1.16	N
DODGE	DURANGO	2013	2WD	1.14	N
DODGE	DURANGO	2013	4WD	1.16	N
DODGE	JOURNEY	2009	2WD	1.20	N
DODGE	JOURNEY	2009	4WD	1.21	N
DODGE	JOURNEY	2010	2WD	1.20	N
DODGE	JOURNEY	2010	4WD	1.21	N
DODGE	JOURNEY	2011	2WD	1.20	N
DODGE	JOURNEY	2011	4WD	1.21	N
DODGE	JOURNEY	2012	2WD	1.20	N
DODGE	JOURNEY	2012	4WD	1.21	N
DODGE	JOURNEY	2013	2WD	1.20	N
DODGE	JOURNEY	2013	4WD	1.21	N
DODGE	MAGNUM	2005	2WD	1.41	N
DODGE	MAGNUM	2006	2WD	1.41	N
DODGE	MAGNUM	2007	2WD	1.41	N
DODGE	MAGNUM	2008	2WD	1.41	N
DODGE	MAGNUM	2008	4WD	1.41	N
DODGE	NITRO	2007	2WD	1.14	N
DODGE	NITRO	2007	4WD	1.15	N
DODGE	NITRO	2008	2WD	1.14	N
DODGE	NITRO	2008	4WD	1.15	N
DODGE	NITRO	2009	2WD	1.14	N
DODGE	NITRO	2009	4WD	1.15	N
DODGE	NITRO	2010	2WD	1.14	N
DODGE	NITRO	2010	4WD	1.15	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
DODGE	NITRO	2011	2WD	1.14	N
DODGE	NITRO	2011	4WD	1.15	N
FORD	EDGE	2007	2WD	1.25	N
FORD	EDGE	2007	4WD	1.30	N
FORD	EDGE	2008	2WD	1.25	N
FORD	EDGE	2008	4WD	1.30	N
FORD	EDGE	2009	2WD	1.25	N
FORD	EDGE	2009	4WD	1.30	N
FORD	EDGE	2010	2WD	1.25	N
FORD	EDGE	2010	4WD	1.30	N
FORD	EDGE	2011	2WD	1.25	N
FORD	EDGE	2011	4WD	1.30	N
FORD	EDGE	2012	2WD	1.25	N
FORD	EDGE	2012	4WD	1.30	N
FORD	EDGE	2013	2WD	1.25	N
FORD	EDGE	2013	4WD	1.30	N
FORD	ESCAPE	2005	2WD	1.17	Y
FORD	ESCAPE	2005	4WD	1.21	Y
FORD	ESCAPE	2006	2WD	1.17	Y
FORD	ESCAPE	2006	4WD	1.21	Y
FORD	ESCAPE	2007	2WD	1.17	Y
FORD	ESCAPE	2007	4WD	1.21	Y
FORD	ESCAPE	2008	2WD	1.13	N
FORD	ESCAPE	2008	4WD	1.17	N
FORD	ESCAPE	2009	2WD	1.13	N
FORD	ESCAPE	2009	4WD	1.17	N
FORD	ESCAPE	2010	2WD	1.13	N
FORD	ESCAPE	2010	4WD	1.17	N
FORD	ESCAPE	2011	2WD	1.13	N
FORD	ESCAPE	2011	4WD	1.17	N
FORD	ESCAPE	2012	2WD	1.13	N
FORD	ESCAPE	2012	4WD	1.17	N
FORD	ESCAPE	2013	2WD	1.19	N
FORD	ESCAPE	2013	4WD	1.20	N
FORD	ESCAPE HEV	2008	2WD	1.14	N
FORD	ESCAPE HEV	2008	4WD	1.17	N
FORD	ESCAPE HEV	2009	2WD	1.14	N
FORD	ESCAPE HEV	2009	4WD	1.17	N
FORD	ESCAPE HEV	2010	2WD	1.14	N
FORD	ESCAPE HEV	2010	4WD	1.17	N
FORD	ESCAPE HEV	2011	2WD	1.13	N
FORD	ESCAPE HEV	2011	4WD	1.17	N
FORD	ESCAPE HEV	2012	2WD	1.13	N
FORD	ESCAPE HEV	2012	4WD	1.17	N
FORD	EXPEDITION	2006	2WD	1.16	N
FORD	EXPEDITION	2006	4WD	1.18	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
FORD	EXPEDITION	2007	2WD	1.16	N
FORD	EXPEDITION	2007	4WD	1.18	N
FORD	EXPEDITION	2008	2WD	1.16	N
FORD	EXPEDITION	2008	4WD	1.18	N
FORD	EXPEDITION	2009	2WD	1.16	N
FORD	EXPEDITION	2009	4WD	1.18	N
FORD	EXPEDITION	2010	2WD	1.16	N
FORD	EXPEDITION	2010	4WD	1.18	N
FORD	EXPEDITION	2011	2WD	1.16	N
FORD	EXPEDITION	2011	4WD	1.18	N
FORD	EXPEDITION	2012	2WD	1.16	N
FORD	EXPEDITION	2012	4WD	1.18	N
FORD	EXPEDITION	2013	2WD	1.16	N
FORD	EXPEDITION	2013	4WD	1.18	N
FORD	EXPLORER	2004	2WD	1.12	Y
FORD	EXPLORER	2004	4WD	1.14	N
FORD	EXPLORER	2005	2WD	1.12	N
FORD	EXPLORER	2006	2WD	1.13	N
FORD	EXPLORER	2006	4WD	1.14	N
FORD	EXPLORER	2007	2WD	1.13	N
FORD	EXPLORER	2007	4WD	1.14	N
FORD	EXPLORER	2008	2WD	1.13	N
FORD	EXPLORER	2008	4WD	1.14	N
FORD	EXPLORER	2009	2WD	1.13	N
FORD	EXPLORER	2009	4WD	1.14	N
FORD	EXPLORER	2010	2WD	1.13	N
FORD	EXPLORER	2010	4WD	1.14	N
FORD	EXPLORER	2012	2WD	1.23	N
FORD	EXPLORER	2012	4WD	1.22	N
FORD	EXPLORER	2013	2WD	1.23	N
FORD	EXPLORER	2013	4WD	1.22	N
FORD	EXPLORER SPORT	2004	2WD	1.07	Y
FORD	EXPLORER SPORT	2004	4WD	1.09	N
FORD	EXPLORER SPORT	2005	2WD	1.07	Y
FORD	EXPLORER SPORT	2005	4WD	1.09	N
FORD	EXPLORER SPORT	2007	2WD	1.15	N
FORD	EXPLORER SPORT	2007	4WD	1.18	N
FORD	EXPLORER SPORT	2008	2WD	1.15	N
FORD	EXPLORER SPORT	2008	4WD	1.18	N
FORD	EXPLORER SPORT	2009	2WD	1.15	N
FORD	EXPLORER SPORT	2009	4WD	1.18	N
FORD	EXPLORER SPORT	2010	2WD	1.15	N
FORD	EXPLORER SPORT	2010	4WD	1.18	N
FORD	FLEX	2009	2WD	1.24	N
FORD	FLEX	2009	4WD	1.27	N
FORD	FLEX	2010	2WD	1.24	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
FORD	FLEX	2010	4WD	1.27	N
FORD	FLEX	2011	2WD	1.24	N
FORD	FLEX	2011	4WD	1.27	N
FORD	FLEX	2012	2WD	1.24	N
FORD	FLEX	2012	4WD	1.27	N
FORD	FLEX	2013	2WD	1.24	N
FORD	FLEX	2013	4WD	1.27	N
FORD	TAURUS X	2005	2WD	1.29	N
FORD	TAURUS X	2005	4WD	1.32	N
FORD	TAURUS X	2006	2WD	1.29	N
FORD	TAURUS X	2006	4WD	1.32	N
FORD	TAURUS X	2007	2WD	1.29	N
FORD	TAURUS X	2007	4WD	1.32	N
FORD	TAURUS X	2008	2WD	1.29	N
FORD	TAURUS X	2008	4WD	1.32	N
FORD	TAURUS X	2009	2WD	1.29	N
FORD	TAURUS X	2009	4WD	1.32	N
GMC	ACADIA	2007	2WD	1.23	N
GMC	ACADIA	2007	4WD	1.26	N
GMC	ACADIA	2008	2WD	1.23	N
GMC	ACADIA	2008	4WD	1.26	N
GMC	ACADIA	2009	2WD	1.23	N
GMC	ACADIA	2009	4WD	1.26	N
GMC	ACADIA	2010	2WD	1.23	N
GMC	ACADIA	2010	4WD	1.26	N
GMC	ACADIA	2011	2WD	1.23	N
GMC	ACADIA	2011	4WD	1.26	N
GMC	ACADIA	2012	2WD	1.23	N
GMC	ACADIA	2012	4WD	1.26	N
GMC	ACADIA	2013	2WD	1.23	N
GMC	ACADIA	2013	4WD	1.26	N
GMC	ENVOY	2004	2WD	1.17	N
GMC	ENVOY	2004	4WD	1.19	N
GMC	ENVOY	2005	2WD	1.17	N
GMC	ENVOY	2005	4WD	1.19	N
GMC	ENVOY	2006	2WD	1.17	N
GMC	ENVOY	2006	4WD	1.19	N
GMC	ENVOY	2007	2WD	1.17	N
GMC	ENVOY	2007	4WD	1.19	N
GMC	ENVOY	2008	2WD	1.17	N
GMC	ENVOY	2008	4WD	1.19	N
GMC	ENVOY	2009	2WD	1.17	N
GMC	ENVOY	2009	4WD	1.19	N
GMC	ENVOY XL	2006	2WD	1.14	N
GMC	ENVOY XL	2006	4WD	1.18	N
GMC	TERRAIN	2010	2WD	1.19	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
GMC	TERRAIN	2010	4WD	1.22	N
GMC	TERRAIN	2011	2WD	1.19	N
GMC	TERRAIN	2011	4WD	1.22	N
GMC	TERRAIN	2012	2WD	1.19	N
GMC	TERRAIN	2012	4WD	1.22	N
GMC	TERRAIN	2013	2WD	1.19	N
GMC	TERRAIN	2013	4WD	1.22	N
GMC	YUKON	2004	2WD	1.12	Y
GMC	YUKON	2004	4WD	1.14	Y
GMC	YUKON	2005	2WD	1.12	Y
GMC	YUKON	2005	4WD	1.14	Y
GMC	YUKON	2006	2WD	1.12	N
GMC	YUKON	2006	4WD	1.14	N
GMC	YUKON	2007	2WD	1.12	N
GMC	YUKON	2007	4WD	1.14	N
GMC	YUKON	2008	2WD	1.12	N
GMC	YUKON	2008	4WD	1.14	N
GMC	YUKON	2009	2WD	1.12	N
GMC	YUKON	2009	4WD	1.14	N
GMC	YUKON	2010	2WD	1.12	N
GMC	YUKON	2010	4WD	1.14	N
GMC	YUKON	2011	2WD	1.12	N
GMC	YUKON	2011	4WD	1.14	N
GMC	YUKON	2012	2WD	1.12	N
GMC	YUKON	2012	4WD	1.14	N
GMC	YUKON	2013	2WD	1.12	N
GMC	YUKON	2013	4WD	1.14	N
GMC	YUKON HEV	2008	2WD	1.12	N
GMC	YUKON HEV	2008	4WD	1.14	N
GMC	YUKON HEV	2009	2WD	1.12	N
GMC	YUKON HEV	2009	4WD	1.14	N
GMC	YUKON HEV	2010	2WD	1.12	N
GMC	YUKON HEV	2010	4WD	1.14	N
GMC	YUKON HEV	2011	2WD	1.12	N
GMC	YUKON HEV	2011	4WD	1.14	N
GMC	YUKON HEV	2012	2WD	1.12	N
GMC	YUKON HEV	2012	4WD	1.14	N
GMC	YUKON HEV	2013	2WD	1.12	N
GMC	YUKON HEV	2013	4WD	1.14	N
GMC	YUKON XL 1500	2005	2WD	1.13	N
GMC	YUKON XL 1500	2005	4WD	1.15	N
GMC	YUKON XL 1500	2006	2WD	1.13	N
GMC	YUKON XL 1500	2006	4WD	1.15	N
GMC	YUKON XL 1500	2007	2WD	1.13	N
GMC	YUKON XL 1500	2007	4WD	1.13	N
GMC	YUKON XL 1500	2008	2WD	1.13	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
GMC	YUKON XL 1500	2008	4WD	1.13	N
GMC	YUKON XL 1500	2009	2WD	1.13	N
GMC	YUKON XL 1500	2009	4WD	1.13	N
GMC	YUKON XL 1500	2010	2WD	1.13	N
GMC	YUKON XL 1500	2010	4WD	1.13	N
GMC	YUKON XL 1500	2011	2WD	1.13	N
GMC	YUKON XL 1500	2011	4WD	1.13	N
GMC	YUKON XL 1500	2012	2WD	1.13	N
GMC	YUKON XL 1500	2012	4WD	1.13	N
GMC	YUKON XL 1500	2013	2WD	1.13	N
GMC	YUKON XL 1500	2013	4WD	1.13	N
HONDA	ACCORD CROSSTOUR	2010	2WD	1.34	N
HONDA	ACCORD CROSSTOUR	2010	4WD	1.37	N
HONDA	ACCORD CROSSTOUR	2011	2WD	1.34	N
HONDA	ACCORD CROSSTOUR	2011	4WD	1.37	N
HONDA	CR-V	2005	2WD	1.18	N
HONDA	CR-V	2005	4WD	1.18	N
HONDA	CR-V	2006	2WD	1.18	N
HONDA	CR-V	2006	4WD	1.18	N
HONDA	CR-V	2007	2WD	1.22	N
HONDA	CR-V	2007	4WD	1.26	N
HONDA	CR-V	2008	2WD	1.22	N
HONDA	CR-V	2008	4WD	1.26	N
HONDA	CR-V	2009	2WD	1.22	N
HONDA	CR-V	2009	4WD	1.26	N
HONDA	CR-V	2010	2WD	1.22	N
HONDA	CR-V	2010	4WD	1.26	N
HONDA	CR-V	2011	2WD	1.22	N
HONDA	CR-V	2011	4WD	1.26	N
HONDA	CR-V	2012	2WD	1.22	N
HONDA	CR-V	2012	4WD	1.22	N
HONDA	CR-V	2013	2WD	1.22	N
HONDA	CR-V	2013	4WD	1.22	N
HONDA	CROSSTOUR	2012	2WD	1.34	N
HONDA	CROSSTOUR	2012	4WD	1.37	N
HONDA	CROSSTOUR	2013	2WD	1.34	N
HONDA	CROSSTOUR	2013	4WD	1.37	N
HONDA	ELEMENT	2007	2WD	1.15	N
HONDA	ELEMENT	2007	4WD	1.17	N
HONDA	ELEMENT	2008	2WD	1.15	N
HONDA	ELEMENT	2008	4WD	1.17	N
HONDA	ELEMENT	2009	2WD	1.15	N
HONDA	ELEMENT	2009	4WD	1.17	N
HONDA	ELEMENT	2010	2WD	1.15	N
HONDA	ELEMENT	2010	4WD	1.17	N
HONDA	ELEMENT	2011	2WD	1.15	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
HONDA	ELEMENT	2011	4WD	1.17	N
HONDA	PILOT	2004	4WD	1.25	N
HONDA	PILOT	2005	4WD	1.25	N
HONDA	PILOT	2006	2WD	1.24	N
HONDA	PILOT	2006	4WD	1.25	N
HONDA	PILOT	2007	2WD	1.24	N
HONDA	PILOT	2007	4WD	1.25	N
HONDA	PILOT	2008	2WD	1.24	N
HONDA	PILOT	2008	4WD	1.25	N
HONDA	PILOT	2009	2WD	1.22	N
HONDA	PILOT	2009	4WD	1.24	N
HONDA	PILOT	2010	2WD	1.22	N
HONDA	PILOT	2010	4WD	1.24	N
HONDA	PILOT	2011	2WD	1.22	N
HONDA	PILOT	2011	4WD	1.24	N
HONDA	PILOT	2012	2WD	1.22	N
HONDA	PILOT	2012	4WD	1.24	N
HONDA	PILOT	2013	2WD	1.22	N
HONDA	PILOT	2013	4WD	1.24	N
HUMMER	H3	2006	4WD	1.12	N
HUMMER	H3	2007	4WD	1.12	N
HUMMER	H3	2008	4WD	1.12	N
HUMMER	H3	2009	4WD	1.12	N
HUMMER	H3	2010	4WD	1.12	N
HYUNDAI	SANTA FE	2005	2WD	1.19	Y
HYUNDAI	SANTA FE	2005	4WD	1.22	Y
HYUNDAI	SANTA FE	2006	2WD	1.19	Y
HYUNDAI	SANTA FE	2006	4WD	1.22	Y
HYUNDAI	SANTA FE	2007	2WD	1.22	N
HYUNDAI	SANTA FE	2007	4WD	1.23	N
HYUNDAI	SANTA FE	2008	2WD	1.22	N
HYUNDAI	SANTA FE	2008	4WD	1.23	N
HYUNDAI	SANTA FE	2009	2WD	1.22	N
HYUNDAI	SANTA FE	2009	4WD	1.23	N
HYUNDAI	SANTA FE	2010	2WD	1.22	N
HYUNDAI	SANTA FE	2010	4WD	1.23	N
HYUNDAI	SANTA FE	2011	2WD	1.22	N
HYUNDAI	SANTA FE	2011	4WD	1.23	N
HYUNDAI	SANTA FE	2012	2WD	1.22	N
HYUNDAI	SANTA FE	2012	4WD	1.23	N
HYUNDAI	SANTA FE SPORT	2013	2WD	1.27	N
HYUNDAI	SANTA FE SPORT	2013	4WD	1.29	N
HYUNDAI	TUCSON	2006	2WD	1.18	N
HYUNDAI	TUCSON	2006	4WD	1.21	N
HYUNDAI	TUCSON	2007	2WD	1.18	N
HYUNDAI	TUCSON	2007	4WD	1.21	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
HYUNDAI	TUCSON	2008	2WD	1.18	N
HYUNDAI	TUCSON	2008	4WD	1.21	N
HYUNDAI	TUCSON	2009	2WD	1.18	N
HYUNDAI	TUCSON	2009	4WD	1.21	N
HYUNDAI	TUCSON	2012	2WD	1.21	N
HYUNDAI	TUCSON	2012	4WD	1.22	N
HYUNDAI	TUCSON	2013	2WD	1.21	N
HYUNDAI	TUCSON	2013	4WD	1.22	N
HYUNDAI	VERACRUZ	2007	2WD	1.23	N
HYUNDAI	VERACRUZ	2007	4WD	1.25	N
HYUNDAI	VERACRUZ	2008	2WD	1.23	N
HYUNDAI	VERACRUZ	2008	4WD	1.25	N
HYUNDAI	VERACRUZ	2009	2WD	1.23	N
HYUNDAI	VERACRUZ	2009	4WD	1.25	N
HYUNDAI	VERACRUZ	2010	2WD	1.23	N
HYUNDAI	VERACRUZ	2010	4WD	1.25	N
HYUNDAI	VERACRUZ	2011	2WD	1.23	N
HYUNDAI	VERACRUZ	2011	4WD	1.25	N
HYUNDAI	VERACRUZ	2012	2WD	1.23	N
HYUNDAI	VERACRUZ	2012	4WD	1.25	N
INFINITI	FX35	2006	2WD	1.25	N
INFINITI	FX35	2006	4WD	1.27	N
INFINITI	FX35	2007	2WD	1.25	N
INFINITI	FX35	2007	4WD	1.27	N
INFINITI	FX35	2008	2WD	1.25	N
INFINITI	FX35	2008	4WD	1.27	N
INFINITI	JX	2013	2WD	1.19	N
INFINITI	JX	2013	4WD	1.23	N
INFINITI	QX56	2006	2WD	1.16	N
INFINITI	QX56	2006	4WD	1.15	N
INFINITI	QX56	2007	2WD	1.16	N
INFINITI	QX56	2007	4WD	1.15	N
INFINITI	QX56	2008	2WD	1.16	N
INFINITI	QX56	2008	4WD	1.15	N
INFINITI	QX56	2009	2WD	1.16	N
INFINITI	QX56	2009	4WD	1.15	N
INFINITI	QX56	2010	2WD	1.16	N
INFINITI	QX56	2010	4WD	1.15	N
ISUZU	ASCENDER	2004	2WD	1.17	N
ISUZU	ASCENDER	2004	4WD	1.19	N
ISUZU	ASCENDER	2005	2WD	1.17	N
ISUZU	ASCENDER	2005	4WD	1.19	N
ISUZU	ASCENDER	2006	2WD	1.16	N
ISUZU	ASCENDER	2006	4WD	1.19	N
ISUZU	ASCENDER	2007	2WD	1.16	N
ISUZU	ASCENDER	2007	4WD	1.19	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
ISUZU	ASCENDER	2008	2WD	1.17	N
ISUZU	ASCENDER	2008	4WD	1.19	N
JEEP	COMMANDER	2006	4WD	1.14	N
JEEP	COMMANDER	2007	4WD	1.14	N
JEEP	COMMANDER	2008	2WD	1.09	N
JEEP	COMMANDER	2008	4WD	1.09	N
JEEP	COMMANDER	2009	2WD	1.09	N
JEEP	COMMANDER	2009	4WD	1.09	N
JEEP	COMMANDER	2010	2WD	1.09	N
JEEP	COMMANDER	2010	4WD	1.09	N
JEEP	COMPASS	2007	2WD	1.20	N
JEEP	COMPASS	2007	4WD	1.24	N
JEEP	COMPASS	2008	2WD	1.20	N
JEEP	COMPASS	2008	4WD	1.24	N
JEEP	COMPASS	2009	2WD	1.20	N
JEEP	COMPASS	2009	4WD	1.24	N
JEEP	COMPASS	2010	2WD	1.20	N
JEEP	COMPASS	2010	4WD	1.24	N
JEEP	COMPASS	2011	2WD	1.20	N
JEEP	COMPASS	2011	4WD	1.24	N
JEEP	COMPASS	2012	2WD	1.20	N
JEEP	COMPASS	2012	4WD	1.24	N
JEEP	COMPASS	2013	2WD	1.20	N
JEEP	COMPASS	2013	4WD	1.24	N
JEEP	GRAND CHEROKEE	2005	2WD	1.17	N
JEEP	GRAND CHEROKEE	2005	4WD	1.19	N
JEEP	GRAND CHEROKEE	2006	2WD	1.17	N
JEEP	GRAND CHEROKEE	2006	4WD	1.19	N
JEEP	GRAND CHEROKEE	2007	2WD	1.17	N
JEEP	GRAND CHEROKEE	2007	4WD	1.19	N
JEEP	GRAND CHEROKEE	2008	2WD	1.17	N
JEEP	GRAND CHEROKEE	2008	4WD	1.19	N
JEEP	GRAND CHEROKEE	2009	2WD	1.17	N
JEEP	GRAND CHEROKEE	2009	4WD	1.19	N
JEEP	GRAND CHEROKEE	2010	2WD	1.17	N
JEEP	GRAND CHEROKEE	2010	4WD	1.19	N
JEEP	GRAND CHEROKEE	2011	2WD	1.17	N
JEEP	GRAND CHEROKEE	2011	4WD	1.23	N
JEEP	GRAND CHEROKEE	2012	2WD	1.17	N
JEEP	GRAND CHEROKEE	2012	4WD	1.23	N
JEEP	GRAND CHEROKEE	2013	2WD	1.17	N
JEEP	GRAND CHEROKEE	2013	4WD	1.23	N
JEEP	LIBERTY	2004	2WD	1.12	N
JEEP	LIBERTY	2004	4WD	1.15	N
JEEP	LIBERTY	2005	2WD	1.12	N
JEEP	LIBERTY	2005	4WD	1.15	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
JEEP	LIBERTY	2006	2WD	1.12	N
JEEP	LIBERTY	2006	4WD	1.15	N
JEEP	LIBERTY	2007	2WD	1.12	N
JEEP	LIBERTY	2007	4WD	1.15	N
JEEP	LIBERTY	2008	2WD	1.11	N
JEEP	LIBERTY	2008	4WD	1.14	N
JEEP	LIBERTY	2009	2WD	1.11	N
JEEP	LIBERTY	2009	4WD	1.14	N
JEEP	LIBERTY	2010	2WD	1.11	N
JEEP	LIBERTY	2010	4WD	1.14	N
JEEP	LIBERTY	2011	2WD	1.11	N
JEEP	LIBERTY	2011	4WD	1.14	N
JEEP	LIBERTY	2012	2WD	1.11	N
JEEP	LIBERTY	2012	4WD	1.14	N
JEEP	PATRIOT	2007	2WD	1.20	N
JEEP	PATRIOT	2007	4WD	1.24	N
JEEP	PATRIOT	2008	2WD	1.20	N
JEEP	PATRIOT	2008	4WD	1.24	N
JEEP	PATRIOT	2009	2WD	1.20	N
JEEP	PATRIOT	2009	4WD	1.24	N
JEEP	PATRIOT	2010	2WD	1.20	N
JEEP	PATRIOT	2010	4WD	1.24	N
JEEP	PATRIOT	2013	2WD	1.15	N
JEEP	PATRIOT	2013	4WD	1.15	N
JEEP	WRANGLER	2005	4WD	1.18	N
JEEP	WRANGLER	2006	4WD	1.18	N
JEEP	WRANGLER	2007	2WD	1.18	N
JEEP	WRANGLER	2007	4WD	1.09	N
JEEP	WRANGLER	2008	2WD	1.18	N
JEEP	WRANGLER	2008	4WD	1.09	N
JEEP	WRANGLER	2009	4WD	1.09	N
JEEP	WRANGLER	2010	4WD	1.09	N
JEEP	WRANGLER	2011	4WD	1.09	N
JEEP	WRANGLER	2012	4WD	1.09	N
JEEP	WRANGLER	2013	4WD	1.09	N
JEEP	WRANGLER UNLIMITED	2009	2WD	1.18	N
JEEP	WRANGLER UNLIMITED	2009	4WD	1.09	N
JEEP	WRANGLER UNLIMITED	2010	2WD	1.18	N
JEEP	WRANGLER UNLIMITED	2010	4WD	1.09	N
JEEP	WRANGLER UNLIMITED	2011	4WD	1.09	N
JEEP	WRANGLER UNLIMITED	2012	4WD	1.09	N
JEEP	WRANGLER UNLIMITED	2013	4WD	1.09	N
KIA	BORREGO	2009	2WD	1.18	N
KIA	BORREGO	2009	4WD	1.21	N
KIA	BORREGO	2010	2WD	1.18	N
KIA	BORREGO	2010	4WD	1.21	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
KIA	BORREGO	2011	2WD	1.18	N
KIA	BORREGO	2011	4WD	1.21	N
KIA	SORENTO	2006	2WD	1.16	N
KIA	SORENTO	2006	4WD	1.17	N
KIA	SORENTO	2007	2WD	1.16	N
KIA	SORENTO	2007	4WD	1.19	N
KIA	SORENTO	2008	2WD	1.16	N
KIA	SORENTO	2008	4WD	1.19	N
KIA	SORENTO	2009	2WD	1.16	N
KIA	SORENTO	2009	4WD	1.19	N
KIA	SORENTO	2011	2WD	1.22	N
KIA	SORENTO	2011	4WD	1.23	N
KIA	SORENTO	2012	2WD	1.21	N
KIA	SORENTO	2012	4WD	1.23	N
KIA	SORENTO	2013	2WD	1.21	N
KIA	SORENTO	2013	4WD	1.23	N
KIA	SOUL	2010	2WD	1.27	N
KIA	SOUL	2011	2WD	1.27	N
KIA	SOUL	2012	2WD	1.27	N
KIA	SOUL	2013	2WD	1.27	N
KIA	SPORTAGE	2007	2WD	1.17	N
KIA	SPORTAGE	2007	4WD	1.22	N
KIA	SPORTAGE	2008	2WD	1.17	N
KIA	SPORTAGE	2008	4WD	1.22	N
KIA	SPORTAGE	2009	2WD	1.17	N
KIA	SPORTAGE	2009	4WD	1.22	N
KIA	SPORTAGE	2010	2WD	1.17	N
KIA	SPORTAGE	2010	4WD	1.22	N
KIA	SPORTAGE	2012	2WD	1.22	N
KIA	SPORTAGE	2012	4WD	1.26	N
KIA	SPORTAGE	2013	2WD	1.22	N
KIA	SPORTAGE	2013	4WD	1.26	N
LEXUS	RX350	2008	2WD	1.18	N
LEXUS	RX350	2008	4WD	1.19	N
LEXUS	RX350	2009	2WD	1.18	N
LEXUS	RX350	2009	4WD	1.19	N
LEXUS	RX350	2010	2WD	1.21	N
LEXUS	RX350	2010	4WD	1.24	N
LEXUS	RX350	2011	2WD	1.21	N
LEXUS	RX350	2011	4WD	1.24	N
LEXUS	RX350	2012	2WD	1.21	N
LEXUS	RX350	2012	4WD	1.24	N
LEXUS	RX350	2013	2WD	1.21	N
LEXUS	RX350	2013	4WD	1.24	N
LEXUS	RX450H	2010	2WD	1.21	N
LEXUS	RX450H	2010	4WD	1.24	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
LEXUS	RX450H	2011	2WD	1.21	N
LEXUS	RX450H	2011	4WD	1.24	N
LEXUS	RX450H	2012	2WD	1.21	N
LEXUS	RX450H	2012	4WD	1.24	N
LEXUS	RX450H	2013	2WD	1.21	N
LEXUS	RX450H	2013	4WD	1.24	N
LINCOLN	MKT	2010	2WD	1.24	N
LINCOLN	MKT	2010	4WD	1.27	N
LINCOLN	MKT	2011	2WD	1.24	N
LINCOLN	MKT	2011	4WD	1.27	N
LINCOLN	MKT	2012	2WD	1.24	N
LINCOLN	MKT	2012	4WD	1.27	N
LINCOLN	MKT	2013	2WD	1.24	N
LINCOLN	MKT	2013	4WD	1.27	N
LINCOLN	MKX	2007	2WD	1.25	N
LINCOLN	MKX	2007	4WD	1.30	N
LINCOLN	MKX	2008	2WD	1.25	N
LINCOLN	MKX	2008	4WD	1.30	N
LINCOLN	MKX	2009	2WD	1.25	N
LINCOLN	MKX	2009	4WD	1.30	N
LINCOLN	MKX	2010	2WD	1.25	N
LINCOLN	MKX	2010	4WD	1.30	N
LINCOLN	MKX	2011	2WD	1.25	N
LINCOLN	MKX	2011	4WD	1.30	N
LINCOLN	MKX	2012	2WD	1.25	N
LINCOLN	MKX	2012	4WD	1.30	N
LINCOLN	MKX	2013	2WD	1.25	N
LINCOLN	MKX	2013	4WD	1.30	N
LINCOLN	NAVIGATOR	2005	4WD	1.19	N
LINCOLN	NAVIGATOR	2006	4WD	1.19	N
LINCOLN	NAVIGATOR	2007	4WD	1.19	N
LINCOLN	NAVIGATOR	2008	2WD	1.16	N
LINCOLN	NAVIGATOR	2008	4WD	1.19	N
LINCOLN	NAVIGATOR	2009	2WD	1.16	N
LINCOLN	NAVIGATOR	2009	4WD	1.19	N
LINCOLN	NAVIGATOR	2010	2WD	1.16	N
LINCOLN	NAVIGATOR	2010	4WD	1.19	N
LINCOLN	NAVIGATOR	2011	2WD	1.16	N
LINCOLN	NAVIGATOR	2011	4WD	1.19	N
LINCOLN	NAVIGATOR	2012	2WD	1.16	N
LINCOLN	NAVIGATOR	2012	4WD	1.18	N
LINCOLN	NAVIGATOR	2013	2WD	1.16	N
LINCOLN	NAVIGATOR	2013	4WD	1.18	N
LINCOLN	NAVIGATOR EXT	2010	2WD	1.16	N
LINCOLN	NAVIGATOR EXT	2010	4WD	1.19	N
LINCOLN	NAVIGATOR EXT	2012	2WD	1.16	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
LINCOLN	NAVIGATOR EXT	2012	4WD	1.18	N
LINCOLN	NAVIGATOR EXT	2013	2WD	1.16	N
LINCOLN	NAVIGATOR EXT	2013	4WD	1.18	N
MAZDA	CX-5	2013	2WD	1.22	N
MAZDA	CX-5	2013	4WD	1.23	N
MAZDA	CX-7	2007	2WD	1.28	N
MAZDA	CX-7	2007	4WD	1.28	N
MAZDA	CX-7	2008	2WD	1.28	N
MAZDA	CX-7	2008	4WD	1.28	N
MAZDA	CX-7	2009	2WD	1.28	N
MAZDA	CX-7	2009	4WD	1.28	N
MAZDA	CX-7	2010	2WD	1.28	N
MAZDA	CX-7	2010	4WD	1.28	N
MAZDA	CX-7	2011	2WD	1.28	N
MAZDA	CX-7	2011	4WD	1.28	N
MAZDA	CX-7	2012	2WD	1.28	N
MAZDA	CX-7	2012	4WD	1.28	N
MAZDA	CX-9	2007	2WD	1.27	N
MAZDA	CX-9	2007	4WD	1.29	N
MAZDA	CX-9	2008	2WD	1.27	N
MAZDA	CX-9	2008	4WD	1.29	N
MAZDA	CX-9	2009	2WD	1.27	N
MAZDA	CX-9	2009	4WD	1.29	N
MAZDA	CX-9	2010	2WD	1.27	N
MAZDA	CX-9	2010	4WD	1.29	N
MAZDA	CX-9	2011	2WD	1.27	N
MAZDA	CX-9	2011	4WD	1.29	N
MAZDA	CX-9	2012	2WD	1.27	N
MAZDA	CX-9	2012	4WD	1.29	N
MAZDA	CX-9	2013	2WD	1.27	N
MAZDA	CX-9	2013	4WD	1.29	N
MAZDA	TRIBUTE	2005	2WD	1.17	Y
MAZDA	TRIBUTE	2005	4WD	1.21	Y
MAZDA	TRIBUTE	2006	2WD	1.17	Y
MAZDA	TRIBUTE	2006	4WD	1.21	Y
MAZDA	TRIBUTE	2008	2WD	1.13	N
MAZDA	TRIBUTE	2008	4WD	1.17	N
MAZDA	TRIBUTE	2009	2WD	1.13	N
MAZDA	TRIBUTE	2009	4WD	1.17	N
MAZDA	TRIBUTE	2010	2WD	1.13	N
MAZDA	TRIBUTE	2010	4WD	1.17	N
MAZDA	TRIBUTE	2011	2WD	1.13	N
MAZDA	TRIBUTE	2011	4WD	1.17	N
MAZDA	TRIBUTE HEV	2008	2WD	1.14	N
MAZDA	TRIBUTE HEV	2008	4WD	1.17	N
MAZDA	TRIBUTE HEV	2009	2WD	1.14	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
MAZDA	TRIBUTE HEV	2009	4WD	1.17	N
MAZDA	TRIBUTE HEV	2010	2WD	1.14	N
MAZDA	TRIBUTE HEV	2010	4WD	1.17	N
MAZDA	TRIBUTE HEV	2011	2WD	1.13	N
MAZDA	TRIBUTE HEV	2011	4WD	1.17	N
MERCEDES-BENZ	ML-CLASS	2006	4WD	1.21	N
MERCEDES-BENZ	ML-CLASS	2007	4WD	1.21	N
MERCEDES-BENZ	ML-CLASS	2008	4WD	1.21	N
MERCEDES-BENZ	ML-CLASS	2009	2WD	1.22	N
MERCEDES-BENZ	ML-CLASS	2009	4WD	1.21	N
MERCEDES-BENZ	ML-CLASS	2010	2WD	1.22	N
MERCEDES-BENZ	ML-CLASS	2010	4WD	1.21	N
MERCEDES-BENZ	ML-CLASS	2011	2WD	1.22	N
MERCEDES-BENZ	ML-CLASS	2011	4WD	1.21	N
MERCEDES-BENZ	ML-CLASS	2013	2WD	1.18	N
MERCEDES-BENZ	ML-CLASS	2013	4WD	1.21	N
MERCEDES-BENZ	ML-CLASS HEV	2010	4WD	1.21	N
MERCEDES-BENZ	ML-CLASS HEV	2011	2WD	1.22	N
MERCEDES-BENZ	ML-CLASS HEV	2011	4WD	1.21	N
MERCURY	MARINER	2005	2WD	1.17	Y
MERCURY	MARINER	2005	4WD	1.21	Y
MERCURY	MARINER	2006	2WD	1.17	Y
MERCURY	MARINER	2006	4WD	1.21	Y
MERCURY	MARINER	2007	2WD	1.17	Y
MERCURY	MARINER	2007	4WD	1.21	Y
MERCURY	MARINER	2008	2WD	1.13	N
MERCURY	MARINER	2008	4WD	1.17	N
MERCURY	MARINER	2009	2WD	1.13	N
MERCURY	MARINER	2009	4WD	1.17	N
MERCURY	MARINER	2010	2WD	1.13	N
MERCURY	MARINER	2010	4WD	1.17	N
MERCURY	MARINER	2011	2WD	1.13	N
MERCURY	MARINER	2011	4WD	1.17	N
MERCURY	MARINER HEV	2008	2WD	1.14	N
MERCURY	MARINER HEV	2008	4WD	1.17	N
MERCURY	MARINER HEV	2009	2WD	1.14	N
MERCURY	MARINER HEV	2009	4WD	1.17	N
MERCURY	MARINER HEV	2010	2WD	1.14	N
MERCURY	MARINER HEV	2010	4WD	1.17	N
MERCURY	MARINER HEV	2011	2WD	1.13	N
MERCURY	MARINER HEV	2011	4WD	1.17	N
MERCURY	MOUNTAINEER	2004	2WD	1.12	Y
MERCURY	MOUNTAINEER	2004	4WD	1.14	N
MERCURY	MOUNTAINEER	2005	2WD	1.12	N
MERCURY	MOUNTAINEER	2006	2WD	1.13	N
MERCURY	MOUNTAINEER	2006	4WD	1.14	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
MERCURY	MOUNTAINEER	2007	2WD	1.13	N
MERCURY	MOUNTAINEER	2007	4WD	1.14	N
MERCURY	MOUNTAINEER	2008	2WD	1.13	N
MERCURY	MOUNTAINEER	2008	4WD	1.14	N
MERCURY	MOUNTAINEER	2009	2WD	1.13	N
MERCURY	MOUNTAINEER	2009	4WD	1.14	N
MERCURY	MOUNTAINEER	2010	2WD	1.13	N
MERCURY	MOUNTAINEER	2010	4WD	1.14	N
MITSUBISHI	OUTLANDER	2007	2WD	1.19	N
MITSUBISHI	OUTLANDER	2007	4WD	1.23	N
MITSUBISHI	OUTLANDER	2008	2WD	1.19	N
MITSUBISHI	OUTLANDER	2008	4WD	1.23	N
MITSUBISHI	OUTLANDER	2009	2WD	1.19	N
MITSUBISHI	OUTLANDER	2009	4WD	1.23	N
MITSUBISHI	OUTLANDER	2010	2WD	1.19	N
MITSUBISHI	OUTLANDER	2010	4WD	1.23	N
MITSUBISHI	OUTLANDER	2011	2WD	1.19	N
MITSUBISHI	OUTLANDER	2011	4WD	1.23	N
MITSUBISHI	OUTLANDER	2012	2WD	1.19	N
MITSUBISHI	OUTLANDER	2012	4WD	1.23	N
MITSUBISHI	OUTLANDER	2013	2WD	1.19	N
MITSUBISHI	OUTLANDER	2013	4WD	1.23	N
MITSUBISHI	OUTLANDER SPORT	2012	2WD	1.19	N
MITSUBISHI	OUTLANDER SPORT	2012	4WD	1.23	N
MITSUBISHI	OUTLANDER SPORT	2013	2WD	1.19	N
MITSUBISHI	OUTLANDER SPORT	2013	4WD	1.23	N
NISSAN	ARMADA	2006	2WD	1.16	N
NISSAN	ARMADA	2006	4WD	1.15	N
NISSAN	ARMADA	2007	2WD	1.16	N
NISSAN	ARMADA	2007	4WD	1.15	N
NISSAN	ARMADA	2008	2WD	1.16	N
NISSAN	ARMADA	2008	4WD	1.15	N
NISSAN	ARMADA	2009	2WD	1.16	N
NISSAN	ARMADA	2009	4WD	1.15	N
NISSAN	ARMADA	2010	2WD	1.16	N
NISSAN	ARMADA	2010	4WD	1.15	N
NISSAN	ARMADA	2011	2WD	1.16	N
NISSAN	ARMADA	2011	4WD	1.15	N
NISSAN	ARMADA	2012	2WD	1.16	N
NISSAN	ARMADA	2012	4WD	1.15	N
NISSAN	ARMADA	2013	2WD	1.16	N
NISSAN	ARMADA	2013	4WD	1.15	N
NISSAN	CUBE	2009	2WD	1.22	N
NISSAN	CUBE	2010	2WD	1.22	N
NISSAN	CUBE	2011	2WD	1.22	N
NISSAN	CUBE	2012	2WD	1.22	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
NISSAN	CUBE	2013	2WD	1.22	N
NISSAN	JUKE	2012	2WD	1.25	N
NISSAN	JUKE	2012	4WD	1.27	N
NISSAN	JUKE	2013	2WD	1.25	N
NISSAN	JUKE	2013	4WD	1.27	N
NISSAN	MURANO	2004	2WD	1.25	N
NISSAN	MURANO	2004	4WD	1.27	N
NISSAN	MURANO	2005	2WD	1.25	N
NISSAN	MURANO	2005	4WD	1.27	N
NISSAN	MURANO	2006	2WD	1.25	N
NISSAN	MURANO	2006	4WD	1.27	N
NISSAN	MURANO	2007	2WD	1.25	N
NISSAN	MURANO	2007	4WD	1.27	N
NISSAN	MURANO	2009	2WD	1.21	N
NISSAN	MURANO	2009	4WD	1.20	N
NISSAN	MURANO	2010	2WD	1.21	N
NISSAN	MURANO	2010	4WD	1.20	N
NISSAN	MURANO	2011	2WD	1.21	N
NISSAN	MURANO	2011	4WD	1.20	N
NISSAN	MURANO	2012	2WD	1.21	N
NISSAN	MURANO	2012	4WD	1.20	N
NISSAN	MURANO	2013	2WD	1.21	N
NISSAN	MURANO	2013	4WD	1.20	N
NISSAN	PATHFINDER	2005	2WD	1.13	N
NISSAN	PATHFINDER	2005	4WD	1.14	N
NISSAN	PATHFINDER	2006	2WD	1.13	N
NISSAN	PATHFINDER	2006	4WD	1.14	N
NISSAN	PATHFINDER	2007	2WD	1.13	N
NISSAN	PATHFINDER	2007	4WD	1.14	N
NISSAN	PATHFINDER	2008	2WD	1.13	N
NISSAN	PATHFINDER	2008	4WD	1.14	N
NISSAN	PATHFINDER	2009	2WD	1.13	N
NISSAN	PATHFINDER	2009	4WD	1.14	N
NISSAN	PATHFINDER	2010	2WD	1.13	N
NISSAN	PATHFINDER	2010	4WD	1.14	N
NISSAN	PATHFINDER	2011	2WD	1.13	N
NISSAN	PATHFINDER	2011	4WD	1.14	N
NISSAN	PATHFINDER	2012	2WD	1.13	N
NISSAN	PATHFINDER	2012	4WD	1.14	N
NISSAN	PATHFINDER	2013	2WD	1.19	N
NISSAN	PATHFINDER	2013	4WD	1.23	N
NISSAN	ROGUE	2008	2WD	1.18	N
NISSAN	ROGUE	2008	4WD	1.21	N
NISSAN	ROGUE	2009	2WD	1.18	N
NISSAN	ROGUE	2009	4WD	1.21	N
NISSAN	ROGUE	2010	2WD	1.18	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
NISSAN	ROGUE	2010	4WD	1.21	N
NISSAN	ROGUE	2011	2WD	1.18	N
NISSAN	ROGUE	2011	4WD	1.21	N
NISSAN	ROGUE	2012	2WD	1.18	N
NISSAN	ROGUE	2012	4WD	1.21	N
NISSAN	ROGUE	2013	2WD	1.18	N
NISSAN	ROGUE	2013	4WD	1.21	N
NISSAN	XTERRA	2006	2WD	1.12	N
NISSAN	XTERRA	2006	4WD	1.11	N
NISSAN	XTERRA	2007	2WD	1.12	N
NISSAN	XTERRA	2007	4WD	1.11	N
NISSAN	XTERRA	2008	2WD	1.12	N
NISSAN	XTERRA	2008	4WD	1.11	N
NISSAN	XTERRA	2009	2WD	1.12	N
NISSAN	XTERRA	2009	4WD	1.11	N
NISSAN	XTERRA	2010	2WD	1.12	N
NISSAN	XTERRA	2010	4WD	1.11	N
NISSAN	XTERRA	2011	2WD	1.12	N
NISSAN	XTERRA	2011	4WD	1.11	N
NISSAN	XTERRA	2012	2WD	1.12	N
NISSAN	XTERRA	2012	4WD	1.11	N
NISSAN	XTERRA	2013	2WD	1.12	N
NISSAN	XTERRA	2013	4WD	1.11	N
OLDSMOBILE	BRAVADA	2004	2WD	1.17	N
OLDSMOBILE	BRAVADA	2004	4WD	1.19	N
PONTIAC	TORRENT	2006	2WD	1.23	Y
PONTIAC	TORRENT	2006	4WD	1.25	Y
PONTIAC	TORRENT	2007	2WD	1.20	N
PONTIAC	TORRENT	2007	4WD	1.24	N
PONTIAC	TORRENT	2008	2WD	1.20	N
PONTIAC	TORRENT	2008	4WD	1.24	N
PONTIAC	TORRENT	2009	2WD	1.20	N
PONTIAC	TORRENT	2009	4WD	1.24	N
SAAB	9-4X	2011	2WD	1.21	N
SAAB	9-4X	2011	4WD	1.24	N
SAAB	9-7X	2007	4WD	1.19	N
SAAB	9-7X	2008	4WD	1.19	N
SAAB	9-7X	2009	4WD	1.19	N
SATURN	OUTLOOK	2007	2WD	1.23	N
SATURN	OUTLOOK	2007	4WD	1.26	N
SATURN	OUTLOOK	2008	2WD	1.23	N
SATURN	OUTLOOK	2008	4WD	1.26	N
SATURN	OUTLOOK	2009	2WD	1.23	N
SATURN	OUTLOOK	2009	4WD	1.26	N
SATURN	OUTLOOK	2010	2WD	1.23	N
SATURN	OUTLOOK	2010	4WD	1.26	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
SATURN	VUE	2004	2WD	1.19	Y
SATURN	VUE	2004	4WD	1.21	Y
SATURN	VUE	2005	2WD	1.19	Y
SATURN	VUE	2005	4WD	1.21	Y
SATURN	VUE	2006	2WD	1.19	Y
SATURN	VUE	2006	4WD	1.21	Y
SATURN	VUE	2007	2WD	1.19	Y
SATURN	VUE	2007	4WD	1.21	Y
SATURN	VUE	2008	2WD	1.20	N
SATURN	VUE	2008	4WD	1.25	N
SATURN	VUE	2009	2WD	1.20	N
SATURN	VUE	2009	4WD	1.25	N
SATURN	VUE	2010	2WD	1.20	N
SATURN	VUE	2010	4WD	1.25	N
SATURN	VUE HEV	2008	2WD	1.20	N
SATURN	VUE HEV	2008	4WD	1.25	N
SATURN	VUE HEV	2009	2WD	1.20	N
SATURN	VUE HEV	2009	4WD	1.25	N
SUBARU	FORESTER	2009	4WD	1.21	N
SUBARU	FORESTER	2010	4WD	1.21	N
SUBARU	FORESTER	2011	4WD	1.21	N
SUBARU	FORESTER	2012	4WD	1.21	N
SUBARU	FORESTER	2013	4WD	1.21	N
SUBARU	OUTBACK	2005	4WD	1.25	N
SUBARU	OUTBACK	2006	4WD	1.25	N
SUBARU	OUTBACK	2007	4WD	1.25	N
SUBARU	OUTBACK	2008	4WD	1.25	N
SUBARU	OUTBACK	2009	4WD	1.25	N
SUBARU	OUTBACK	2010	4WD	1.22	N
SUBARU	OUTBACK	2011	4WD	1.22	N
SUBARU	OUTBACK	2012	4WD	1.22	N
SUBARU	OUTBACK	2013	4WD	1.22	N
SUBARU	TRIBECA	2006	4WD	1.24	N
SUBARU	TRIBECA	2007	4WD	1.24	N
SUBARU	TRIBECA	2008	4WD	1.24	N
SUBARU	TRIBECA	2009	4WD	1.24	N
SUBARU	TRIBECA	2010	4WD	1.24	N
SUBARU	TRIBECA	2011	4WD	1.24	N
SUBARU	TRIBECA	2012	4WD	1.24	N
SUBARU	TRIBECA	2013	4WD	1.24	N
SUZUKI	GRAND VITARA	2006	2WD	1.19	N
SUZUKI	GRAND VITARA	2006	4WD	1.20	N
SUZUKI	GRAND VITARA	2007	2WD	1.19	N
SUZUKI	GRAND VITARA	2007	4WD	1.20	N
SUZUKI	GRAND VITARA	2008	2WD	1.19	N
SUZUKI	GRAND VITARA	2008	4WD	1.20	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
SUZUKI	GRAND VITARA	2009	2WD	1.19	N
SUZUKI	GRAND VITARA	2009	4WD	1.20	N
SUZUKI	GRAND VITARA	2010	2WD	1.19	N
SUZUKI	GRAND VITARA	2010	4WD	1.20	N
SUZUKI	GRAND VITARA	2011	2WD	1.19	N
SUZUKI	GRAND VITARA	2011	4WD	1.20	N
SUZUKI	GRAND VITARA	2012	2WD	1.19	N
SUZUKI	GRAND VITARA	2012	4WD	1.20	N
SUZUKI	GRAND VITARA	2013	2WD	1.19	N
SUZUKI	GRAND VITARA	2013	4WD	1.20	N
SUZUKI	XL7	2007	2WD	1.21	N
SUZUKI	XL7	2007	4WD	1.24	N
SUZUKI	XL7	2008	2WD	1.21	N
SUZUKI	XL7	2008	4WD	1.24	N
SUZUKI	XL7	2009	2WD	1.21	N
SUZUKI	XL7	2009	4WD	1.24	N
TOYOTA	4RUNNER	2004	2WD	1.15	N
TOYOTA	4RUNNER	2004	4WD	1.17	N
TOYOTA	4RUNNER	2005	2WD	1.15	N
TOYOTA	4RUNNER	2005	4WD	1.17	N
TOYOTA	4RUNNER	2006	2WD	1.15	N
TOYOTA	4RUNNER	2006	4WD	1.17	N
TOYOTA	4RUNNER	2007	2WD	1.15	N
TOYOTA	4RUNNER	2007	4WD	1.17	N
TOYOTA	4RUNNER	2008	2WD	1.15	N
TOYOTA	4RUNNER	2008	4WD	1.17	N
TOYOTA	4RUNNER	2009	2WD	1.15	N
TOYOTA	4RUNNER	2009	4WD	1.17	N
TOYOTA	4RUNNER	2010	2WD	1.12	N
TOYOTA	4RUNNER	2010	4WD	1.12	N
TOYOTA	4RUNNER	2011	2WD	1.12	N
TOYOTA	4RUNNER	2011	4WD	1.12	N
TOYOTA	4RUNNER	2012	2WD	1.12	N
TOYOTA	4RUNNER	2012	4WD	1.12	N
TOYOTA	4RUNNER	2013	2WD	1.12	N
TOYOTA	4RUNNER	2013	4WD	1.12	N
TOYOTA	FJ CRUISER	2007	2WD	1.11	N
TOYOTA	FJ CRUISER	2007	4WD	1.10	N
TOYOTA	FJ CRUISER	2008	2WD	1.11	N
TOYOTA	FJ CRUISER	2008	4WD	1.10	N
TOYOTA	FJ CRUISER	2009	2WD	1.11	N
TOYOTA	FJ CRUISER	2009	4WD	1.10	N
TOYOTA	FJ CRUISER	2010	2WD	1.11	N
TOYOTA	FJ CRUISER	2010	4WD	1.10	N
TOYOTA	FJ CRUISER	2011	2WD	1.11	N
TOYOTA	FJ CRUISER	2011	4WD	1.10	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
TOYOTA	FJ CRUISER	2012	2WD	1.11	N
TOYOTA	FJ CRUISER	2012	4WD	1.10	N
TOYOTA	FJ CRUISER	2013	2WD	1.11	N
TOYOTA	FJ CRUISER	2013	4WD	1.10	N
TOYOTA	HIGHLANDER	2005	2WD	1.21	N
TOYOTA	HIGHLANDER	2005	4WD	1.22	N
TOYOTA	HIGHLANDER	2006	2WD	1.21	N
TOYOTA	HIGHLANDER	2006	4WD	1.22	N
TOYOTA	HIGHLANDER	2007	2WD	1.21	N
TOYOTA	HIGHLANDER	2007	4WD	1.22	N
TOYOTA	HIGHLANDER	2008	2WD	1.18	N
TOYOTA	HIGHLANDER	2008	4WD	1.22	N
TOYOTA	HIGHLANDER	2009	2WD	1.18	N
TOYOTA	HIGHLANDER	2009	4WD	1.22	N
TOYOTA	HIGHLANDER	2010	2WD	1.18	N
TOYOTA	HIGHLANDER	2010	4WD	1.22	N
TOYOTA	HIGHLANDER	2011	2WD	1.18	N
TOYOTA	HIGHLANDER	2011	4WD	1.22	N
TOYOTA	HIGHLANDER	2012	2WD	1.18	N
TOYOTA	HIGHLANDER	2012	4WD	1.22	N
TOYOTA	HIGHLANDER	2013	2WD	1.22	N
TOYOTA	HIGHLANDER	2013	4WD	1.22	N
TOYOTA	HIGHLANDER HEV	2008	4WD	1.22	N
TOYOTA	HIGHLANDER HEV	2009	2WD	1.18	N
TOYOTA	HIGHLANDER HEV	2009	4WD	1.22	N
TOYOTA	HIGHLANDER HEV	2010	2WD	1.18	N
TOYOTA	HIGHLANDER HEV	2010	4WD	1.22	N
TOYOTA	HIGHLANDER HEV	2011	4WD	1.22	N
TOYOTA	HIGHLANDER HEV	2012	4WD	1.22	N
TOYOTA	HIGHLANDER HEV	2013	4WD	1.22	N
TOYOTA	RAV4	2006	2WD	1.21	N
TOYOTA	RAV4	2006	4WD	1.22	N
TOYOTA	RAV4	2007	2WD	1.21	N
TOYOTA	RAV4	2007	4WD	1.22	N
TOYOTA	RAV4	2008	2WD	1.21	N
TOYOTA	RAV4	2008	4WD	1.22	N
TOYOTA	RAV4	2009	2WD	1.20	N
TOYOTA	RAV4	2009	4WD	1.22	N
TOYOTA	RAV4	2010	2WD	1.20	N
TOYOTA	RAV4	2010	4WD	1.22	N
TOYOTA	RAV4	2011	2WD	1.20	N
TOYOTA	RAV4	2011	4WD	1.22	N
TOYOTA	RAV4	2012	2WD	1.20	N
TOYOTA	RAV4	2012	4WD	1.22	N
TOYOTA	RAV4	2013	2WD	1.22	N
TOYOTA	RAV4	2013	4WD	1.23	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
TOYOTA	SCION XB	2008	2WD	1.30	N
TOYOTA	SCION XB	2009	2WD	1.30	N
TOYOTA	SCION XB	2010	2WD	1.30	N
TOYOTA	SCION XB	2011	2WD	1.30	N
TOYOTA	SCION XB	2012	2WD	1.30	N
TOYOTA	SCION XB	2013	2WD	1.30	N
TOYOTA	SEQUOIA	2008	2WD	1.20	N
TOYOTA	SEQUOIA	2008	4WD	1.20	N
TOYOTA	SEQUOIA	2009	2WD	1.20	N
TOYOTA	SEQUOIA	2009	4WD	1.20	N
TOYOTA	SEQUOIA	2010	2WD	1.20	N
TOYOTA	SEQUOIA	2010	4WD	1.20	N
TOYOTA	SEQUOIA	2011	2WD	1.20	N
TOYOTA	SEQUOIA	2011	4WD	1.20	N
TOYOTA	SEQUOIA	2012	2WD	1.20	N
TOYOTA	SEQUOIA	2012	4WD	1.20	N
TOYOTA	SEQUOIA	2013	2WD	1.20	N
TOYOTA	SEQUOIA	2013	4WD	1.20	N
TOYOTA	VENZA	2009	2WD	1.26	N
TOYOTA	VENZA	2009	4WD	1.29	N
TOYOTA	VENZA	2010	2WD	1.26	N
TOYOTA	VENZA	2010	4WD	1.29	N
TOYOTA	VENZA	2011	2WD	1.26	N
TOYOTA	VENZA	2011	4WD	1.29	N
TOYOTA	VENZA	2012	2WD	1.26	N
TOYOTA	VENZA	2012	4WD	1.29	N
TOYOTA	VENZA	2013	2WD	1.26	N
TOYOTA	VENZA	2013	4WD	1.29	N
VOLKSWAGEN	TIGUAN	2009	2WD	1.20	N
VOLKSWAGEN	TIGUAN	2009	4WD	1.22	N
VOLKSWAGEN	TIGUAN	2010	2WD	1.20	N
VOLKSWAGEN	TIGUAN	2010	4WD	1.22	N
VOLKSWAGEN	TIGUAN	2011	2WD	1.20	N
VOLKSWAGEN	TIGUAN	2011	4WD	1.22	N
VOLKSWAGEN	TIGUAN	2012	2WD	1.20	N
VOLKSWAGEN	TIGUAN	2012	4WD	1.22	N
VOLKSWAGEN	TIGUAN	2013	2WD	1.20	N
VOLKSWAGEN	TIGUAN	2013	4WD	1.22	N
VOLKSWAGEN	TOUAREG	2007	4WD	1.23	N
VOLKSWAGEN	TOUAREG 2	2008	4WD	1.23	N
VOLKSWAGEN	TOUAREG 2	2009	4WD	1.23	N
VOLKSWAGEN	TOUAREG 2	2010	4WD	1.23	N
VOLVO	XC60	2011	2WD	1.22	N
VOLVO	XC60	2011	4WD	1.22	N
VOLVO	XC60	2012	2WD	1.22	N
VOLVO	XC60	2012	4WD	1.22	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
VOLVO	XC60	2013	2WD	1.22	N
VOLVO	XC60	2013	4WD	1.22	N
VOLVO	XC90	2004	4WD	1.21	N
VOLVO	XC90	2005	4WD	1.21	N
VOLVO	XC90	2006	4WD	1.21	N
VOLVO	XC90	2007	4WD	1.21	N
VOLVO	XC90	2008	2WD	1.19	N
VOLVO	XC90	2008	4WD	1.21	N
VOLVO	XC90	2009	2WD	1.19	N
VOLVO	XC90	2009	4WD	1.21	N
VOLVO	XC90	2010	2WD	1.19	N
VOLVO	XC90	2010	4WD	1.21	N
VOLVO	XC90	2011	2WD	1.19	N
VOLVO	XC90	2011	4WD	1.21	N
VOLVO	XC90	2012	2WD	1.19	N
VOLVO	XC90	2012	4WD	1.21	N
VOLVO	XC90	2013	2WD	1.19	N
VOLVO	XC90	2013	4WD	1.21	N

A.3 SSF of Pickup Trucks MY 2004 to 2013

Description	Drive System
2WD	Front-wheel Drive, Rear-wheel Drive, 4x2
4WD	All-wheel Drive, 4x4

Employing the convention of the table in Section 2.1.3, the following table shows the make name, the model name, MY, the drive system description, and the NCAP dynamic rollover test result of the test pickup trucks from MY 2004 to 2013.

Make	Model	MY	Drive System Description	SSF	TIP-UP
CHEVROLET	COLORADO	2005	2WD	1.20	N
CHEVROLET	COLORADO	2005	4WD	1.21	N
CHEVROLET	COLORADO	2006	2WD	1.20	N
CHEVROLET	COLORADO	2006	4WD	1.21	N
CHEVROLET	COLORADO	2007	2WD	1.20	N
CHEVROLET	COLORADO	2007	4WD	1.21	N
CHEVROLET	COLORADO	2008	2WD	1.20	N
CHEVROLET	COLORADO	2008	4WD	1.21	N
CHEVROLET	COLORADO	2009	2WD	1.20	N
CHEVROLET	COLORADO	2009	4WD	1.21	N
CHEVROLET	COLORADO	2010	2WD	1.20	N
CHEVROLET	COLORADO	2010	4WD	1.21	N
CHEVROLET	COLORADO	2011	2WD	1.20	N
CHEVROLET	COLORADO	2011	4WD	1.21	N
CHEVROLET	COLORADO	2012	2WD	1.20	N
CHEVROLET	COLORADO	2012	4WD	1.21	N
CHEVROLET	SILVERADO 1500	2007	2WD	1.19	N
CHEVROLET	SILVERADO 1500	2007	4WD	1.20	N
CHEVROLET	SILVERADO 1500	2008	2WD	1.19	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
CHEVROLET	SILVERADO 1500	2008	4WD	1.20	N
CHEVROLET	SILVERADO 1500	2009	2WD	1.19	N
CHEVROLET	SILVERADO 1500	2009	4WD	1.20	N
CHEVROLET	SILVERADO 1500	2010	2WD	1.19	N
CHEVROLET	SILVERADO 1500	2010	4WD	1.20	N
CHEVROLET	SILVERADO 1500	2011	2WD	1.19	N
CHEVROLET	SILVERADO 1500	2011	4WD	1.20	N
CHEVROLET	SILVERADO 1500	2012	2WD	1.19	N
CHEVROLET	SILVERADO 1500	2012	4WD	1.20	N
CHEVROLET	SILVERADO 1500	2013	2WD	1.19	N
CHEVROLET	SILVERADO 1500	2013	4WD	1.20	N
CHEVROLET	SILVERADO 1500 CLASSIC	2004	2WD	1.25	N
CHEVROLET	SILVERADO 1500 CLASSIC	2004	4WD	1.20	N
CHEVROLET	SILVERADO 1500 CLASSIC	2005	2WD	1.25	N
CHEVROLET	SILVERADO 1500 CLASSIC	2005	4WD	1.20	N
CHEVROLET	SILVERADO 1500 CLASSIC	2006	2WD	1.25	N
CHEVROLET	SILVERADO 1500 CLASSIC	2006	4WD	1.20	N
CHEVROLET	SILVERADO 1500 CLASSIC	2007	2WD	1.25	N
CHEVROLET	SILVERADO 1500 CLASSIC	2007	4WD	1.20	N
CHEVROLET	SILVERADO 2500	2009	2WD	1.17	N
CHEVROLET	SILVERADO 2500	2009	4WD	1.19	N
CHEVROLET	SILVERADO 2500	2010	2WD	1.17	N
CHEVROLET	SILVERADO 2500	2010	4WD	1.19	N
CHEVROLET	SILVERADO 2500	2011	2WD	1.17	N
CHEVROLET	SILVERADO 2500	2011	4WD	1.19	N
CHEVROLET	SILVERADO 2500	2012	2WD	1.17	N
CHEVROLET	SILVERADO 2500	2012	4WD	1.19	N
CHEVROLET	SILVERADO 2500	2013	2WD	1.17	N
CHEVROLET	SILVERADO 2500	2013	4WD	1.19	N
DODGE	DAKOTA	2005	2WD	1.19	N
DODGE	DAKOTA	2005	4WD	1.21	N
DODGE	DAKOTA	2006	2WD	1.19	N
DODGE	DAKOTA	2006	4WD	1.21	N
DODGE	DAKOTA	2007	2WD	1.19	N
DODGE	DAKOTA	2007	4WD	1.21	N
DODGE	DAKOTA	2008	2WD	1.19	N
DODGE	DAKOTA	2008	4WD	1.21	N
DODGE	DAKOTA	2009	2WD	1.19	N
DODGE	DAKOTA	2009	4WD	1.21	N
DODGE	DAKOTA	2010	2WD	1.19	N
DODGE	DAKOTA	2010	4WD	1.21	N
DODGE	RAM 1500	2005	2WD	1.21	N
DODGE	RAM 1500	2005	4WD	1.18	N
DODGE	RAM 1500	2006	2WD	1.21	N
DODGE	RAM 1500	2006	4WD	1.18	N
DODGE	RAM 1500	2007	2WD	1.21	N
DODGE	RAM 1500	2007	4WD	1.18	N
DODGE	RAM 1500	2008	2WD	1.21	N
DODGE	RAM 1500	2008	4WD	1.18	N
DODGE	RAM 1500	2009	2WD	1.18	N
DODGE	RAM 1500	2009	4WD	1.15	N
DODGE	RAM 1500	2010	2WD	1.18	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
DODGE	RAM 1500	2010	4WD	1.15	N
DODGE	RAM 2500	2010	2WD	1.26	N
DODGE	RAM 2500	2010	4WD	1.13	N
FORD	F-150	2004	2WD	1.22	N
FORD	F-150	2004	4WD	1.18	N
FORD	F-150	2005	2WD	1.22	N
FORD	F-150	2005	4WD	1.18	N
FORD	F-150	2006	2WD	1.22	N
FORD	F-150	2006	4WD	1.18	N
FORD	F-150	2007	2WD	1.22	N
FORD	F-150	2007	4WD	1.18	N
FORD	F-150	2008	2WD	1.22	N
FORD	F-150	2008	4WD	1.18	N
FORD	F-150	2009	2WD	1.18	N
FORD	F-150	2009	4WD	1.14	N
FORD	F-150	2010	2WD	1.18	N
FORD	F-150	2010	4WD	1.14	N
FORD	F-150	2011	2WD	1.18	N
FORD	F-150	2011	4WD	1.14	N
FORD	F-150	2012	2WD	1.18	N
FORD	F-150	2012	4WD	1.14	N
FORD	F-150	2013	2WD	1.18	N
FORD	F-150	2013	4WD	1.14	N
FORD	F-250	2009	2WD	1.19	N
FORD	F-250	2009	4WD	1.13	N
FORD	F-250	2010	2WD	1.19	N
FORD	F-250	2010	4WD	1.13	N
FORD	F-250	2011	2WD	1.19	N
FORD	F-250	2011	4WD	1.13	N
FORD	F-250	2012	2WD	1.19	N
FORD	F-250	2012	4WD	1.13	N
FORD	F-250	2013	2WD	1.19	N
FORD	F-250	2013	4WD	1.13	N
FORD	RANGER	2005	2WD	1.15	N
FORD	RANGER	2005	4WD	1.07	N
FORD	RANGER	2006	2WD	1.15	N
FORD	RANGER	2006	4WD	1.07	N
FORD	RANGER	2007	2WD	1.15	N
FORD	RANGER	2007	4WD	1.07	N
FORD	RANGER	2008	2WD	1.15	N
FORD	RANGER	2008	4WD	1.10	N
FORD	RANGER	2009	2WD	1.15	N
FORD	RANGER	2009	4WD	1.10	N
FORD	RANGER	2010	2WD	1.15	N
FORD	RANGER	2010	4WD	1.10	N
FORD	RANGER	2011	2WD	1.15	N
FORD	RANGER	2011	4WD	1.10	N
GMC	CANYON	2005	2WD	1.20	N
GMC	CANYON	2005	4WD	1.21	N
GMC	CANYON	2006	2WD	1.20	N
GMC	CANYON	2006	4WD	1.21	N
GMC	CANYON	2007	2WD	1.20	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
GMC	CANYON	2007	4WD	1.21	N
GMC	CANYON	2008	2WD	1.20	N
GMC	CANYON	2008	4WD	1.21	N
GMC	CANYON	2009	2WD	1.20	N
GMC	CANYON	2009	4WD	1.21	N
GMC	CANYON	2010	2WD	1.20	N
GMC	CANYON	2010	4WD	1.21	N
GMC	CANYON	2011	2WD	1.20	N
GMC	CANYON	2011	4WD	1.21	N
GMC	CANYON	2012	2WD	1.20	N
GMC	CANYON	2012	4WD	1.21	N
GMC	SIERRA 1500	2007	2WD	1.19	N
GMC	SIERRA 1500	2007	4WD	1.20	N
GMC	SIERRA 1500	2008	2WD	1.19	N
GMC	SIERRA 1500	2008	4WD	1.20	N
GMC	SIERRA 1500	2009	2WD	1.19	N
GMC	SIERRA 1500	2009	4WD	1.20	N
GMC	SIERRA 1500	2010	2WD	1.19	N
GMC	SIERRA 1500	2010	4WD	1.20	N
GMC	SIERRA 1500	2011	2WD	1.19	N
GMC	SIERRA 1500	2011	4WD	1.20	N
GMC	SIERRA 1500	2012	2WD	1.19	N
GMC	SIERRA 1500	2012	4WD	1.20	N
GMC	SIERRA 1500	2013	2WD	1.19	N
GMC	SIERRA 1500	2013	4WD	1.20	N
GMC	SIERRA 1500 CLASSIC	2004	2WD	1.25	N
GMC	SIERRA 1500 CLASSIC	2004	4WD	1.20	N
GMC	SIERRA 1500 CLASSIC	2005	2WD	1.25	N
GMC	SIERRA 1500 CLASSIC	2005	4WD	1.20	N
GMC	SIERRA 1500 CLASSIC	2006	2WD	1.25	N
GMC	SIERRA 1500 CLASSIC	2006	4WD	1.20	N
GMC	SIERRA 1500 CLASSIC	2007	2WD	1.25	N
GMC	SIERRA 1500 CLASSIC	2007	4WD	1.20	N
GMC	SIERRA 2500	2009	2WD	1.17	N
GMC	SIERRA 2500	2009	4WD	1.19	N
GMC	SIERRA 2500	2010	2WD	1.17	N
GMC	SIERRA 2500	2010	4WD	1.19	N
GMC	SIERRA 2500	2011	2WD	1.17	N
GMC	SIERRA 2500	2011	4WD	1.19	N
GMC	SIERRA 2500	2012	2WD	1.17	N
GMC	SIERRA 2500	2012	4WD	1.19	N
GMC	SIERRA 2500	2013	2WD	1.17	N
GMC	SIERRA 2500	2013	4WD	1.19	N
HONDA	RIDGELINE	2006	4WD	1.29	N
HONDA	RIDGELINE	2007	4WD	1.29	N
HONDA	RIDGELINE	2008	4WD	1.29	N
HONDA	RIDGELINE	2009	4WD	1.29	N
HONDA	RIDGELINE	2010	4WD	1.29	N
HONDA	RIDGELINE	2011	4WD	1.29	N
HONDA	RIDGELINE	2012	4WD	1.29	N
HONDA	RIDGELINE	2013	4WD	1.29	N
ISUZU	I-280	2006	2WD	1.20	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
ISUZU	I-280	2006	4WD	1.21	N
ISUZU	I-290	2007	2WD	1.20	N
ISUZU	I-290	2007	4WD	1.21	N
ISUZU	I-290	2008	2WD	1.20	N
ISUZU	I-290	2008	4WD	1.21	N
ISUZU	I-350	2006	2WD	1.20	N
ISUZU	I-350	2006	4WD	1.21	N
ISUZU	I-370	2007	2WD	1.20	N
ISUZU	I-370	2007	4WD	1.21	N
ISUZU	I-370	2008	2WD	1.20	N
ISUZU	I-370	2008	4WD	1.21	N
LINCOLN	MARK LT	2006	2WD	1.22	N
LINCOLN	MARK LT	2006	4WD	1.18	N
LINCOLN	MARK LT	2007	2WD	1.22	N
LINCOLN	MARK LT	2007	4WD	1.18	N
LINCOLN	MARK LT	2008	2WD	1.22	N
LINCOLN	MARK LT	2008	4WD	1.18	N
MAZDA	B-SERIES	2005	2WD	1.15	N
MAZDA	B-SERIES	2005	4WD	1.07	N
MAZDA	B-SERIES	2006	2WD	1.15	N
MAZDA	B-SERIES	2006	4WD	1.07	N
MAZDA	B-SERIES	2007	2WD	1.15	N
MAZDA	B-SERIES	2007	4WD	1.07	N
MAZDA	B-SERIES	2008	2WD	1.15	N
MAZDA	B-SERIES	2008	4WD	1.10	N
MAZDA	B-SERIES	2009	2WD	1.15	N
MAZDA	B-SERIES	2009	4WD	1.10	N
MITSUBISHI	RAIDER	2007	2WD	1.19	N
MITSUBISHI	RAIDER	2007	4WD	1.21	N
MITSUBISHI	RAIDER	2008	2WD	1.19	N
MITSUBISHI	RAIDER	2008	4WD	1.21	N
MITSUBISHI	RAIDER	2009	2WD	1.19	N
MITSUBISHI	RAIDER	2009	4WD	1.21	N
NISSAN	FRONTIER	2006	2WD	1.16	N
NISSAN	FRONTIER	2006	4WD	1.18	N
NISSAN	FRONTIER	2007	2WD	1.16	N
NISSAN	FRONTIER	2007	4WD	1.18	N
NISSAN	FRONTIER	2008	2WD	1.16	N
NISSAN	FRONTIER	2008	4WD	1.18	N
NISSAN	FRONTIER	2009	2WD	1.16	N
NISSAN	FRONTIER	2009	4WD	1.18	N
NISSAN	FRONTIER	2010	2WD	1.16	N
NISSAN	FRONTIER	2010	4WD	1.18	N
NISSAN	FRONTIER	2011	2WD	1.16	N
NISSAN	FRONTIER	2011	4WD	1.18	N
NISSAN	FRONTIER	2012	2WD	1.16	N
NISSAN	FRONTIER	2012	4WD	1.18	N
NISSAN	FRONTIER	2013	2WD	1.16	N
NISSAN	FRONTIER	2013	4WD	1.18	N
NISSAN	TITAN	2006	2WD	1.19	N
NISSAN	TITAN	2006	4WD	1.16	N
NISSAN	TITAN	2007	2WD	1.19	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
NISSAN	TITAN	2007	4WD	1.16	N
NISSAN	TITAN	2008	2WD	1.19	N
NISSAN	TITAN	2008	4WD	1.16	N
NISSAN	TITAN	2009	2WD	1.19	N
NISSAN	TITAN	2009	4WD	1.16	N
NISSAN	TITAN	2010	2WD	1.19	N
NISSAN	TITAN	2010	4WD	1.16	N
NISSAN	TITAN	2011	2WD	1.19	N
NISSAN	TITAN	2011	4WD	1.16	N
NISSAN	TITAN	2012	2WD	1.19	N
NISSAN	TITAN	2012	4WD	1.16	N
NISSAN	TITAN	2013	2WD	1.19	N
NISSAN	TITAN	2013	4WD	1.16	N
RAM	1500	2011	2WD	1.18	N
RAM	1500	2011	4WD	1.15	N
RAM	1500	2012	2WD	1.18	N
RAM	1500	2012	4WD	1.15	N
RAM	1500	2013	2WD	1.18	N
RAM	1500	2013	4WD	1.15	N
RAM	2500	2011	2WD	1.26	N
RAM	2500	2011	4WD	1.13	N
RAM	2500	2012	2WD	1.26	N
RAM	2500	2012	4WD	1.13	N
RAM	2500	2013	2WD	1.26	N
RAM	2500	2013	4WD	1.13	N
RAM	DAKOTA	2011	2WD	1.19	N
RAM	DAKOTA	2011	4WD	1.21	N
SUZUKI	EQUATOR	2009	2WD	1.16	N
SUZUKI	EQUATOR	2009	4WD	1.18	N
SUZUKI	EQUATOR	2010	2WD	1.16	N
SUZUKI	EQUATOR	2010	4WD	1.18	N
SUZUKI	EQUATOR	2011	2WD	1.16	N
SUZUKI	EQUATOR	2011	4WD	1.18	N
SUZUKI	EQUATOR	2012	2WD	1.16	N
SUZUKI	EQUATOR	2012	4WD	1.18	N
TOYOTA	TACOMA	2004	2WD	1.23	Y
TOYOTA	TACOMA	2004	4WD	1.12	Y
TOYOTA	TACOMA	2006	2WD	1.28	N
TOYOTA	TACOMA	2006	4WD	1.19	N
TOYOTA	TACOMA	2007	2WD	1.28	N
TOYOTA	TACOMA	2007	4WD	1.19	N
TOYOTA	TACOMA	2008	2WD	1.28	N
TOYOTA	TACOMA	2008	4WD	1.19	N
TOYOTA	TACOMA	2009	2WD	1.28	N
TOYOTA	TACOMA	2009	4WD	1.19	N
TOYOTA	TACOMA	2010	2WD	1.28	N
TOYOTA	TACOMA	2010	4WD	1.19	N
TOYOTA	TACOMA	2011	2WD	1.28	N
TOYOTA	TACOMA	2011	4WD	1.19	N
TOYOTA	TACOMA	2012	2WD	1.28	N
TOYOTA	TACOMA	2012	4WD	1.19	N
TOYOTA	TACOMA	2013	2WD	1.28	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
TOYOTA	TACOMA	2013	4WD	1.19	N
TOYOTA	TUNDRA	2006	2WD	1.16	N
TOYOTA	TUNDRA	2006	4WD	1.17	N
TOYOTA	TUNDRA	2007	2WD	1.17	N
TOYOTA	TUNDRA	2007	4WD	1.18	N
TOYOTA	TUNDRA	2008	2WD	1.17	N
TOYOTA	TUNDRA	2008	4WD	1.18	N
TOYOTA	TUNDRA	2009	2WD	1.17	N
TOYOTA	TUNDRA	2009	4WD	1.18	N
TOYOTA	TUNDRA	2010	2WD	1.17	N
TOYOTA	TUNDRA	2010	4WD	1.18	N
TOYOTA	TUNDRA	2011	2WD	1.17	N
TOYOTA	TUNDRA	2011	4WD	1.18	N
TOYOTA	TUNDRA	2012	2WD	1.17	N
TOYOTA	TUNDRA	2012	4WD	1.18	N
TOYOTA	TUNDRA	2013	2WD	1.17	N
TOYOTA	TUNDRA	2013	4WD	1.18	N

A.4 SSF of Minivans MY 2004 to 2013

Description	Drive System
2WD	Front-wheel Drive, Rear-wheel Drive, 4x2
4WD	All-wheel Drive, 4x4

Employing the convention of the table in Section 2.1.3, the following table shows the make name, the model name, MY, the drive system description, and the NCAP dynamic rollover test result of the test minivans from MY 2004 to 2013.

Make	Model	MY	Drive System Description	SSF	TIP-UP
BUICK	TERRAZA	2006	2WD	1.17	N
BUICK	TERRAZA	2007	2WD	1.17	N
CHEVROLET	UPLANDER	2006	2WD	1.17	N
CHEVROLET	UPLANDER	2007	2WD	1.17	N
CHEVROLET	UPLANDER	2008	2WD	1.17	N
CHRYSLER	TOWN & COUNTRY	2008	2WD	1.24	N
CHRYSLER	TOWN & COUNTRY	2009	2WD	1.24	N
CHRYSLER	TOWN & COUNTRY	2010	2WD	1.24	N
CHRYSLER	TOWN & COUNTRY	2011	2WD	1.24	N
CHRYSLER	TOWN & COUNTRY	2012	2WD	1.24	N
CHRYSLER	TOWN & COUNTRY	2013	2WD	1.24	N
CHRYSLER	TOWN & COUNTRY LWB	2005	2WD	1.22	N
CHRYSLER	TOWN & COUNTRY LWB	2006	2WD	1.22	N
CHRYSLER	TOWN & COUNTRY LWB	2007	2WD	1.22	N
CHRYSLER	TOWN & COUNTRY SWB	2006	2WD	1.23	N
CHRYSLER	TOWN & COUNTRY SWB	2007	2WD	1.23	N
CHRYSLER	TOWN & COUNTRY	2008	2WD	1.24	N
CHRYSLER	TOWN & COUNTRY	2009	2WD	1.24	N
CHRYSLER	TOWN & COUNTRY	2010	2WD	1.24	N
CHRYSLER	TOWN & COUNTRY	2011	2WD	1.24	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
CHRYSLER	TOWN & COUNTRY	2012	2WD	1.24	N
CHRYSLER	TOWN & COUNTRY	2013	2WD	1.24	N
DODGE	CARAVAN	2006	2WD	1.23	N
DODGE	CARAVAN	2007	2WD	1.23	N
DODGE	GRAND CARAVAN	2005	2WD	1.22	N
DODGE	GRAND CARAVAN	2006	2WD	1.22	N
DODGE	GRAND CARAVAN	2007	2WD	1.22	N
DODGE	GRAND CARAVAN	2008	2WD	1.24	N
DODGE	GRAND CARAVAN	2009	2WD	1.24	N
DODGE	GRAND CARAVAN	2010	2WD	1.24	N
DODGE	GRAND CARAVAN	2011	2WD	1.24	N
DODGE	GRAND CARAVAN	2012	2WD	1.24	N
DODGE	GRAND CARAVAN	2013	2WD	1.24	N
FORD	FREESTAR	2004	2WD	1.28	N
FORD	FREESTAR	2005	2WD	1.28	N
FORD	FREESTAR	2006	2WD	1.28	N
FORD	FREESTAR	2007	2WD	1.28	N
FORD	TRANSIT CONNECT	2010	2WD	1.11	N
FORD	TRANSIT CONNECT	2011	2WD	1.11	N
FORD	TRANSIT CONNECT	2012	2WD	1.11	N
FORD	TRANSIT CONNECT	2013	2WD	1.11	N
HONDA	ODYSSEY	2005	2WD	1.30	N
HONDA	ODYSSEY	2006	2WD	1.30	N
HONDA	ODYSSEY	2007	2WD	1.30	N
HONDA	ODYSSEY	2008	2WD	1.30	N
HONDA	ODYSSEY	2009	2WD	1.30	N
HONDA	ODYSSEY	2010	2WD	1.30	N
HONDA	ODYSSEY	2011	2WD	1.34	N
HONDA	ODYSSEY	2012	2WD	1.34	N
HONDA	ODYSSEY	2013	2WD	1.34	N
HYUNDAI	ENTOURAGE	2007	2WD	1.31	N
HYUNDAI	ENTOURAGE	2008	2WD	1.31	N
HYUNDAI	ENTOURAGE	2009	2WD	1.31	N
HYUNDAI	ENTOURAGE	2010	2WD	1.31	N
KIA	SEDONA	2005	2WD	1.27	N
KIA	SEDONA	2006	2WD	1.31	N
KIA	SEDONA	2007	2WD	1.31	N
KIA	SEDONA	2008	2WD	1.31	N
KIA	SEDONA	2009	2WD	1.31	N
KIA	SEDONA	2010	2WD	1.31	N
KIA	SEDONA	2011	2WD	1.31	N
KIA	SEDONA	2012	2WD	1.31	N
MERCURY	MONTEREY	2004	2WD	1.28	N
MERCURY	MONTEREY	2005	2WD	1.28	N
MERCURY	MONTEREY	2006	2WD	1.28	N
MERCURY	MONTEREY	2007	2WD	1.28	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
NISSAN	QUEST	2004	2WD	1.36	N
NISSAN	QUEST	2005	2WD	1.36	N
NISSAN	QUEST	2006	2WD	1.36	N
NISSAN	QUEST	2007	2WD	1.36	N
NISSAN	QUEST	2008	2WD	1.36	N
NISSAN	QUEST	2009	2WD	1.36	N
PONTIAC	MONTANA SV6	2006	2WD	1.17	N
SATURN	RELAY	2006	2WD	1.17	N
SATURN	RELAY	2007	2WD	1.17	N
TOYOTA	SIENNA	2004	2WD	1.25	N
TOYOTA	SIENNA	2005	2WD	1.25	N
TOYOTA	SIENNA	2006	2WD	1.25	N
TOYOTA	SIENNA	2007	2WD	1.25	N
TOYOTA	SIENNA	2008	2WD	1.25	N
TOYOTA	SIENNA	2008	4WD	1.23	N
TOYOTA	SIENNA	2009	2WD	1.25	N
TOYOTA	SIENNA	2009	4WD	1.23	N
TOYOTA	SIENNA	2010	2WD	1.25	N
TOYOTA	SIENNA	2010	4WD	1.23	N
TOYOTA	SIENNA	2011	2WD	1.30	N
TOYOTA	SIENNA	2011	4WD	1.30	N
TOYOTA	SIENNA	2012	2WD	1.30	N
TOYOTA	SIENNA	2012	4WD	1.30	N
TOYOTA	SIENNA	2013	2WD	1.30	N
TOYOTA	SIENNA	2013	4WD	1.30	N
VOLKSWAGEN	ROUTAN	2009	2WD	1.24	N
VOLKSWAGEN	ROUTAN	2010	2WD	1.24	N
VOLKSWAGEN	ROUTAN	2011	2WD	1.24	N
VOLKSWAGEN	ROUTAN	2012	2WD	1.24	N
VOLKSWAGEN	ROUTAN	2013	2WD	1.24	N

A.5 SSF of Full-size passenger vans MY 2004 to 2013

Description	Drive System
2WD	Front-wheel Drive, Rear-wheel Drive, 4x2
4WD	All-wheel Drive, 4x4

Employing the convention of the table in Section 2.1.3, the following table shows the make name, the model name, MY, the drive system description, and the NCAP dynamic rollover test result of the test full-size passenger vans from MY 2004 to 2013.

Make	Model	MY	Drive System Description	SSF	TIP-UP
CHEVROLET	EXPRESS 1500	2006	2WD	1.12	Y
CHEVROLET	EXPRESS 1500	2007	2WD	1.12	Y
CHEVROLET	EXPRESS 1500	2008	2WD	1.09	N
CHEVROLET	EXPRESS 1500	2008	4WD	1.14	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
CHEVROLET	EXPRESS 1500	2009	2WD	1.09	N
CHEVROLET	EXPRESS 1500	2009	4WD	1.14	N
CHEVROLET	EXPRESS 1500	2010	2WD	1.09	N
CHEVROLET	EXPRESS 1500	2010	4WD	1.14	N
CHEVROLET	EXPRESS 1500	2011	2WD	1.09	N
CHEVROLET	EXPRESS 1500	2011	4WD	1.14	N
CHEVROLET	EXPRESS 1500	2012	2WD	1.09	N
CHEVROLET	EXPRESS 1500	2012	4WD	1.14	N
CHEVROLET	EXPRESS 1500	2013	2WD	1.09	N
CHEVROLET	EXPRESS 1500	2013	4WD	1.14	N
CHEVROLET	EXPRESS 2500	2008	2WD	1.08	N
CHEVROLET	EXPRESS 2500	2009	2WD	1.08	N
CHEVROLET	EXPRESS 2500	2010	2WD	1.08	N
CHEVROLET	EXPRESS 2500	2011	2WD	1.08	N
CHEVROLET	EXPRESS 2500	2012	2WD	1.08	N
CHEVROLET	EXPRESS 2500	2013	2WD	1.08	N
CHEVROLET	EXPRESS 3500	2004	2WD	1.09	N
CHEVROLET	EXPRESS 3500	2005	2WD	1.09	N
CHEVROLET	EXPRESS 3500	2006	2WD	1.09	N
CHEVROLET	EXPRESS 3500	2007	2WD	1.09	N
CHEVROLET	EXPRESS 3500	2008	2WD	1.09	N
CHEVROLET	EXPRESS 3500	2009	2WD	1.08	N
CHEVROLET	EXPRESS 3500	2010	2WD	1.08	N
CHEVROLET	EXPRESS 3500	2011	2WD	1.08	N
CHEVROLET	EXPRESS 3500	2012	2WD	1.08	N
CHEVROLET	EXPRESS 3500	2013	2WD	1.08	N
CHEVROLET	UPLANDER	2006	2WD	1.17	N
CHEVROLET	UPLANDER	2007	2WD	1.17	N
CHEVROLET	UPLANDER	2008	2WD	1.17	N
DODGE	SPRINTER 2500	2008	2WD	0.92	N
DODGE	SPRINTER 2500	2009	2WD	0.92	N
FORD	E-150	2005	2WD	1.11	Y
FORD	E-150	2006	2WD	1.11	Y
FORD	E-150	2007	2WD	1.09	N
FORD	E-150	2008	2WD	1.09	N
FORD	E-150	2009	2WD	1.09	N
FORD	E-150	2010	2WD	1.09	N
FORD	E-150	2011	2WD	1.09	N
FORD	E-150	2012	2WD	1.09	N
FORD	E-150	2013	2WD	1.09	N
FORD	E-350	2006	2WD	1.07	N
FORD	E-350	2007	2WD	1.07	N
FORD	E-350	2008	2WD	1.07	N
FORD	E-350	2009	2WD	1.08	N
FORD	E-350	2010	2WD	1.08	N
FORD	E-350	2011	2WD	1.08	N

Make	Model	MY	Drive System Description	SSF	TIP-UP
FORD	E-350	2012	2WD	1.08	N
FORD	E-350	2013	2WD	1.08	N
FORD	TRANSIT CONNECT	2010	2WD	1.11	N
FORD	TRANSIT CONNECT	2011	2WD	1.11	N
FORD	TRANSIT CONNECT	2012	2WD	1.11	N
FORD	TRANSIT CONNECT	2013	2WD	1.11	N
FREIGHTLINER	SPRINTER 2500	2010	2WD	0.92	N
FREIGHTLINER	SPRINTER 2500	2011	2WD	0.92	N
FREIGHTLINER	SPRINTER 2500	2012	2WD	0.92	N
FREIGHTLINER	SPRINTER 2500	2013	2WD	0.92	N
GMC	SAVANA 1500	2006	2WD	1.12	Y
GMC	SAVANA 1500	2007	2WD	1.12	Y
GMC	SAVANA 1500	2008	2WD	1.09	N
GMC	SAVANA 1500	2008	4WD	1.14	N
GMC	SAVANA 1500	2009	2WD	1.09	N
GMC	SAVANA 1500	2009	4WD	1.14	N
GMC	SAVANA 1500	2010	2WD	1.09	N
GMC	SAVANA 1500	2010	4WD	1.14	N
GMC	SAVANA 1500	2011	2WD	1.09	N
GMC	SAVANA 1500	2011	4WD	1.14	N
GMC	SAVANA 1500	2012	2WD	1.09	N
GMC	SAVANA 1500	2012	4WD	1.14	N
GMC	SAVANA 1500	2013	2WD	1.09	N
GMC	SAVANA 1500	2013	4WD	1.14	N
GMC	SAVANA 2500	2008	2WD	1.08	N
GMC	SAVANA 2500	2009	2WD	1.08	N
GMC	SAVANA 2500	2010	2WD	1.08	N
GMC	SAVANA 2500	2011	2WD	1.08	N
GMC	SAVANA 2500	2012	2WD	1.08	N
GMC	SAVANA 2500	2013	2WD	1.08	N
GMC	SAVANA 3500	2004	2WD	1.09	N
GMC	SAVANA 3500	2005	2WD	1.09	N
GMC	SAVANA 3500	2006	2WD	1.09	N
GMC	SAVANA 3500	2007	2WD	1.09	N
GMC	SAVANA 3500	2008	2WD	1.09	N
GMC	SAVANA 3500	2009	2WD	1.08	N
GMC	SAVANA 3500	2010	2WD	1.08	N
GMC	SAVANA 3500	2011	2WD	1.08	N
GMC	SAVANA 3500	2012	2WD	1.08	N
GMC	SAVANA 3500	2013	2WD	1.08	N
MERCEDES-BENZ	SPRINTER 2500	2011	2WD	0.92	N
MERCEDES-BENZ	SPRINTER 2500	2012	2WD	0.92	N
MERCEDES-BENZ	SPRINTER 2500	2013	2WD	0.92	N
NISSAN	NV 3500	2013	2WD	1.07	N

Appendix B

B.1 Trend of the Estimated Effect of SSF on First-event Rollovers by Passenger Cars

This section shows the trend of the estimated effect of SSF on first-event rollovers by passenger cars when the SSF increases by 0.01. The effect of SSF on first-event rollovers by passenger cars is estimated by $\left(1 - \widehat{\mathrm{Odds\ Ratio}}\right) 100\%$, in which $\widehat{\mathrm{Odds\ Ratio}}$ is the estimated odds ratio expressed by Equation 3 in Section 5.5.1. The following expresses the estimated odds ratio, where the curb weight is in 100 lb. per unit.

$$\widehat{\mathrm{Odds\ Ratio}} = \exp(2.9699 \cdot 0.01 + 3.6477 \cdot 0.01 \cdot ESC - 0.2304 \cdot 0.01 \cdot CURB\ WEIGHT)$$

Equation 3

The estimated effect of SSF on first-event rollovers by passenger cars depends on the ESC installation rate and the curb weight, and the trend of the estimated effect of SSF will be evaluated by substituting different values of ESC installation rate and curb weight. This section uses two levels of ESC installation rate (i.e., 0 % and 50 %) and percentiles of curb weight in the passenger cars that experienced single vehicle crashes. The following table shows the distribution of curb weight in the analysis data set.

Percentile	10th	20th	30th	40th	50th	60th	70th	80th	90th
Curb Weight (lb.)	2,623	2,722	2,821	3,041	3,197	3,246	3,354	3,472	3,603

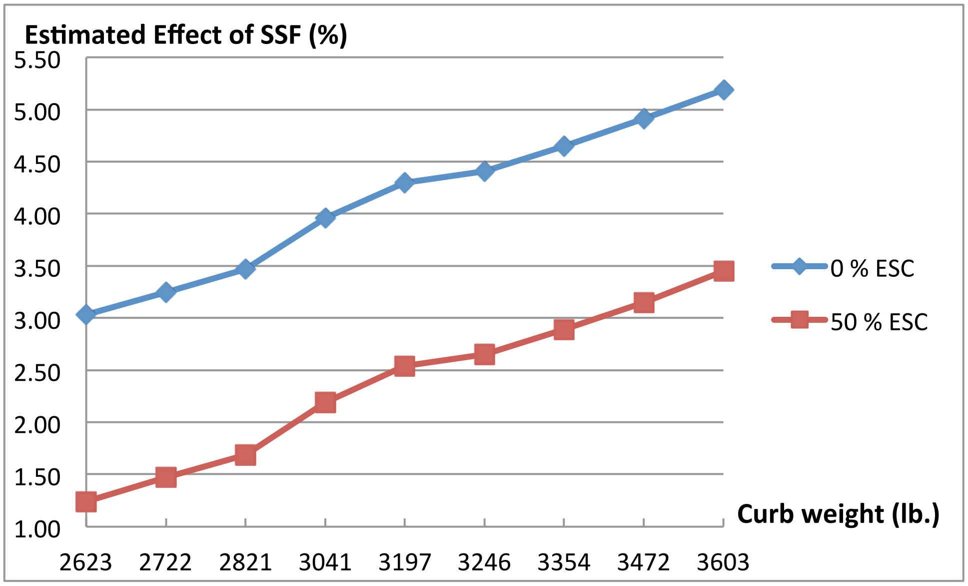
The estimated odds ratio is calculated by substituting the ESC installation rate and the curb weight into Equation 3, and then the effect of SSF is estimated. The following table shows the ESC installation rate, the curb weight, the estimated odds ratio and the estimated effect of SSF when the SSF increases by 0.01.

0% ESC Installation Rate									
Curb weight (lb.)	2,623	2,722	2,821	3,041	3,197	3,246	3,354	3,472	3,603
Estimated Odds Ratio	0.9697	0.9675	0.9653	0.9604	0.9570	0.9559	0.9535	0.9509	0.9481
Estimated Effect of SSF	3.03%	3.25%	3.47%	3.96%	4.30%	4.41%	4.65%	4.91%	5.19%

50% ESC Installation Rate									
Curb weight (lb.)	2,623	2,722	2,821	3,041	3,197	3,246	3,354	3,472	3,603
Estimated Odds Ratio	0.9876	0.9853	0.9831	0.9781	0.9746	0.9735	0.9711	0.9685	0.9655
Estimated Effect of SSF	1.24%	1.47%	1.69%	2.19%	2.54%	2.65%	2.89%	3.15%	3.45%

With 0 percent ESC installation rate and 2,623 lb. curb weight, the estimated odds ratio is 0.9697 ($\exp(2.9699 \cdot 0.01 + 3.6477 \cdot 0.01 \cdot 0 - 0.2304 \cdot 0.01 \cdot 26.23)$), and the estimated effect of

SSF is 3.03 percent ($(1 - 0.9697) \cdot 100\%$) when the SSF increases by 0.01. With 50 percent ESC installation rate and 2,623 lb. curb weight, the estimated odds ratios is 0.9876 ($\exp(2.9699 \cdot 0.01 + 3.6477 \cdot 0.01 \cdot 0.5 - 0.2304 \cdot 0.01 \cdot 26.23)$), and the estimated effect of SSF is 1.24 percent ($(1 - 0.9876) \cdot 100\%$) when the SSF increases by 0.01. The combinations of ESC installation rate and curb weight in the above tables should not account for any make-models in passenger cars. Based on the above tables, the following graph shows the trend of estimated effect of SSF on first-event rollovers when the SSF increases by 0.01.



With ESC installation rate being held constant, the estimated effect of SSF increases when the curb weight increases. With the curb weight being held at a constant value, the SSF is more effective in first-event rollovers when the ESC installation rate is lower.

B.2 Trend of the Estimated Effect of ESC on First-event Rollovers by Passenger Cars

This section shows the trend of the estimated effect of ESC installation rate on first-event rollovers by passenger cars when ESC installation rate increases from 0 to 100 percent. The effect of ESC installation rate on first-event rollovers by passenger cars is estimated by $\left(1 - \widehat{\text{Odds Ratio}}\right) \cdot 100\%$, in which $\widehat{\text{Odds Ratio}}$ is the estimated odds ratio expressed by Equation 5 in Section 5.5.2. The following expresses the estimated odds ratio, where the curb weight is in 100 lb. per unit.

$$\widehat{\text{Odds Ratio}} = \exp\left(-4.8501 + 3.6477 \cdot SSF - 0.0530 \cdot CURB\ WEIGHT + 0.2979 \cdot I_{WET} + 0.2609 \cdot I_{HILL} + 0.2807 \cdot I_{CURVE} + 0.4068 \cdot I_{MALE}\right)$$

Equation 5

The estimated effect of ESC installation rate on first-event rollovers by passenger cars depends on the SSF, the curb weight, the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and the driver's gender (i.e., I_{MALE}), where the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and the driver's gender (i.e. I_{MALE}) are binary variables. There are sixteen (2^4) different combinations among the circumstance variables (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and the driver's gender (i.e. I_{MALE}), and this section only considers the following two combinations to investigate the trend of the estimated effect of ESC installation rate on first-event rollovers by passenger cars.

- Wet, up/down grade and curve roadways (i.e., $I_{WET} = 1$, $I_{HILL} = 1$ and $I_{CURVE} = 1$) with male drivers (i.e., $I_{MALE} = 1$)
- Dry, level and straight roadways (i.e., $I_{WET} = 0$, $I_{HILL} = 0$ and $I_{CURVE} = 0$) with female drivers (i.e., $I_{MALE} = 0$)

With the combination of the circumstance variables (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and the driver's gender (i.e. I_{MALE}) being held constant, the trend of the estimated effect of ESC installation rate will be evaluated by substituting different values of the SSF and the curb weight into Equation 5. This section uses percentiles of SSF and quantiles of curb weight in passenger cars that experienced single-vehicle crashes. The following tables show the distributions of the SSF and the curb weight, respectively.

Percentile	10^{th}	20^{th}	30^{th}	40^{th}	50^{th}	60^{th}	70^{th}	80^{th}	90^{th}
SSF	1.33	1.37	1.39	1.40	1.41	1.42	1.43	1.44	1.46

Quantile	2^{nd}	3^{rd}
Curb Weight (lb.)	3,197	3,420

The estimated odds ratio is calculated by substituting the circumstance variables (i.e., I_{WET}, I_{HILL} and I_{CURVE}), the driver's gender (i.e. I_{MALE}), the SSF, and the curb weight into Equation 5. The effect of ESC installation rate is then estimated. With the circumstance variables (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and the driver's gender (i.e. I_{MALE}) both being held constant, the following tables show the SSF, the curb weight, the estimated odds ratio and the estimated effect of ESC installation rate when the ESC installation increases from 0 to 100 percent.

Wet, up/down grade, and curve roadways with male drivers
($I_{WET} = 1$, $I_{HILL} = 1$, $I_{CURVE} = 1$ and $I_{MALE} = 1$)

3,197 lb. Curb Weight									
SSF	1.33	1.37	1.39	1.40	1.41	1.42	1.43	1.44	1.46
Estimated Odds Ratio	0.6397	0.7402	0.7962	0.8258	0.8565	0.8883	0.9213	0.9555	0.9947
Estimated Effect of SSF	36.03%	25.98%	20.38%	17.42%	14.35%	11.17%	7.87%	4.45%	0.53%

3,420 lb. Curb Weight

SSF	1.33	1.37	1.39	1.40	1.41	1.42	1.43	1.44	1.46
Estimated Odds Ratio	0.5684	0.6577	0.7074	0.7337	0.7610	0.7893	0.8186	0.8490	0.9132
Estimated Effect of SSF	43.16%	34.23%	29.26%	26.63%	23.90%	21.07%	18.14%	15.10%	8.68%

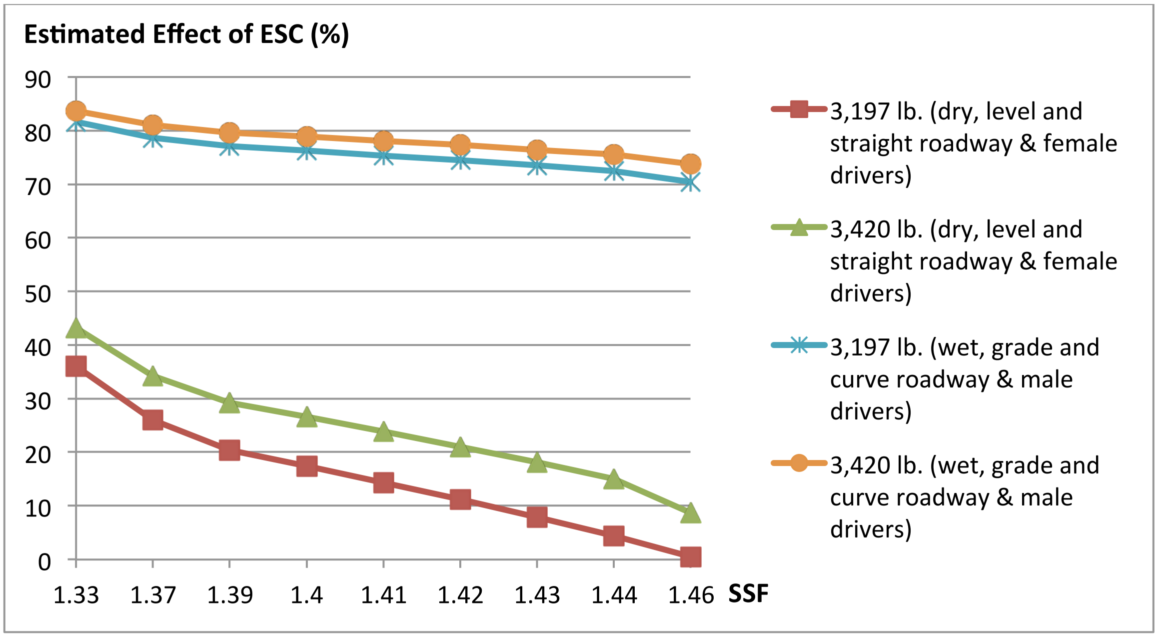
Dry, level, and straight roadways with female drivers
($I_{WET} = 0$, $I_{HILL} = 0$, $I_{CURVE} = 0$ and $I_{MALE} = 0$)

3,197 lb. Curb Weight									
SSF	1.33	1.37	1.39	1.40	1.41	1.42	1.43	1.44	1.46
Estimated Odds Ratio	0.1840	0.2129	0.2290	0.2375	0.2463	0.2554	0.2649	0.2748	0.2956
Estimated Effect of SSF	81.60%	78.71%	77.10%	76.25%	75.37%	74.46%	73.51%	72.52%	70.44%

3,420 lb. Curb Weight									
SSF	1.33	1.37	1.39	1.40	1.41	1.42	1.43	1.44	1.46
Estimated Odds Ratio	0.1634	0.1891	0.2034	0.2110	0.2188	0.2270	0.2354	0.2441	0.2626
Estimated Effect of SSF	83.66%	81.09%	79.66%	78.90%	78.12%	77.30%	76.46%	75.59%	73.74%

With male drivers and road conditions such as wet, up/down grade, and curve, the estimated odds ratio is 0.6397 (exp $(-4.8501 + 3.6477 \cdot 1.33 - 0.0530 \cdot 31.97 + 0.2979 \cdot 1 + 0.2609 \cdot 1 + 0.2807 \cdot 1 + 0.4068 \cdot 1)$), and the estimated effect of ESC installation rate is 36.03 percent ($(1 - 0.6397) \cdot 100\%$) when the SSF and the curb weight are 1.33 and 3,197 lb., respectively. With female drivers and road conditions such as dry, level, and straight, the estimated odds ratios is 0.1840 (exp $(-4.8501 + 3.6477 \cdot 1.33 - 0.0530 \cdot 31.97 + 0.2979 \cdot 0 + 0.2609 \cdot 0 + 0.2807 \cdot 0 + 0.4068 \cdot 0)$), and the estimated effect of ESC installation rate is 81.60 percent ($(1 - 0.1840) \cdot 100\%$) when the SSF and the curb weight are 1.33 and 3,197 lb., respectively. The combinations of the SSF and the curb weight in the above tables should not account for any make-models in passenger cars.

Based on the above two tables, the following graph shows the trend of the estimated effect of ESC installation rate on first-event rollovers when the ESC installation rate increases from 0 to 100 percent.



With the curb weight, the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and the driver's gender (i.e. I_{MALE}) being held constant, the estimated effect of ESC installation rate decreases when the SSF increases. With the SSF, the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and the driver's gender (i.e. I_{MALE}) being held constant, the estimated effect of ESC installation rate increases when curb weight increases. With the SSF and the curb weight both being held constant, the estimated effect of ESC installation rate is greater with dry, level, and straight roadways and female drivers than with wet, grade and curve roadways and male drivers.

B.3 Trend of the Estimated Effect of ESC on First-event Rollovers by LTVs

This section shows the trend of the estimated effect of ESC installation rate on first-event rollovers by LTVs when the ESC installation rate increases from 0 to 100 percent. The effect of ESC installation rate on first-event rollovers by LTVs is estimated by $\left(1 - \widehat{\text{Odds Ratio}}\right) \cdot 100\%$, in which $\widehat{\text{Odds Ratio}}$ is the estimated odds ratio expressed by Equation 9 in Section 5.8.2.

$$\widehat{\text{Odds Ratio}} = \exp\left(-1.5236 + 0.1388 \cdot I_{DARK} + 0.3353 \cdot I_{WET} + 0.2449 \cdot I_{HILL} + 0.2914 \cdot I_{CURVE}\right)$$

Equation 9

Based on Equation 9, the estimated effect of ESC installation rate on first-event rollovers by LTVs depends on the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and the light condition (i.e., I_{DARK}). The following indicator variables are used to represent the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and the light condition (i.e., I_{DARK}).

$$I_{CURVE} = \begin{cases} 1, \text{if curve road} \\ 0, \text{otherwise} \end{cases}$$

$$I_{HILL} = \begin{cases} 1, \text{if hill road} \\ 0, \text{otherwise} \end{cases}$$

$$I_{WET} = \begin{cases} 1, \text{if wet surface} \\ 0, \text{otherwise} \end{cases}$$

$$I_{DARK} = \begin{cases} 1, \text{if driving in the dark} \\ 0, \text{otherwise} \end{cases}$$

The different estimates of the effect of ESC installation rate will be evaluated by substituting different values of the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and the light condition (i.e., I_{DARK}) into Equation 9. This section uses all combinations of the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and the light condition (i.e., I_{DARK}) to evaluate the estimated effect of ESC installation rate. The estimated odds ratio is calculated by substituting the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}) and the light condition (i.e., I_{DARK}) into Equation 9, and then the effect of ESC installation rate is estimated. The following table shows the circumstance covariates (i.e., I_{WET}, I_{HILL} and I_{CURVE}), the light condition (i.e., I_{DARK}), the estimated odds ratio and the estimated effect of ESC installation rate.

I_{DARK}	I_{WET}	I_{HILL}	I_{CURVE}	Estimated Odds Ratio	Estimated Effect of ESC
0	0	0	0	0.2179	78.21%
1	0	0	0	0.2504	74.96%
0	1	0	0	0.3047	69.53%
0	0	1	0	0.2784	72.16%
0	0	0	1	0.2917	70.83%
1	1	0	0	0.3501	64.99%
1	0	1	0	0.3199	68.01%
1	0	0	1	0.3351	66.49%
0	1	1	0	0.3893	61.07%
0	1	0	1	0.4078	59.22%
0	0	1	1	0.3726	62.74%
1	1	1	0	0.4473	55.27%
1	1	0	1	0.4686	53.14%
1	0	1	1	0.4281	57.19%
0	1	1	1	0.5210	47.90%
1	1	1	1	0.5986	40.14%

The second row on the above table indicates a dry (i.e., $I_{WET} = 0$), level (i.e., $I_{HILL} = 0$) and straight (i.e., $I_{CURVE} = 0$) roadways in the daylight (i.e., $I_{DARK} = 0$) while the third row on the above table indicates a dry (i.e., $I_{WET} = 0$), level (i.e., $I_{HILL} = 0$) and straight (i.e., $I_{CURVE} = 0$) roadways in the dark (i.e., $I_{DARK} = 1$).

With a dry (i.e., $I_{WET} = 0$), level (i.e., $I_{HILL} = 0$) and straight (i.e., $I_{CURVE} = 0$) roadway in the daylight (i.e., $I_{DARK} = 0$), the estimated odds ratio is 0.2179 (exp $(-1.5236 + 0.1388 \cdot 0 +$

$0.3353 \cdot 0 + 0.2449 \cdot 0 + +0.2914 \cdot 0$), and the estimated effect of ESC installation rate is 78.21 percent ($(1 - 0.2179) \cdot 100\%$) when the ESC installation rate increases from 0 to 100 percent.

Based on the above table, the ESC installation rate has the greatest effect on first-event rollovers by LTVs when LTVs are traveling on dry, level and straight roadways in the daylight. The ESC installation rate has the lowest effect on first-event rollovers by LTVs when LTVs are traveling on wet, up/down hill and curve roadways in the dark.

B.4 Trend of the Estimated Effect of SSF on First-event Rollovers by LTVs without ESC

This section shows the trend of the estimated effect of SSF on first-event rollovers by LTVs without ESC when the SSF increases by 0.01. The effect of SSF on first-event rollovers by LTVs without ESC is estimated by $(1 - \widehat{\text{Odds Ratio}}) \cdot 100\%$, in which $\widehat{\text{Odds Ratio}}$ is the estimated odds ratio expressed by Equation 10 in Section 5.9.

$$\widehat{\text{Odds Ratio}} = \exp(-4.3011 \cdot 0.01 - 0.0320 \cdot 0.01 \cdot DRIVER\ AGE)$$

Equation 10

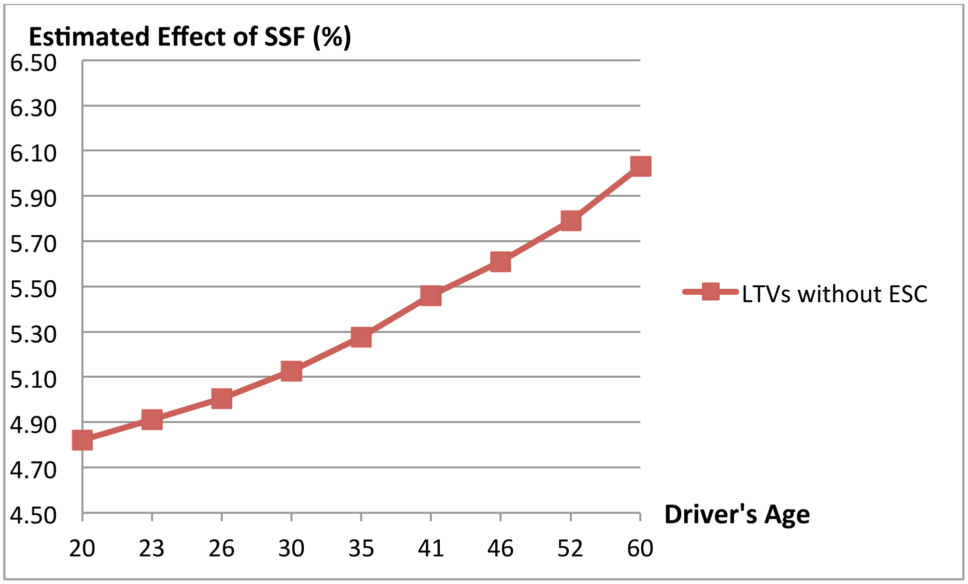
The estimated effect of SSF on first-event rollovers by LTVs without ESC depends on the driver's age, and the trend of the estimated effect of SSF will be evaluated by substituting different drivers' ages. This section uses percentiles of the driver's age in single-vehicle crashes caused by LTVs without ESC to evaluate the estimated effect of SSF, and the following table shows the distribution of driver's age in the analysis data set.

Percentile	10th	20th	30th	40th	50th	60th	70th	80th	90th
Driver's Age	20	23	26	30	35	41	46	52	60

The estimated odds ratio is calculated by substituting the driver's age into Equation 10, and then the effect of SSF is estimated. The following table shows the driver's age, the estimated odds ratio and the estimated effect of SSF.

Driver's Age	20	23	26	30	35	41	46	52	60
Estimated Odds Ratio	0.9518	0.9509	0.9500	0.9487	0.9472	0.9454	0.9439	0.9421	0.9397
Estimated Effect of SSF	4.82%	4.91%	5.00%	5.13%	5.28%	5.46%	5.61%	5.79%	6.03%

With a 20-year old driver, the estimated odds ratio is 0.9518 ($\exp(-4.3011 \cdot 0.01 - 0.0320 \cdot 0.01 \cdot 20)$), and the estimated effect of SSF is 4.82 percent ($(1 - 0.9518) \cdot 100\%$) when the SSF increases by 0.01. Based on the above table, the following graph shows the trend of the estimated effect of SSF on first-event rollovers by LTVs without ESC.



The estimated effect of SSF increases when the driver's age increases, and the SSF has a greater effect on first-event rollovers by LTVs without ESC with older drivers than with younger drivers.

B.5 Trend of the Estimated Effect of SSF on Subsequent Rollovers by Passenger Cars with Wet Roadway Surfaces

This section shows the trend of the estimated effect of SSF on subsequent rollovers by passenger cars with wet roadway surfaces when the SSF increases by 0.01. The effect of SSF on subsequent rollovers by passenger cars with wet roadway surfaces is estimated by $\left(1 - \widehat{\text{Odds Ratio}}\right) \cdot 100\%$, in which $\widehat{\text{Odds Ratio}}$ is the estimated odds ratio expressed by Equation 13 in Section 6.5.1.

$$\widehat{\text{Odds Ratio}} = \exp(-6.0408 \cdot 0.01 + 9.4391 \cdot 0.01 \cdot 1 - 0.0879 \cdot 0.01 \cdot DRIVER\ AGE)$$

Equation 13

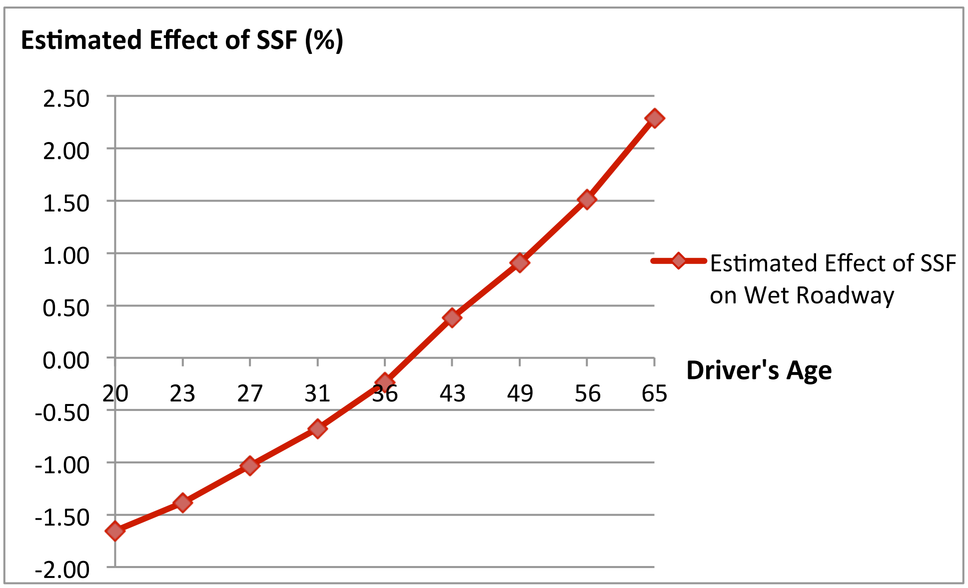
The estimated effect of SSF on subsequent rollovers by passenger cars with wet roadway surfaces depends on the driver's age. The trend of the estimated effect of SSF is evaluated by substituting different drivers' ages into Equation 13. This section uses percentiles of the driver's age in side-impact multi-vehicle crashes caused by passenger cars with wet roadway surfaces to evaluate the estimated effect of SSF, and the following table shows the distribution of the driver's age in the analysis data set.

Percentile	10^{th}	20^{th}	30^{th}	40^{th}	50^{th}	60^{th}	70^{th}	80^{th}	90^{th}
Driver's Age	20	23	27	31	36	43	49	56	65

The estimated odds ratio is calculated by substituting the driver's age into Equation 13, and then the effect of SSF is estimated. The following table shows the driver's age, the estimated odds ratio and the estimated effect of SSF.

Driver's Age	20	23	27	31	36	43	49	56	65
Estimated Odds Ratio	1.0165	1.0139	1.0103	1.0068	1.0023	0.9962	0.9910	0.9849	0.9771
Estimated Effect of SSF	-1.65%	-1.39%	-1.03%	-0.68%	-0.23%	0.38%	0.90%	1.51%	2.29%

With a 20-year old driver, the estimated odds ratio is 1.0165 ($\exp(-6.0408 \cdot 0.01 + 9.4391 \cdot 0.01 \cdot 1 - 0.0879 \cdot 0.01 \cdot 20)$), and the estimated effect of SSF is -1.65 percent ($(1 - 1.0165) \cdot 100\%$) when the SSF increases by 0.01. Based on the above table, the following graph shows the trend of the estimated effect of SSF on subsequent rollovers by passenger cars with wet roadway surfaces.



The effect of SSF is not statistically significant on reducing subsequent rollovers by passenger cars with wet roadway surfaces, since the estimated effects of SSF are negative in some cases.

B.6 Trend of the Estimated Effect of SSF on Subsequent Rollovers by Passenger Cars with Dry Roadway Surfaces

This section shows the trend of the estimated effect of SSF on subsequent rollovers by passenger cars with dry roadway surfaces when the SSF increases by 0.01. The effect of $\widehat{\text{SSF}}$ on subsequent rollovers by passenger cars with dry roadway surfaces is estimated by $(1 - \text{Odds Ratio}) \cdot 100\%$, in which $\widehat{\text{Odds Ratio}}$ is the estimated odds ratio expressed by Equation 14 in Section 6.5.1.

$$\widehat{\text{Odds Ratio}} = \exp(-6.0408 \cdot 0.01 - 0.0879 \cdot 0.01 \cdot DRIVER\ AGE)$$

Equation 14

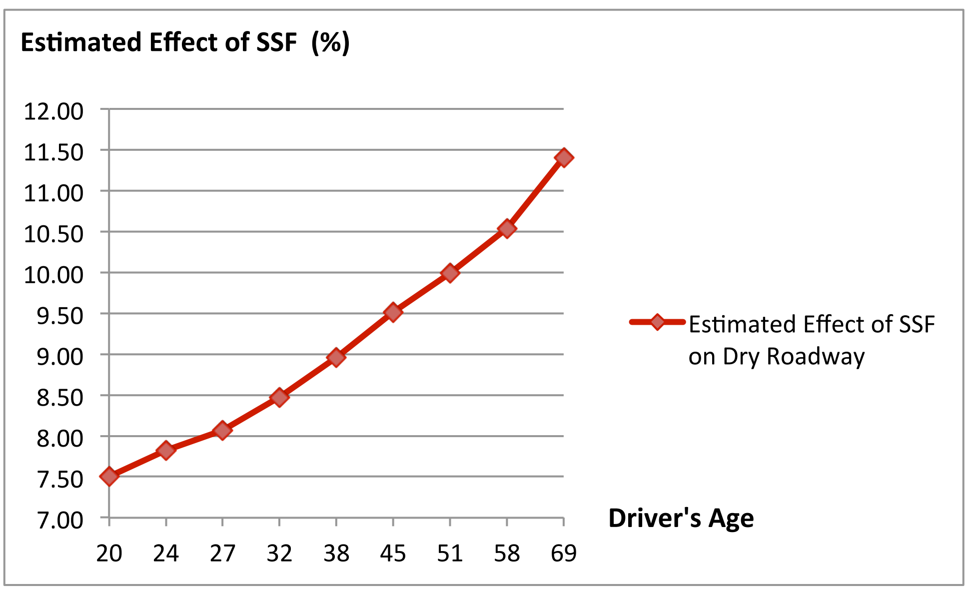
The estimated effect of SSF on subsequent rollovers by passenger cars with dry roadway surfaces depends on the driver's age. The trend of the estimated effect of SSF is evaluated by substituting different drivers' ages into Equation 14. This section uses percentiles of the driver's age in side-impact multi-vehicle crashes caused by passenger cars with dry roadway surfaces to evaluate the estimated effect of SSF, and the following table shows the distribution of the driver's age in the analysis data set.

Percentile	10th	20th	30th	40th	50th	60th	70th	80th	90th
Driver's Age	20	24	27	32	38	45	51	58	69

The estimated odds ratio is calculated by substituting the driver's age into Equation 14, and then the effect of SSF is estimated. The following table shows the driver's age, the estimated odds ratio and the estimated effect of SSF.

Driver's Age	20	24	27	32	38	45	51	58	69
Estimated Odds Ratio	0.9250	0.9217	0.9193	0.9153	0.9105	0.9049	0.9001	0.8946	0.8860
Estimated Effect of SSF	7.50%	7.83%	8.07%	8.47%	8.95%	9.51%	9.99%	10.54%	11.40%

With a 20-year old driver, the estimated odds ratio is 0.9250 ($\exp(-6.0408 \cdot 0.01 - 0.0879 \cdot 0.01 \cdot 20)$), and the estimated effect of SSF is 7.50 percent ($(1 - 0.9250) \cdot 100\%$) when the SSF increases by 0.01. Based on the above table, the following graph shows the trend of the estimated effect of SSF on subsequent rollovers by passenger cars with wet roadway surfaces.



The effect of SSF is statistically significant on reducing subsequent rollovers by passenger cars with dry roadway surfaces, since the estimated effects of SSF are positive in all cases.

B.7 Trend of the Estimated Effect of ESC on Subsequent Rollovers by LTVs

This section shows the different estimates of the effect of ESC installation rate on subsequent rollovers by LTVs when the ESC installation rate increases from 0 to 100 percent. The effect of ESC installation rate on subsequent rollovers by LTVs is estimated by $\left(1 - \widehat{\text{Odds Ratio}}\right)$ 100%, in which $\widehat{\text{Odds Ratio}}$ is the estimated odds ratio expressed by Equation 15 in Section 6.6.2.

$$\widehat{\text{Odds Ratio}} = \exp\left(-0.1717 - 0.4644 \cdot I_{WET}\right)$$

Equation 15

The estimated effect of ESC installation rate on subsequent rollovers by LTVs depends on the roadway surface (i.e., I_{WET}), and the different estimates of the effect of ESC installation rate are evaluated by substituting different values of the roadway surface (i.e., I_{WET}) into Equation 15. The roadway surface (i.e., I_{WET}) is a binary variable, and the following indicator variable is used to represent the roadway surface.

$$I_{WET} = \begin{cases} 1, \text{if wet surface} \\ 0, \text{otherwise} \end{cases}$$

The estimated odds ratio is calculated by substituting the roadway surface (i.e., I_{WET}) into Equation 15, and then the effect of SSF is estimated. With the roadway surface (i.e., I_{WET}) being held constant, the following table shows the estimated odds ratio and the estimated effect of ESC installation rate.

Dry Roadway Surface
($I_{WET} = 0$)

Estimated Odds Ratio	0.8422
Estimated Effect of SSF	15.78%

Wet Roadway Surface
($I_{WET} = 1$)

Estimated Odds Ratio	0.5294
Estimated Effect of SSF	47.06%

With dry roadway surfaces (i.e., $I_{WET} = 0$), the estimated odds ratio is 0.8422 ($\exp(-0.1717 - 0.4644 \cdot 0)$), and the estimated effect of SSF is 15.78 percent ($(1 - 0.8422)\cdot 100\%$) when the ESC installation rate increases from 0 to 100 percent. With wet roadway surfaces (i.e., $I_{WET} = 1$), the estimated odds ratio is 0.5294 ($\exp(-0.1717 - 0.4644 \cdot 1)$), and the estimated effect of ESC installation rate is 47.06 percent ($(1 - 0.5294)\cdot 100\%$) when the ESC installation rate increases from 0 to 100 percent. Based on the above tables, the estimated effect of ESC installation rate on subsequent rollovers is greater with wet roadway surfaces than with dry roadway surfaces.

DOT HS 812 444

August 2017

U.S. Department
of Transportation

National Highway
Traffic Safety
Administration

NHTSA

13125-081517-v2