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Cassandra Cole and Kathleen McCullough
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The Impact of Motor Vehicle Simulator
Training on Law Enforcement Officer
Driving Behavior: Empirical Evidence
from Accident Frequency and Severity

Robert E. Hoyt



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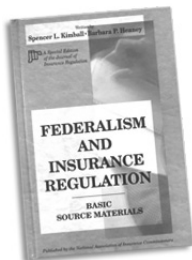
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The Impact of Motor Vehicle Simulator Training on Law Enforcement Officer Driving Behavior: Empirical Evidence from Accident Frequency and Severity

Robert E. Hoyt*

Abstract

Local Government Risk Management Services (LGRMS) indicates that its No. 1 loss within law enforcement continues to be related to motor vehicle incidents. In order to reduce the risk of these incidents from occurring in the future, LGRMS provides simulator training for its members. As documented by our review of the literature, a question that has remained largely unanswered by prior studies is the efficacy of this sort of training in mitigating risk management costs. In this study, we use accident loss cost data over the period 2000–2015 to determine whether motor vehicle simulator training is reducing loss frequency and severity, and whether such training is cost effective. Our analysis suggests that the training not only reduces accident frequency, and to some extent loss severity, but its return on investment (ROI) is 12:1. Given the recent concern over increasing motor vehicle loss frequency and severity in most states, our research has important implications

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for state legislative and regulatory authorities as they seek ways to mitigate growing motor vehicle loss costs. In addition to the benefits that we document for the use of motor vehicle simulator training of law enforcement officers (LEOs), our results suggest that efforts by state insurance regulators and legislators to facilitate and encourage motor vehicle simulator use as part of their state's licensing and insurance requirements would provide important benefits to the public in their state.

Introduction

Local Government Risk Management Services (LGRMS) provides risk control services for the Association County Commissioners of Georgia (ACCG) and the Georgia Municipal Association's (GMA) workers' compensation and property/liability insurance pools. These pools provide insurance for thousands of police and sheriff's deputies across Georgia, as well as the public entities for which they work.

LGRMS indicates that its No. 1 loss within law enforcement continues to be related to motor vehicle incidents. In order to reduce the risk of these incidents from occurring in the future, LGRMS utilizes training activities that focus on the behavior of law enforcement officers (LEOs) that contribute to incidents. As one important example of such behavioral-focused activities, LGRMS provides simulator training for its members. LGRMS has three mobile units that provide pursuit/emergency vehicle operator courses (EVOCs) and distracted driving simulation training (law enforcement driving simulators—LEDS).

As documented by our review of the literature, a question that remains largely unanswered by prior studies is the efficacy of this sort of training in affecting driving behavior and in mitigating risk management costs. A primary gap that exists in the study of LEDS training is how the reduction in officer-involved traffic crashes (OITCs) ultimately affects reductions in insurance premiums, liability costs, workers' compensation and officer downtime. There is some data from prior studies, but it is limited in nature.

LGRMS not only provides motor vehicle simulator training to its members, but it also oversees the loss cost data for motor vehicle accidents involving LEOs employed by its members. As a result, LGRMS is in a unique position to facilitate the analysis conducted in this study.

Overview of the Study

This paper reviews the findings of our study of the data provided by LGRMS on auto liability and property damage costs associated with motor vehicle accidents involving LEOs employed by ACCG- and GMA-member counties and municipalities. The paper is organized as follows. First, we provide a detailed review of the existing literature relating to the impact of driving simulator training on reducing motor vehicle accidents. This includes some recommendations related

to driving simulator use and the effects on driving behavior based on our review of these prior studies. Second, we describe the methodology, data and statistical analysis used in this study. Third, we report on the results and empirical findings of our analysis of the ACCG and GMA law enforcement data and report on our estimates of the fiscal cost reductions associated with this training. Fourth, we provide data from LGRMS on its estimated annual costs associated with the driver simulator training that it provides to its members and highlight the estimated ROI that we find. Finally, we summarize our findings and report on future areas for research relative to the efficacy of motor vehicle simulator training of LEOs in mitigating risk management costs.

A key question that we seek to address in this study is whether any reduction in motor vehicle accident frequency and/or severity associated with the motor vehicle simulator training provided by LGRMS to its members offsets the costs of providing this training. Further, the recent concern over increasing motor vehicle loss frequency and severity in most states means that our research also has important implications for state legislative and regulatory authorities as they seek ways to mitigate growing motor vehicle loss costs. In addition to the oversight responsibilities that state insurance regulators and legislators have relative to motor vehicle accident costs and related impacts on insurance costs, these public policymakers also oversee motor vehicle licensing and associated training requirements for motor vehicle operators in their states. Cost-effective training strategies are not only important for motor vehicle loss mitigation associated with LEOs in their states, but they are important for commercial and private passenger motor vehicle operators, as well.

Review of the Existing Literature on the Effectiveness of Driving Simulators in Reducing Motor Vehicle Losses

The purpose of this review is to provide background information on some of the prevailing benefits to using driving simulators to train LEOs in order to reduce department costs. The most important correlation this literature review seeks to establish is between the frequency of OITCs and insurance premiums, liability costs, workers' compensation and officer downtime. In short, if law enforcement departments can reduce the number of OITCs, department costs will decrease. Additionally, this review examines the operational cost savings that come from using simulators in LEO training. The review is organized by first presenting important findings, identifying gaps in existing research, and making recommendations.

Reducing the Number of OITCs

An important finding in prior studies is that the use of LEDS to train LEOs reduces the number of OITCs. More broadly, better training will result in fewer OITCs. An analysis of this finding begins with a look at LEO driving training as a whole. Two main methodologies are used to turn LEOs into capable drivers: 1) “behind-the-wheel” training in EVOCs; and 2) simulated scenarios in LEDS training.¹ The EVOC is the most basic form of skills-based driver training and focuses on teaching LEOs to be proficient drivers. EVOC training requires that an LEO practice his/her driving skills in an actual vehicle, in the presence of a certified instructor, on a closed driving track or course. On the contrary, LEDS training focuses on decision-making, presenting worst-case scenarios to LEOs in non-life-threatening situations. Law enforcement departments around the nation utilize various combinations of these methodologies to train LEOs, and a 2009 report published by the California Commission on Peace Officer Standards and Training (POST) studied the effectiveness of EVOC training and LEDS training in a group of 7,431 LEOs.²

The study first looked at the effect of EVOC-only training on the number of OITCs. About 52% of LEOs without any form of EVOC training (and no LEDS training) were involved in an OITC in the study period, but only 48% of the LEOs with EVOC training (but still no LEDS training) were involved in an OITC in the study period. The study claims that the 4% reduction is statistically significant, and evidence that the use of EVOC as the sole component of an LEO training regimen will reduce the number of OITCs.³

The study then looked at the effect of LEDS-only training on the number of OITCs. About 55% of LEOs without any form of LEDS training (and no EVOC training) were involved in an OITC in the study period, whereas only about 47% of LEOs with LEDS training (but still no EVOC training) were involved in an OITC during the study period. Again, that 8% reduction is reported to be statistically significant, and evidence that the use of LEDS training as the sole component of an LEO training regimen will reduce the number of OITCs by more than a training regimen composed solely of EVOC training.⁴

Finally, the study looked at the effects of combining EVOC training and LEDS training. About 52% of LEOs without a combined EVOC/LEDS training were involved in an OITC in the study period, but only about 43% of LEOs that participated in a training program consisting of EVOC training and LEDS training were involved in an OITC in the study period. Again, the study claims that the almost 10% reduction is statistically significant and combining EVOC training and LEDS training will also reduce the number of OITCs.

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1. California Commission (2009).
 2. California Commission (2009).
 3. California Commission (2009).
 4. California Commission (2009).

The takeaway from this study is the determination that a training regimen consisting of both EVOC training and LEDS training is the most effective way to reduce the number of OITCs. The evidence suggests that while EVOC-only training can reduce the number of OITCs to a certain point, after that point, the incidence of OITCs is not as much related to LEO skill, but rather more directly linked to judgment and decision-making. More specifically, LEOs show better judgment and decision-making after they have experienced a situation that had legitimate potential to harm them.⁵ For obvious reasons, the scenarios included in EVOCs cannot include legitimate life-threatening parameters. Similarly, EVOCs cannot accurately depict the driving conditions that LEOs should expect to see in the real world on a consistent basis.

The addition of LEDS training into a training regimen addresses these shortcomings and adds other key benefits. First, the LEDS training model is more focused on the judgment and decision-making aspects of driver training. According to Bob Davis, CEO of Virtual Driver Interactive, “[w]hen teaching fleet drivers, it’s all about the decisions you make. It’s less about the [vehicle] handling...”⁶ Second, LEDS can make LEOs more aware of the consequences of their decisions, having been exposed to the worst-case scenario results of a potential OITC. In this way, LEDS do not speak to the eyes and ears of LEOs, but rather to their hearts and values.⁷ Similarly, students learn more from failures than from successes.⁸ Third, LEDS allow LEOs to practice driving in conditions that would be difficult to depict in an EVOC scenario, be it a replication of weather, time of day or traffic patterns. Likewise, LEDS allow LEOs to practice driving in a variety of different vehicles more easily; e.g., a high-speed pursuit in a Chevrolet Impala will require a different set of skills and decision-making expertise than will a high-speed pursuit in a GMC Yukon. Rather than purchase every type of vehicle an LEO would be likely to drive, a department can instead require LEOs to drive different types of vehicles in simulated scenarios. Finally, LEDS can allow for better recurrent training. The 2009 California POST report examines the advantages of LEO age and experience (identified as confounding factors).⁹ From an age perspective, age does not always yield better driving. For example, even though an LEO may become a more skilled driver with age, that same LEO may also become more complacent. Additionally, while age builds confidence, self-confidence may exceed actual skill; i.e., an older police officer may think he is better at driving than he actually is. Similarly, more experience does not guarantee fewer OITCs. For example, officers with more experience may not drive as often, meaning that more overall experience may actually result in less competent drivers. Also, better LEOs may be assigned to drive more often; therefore, they may be subject to a higher rate of OITCs, even though they are considered to be better than the average LEO. These confounding factors

5. FAAC Incorporated.

6. Lockridge (2014).

7. FAAC Incorporated.

8. Raheb (2011).

9. California Commission (2009).

can be addressed more effectively and inexpensively in a LEDS training program rather than in an EVOC course. For all of the reasons listed, a law enforcement department can most effectively reduce the number of OITCs by including both EVOC training and LEDS training in a comprehensive training regimen.

In addition to the California POST report, other law enforcement departments have published studies that support the effectiveness of LEDS training in reducing OITCs. In 2005, the Utah Department of Public Safety (UDPS) sought to implement a new LEO training program that included both EVOC training and LEDS training.^{10,11} In an initial rollout of the new training regimen to a group of 355 LEOs, the UDPS saw a “67% reduction in risk for collisions by reduction of critical errors.”¹² Following the success of that initial rollout, the UDPS expanded the program to a larger group of LEOs and reaffirmed the initial findings; i.e., the inclusion of LEDS training has a measurable impact on reducing the number of OITCs.¹³ In the United Kingdom (UK), the South Wales Police Roads Policing Unit began an integrated (EVOC and LEDS) form of LEO driver training in 2008, and it reported a 10% reduction in OITCs the first year.¹⁴

The use of LEDS training is not unique to the law enforcement industry. In trucking and transportation, Schneider National incorporated simulator training into its driver training program and saw a 21% reduction in preventable accidents in just the first 90 days.¹⁵ Bison Transport, a trucking company based in Manitoba, Canada, implemented simulator training in 2002 and has seen an 83% improvement in mean time among incidents after simulator training for preventable accidents.¹⁶ Logistics giant the United Parcel Service (UPS) saw a 38% reduction in collisions just one year after integrating simulators into its already extensive driver training program.¹⁷ The New York City Fire Department Bureau of Emergency Medical Service (FDNY EMS) responds to more than 1.2 million calls for assistance every year, understandably creating a lot of opportunity for collisions.¹⁸ In 2000, the rate of intersection collisions was about 40% of the total number of collisions; by 2007, after integrating simulators into the training program for EMS drivers, intersection collisions had declined to 11% of the total collision rate—a drop of about 75%.¹⁹ The Utah Department of Transportation purchased snowplow simulators in order to allow its drivers to train year-round. The addition of simulators to the training program reduced the odds of a driver getting into a collision in the first six months

10. The UDPS had already been using a training program composed of EVOC training and LEDS training, but the LEDS course was essentially a “game-based situational-awareness exercise” that was not effective in simulating real-world hazards. The new training program which began in 2005 sought to increase the realism and effectiveness of the LEDS portion of the regimen.

11. Turpin et al. (2007).

12. Turpin et al. (2007).

13. Turpin et al. (2007).

14. RoadSafe (2010).

15. Lockridge (2006).

16. Lockridge (2006).

17. Lockridge (2014).

18. Raheb (2011).

19. Raheb (2011).

after training.²⁰ Other trades—including aviation, medical training, equipment maintenance, military combat and education—have also successfully implemented simulators into training programs.²¹

The law enforcement industry is not new to the use of simulators in LEO training either. In 1999, the National Institute of Justice (NIJ) provided funding to Eastern Kentucky University to study the effectiveness of the Professional Range Instruction Simulator (PRISim) system, a mobile, interactive firearms/judgment simulation system designed to enhance the ability of LEOs to determine the appropriate use of deadly force.²² According to the final published report of the study, “[i]nteractive computer simulation systems can engross senses in a computer-generated environment and has allowed trainers to recreate diverse situations in a safe, realistic environment. Simulation can provide a means for practicing a particular skill, focusing on planning, assessment and improvement.”²³ The study concluded that the simulation was effective in improving accuracy and the use of cover, avoiding the unintentional shooting of innocent bystanders, and ensuring the appropriate use of deadly force. Additionally, the study found that LEOs who participated in the training were overwhelmingly positive in their assessment of its effectiveness.²⁴ Based on the success of this case study, it is logical to presume that the law enforcement industry can see similar success in the widespread adoption of LEADS training, as well.

Other Cost Reductions

Other studies find that the inclusion of LEADS training in a department’s training program can reduce department spending on training vehicles and related equipment, especially in the following key areas: fleet management; vehicle maintenance; and fuel. As stated in one article, “[simulators] don’t need fuel or insurance; they don’t put wear and tear on tires and components; and you don’t need to worry about possibly damaging the [vehicle] while training the driver.”²⁵

Fleet Management

Many departments have different types of vehicles (cars, vans, sport utility vehicles (SUVs), etc.) by different manufactures (Ford, Chevrolet, etc.) of different ages (older vehicles with higher mileage drive differently than new vehicles).²⁶ In order to provide accurate and reliable training, a department would have to purchase all of the vehicles an LEO in that department could use. Instead, departments can

20. Strayer (2004).

21. Boosman (2007).

22. Justice and Safety Center (2003).

23. Justice and Safety Center (2003).

24. Justice and Safety Center (2003).

25. Lockridge (2014).

26. Yates (2009).

use LEDS to train LEOS in all of the vehicles they can expect to drive in the real world; changing the type of vehicle is as easy as clicking a button.

Vehicle Maintenance

Terry Godchaux of the Alameda County, California, Sheriff's Office estimates that to run the EVOC program, the department uses six instructors and 12 cars, and it goes through at least 10 tires daily.²⁷ If a department can shift a portion of EVOC participants to LEDS, that department may be able to save on costs, especially those attributed to vehicle damage as a result of inexperienced handling.

Fuel

Trucking company Schneider National has looked at the impact of training vehicle fuel costs on its bottom line. The company estimates that one hour of in-truck training consumes about two-and-a-half gallons of fuel.²⁸ At a price of \$2 per gallon (and assuming similar consumption), it would cost a department about \$5 per hour per vehicle to operate an in-car training scenario (note the variability in that estimate; as fuel costs increase, so do training costs). Another study suggests that actual car efficiency increases with simulator training because drivers become more adept at braking and accelerating more efficiently.²⁹

Prior Studies in the Academic Literature

In addition to the industry and professional analysis reviewed above, a number of academic articles also discuss and analyze the impact of various driver training programs inside and outside of law enforcement on accidents and driving performance. This includes the use of driving simulators. Dorn and Barker (2005), using a police officer sample, investigate whether professionally trained and experienced drivers exhibit safer driving behavior in a simulated driving task compared with drivers without professional driver training. The professionally trained drivers were significantly less likely to engage in two forms of unsafe driving behavior than the drivers without professional training. They also discuss simulated driving performance with reference to the implications for driver training assessment and skill development.

Underwood et al. (2011) focus on assessing the comparability of driving on a road and "driving" in a simulator. The authors consider whether similar patterns of behavior are observed between individuals operating on road and individuals operating within simulators. Based on their analysis, they conclude that driving in the simulator will deliver representative results and the advantages of simulators (i.e., controlled environments, hazardous situations) can be appreciated. They suggest that this comparability encourages the use of simulators in driver training and testing.

27. FAAC Incorporated.

28. Kilcarr (2012).

29. Strayer (2004).

Outside of law enforcement, Beanland et al. (2013) sought to address the question of how effective driver training has been in improving on-road safety by newer drivers. They approached this question by conducting a comprehensive review of the literature for the period 2001–2011. Their review of prior studies suggests that traditional pre-license training programs have not reduced crash risk among young drivers. However, they found that post-license training programs, including those utilizing simulators, do show some evidence of effectiveness. However, they caution that it is unclear how transferable these are to other settings. They concluded that evaluations have generally demonstrated that training improves objective driving skills in simulated driving, especially when the scenarios are highly similar to those encountered in training.

Additionally, other academic studies review the effectiveness of simulator training applied to other aspects of law enforcement. On this last point, Arnetz et al. (2009) focus on testing the effects of police trauma resilience training on stress and performance in the context of a critical incident simulation. They found that officers trained using imagery and simulation training exhibited lower stress levels and better police performance.

Beanland et al. (2013) call for more robust research directed toward evaluating driver training programs, and our review suggests there is a gap in literature with respect to the value of driving simulator training in mitigating risk management costs.

Gaps Identified in the Research

The primary gap that exists in the study of LEDS training is how the reduction in OITCs ultimately affects reductions in insurance premiums, liability costs, workers' compensation and officer downtime. There is some data from prior studies, but it is limited in nature.

Insurance Premiums, Liability Costs and Workers' Compensation

Departments across the U.S. contend that LEDS reduce insurance, liability and workers' compensation costs, but the data to back up those claims is difficult to find. The South Wales Police Department in the UK points to internal studies that show measurable savings on department insurance premiums by decreasing damages paid to victims of OITCs.³⁰ According to the Texas Association of Counties (TAC), the addition of LEDS training in some of the largest counties in Texas reduced auto liability claims by 55% (note that this reduction stemmed from an 18% reduction in the number of collisions involving all county vehicles, not just those driven by LEOs).³¹

From a workers' compensation perspective, payouts to LEOs involved in OITCs can be quite high.³² Several studies have claimed that LEDS training reduces

30. RoadSafe (2010).

31. FAAC Incorporated.

32. www.pennprime.com/index.asp?Type=B_BASIC&SEC=%7BF64D3B62-9596-4175-81

workers' compensation costs, but the concrete data to back up that claim is difficult to find.

Officer Downtime

In one particular example in Pennsylvania, an LEO was on medical leave for more than a year following an OITC.³³ Aside from workers' compensation claims and costs related to paying that LEO, his or her place on the force either had to be filled by others (likely working overtime) or by a new hire. According to the data, the hiring of a new LEO is a lengthy, complicated and costly process.³⁴

Another study points to the administrative and investigative costs related to the OITC. Specifically, the South Wales Police Department has seen a 10% reduction in OITCs since implementing LEDS training, and it subsequently calculates a savings of 225 hours of officer downtime related to accident investigation.³⁵

Methodology (Data and Statistical Approach)

As noted above, motor vehicle-related accidents have been a significant cost for GMA and ACCG members. While it may be beneficial to society to eliminate all motor vehicle accidents, no organization or economy could afford to expend the unlimited resources that would be necessary to achieve such an outcome. However, it is important for organizations to assess the value of various strategies targeted at mitigating the loss costs associated with aspects of their operations through changing behavior. In this context, it is important for LGRMS and its members to consider the efficacy of motor vehicle simulator training of LEOs in mitigating risk management costs.

LGRMS and its supporting service providers provided data related to automobile accidents involving members' LEOs. Those data were organized and refined to support the statistical analysis that is conducted in this study. All available data from LGRMS was provided for member counties and municipalities in the ACCG and the GMA. These data included the number of LEOs, information on individual accident details and costs, and information on simulator training. These data were available for the period 2000–2015. As described below, the analysis conducted in this study was carried out at the county or municipality level (i.e., the member level).

In assessing loss causation and loss costs, it is common in risk management to focus on three elements: 1) loss frequency, or how many losses occur; 2) loss severity, or how high the loss is when it has occurred; and 3) total loss, which is the

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33. www.pennprime.com/index.asp?Type=B_BASIC&SEC=%7BF64D3B62-9596-4175-8115-A59C23DE0FC9%7D.

34. Hardesty (2014).

35. RoadSafe (2010).

combination of frequency and severity, or how high the financial loss is during a given period, usually a year. In this study, we also focus on these three components.

Frequency Measure

Several measures of frequency could be chosen. The key is to utilize a measure that adjusts for exposure differences between units. Measures of frequency that are adjusted for exposure are often referred to as incident rates. Given the primary focus of this study, we chose to adjust or scale the number of accidents or frequency by the number of LEOs within a law enforcement department. Specifically, we compute the number of accidents incurred by a member department for each year, and then we divide that number by the number of LEOs to calculate the incident rate for that member department for each year. If motor vehicle simulator training conducted by LGRMS is effective in reducing the number of accidents incurred, we should find a negative relationship between the incident rate and the training variable.

Severity Measure

A common measure for severity is the average loss severity. We compute this by dividing the sum of all losses incurred by a member department in each year by the number of accidents incurred in that year. If motor vehicle simulator training conducted by LGRMS is effective in reducing the average severity or magnitude of losses incurred, we should find a negative relationship between the severity measure and the training variable.

Training Measure

From LGRMS, we had data on when simulator training was conducted in a particular city or county. For the purposes of the analysis conducted here, we created an indicator (or dummy) variable that takes the value of 1 if training was conducted for a member (i.e., a city or county law enforcement department) during a given year. A member is coded as 0 if no training was conducted in that year or in any preceding year. Once training was conducted in a member county or city, the variable was coded as 1 in that year and all subsequent years. While some members had additional training sessions conducted in subsequent years, our primary results focus just on “trained” versus “untrained” counties and cities. In our sample period, 48 out of the 159 counties (approximately 30%) had two or more training sessions using the driving simulators. We did not have any situations where training sessions carried over from one year to the next. For most counties that had a second or subsequent training session, that repeated session was conducted more than three or four years after the previous one. In the Robustness and Additional Testing section, we provide the results related to tests of the effect of members repeating training

activities in more than one year during the period of our analysis. As noted below, we find those results to be consistent with our core findings.³⁶

Summary Data

To provide some overall sense of the data included in this study, we include here a brief discussion of summary statistics for the key variables included in the analysis based on the ACCG data. The mean incident rate was 0.0863. The median value was 0.0556, suggesting that the distribution of the incident rate was right skewed. The mean incident rate in “trained” member counties was 0.0787, and it was statistically significantly lower than the mean incident rate in “untrained” member counties of 0.0939. While this result does not control for differences across member counties and across time, it does provide some initial indication that training may be effective in reducing accident frequency. The average number of accidents had a mean value of 3.37, and it ranged from a low of zero to a high of 39. Average severity had a mean value of \$21,235, and it ranged from a low of \$0 to a high of more than \$560,000. The number of officers in member counties had a mean value of 55, and it ranged from a low of three to a high of 453. The relative relationships in the summary values for the GMA data are similar to those presented here for the ACCG. However, as noted below, GMA members include a number of smaller departments that did not experience any losses (zero frequency).

Statistical Methodology

Utilizing training and accident loss cost data for ACCG and GMA members, we perform the analysis at the member/county level. We do this separately for the accident frequency and the accident severity. We utilize ordinary least squares (OLS) regression. In this analysis, we control for time and county/city differences while assessing the impact of the variables of interest. This method controls for differences across counties/cities that may influence the incident rate (accident frequency) and the average incident cost (accident severity). We also have included a variable that measures whether the county is urban or rural and whether driver simulator training had been conducted by LGRMS for that county/city. The last variable is the one that provides evidence on whether driving simulator training is affecting motor vehicle accident frequency and severity.

36. While it would be interesting to consider training effects at the individual officer level, the data available from LGRMS did not allow us to link specific training events to individual officers. As noted above, we do provide some additional analysis in the Robustness and Additional Testing section of the paper that does consider the impact of additional training sessions repeated by a member county/city.

Base Specification

Model 1a and Model 1b use dummy variables to indicate whether each law existed for a given member (i) and year (t).

$$FREQ_{it} = \alpha + \beta TRAIN_{it} + \gamma URBAN_{it} + \sum_{t=2000}^{2015} \tau_t T_t + \sum_{i=1}^N \delta_i M_i + \varepsilon_{it} \quad (1a)$$

$$SEV_{it} = \alpha + \beta TRAIN_{it} + \gamma URBAN_{it} + \sum_{t=2000}^{2015} \tau_t T_t + \sum_{i=1}^N \delta_i M_i + \varepsilon_{it} \quad (1b)$$

The variables $FREQ_{it}$ and SEV_{it} represent frequency and severity of loss for member i at time t . $TRAIN_{it}$ represents the training measures discussed above. $URBAN_{it}$ represents the nature of the member county/municipality i 's location (urban or rural) at time t . $URBAN_{it}$ takes on the value of 1 in the county/municipality if the percentage of the population living in an urban area, based on U.S. Census Bureau data, is greater than 50%. Of Georgia's 159 counties, 31.4% were defined as urban based on this measure.³⁷ Time and state fixed effects, T_t and S_i , control for unobserved time trends that affect all states in common and for unobserved characteristics within states that are constant over time, respectively.

The coefficient estimates on the training variable are interpreted as the average effects of the training after it is administered. It tests whether the incident rate or the average severity of loss are lower on average after training is conducted than before. However, this simple test may be biased if the training was conducted in response to changes in accident frequency or severity. If members conducted training because frequency or severity was increasing and the training lowered losses, the estimates underestimate the reduction in accident frequency or severity; i.e., the before and after averages would show little difference. Likewise, if the training was conducted when accident frequency or severity was declining, the bias would be in the opposite direction. To determine whether such a bias is an issue, we test for such trends using a method described in the next section.

Before and After Trends

A common approach to control for this type of endogeneity is to use instrumental variables. Valid instruments must be correlated with the decision to

37. It is also possible that accident rates and severity could vary depending on whether the accident location within a county is urban or rural. We are unable to evaluate this issue given the current nature of our data.

conduct training but uncorrelated with the variable of interest (incident rate or average severity). Identifying a suitable instrument can be difficult. Therefore, we use an alternative method that controls for before and after time trends for the training variable, as shown in Model 2a and Model 2b.

$$FREQ_{it} = \alpha + \beta TRAINBEFORE_{it} + \gamma TRAINAFTER_{it} + \eta URBAN_{it} + \sum_{t=2000}^{2015} \tau_t T_t + \sum_{i=1}^N \delta_i M_i + \varepsilon_{it} \quad (2a)$$

$$SEV_{it} = \alpha + \beta TRAINBEFORE_{it} + \gamma TRAINAFTER_{it} + \eta URBAN_{it} + \sum_{t=2000}^{2015} \tau_t T_t + \sum_{i=1}^N \delta_i M_i + \varepsilon_{it} \quad (2b)$$

By using this estimation technique, we follow a growing literature that uses before and after time trends to control for the potential bias described above.³⁸ Once we estimate these trends, we can test whether the differences in the before and after trends are statistically significant. This approach has two important advantages. First, the coefficient estimates are easy to interpret; i.e., positive coefficient estimates on the before and after trends indicate that accident frequency or severity was increasing before and after the laws were enacted. Second, it does not shorten the sample, as would the use of a series of leads and lags. Table 1 depicts the differences in the two estimation strategies. We present the results of the before and after trends analysis in the Robustness and Additional Testing section.

Results and Empirical Findings

We carried out the analysis described above by estimating separate regression models for the ACCG for both incident rate and average severity. We also estimated separate regression models for the GMA for both incident rate and average severity. We report on the relationship between driver simulator training and those outcomes. We then provide estimates of the fiscal impact of those findings in terms of any reduction in total loss costs per annum. Finally, we report briefly on some additional analysis that we conducted that provides further evidence on the reliability of our findings.

38. Table 1 allows comparison of the *TRAIN* variables in model 1 to the *TRAINBEFORE* and *TRAINAFTER* variables in model 2. Others who have used this empirical technique to evaluate the impact of laws are Grinols and Mustard (2006); Hoyt et al. (2006); Lott, Jr. (1998); Mustard (2001); and Plassman and Whitley (2003).

Table 1:
Comparison of Training Variables

Year	<i>TRAIN</i> (Model 1a,1b)	<i>TRAINBEFORE</i> (Model 2a,2b)	<i>TRAINAFTER</i> (Model 2a,2b)
2000	0	-6	0
2001	0	-5	0
2002	0	-4	0
2003	0	-3	0
2004	0	-2	0
2005	0	-1	0
2006	1	0	0
2007	1	0	1
2008	1	0	2
2009	1	0	3
2010	1	0	4
2011	1	0	5
2012	1	0	6
2013	1	0	7
2014	1	0	8
2015	1	0	9

Represents the three variables for training administered in 2006.

First, estimating Model 1a (described above) resulted in the following empirical results for accident frequency when applied to the data available from ACCG members. As illustrated in Table 2, while controlling for the variables mentioned above, we find evidence of a statistically significant reduction in accident frequency associated with driver simulator training. This result is highly statistically significant (significant at less than the .01 level). The results for the urban indicator control variable were negative and statistically significant which, logically, suggests a lower accident frequency in urban counties.

Estimating Model 1b (described above) resulted in the following empirical results for accident severity when applied to the data available from ACCG members. As illustrated in Table 3, while controlling for the variables mentioned above, we find a negative coefficient on the training variable, but this result on the relationship between driving simulator training and accident severity is not statistically significant. For the severity data, the coefficient on the urban indicator control variable is positive and statistically significant, which suggests higher accident severities in urban counties.

**Table 2:
Frequency Regression Results (ACCG)**

Dependent variable: number of accidents incurred divided by the number of officers (incident rate)		
Variable	Estimate	t-value
Intercept	-6.8843	-4.8536**
Trained	-0.0293	-4.6333**
Urban	-0.0180	-2.6548**
Member Fixed Effects	Yes	
Year Fixed Effects	Yes	
R ² (%)	2.75	
Observations	1,463	

+ indicates statistical significance at the 10% level

* indicates statistical significance at the 5% level

** indicates statistical significance at the 1% level

**Table 3:
Severity Regression Results (ACCG)**

Dependent variable: sum of all losses incurred divided by the number of accidents incurred (average severity)		
Variable	Estimate	t-value
Intercept	-1411753.559	-2.0547*
Trained	-2088.283	-0.7042
Urban	23717.048	7.8534**
Member Fixed Effects	Yes	
Year Fixed Effects	Yes	
R ² (%)	6.78	
Observations	1,159	

+ indicates statistical significance at the 10% level

* indicates statistical significance at the 5% level

** indicates statistical significance at the 1% level

Based on these model results for ACCG members' data, we have estimated the fiscal impact of these findings. These results translate into a reduction in total accident costs per year of approximately \$2.3 million for member counties that have used training offered by LGRMS. Specifically, as reported in Table 2, the coefficient on the training variable that was estimated in the ACCG data was -0.0293. This means that training resulted in a reduction in loss frequency per officer of 0.0293 per annum. Based on the average claims severity of \$17,000, the estimated reduction in costs per officer is \$498.40 (.0293 x \$17,000). Based on the total of

4,724 officers in counties that had training, the total fiscal impact was \$2,354,426.46 (.0293 x \$17,000 x 4,724).

Additionally, our analysis suggests that if training was utilized in member counties that have not yet been trained, this would result in a roughly \$600,000 reduction in total accident costs per year in those member counties. With 1,251 officers in counties with no training, the same calculations result in a total estimated fiscal impact of \$623,494.39 (.0293 x \$17,000 x 1,251). These results also translate into a total reduction in accidents per year of 175 $([4,724+1,251] \times .0293)$.

Second, estimating Model 1a (described above) resulted in the following empirical results for accident frequency when applied to the data available from GMA members. As illustrated in Table 4, while controlling for the variables mentioned above, we also find evidence of a statistically significant reduction in accident frequency associated with driving simulator training. This result is statistically significant (significant at less than the .05 level). Because GMA members are towns and cities, and due to some coding difficulties, we did not include the urban/rural indicator control variable in the models applied to the GMA data. It should be noted here that we removed observations from a number of smaller departments that did not experience any losses (zero frequency). For comparison, we also re-estimated the results provided in Table 2 and Table 3 while omitting the urban/rural indicator variable. In those cases, the sign on the training variable remains negative and statistically significant, consistent with the results in Table 4 and Table 5 for the GMA data.

**Table 4:
Frequency Regression Results (GMA)**

Dependent variable: number of accidents incurred divided by the number of officers (incident rate)		
Variable	Estimate	t-value
Intercept	1.0792	0.2506
Trained	-0.0445	-2.1222*
Member Fixed Effects	Yes	
Year Fixed Effects	Yes	
R ² (%)	.36	
Observations	1,993	

+ indicates statistical significance at the 10% level

* indicates statistical significance at the 5% level

** indicates statistical significance at the 1% level

Estimating Model 1b (described above) resulted in the following empirical results for accident severity when applied to the data available from GMA members. As illustrated in Table 5, while controlling for the variables mentioned above, we find that the coefficient on the training variable indicates a reduction of roughly

\$4,000 in average severity and, unlike the results for the ACCG data, this result was statistically significant at the .05 level.

Table 5:
Severity Regression Results (GMA)

Dependent variable: sum of all losses incurred divided by the number of accidents incurred (average severity)		
Variable	Estimate	t-value
Intercept	-1641665.846	-3.7857**
Trained	-4247.844	-2.0122*
Member Fixed Effects	Yes	
Year Fixed Effects	Yes	
R ² (%)	.81	
Observations	1,994	

+ indicates statistical significance at the 10% level

* indicates statistical significance at the 5% level

** indicates statistical significance at the 1% level

Based on these model results, we have estimated the fiscal impact of these findings. These results translate into a reduction in total accident costs per year of approximately \$1.3 million for member municipalities that have utilized training offered by LGRMS (the estimated number was \$1,373,217.82). A similar approach and calculations to those reported above for the ACCG data was used in the case of the GMA data. The coefficient on the training variable that was estimated in the GMA data was -0.0445 as reported in Table 4. The average claims severity was \$13,127, and the number of LEOs in units included in our analysis was 2,351 in trained municipalities and 1,220 in untrained municipalities. While the training variable was statistically significant in the severity data of GMA (unlike the case of the ACCG data), to error on the side of conservatism, we did not include a reduction in the average severity when making our calculations of the estimated savings in accident costs. Additionally, our analysis suggests that if training was utilized by member counties that have not yet been trained, this would result in a roughly \$700,000 reduction in total accident costs per year in those member municipalities (the estimated number was \$712,601.34). These results also translate into a reduction per officer in loss costs per year of \$584 and a total reduction in accidents per year of 158.

Combining the cost reductions estimated above, the total fiscal impact for members that have utilized training is approximately \$3.6 million per annum, and the total potential fiscal impact for members that have not yet utilized training is an additional \$1.3 million per annum. The aggregate fiscal impact for ACCG and GMA members included in our analysis would be \$4.9 million per annum. It should be noted here that in order to provide a conservative estimate of cost savings, we do not currently incorporate any allowance for our finding in the GMA data of a

statistically significant impact in reducing the average loss severity. We do this because we did not find evidence of a statistically significant reduction in the average loss severity in the ACCG data. Finally, it should also be noted that due to missing data, some members were not included in the analysis presented here. If the reduced loss costs associated with driving simulator training that we estimate here could be realized by these other member counties and municipalities, this would lead to even greater total cost reductions.

Robustness and Additional Testing

A potential concern with the indicator variable approach that we used above is that the choice by a county or city to carry out simulator training may be motivated by higher losses that are being experienced by that member. As discussed above, this type of phenomenon in a statistical sense is referred to as selection bias or endogeneity. If average potential outcomes are not independent of the treatment (in this case, simulator training), then the average treatment effect is not equal to the difference in observed means (which is what we are measuring with the dummy variable approach in our base model). To test for this, we use a method that includes before- and after-trend variables for the training decision (this approach was presented above as Model 2a and Model 2b). If increased losses are leading to the decision to offer training, we would expect the sign on the before-trend variable to be positive and statistically significant. If the training is reducing losses, we would expect the difference between the before- and after-trend variables to be negative and statistically significant. The results of this estimation for incident rate on ACCG data are presented in Table 6.

**Table 6:
Before- and After-Trend Variable – Frequency Regression Results (ACCG)**

Variable	Estimate	<i>t-value</i>	<i>F-Value</i>
Intercept	-7.0930	-3.9454**	
Trained Before	0.0023	1.4401	5.432** negative
Trained After	-0.0051	-4.6083**	
Urban	-0.0185	-2.7382**	
Member	0.0001	1.2452	
Year	0.0035	3.9983**	
R ² (%)	2.90		
Observations	1,463		

+ indicates statistical significance at the 10% level
 * indicates statistical significance at the 5% level
 ** indicates statistical significance at the 1% level

In this additional analysis, we find that the sign on the before-trend variable is indeed positive, but not statistically significant. However, the difference between the before- and after-trend variables is negative and highly statistically significant. This result is consistent with our core results presented above, and it suggests that endogeneity is not influencing our results. Analysis for the other average severity and for GMA data also do not suggest any evidence of bias.

The likely impact of the endogeneity of treatments under different assumptions is discussed by Guryan (2004). Ashenfelter and Card (1985) use a lagged dependent variable as an additional explanatory variable as one approach to controlling for the possible endogeneity of treatments. Following this approach, we re-estimate the base model, including the lagged value of the dependent variable (incident and average severity) as an additional independent variable, and the results are consistent with those found in the base model. Specifically, while the coefficient on the lagged variable is positive and highly statistically significant, the training variable in the incident rate model remains statistically significant at the .01 level, negatively signed, and of similar magnitude. These results, as well as those from the before- and after-trend variable approach above, suggest that endogeneity is not influencing our results.

Also, as mentioned above, some members repeated training sessions in more than one year during the period of our analysis. To assess the potential impact of repeated training sessions, we also estimated the models with indicator variables for members that had two or three training periods. In these models, the two indicator variables were not statistically significant, but the indicator variable for at least one training session remained negative and statistically significant, which is consistent with our core results presented above. It is still possible that repeated training sessions would be valuable if we could measure the training effect at the individual LEO level. However, as noted above, data limitations prevented us from linking the training sessions with individual LEOs.

LGRMS Driver Simulator Training Costs

Based on 2016 information, LGRMS estimates the operating costs associated with training using its current simulators to be as presented in Table 7. As noted in Table 6, simulator training costs are \$403,500 per year. Based on the analysis conducted in this study, the magnitude of these findings suggests a positive ROI of more than 12:1 for LGRMS' driver simulator training. It is important to note here that these estimates are based only on automobile liability and property damage loss data. As observed in our review of the prior literature, and by LGRMS' own experience, motor vehicle accidents involving LEOs also result in substantial workers' compensation-related costs to counties and municipalities, and these are not captured in our analysis. Inclusion of these costs would result in a further increase of the ROI estimated in our study. Additionally, several noneconomic impacts are not considered in our analysis.

**Table 7:
LGRMS Simulator Training Costs**

Current system cost:

Ford F250 Truck	\$ 35,000
Trailer	\$ 50,000
Doran Simulator	\$100,000
Total	\$185,000

Annual operating expense estimates:

Depreciation of truck, trailer, simulator over 10 years	\$ 18,500
Maintenance	\$ 10,000
PSRC Salary	\$ 55,000
PSRC Benefits	\$ 31,000
Travel	\$ 20,000
Annual Expense for Each PSRC	\$134,500
Annual Expense for Total PSRC	\$403,500

Conclusions and Opportunities for Additional Research

LGRMS indicates that its No. 1 loss within law enforcement continues to be related to motor vehicle incidents. In order to reduce the risk of these incidents from occurring in the future, LGRMS provides simulator training for its members. As documented by our review of the literature, a question that has remained largely unanswered by prior studies is the efficacy of this sort of training in mitigating risk management costs.

Based on data supplied by LGRMS, we conducted research related to the efficacy of motor vehicle simulator training of LEOs in mitigating risk management costs. A key question that we sought to address in this study is whether any reduction in motor vehicle accident frequency and/or severity associated with the motor vehicle simulator training provided by LGRMS to its members offsets the costs of providing this training. LGRMS not only provides motor vehicle simulator training to its members, but it also oversees the loss cost data for motor vehicle accidents involving LEOs employed by its members. As a result, LGRMS was in a unique position to facilitate the analysis conducted in this study.

Based on our analysis, we estimate that the current annual investment LGRMS makes in providing motor vehicle simulator training is producing a ROI to its members of roughly 12:1 (i.e., loss cost reductions 12 times larger than the annual motor vehicle simulator training costs). We believe that our analysis provides strong evidence relative to the efficacy of motor vehicle simulator training of LEOs in mitigating risk management costs through changing behavior.

Recommendations and Findings Based on Our Review of Prior Studies

Based on existing research and the findings of our study, it seems appropriate to include the following recommendations to any law enforcement department considering LEDS training.

1. Do not abandon or replace traditional classroom and/or EVOC training. The most effective way to reduce OITCs is by integrating LEDS training into an already established training program consisting of classroom and/or EVOC training.
2. Ensure that LEDS training software is realistic and not “game-like.” The images, streets, driving conditions, traffic patterns, and presence of pedestrians should be as close to reality as possible.
3. Similar to the second recommendation, spend time and money to ensure that the physical LEDS structure is as realistic as possible. Include actual seats, steering wheels, buttons, pedals, etc. Ensure that the physical layout of the simulator is exactly the same as what LEOs can expect to see in actual vehicles. If possible, include gyroscopic technology that will allow for movement of the simulator and haptic feedback.
4. Allow LEO trainees to fail. As mentioned, the best lessons come from failures. A key learning point in simulator training is the “worst-case scenario.” Allow LEOs to experience those scenarios in the simulator so they can better cope with a similar experience in the real world.

To the best of our knowledge, it appears that, to a large extent, the simulator training being offered by LGRMS is incorporating these best practices. In fact, it is likely that these very elements are contributing to the beneficial impacts that we find in our analysis of the ACCG and GMA loss data.

Implications for Public Policy and Future Research

The recent concern over increasing motor vehicle loss frequency and severity in most states means that our research has important implications for state legislative and regulatory authorities as they seek ways to mitigate growing motor vehicle loss costs. In addition to the oversight responsibilities that state insurance regulators and legislators have relative to motor vehicle accident costs and related impacts on insurance costs, these public policy makers also oversee motor vehicle licensing and associated training requirements for motor vehicle operators in their states. Cost-effective training strategies are not only important for motor vehicle loss mitigation associated with LEOs in their states, but for commercial and private passenger motor vehicle operators, as well. In addition to the benefits we document for the use of motor vehicle simulator training of LEOs, our results suggest that efforts by state insurance regulators and legislators to facilitate and encourage motor vehicle

simulator use as part of their state's licensing and insurance requirements would provide important benefits to the public in their state.

Given our overall finding that motor vehicle simulator training is related to a reduction in loss frequency, further research targeted at identifying the specific aspects of training programs that contribute to this reduction would be warranted. Such research could improve the quality and effectiveness of simulator and other motor vehicle training programs. Also, LGRMS and related organizations in other states could provide the necessary data and experience to facilitate an expansion of the focus of this current study.

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Cummins, J. David and Richard A. Derrig, eds., 1989. *Financial Models of Insurance Solvency*, Norwell, Mass.: Kluwer Academic Publishers.

Manders, John M., Therese M. Vaughan and Robert H. Myers, Jr., 1994. “Insurance Regulation in the Public Interest: Where Do We Go from Here?” *Journal of Insurance Regulation*, 12: 285.

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“Spreading Disaster Risk,” 1994. *Business Insurance*, Feb. 28, p. 1.

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