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Essays on the Creation, Passage, and Effectiveness of Laws and Regulations

Jonathan Orry Ernest
Clemson University

Essays on the Creation, Passage, and Effectiveness of Laws and Regulations

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Jonathan Ernest
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Accepted by:
Dr. F. Andrew Hanssen, Committee Chair
Dr. Thomas Hazlett
Dr. Robert Fleck
Dr. Michael Makowsky

Abstract

In the United States, individual states pass a variety of rules and regulations in order to create and enforce laws. My dissertation examines several key portions of this process, by focusing on regulations impacting the auto insurance industry. I construct three essays which examine strategies for passing such a regulation in state legislatures, factors affecting which states implement the regulation and at what time, and the effectiveness of the law itself. First, I evaluate the effect of state laws establishing electronically accessible statewide databases of insured drivers on uninsured driving and precaution. I find that the laws themselves do not cause a significant change in the rate of uninsured motorists. However, there is a consistent, but not statistically significant, decrease in the number of crashes and fatalities that occur after the law is implemented. This indicates that any effect the law has in encouraging drivers to obtain insurance is outweighed by those drivers who remain uninsured but drive more carefully in order to avoid detection and the resulting penalties. Second, I examine the market conditions associated with states' implementation of these laws. I find that states with lower rates of uninsured driving are *more* likely to implement an insurance database law. In addition, states with higher levels of market concentration are *less* likely to implement the law. There is also some support for a diffusion theory where states are more likely to implement laws their neighboring states have passed.

Last, I evaluate the use of sunset provisions as a legislative bargaining tool that could assist in gaining the majority needed to pass similar laws in additional states. I predict that, under conditions where it is preferable to limit a law's durability rather than changing the content of the law, sunset provisions will be used more frequently when the makeup of the legislative body is more volatile, or when the majority is slim.

Dedication

To my parents, Terry and Alice Ernest, and my wonderful wife Jennifer.

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I would like to sincerely thank a multitude of people and groups without whom it would have been impossible to reach this goal. First and foremost, I would like to thank my advisor, Dr. Andrew Hanssen. The guidance and support I received were instrumental in shaping my many ideas into a focused finished product. I would also like to thank the other members of my dissertation committed. To Dr. Thomas Hazlett, who not only provided suggestions for changes and additions to my feedback, but also helped me gain research experience by working on a variety of projects applying my limited skills to his vast wealth of knowledge. I cannot overstate the value provided by Dr. Rob Fleck in his constant willingness to provide positive feedback and support on any paper I sent him. Finally, to Dr. Michael Makowsky, who would quickly understand the topic or issue I was presenting, and have a suggestion to further the research with cutting-edge ideas and techniques.

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Chapter 1

Ensuring Compliance: The Effect of Enhanced Auto Insurance Enforcement on Uninsured Drivers and Precaution

1.1 Introduction

Private passenger automobile insurance is legally required in order to operate a motor vehicle in 49 states and the District of Columbia.[1] While driving without automobile insurance is illegal, the anticipated cost of being caught doing so is not high enough to convince a nontrivial proportion of U.S. drivers (approximately 12.6 percent in 2012) to acquire insurance or stop driving. On average across all states, the maximum fine

[1]While New Hampshire does not explicitly require liability insurance, the state does require drivers to show proof of financial responsibility in order to operate a vehicle.

for a first offense of driving without insurance is about $650, compared to average insurance premiums of $786 per vehicle per year in 2012. However, fines only provide a deterrent to the extent that they are enforceable. One reason for weak deterrence is the inability of police to quickly and accurately verify proof of insurance during a traffic stop or other interaction.[2]

Recent technology improvements have lowered the cost of enforcing auto insurance requirements. Specifically, several states have passed laws funding the creation and maintenance of statewide electronic databases of currently insured drivers.[3] Police are able to verify the insurance ID cards provided by drivers against the database, improving the ability to accurately identify policies that are in force.[4] The ease of access to insurance status information reduces the cost of enforcement, and therefore increases the likelihood of being caught driving while uninsured. Thus, when police gain the ability to quickly and accurately verify a driver's insurance status, the proportion of uninsured drivers may decrease. While proponents of these laws point to a strong correlation between the law's implementation and fewer uninsured drivers, I find that after controlling for other relevant variables there is no significant decrease in the proportion of uninsured drivers, as compared to states that did not implement such a law.

[2]Typically, proof of insurance may be provided by a printed or electronic version of an ID card produced by the insurance company. An insurance policy may be canceled before the end of the policy term, with a prorated premium returned to the driver for any unused days, but the ID card is not revoked. As the Kansas Legislative Research Department (2015) report confirms: "States' motor vehicle departments have reported increasing problems with fraudulent cards and with motorists paying for insurance and then canceling that insurance but keeping the card."

[3]III (2014) defines these databases as "...Insurer verification laws mandating that all insurance companies in a state submit the entire list of their policyholders to an outside vendor or a state agency, which match them to motor vehicle registrations..."

[4]I investigate the effectiveness of two levels of stringency used in introducing such a database. I examine the nine states that established an electronic link for police to access a driver's insurance status in real time, directly from the insurer. I also consider the 13 total states that require insurers to periodically provide their entire book of business to update a database for police to access, without creating a direct link between police and insurers.

In addition to affecting drivers' decisions of whether to acquire insurance, the increased ability of police to accurately identify uninsured drivers could have an effect on the level of precaution used on the nation's roadways, which I estimate using two measures: total reported crashes and fatal crashes. The predicted effect on driver precaution is ambiguous, due to competing effects. Some drivers may be incentivized to obtain insurance as a result of the law change, in response to the increased chance of detection. These drivers experience moral hazard, which causes them to use less precaution now that they are insured. The law may also have an impact on drivers who remain uninsured, as the increased probability of detection encourages them to drive more cautiously in response to the higher expected costs of being pulled over. Drivers who break the law by driving uninsured may use extra precaution while driving to attempt to avoid detection. I estimate that the implementation of these laws results in a negative but statistically insignificant effect on both total reported crashes and fatal crashes per million licensed drivers per year. This suggests that the predominate effect of the law is incentivizing uninsured drivers to drive more carefully, creating relatively safer roadways without a significant change in the proportion of uninsured drivers.

My research seeks to make two main contributions to the literature on regulation, insurance, and optimal deterrence. First, I examine the effect on uninsured driving of reducing the cost of enforcement of uninsured motorist laws. Second, I have constructed a novel dataset of state-level reported crashes by year to analyze whether these changes result in roads that are safer or more dangerous, specifically by examining changes both in the rate of fatalities and in the rate of total crashes.[5]

[5]While fatal crashes are unlikely to occur without being reported, the sporadic nature and limited number of crashes involving a fatality make it difficult to identify root causes of differences over time. While total reported crashes are more common and less volatile, the likelihood of unreported crashes is also higher. Thus, I consider both measures.

I find that electronic database laws are not successful in accomplishing their intended result of decreasing the proportion of uninsured drivers on the road, but that they cause a small (but statistically insignificant) decrease in the total number of crashes per licensed driver on U.S. roadways.

1.2 Background

An economic reason for government to require automobile insurance is to adjust for the inability of injured parties to collect full damages from those who cause them harm. When a driver causes an accident, it is possible that he could cause damages well in excess of his ability to pay. Due to this constraint, most states require mandatory automobile liability insurance that meets certain minimum limits in order to better assure drivers that they will be indemnified in the event of an accident. However, liability coverage is limited to the coverage levels purchased by the insured driver who caused the accident.[6] Thus, because a driver cannot pay more than the sum of his total assets and liability coverage in the event of an accident, the market failure lies in the fact that a negligent driver is subject to limited liability.[7]

There is some debate in the literature over how dangerously uninsured motorists drive.[8] However, it is possible to predict the relative level of precaution used by an individual driver when he does or does not have insurance. A driver who is uninsured

[6] A general overview of the insurance market is presented in the Appendix.

[7] See Keeton and Kwerel (1984) for further discussion.

[8] Because uninsured drivers seek to avoid detection, they are often only identified when committing a traffic violation or as part of an automobile accident. Khazzoom (2000) provides additional discussion of knowns and unknowns considering uninsured motorists, Query and Berryman (2010) offer a targeted discussion of uninsured motorists in New Mexico, and Butler (2004) argues that uninsured drivers may not be more dangerous than insured drivers, as the population of only accident involved uninsured drivers is compared to the entire population of insured drivers, and does not take into account differences in the number of miles driven.

is predicted to drive more cautiously, in order to avoid fines and responsibility for any damages caused in an accident. Drivers who obtain insurance face a moral hazard problem, in which they drive less carefully than they would if they remained uninsured, knowing that they are subject to fewer costs for damage they may cause.

If uninsured motorists are driving more carefully in order to avoid detection, then a law with an intended effect of reducing the uninsured motorist rate could also create an unintended consequence of incentivizing people to drive less carefully. This concept builds upon the idea of the *Peltzman Effect*, pioneered by Peltzman (1975), who showed that regulations requiring seat belts led to an *increase* in pedestrian deaths and non-fatal crashes. Conversely, it is possible that this effect is outweighed by the extra precaution employed by uninsured motorists, in order to continue to evade detection and penalties.

Previous research has explored the factors that contribute to uninsured driving, as well as precaution and roadway fatalities. Ma and Schmit (2000) analyzed the role of various factors on the likelihood of purchasing auto insurance, finding that stricter enforcement (such as requiring compulsory insurance) and larger fines were associated with lower proportions of uninsured drivers.[9] I expand the analysis to consider the impact of insured driver databases, as well as studying the effect on fatal and total accidents.

Cohen and Dehejia (2004) use an instrumental variables approach on a panel of 50 states from 1970-98. The authors employ the introduction of compulsory insurance and no-fault laws as an instrument for the rate of uninsured drivers, finding that an

[9]Additional research has explored other factors that may contribute to the proportion of uninsured motorists. For instance, Query and Berryman (2010) show that, all else equal, an increase in illegal immigration increases the percentage of uninsured motorists in a state. Cole et al. (2001) find that higher levels of fines are associated with more compliance with uninsured motorist laws, but do not find evidence that other penalties, such as longer jail sentences, increase rates of compliance.

increase in traffic fatalities was produced by a reduction in the incidence of uninsured motorists. The increase in fatalities is contributed to the moral hazard associated with obtaining insurance coverage. I explore similar, but distinct, questions. First, because I examine a market where many states have required mandatory insurance for decades, I can look specifically at the effect of lowering the cost of enforcement of an existing law. Second, Cohen and Dehejia note that "...those drivers who remain uninsured are induced to drive more carefully...If, however, compulsory insurance laws were ineffective, there would be no effect on insured drivers" (Cohen and Dehejia, 2004, p. 365). I focus on this prevailing effect of uninsured drivers adjusting their level of precaution, rather than obtaining insurance.[10] Additionally, as the effect on fatalities is determined by competing forces (drivers obtaining insurance using less precaution; drivers remaining uninsured using more precaution), I test which of these effects outweighs the other when impacting the subset of drivers who were breaking the law by driving without insurance.

1.2.1 Verifying Insurance Coverage

For police officers, the task of verifying insurance coverage has not always been as straightforward as it may seem. When a driver purchases an insurance policy, the insurer provides the driver with an ID card, which lists information on coverages purchased, as well as an end date for the policy period. A typical policy is written to provide six months of coverage before the policy must be renewed.

[10]Cole and McCullough (2007) propose the solution of improved tracking techniques and enforcement to reduce the number of uninsured drivers. They acknowledge the costs and problems associated with creating and maintaining a database of insured drivers, but also mention the success in reducing the uninsured motorist rate in states that had begun implementing such programs. However, the authors make no attempt to further investigate these claims to determine whether the regulation is the causal factor driving the decrease.

If a driver is stopped by a police officer for a primary offense (reckless driving, for instance), the officer can then request that the driver show proof of insurance on the vehicle.[11] However, if a driver cancels the insurance policy, he is not forced to return the ID card. For police officers, there was not previously a low cost way of verifying that the information on the card was correct.

In response to this issue, states have begun implementing two types of laws to improve the ability of police to determine the validity of an insurance policy. Beginning in 1995, Utah was the first state to implement a "Book of Business" (BOB) law, which requires all insurers in a state to upload their entire book of business to a police accessible statewide database of insured drivers on a periodic basis.[12] As of 2014, a total of 13 states had laws requiring BOB reporting. Several years later, technology progressed to make possible another way for police to verify an insurance policy, through an immediate direct electronic connection to the insurance companies writing policies in the state. These "Online Verification" (OLV) laws provide additional assurance that the insurance policy is currently in effect at the time of the officer's inquiry. Table 1.1 provides the states and year of implementation for each type of law. For my analysis I consider OLV and BOB laws together, due to the limited number of states that implemented such laws during my sample period.

1.3 Model

I consider a model of the optimal level of uninsured driving following the implications of the model of an optimal level of crime put forth by Becker (1974). Even with

[11] Driving without insurance is considered a secondary offense in all states, and therefore a driver cannot be stopped solely on the suspicion of driving without insurance.

[12] See Figures 1.4 & 1.5 for diagrams of these procedures.

compulsory insurance laws in place, some drivers continue to choose to drive without insurance. The relative costs and benefits of choosing to drive without insurance are influenced by a combination of the expected penalty assessed when caught, and the probability of being caught. People respond to changes in the penalty or likelihood of being caught, and for some, this leads to a decision to switch from driving without insurance, to becoming insured.

As Becker argued, "[if] muggers are rational, we do not have to make mugging impossible in order to prevent it, merely unprofitable." The same may be said to a certain extent for driving without insurance. However, raising the fine for driving uninsured is only one way to decrease the "unprofitability." In this context, driving uninsured is also less profitable when being caught is more probable.[13] It is with this in mind that states have attempted to increase the likelihood of drivers being caught.

A driver decides whether to drive with or without insurance by considering whether the costs associated with driving without insurance outweigh the costs of being insured as represented in Equation 1.1.

$$\overbrace{(\rho)Fine + (\alpha_{un})Damages}^{\text{Cost of Driving Uninsured}} \gtreqless \overbrace{Premiums + (\alpha_{in})Deductible}^{\text{Cost of Driving Insured}} \tag{1.1}$$

where ρ is the probability that a the driver is caught violating the compulsory insurance law, α_{un} is the probability of an accident if the driver is uninsured, and α_{in} is the probability of an accident if the driver has insurance.

[13] See Polinsky and Shavell (1999) for an in depth overview of the theory and relevant literature on the public enforcement of law. Also, papers including Mookherjee (1997) and Levitt (2007), which discuss when and how enforcement methods may be most effective under various conditions.

The left-hand side of this equation can be thought of as a combination of several possible outcomes from driving without insurance.[14] Each driver weighs his relative likelihood of experiencing these costs. For the marginal uninsured driver, the left-hand side of Equation 1.1 is less than or equal to the right-hand side.[15] I treat the implementation of an auto insurance database law as an exogenous shock, which increases ρ, and alters this balance for some drivers. The affected drivers would be expected to purchase an insurance policy in response to this change.

Put simply, I consider how a policy which increases the expected cost of driving uninsured (by lowering the cost of enforcement) affects this choice. Cohen and Dehejia (2004) consider a similar question, examining the initial implementation of compulsory auto insurance laws. They find that that compulsory insurance laws reduced the proportion of uninsured drivers. However, compulsory insurance laws introduced both ρ and *Fine* simultaneously, and therefore a distinction could not be made between drivers' responses to increased fines, and drivers' responses to increased enforcement.

1.3.1 Effect of Policy on Obtaining Insurance

Consider a policy which makes it easier (less costly) to identify uninsured motorists. This policy does not directly affect the costs of driving *with* insurance, but does affect the costs of driving *without* insurance. In particular, the policy decreases the cost of enforcement, which increases ρ, and therefore increases the expected cost of driving uninsured. As the Becker model suggests, increased enforcement should lead to more

[14] See Equation A.2 in the appendix for a representation of possible outcomes.

[15] For simplicity, the costs associated with each of the descriptions listed is assumed to include both the direct monetary cost, and any additional costs imposed such as administrative and court costs.

compliance with the law, and thus less uninsured driving.

Hypothesis 1: An increase in the expected cost of driving without automobile insurance will result in a decrease in the proportion of drivers who are uninsured.

1.3.2 Effect of Policy on Fatalities

Increased enforcement of uninsured motorists laws may have an effect on the level of precaution used while driving. Most notable is the optimal response of drivers who are uninsured before the increased enforcement is put into place.

1.3.2.1 Uninsured Status Before and After Policy

Implementing a law enhancing enforcement of uninsured driving will likely impact the distribution of insured and uninsured drivers. As can be seen in Table 1.2, individuals may change their behavior and fall into a different category as a result of the policy. Potential drivers are represented as either Uninsured (U), Insured (I), or Not Driving (N) before ($_0$) and after ($_1$) the policy change.

- Group (U_0, I_1) is the main group targeted by the policy considered in this paper. Drivers in this group were uninsured before the policy change, but have now acquired insurance in response to an increase in the expected cost of driving without insurance. This group is subject to moral hazard, as insurance companies cannot perfectly monitor their actions. These drivers are predicted to use less precaution, as they now have coverage in the case of an accident and will not be fined for lack of insurance if pulled over.
- Groups (U_0, U_1), (I_0, I_1), and (N_0, N_1), contain individuals who do not modify

their driving status or insured status. However, the drivers who are uninsured both before and after the policy change are expected to drive more cautiously now that the probability of being caught has increased.

- Group (U_0, N_1) may also respond directly to the policy. Rather than continuing to drive with no insurance, these drivers stop driving all together.

- Groups (I_0, U_1), (I_0, N_1), (N_0, U_1), and (N_0, I_1) contain individuals who are unlikely to change their insurance status directly as a result of the policy. An insured driver is not predicted to cancel his insurance coverage or stop driving, and a non-driver would not begin driving with or without insurance in response to an increase in the probability of being caught driving uninsured.

Hypothesis 2: The implementation of a law that lowers the cost of enforcement of uninsured motorist prohibitions will have an ambiguous effect on precaution, depending on the relative impact of the moral hazard and selection effects. If the prevailing effect from increased enforcement of uninsured driving is drivers obtaining insurance, then crashes may increase due to moral hazard effects. If the prevailing effect from raising the cost of uninsured driving is drivers remaining uninsured, then crash frequencies are expected to decrease as these individuals drive more safely to avoid detection.

Thus, whether insurance database laws will increase or decrease crashes and fatalities is an empirical question. The more effective the law is in decreasing the proportion of uninsured drivers, the more an increase in crashes is expected. Conversely, when uninsured drivers remain uninsured, their increased level of precaution used to avoid detection is expected to result in fewer crashes.

1.3.3 Measurement

It is impossible to observe the number of uninsured drivers directly, so the proportion of uninsured drivers on the road must be estimated.[16] I utilize a measure which estimates the percentage of uninsured motorists in a state as the fraction of reported accidents with an uninsured motorist claim compared to those with a bodily injury claim.

$$\%Uninsured = \frac{\#AccidentsUMClaim}{\#AccidentsBIClaim} \tag{1.2}$$

The limitations of this measure should be noted. First, this measure fails to capture accidents that were not reported to the police or insurance companies, which may be the case if anyone involved in an accident seeks to pay damages directly to those harmed rather than risk additional penalties for driving uninsured. Additionally, this measure may include accidents involving drivers registered in other states, who would not be directly affected by the database regulation.[17] Finally, this measure assumes that uninsured motorists are involved in accidents with the same frequency as insured drivers. If uninsured drivers are, on average, more accident prone than the average insured driver in a state, Equation 1.2 would overstate the true percentage of uninsured motorists, while the estimate would understate the true percentage if uninsured drivers are on average less accident-prone.[18]

[16] See Khazzoom (2000) for additional discussion of the benefits and drawbacks of other methods of estimating the rate of uninsured motorists through randomly sampling registered vehicles, matching databases, or surveying samples of households on their insurance status.

[17] Drivers' insurance requirements are based on their home state. While this insurance follows the driver across state lines, the database policy studied in this paper is state specific, and therefore doesn't provide a new mechanism for immediately identifying the insurance status of out-of-state drivers.

[18] Alternatively, one could estimate the proportion of uninsured drivers by comparing the number of vehicle registrations in a state to the number of insured vehicles. While most states require insurance in order to register a vehicle, many people will drop or fail to renew their insurance

1.4 Data

I construct a data set consisting of a balanced panel spanning 14 years (2001-2014) of state and year level observations. Data from the National Association of Insurance Commissioners (2017) (NAIC) were used to construct estimates of the rate of uninsured motorists in each state, following Equation 1.2. The NAIC reports also provided data on average insurance premiums. These were combined with data from the Property Casualty Insurers Association of America (PCI) and Verisk Solutions (2015) on law implementation dates, from individual state Annual State Crash Facts reports on total reported crashes, from the Fatality Analysis Reporting System (FARS) on roadway fatalities, data on the number of licensed drivers from the Federal Highway Administration, the National Center for Statistics and Analysis (2017) on the number of miles driven for motorists each year, and the US Census for other demographic data.

1.4.1 Summary Statistics

The data for this paper include 49 states and the District of Columbia over a 14 year period, 2001 - 2014.[19] During this time, a total of 13 states implemented at least one of the Book of Business or Online Verification laws, in addition to three states which had BOB laws in place before 2001, with a total of nine states implementing the stricter OLV type of law, providing police with immediate electronic verification of insurance. Table 1.1 describes the implementation across states over time.

while the vehicle remains registered. The result is the potential for a difference in the number of registrations and the number of insured vehicles in a state. Unfortunately, an accurate count of insured vehicles is not available for the vast majority of states and years in my sample period, thus this measure cannot be employed.

[19]The data set excludes Texas, as data on bodily injury and uninsured motorist claims frequency were not available.

Summary statistics for variables of interest are presented in Table 1.3. An estimated average of 16.14% of drivers were uninsured across the 14 years in my sample data set. The average six-month insurance premium was $775, while the average minimum fine for a first offense of driving uninsured was $653. States experienced an average of 33,285 total crashes per million licensed drivers during this time period, with an average of 202.5 of those crashes involving a fatality. In my sample time frame, an average of 72.7% of residents lived in an urban area of their state, and approximately 12.8% lived below the poverty line.

1.5 Empirical Methodology

1.5.1 Estimating Effect of Policy on Uninsured

I estimate the effect of a state implementing a law which allows for enhanced enforcement of uninsured motorist prohibitions. I include state and year fixed effects to control for state specific unobservables and trends in the proportion of uninsured motorists over time, as well as a vector of exogenous covariates.[20]

I estimate the following,

$$\begin{aligned} ProportionUninsuredMotorists_{it} = \beta_0 + \beta_1 EnforcementLaw_{it} + \beta_2 Fine_i + \\ \mathbf{X}\beta_3 + \tau_t + \sigma_i + \epsilon_{it} \end{aligned} \tag{1.3}$$

Where,

[20] I also estimate this regression no fixed effects and with no controls.

- $ProportionUninsuredMotorists_{it}$ represents the estimated percentage of motorists who do not have state minimum levels of insurance in state i in year t,
- $EnforcementLaw_{it}$ is a dummy variable taking the value 1 if the enhanced enforcement law is in effect in state i in year t and 0 otherwise,[21]
- $Fine_i$ is the maximum listed penalty, in thousands of dollars, for a first offense conviction for driving uninsured in state i,
- τ_t represents year level time fixed effects, and
- σ_i represents state fixed effects.

The vector of other covariates, $\mathbf{X}$, includes:

- $AveragePremium_{it}$ represents the average cost paid to purchase one year of insurance coverage in state i in year t,
- $NoPlay_{it}$ is a dummy variable equal to 1 if a state has "No Pay, No Play" laws, which limit an uninsured driver's ability to collect damages from an insured driver, when the insured driver was at fault in an accident,[22]
- $NoFault_{it}$ is a dummy variable equal to 1 if a state has "No Fault" laws, and 0 otherwise,
- $Urban_{it}$ represents the proportion of residents in each state living in areas classified as urban, and

[21] I separately estimate the EnforcementLaw variable considering if a state has introduced either law (OLV or BOB), OLV, or BOB individually.

[22] No pay, no play laws are currently in effect in 10 states (Alaska, California, Iowa, Kansas, Louisiana, Michigan, New Jersey, North Dakota, Oklahoma, and Oregon). These laws "limit an uninsured drivers ability to claim damages if he or she is in an accident with an insured motorist. The Insurance Research Council (IRC) found that 'no play' laws had a modest effect on uninsured rates, reducing them an average of 1.6 percent."Wiltz (2015)

- $Poverty_{it}$ represents the proportion of residents in each state below the poverty line.

1.5.2 Estimating Effect of Uninsured on Precaution

I utilize a reduced form analysis to estimate the effect of laws that provide for enhanced enforcement of uninsured motorist prohibitions on total crashes, as well as on fatal crashes. Once again, I include state and year fixed effects, as well as a vector of exogenous covariates. I estimate,

$$CrashesPerDriver_{it} = \gamma_0 + \gamma_1 EnforcementLaw_{it} + \gamma_2 Fine_i + \mathbf{X}\gamma_3 + \sigma_t + \epsilon_i \quad (1.4)$$

Where,

- $CrashesPerDriver_{it}$ represents the number of total reported crashes per million licensed drivers in state i in year t, in my first specification, and the number of fatal crashes per million licensed drivers in my second specification.[23]

The literature has traditionally focused only on fatal crashes, as the data are more readily accessible at the state-year level. In this context, using fatalities as a measure of driver precaution has the benefit of not likely being under-reported. A driver who is uninsured that causes a minor accident may want to avoid police involvement,

[23]Crashes are measured per million licensed drivers in order to adjust for any changes in the number of crashes resulting from having more or few drivers on the road. However, this does not directly account for other adjustments that may be made by these drivers. Specifically, one could also measure crashes per miles driven, in order to account for changes along the margin of *how much* driving is limited or increased, rather than *how many* drivers are on the roadways. Either measure is an attempt to estimate changes in the amount of precaution used by drivers before and after a change.

whereas an accident involving a fatality is likely to generate a police report.

However, fatal accidents occur relatively infrequently, making it difficult to predict changes with a high level of certainty. For this reason, I have compiled a data set of the total number of crashes in each state for the years in my sample period. Observing all crashes, rather than only fatal crashes, provides several benefits. First, there is a much larger number of total crashes per year, and the measurement is much less sporadic. Second, I seek to measure the degree to which uninsured drivers are adapting to avoid police protection when a law is passed. It is much more likely that the additional precaution used is put forth to avoid less severe accidents, as the reckless driving that generates fatal crashes is more likely to garner the attention of law enforcement.

With either measure, a negative sign on the coefficient on $EnforcementLaw_{it}$ would indicate that the dominating effect is drivers using more precaution after the law is passed.

1.6 Results

1.6.1 Effect of Policy on Uninsured Motorist Rate

I find that an increase in the expected cost of driving without automobile insurance does not result in a statistically significant decrease in the proportion of drivers who are uninsured. Specifically, Table 1.4 column 3 shows that controlling for state and year fixed effects produces an estimate of the proportion of motorists who are uninsured in a state when the policy change is implemented that is not significantly

different from 0.[24] There are two possible reasons for this to occur. The law itself may not be impactful enough to alter drivers' behaviors, or drivers may be adjusting along another margin, rather than by obtaining insurance.

Table 1.4 also displays the expected sign on the control variables of interest. Higher average premiums, the presence of "No Fault" laws, and higher levels of poverty are all associated with more uninsured drivers, while higher fines are associated with fewer uninsured drivers.

1.6.2 Effect of Policy on Precaution

While the laws considered in this paper are not necessarily effective in lowering the percentage of uninsured drivers, my results indicate that the laws may have an effect on driver safety.

A decrease in total and fatal crashes as a result of the law's implementation indicates that the law is effective in making streets slightly safer, as uninsured drivers use more precaution in order to avoid detection. As a result, roadways do not have fewer uninsured drivers, but the roads are safer. While Cohen and Dehejia (2004) observed an increase in fatalities when more drivers obtained insurance, I find that in my sample it is the drivers who remain uninsured who have the larger effect.

Thus, while these programs do not appear to be successful in their stated purpose of reducing the number of uninsured drivers in a state, the $1.05 to $7 million in start-up costs needed to initiate such a program [25] may still be generating a positive effect. States must consider any additional benefit associated with less dangerous roadways

[24] Figure 1.8.2 demonstrates the overall decrease in uninsured motorist rates during this time period for states that did not have a database regulation in place.

[25] Estimated by Carlson et al. (2015).

and fewer fatalities as a result of these laws.

1.7 Conclusion

This paper evaluates the effect of state laws establishing electronically accessible statewide databases of insured drivers on uninsured driving and precaution. Lowering the enforcement cost of identifying and penalizing uninsured drivers will raise the expected cost to drivers of operating a vehicle while uninsured. I find that states implementing such a policy are not successful in reducing the proportion of uninsured drivers on their roadways, but that the drivers who remain uninsured may use more precaution in order to avoid the enhanced enforcement. My results show that a Becker-type model of an optimal level of uninsured drivers can be applied, and that drivers respond to changes not only in the severity of a penalty for non-compliance, but in the likelihood of receiving such a penalty. In this case, drivers who respond to increased enforcement by purchasing insurance have weaker incentives to drive with precaution as compared to those who remain uninsured. Thus, the more successful a policy is in convincing additional drivers to obtain insurance, the more dangerous roadways could become.

1.8 Tables and Figures

1.8.1 Tables

Table 1.1: Online Verification and Book of Business Implementation Dates

State	Implementation Year	Online Verification	Book of Business
UT	1995		X
NE	1999		X
MO	2000		X
SC[a]	2004	X	X
KS	2005		X
CA[a]	2006	X	
KY	2006		X
OK	2006		X
WY	2006	X	X
TX[b]	2008	X	
NV	2009		X
OK	2009	X	
MI	2012		X
MT	2012	X	X
AL	2013	X	X
UT[c]	2013	X	
WV	2013	X	X
CT	2015	X	X
RI	2015		X
LA	2016	X	X
MS	2017	X	
TN	2017	X	

Note: My sample contains data for 2001 - 2014. The three states in dark gray had laws in place spanning the entire sample period, while the five states in light gray did not implement OLV or BOB laws until after the sample period.

[a] South Carolina and California allow for voluntary participation of insurers in the Online Verification program.

[b] Texas is excluded from all analysis, as the data necessary to calculate the proportion of uninsured motorists are not available.

[c] Utah's 2013 law introduced Online Verification requirements which updated the 'Insure-Rite' Book of Business program that had made Utah a pioneer in auto insurance enforcement programs in 1995.

Table 1.2: Insurance Status - Before and After Increased Enforcement

Possible Insured/Uninsured Status for Potential Drivers Before and After Law			**After Law**		
			Driving		Not Driving
			Insured	Uninsured	N/A
Before Law	Driving	Insured	$(\mathbf{I}_0,\mathbf{I}_1)$	$(\mathbf{I}_0,\mathbf{U}_1)$	$(\mathbf{I}_0,\mathbf{N}_1)$
		Uninsured	$(\mathbf{U}_0,\mathbf{I}_1)$	$(\mathbf{U}_0,\mathbf{U}_1)$	$(\mathbf{U}_0,\mathbf{N}_1)$
	Not Driving	N/A	$(\mathbf{N}_0,\mathbf{I}_1)$	$(\mathbf{N}_0,\mathbf{U}_1)$	$(\mathbf{N}_0,\mathbf{N}_1)$

Table 1.3: Summary Statistics

	Descriptive Statistics			
	Mean (Std Dev)	Min	Max	Source
Uninsured Motorist Rate	16.14 (5.95)	2.54	35.86	NAIC Database Reports
Regulation	0.15 (0.36)	0	1	PCI; Verisk
Online Verification	0.07 (0.26)	0	1	PCI; Verisk
Book Of Business	0.14 (0.34)	0	1	PCI; Verisk
Fatalities	694.28 (675.55)	15	4333	FARS
Total Reported Crashes	126097.71 (112890.64)	3258	544742	Annual State Crash Facts
Total Crash Per Mil. Driver	33285.32 (9715.26)	6321.94	59143.54	Annual State Crash Facts
Fatal Crash Per Mil. Driver	202.50 (84.42)	37.41	580.17	Annual State Crash Facts
Injury Crash Per Mil Driver	9727.58 (2573.54)	3211.42	18231.84	Annual State Crash Facts
Fine (in $s)	653.50 (794.14)	0.00	5000.00	CFA Report
Average Premium (in $s)	775.53 (172.42)	498.00	1263.67	NAIC Database Reports
No Pay, No Play	0.20 (0.40)	0	1	IRC
No Fault	0.24 (0.43)	0	1	IRC
Urban	72.71 (15.10)	38.20	100	Census, CPS Data
Poverty	12.81 (3.49)	5.40	25.75	Census, CPS Data
N	700			

Note: Summary statistics cover yearly observations for 50 states from 2001-2014. Uninsured Motorist Rate is the estimated number of drivers with no insurance per 100 drivers. Regulation, Online Verification, and Book of Business are equal to 1 when a state has such a law in place, and 0 otherwise. Fatalities and Total Crashes are annual measurements at the state level. Fine is measured as the maximum fine for a first offense of driving without insurance. Average Premium is measured as the average amount paid for a policyholder to purchase one year of insurance coverage in the state. No Pay, No Play and No Fault are indicators equal to 1 when a state has the respective law in place. Urban measures the proportion of a state's population living in an urban area, and Poverty represents the proportion of a state's population living below the poverty line.

Table 1.4: Effect of Uninsured Driving Enforcement Laws on Uninsured Motorist Rate

	No Controls	No FE	Region FE	State FE	Year FE	Region & Year FE	State & Year FE
Regulation	-2.099*	-1.679	-2.223	-0.580	-0.210	-1.815	-0.153
	(1.177)	(1.039)	(1.295)	(0.861)	(0.791)	(1.255)	(0.829)
Fine		-0.000709	-0.00124*	(.)	-0.000717	-0.00125*	(.)
		(0.000623)	(0.000476)		(0.000980)	(0.000526)	
Average Premium		0.00886*	0.0156**	-0.00466	0.00803	0.0169**	0.00729
		(0.00524)	(0.00313)	(0.00419)	(0.00610)	(0.00320)	(0.00686)
No Pay, No Play		-0.0812	-0.875	1.155	-0.129	-0.989	1.009
		(1.550)	(1.768)	(0.755)	(1.190)	(1.802)	(0.891)
No Fault		1.412	2.679	8.916	6.081	2.614	8.484*
		(2.048)	(1.342)	(5.113)	(3.861)	(1.381)	(4.828)
Urban		0.00474	-0.0596	-0.113	-0.00338	-0.0656	0.101
		(0.0619)	(0.0508)	(0.155)	(0.0979)	(0.0488)	(0.257)
Poverty		0.297	0.0374	-0.212*	-0.0489	0.120	-0.0794
		(0.180)	(0.200)	(0.0845)	(0.0780)	(0.247)	(0.0818)
Constant	16.45***	5.506	8.555	21.14***	11.11*	9.032	3.098
	(0.894)	(3.998)	(4.433)	(10.46)	(5.990)	(4.591)	(16.97)
Observations	700	700	700	700	700	700	700
R^2	0.016	0.135	0.176	0.129	0.171	0.195	0.177
Region FE			X			X	
State FE				X			X
Year FE					X	X	X

Robust clustered standard errors in parentheses

Dependent Variable Proportion of Uninsured Motorists. 50 states, 2001-2014.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.5: Effect of Uninsured Driving Enforcement Laws on Crashes

	Dependent Variable:					
	Total Crashes			*Fatal Crashes*		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Regulation	-789.1	-472.1	-462.2	15.59**	-9.310	-13.43
	(2,188)	(946.8)	(991.8)	(4.038)	(10.72)	(11.79)
Fine	0.191	-0.0930	(-)	-0.00116	-0.000125	(-)
	(0.438)	(1.169)		0.00909	(0.00647)	
Average Premium	18.41**	12.11*	12.96*	-0.00217	0.0338	0.0510
	(4.842)	(6.634)	(7.695)	(0.0366)	(0.0371)	(0.0450)
No Pay, No Play	-83.13	335.2	741.8	-6.933	-4.118	-3.545
	(5,932)	(1,986)	(962.7)	(25.63)	(14.53)	(5.824)
No Fault	-2,164	1,139	2,387***	16.83	2.899	18.77*
	(3,682)	(1,361)	(851.2)	(8.474)	(13.11)	(10.91)
Urban	-81.62	15.47	378.6	-2.957*	-3.012***	-2.654
	(69.17)	(120.5)	(313.4)	(1.124)	(0.802)	(3.032)
Poverty	125.9	-226.7**	-293.9**	1.568	-1.422*	-2.483**
	(565.4)	(110.7)	(118.0)	(1.143)	(0.863)	(0.933)
Constant	23,967**	30,233***	4,048	394.8*	448.2***	418.3*
	(6,244)	(6,964)	(22,708)	(74.59)	(59.41)	(221.0)
N	630	630	630	700	700	700
Region FE	X			X		
State FE			X			X
Year FE		X	X		X	X

Robust Standard errors in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

1.8.2 Figures

Figure 1.1: States Enacting Either Uninsured Driving Enforcement Law

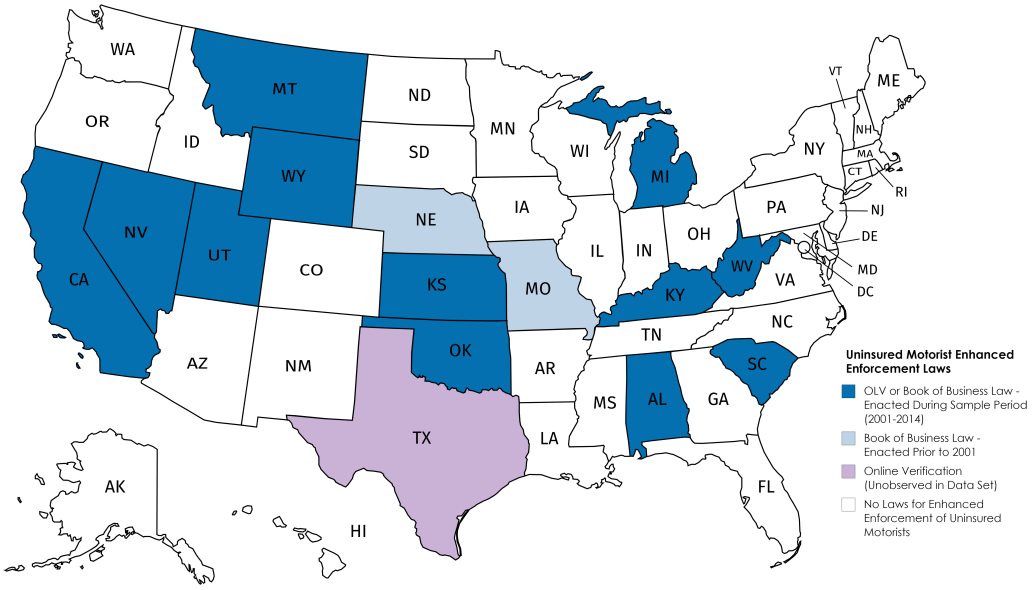


Figure 1.2: States Enacting Laws for Immediate Online Verification of Auto Insurance Policies

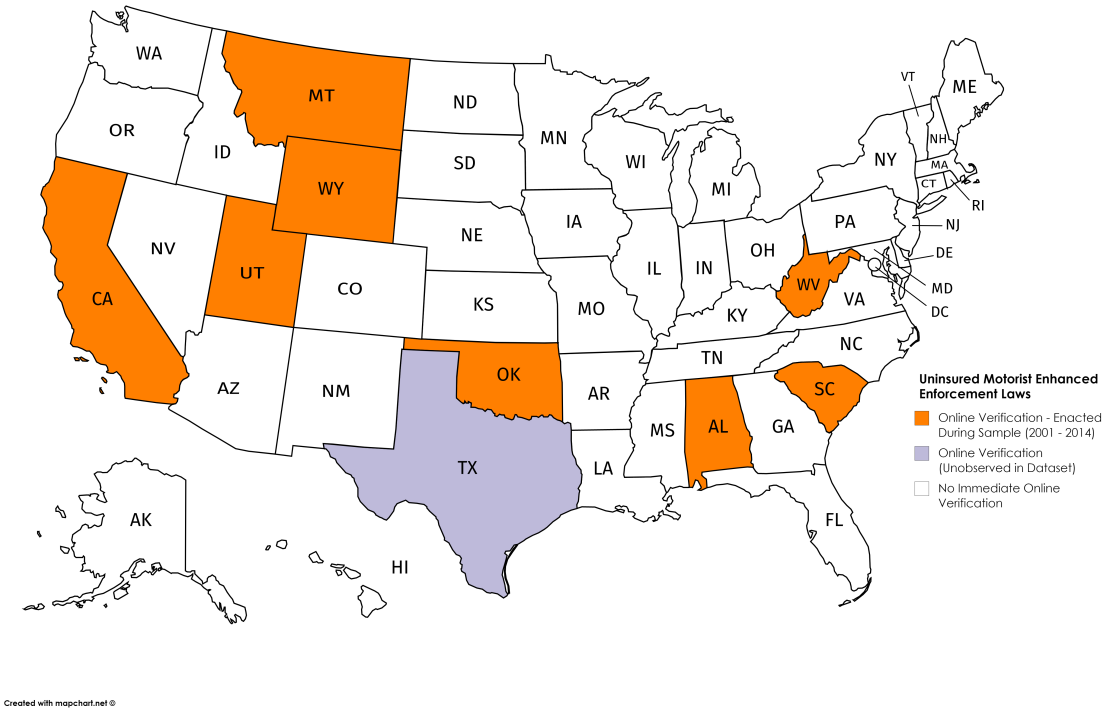


Figure 1.3: States Enacting Laws Requiring Insurers to Periodically Submit Entire Book of Business

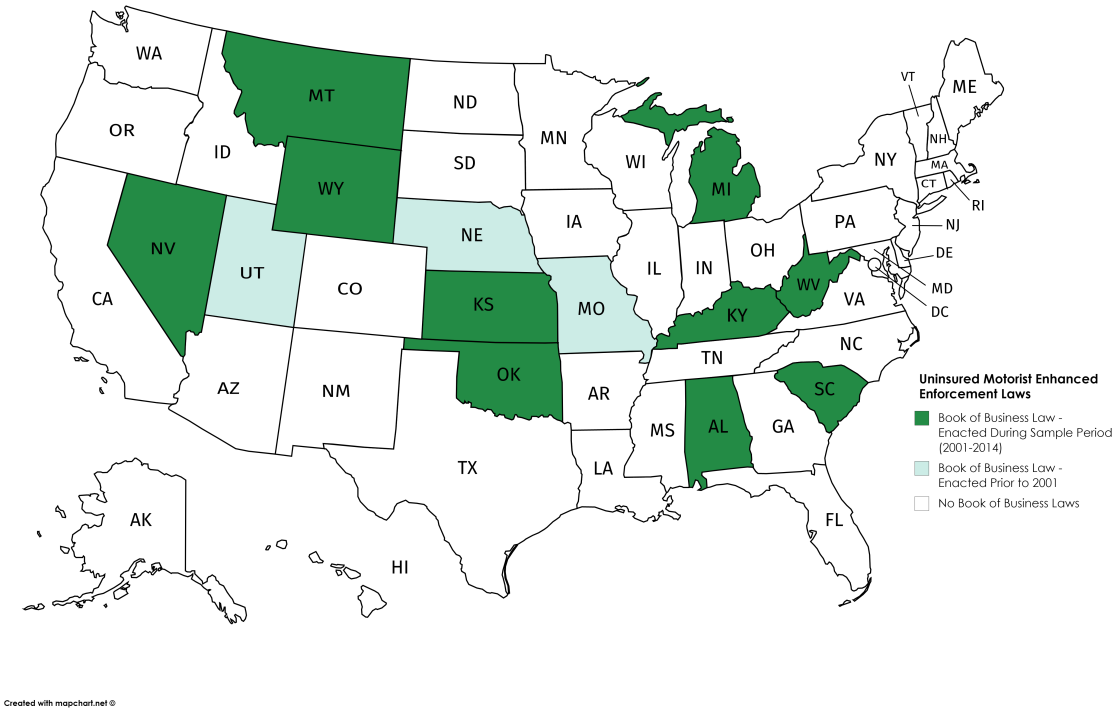


Figure 1.4: Procedure for Insurance Verification: Before Law

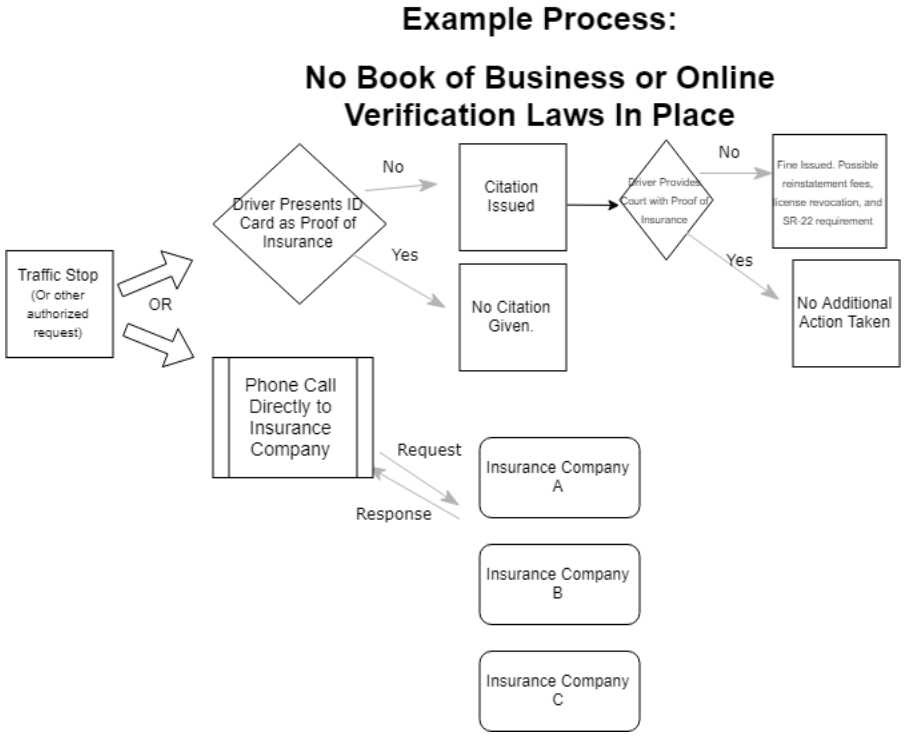


Figure 1.5: Procedure for Insurance Verification: After Law

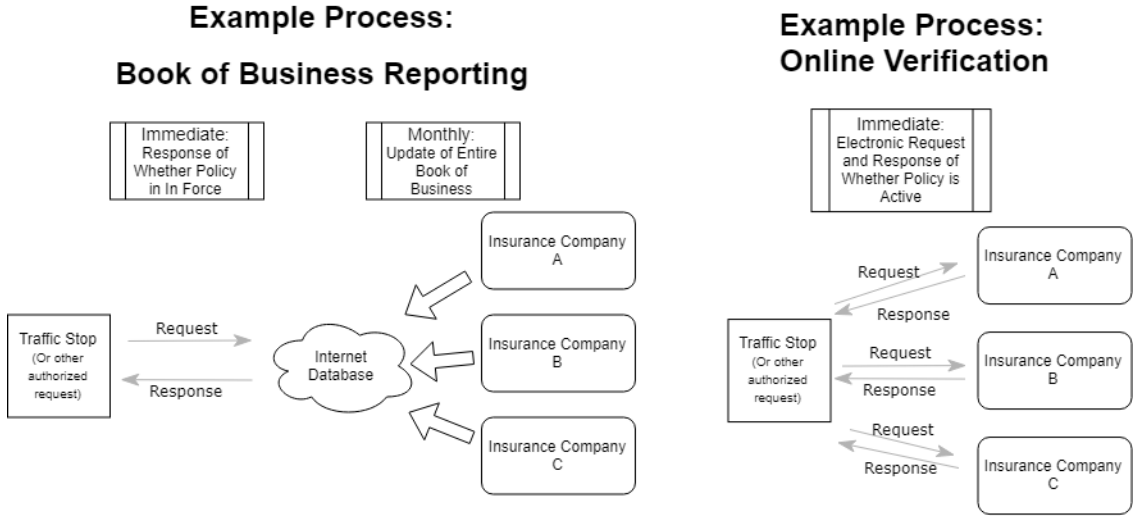


Figure 1.6: Average Uninsured Motorist Rates - By Year - States with no Database Regulation

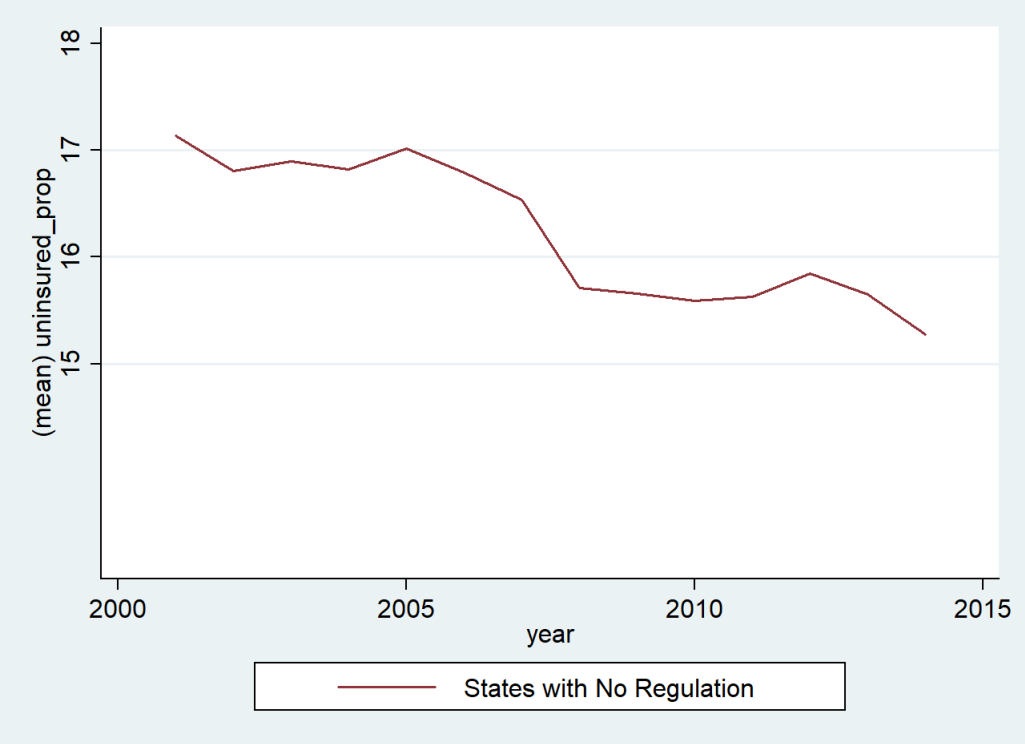


Figure 1.7: Insurance Verification Laws and Uninsured Motorist Rates (1/3)

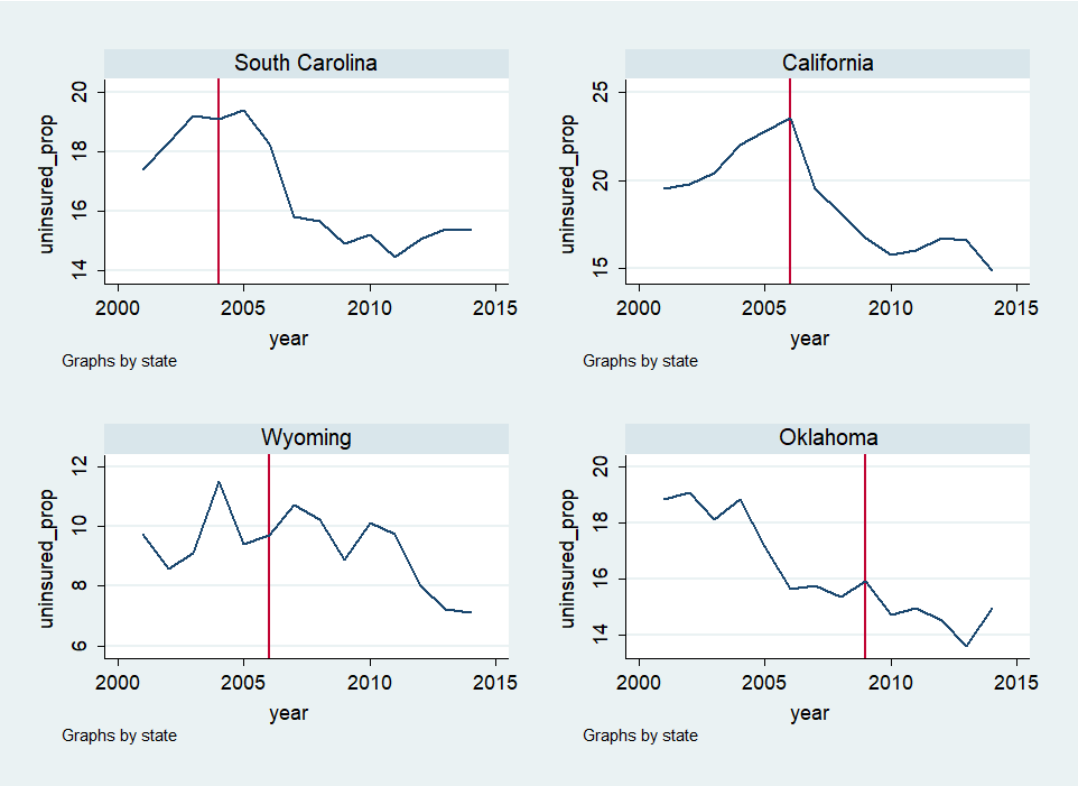


Figure 1.8: Insurance Verification Laws and Uninsured Motorist Rates (2/3)

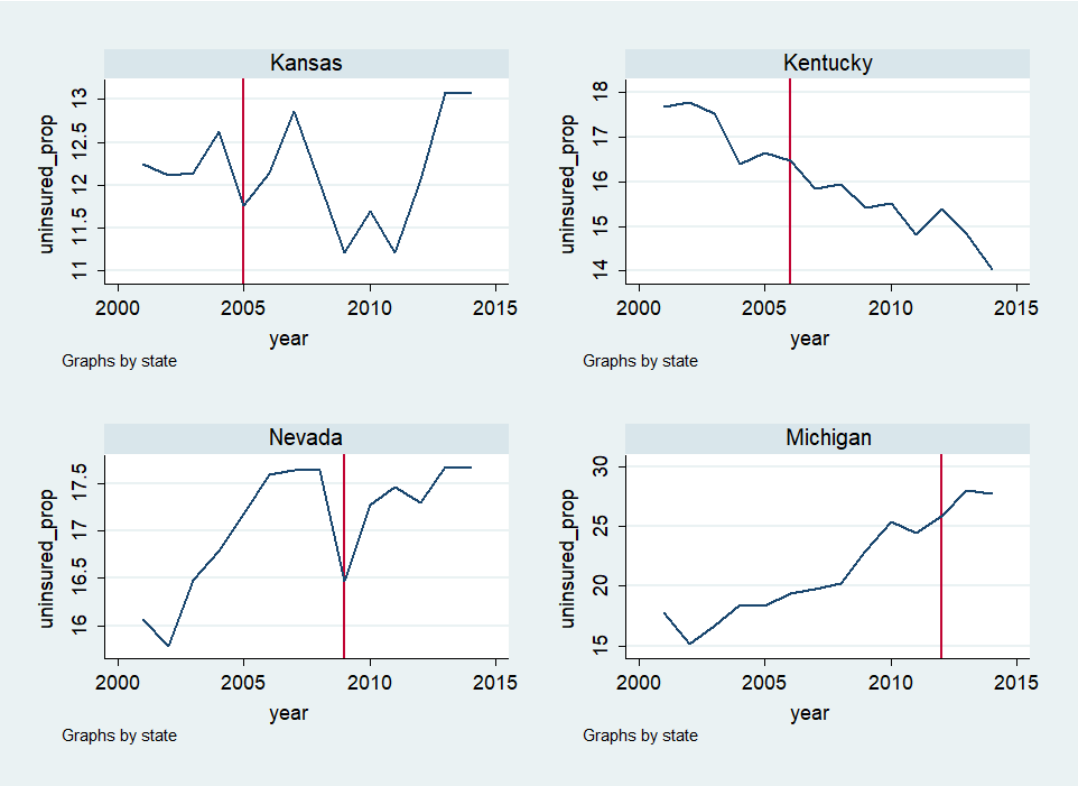


Figure 1.9: Insurance Verification Laws and Uninsured Motorist Rates (3/3)

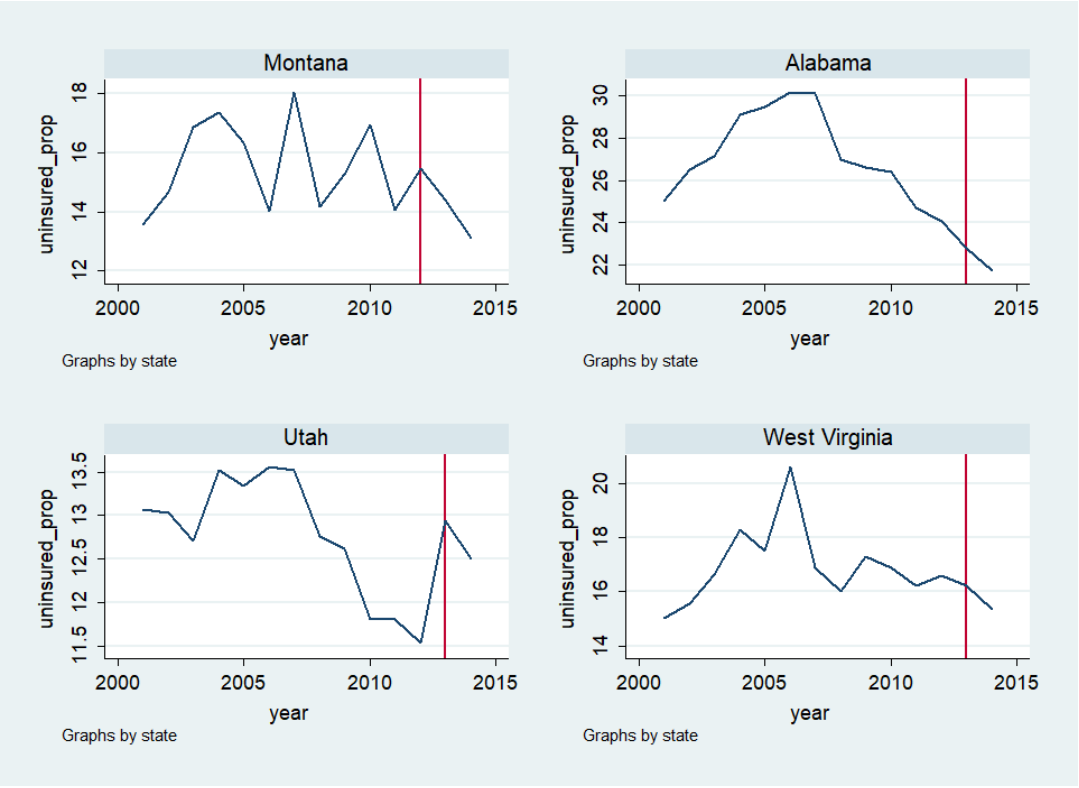


Figure 1.10: Insurance Verification Laws and Total Reported Crash Rates (1/3)

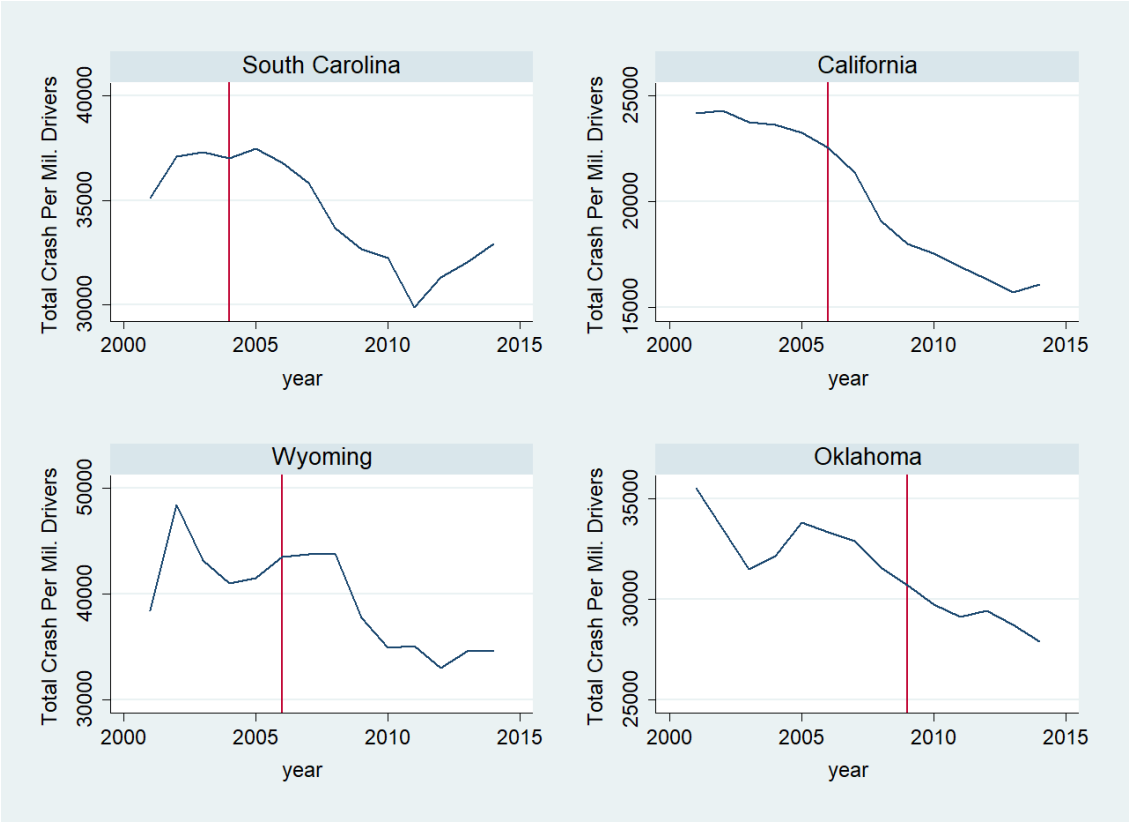


Figure 1.11: Insurance Verification Laws and Total Reported Crash Rates (2/3)

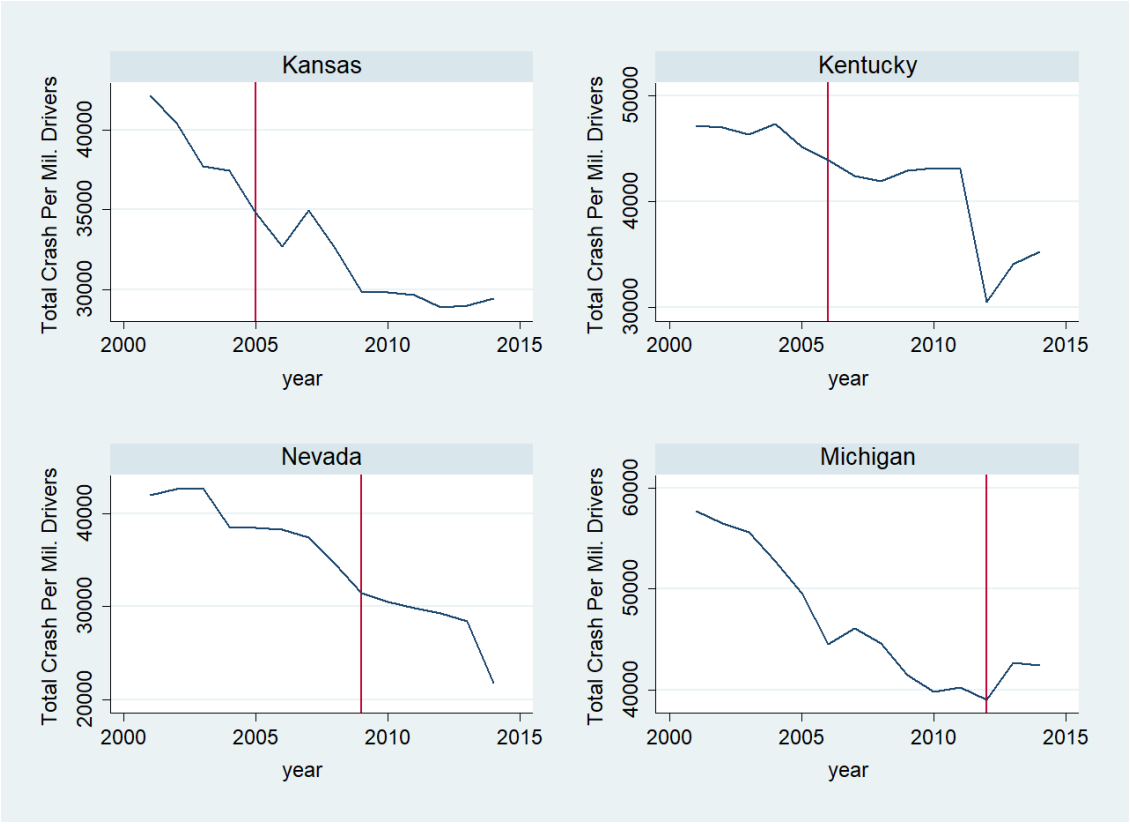
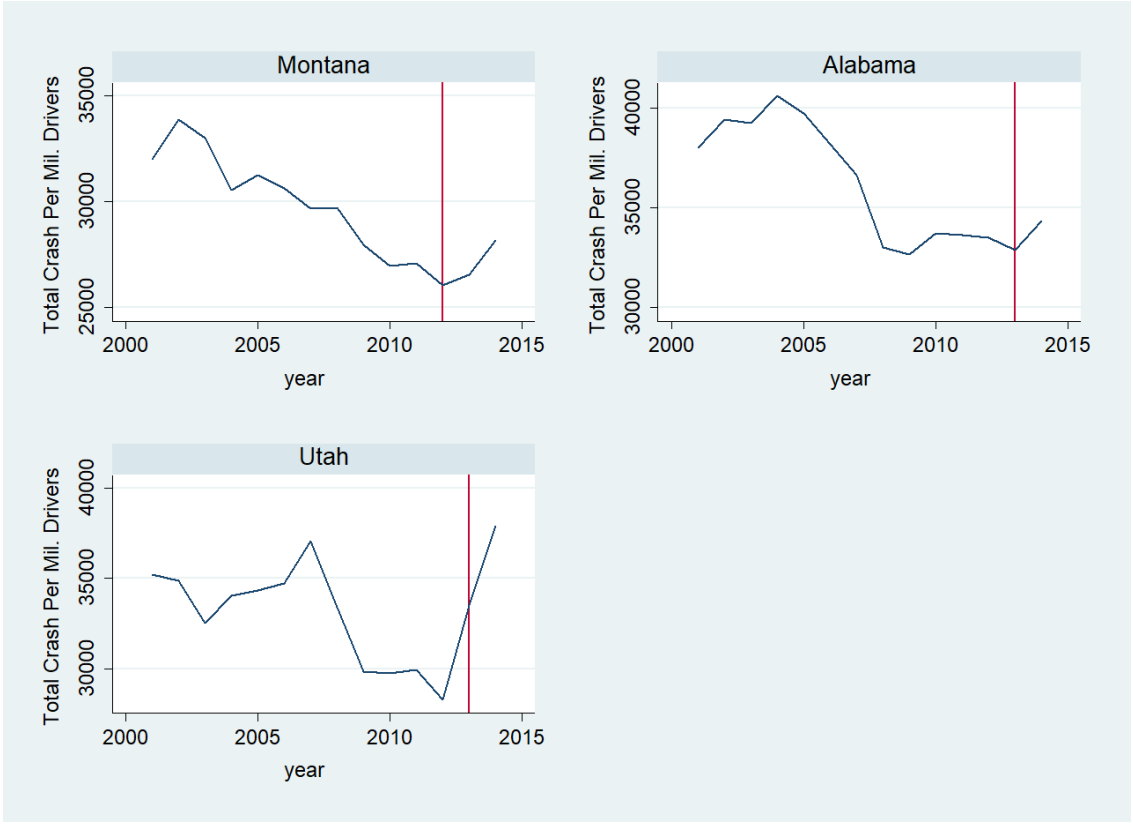


Figure 1.12: Insurance Verification Laws and Total Reported Crash Rates (3/3)



Chapter 2

An Investigation of the Factors Associated with States' Implementation of Enhanced Auto Insurance Enforcement Laws

2.1 Introduction

The optimal level of enforcement for existing laws may vary from state to state, based on the relative cost and benefit of increasing or decreasing enforcement and compliance. A state's decision of how, and how much, to enforce its laws requiring drivers to maintain automobile liability insurance could be based on a variety of factors. In the years spanning 2004 to 2014, 13 states implemented new laws intended to reduce uninsured driving by making it easier for police to identify whether drivers were in-

sured.[1] This is accomplished by requiring insurers to provide up-to-date information on the which drivers have active policies. What caused 13 states to implement such a law? I explore whether three main factors have a significant impact on a state's decision to implement the law; the rate of uninsured driving, market concentration, and neighboring states' implementation of the law.

While it would at first seem that states with high rates of uninsured driving would have the most to gain from an enhanced auto insurance enforcement law, as they have the most room for improvement, there also exists the possibility that states with low rates of uninsured driving place a higher value on restricting the number of uninsured drivers on the road. Therefore, I first examine and compare the uninsured motorist rate across states that did and did not implement such a law.

Legislators who consider a database law may be influenced not only by their constituents, but by interest groups from the affected industry as well. In order to comply with the law, insurers must endure the fixed and variable costs associated with developing and maintaining the systems necessary to relay information on their book-of-business to the state. However, insurers could also expect to benefit from the law's effectiveness, as they have the opportunity to sell additional policies if more drivers become insured. This effect may not be felt evenly among insurers of different size. Thus, I investigate whether market concentration among auto insurance companies in each state can predict the law's implementation.

The structure of state governments in the United States provides state legislators with the ability to observe how regulations perform in other states, before enacting the law themselves. Regional diffusion theory argues that states' decisions on which

[1]Note that Ernest (2018) finds no evidence that these laws are effective in reducing the rate of uninsured driving in a given state, but that they may create incentives for safer driving and fewer crashes.

legislation to enact are influenced by laws that have been enacted in neighboring states. I investigate whether this phenomenon is applicable to the passage of auto insurance database regulation laws.

After investigation of each of these factors, I find that an insurance database law is more likely to be implemented in a state with a relatively low rate of uninsured driving. This suggests that states with a strong interest in keeping uninsured driving to a minimum implement the law to satisfy this preference, rather than in an attempt to lower extremely high rates of uninsured driving. In addition, the market concentration of insurers in the state plays a role, with the law having a greater chance of implementation in states with higher levels of competition. Finally, I find some evidence for diffusion theory in explaining states' decisions to implement database laws when neighboring states have done so.

2.2 Background - Theory

The federal system of government in the United States creates a structure of shared power between the federal and state governments. This structure allows for the possibility of individual states to pass laws in a sort of testing-ground for the law's effectiveness, with many studies having been conducted on the diffusion of such innovations.[2] If the regulation performs well, the law could then be implemented on a larger scale, or even at the national level. For the automobile insurance market, however, the responsibility for implementing and enforcing laws and regulations remains with the individual states.[3]

[2]See Walker (1969) for discussion of diffusion theory and states' incentives to adopt policies that were enacted in neighboring states.

[3]The McCarran-Ferguson Act (1945) exempted the insurance industry from most federal regulation. Thus, states enact laws and requirements individually at the state level.

While 49 states and the District of Columbia require that private passenger automobiles meet minimum liability limits for insurance in order to legally operate a vehicle on the state's roadways, a proportion of the drivers in each state break this law and drive without insurance. Estimates of the fraction of drivers in each state who do not have the minimum level of liability coverage range from less than 5% to more than 30%, depending on the state and year. These drivers are referred to as "uninsured drivers",[4] and they are subject to fines and other penalties if caught driving without insurance.[5]

Police have historically been limited in their ability to identify uninsured drivers at low cost, in order to enforce these laws. Typically, proof of insurance is provided by a printed or electronic version of an ID card produced by the insurance company. An insurance policy may be canceled before the end of the policy term, with a prorated premium returned to the driver for any unused days, but the ID card is not revoked. As the Kansas Legislative Research Department (2015) report confirms: "States' motor vehicle departments have reported increasing problems with fraudulent cards and with motorists paying for insurance and then canceling that insurance but keeping the card."

In 1995, Utah implemented a new law which required all insurers in the state to contribute to a database of insured drivers, and allowed police access to this database in order to enforce insurance laws. In 1999, Nebraska introduced a similar law, with Missouri adding a "Book of Business" (BOB) law in the year 2000. In 2004, South

[4]The term "uninsured driver" is a misnomer, as insurance policies apply to vehicles, with the insurance extending to the current driver of the vehicle, unless certain restrictions or named-driver exclusions apply.

[5]It is impossible to directly observe the number of uninsured drivers in a state, as these drivers have an incentive to avoid detection so that they do not face the associated penalties. However, the literature generally estimates the proportion of uninsured drivers as the fraction of accidents involving an uninsured motorist claim, divided by the total number of accidents involving a bodily injury claim. I follow Ernest (2018) in using this method to estimate uninsured rates for this paper.

Carolina added an Online Verification (OLV) requirement which allowed police real-time access to an insurer's current written policies. This access removed any delays which could cause a "false positive" result of when a driver had cancelled a policy after the last time the insurer updated the database. By 2014, 15 states had implemented one or both of these types of laws, with at least 5 more states joining in by 2017. Table 2.1 displays the year and type of law for each participating state.

2.2.1 Verifying Insurance Coverage

In order for police officers to enforce laws requiring drivers to maintain automobile insurance, there must be a way for drivers to demonstrate to police that they have acquired the necessary coverage. Traditionally, this was handled through requirements for insurers in each state to provide drivers with an ID Card listing the insurance coverages the driver had purchased for the policy period.[6] This ID card would be presented to police during a traffic stop or other interaction, in order to verify coverage.[7] However, if a driver cancels the insurance policy, he is not forced to return the ID card. For police officers, there was not previously a low cost way of verifying that the information on the card was correct.

In response to this issue, states have begun implementing two types of laws to improve the ability of police to determine the validity of an insurance policy. Beginning in 1995, Utah was the first state to implement a "Book of Business" (BOB) law, which requires all insurers in a state to upload their entire book of business to a police accessible statewide database of insured drivers on a periodic basis.[8] As of 2014, a

[6] A typical automobile insurance policy provides coverage for six months before it must be renewed.

[7] Driving without insurance is considered a secondary offense in all states, and therefore a driver cannot be stopped solely on the suspicion of driving without insurance.

[8] See Figures 1.4 & 1.5 for diagrams of these procedures.

total of 13 states had laws requiring BOB reporting. Later, technology progressed to make possible another way for police to verify an insurance policy, through an immediate direct electronic connection to the insurance companies writing policies in the state. These "Online Verification" (OLV) laws provide additional assurance that the insurance policy is currently in effect at the time of the officer's inquiry. Table 2.1 provides the states and year of implementation for each type of law. For my analysis I consider OLV and BOB laws together, as the laws are similar in nature and ultimate intention.

2.3 State-Specific Factors

There are many variables which could prove to be factors in a state legislature deciding to implement an auto insurance database law. Some of these variables may influence the calculus of relative costs and benefits of mandating such a program, while others provide an indication of the unique preferences present in the state. I discuss the relevant factors for my analysis in this section.

2.3.1 Proportion of Uninsured Drivers

The urgency to pass a law to combat uninsured driving could reasonably be associated with the amount of uninsured driving in the state. The percentage of drivers who do not possess minimum insurance coverage varies substantially across states, from less than 4% to more than 30%. One could assume that states with more uninsured driving would be more likely to implement a database law to help identify and stop these uninsured drivers. However, it is also possible that states with few uninsured

drivers are more likely to implement such a law, as these states may place a higher value on keeping uninsured driving to a minimum. As database laws are one tool among many for deterring uninsured driving, these states could already be placing more emphasis on minimizing uninsured driving through other methods.[9]

2.3.1.1 Measurement

Directly observing the number of uninsured drivers in a state is impossible, but the proportion of drivers without insurance can be estimated. Khazzoom (2000) provides discussion of the limitations of several methods of estimation. For this paper, I follow Ernest (2018) in calculating the uninsured motorist rate using Equation 2.1. This measure estimates the percentage of uninsured motorists as the fraction of accidents with an uninsured motorist claim, out of the total number of accidents with a bodily injury claim.

$$\%Uninsured = \frac{\#AccidentsUMClaim}{\#AccidentsBIClaim} \tag{2.1}$$

This measure may include accidents involving drivers registered in other states, who would not be directly affected by the database regulation. Drivers' insurance requirements are based on their home state. While this insurance follows the driver across state lines, the database policy studied in this paper is state specific, and therefore doesn't provide a new mechanism for immediately identifying the insurance status of out-of-state drivers. The database laws currently being implemented also do not provide the ability for police to immediately verify the insurance status of out-of-state drivers. However, if several neighboring states were to successfully implement new

[9]Other methods which are not explicitly considered in this paper could include such efforts as increased or more targeted policing.

agreements in the future, database laws could be made more effective by allowing officers in a state to access the out-of-state databases of uninsured drivers.

2.3.2 Demographic Factors

Demographic factors may play a large role in a state's decision to pass a database law. State-level factors which represent unique characteristics of the state could affect this decision in two ways. The preferences of constituents, and relevant interest groups, may differ, and the overall effect of enforcement will depend on demographic factors as well. For example, a state with a high poverty rate may feel less pressure from wealthy drivers who are concerned they will be involved in accidents with uninsured drivers, but the state could also find it more difficult to collect fines and penalties from poorer uninsured drivers.

2.3.3 Concentration of Insurance Providers

Complying with the requirements of an insurance database law is costly for insurance companies, but these costs are not necessarily equally spread among all competitors. The fixed cost associated with setting up technology to provide the required information to the database puts smaller insurers at a disadvantage, as they must spread the fixed costs across fewer policies.[10] To investigate the influence of insurers in lobbying for or against these laws, I construct a Herfindahl Index (HHI) as a measure of the market share held by the top insurers in each state. I predict that states with market

[10]States have acknowledged the regulatory burden that these laws may place on especially small insurers, and often include an exemption for insurers that write fewer that 500 policies in the state. However, this exemption limits the effectiveness of the database laws, as an incomplete database provides a less reliable tool for police to confidently access to determine a driver's current insurance status.

share concentrated among a handful of insurers will be more likely to pass a database law. The few large insurers will find the costs of implementation less burdensome than their smaller competitors, and may expect to capture a large number of new policyholders who obtain insurance in response to the database law.

2.3.3.1 Insurer Concentration - Herfindahl Index

I measure the relative level of competition among insurers in each state by measuring the HHI and market share at the state-year level.[11]

$$HHI(10)_{sy} = \sum_{m=1}^{10} m_{sy}^2 \tag{2.2}$$

Equation 2.2 provides the method of construction for the Herfindahl Index (HHI) values. The measure considers the market share m of the top 10 insurers in state s in year y.[12] I calculate this measure for HHI(10), which represents the concentration the top 10 insurers in the state. The values of the HHI range between 0 and 1, with 0 representing perfect competition, and 1 representing monopoly. While the market share is also measured directly as the sum of the top 4 or top 10 insurers' market share in the state, the HHI measure provides more information on how the market share is spread *among* those top insurers.[13]

[11] While constructing a true HHI measure would require market share information for all competitors in the state, I construct an HHI measure for the top 10 insurers, which consistently make up more than 80% of the market in each state year.

[12] The market share takes a value of $0 \leq m \leq 1$ where a value of .25 represents a company holding 25% of written premiums in the state in year y.

[13] For example, if the top 4 insurers each held 20% market share in a state, we would expect them to behave differently than a state where the top insurer held 77% market share, with the other 3 top insurers each holding 1%.

2.3.4 Regional Diffusion Theory

While the specific characteristics of a state may influence legislative priorities, states may also be affected by the actions of other states. As laid out by Walker (1969), Regional Diffusion Theory would argue that the behavior of neighboring states in passing these laws would explain the decision of other states to follow suit.[14] This could apply for one of two reasons. First, states may feel pressure from their constituents and interest groups to introduce a law which has been implemented in nearby states, in order to avoid the appearance of falling-behind or not actively addressing any perceived issues with uninsured driving. Second, while states are not currently able to immediately access a database of insured drivers from outside of their particular state, the widespread adoption of such laws could eventually lead to regional cooperatives in which states share information to allow out-of-state law enforcement to access this information in a timely fashion.

2.4 Data

The data for this analysis were aggregated from a variety of sources, and compiled at the state-year level. The National Association of Insurance Commissioners (2017) (NAIC) reports were used for estimation of Equation 2.1, to determine the rate of uninsured driving in each state. These reports also provided data on state-specific factors including average insurance premiums. Specifics of database law implementation dates were derived from a combination of data from the Property Casualty

[14]For a similar application, see Hageman and Robb (2011) who provide an example demonstrating that states exhibit a sort of herding behavior by adopting anti-passive investment company laws more often when other states within their particular Bureau of Economic Analysis region have adopted the laws.

Insurers Association of America (PCI) and Verisk Solutions (2015). I include data on the market share of auto insurance companies in each state and year. These data measure market share by the amount of written premiums for the top 10 insurers, and are derived from the NAIC's annual 'Market Share Reports for Property/Casualty Groups and Companies' spanning 2004-2014. Data on the number of licensed drivers are from the Federal Highway Administration, the National Center for Statistics and Analysis (2017) provides data on annual miles driven, and the US Census provides additional demographic data.

2.4.1 Summary Statistics

The data for this paper span an 11 year period of observation, including 49 states and the District of Columbia.[15] During this time, a total of 13 states implemented a database law, in addition to three states which had laws in place before 2004.

Summary statistics for variables of interest are presented in Table 2.2. An estimated average of 15.96% of drivers were uninsured across the 11 years in my sample data set. Market share for the top four insurers, as measured by total written premiums for each company by state, ranged from a low of 38.8% in 2004 Connecticut to over 76% in 2015 Alaska. For the HHI measure, a score of 1 would represent a monopoly, while scores approaching 0 represent highly competitive markets. HHI(10) scores range from a low of 0.06 in the competitive market in 2007 Maine to over 0.18 in the less competitive 2009 District of Columbia market.

[15]The data set excludes Texas, as data on bodily injury and uninsured motorist claims frequency were not available.

2.5 Empirical Methodology

2.5.1 Estimating Contributing Factors

I estimate the impact of the various factors discussed above on a state implementing a database law using Ordinary Least Squares estimation as seen in Equation 2.3.

$$Database_{st} = \beta_0 + \beta_1 HHI_{st} + \beta_2 PropUM_{st} + \mathbf{X}\beta_3 + \epsilon_{st} \tag{2.3}$$

This equation evaluates the relative impact of the proportion of uninsured motorists in a state "*PropUM*", the level of competition in the state's insurance market "*HHI*", the state's willingness to enforce its uninsured motorist laws through large fines for non-compliance "*Fine*", and a variety of other controls on a state's likelihood of implementing an insurance database law.[16]

2.6 Results

Table 2.3 provides the results of the above analysis. After controlling for several likely factors, there remains a small significant impact of the rate of uninsured driving on a state implementing a database law. In fact, a state with more uninsured drivers is less likely to implement such a law. This supports the hypothesis that states with already low rates of uninsured driving implement the database law as one additional tool to keep those rates low.

The results also demonstrate that market concentration of insurers may play a role

[16]Similarly, I replace the HHI variable with Market Share(4), to test the effect of the concentration of the top four insurers in each market.

in states' legislative decisions to implement a database law. In fact, the more concentrated the market is, the less likely the state will be to implement a database law.

Interestingly, while the presence of No Fault laws are significantly and positively correlated with database laws, there is no significant correlation between a state having a "No Pay, No Play" law and a database law.

2.6.1 Diffusion Theory

State specific factors play a role in the state passing a database law, but neighboring states' actions seem to play a role as well. Following Utah's implementation of the first database law in 1995, 14 states implemented their own laws over the following 20 years. Nine of the 14 states, over 64%, shared at least one border with a state that had a database law in place at the time. Figure 1.8.2 demonstrates how these states eventually stretched from coast to coast, but rarely in a state that is separated from other states that had tested the law first. This trend continued after the sample period, with the laws spreading to the northeast for the first time, and four of the five states implementing the law between 2015-2017 bordering a state that had already passed a database law. This provides some initial support for the idea that states are influenced to pass laws similar to those adopted by their geographic neighbors.

2.7 Conclusion

This paper evaluates the factors which lead states to implement a law aimed at reducing the amount of uninsured driving in the state. Specifically, I focus on the

role that market concentration and uninsured motorist rates play in this decision. I find that states with high rates of uninsured driving are not the most likely to implement a law requiring a database of insured drivers. Instead, the database law is more likely to be enacted in states that already have lower-than-average proportions of uninsured motorists.

To an extent, market concentration in the auto insurance industry also plays a role. I construct a Herfindahl Index and determine that states in which most policies are sold by a few large insurers are less likely to pass a database law. These insurers may be better organized and able to lobby against the laws which would force additional costs of compliance upon them.

Finally, I investigate the applicability of Regional Diffusion Theory in explaining why states implement these laws. This theory would suggest that states feel more pressure to implement the law when their neighboring states have the law in place. I find some initial support for this theory, with almost two-thirds of new state database laws by 2014 being passed in states which border at least one state that had already adopted the law.

2.8 Tables and Figures

2.8.1 Tables

Table 2.1: Online Verification and Book of Business Implementation Dates

State	Implementation Year	Online Verification	Book of Business
UT	1995		X
NE	1999		X
MO	2000		X
SC[a]	2004	X	X
KS	2005		X
CA[a]	2006	X	
KY	2006		X
OK	2006		X
WY	2006	X	X
TX[b]	2008	X	
NV	2009		X
OK	2009	X	
MI	2012		X
MT	2012	X	X
AL	2013	X	X
UT[c]	2013	X	
WV	2013	X	X
CT	2015	X	X
RI	2015		X
LA	2016	X	X
MS	2017	X	
TN	2017	X	

Note: My sample contains data for 2004 - 2014. The three states in dark gray had laws in place spanning the entire sample period, while the five states in light gray did not implement OLV or BOB laws until after the sample period.

[a] South Carolina and California allow for voluntary participation of insurers in the Online Verification program.

[b] Texas is excluded from all analysis, as the data necessary to calculate the proportion of uninsured motorists are not available.

[c] Utah's 2013 law introduced Online Verification requirements which updated the 'Insure-Rite' Book of Business program that had made Utah a pioneer in auto insurance enforcement programs in 1995.

Table 2.2: Summary Statistics

	Descriptive Statistics			
	Mean (Std Dev)	Min	Max	Source
Uninsured Motorist Rate	15.96 (5.79)	3.16	35.86	NAIC Database Reports
HHI(10)	.102 (.0242)	.0556	.1861	NAIC Market Share Reports
Market Share (4)	.5466 (.0674)	.3882	.7675	NAIC Market Share Reports
Fatalities	671.44 (654.98)	15	4333	FARS
Total Crash Per Mil. Driver	32195.84 (9249.25)	9249.25	59143.54	Annual State Crash Facts
Fatal Crash Per Mil. Driver	178.499 (70.77)	44.89	432.74	Annual State Crash Facts
Fine (in $s)	653.50 (794.29)	0.00	5000.00	CFA Report
Average Premium (in $s)	783.89 (175.51)	503.00	1263.67	NAIC Database Reports
No Pay, No Play	0.20 (0.40)	0	1	IRC
No Fault	0.24 (0.43)	0	1	IRC
Urban	72.89 (15.07)	38.20	100	Census, CPS Data
Poverty	13.14 (3.50)	5.40	25.75	Census, CPS Data
N	550			

Note: Summary statistics cover yearly observations for 50 states from 2004-2014. Uninsured Motorist Rate is the estimated number of drivers with no insurance per 100 drivers. HHI and Market Share are calculated based on the total written premiums of the top 4 and 10 insurers per state and year. Fatalities and Total Crashes are annual measurements at the state level. Fine is measured as the maximum fine for a first offense of driving without insurance. Average Premium is measured as the average amount paid for a policyholder to purchase one year of insurance coverage in the state. No Pay, No Play and No Fault are indicators equal to 1 when a state has the respective law in place. Urban measures the proportion of a state's population living in an urban area, and Poverty represents the proportion of a state's population living below the poverty line.

Table 2.3: Effect of Market Concentration and Uninsured Motorist Rate on Database Law

	MS4	HHI10
Market Share / HHI	-0.00371*	-0.919
	(0.00220)	(0.642)
Prop Uninsured	-0.00682***	-0.00694***
	(0.00234)	(0.00233)
Average Premium	4.51e-06	4.50e-06
	(9.61e-05)	(9.70e-05)
Fine	-0.0662***	-0.0678***
	(0.0194)	(0.0194)
No Pay, No Play	-0.0245	-0.0246
	(0.0292)	(0.0294)
No Fault	0.115***	0.107***
	(0.0373)	(0.0373)
Urban	0.00588***	0.00537***
	(0.00446)	(0.00173)
Poverty	0.00588	0.00616
	(0.00446)	(0.00468)
Constant	-0.0763	-0.0191***
	(0.0853)	(0.0751)
Observations	491	491
R^2	0.117	0.115

Robust standard errors in parentheses

Dependent Variable Presence of Database. 50 states, 2004-2014.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Chapter 3

Sunsetting Yourself Up for Success: A Model of Legislative Usage of Sunset Provisions

3.1 Introduction

This paper investigates alternative motivations for the use of sunset provisions[1], which are a legislative tool used to enact a law that will cease to exist at some finite time in the future, unless renewed. Modern usage of the sunset provision is widely attributed[2] to University of Chicago political theorist Theodore J. Lowi who proposed the general idea of sunsetting in his 1969 book *The End of Liberalism.* Lowi proposed these provisions as a way to motivate the continual review of government bureaucracies, by

[1]I borrow the definition of a sunset provision from Kysar (2016), who defines 'sunset provision' "to mean 'those clauses that cause legislation to expire by its own terms.' This definition is derived from *Black's Law Dictionary* which defines a 'sunset law' as a 'statute under which a governmental agency or program automatically terminates at the end of a fixed period unless it is formally renewed.'"

[2]See Mooney (2004).

forcing the legislature to vote every five to 10 years to reauthorize the agencies, or else they would disappear. Thus, one explanation for the use of sunset provisions is to force the review of laws, or agencies created by those laws, in order to weed out any that are no longer functioning properly.[3,4] However, this is not the only application of sunset provisions which has been observed.

A second argument has portrayed the use of sunset provisions as a valuable tool for enacting legislation when the effects of the law are not fully known, but there is some urgency to have a law in place. For example, the USA PATRIOT Act, enacted shortly after the attacks of September 11, 2001, was originally set to expire on December 31, 2005.[5] The use of a sunset provision allows legislators to "test" a policy, with less fear that inefficient policies will become entrenched when the transactions costs associated with passing new legislation to remove them become greater than the costs of inefficiency associated with the law staying in place.

In this paper, I contend that a third motivation exists for including a sunset provision in legislation. It is possible that there is no uncertainty as to the effect of a law, yet a bill may still pass with the inclusion of a sunset provision. I argue that the usage of sunset provisions is not necessarily based on a concern that bad legislation will persist indefinitely, nor because of an urgency for a law to be enacted without proper time for review and consideration, but rather is motivated by a strategic game in which legislators use limits on the lifetime of the law as a concession in order to build a winning coalition for the legislation. For example, if Congress were attempting to pass a ban on assault weapons, the bill's proposer could include a sunset provision

[3]Davis (1981) points out that the burden of proof is thus in proving that a program or agency remains effective in order to avoid being disbanded. The author notes that the requirements for this proof are often ill-defined.

[4]Adams and Sherman (1978) go so far as to refer to sunset legislation as "one of the most significant public management issues of the 1970's".

[5]See Fahrenthold (2012).

when doing so were a viable way of swaying enough marginal voters to gain a winning coalition for the legislation.

While sunset provisions are a potentially useful tool for passing legislation, limiting the duration of a policy will not always be the least costly avenue for a bill author to obtain a winning coalition. In one case, a bill may gain a winning coalition without ever having to concede a limited time of enactment for the law. This is likely achieved by adjusting the content of the bill itself, rather than the duration of its enactment. In other cases, even limiting a law to an extremely short duration may not be enough to obtain a majority. I focus on the cases between these two scenarios, where the use of sunsets may be a necessary and sufficient bargaining tool.

Figure B.1 demonstrates the increased usage of sunset provisions as a legislative tool in one area of legislative purview; the tax code.[6] This figure paints a clear picture of the increased impact of sunset provisions after the turn of the century. It is not clear whether provisions are being used for a larger number of bills, for only those bills with a more significant impact, or both. In this paper, I offer one explanation of why legislators are relying more heavily on sunset provisions as a legislative tool in recent decades.

A *Washington Post* article, Fahrenthold (2012), quotes Senator Dianne Feinstein as an example of how legislators can be enticed by sunset provisions:

[6]Note: The example of the increased usage of sunset provisions as a tool in the tax code is not necessarily representative of the overall level of usage across different types of legislation. However, anecdotal evidence does point towards increased use in many areas, as evidenced in the examples given throughout this paper.

> ...tax cuts approved under President George W. Bush in 2001 and 2003. These originally carried a sunset date in 2010. That provision was added so the cuts could pass with a simple majority while also calming many lawmakers worried about the deficit. **"This bill contains sunset provisions - critical to my decision to support this legislation - which will allow us to revisit the components of this bill in the future."** [Emphasis Added] Sen. Dianne Feinstein (D-Calif.) told her colleagues back in 2001.

The suggestion that a sunset provision would "allow us to revisit the components of the bill" supports the idea that bill reconsideration is otherwise a costly endeavor. By requiring legislators to revisit legislation at some prescribed time in the future, a sunset provides a prolonged form of agenda-setting in which current legislators can force issues to be reconsidered when the sunset period arrives.

I evaluate the decision of whether to include a sunset provision based on each party's expectation of maintaining or regaining control of the legislature in the following period. I suggest several methods of estimating these probabilities, and discuss the resulting effect on the likelihood of sunset provision use under a varied set of conditions. I predict that sunset provisions will be used more frequently when control of the legislature is more volatile, or when the size of the legislative majority is slim.

3.2 Literature Review

The field of public choice has focused on many aspects of the legislative bargaining and decision making process. In "Public Choice and Legislation," Tollison (1988) provides an overview and more specifically discusses the value to interest groups of

long-lasting (or "durable") laws. Maltzman and Shipan (2008) examine how soon and how often laws are revisited and amended after their initial implementation, finding that divided government and differences in ideological beliefs between the upper and lower legislative branches influence the likelihood of amending a law.[7] Likewise, Landes and Posner (1975) argue that an independent judiciary extends the durability of laws. These findings help explain why the cost of revisiting and ending a law mean that the vast majority of laws are not immediately overturned when another party gains a majority. The authors also discuss a second cause of legislation's durability, namely the rules and structure of the legislature itself. I address this idea from a different angle. I focus directly on the concept that explicitly limiting a law's duration serves as a bargaining chip in gaining a consensus for the passage of that law.

The increased use of sunset provisions has not gone unnoticed by other disciplines as well. Much of the focus has centered around two areas; whether permanent or temporary legislation should be the default choice in prudent lawmaking, and the impact of sunsets when applied to budgetary and tax policies.

A debate exists in the literature over whether or not sunset provisions should be the default type of legislation. Gersen (2006) argues, first, that this type of legislation has been used quite prevalently in the United States since the nation was founded.[8]

[7]Maltzman and Shipan acknowledge that sunset provisions "are likely to be caused by the same factors that also determine legislative durability." They account for sunset provisions in their analysis specifically because sunset provisions could be aimed at increasing the probability of laws being significantly revised in some future period. However they do not explicitly consider the use of sunsets as purely a legislative bargaining tool.

[8]Thomas Jefferson was a strong proponent limiting the duration of all laws to a generation. Jefferson (1789) argues in his letters to James Madison: "*On similar ground it may be proved that no society can make a perpetual constitution, or even a perpetual law. The earth belongs always to the living generation. They may manage it then, and what proceeds from it, as they please, during their usufruct. They are masters too of their own persons, and consequently may govern them as they please. But persons and property make the sum of the objects of government. The constitution and the laws of their predecessors extinguished then in their natural course with those who gave them being.*" Jefferson's idea of generational sovereignty would entail that even constitutions would be limited in duration, so as not to give the current generation undue power of their successors.

Gersen then makes the case that "within certain well-specified policy domains, temporary legislation should be embraced as the rule rather eschewed even as an exception." However, Gersen's focus is on whether temporary or permanent legislation should be the default choice, rather than specifically focusing on the legislator's marginal decision of whether to include a sunset provision as a bargaining tool. For the purposes of my model, I assume that laws are initially written as permanent legislation, with the choice being made of whether to include a sunset (and of what duration).

Kysar (2016) argues that sunset provisions are not ideal, as applied to tax policies, as they "reduce the reliability of revenue estimates and [create] substantial obstacles to the re-enactment of certain budget rules." Kysar also argues that the proponents of sunset provisions fail to acknowledge the additional opportunities for rent-seeking created by more frequent deadlines and discussions of legislation.[9]

In addition to the costs and benefits associated with a law's durability, studies have even examined the impact of sunset provision use on legislative attitudes.[10] Rather than attempting to settle the debate on the overall benefits or costs to society introduced by sunset provisions, I instead contribute to the literature by focusing specifically on the political decision of when to utilize a sunset provision to obtain a winning coalition in support of a piece of legislation.

[9]Kysar (2011) argues for a tendency towards lasting legislation, noting "temporary legislation increases rents from interest groups, entrenches current majoritarian preferences, and produces planning conundrums for public and private actors alike."

[10]For example, Lyons and Freeman (1984) found that introducing sunset legislation in Tennessee led to more understanding and cooperation, as well as an increased tendency toward other forms of oversight, for both the legislators and agency officials. Hamm and Robertson (2006) look at U.S. states and finds that states with low levels of legislative professionalism and little oversight tend to be the first to use sunset provisions.

3.3 Model

The model constructed in this paper examines how the use of sunset provisions in legislation enables proponents of a bill to build a winning coalition. The model considers whether or not a sunset provision is included in a piece of legislation and, if so, the amount of time before the sunset occurs. A 2-party model is considered, with several possibilities for informing the legislators' expectations of when the legislative majority will change to the other party's control. This expectation impacts the choice of members of the opposing party as to whether or not to support the bill. The model considers adding a sunset provision as a form of concession to entice additional legislators to support the proposed legislation.

3.3.1 Assumptions

Several simplifying assumptions are made in the creation of this model. These assumptions may be relaxed, with varying degrees of significance in changing outcomes. The assumptions include the following:

- Members of the legislature belong to one of two parties.
- The majority party consists of a simple majority of legislative members. A coinflip decides the majority in the case of a tie. Alternatively, one could assume an odd number of legislators, although this would not necessarily prevent ties if the two-party assumption were relaxed.
- All legislation is initially written as "permanent" legislation, which if enacted will remain in effect indefinitely.
- No amendments are permitted to the content ("quality") of the proposed legis-

lation; however

- A sunset provision, limiting a law's effective duration to length of time "t", may be added to the legislation; t $\in [0, \infty]$
  - Note: A sunset of infinite length is equivalent to no sunset provision being included
- Enacted legislation containing a sunset provision may be reconsidered before the scheduled sunset at a cost, C_{recon} on the proposer of the reconsideration.

3.3.2 Model

A randomly chosen member of the minority party proposes a law with a specified level of content, q. The legislator attempts to maximize his utility by garnering enough votes to pass this legislation, which must be achieved by acquiring votes from the opposing party in order to reach a simple majority. The content, q, of the bill is assumed to be held fixed, but votes can be won by limiting the time during which the proposed law will be in effect.

The proposing legislator maximizes the following equation:

$$\mathcal{L}_R(T) = q_R^{\alpha} T^{1-\alpha} + \lambda(N_D - N_T) \tag{3.1}$$

Where:

$$N_D = \frac{q_D}{T(1-\delta)} \tag{3.2}$$

- $T \equiv$ the duration of the proposed law before sunset
- $q_R \equiv$ the "quality" or value of the content of the bill for a Republican legislator.

- $q_D \equiv$ the "quality" or value of the content of the bill for a Democratic legislator.
- $N_D \equiv$ the number of votes received from Democrats in favor of the bill.
- $N_T \equiv$ the threshold number of Democratic voters required, in order for the bill to receive a majority of votes in favor.
- $\delta \equiv$ the expected probability that Democrats remain in power.
- $(1-\delta) \equiv$ the expected probability that Republicans transition into power.

In Equation 3.2, legislators in the minority party, one of whom proposes the legislation, attempt to maximize their utility by passing a law. The legislator of the proposing party prefers a longer duration, T, of the law, and values the fixed content of the law at q_R. $N_D - N_T$ represents the difference between the threshold number of votes needed from the other party in order to obtain a majority, (N_T), and the actual number of votes in favor of the legislation received from the other party (N_D). When this difference is equal to zero, the bill receives the minimum number of votes needed to pass.

3.3.2.1 Comparative Statics

With "quality" (q) treated as an exogenous variable which has already been determined, the proposing legislator attempts to adjust T to limit the duration of the bill only as is necessary to garner a majority of votes for the bill.

$$\frac{\delta \mathcal{L}_R}{\delta T} = (1-\alpha) q_R^{\alpha} T^{-\alpha} + (-1) \frac{\lambda q_D}{T^2(1-\delta)} = 0 \tag{3.3}$$

which simplifies[11] to:

$$T^{2-\alpha} = \frac{\lambda q_D}{(1-\alpha)(1-\delta)q_R^{\alpha}} \tag{3.4}$$

where $0 \leq \alpha \leq 1$; $0 \leq \delta \leq 1$; $0 \leq q_D$; and $0 \leq q_R$.

Analyzing Equation 3.4, it can be seen that a longer duration for the law's effectiveness, T, will be chosen when the majority (non-proposing) party finds more value in the "quality", q_D, of the legislation. Because the opposing party appreciates the bill more, less of a concession in duration is necessary in order to win their vote. Similarly, when the proposing party values the quality of the bill, q_R, more highly, the optimal duration will be shorter, as the proposing party is more willing to limit the duration of the law to ensure its passage.

In addition, α can be thought of as the relative weight the legislator places on the quality of the bill, as compared to the weight placed on the law's duration. As the relative weight on quality is higher, bills are expected to sunset more quickly.

Lastly, the $(1-\delta)$ term represents the likelihood that the minority party, which is proposing the legislation, will retake power. The higher the expected likelihood that power will transition, the shorter will be the optimal duration before a law's sunset. There are several methods by which the variable, δ, may be endogenously determined. These methods are discussed in the following section.

[11] See Appendix for full derivation

3.3.3 Estimating Probability of Transition

If Democrats are the current majority party in the legislature, there is some probability, δ that they maintain that majority, with $(1-\delta)$ representing the probability that the majority transitions to the Republicans.

$$\delta \equiv Pr(Maj_{t+1} = D | Maj_t = D) \tag{3.5}$$

$$(1-\delta) \equiv Pr(Maj_{t+1} = R | Maj_t = D) \tag{3.6}$$

Similarly, if Republicans hold the majority, the probability of transition may differ.

$$\rho \equiv Pr(Maj_{t+1} = R | Maj_t = R) \tag{3.7}$$

$$(1-\rho) \equiv Pr(Maj_{t+1} = D | Maj_t = R) \tag{3.8}$$

I consider a variety of ways in which legislators may consider the current makeup of the legislature, as well as historical trends, in order to estimate δ and ρ.

Table 3.1 provides historical data on how often this transition has occurred in the U.S. House of Representatives. With elections held for all legislators every two years, there have been 81 elections, with power transitioning 18 times. On average, Democrats have maintained majority power longer, lasting between 1 and 20 sessions before losing power, with an average of 5 sessions before Republicans took over. When

Republicans have held power, they have maintained it for 1 to 8 sessions, with an average of 4.

3.3.3.1 Historical Average

One method of estimating the probability of transition is to assume that the probability of transition for the party currently in power is equal to the sum of the number of periods for which the party lost power after an election, divided by the total number of times the party was in power. Table 3.2 provides this estimate for the probability of the legislative majority switching power, based on the current state.

$$(\rho) \equiv \frac{\text{\# Elections Republicans Maintained Majority}}{\text{Total \# of Elections while Republicans were in Majority Power}} \tag{3.9}$$

For this estimate, I assume that representatives view the likelihood of a switch next period simply as the average likelihood of their party regaining power between 1858-2018.[12] Figure 3.1 displays the probability of switching based on these assumptions, as presented in a Markov chain.

As more periods are observed, these estimates are updated each period with the new average likelihood of transition. For each estimate, all periods are weighted equally, no matter how recent.

This estimate assumes that there is an equal chance of transition in each period, no matter the size of the majority, and without taking any other relevant information into account.

[12]Data on party control of congress were compiled using vital statistics provided by the U.S.House (House) of Representatives website, house.gov.

3.3.3.2 Size of Majority

It is likely that a legislature in which there is a slim majority will have a different probability of transition than a legislature with in which one party has a large majority.[13] Table 3.3 provides a slightly more complex example of how legislators may predict when the majority party will next transition. This table estimates the probability of transition based on historical trends of transition while also taking into account the size of the majority.

Under this estimation method, the probability of a transition is, in part, a function of the size of the majority. A simple functional form could involve taking the difference in the number of seats held by the majority party and those of the minority party, while more complex functions could be assumed which allow for larger majorities to imply a greater likelihood of transition. Under the first assumption, this estimation method predicts that the majority party is more likely to stay in power when the majority is larger. Under the second set of assumptions, a larger majority could indicate a the likelihood of some negative shock for the majority party, which could affect a large number of elections and make transition of power more likely.

3.3.4 Cost of Proposal

A sunset provision would not be useful if there were no cost associated with introducing legislation to end a law that is currently in place. In this model, legislators are

[13]In this paper, I use data for the U.S. House of Representatives, for which all members face elections every two years. Thus, it is always possible for a transition in the majority party to occur during any election. If the model is extended to include legislative bodies which operate in a different manner, such as the U.S. Senate, it should be realized that there may be periods where no transition is possible during one election. For these bodies, a simple historical average probability of transition may be less informative.

policy motivated, and must consider the cost of re-introducing a bill before the sunset period, which could include time spent researching and debating the legislation, as well as any loss of political capital spent in the renegotiation process.[14]

If the bill fails to pass, legislators have endured the costs of introducing and debating the bill, but do not receive any of the benefits associated with the bill's passage. Thus, there is a strong incentive for all players to work towards finding a version of the bill that will pass, using the available mechanism of sunset provision duration adjustments.

3.3.5 Players and Preferences

The players in this model consist of N legislators representing two political parties, D and R. Each legislator has preferences over a proposed law which are determined by the content of the law as well as the duration. These preferences stretch along a uni-dimensional policy space. For instance, if a bill is proposed by a member of the majority party, Legislator$_i$ will take into account her preference for the content of the bill, which will typically be stronger for members of the same party than for those of the opposing party, and also whether the bill creates the law indefinitely or only for a limited time. Thus, members are policy motivated. They are concerned with which laws will be in place, both now and in the future, but they do not derive additional utility from holding the office themselves.

[14]I have explicitly chosen not to allow the cost of bringing up legislation early to vary with the length of time before the sunset period ends. This is to allow these costs to be thought of as the opportunity costs of a legislator's limited time to consider proposals in each period. The benefits, however, of reintroducing a bill before its scheduled sunset will vary with the amount of time remaining.

3.3.6 Timing

1. A member of the legislature's minority party is randomly chosen to propose a bill.
2. The content of the bill, measured as "quality", is determined.
3. The legislator chooses whether to add a sunset provision of duration "t" periods to the bill.
4. Legislators vote their true preferences for or against the bill.
5. If the bill passes, the policy is enacted for the specified time period.
6. In the sunset period, if applicable, the bill is reconsidered by the legislature at cost $C_{rec} < C$, or the policy is allowed to end at 0 additional cost.

3.3.7 The Economic Model

The legislators in this model cast a vote for or against proposed legislation in order to maximize their individual utility. A legislator may be convinced to vote for a law for two reasons. First, if the legislator's preferred policy is relatively close to the proposed policy, the legislator will derive positive utility from the passage of the legislation, and will accrue more utility the longer the law is expected to remain in effect. For a legislator whose preferred policy is farther from the proposed policy (perhaps she is in the minority party), the legislator prefers a more imminent sunset period for the legislation, to force its reconsideration in the near future. However, each legislator hopes to strategically set the sunset period during a time in which she believes her party will have gained the majority, so that the amendment or repeal of the law will lead to a policy which is closer to her ideal point.

3.3.8 The Political Model

The political model involves building a coalition of legislators in order to obtain a simple majority in favor of the proposer's legislation. Legislators are policy motivated, and do not directly derive any utility explicitly from holding office. Legislators are elected to the legislative body through elections in their districts, and declare affiliations to one of the two parties. The results of these elections each period determine which party has a legislative majority in that period.

3.3.9 Equilibrium

The model presented here predicts when legislators use sunset provisions as a form of concession to opponents, in order to build a coalition for their legislation. The proposer offers a sunset provision of a duration just short enough to incentivize a sufficient number of marginal voters to cast their votes in favor of the legislation, in order to gain a majority. If a majority can be obtained without offering a sunset provision, then $t = \infty$, with no sunset included. The utility maximizing duration of t is chosen based on the estimates of ρ or δ[15], the probability of majority control transitioning to the other party.

3.4 Implications

The model predicts that sunset provisions will be used more often, and the length of time before sunset will be shorter, when a transition in political power is more

[15]When Republicans hold majority power, ρ estimates the probability of transition, while δ is the measure when Democrats currently hold the majority.

likely. The legislator proposing the legislation finds this concession to be necessary in order to appeal to just enough legislators until a majority coalition is obtained. Additionally, the predicted length of time before the sunset is longer as the majority party controls a larger percentage of the legislative body.

While the size of majority is a predictive factor in the use and duration of sunset provisions, the direction of the effect is uncertain. A large majority does not necessarily entail a smaller probability of a transition in majority power. For example, "wave elections" in which there is sharp shift ushering in many new officials could occur more commonly when there is a large majority. On the other hand, wave elections could take place with the minority party gaining a large number of seats in the next election, but still failing to capture a majority.[16] The result is an uncertain effect of majority size on sunset provision duration.

For example, if legislators consider the size of the current majority as an indicator of the likelihood of party control switching, then the Democratic Party holding a two-member majority in the U.S. House may lead to a relatively high expectation of Republicans taking transitioning into power. Furthermore, if the historical average number of seats gained or lost in each election were relatively high (say on average a 150 seat swing out of the 435 contested seats in an election), then the probability of the majority party losing power is increased.[17] Under this scenario, the shorter sunsets would be used to pass less durable laws. This is the case for two reasons.

[16]Trende (2018) discusses each of these possibilities. "In a way, the concept of a wave is irrelevant. Years like 1954, where Democrats barely gained seats but still flipped the House, are probably more consequential than a major wave year like 1922, where Democrats gained over 70 seats but failed to capture the chamber."

[17]There are two ways to consider the "relative" amount of seats gained or lost. First, one could compare the number of seats gained or lost in some number of recent elections (perhaps the past 5 elections), versus the historical average. Second, one could consider the percentage of seats gained or lost in comparison to elections of other bodies, whether comparing the U.S. House to the U.S. Senate, to state legislatures, or to some other comparable body.

The first is that the proposing party prefers to pass a bill, but finds it less costly for the bill to sunset when the party is likely to have gained a majority, because there would then be an easier path towards extending the law or adjusting the content. The second is that the majority party knows that if it is able to maintain power, or regain power before the bill sunsets, it will be less costly to endure the law for a short period of time and then choose from one of two possibilities. The majority party could let the legislation die without bringing it back up for debate, or introduce a new or amended version of the bill that better suits the policy preferences of that party. Each of these options is available under the assumption that it is more costly to reconsider a bill before the sunset period has elapsed.

As the makeup of the legislative body and amount of volatility in maintaining a majority tends to move in a cyclical pattern over time, I would not expect the use of sunset provisions to continue increasing at the current pace. Instead, the use would be expected to follow similar cycles, based on the variables of interest outlined above.

3.5 Empirical Tests

Tests of this model's predictions are possible by observing particular features of legislatures. When a legislature has a high probability of transitioning to a new majority party, the model predicts more and shorter sunset provisions to be used. Additionally, observing the size of a majority should provide information to assist in predicting when a sunset is likely to be used.

3.5.0.1 Stop-Gap Measures

One important empirical test which is not well defined in my model is how often a sunset provision is set to expire before the next election takes place. This type of stop-gap measure may serve to limit the cost associated with failing to pass legislation, such as avoiding sequester by passing a budget with a three month sunset. However, my model of parties switching majority control does not allow for predictions of this type of sunset usage, as majority control will typically only change following an election. Stop-Gap measures likely fall under the other reasons for using sunset legislation discussed in Section 3.2, which are not the main focus of this paper.

3.5.0.2 Realistic Assumptions

For this paper, I have assumed that a sunset provision required that the law would be stricken from the books, with nothing to take its place. However, it merits further consideration of the predictions of this model when a different outcome is used. For instance, when sunset provisions are used in legislation enacting a yearly budget, failing to renew the legislation when time elapses will generally lead to the continuation of some previous year's budget (potentially a version with adjusted levels of spending), rather than no budget at all. That is to say, the expiration of the law could entail a return to something other than the previous status-quo.

For simplicity, I have only considered a unicameral legislature. Clearly, this does not take into account the necessity of bills in the U.S. Congress to also be passed by the other chamber, as well as signed by the President. I have also limited any additional discussion in judicial oversight in prolonging or ending the effects of legislation.

Lastly, future research will focus on not only when sunset provisions are initially

included, but how often they are extended, and for what length of time. The model presented in this paper does not fully address the decisions being made during the sunset period. This is partially due to the fact that the model excludes the possibility of amendments to the legislation, but the sunset period is a prime opportunity to apply changes to the law in order to update it to align with current preferences. The length of any sunset extensions could also be considered, based on updated predictions of when majority power would be transferred.

3.5.1 Relaxing Assumptions

To what degree does the model presented in this paper represent a simplified but accurate depiction of legislative bodies? As mentioned above, the assumption of a unicameral legislature vastly simplifies the interactions between the House, Senate, and Executive branch which are necessary in order to enact legislation.

Additionally, as mentioned in the Assumptions section, we do not observe a simple two-party breakdown in Congress. However, relaxing this assumption to allow for additional parties should not have a significant impact on the predictions of this model.

The assumption concerning an inability to amend legislation does not accurately reflect most legislative processes observed in the United States. Relaxing this assumption would dampen the effects predicted in this model. However, there is some anecdotal evidence that the sunset provision mechanism is not fully overwhelmed by the option to amend the policy content of legislation. If this were the case, we would not expect to see any instances of sunset provisions being used. This is clearly not what we observe in the modern day legislature, even in types of legislation that

are not focused on temporary tax policy. Thus, a more advanced model could be constructed which allows for adjustments in both sunset provision usage as well as amendments to the content of legislation.

3.5.2 Expanding the Model

Additional focus could be placed on estimating the costs of introducing new legislation, or revisiting laws before the sunset period, and revisting laws during the sunset period. For the model, I assume that the cost of revisiting a law is higher than the cost of initial introduction of a bill. The subsequent costs may be higher as laws, programs, and funding become entrenched and valued by those who benefit from them. However, the costs could also arise due to the opportunity cost of time. Not only does a legislator have limited time to craft and propose bills, a legislative body can only feasibly give consideration to a limited number of bills and resolutions each session. The more time that a legislator must commit to speaking for or against a bill, having staff conduct research, and explaining to her constituents her reasoning for votes cast, the less time she has for considering additional issues. Constituents may see repeated consideration of a bill as a "waste of time," and therefore view their representatives as ineffective. There was a fair amount of negative press surrounding the U.S. House of Representatives repeated votes to repeal "Obamacare" (The Affordable Care Act), Walsh (2015), as one example.

An additional cost of frequently requiring the legislature to act on the same legislation is the effect on perceptions of stability and reliability. With less durable laws, long-term planning becomes more difficult, and commitments less tractable, when there is a real and recurring threat to undo or vastly alter laws and regulations. For example,

the implications of the U.S. Congress increasing the country's debt ceiling by small amounts and thus frequently debating whether or not to authorize more increases have been far reaching. The perceived threat of Congress not raising the debt ceiling each time it is reached has created enough uncertainty and instability that rating agency *Standard and Poor's* cited it as a reason for downgrading the United States' credit rating in 2011.[18]

3.6 Future Considerations

Future extensions of this research will focus on additional variables that may play a role in the expected value of limited legislation. One avenue to be explored is the impact of announced retirements on a legislator's willingness to accept shorter or longer sunset duration. Polling data will also be incorporated in two ways. First, to the extent that polling is conducted for an individual law, polling data could provide good insights into popular opinion on the content of legislation. Second, polling on popularity and pre-election polling for incumbent candidates could help predict whether individual legislators expect to be in power during the next period.

3.7 Conclusion

This paper sets forth a third explanation of how and why sunset provisions are included in legislation. While others have argued that sunset provisions are used to test the uncertain effects of legislation, or to provide a less costly check on government bureaucracies, I model the choice of whether to include a sunset provision as motivated

[18]See James et al. (2011) article for ABC News.

by a strategic game. In this game, legislators use limits on the lifetime of the law as a concession in order to build a winning coalition for the legislation. The model predicts that sunsets will be used more often, with less time before the law expires, when there is a higher probability of majority party transition. Additionally, sunsets will be used more often when there is more volatility in legislative majorities.

3.8 Tables and Figures

3.8.1 Tables

Table 3.1: Historical Majority Party Transitions - U.S. House of Representatives

Election Year	Congress	Democrats	Republicans	Other	TOTAL Representatives	Democratic Gain/Loss	Republican Gain/Loss	Rep Take Control	Sessions before Switch
1858	36	83	116	39	238	-49	26	1	**1**
1874	44	182	103	8	293	94	-96	0	**8**
1880	47	128	151	14	293	-13	19	1	**3**
1882	48	196	117	12	325	68	-34	0	**1**
1888	51	152	179	1	332	-15	27	1	**3**
1890	52	238	86	8	332	86	-93	0	**1**
1894	54	93	254	10	357	-125	130	1	**2**
1910	62	230	162	2	394	58	-57	0	**8**
1918	66	192	240	2	435	-22	25	1	**4**
1930	72	216	218	1	435	52	-52	0	**6**
1946	80	188	246	1	435	-56	57	1	**8**
1948	81	263	171	1	435	75	-75	0	**1**
1952	83	213	221	1	435	-22	22	1	**2**
1954	84	232	203	0	435	19	-18	0	**1**
1994	104	204	230	0	435	-54	54	1	**20**
2006	110	233	202	0	435	32	-31	0	**6**
2010	112	193	242	0	435	-64	64	1	**2**
2018	116	235	199	1	435	41	-42	0	**4**

Table 3.2: Estimated Probability Party Majority Next Period

	Prob. Control Next Period		
Current Control	Party	D	R
	D	.80	.20
	R	.25	.75

Note: Based on simple historical average of probability of switching party control, 1858-2018.

Table 3.3: Estimated Probability Party Majority Next Period - Size of Majority

	Prob. Control Next Period		
Current Control	Party	D	R
	D	$(D_{leg} - R_{leg}) * \delta$	$1 - [(D_{leg} - R_{leg}) * \delta]$
	R	$(R_{leg} - D_{leg}) * \rho$	$1 - [(R_{leg} - D_{leg}) * \rho]$

Note: Based on historical size of majority in period before party switches party control, 1858-2018.

3.8.2 Figures

Figure 3.1: Markov Chain of Probability – Switching based on Current Majority

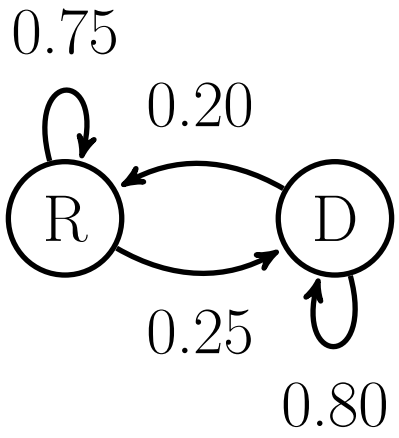
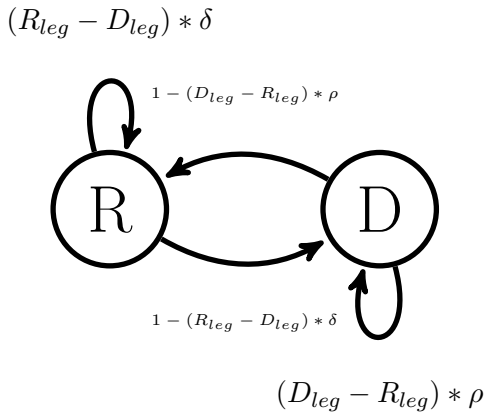


Figure 3.2: Markov Chain of Probability – Switching - Size of Majority



Appendices

Appendix A Ensuring Compliance - Facts, Tables, and Figures

A.1 Insurance Overview

This section provides a brief overview of the types of insurance, as is pertinent to facilitate a discussion of the economic ideas presented in this paper among a general audience.

A.1.1 Insurance Functions

Automobile insurance, like any insurance, is used to protect against loss by pooling risk among a large group. This paper focuses on "uninsured motorists" or "uninsured drivers" because it is the driver who bears the penalty if charged with driving uninsured. However, automobile insurance does not apply specifically to one driver, but rather to a vehicle. That is to say, I am insured to drive my car if I have purchased at least the minimum limits of coverage for it, but this insurance does not apply if I drive your vehicle.

Forty-nine states and Washington D.C. require minimum levels of liability coverages to be purchased in order to qualify as "insured." There are additional coverages that may also be added to a policy, but vehicle owners are not considered uninsured if they forgo them.

A.1.2 Mandatory Coverages

All states, except New Hampshire, require motorists to purchase minimum limits of liability coverages. These consist of bodily injury (BI) and property damage (PD) coverage. Bodily injury liability insurance covers damage an insured driver causes to other people, while property damage liability insurance covers damage an insured driver causes to other people's vehicles or property. These mandatory liability coverages do not insure against bodily harm to the insured driver or damage to the insured driver's vehicle or property.

A.1.3 Optional Coverages

Additional coverage may be purchased in order to insure against damage to an insured driver's vehicle. Collision insurance provides coverage for repair or replacement of the insured driver's own vehicle in the event of an accident where the driver crashes into a car or another object. Comprehensive insurance covers damage to the insured driver's car from events that are not accident related, such as fire, falling objects, hitting deer or other animals, and natural disasters.

A.1.4 Uninsured and Underinsured Motorist Coverages

Drivers have the option to purchase "uninsured motorist coverage" (UM) and "underinsured motorist coverage" (UIM), which will cover damages to themselves and their property that is caused by an uninsured (or underinsured) driver.[19] When an

[19]An "underinsured driver" is a driver who has liability insurance, but has purchased a level of coverage too low to cover all of the damages caused to others when an accident occurs. For this paper, I focus exclusively on uninsured motorists for two reasons. First, underinsured motorists by definition hold at least the minimum amount of liability insurance required by the state. As such, they are not driving illegally in this sense. Second, the data do not contain information allowing for

uninsured driver causes an accident with an insured driver, the insured driver's UM coverage will cover bodily injury and property damages up to the limits of the (insured driver's) policy. However, the insured driver faces the additional burden of paying a deductible, as well as the possibility of damages incurred in excess of the coverage limits.

A.1.5 Relation to This Paper

This paper is focused on whether someone meets the minimum limits of liability coverage as set by the state in which the vehicle is registered. However, other coverages do come into play when discussing other margins of adjustment by drivers who are making the decision not only of whether or not to purchase insurance, but also how much coverage to purchase.

A.2 Equations

Possible Outcomes in Cost of Driving Uninsured:

$$\begin{cases} 0, & \text{if } No\ Accident\ \&\ No\ Violation \\ Fine, & \text{if } Violation\ \&\ No\ Accident \\ Damages, & \text{if } Damages < Wealth\ \&\ Unreported \\ Damages + Fine, & \text{if } Damages < Wealth\ \&\ Violation \\ Wealth, & \text{if } Damages \geq Wealth \end{cases}$$

an estimate which distinguishes underinsured drivers.

A.3 Tables and Figures

A.3.1 Tables

Table A.1: Predicted Effect of Law on Uninsured Driving and Precaution (Fatalities)

	Estimated Effect of Change in Driver Status:	
Driver Status	**Uninsured Proportion of Drivers**	**Fatalities per Driver**
(I_0,I_1)	N/A	N/A
(I_0,U_1)	(+)	(-)
(I_0,N_1)	(+)	N/A
(U_0,I_1)	(-)	(+)
(U_0,U_1)	N/A	(-)
(U_0,N_1)	(-)	(+) or (-)[a]
(N_0,I_1)	(-)	N/A
(N_0,U_1)	(+)	N/A
(N_0,N_1)	N/A	N/A

[a] The expected effect on driver precaution of uninsured drivers who stop driving depends on how dangerous these drivers were, in comparison to the average driver on the road.

Table A.2: Roadway Fatalities By Year

State	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Alabama	996	991	1038	1004	1154	1148	1207	1110	969	848	862	895	865	853	820	849
Alaska	106	89	89	98	101	73	74	82	62	64	56	72	59	51	73	65
Arizona	1036	1051	1132	1118	1151	1179	1293	1071	938	806	759	826	821	849	773	893
Arkansas	652	611	640	640	703	654	665	649	600	596	571	551	560	498	470	531
California	3753	3956	4088	4224	4120	4333	4240	3995	3434	3090	2720	2816	2966	3107	3102	3176
Colorado	681	741	743	642	667	606	535	554	548	465	450	447	474	482	488	546
Connecticut	341	318	325	298	294	278	311	296	302	224	320	221	264	286	248	266
Delaware	123	136	124	142	134	133	148	117	121	116	101	99	114	99	124	126
DC	48	68	47	67	43	48	37	44	34	29	24	27	15	20	23	23
Florida	2999	3012	3136	3169	3244	3518	3357	3213	2980	2560	2444	2400	2431	2403	2494	2939
Georgia	1541	1647	1524	1603	1634	1729	1693	1641	1495	1292	1247	1226	1192	1180	1164	1430
Hawaii	132	140	119	133	142	140	161	138	107	109	113	100	125	102	95	94
Idaho	276	259	264	293	260	275	267	252	232	226	209	167	184	214	186	216
Illinois	1418	1414	1420	1454	1355	1363	1254	1248	1043	911	927	918	956	991	924	998
Indiana	886	909	792	833	947	938	902	898	820	693	754	751	781	784	745	821
Iowa	445	446	405	443	388	450	439	446	412	371	390	360	365	317	322	320
Kansas	461	494	507	469	459	428	468	416	384	386	431	386	405	350	385	355
Kentucky	820	845	915	928	964	985	913	864	825	791	760	720	746	638	672	761
Louisiana	938	952	907	940	927	963	987	993	916	824	721	680	723	703	740	726
Maine	169	192	216	207	194	169	188	183	155	159	161	136	164	144	131	156
Maryland	588	659	661	650	643	614	652	614	591	549	496	485	511	465	442	513
Massachusetts	433	477	459	462	476	441	429	434	364	340	347	374	383	351	354	306
Michigan	1382	1328	1277	1283	1159	1129	1086	1087	980	872	942	889	940	947	901	963
Minnesota	625	568	657	655	567	559	494	510	455	421	411	368	395	387	361	411
Mississippi	949	784	885	872	900	931	911	884	783	700	641	630	582	613	607	677
Missouri	1157	1098	1208	1232	1130	1257	1096	992	960	878	821	786	826	757	766	869
Montana	237	230	269	262	229	251	264	277	229	221	189	209	205	229	192	224
Nebraska	276	246	307	293	254	276	269	256	208	223	190	181	212	211	225	246
Nevada	323	314	381	368	395	427	431	373	324	243	257	246	261	266	291	325
New Hampshire	126	142	127	127	171	166	127	129	138	110	128	90	108	135	95	114
New Jersey	731	745	771	733	723	747	771	724	590	584	556	627	589	542	556	562
New Mexico	432	464	449	439	521	488	484	413	366	361	349	350	366	311	386	298
New York	1460	1564	1530	1493	1495	1434	1454	1332	1238	1158	1201	1171	1180	1202	1041	1121
North Carolina	1557	1530	1576	1553	1573	1547	1554	1676	1428	1313	1320	1230	1299	1290	1284	1379

Table A.2 continued from previous page

North Dakota	86	105	97	105	100	123	111	111	104	140	105	148	170	148	135	131
Ohio	1366	1378	1418	1274	1286	1321	1238	1255	1191	1022	1080	1017	1121	989	1006	1110
Oklahoma	650	682	739	671	774	803	765	766	750	737	668	696	709	678	669	643
Oregon	451	488	436	512	456	487	478	455	416	377	317	331	337	313	357	447
Pennsylvania	1520	1532	1614	1577	1490	1616	1525	1491	1468	1256	1324	1286	1310	1210	1195	1200
Rhode Island	80	81	84	104	83	87	81	69	65	83	67	66	64	65	51	45
South Carolina	1065	1060	1053	969	1046	1094	1045	1077	921	894	809	828	863	767	823	977
South Dakota	173	171	180	203	197	186	191	146	121	131	140	111	133	135	136	133
Tennessee	1307	1251	1177	1193	1339	1270	1284	1211	1043	986	1032	937	1015	995	963	958
Texas	3779	3736	3823	3821	3699	3536	3531	3466	3476	3104	3023	3054	3408	3389	3536	3516
Utah	373	291	328	309	296	282	287	299	276	244	253	243	217	220	256	276
Vermont	76	92	78	69	98	73	87	66	73	74	71	55	77	69	44	57
Virginia	929	935	914	943	922	947	962	1027	825	758	740	764	776	740	703	753
Washington	631	649	658	600	567	649	633	571	521	492	460	454	438	436	462	568
West Virginia	411	376	439	394	410	374	410	432	378	357	315	338	339	332	272	268
Wisconsin	799	763	803	848	792	815	724	756	605	561	572	582	615	543	506	566
Wyoming	152	186	176	165	164	170	195	150	159	134	155	135	123	87	150	145
USA	41945	42196	43005	42884	42836	43510	42708	41259	37423	33883	32999	32479	33782	32893	32744	35092

Appendix B Sunsets - Additional Equations, Tables, and Figures

B.1 Equations

The Legislator proposing a bill attempts to maximize:

$$\frac{\delta \mathcal{L}_R}{\delta T} = (1-\alpha) q_R^{\alpha} T^{-\alpha} + (-1) \frac{\lambda q_D}{T^2(1-\delta)} = 0 \tag{10}$$

Taking first differences provides:

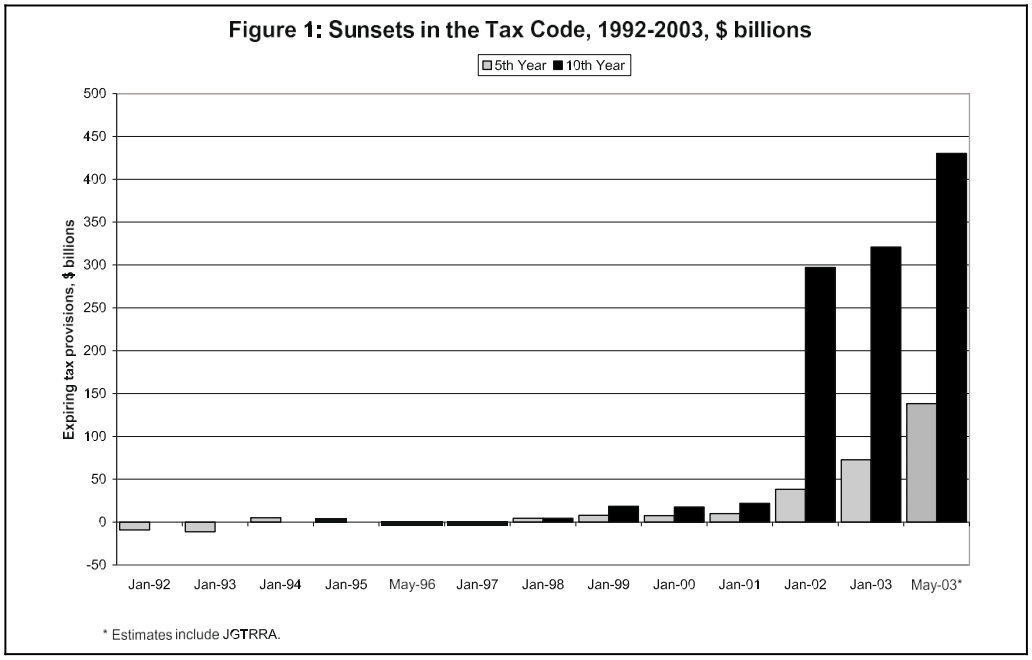
$$(1-\alpha)\frac{q_R^{\alpha}}{T^{\alpha}} = \frac{\lambda q_D}{T^2(1-\delta)} \tag{11a}$$

$$T^{\alpha-2} = \frac{(1-\alpha)(1-\delta)q_R^{\alpha}}{\lambda q_D} \tag{11b}$$

$$T^{2-\alpha} = \frac{\lambda q_D}{(1-\alpha)(1-\delta)q_R^{\alpha}} \tag{11c}$$

B.2 Figures

Figure B.1: Sunsets in Tax Code



*Source: Gale and Orszag (2003).

Figure B.2: Markov Chain of Probability – Switching based on Current Majority - General

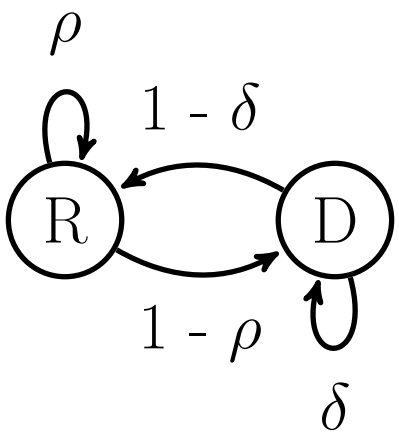
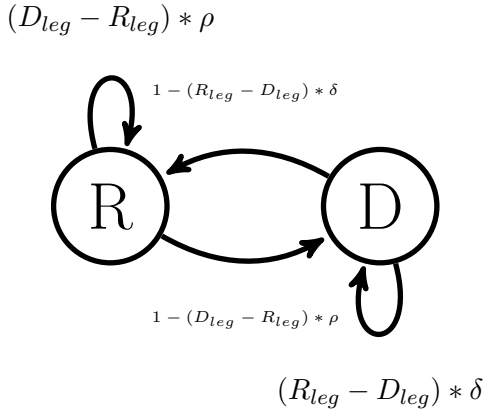


Figure B.3: Markov Chain of Probability – Switching - Size of Majority - General



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